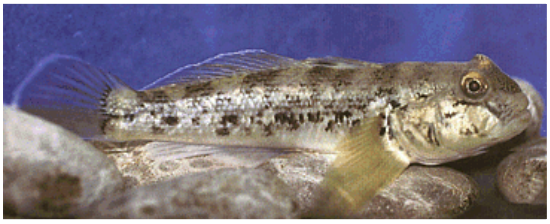
**Lake Huron's New Ecosystem and Foodweb**
**Spring 2007**

The ecosystem of Lake Huron has undergone fundamental change since about 1992. By the late 1990s these changes were manifested in the quality and character of the lake's valuable recreational and commercial fisheries. The ecosystem changes were driven (principally) by 5 evidently permanent changes in the foodweb:

1. Colonization by new invasive species: Zebra and quagga mussels have trapped much of the lake's productivity into mussel colony "sinks" on the lake bottom, where high biomass has accumulated that is not efficiently channeled to the rest of the food chain. Mussel colonies appear to have caused productivity to shift from plankton in the water column to the "benthic zone", which is to say the bottom of the lake, particularly in the shallow bays and nearshore areas of the lake. Production in the offshore waters known as the "pelagic zone", where alewives and salmon once were dominant, is now only a fraction of levels prior to 2003.

**Zebra mussels are trapping nutrients on the bottom of Lake Huron.**

2. The mussel invasion paved the way for another invader, the round goby, a bottom oriented fish that evolved with zebra and quagga mussels in Europe. The round goby feeds on small mussels and invertebrates associated with mussel colonies. Round gobies reached the Great Lakes through ballast water discharges of salt water vessels.



**The round goby is another invader, specially adapted to living with mussel colonies**

3. Biologists are alarmed at the decline and near disappearance of a crustacean called Diporeia. This shrimp-like animal feeds on plankton that settles to the bottom. Diporeia migrate off the bottom at night making them available as prey for such fish as alewives and whitefish. Diporeia thus acted as a mechanism for recycling settled nutrients back to the midwater foodchain, enhancing production of alewives and Chinook salmon. Although the mechanism for the collapse of Diporeia is not clear, their demise came closely on the heels of the zebra and quagga mussel invasions.

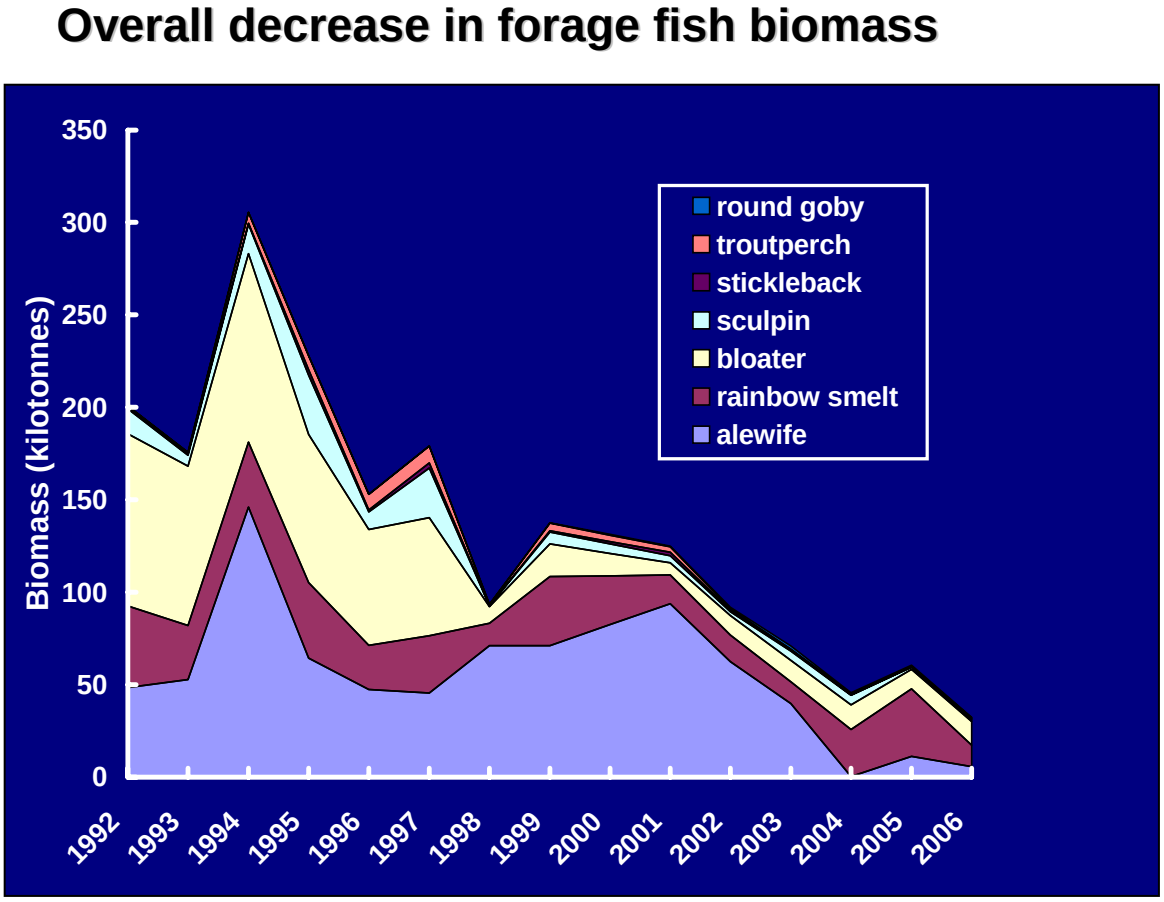
**Diporeia – victim of invasive species?**

