FISH COMMUNITY OBJECTIVES FOR LAKE SUPERIOR

edited by

Thomas R. Busiahn

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PREFACE

Fish Community Objectives for *Lake Superior* represents an important new development in cooperative management of Lake Superior fisheries. The lake committees for each of the Great Lakes were directed to prepare fish community objectives *in* the visionary *Joint Strategic Plan for Management of Great Lakes Fisheries* (SGLFMP). Signed by all agencies with management responsibilities for Great Lakes fisheries, SGLFMP commits signatory agencies to plan for the restoration and maintenance of desirable fish communities using a strategy of consensus. *Fish Community Objectives for Lake Superior* is a product of the consensus process.

This document should be viewed as a step toward truly cooperative fishery management, but certainly not the final step. The fish community objectives will serve as a template for “state-of-the-lake” reports for Lake Superior, to be prepared in 1990 and every three years thereafter. It is expected that the fish community objectives will be revised? strengthened, and made more specific during the period between state-of-the-lake reports.

By systematically setting objectives and reporting on progress for the whole-lake fish community, the Lake Superior Committee will focus attention on critical fisheries issues, and will enhance communication and understanding on those issues among agency personnel, habitat protection agencies, political bodies, and the general public.

DESCRIPTION OF THE LAKE AND HABITAT

Lake Superior lies along the southern edge of the Canadian Shield, a region of complex geological history dominated by granite and sandstone overlain by glacial till. The great size and depth of the lake and its low temperature and dissolved solids clearly mark Lake Superior as oligotrophic.

The lake has a relatively small littoral zone, especially on its northwestern and northeastern shores, where the bottom drops steeply to depths of 600-800 ft (180-250 m). About 80 % of the lake is deeper than 40 fathoms (240 ft, 73 m), roughly the depth at which "deepwater" fish species begin to dominate the community.

Summer thermal stratification occurs only temporarily in open waters, and is more persistent in sheltered inshore waters. Currents and upwellings are prominent features of the thermal habitat, induced by uneven heating and the prevailing westerly winds. Currents distribute summer heat gain so that maximum heat content occurs near October 1, well after maximum summer temperatures (Bennett 1978).

Primary productivity by phytoplankton, the basis for fish production, is very low -- near the low end of the range for freshwater ecosystems. Water clarity is high, with visibility typically 33 ft (10 m) or more, indicative of the sparse phytoplankton populations.

FISH COMMUNITY PAST & PRESENT

Lake Superior is dominated by fishes typical of northern oligotrophic lakes, especially trout, whitefishes, and their relatives. Lawrie (1978) listed 73 species of 18 families known to have occurred in Lake Superior and its tributaries during this century, 14 of them introduced (Appendix 1). More recently, several exotic species have been found in western Lake Superior harbors, presumably transported there in ship ballast water. The ruffe, a European species, and the white perch, a native of the eastern U.S., were found to have reproduced in St. Louis Bay (Lake Superior Committee 1988 minutes). Threespine and fourspine sticklebacks, both native to coastal drainages, have been reported from Thunder Bay (OMNR files).

One native species, the blackfin cisco, is extinct. Three other species are only occasionally recorded: longnose gar, American eel, and gizzard shad. Twelve other species occur only in shallow bays, estuaries, and tributaries. Thus, Lake Superior proper is inhabited by 48 native species adapted to a broad range of habitat conditions from nearshore to open water.

Only five of the 14 species introduced in Lake Superior were intentionally stocked. Introduced fishes have increased the species diversity at both predator and prey levels, with significant effects on the native fish community.

The low productivity of Lake Superior is indicated by documented fish yields (Baldwin et al. 1979). During 1916-40, a period of high and stable yields, Lake Superior produced annual yields of 0.8 lb/A (0.9 kg/ha), probably near the maximum sustainable level (Ontario Ministry of Natural Resources 1987). During the period 1879-1969, annual commercial yields averaged 0.7 lb/A (0.8 kg/ha) (Smith 1972). Current annual yield is about 0.4 lb/A (0.5 kg/ha), reflecting low catches of lake herring, which dominated historical yields (Table 1).

