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Fisheries and Environmental Research by the Minnesota Sea Grant College Program

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ABSTRACT—Minnesota's Sea Grant College Program has funded research and outreach activities since 1977. Research results combined with public education serve the citizens, government, and businesses of the state. Research on commercial and sport fisheries, aquaculture, and environmental contamination is highlighted here. This article shows Sea Grant's contributions to understanding the Lake Superior ecosystem, including its chemical, biological, and human aspects.

Minnesota Sea Grant is a statewide program that funds research, extension, and education efforts on Lake Superior. In its twelve years of funding academic research, Sea Grant has made major contributions to understanding the lake's fisheries and environment.

Fisheries

Lake Superior, like all the Great Lakes, has experienced dramatic changes in its fisheries during the last 100 years. The parasitic lamprey, which invaded the lakes in the late 1940s, drastically reduced the lake trout populations in Lake Superior by 1953. Since the lake trout was the dominant predator in all the Great Lakes, collapse of its population altered the food chain and balance of the lakes' fisheries. New forage species, smelt and alewives, were also introduced, affecting the native forage species—the herring—and changing the lakes' forage base.

Sea Grant provides management agencies with research results in an effort to restore some of the endemic species to the lakes. Controlling the exotic lamprey, returning the lake trout to its dominant position as predator, improving natural reproduction of lake trout, and managing the forage base are essential to this goal. Sea Grant's research results from the University of Minnesota will be used to help solve these problems. In the area of Great Lakes fisheries, most of the work has been done in the University of Minnesota's Department of Fisheries and Wildlife.

Lamprey

After 30 years of chemical control in Lake Superior, lamprey continue to kill significant numbers of lake trout, enough to keep trout populations too low to fully recover. George Spangler and his co-workers have found that changes are needed in lamprey control methods before lake trout will recover (1). They developed a computer model (2) to help fishery managers determine how different levels of lamprey control, stocking rates, and fishing limits might affect lake trout. Jacobson (3) modeled lamprey parasitism in Lake Superior (Figure 1), and found that lamprey abundance was linked to trout abundance.

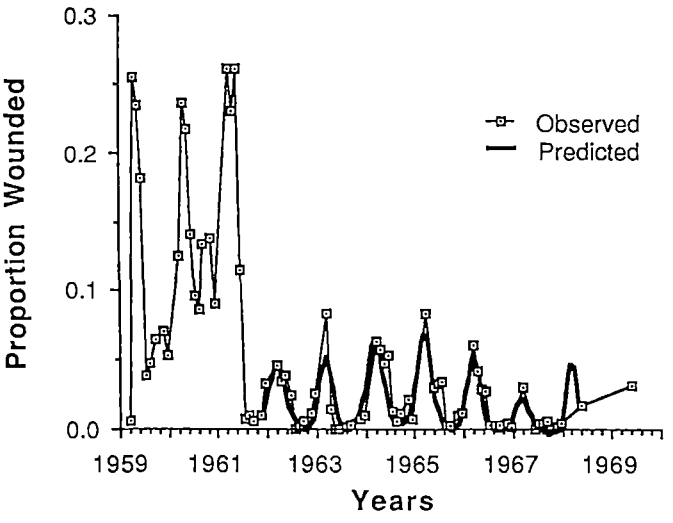

Figure 1. Observed and predicted values for percentage wounded lake trout taken near the Huron Islands in Wisconsin waters of Lake Superior during 1959 to 1969. (From Jacobson 1989, with permission of publisher.)

Yosef Cohen is researching how Lake Superior has changed since the lamprey invasion (4, 5). His findings will help managers make decisions based on more accurate information about the resource. His study will reveal if there is hope of stabilizing the fish community and returning it to the natural balance that existed before the lamprey invaded; yields of lake trout appear reasonably stable (Figure 2), only because yield to man is regulated.

Forage base

Smelt were introduced to the Great Lakes in 1906. Since then, populations of the native herring have declined (6, 7). Sea Grant has funded a number of studies on how this change in forage has affected the lake's ecosystem. Hollie Collins found that smelt have become the major food source for North Shore trout and salmon (8). Even when herring become more abundant, trout seem to prefer the smelt.

This is important for several reasons; one being that smelt are known to be high in thiaminase, an enzyme that destroys thiamine. Thiamine deficiencies are known to impair the

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reproductive capacity of birds and mammals. Ira Adelman is studying whether a diet high in smelt is reducing the lake trout's ability to reproduce (9). Lake Superior is the only one of the Great Lakes with some naturally reproducing lake trout. The other lakes are totally dependent on stocking to maintain populations.

Improving Fish Production

Why certain stocks of trout have been able to reproduce, while most fish introduced by hatcheries have not, is being studied by Anne Kapuscinski. Her research is determining whether the variation among lake trout stocks is due to genetics as well as environmental differences (10). By studying cross breeding of different strains of trout, she will determine the potential to develop new fish hybrid strains that could more successfully reproduce in the lake. This could save millions of dollars by reducing the number of fish required to stock the Great Lakes.

The growing Great Lakes sportfishing industry is heavily dependent on stocking. Sea Grant research is saving hatchery managers time and money by improving fish production for stocking.

Hatcheries are raising more of Minnesota's best sport fish without increasing costs using techniques developed by Edmund Graham. He developed a semen extender that can be used by hatcheries to fertilize eggs after the spawning season (11). This technique allows dramatic increases in production of certain fish species.

New research by a team of University of Minnesota faculty may revolutionize hatchery operations. Professors A. Kapuscinski, K. Guise, P. Hackett, and A. Faras are trying to develop an efficient way to add extra growth genes to fish. If they are successful, their techniques would make fish grow faster, making hatchery operations more economical and efficient (12, 13).