More recently, the Environmental Protection Agency noticed a sharp decline in abundance of other planktonic foods preferred by alewives. Plankton abundance since 2003 in the offshore waters of Lake Huron has recently been described as similar to that of Lake Superior. This represents a distinct reduction in offshore food resources for pelagic prey fish like alewives.

4. Reproduction of Chinook salmon rose sharply after 1992. Approximately 80% of Lake Huron's Chinooks born in 2000, 2001, 2002, and 2003 were wild. Survival of hatchery Chinooks declined sharply as reproduction rose. Thus, most Chinooks caught from Lake Huron in recent years are wild. Most Chinook reproduction is in Ontario's tributaries to Georgian Bay and North Channel.

Consequently, as Chinooks mature they tend to leave Michigan waters in late summer to spawn in their natal streams in Ontario.

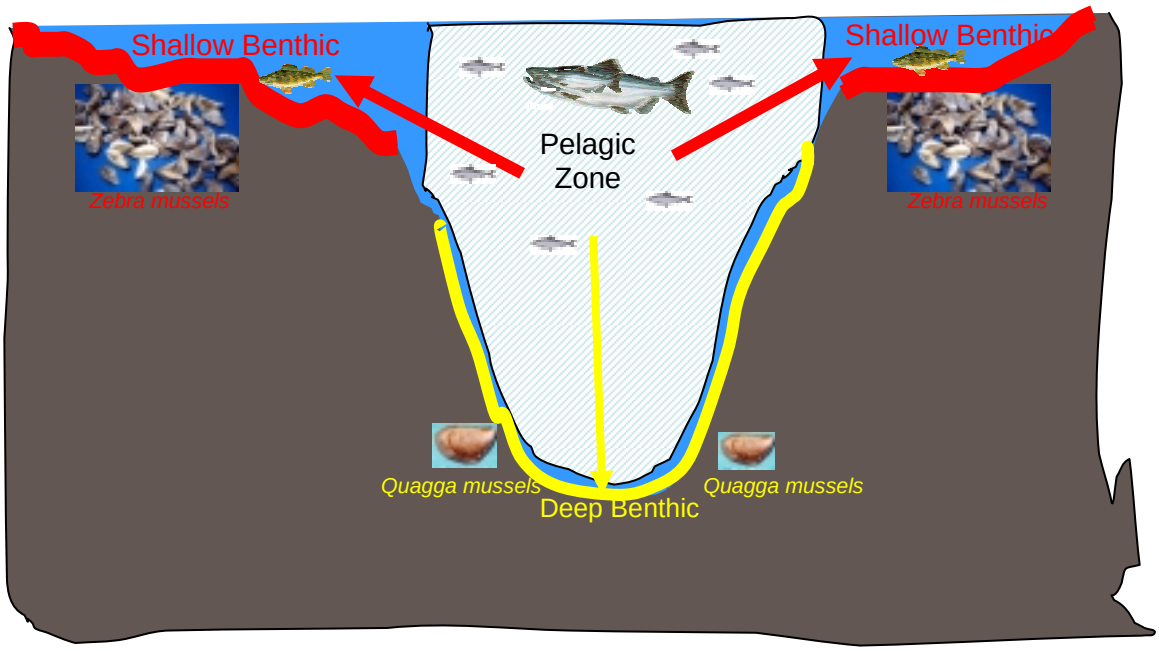
5. As a result of the above factors, alewives, which had been the chief prey of Chinook salmon in the 1990s, have nearly disappeared. And so did most other prey fish species. Alewives were caught in a squeeze between lower availability of nutrients caused by the mussel colony "nutrient trap" and elevated predation rates caused by reproduction of Chinook salmon.



