Muskegon Futures:
Steelhead in the Muskegon River

Muskegon Watershed Research Partnership **Volume 8**

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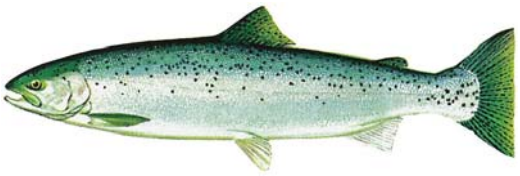
Critical Habitats:



In the Muskegon River, critical habitats for spawning steelhead include holes and riffle areas of tributary creeks and in the main stem channel from Croton Dam to below Newaygo (FIG. 1, pg 2). Spawning females deposit eggs in nests (redds) on gravel/cobble substrates. After incubation and hatch, fry migrate from redds to stream margins to feed, grow, and seek shelter from predators. Steehead fry hatch during late May and live in stream habitats from one to three years before migrating as smolts through Muskegon Lake to Lake Michigan. Juvenile steelhead move away from channel margins as they grow and seek areas of higher flows on gravel bars and pool margins, or near boulders and fallen trees. The presence of abundant groundwater in tributary creeks makes these habitats particularly important for survival of steelhead during their stream phase. Water temperatures in groundwater are much lower (55-60 °F) than surrounding stream temperatures, particularly in the main stem channel where temperatures can rise to stressful levels (71-74 °F) for steelhead during summer.

Natural Reproduction and Early Survival

Steelhead spawn primarily in spring (March-May, peaking in April), although some individuals may spawn anytime during winter. Survival of naturally spawned steelhead is limited in the Muskegon River, and the spawning run is composed of mostly hatchery fish (FIG. 2A, pg 2). Although there is plenty of high quality spawning habitat for steelhead in the main stem channel and hatching success and fry survival are high, survival is quite low during summer of the first year and by fall there are few steelhead present to survive through winter (FIG. 2B, pg 3). We used smolt traps and mark-recapture studies of juveniles and adults to estimate that nearly 10,000 steelhead smolts are naturally produced annually in the Muskegon watershed to enter the fishery in Lake Michigan. This number is low compared to natural reproduction of steelhead in the Little Manistee and Pere Marquette Rivers, which both average about 40,000 smolts/year to enter the lake fishery (FIG. 2C, pg 3). In the Muskegon watershed, nearly all steelhead smolts are produced in tributary creeks such as Bigelow Creek, Cedar Creek, and Mosquito Creek (FIG. 1, pg 2). Survival of young steelhead in the main stem is believed to be limited by stressful high temperatures during summer, which allows abundance of cool and warm water predators such as bass and walleye to inhabit the river and consume available steelhead. In contrast to main stem channel habitats, steelhead young survive well in tributary creeks such as Bigelow Creek, Cedar Creek, and Mosquito Creek.

Size Composition and Growth

Size and growth of adult steelhead in the Muskegon River depend on temperature and forage conditions (principally alewife) in Lake Michigan, as steelhead stop feeding during the spawning migration. Lengths of steelhead in the Muskegon River are comparable in size to steelhead in other Lake Michigan tributaries (FIG. 3A, pg 3). Size and growth of young steelhead are good, and depend on high density of invertebrate prey and suitable temperatures in stream habitats. Steelhead juveniles in the Muskegon River are larger by the end of the first year than steelhead in many other rivers throughout the state of Michigan (FIG. 3B, pg 4).

Movement

Most adult steelhead migrate into the Muskegon River during fall or spring, and then return to Lake Michigan after spawning. Steelhead fry move to stream margins after hatching from the redd, and inhabit deeper waters near stream margins as they grow. In late fall of their first year, they move to overwinter habitat in tributary creeks or hide under logs in the main channel. After their first year nearly half the steelhead juveniles leave the river in May as smolts, with the rest leaving after another year of stream life. As with Chinook smolts, steelhead smolts aggregate in groups and migrate downstream at night to avoid predation. Smolts move quickly through Muskegon Lake and head for deep waters offshore in Lake Michigan. After two or three years in Lake Michigan, steelhead become mature and migrate back to the Muskegon River to spawn. After spawning, nearly half of all adult steelhead from the Muskegon River will survive to spawn again the next year.

