



# Muskegon Futures: Fisheries Overview on Chinook Salmon in the Muskegon River

Muskegon Watershed Research Partnership

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## Critical Habitats

Adult Chinook salmon use holes and riffle habitats in tributary creeks and in the main stem area of Muskegon River from Croton to below Newaygo (FIG. 1). 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. Juvenile steelhead move away from channel margins as they grow, and seek areas of higher flows on gravel bars and margins of pools, or near boulders and fallen trees. Chinook parr prefer shore-line areas with riparian cover and woody debris in tributary creeks and along the margins of the main stem channel. After smolting, Chinook inhabit nearshore areas of Muskegon Lake and near-shore Lake Michigan before migrating offshore to deep water in late summer.

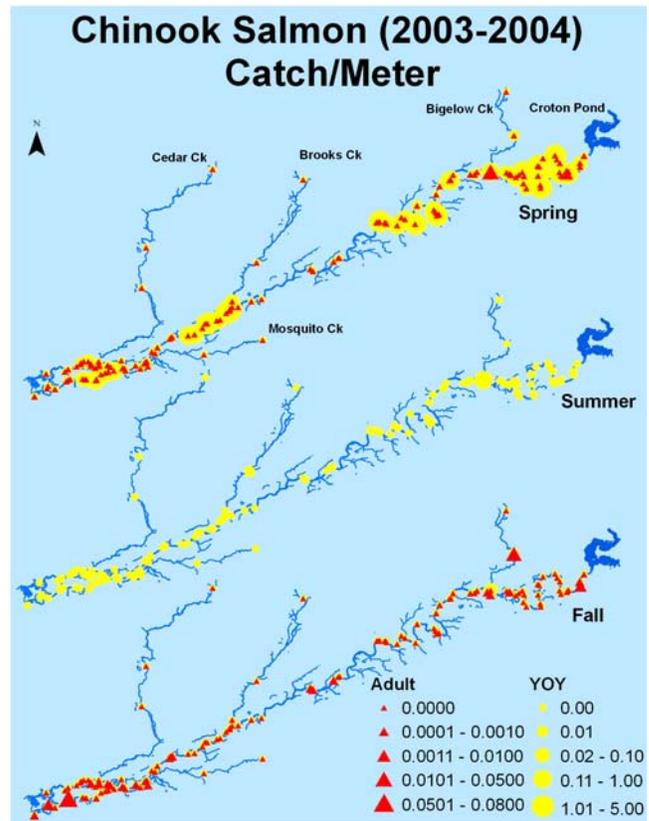


FIGURE 1. Distribution and relative abundance of Chinook salmon adults and juveniles (YOY) in the lower Muskegon River watershed during 2003 and 2004. Seasons are Spring (May-June), summer (July-August), and Fall (September-October).

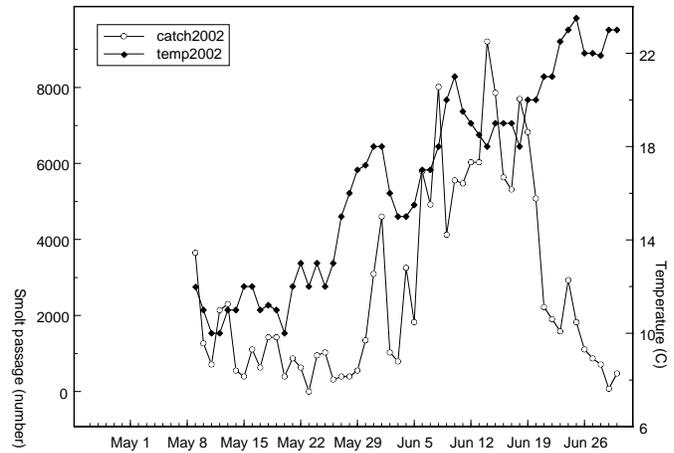
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## Natural Reproduction, Survival in Early Life, and Recruitment to the Fishery

Chinook salmon adults migrate into the Muskegon River to spawn in fall. The spawning run typically begins in late August, peaks in mid-September or early October, and finishes by November. Eggs develop from fall to late February, then hatch into alevins which remain in the redd. Chinook fry hatch from the redd in mid March, and grow rapidly from 1 inch to 3.5 or 4 inches, at which point they migrate downstream to Lake Michigan from mid May through June (FIG. 2A).