Environment

Stocking fish for sportfishing is economical only if the fish are safe to eat. Contaminants in the lake and in fish have been studied by Sea Grant researchers for years. Most contaminant research has been done in the University of Minnesota's Department of Civil and Mineral Engineering. Steven Eisenriech and his students discovered that contaminants like PCBs enter the lake from the atmosphere (14). Currently, PCB concentrations over large urban areas are higher than over the lakes (Figure 3). Sea Grant also funded research done on the first submersible dives in Lake Superior to study how contaminants circulate throughout the lake (16, 17). Using

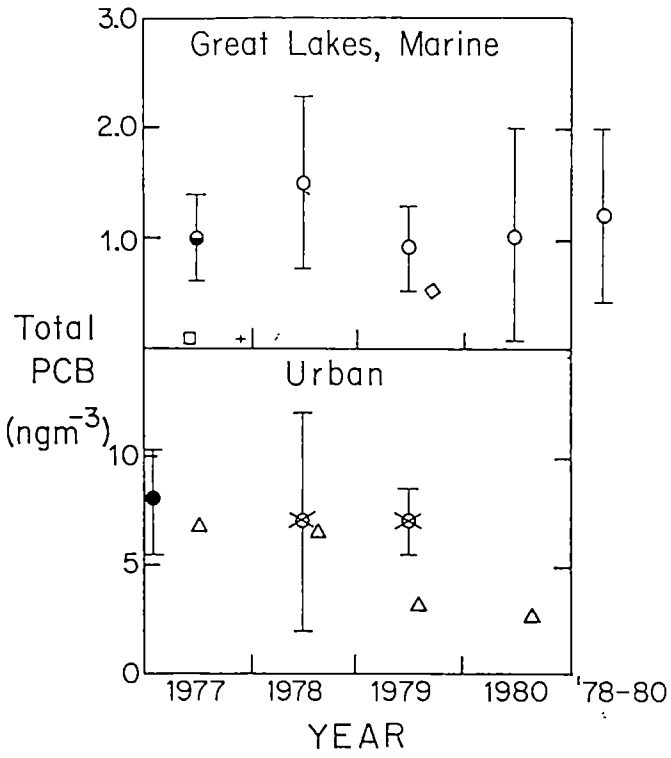

Figure 3. PCB concentrations in air over Great Lakes (Lake Superior O, Lake Michigan ◒) compared to urban areas (Minneapolis, MN ⊗; Chicago, IL ●; Columbia, SC△). (Provided from Eisenreich, Looney, and Hollod, 1983 with permission of publisher.)

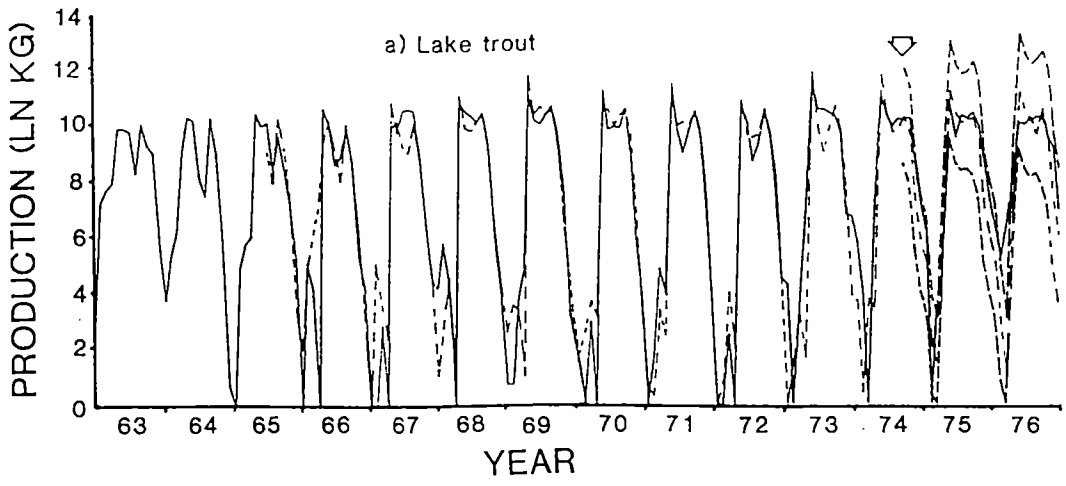

Figure 2. Catch series (solid line) with model fit (broken line) and forecasts (beginning at arrow) with one standard error (upper and lower broken lines) for lake trout caught in Lake Superior. (From Cohen 1986, with permission of publisher.)

the sub, Eisenreich discovered that particles move up and down the lake's water column; they do not settle safely on the bottom of the lake as scientists had thought. Consequently, contaminants like PCBs, which attach to sediment particles, are available to algae, zooplankton, and ultimately to fish (18, 19).

The link between fish and contaminants is of concern to the public. Fish advisories are issued each year warning anglers about which fish should be avoided or eaten in limited amounts. New Sea Grant results may help predict how PCBs accumulate in fish. Deborah Swackhamer found that algae take longer to absorb PCBs than previously assumed (20). This means the techniques scientists use to predict contaminant levels in fish may overestimate the amounts reaching fish through the food chain.

Extending Results

Sea Grant's fisheries and environmental researchers provide essential knowledge to improve management of Lake Superior and other Great Lakes. Sea Grant is unique because its extension and communications staff ensure these results get to organizations that can best implement them. In the fisheries area alone, Sea Grant has extended results through workshops, manuals on how to manage fisheries, and computer software packages on new management techniques.

Fisheries and environmental studies are only part of the Sea Grant program. Other research areas include biotechnology, aquaculture, tourism, policy, and law.

Acknowledgements

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