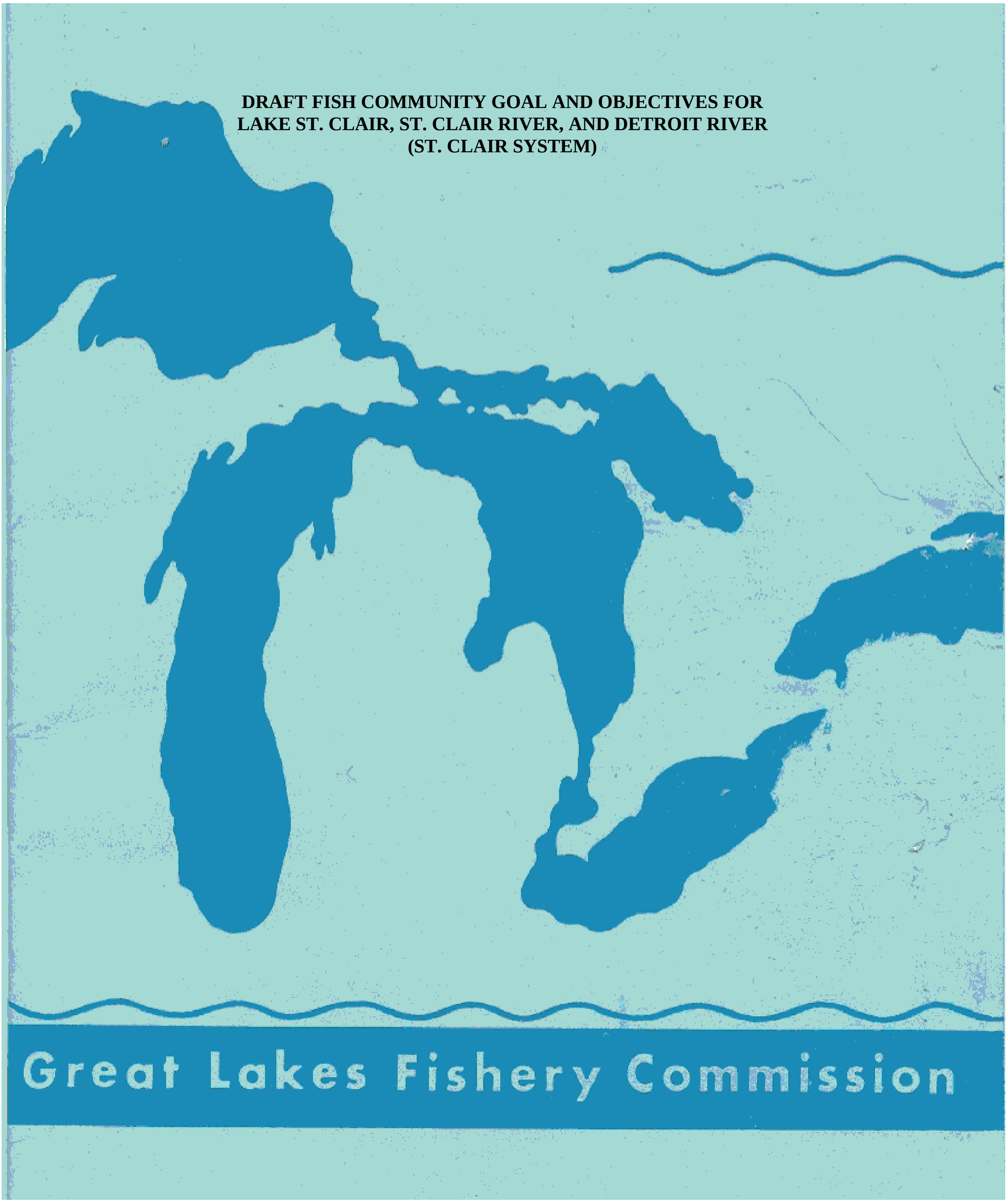
DRAFT FISH COMMUNITY GOAL AND OBJECTIVES FOR LAKE ST. CLAIR, ST. CLAIR RIVER, AND DETROIT RIVER (ST. CLAIR SYSTEM)



DRAFT FISH COMMUNITY GOAL AND OBJECTIVES FOR LAKE ST. CLAIR, ST. CLAIR RIVER, AND DETROIT RIVER (ST. CLAIR SYSTEM)

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1.0 INTRODUCTION

The Lake St. Clair and Connecting Waters Fish Community Goal Task Group was charged by the Great Lakes Fishery Commission (GLFC) Lake Erie Committee with defining fish community goals for Lake St. Clair and connecting waters. At its initial meeting, the task group agreed that the scope of reference for the fish community goal and objectives would include Lake St. Clair, the St. Clair and Detroit Rivers hereinafter called the St. Clair System. It was agreed that the task group would recommend fish community objectives for the St. Clair System as a whole rather than separate objectives for Lake St. Clair and the St. Clair and Detroit Rivers.