Table 1. Average annual yield (round weight) reported by Lake Superior agencies for 1984 - 1987 (includes sport, commercial, and subsistence fisheries).

	Pounds	Kilograms
PREDATORS		
Lake trout	1,626,561	739,346
Salmon	265,921	120,873
Walleye	14,188	6,449
Burbot	5,229	2,377
Rainbow trout	22,123	10,056
TOTAL PREDATORS	1,934,022	879,101
FORAGE		
Lake herring	2,172,856	987,662
Deepwater cisco (chubs)	480,724	218,511
Rainbow smelt	461,300	209,682
TOTAL FORAGE	3,114,880	1,415,855
OTHER		
Lake whitefish	2,759,159	1,254,163
Round whitefish	51,104	23,229
Yellow perch	56,146	25,521
Suckers	341,623	155,283
TOTAL OTHER	3,208,032	1,458,196
TOTAL ALL SPECIES	8,256,934	3,753,152

The Lake Superior fish community has been subjected to a series of stresses which have affected it temporarily or permanently. During the logging era of the late 19th and early 20th centuries, “shallow-water benthic environments were ruinously affected by the deposition of sawdust and other woody, allochthonous materials” (Lawrie 1978). Sturgeon, whitefish, and some fluvial and estuarine stocks were lost or adversely affected.

Later in the 20th century, widespread low-level contamination of fishes by a multitude of organic compounds and heavy metals has been measured. Adverse effects on fish stocks have not been observed in Lake Superior, but cannot be ruled out. Several of the contaminants, notably mercury and PCBs, are known to cause serious human health effects, both chronic and acute, at sufficiently high levels. (See Appendix 2, Fish Consumption Advisories for Lake Superior.)

A third stress on the fish community was the fishery itself. Uncontrolled fishing by the “aggressive and enterprising commercial fisheries” produced the destabilizing effects of intense size-selective predation (Lawrie 1978). The fishery was probably too intensive to persist for long at that level, but the invasion of the sea lamprey doomed the fishery to near collapse.

Sea lamprey were first noted in Lake Superior in 1946, and by the late 1950’s had nearly destroyed the lake trout population. A successful search for a control method culminated in completion of the first round of treatments of sea lamprey spawning streams with the toxicant TFM in 1960. The ensuing history of the sea lamprey has been extensively documented (e.g. Smith and Tibbles 1980).

Today the fish community is in transition. Many populations of the native lake trout and lake herring are recovering, though one of the largest herring stocks (Black Bay, Ontario) is in severe decline. Populations of several introduced species have become self-sustaining and are considered naturalized, including rainbow smelt, sea lamprey, and coho salmon, among others. Populations of some introduced species are affected primarily by stocking, notably chinook salmon and splake, the lake trout x brook trout hybrid. Community interactions among native, naturalized, and stocked species are poorly known, and present a major challenge to fishery management.

FISH COMMUNITY GOAL AND GUIDING PRINCIPLES

The following "Common Goal Statement for Great Lakes Fishery Agencies" is from the *Joint Strategic Plan for Management of Great Lakes Fisheries* (SGLFMP). It forms the basis for the Lake Superior fish community objectives.

> 'To provide fish communities, based on foundations of stable self-sustaining stocks, supplemented by judicious plantings of hatchery-reared fish, and provide from these communities an optimum contribution of fish, fishing opportunities and associated benefits to meet needs identified by society for: wholesome food, recreation, employment and income, and a healthy human environment."

Fisheries management on Lake Superior will be guided by the goal of SGLFMP as well as by principles that are widely accepted within the fisheries science community. The combination of management experience and the knowledge gained through advances in fisheries science, especially the 1972 Symposium on Salmonid Communities in Oligotrophic Lakes (SCOL), and the 1976 Percid International Symposium (PERCIS) has resulted in the establishment of a number of fisheries management principles.

* Naturally-reproducing fish communities based on native fish populations provide predictable and sustainable benefits with minimal long-term cost to society.

* There is a limit to the amount of fish that can be harvested from healthy aquatic ecosystems. Since the activities of man can diminish this productive capability, healthy naturally-reproducing fish communities can only be ensured by managing the ecosystem and man's activities as part of that system.