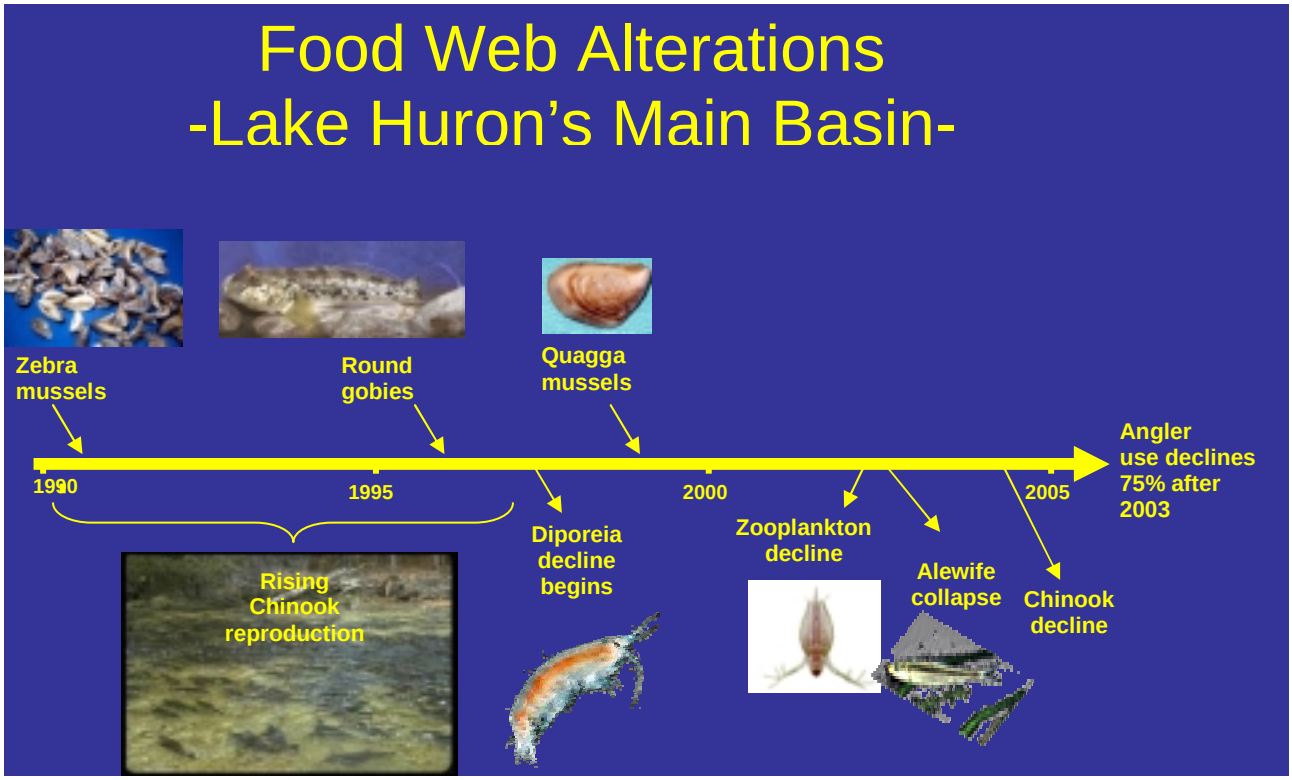

**Trends in prey fish biomass, Lake Huron. Caught between the effects of zebra and quagga mussels and rising predation rates, alewives collapsed.** ***Courtesy of United States Geological Survey, Great Lakes Science Center.***

There were other factors involved. For example, harsh winters probably contributed to the alewife decline. Lake trout are surviving better as a result of more effective sea lamprey control and increased protection of lake trout from commercial fishing caused by the 2000 Consent Decree with Treaty of 1836 tribes. Thus, predation rates from lake trout have also risen. However, these are the leading factors that precipitated the changes anglers are now witnessing.

# Lake Zones




**Production zones. Production in Lake Huron has shifted from the pelagic zone, where alewives and Chinooks once predominated, to the benthic zone. Near-shore benthic production is represented in red and is where both zebra and quagga mussels have proliferated. Deep-benthic production, represented with yellow, is where quagga mussel are now abundant.**




**Time line representing the sequence of major changes to Lake Huron's foodweb caused principally by invasive species.**

**The new ecosystem:**

Change is never welcome especially when people are happy with the status quo. Until 2003, Chinook salmon success rates (fish harvested per angler day) on Lake Huron were highest of Michigan's Great Lakes. Now, with the near disappearance of alewives, we are seeing the following new conditions:

1. **Chinook recreational harvest** (Figure 1) declined precipitously after 2003. Harvest of Chinook salmon in 2005 and 2006 was only about one seventh the long term average. With prospects for Chinook so low, fishing pressure at major Chinook fishing ports declined 75% (Figure 2), with serious economic consequences to tackle shops and other elements of the recreational fishing industry. The decline in Chinook harvest has cost 10 major Lake Huron Chinook salmon fishing ports in Michigan approximately $19 million per year in lost economic activity since 2004.

2. **Chinook condition** (plumpness) is the lowest ever measured in Great Lakes salmon. And three-year-old salmon that once averaged over 15 pounds weighed only 8.1 pounds in 2004 (Figure 3). Most Chinook salmon observed since 2003 had empty stomachs. Some fish were visibly emaciated. It appears lack of food caused the population to decline; thus leading to the sharp drop in Chinook harvest from 2004 through 2006.