Diet and Food Web


Picture Courtesy of UofM

We have examined stomachs of juvenile steelhead collected from both the Muskegon River and its tributaries over several years. Young steelhead eat a variety of macroinvertebrate prey, including midges, scuds, mayfly larvae, and fish eggs. The diet varies by location and season. Juvenile steelhead collected near Croton Dam consume an abundance of water fleas (Daphnia) which inhabit Croton pond and are swept over the dam. In contrast, juveniles collected near Thornapple or Newaygo eat a variety of midges and scuds. Juvenile steelhead also gorge themselves on eggs of adult salmon and steelhead during spawning season. In Bigelow Creek during fall we found salmon eggs made up 90% of the prey in young steelhead stomachs (FIG. 4A, pg 4), in contrast to a diet of mayflies and midges during spring (FIG. 4B, pg 4).

Zebra Mussels May Affect Juvenile Steelhead

We found that introduction of exotic zebra mussels may have affected adult spawning distributions, availability of prey, and foraging success of young steelhead. We compared density of juvenile steelhead, their invertebrate prey abundance, and composition in the diet before and after zebra mussel invasion in 1999. In contrast to pre-mussel conditions, the density of young steelhead fry declined nearest Croton Dam where zebra mussel densities were highest. Densities of large invertebrates also declined after zebra mussel introduction, and were reflected in steelhead diet and growth. After zebra mussel introduction, the diet composition of young steelhead changed from larger to smaller invertebrates, and steelhead growth also declined.

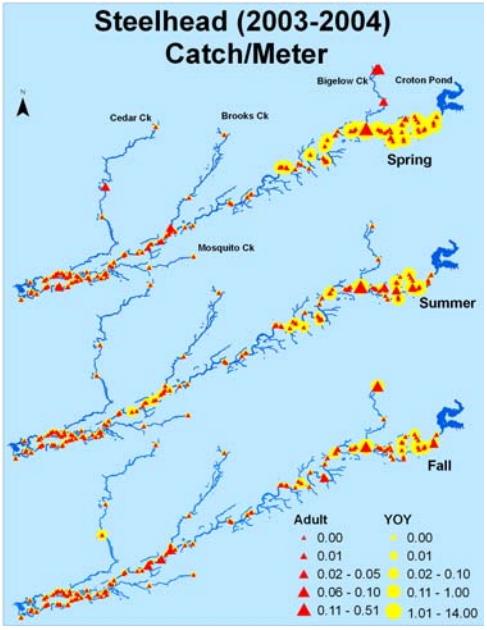


FIGURE 1. Distribution of adult and juvenile Young Of Year (YOY) steelhead in the Muskegon River during spring May-June), summer (July-August), and fall (Sept-October) during 2003 and 2004. Darker colors indicate higher steelhead densities (number per meter).

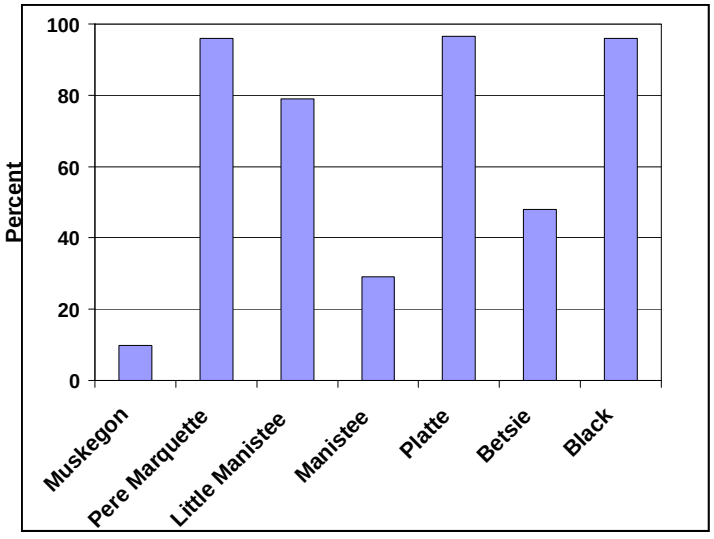


FIGURE 2A. Percentage of spawning run composed of naturally produced adults in Muskegon River and other Lake Michigan tributaries.