* Sustainable development of aquatic ecosystems requires that adverse impacts on the quality of air, water, and other natural elements are minimized in order to sustain the ecosystem's overall integrity.

* Fisheries are a precious cultural heritage. Therefore, the social, cultural, and economic benefits and costs to society, both present and future, are important considerations in making sound management decisions.

* Good fisheries management is based on the best available knowledge. Fisheries science has found that similar fish communities respond to stress in similar and predictable ways. Consequently, results from intensive studies of representative fish communities can be applied to the management of all Lake Superior's fish resources.

FISHERIES OBJECTIVES

Forage

> Rehabilitate herring stocks to historical levels of abundance for the purposes of lake trout rehabilitation, production of other predators, and fishery harvest (historical reference period: 1916-1940).

Lake herring was historically the dominant prey fish in Lake Superior. During the 25-year historical reference period, herring made up 64% of the reported commercial fishery landings of 424 million lb (193 million kg; Baldwin et al. 1979). During that period, lake herring made up 70% of reported production in U.S. waters and 49% in Ontario.

By the 1970's, lake herring were scarce in much of Lake Superior. The decline began in Minnesota possibly as early as 1941, when reported annual harvest first fell below that state's historical average of 5.9 million lb (2.7 million kg; Baldwin et al. 1979). Similarly, reported annual production dropped below the historical average in Wisconsin in 1963 (1.5 million lb; 0.7 million kg) and in Michigan in 1970 (1.5 million lb; 0.7 million kg). In Ontario, reported commercial landings remained near the historical average (2.0 million lb; 0.9 million kg), until 1988 when harvest fell to 0.9 million lb (0.4 million kg), due to a sharp decline in Black Bay, where only 19% of the 0.75 million kg quota was taken.

The cause of lake herring declines has been a subject of debate. One suspected cause is predation on, and competition with, lake herring larvae by rainbow smelt (Anderson and Smith 1971). Smelt were first recorded in Lake Superior in 1930, and became abundant during the 1950's, when reported commercial production rose to 1 million lb (0.45 million kg).

Another suspected cause of the decline of lake herring in U.S. waters is overfishing (Selgeby 1982). Lake herring were sequentially fished-up while segregated into discrete stocks during the fall spawning season. Thus commercial harvest and catch rates remained deceptively high as fishing activity moved from depleted stocks to yet productive ones. Because fishing intensity may influence the prospects for recovery of lake herring, management agencies were recently advised to maintain catches below the 1974-1983 average until recovery is apparent or new information for determining allowable catches is available (Lake Superior Technical Committee 1986).

Populations of smelt and lake herring have been highly variable in recent years (MacCallum and Selgeby 1987). Smelt abundance remained high until declining sharply in 1978-81, followed by a partial recovery. Lake herring abundance in U.S. waters has increased sharply since 1981, though the recovery has not occurred in all areas where herring were formerly abundant. Since the 1960's, smelt have dominated the diets of lake trout and other salmonid predators, though increased occurrence of lake herring in their diets has been recently observed.

Preferred management objectives for smelt differ among Lake Superior fishery agencies; therefore, no objective for lakewide smelt management is offered here, Some agencies maintain that smelt should be fished down to encourage recovery of native species. Others believe that smelt should be afforded some protection as an important prey species.

Predators

> Achieve a sustained annual yield of 4 million pounds of lake trout from naturally reproducing stocks, and an unspecified yield of other salmonid predators, while maintaining a predator/prey balance which allows normal growth of lake trout.

The dominant native predators in open waters were lake trout (including several distinct races) and burbot, with northern pike and walleye common in shallow bays (Lawrie 1978). Rainbow trout and brown trout were introduced around 1900 and have become naturalized. Pink salmon were inadvertently stocked in 1956. Coho, chinook, and Atlantic salmon have been stocked since 1966 to provide additional angling experiences. Pink and coho salmon have established reproducing populations, and are considered naturalized. A current lakewide marking study will measure the extent of chinook salmon reproduction.