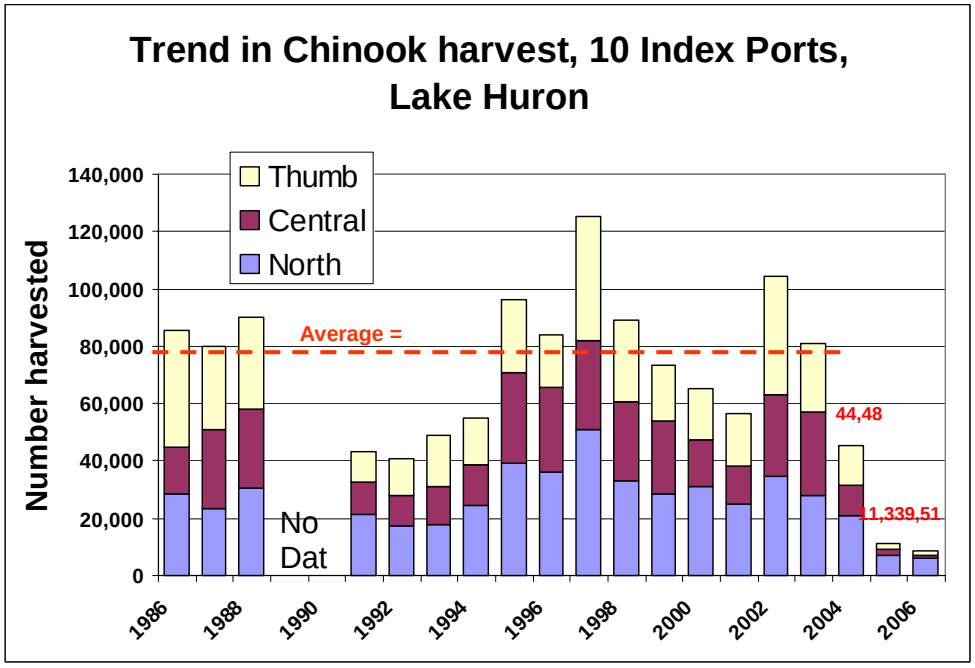



**Figure 1. Trends in Chinook harvest at 10 Main Basin index ports. Lake Huron. Harvest in 2005 and 2006 was only one seventh of the long-term average.**

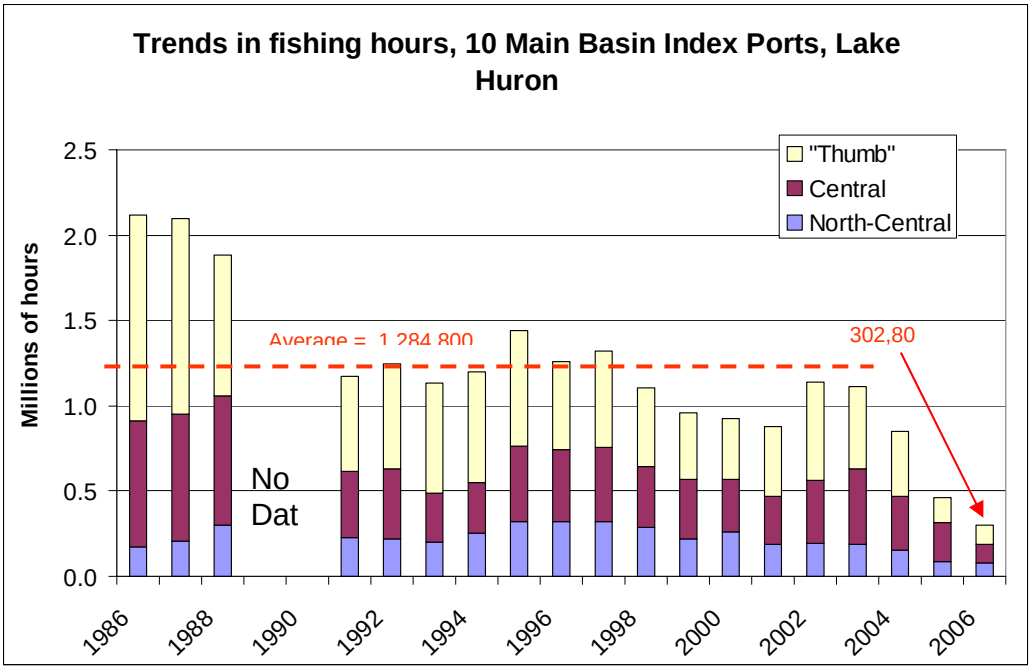



**Figure 2. Trends in hours of fishing at the 10 index ports, Main Basin of Lake Huron. Fishing pressure declined by 75% from 2003-2006.**