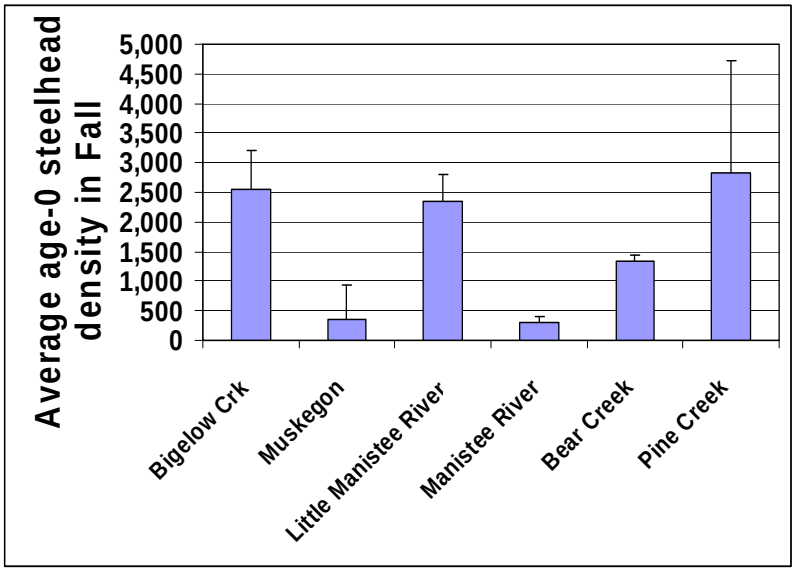


FIGURE 2B. Fall density (number per meter of shoreline) of juvenile steelhead in the Muskegon River main stem, Bigelow Creek, and other tributary creeks and rivers. Error bars represent one standard deviation about mean density.

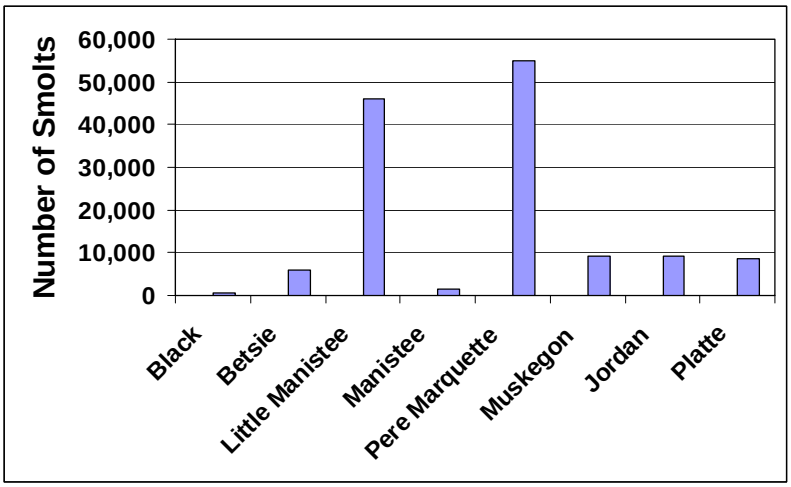


FIGURE 2C. Average number of naturally produced steelhead smolts each year in the Muskegon River Watershed and in other tributaries to Lake Michigan.

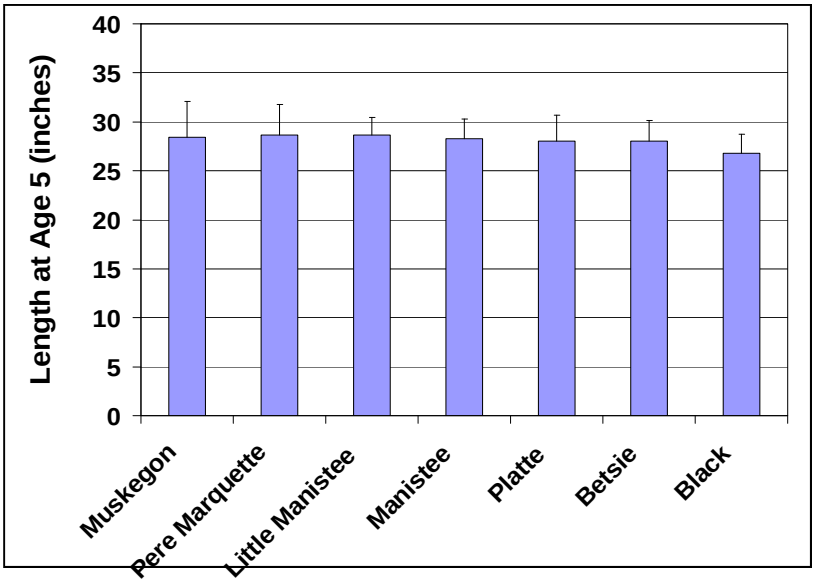


FIGURE 3A. Average length of adult steelhead caught in Muskegon River watershed and in other tributaries to Lake Michigan. Error bars represent 1 standard deviation around mean length.