The Lake Superior Committee in 1986 adopted a lake trout rehabilitation plan with a goal of 4 million pounds sustained annual yield from naturally reproducing stocks (Lake Superior Technical Committee 1986). The Lake Superior Committee interprets this goal to include all races and subspecies of lake trout. The goal emphasizes a commitment to re-establish and maintain the basic predator community structure that evolved since the last ice age, with the addition of stocked predator species that diversify the fishery and the fish community. The total potential for harvest of predators from the diversified predator community is unknown, but the Lake Superior Committee has adopted a temporary ceiling for chinook salmon planting of 2.2 million pending further data.

Progress toward the predator goal should be measured in accordance with the lake trout rehabilitation plan, with recognition that agency budgets will not permit collection of all desired data in all areas. Total mortality of lake trout should be measured by standardized methods and should not exceed an annual rate of 50 percent (Lake Superior Technical Committee 1986). Withdrawals of lake trout by fisheries should be thoroughly documented. Sea lamprey wounding rates should be recorded to monitor the other major mortality factor. Lake trout growth should be monitored and related to information on forage abundance and the diets and abundance of other predators. Population dynamics of lake trout should be analyzed to determine when the naturally produced segment of the population is capable of a 4 million pound sustained annual yield.

The deepwater predator community dominated by siscowet lake trout should be managed through commercial harvest to avoid adverse effects on deepwater cisco or lean lake trout populations. Present indications are that siscowets may be depressing populations of deepwater cisco through predation, and competing with lean lake trout during seasons when their depth distributions overlap. The contribution of siscowets to historical records of lake trout production should be investigated to assist in setting achievable predator harvest goals.

Other species

Manage exploitation of non-depleted stocks to maintain stable self-sustaining status.
Examples: whitefish, chubs, suckers, walleye

Re-establish depleted stocks of native species.
Examples: sturgeon, brook trout, walleye

Management agencies should maintain and encourage the commercial harvest of food fish to satisfy consumer needs, to promote employment, and to generate income. Management agencies should also maintain and encourage the recreational use of healthy stocks. Commercially harvested species include whitefish, deepwater cisco (chubs), suckers, lake trout, lake herring, and round whitefish. Species used primarily for recreation include trout and salmon, walleye, northern pike, and yellow perch.

Whitefish should be managed as self-sustaining stocks mostly for commercial harvest, considering ecosystem productivity (historical harvest suggests perhaps 0.1 lb/A) and target mortality rates (perhaps 60-65%). Deepwater ciscos should be managed as self-sustaining stocks for lake trout forage and for commercial harvest. Historical harvest indicates surplus production may be 0.05 lb/A. Commercial production of under-utilized species should be encouraged. Examples are burbot, suckers, and carp.

Depleted stocks of native species should be, re-established by management of habitat for spawning arid rearing via habitat inventory, protection, arid rejuvenation or replacement of degraded habitat. Most of these species are anadromous (for example sturgeon, brook trout, and walleye), so protection of tributary stream habitat is vital. These stocks also require protection from overharvest through regulation and enforcement. Depleted stocks may be replaced or enhanced by stocking of appropriate early life stages.

Sea lamprey

Achieve a 50% reduction in parasitic-phase sea lamprey abundance by 2000.
Achieve a 90% reduction in parasitic-phase sea lamprey abundance by 2010.

The Great Lakes Fishery Commission and cooperating agencies have been successful in reducing abundance of sea lamprey and their predation on valuable fish stocks. Initial stream treatments with the toxicant TFM in 1961 reduced adult sea lamprey abundance by about 90%. Continuing control efforts reduced sea lamprey abundance to about 5% of pretreatment levels.

While reducing sea lamprey abundance, the control program has brought about new problems and uncertainties. If eradication is not possible, what level of sea lamprey abundance is acceptable, and what level of control is economically justified? Rising costs, coupled with increased control efforts on the lower Great Lakes, strain the program funding. Control of larval sea lamprey is of doubtful feasibility with current technologies in some larger tributaries, in estuaries, and in the lake adjacent to river mouths. Data on the number of sea lamprey inhabiting Lake Superior and their effects on other species have been elusive and difficult to interpret. Chemical treatments with TFM have come under growing public scrutiny and protest, and potential long-term impacts of the treatments are unknown.