Natural reproduction of Chinook salmon in the Muskegon River is exceptional! It is better than in any other tributary to Lake Michigan, and second only to Chinook reproduction in the Salmon River tributary to Lake Ontario. We estimated the numbers of Chinook parr in the nursery area from Croton to Newaygo over several years using electrofishing, traps, and analysis of tagged and untagged spawners that were stocked or spawned in the river as smolts. Although reproductive success of salmon varies quite widely from year to year, the average numbers of Chinook smolts produced in the Muskegon watershed = 226,000 smolts. Smolt production in the Muskegon is higher than in the Manistee River (170,000 smolts), the Little Manistee River (60,000 smolts), or the Pere Marquette River (102,000 smolts).



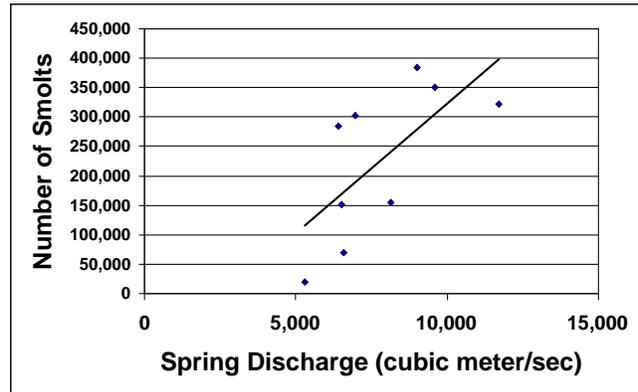
**FIGURE 2A. Water temperature ( $^{\circ}$  Celsius) and catch of Chinook salmon smolts in screw trap (below) in lower Muskegon River during May and June, 2002.**



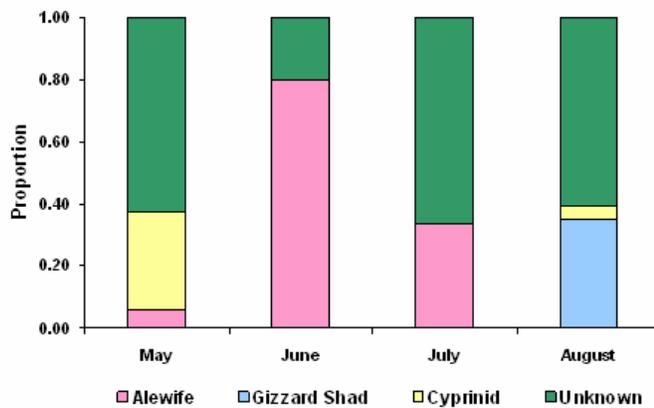
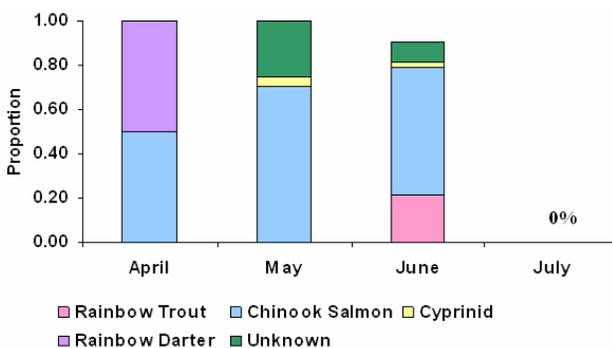
**Natural Reproduction, Survival in Early Life, and Recruitment to the Fishery** (continued)

Fish recruitment is defined as the number of young fish that will enter the fishery. For Chinook, recruitment can vary nearly 6-fold from year to year. We found that river flows during the hatching and nursery period greatly affect survival of Chinook parr (FIG. 2B). High river flows during early life increase the amount of habitat available to Chinook parr, providing more food, and enhancing emigration of smolts downstream compared to low river flows. The other factor affecting Chinook salmon reproductive success is consumption by stocked walleye and brown trout of Chinook parr. We have found large numbers of Chinook parr in stomachs of walleye (FIG. 3A) and brown trout during April and May. The numbers of Chinook parr eaten by both predators depends heavily on stocking numbers of brown trout. Brown trout prefer to eat small Chinook parr, so more brown trout stocked means more Chinook parr eaten. However, walleye consumption of Chinook parr varies inversely with numbers of stocked brown and rainbow trout, since walleye prefer to eat the larger trout. When fewer trout are stocked, more Chinook parr are eaten by walleye.