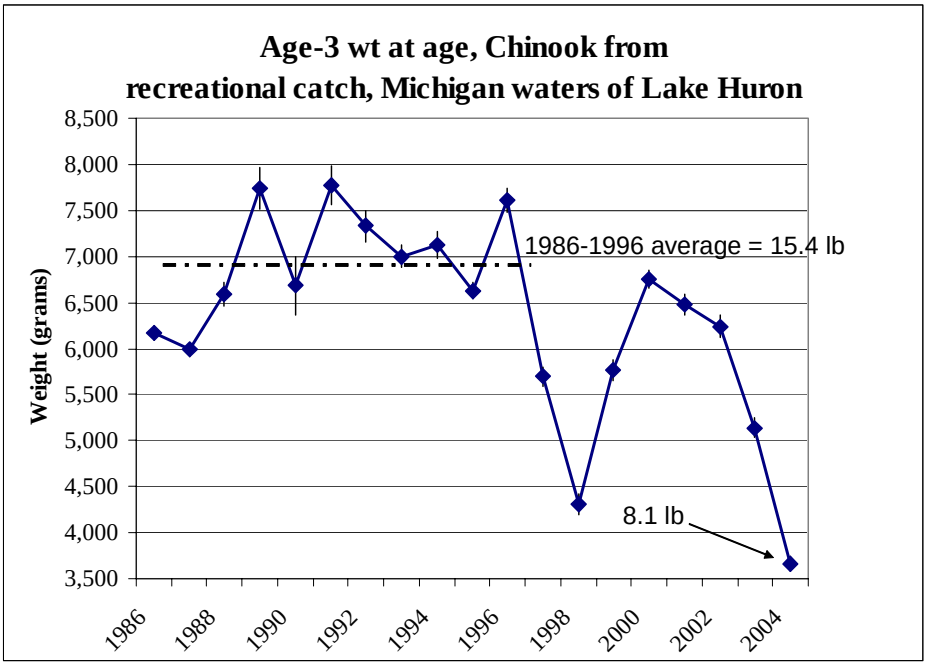



**Figure 3. Weight of three-year-old Chinook salmon declined to a record low of only 8.1 pounds in 2004 and has remained near that level since.**

**Chinook salmon suffering malnutrition, fall 2004**.

3. **Lake trout** catch rates (Figure 4) soared to the highest ever seen in Lake Huron in 2004 and 2005, then declined somewhat in 2006. In 2004 lake trout replaced Chinook salmon as the lead salmonid harvested by anglers in Michigan's waters of Lake Huron. This trend continued into 2005 and 2006. The rise in the lake trout fishery is attributed to their rise in numbers following the successful treatment of sea lampreys in the St. Marys River, more restrictive harvest controls provided by the 2000 Consent Decree and higher vulnerability to angling. Lake trout are easier to catch when they are hungry; they spend more time feeding and are thus more likely to hit a lure. And they are hungry now that alewives are almost gone. Although lake trout growth rates have declined with the alewife collapse, they remain healthy and are not showing signs of emaciation. They appear to be adapting well to new prey sources. Since 2003 lake trout have been turning to round gobies for food. This means they are spending more time feeding near the bottom. Anglers presenting their lures near the bottom are being rewarded with excellent catches of lake trout.