Recent work under the strategy of Integrated Pest Management has contributed toward greater understanding of the sea lamprey problems. Koonce (1987) developed methods for estimating sea lamprey predation on lake trout and evaluating the benefits of sea lamprey control. The adult sea lamprey population in U.S. tributaries was estimated for the first time in 1986 at 60,500, using mark-recapture techniques and stream flow measurements. Lakewide estimates in 1987 ranged from 33,000 to 47,000. A new sea lamprey barrier dam on the Brule River, Wisconsin, a major sea lamprey producer, captured 6700 adults in 1986 and 1800 in 1987. Initial tests were conducted on Lake Superior in 1987 on sterile-male release techniques, the most promising new technology for reducing sea lamprey spawning success.

A population of 40,000 sea lamprey in Lake Superior is capable of killing over 1.5 million pounds of fish annually. The effort to rehabilitate stocks of native lake trout is clearly hampered, by the existing sea lamprey population, as is the level of human benefits derived from the fisheries. Agencies of the Lake Superior Committee agree that solid progress toward the Fish Community Goal Will require substantial reductions in sea lamprey abundance.

However, the agencies have not achieved a consensus on a reasonable target for sea lamprey reduction. Total eradication would be desired by all, but a reduction of 90 % is supported by some as a level at which sea lamprey predation would be a minor component of total mortality. A reduction of 50% is considered by others as a reasonable target in view of limited financial and programmatic resources. Despite different views on specific sea lamprey management targets, the desired direction of progress is clear. Achievement of sea lamprey management objectives will require continued diligence in application of existing technology, and continued efforts to develop new technologies that will achieve dramatic -- not just incremental -- reductions in sea lamprey abundance.

HABITAT

> Achieve no net loss of the productive capacity of habitats supporting Lake Superior fisheries.
>
> Restore the productive capacity of habitats that have suffered damage.
>
> Reduce contaminants in all fish species to levels below consumption advisory levels.

Habitat protection and management are integral components of fish community management (Department of Fisheries and Oceans 1986; Great Lakes Fishery Commission 1987). Fish habitat concerns on Lake Superior encompass water quality and the physical, biological, and chemical environment that is required to support the desired fish community. Socioeconomic considerations are implicit in the designation of desirable species and the definition of habitat quality.

Fish habitat on Lake Superior is subject to impairment or loss due to industrial activities, such as from forest products industries and mining; governmental activities, such as sewage disposal and road construction; and aerial deposition of pollutants from distant sources. Damaged habitat may be improved through remedial action, requiring mutual support and information exchange among scientists, environmental regulators, fishery managers, and political bodies.

The “no net loss” objective is firm; however, planning to meet the objective can recognize socioeconomic concerns. The objective may be applied to specific fish stocks, to geographic areas, or the size and structure of the fish community. Fisheries agencies should review physical habitat alteration on a case-by-case basis and on a system-wide basis to prevent loss of productive capacity. Planning should incorporate mitigation as an integral part of projects involving habitat alteration. However, "improvement" of habitat through physical alteration should be limited to cases of restoration of degraded habitat.

Contamination of fish by toxic substances is a threat to fish communities and human health. The objective to reduce contaminants below consumption advisory levels (Appendix 2) highlights water quality issues both past and future, and reflects an increasing awareness and concern for levels of contaminants in fish. In Lake Superior these problems are most severe in localities identified as Areas of Concern by the International Joint Commission's Water Quality Board (Appendix 3). Remedial Action Plans are being developed for all Areas of Concern. Remedial Action Plans must include fisheries interests through their participation in planning, review, and implementation.

FUTURE ISSUES

The future of the fish forage base in Lake Superior is a vital concern that remains in some doubt. The recovery of lake herring in some areas is welcomed, but is occurring without the benefit of management. The management status of smelt must be agreed upon to guide coordinated fishery harvest and predator stocking strategies.