In contrast to high mortality in Muskegon River, it appears that fewer smolts are eaten in Muskegon Lake (FIG. 3B). We have only found a few Chinook salmon smolts in predator stomachs in Muskegon Lake. Apparently the abundance of larger soft-rayed prey such as alewives serves to protect Chinook salmon smolts from predation by walleye and other large predators.



**FIGURE 2B.** Annual recruitment (numbers of smolts) in the Muskegon River varies with river flow during the period from hatch (mid-March) through the stream resident phase (end of June).



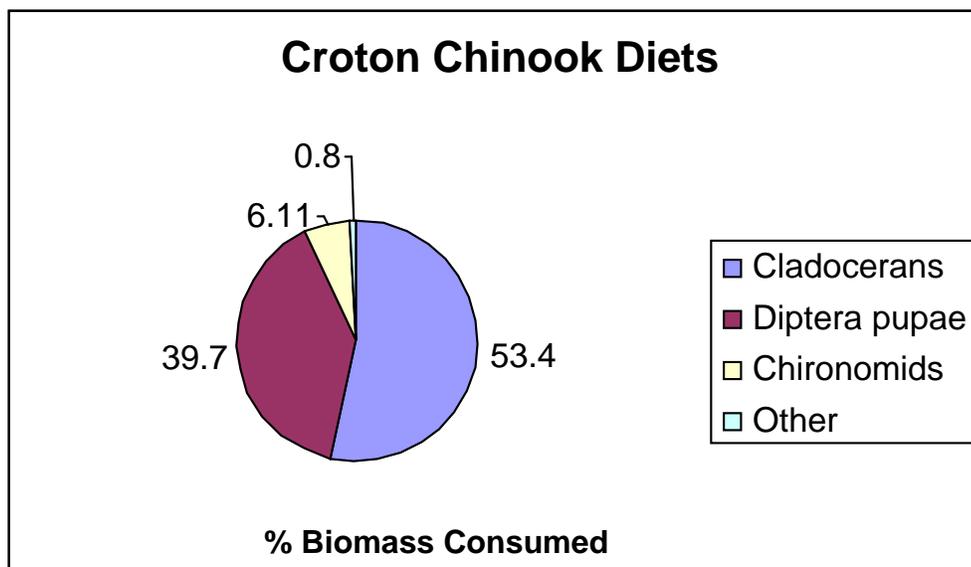
**FIGURE 3A.** Diet of walleye in Muskegon River, 2005. No walleye examined had food in July.

**FIGURE 3B.** Diet of walleye in Muskegon Lake, 2005.

## Size, Composition, Diet and Growth

Size and growth of adult salmon in the Muskegon River depend on conditions in Lake Michigan, as adults stop feeding during their spawning migration. Sizes of adults vary annually depending on abundance of available forage, principally alewife.

Growth of young salmon in Muskegon River is good, and depends on adequate water flows, high densities of invertebrate prey and suitable temperatures. We have examined stomachs of juvenile steelhead and salmon collected from both Muskegon River and its tributaries over several years. Chinook juveniles eat invertebrate prey, including water fleas, midges, scuds, and mayfly larvae. The diet varies by location and season. Juvenile salmon collected near Croton Dam consume an abundance of water fleas (*Daphnia*, FIG 4) which inhabit Croton pond and are swept over the dam. In contrast, juveniles collected near Thornapple boat launch or Newaygo eat a variety of midges and scuds.



**FIGURE 4. Diet of juvenile Chinook salmon collected below Croton dam, 2003. Diet composition includes water fleas (cladocerans), midge larvae (chironomids) and other flies (Diptera).**

## Movement

Nearly all adult Chinook salmon migrate in fall from Lake Michigan through Muskegon Lake to spawn in tributary creeks and the main stem area between Croton and Newaygo. Spawning movements are stimulated primarily by high river flows. All adult salmon die after spawning. Young Chinook fry move to stream margins after hatching from the redd. As they grow through the parr stage, Chinook juveniles move increasingly further from stream margins and out of creeks to the main stem river. After reaching a length of 3-4 inches, Chinook parr change coloration from vertical bars (parr stage) to a shiny silver color (smolt stage), and aggregate in schools before migrating downstream at night to Muskegon Lake and then to Lake Michigan, where they inhabit nearshore areas before gradually moving offshore in late summer and fall. The smolts migration is cued primarily by temperature.