**The lake trout**

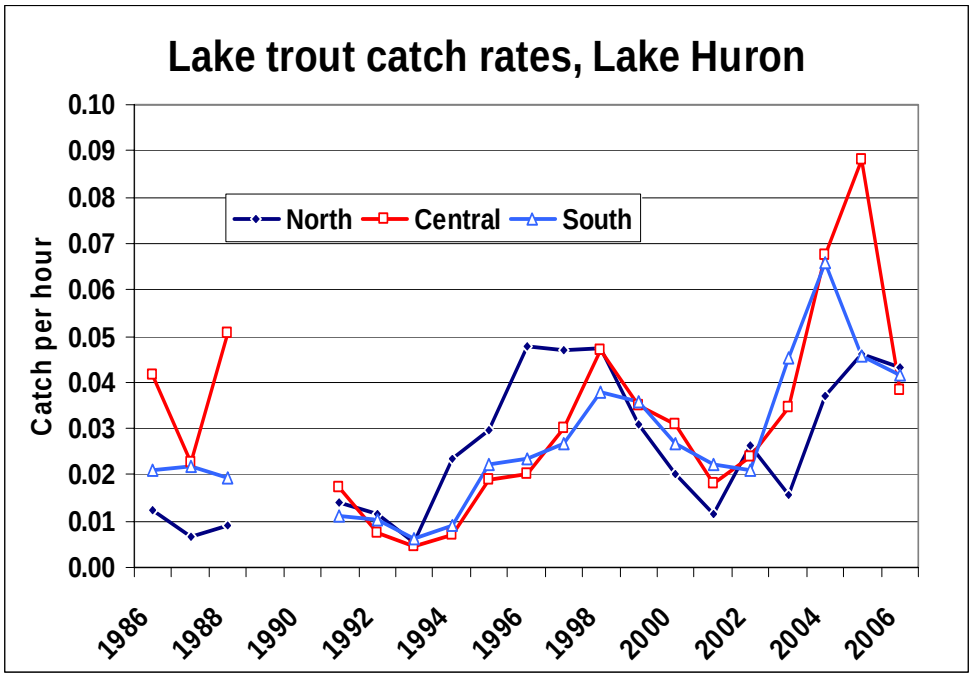


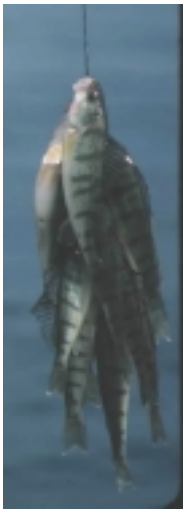

**Figure 5. Lake trout catch rates rose sharply from 2003-2005. Lake trout have switched from a diet of mostly alewives to one of round gobies and smelt.**

4. **Whitefish** are Lake Huron's lead commercial fish. Whitefish have become thinner, eroding their marketability and price per pound. The decline in whitefish growth and condition is almost certainly caused by the disappearance of Diporeia, which for eons had been the preferred prey of lake whitefish. Whitefish are now eating mostly quagga mussels, but these mussels are not nearly as nutritious as Diporeia.

**Commercial fishermen landing whitefish in Alpena in fall 2001.**

5. **Other native species** have begun reproducing at some of the highest rates measured since at least 1970. The recent rise in native fish reproduction is thought to be largely due to the alewife collapse. There are two theories of how alewives suppress native species: 1) predators that eat almost exclusively alewives suffer deficiencies of thiamine (the "alewife's revenge") that can be lethal to the predator fish and /or cause the predators to become infertile, and 2) adult alewives prey on, and compete with, the young of other species. Recovery of native predators such as **lake trout and walleyes** would act to maintain predation pressure on the beleaguered alewife population, which could in turn ensure future reproduction of native species.

   **Walleye** reproduction in Saginaw Bay reached record levels in 2003, the year alewives collapsed. Two more huge year classes were produced in 2004 and 2005. As a direct result of this rise in reproduction, angler catch rates soared in 2006 to record levels (See Saginaw Bay studies on this web site).



**Yellow perch** have been one of Lake Huron's most sought after game fish. Unfortunately, perch numbers in the Main Basin of Lake Huron declined to record lows in 2004 and 2005. A recovery of yellow perch now seems possible, perhaps likely. If reproduction continues at the 2003 and 2004 pace, and if the young perch survive four or five years to reach desirable size, there could be resurgence in perch and interest in perch fishing. Recoveries of traditionally important perch fisheries, such as those of Les Cheneaux Islands, Saginaw Bay, Tawas, Pt. Austin, Harbor Beach, Port Sanilac, and Lexington, would likely attract increased fishing pressure and stimulate industries (motels, restaurants,

charter excursions, and tackle stores) related to the recreational fishery in these communities. This, in turn, could offset reduced production of Chinook salmon. Unfortunately, the reproduction of perch in 2003 and 2004 has failed to produce evidence of strong year classes in Saginaw Bay. It now appears that growth rates for these year classes were low and predation on these small perch was high. However, there are strong signs of perch recovery elsewhere, particularly the Les Cheneaux Islands and Port Sanilac. An estimated 68,000 perch were caught at Port Sanilac 2006.

**Emerald shiners**, another native fish, was once an important bait fish in Lake Huron. Emerald shiners staged a major recovery in 2005 and 2006.

**The emerald shiner**

**Shiners schooled in spring 2007**

Emerald shiners live near the beach and in surface waters where summer temperatures are quite warm. We do not know yet how important emerald shiners will prove to be for cold water predators like trout and salmon. But if walleyes turn to shiners for food, this might provide the opportunity for many perch that otherwise might have been eaten by walleyes to survive to harvestable size.