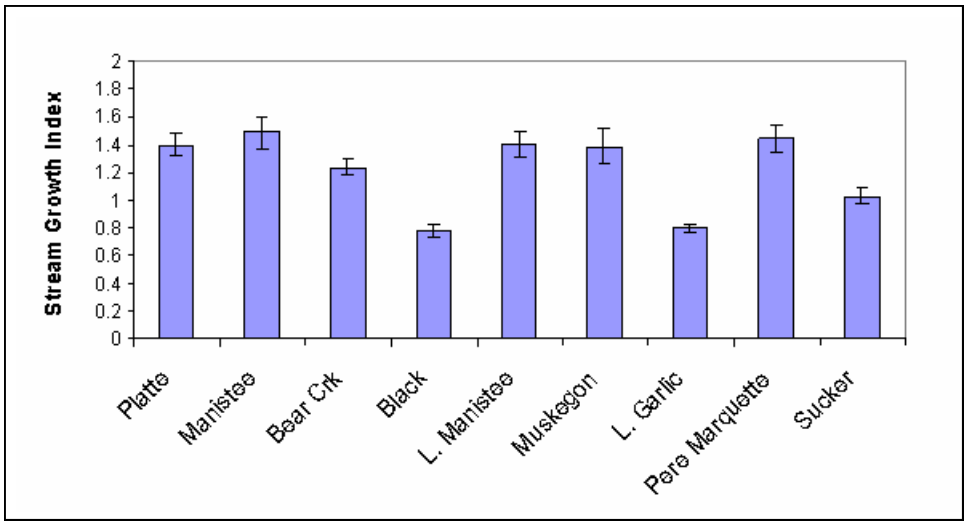


FIGURE 3B. Index of stream growth of juvenile steelhead in the Muskegon River and other Great Lakes tributaries. Bars represent 2 standard deviations around mean growth index

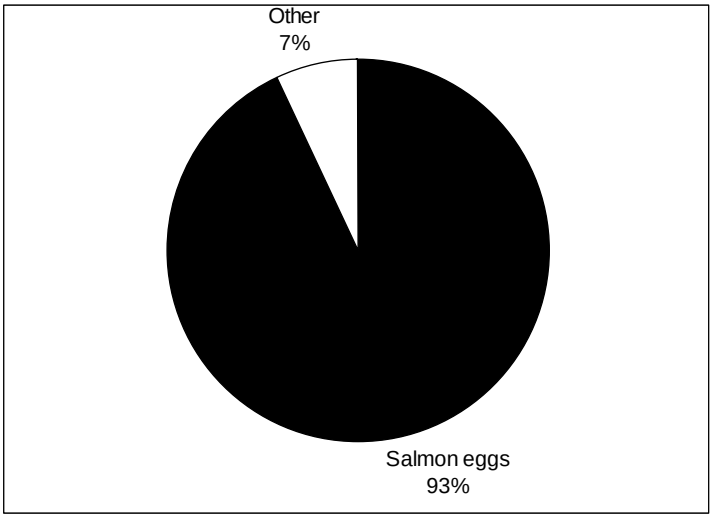


FIGURE 4A. Proportion (of total weight) of juvenile steelhead diets in Bigelow Creek during October 1998. 'Other' category includes midges, caddisflies, and mayflies.

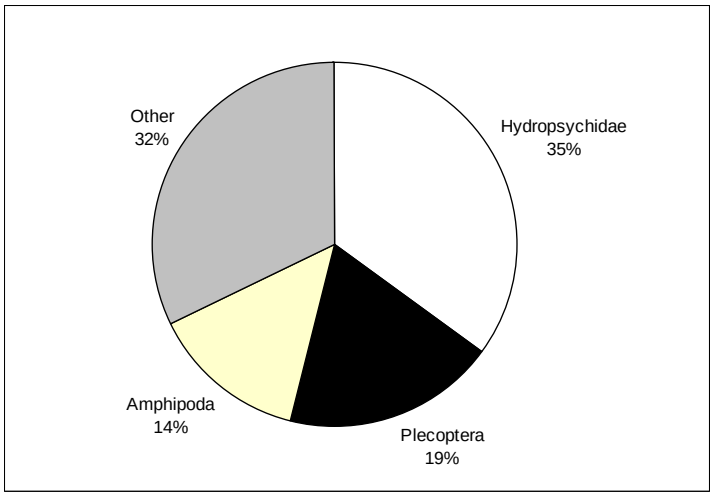


FIGURE 4B. Proportion (of total weight) of juvenile steelhead diets in Bigelow Creek during May, 1999. Food groups are scuds 'Amphipods', caddisflies 'Hydropsychidae'; and stoneflies 'Plecoptera'; Other category includes other species of caddisflies mayflies, midges, and dragonfly and damselfly larvae.