In the future, the Lake Superior Committee must move toward a system of allocating forage stocks toward production of predators and fishery harvest. Such a system will be largely determined by constraints imposed by the ecosystem, but will guide specific stocking and harvest decisions. Planning for the composition of the predator community (other than lake trout) awaits further scientific determination of the potential for predator production, but an initial guideline for chinook salmon stocking has been adopted. Eventually, Lake Superior predator stocks can likely be totally supported by natural reproduction, though stocking may be necessary to provide harvest opportunities in some geographic areas.

The future success of sea lamprey control is another uncertainty bearing heavily on the fish community of the future. As long as sea lamprey predation remains a significant mortality factor, benefits from the Lake Superior fish community will be significantly compromised. If the objective of the Lake Superior Committee is attained, substantial increases in the production of desirable fishes will be feasible.

Habitat quality and quantity are the ultimate constraints on future benefits accruing from the fish community. Challenges for the future include inventorying existing habitat for the purpose of measuring change, and placing fish habitat needs high on the agenda of environmental decision-makers.

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APPENDIX 1

Fishes of Lake Superior
(updated from Lawrie 1978)

P = Planned introduction
A = Accidental introduction
E = Extinct

Petromyzontidae	
Northern brook lamprey	*Ichthyomyzon fossor*
Silver lamprey	*I. unicuspis*
American brook lamprey	*I. lamottei*
(A) Sea lamprey	*Petromyzon marinus*
Acipenseridae	
Lake sturgeon	*Acipenser fulvescens*
Lepisosteidae	
Longnose gar	*Lepisosteus osseus*
Clupeidae	
(A) Alewife	*Alosa pseudoharengus*
Gizzard shad	*Dorosoma cepedianum*
Salmonidae	
(A) Pink salmon	*Oncorhynchus gorbuscha*
(P) Coho salmon	*0. kisutch*
(P) Chinook salmon	*0. tshawytscha*
(P) Rainbow trout	*0. mykiss*
(P) Atlantic salmon	*Salmo salar*
(P) Brown trout	*S. trutta*
Brook trout	*Salvelinus fontinalis*
Lake trout	*S. namaycush*
Lake herring	*Coregonus artedii*
Bloater	*C. hoyi*
Kiyi	*C. kiyi*
(E) Blackfin cisco	*C. nigripinnis*
Shortnose cisco	*C. reighardi*
Shortjaw cisco	*C. zenithicus*
Lake whitefish	*C. clupeaformis*
Pygmy whitefish	*Prosopium coulteri*
Round whitefish	*P. cylindraceum*

Osmeridae		
(A)	Rainbow smelt	*Osmerus mordax*
Umbridae		
	Central mudminnow	*Umbra limi*
Esocidae		
	Northern pike	*Esox lucius*
	Muskellunge	*E. masquinongy*
Cyprinidae		
	Northern redbelly dace	*Chrosomus eos*
	Finescale dace	*C. neogaeus*
	Lake chub	*Couesius plumbeus*
(A)	Carp	*Cyprinus carpio*
	Brassy minnow	*Hybognathus hankinsoni*
	Golden shiner	*Notemigonus crysoleucas*
	Emerald shiner	*Notropis atherinoides*
	Common shiner	*N. cornutus*
	Blackchin shiner	*N. heterodon*
	Blacknose shiner	*N. heterolepis*
	Spottail shiner	*N. hudsonius*
	Rosyface shiner	*N. rubellus*
	Sand shiner	*N. stramineus*
	Mimic shiner	*N. volucellus*
	Bluntnose minnow	*Pimephales notatus*
	Fathead minnow	*P. promelas*
	Longnose dace	*Rhinichthys cataractae*
	Creek chub	*Semotilus atromaculatus*
	Pearl dace	*S. margarita*
Catostomidae		
	Longnose sucker	*Catostomus Catostomus*
	White sucker	*C. commersoni*
	Silver redhorse	*Moxostoma anisurum*
	Shorthead redhorse	*M. macrolepidotum*
Ictaluridae		
	Brown bullhead	*Ictalurus nebulosus*
Anguillidae		
	American eel	*Anguilla rostrata*