**VHS, the latest invasive threat.**

Viral hemorrhagic septicemia (VHS), a virus native to Europe, was found in Chinook salmon, walleyes, and whitefish in Lake Huron in 2006. The disease almost certainly entered the Great Lakes with ballast water discharges from salt-water navigating ships. This disease has produced serious losses of fish, including yellow perch and walleyes, in Lake Erie. Trout are especially susceptible to VHS in Europe. The walleye population of Saginaw Bay is nearly recovered and we remain hopeful that yellow perch will also recover in Lake Huron. However, VHS presents a new threat to Lake Huron's trout, salmon, and whitefish fisheries and could deal a setback to perch and walleye recoveries. For more about VHS please see click on the following link:

http://www.michigan.gov/dnr/0,1607,7-153-10364_10950_46202---,00.html

**What's it all mean?**

Clearly Lake Huron is experiencing the full force of an invasive species storm, precipitated for the most part by stow-away creatures in the ballast water of salt-water freighters.

It appears that midwater (pelagic) food supplies declined sharply after exotic mussel colonization of Lake Huron. Nutrients that once fed the pelagic fish community are now locked in beds of zebra and quagga mussels. Plankton and shrimp (Diporeia) declined, contributing to the collapse of alewives, the principal food of Chinook salmon. Chinook salmon feed almost exclusively in the pelagic zone rather than the bottom; thus Chinook salmon are especially vulnerable to the effects of mussel colonization. Lake trout and walleyes, on the other hand, are more opportunistic feeders and appear to be adapting to the new food web. The invasive round goby frequently appears in the diets of walleyes and lake trout, but almost never in Chinook salmon. Lake whitefish once fed heavily on Diporeia. There is much uncertainty regarding whether Diporeia will recover and how lake whitefish will fare in the absence of Diporeia. For now, whitefish are eating the much less nutritious mussels.

Rising reproduction rates of walleyes, yellow perch, and perhaps lake trout may mean that Lake Huron will become less dependant on hatchery supplementation than in the past. A less hatchery-dependent system will be significantly less costly to manage but will be more likely to produce "surprises". The lake's users will need to adapt to what the lake "chooses" to offer (and what the salt-water freighters bring in), rather than to what the DNR chooses to stock. Agencies will be less successful than in the past in molding the lake to their wishes. For example, no amount of stocking or other management is likely to bring back the kind of Chinook fishing Lake Huron was known for if the open-water food supply remains suppressed.

While open water production has declined, it appears that Chinook numbers and their predation rates have declined to the point that a niche, albeit a smaller one, for open-water prey fish has opened. Nature hates a vacuum and there now appears to be one for bait fish in the wake of the Chinook decline. There are several ways the future could play out to fill the open water niche.

1. Alewives could experience more favorable conditions in the form of declining predation and mild winters and stage a recovery. If this happens, Chinook might recover in turn and, like the proverbial coyote-jack rabbit cycle, an alternating pattern of predator and prey abundance evolves. During periods of low alewife abundance, Chinook would decline, but other species could experience high

reproduction levels. During high alewife abundance, Chinook would rebound but reproduction of other species might decline.

2. Alewives could remain present but never regain dominance. In this scenario, rainbow smelt and the native emerald shiner and lake herring could become more abundant and share dominance. Lake trout and walleye might then become self sustaining and salmon would play a secondary role. This is the condition that evolved as Lake Superior's native predator fish recovered from near extinction. Lake herring are currently absent in Lake Huron's Saginaw Bay and Thunder Bay, which once were population centers for this species. Reintroduction of lake herring to these locations is a management option under consideration.
3. The alewife niche could be filled by some other species and, in a worst case scenario, by another invasive species which has been waiting in the wings for this opportunity. Great Lakes ecosystems are complex and respond to change in unpredictable ways, particularly with their current vulnerability to invasive species from ballast water. There will certainly be some elements of surprise in whatever the future holds for Lake Huron.