Gadidae	
Burbot	*Lota lota*
Gasterosteidae	
Brook stickleback	*Culaea inconstans*
Ninespine stickleback	*Pungitius pungitius*
(A) Threespine stickleback	*Gasterosteus aculeatus*
(A) Fourspine stickleback	*Apeltes quadracus*
Percopsidae	
Trout-perch	*Percopsis omiscomaycus*
Percichthyidae	
(A) White perch	*Morone americana*
Centrarchidae	
Rock bass	*Ambloplites rupestris*
Pumpkinseed	*Lepomis gibbosus*
Bluegill	*L. macrochirus*
Smallmouth bass	*Micropterus dolomieui*
Black crappie	*Pomoxis nigromaculatus*
Percidae	
(A) Ruffe	*Gymnocephalus cernuum*
Yellow perch	*Perca flavescens*
Sauger	*Stizostedion canadense*
Walleye	*S. vitreum*
Iowa darter	*Etheostoma exile*
Johnny darter	*E. nigrum*
Logperch	*Percina caprodes*
Cottidae	
Mottled sculpin	*Cottus bairdi*
Slimy sculpin	*C. cognatus*
Spoonhead sculpin	*C. ricei*
Deepwater sculpin	*Myoxocephalus quadricornis*

APPENDIX 2

Fish Consumption Advisories for Lake Superior

MINNESOTA (1987)

Lake trout	No consumption advised for lengths over 30 inches due to PCB's. Limited consumption advised in some areas.
Chinook salmon	Limited consumption advised of 25-30 inch fish due to PCB's.
Northern pike	In St. Louis estuary, no consumption advised for lengths 25-30 inches, limited consumption for 15-25 inch fish, due to mercury.
Walleye	In St. Louis estuary, no consumption advised for lengths 20-25 inches, limited consumption for fish 15-20 inches, due to PCB's and mercury.
White sucker	In St. Louis estuary, limited consumption advised for lengths 15-20 inches.

WISCONSIN (April 1989)

Lake trout	No consumption advised for lengths over 30 inches.
Walleye	In St. Louis estuary, no consumption advised for lengths over 26 inches, limited consumption for fish 18-26 inches due to mercury.

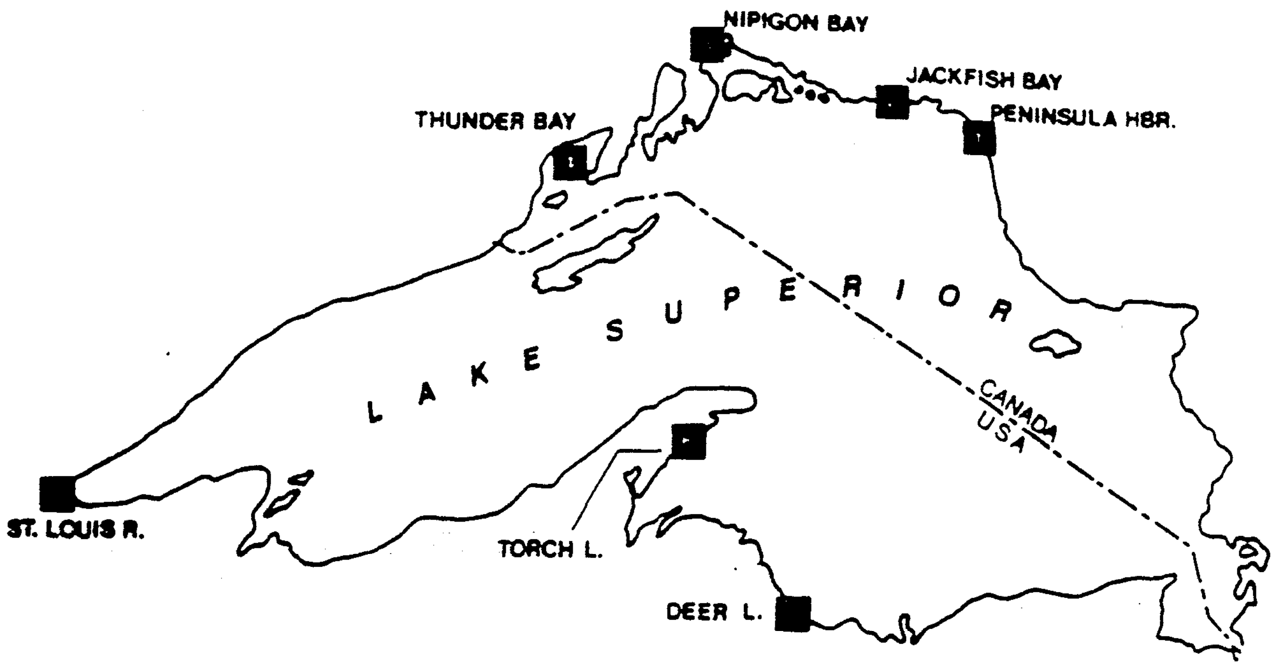
MICHIGAN (December 1988)

Lake trout	No consumption advised for lengths over 30 inches, limited consumption for fish of 20-30 inches.

ONTARIO (1987)

Lake trout	No consumption advised: Over 26 inches - SE of Michipicoten Island Limited consumption advised: 14 - 18 inches - Old Woman River Over 14 inches - Dog Harbour 18 - 26 inches - SE of Michipicoten Island Over 18 inches - Jackfish Bay Over 18 inches - Mamainse Point Over 18 inches - SW of Michipicoten Island Over 18 inches - Rossport Over 22 inches - Batchawana Bay Over 22 inches - Gape Gargantua offshore Over 22 inches - E of Caribou I, Thunder Bay Over 22 inches - Cloud Bay Over 22 inches - Michipicoten Bay Over 22 inches - Ganley Harbour Over 22 inches - S of Marathon Over 26 inches - Welcome Islands Over 26 inches - Hare Island Over 26 inches - Peninsula Harbour Over 26 inches - Michipicoten Island Over 26 inches - Pie Island Over 26 inches - State Islands Over 30 inches - Caribou Island
Siscowet	No consumption advised: Over 26 inches - W of Montreal Island Limited consumption advised: 14 - 26 inches - W of Montreal Island Over 14 inches - Pie Island Over 18 inches - Old Woman River Over 18 inches - Otter Island Over 22 inches - Alona Bay Over 22 inches - Gape Gargantua offshore Over 22 inches - Mamainse Point
Lake whitefish	Limited consumption advised: Over 12 inches - Peninsula Harbour Over 18 inches - Rossport Over 22 inches - Pine Bay

White sucker	No consumption advised: Over 18 inches - Peninsula Harbour Limited consumption advised: 10 - 18 inches - Peninsula Harbour Over 18 inches - Kam River mouth - Thunder Bay Harbour
Walleye	No consumption advised: Over 22 inches - Goulais Bay Over 22 inches - Pine Bay Over 26 inches - Batchawana Bay Limited consumption advised: 18 - 26 inches - Batchawana Bay 18 - 22 inches - Goulais Bay 18 - 22 inches - Pine Bay Over 18 inches - Current River Over 18 inches - Kam River mouth Over 18 inches - Mission River mouth Over 18 inches - Pigeon Bay
Longnose sucker	No consumption advised: Over 18 inches - Peninsula Harbour Limited consumption advised: 8 - 18 inches - Peninsula Harbour
Redhorse sucker	In Peninsula Harbour, no consumption advised for lengths over 14 inches, and limited consumption advised for lengths 8-14 inches
Northern pike	Limited consumption advised: Over 22 inches - Kam River mouth Over 26 inches - Thunder Bay Harbour Over 30 inches - Batchawana Bay Over 30 inches - Current River
Yellow perch	Limited consumption advised for lengths over 12 inches in Nipigon Bay



MAP REF. NO.	AREA OF CONCERN	JURISDICTION	CATEGORY
1	Peninsula Harbour	ON	3
2	Jackfish Bay	ON	3
3	Nipigon Bay	ON	3
4	Thunder Bay	ON	3
5	St. Louis River	MN	4
6	Torch Lake	MI	2
7	Deer Lake-Carp River	MI	4

APPENDIX 3 - International Joint Commission Areas of Concern in Lake Superior

APPENDIX 4

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