> The task group has prepared the following candidate fish community goal and recommends that it be adopted by the Lake Erie Committee.
>
> "To ensure a diverse balanced fish community supported by a healthy ecosystem with percids, centrarchids, and esocids as top predators based on a foundation of self-sustaining stocks and provide an optimum contribution of fish, diverse fishing opportunities and associated benefits to meet societal needs."

This report presents information on the fish community of the St. Clair System providing trophic status, historic and recent harvests. It also outlines fish community management principles and recommended objectives for the management of the St. Clair System fish community. This report is intended to be dynamic, requiring updates as ecosystem changes occur and research data become available.

2.0 DEVELOPMENT OF FISH COMMUNITY GOAL AND OBJECTIVES

2.1 Planning Documents

A number of resource management planning documents are available which serve as higher level direction for establishing the St. Clair System goal and objectives. The Strategic Great Lakes Fisheries Management Plan (SGLFMP) (GLFC 1997 Revision) was adopted by Canada and the United States in which a common goal statement for Great Lakes fisheries management was established:

> "To secure 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, cultural heritage, employment income, and a healthy human environment."

The SGLFMP plan outlines a variety of Great Lakes issues and proposes a variety of broad strategies for managing Great Lakes fisheries (GLFC 1997 Revision). The Fish Community Objectives for Lake Ontario (Stewart et al. 1999), Lake Michigan (Eshenroder et al. 1995), Lake Superior (Busiahn 1990), Lake Huron (DesJardine et al. 1995) and Lake Erie (Ryan et al. 2003) served as a useful guide and template for structuring the St. Clair System Fish Community Goal and Objectives draft. The "Strategic Plan For Ontario Fisheries" (SPOF II) (OMNR, 1992) also provided general direction in terms of management principles, goals, and objectives for fisheries management in Ontario.

Other documents which have applicability to the St. Clair System Fish Community Goal and Objectives are the Southern Ontario Coordinated Program Strategy (SOCPS) (OMNR 1982) which provided general policies, guidelines and targets for resource management for the administrative districts within southern Ontario. The SCOL 2 Manuscript (MacLennan et al. 2002) provided information on the past and recent ecological status of Lake St. Clair. We also recognize the priorities discussed in the proceedings of the Workshop on Environmental Objectives sponsored by the habitat Advisory Board of the GLFC (GLFC 1993; Koonce 1994). Most recently, a Lake St. Clair/St. Clair River Management Plan is being developed by the Great Lakes Commission for the U.S. Army Corps of Engineers that may have future applicability.

2.2 Public Input

This is a draft document subject to public review and modification. This section will be completed after public input.

2.3 Management Principles

To be meaningful and useful for fisheries management, fish community goal and objectives for the St. Clair System must reflect our current and most complete scientific understanding of the structure and function of the aquatic biota of the St. Clair System. They must be responsive to the social, economic, and cultural needs and preferences of the interested stakeholders while representing sound and sustainable ecological principles. The combination of management experience and the knowledge gained through advances in fisheries science has resulted in the establishment of a number of fisheries management principles. These principles serve as general guidelines in the development of fish species objectives and subsequent strategic management actions.

The following fisheries management principles were among those considered by the St. Clair System Fish Community Goal Task Group:

- *Watershed Approach*

The close interrelationship between natural aquatic habitat and fish community structure is recognized as an integral part of a healthy ecosystem and underlies the development of fish community goals and fish species objectives (US EPA 1997; Weeks 1997). Watershed management is the interdisciplinary study and management of the physical, chemical, biological, and ecological interactions in a drainage basin that affect water resources. This approach allows scientists to identify and manage the quality, yield, and instream uses of aquatic resources. The emphasis in the watershed approach is placed on the source areas of water supplies rather than on the water in major river systems (Heathcote 1998).

- *Public Involvement*

The general public has a responsibility and interest in ensuring that healthy fish communities and fisheries are passed on to future generations.

- *Humans are Part of the Ecosystem*

Human activity can influence certain aspects of the ecosystem, but the ability to redirect its future course is limited by economics, societal trends, species introductions, and myriad other factors. Consequently, issues of ecological sustainability and economic sustainability become synonymous in the long run. Responsible management must continually strive to better understand the structure, function, and limits of the St. Clair ecosystem.

- *Stewardship and Accountability*

Stakeholders contribute important biological, social, economic, and cultural information to fisheries management agencies in support of management decision-making. Involvement in decision-making results in shared accountability and stewardship.

- *Long-term Perspective*

Managing fish communities in the St. Clair System requires a long-term perspective, while recognizing the short-term social, cultural, and economic requirements. Human use that is not ecologically sustainable cannot yield sustainable benefits. Protection and rehabilitation of the fish communities and aquatic habitats in the St. Clair System are the most fundamental requirements for productive, long-term fisheries.

- *Limit to Resource*

There is a limit to the natural productive capacity of aquatic ecosystems and therefore a limit to the amount of fish and aquatic organisms that can be harvested from them (Le Cren 1972; Hayes et al. 1993).

- *Natural Reproduction and Naturalized Species*

Naturally reproducing fish communities, based on natural fish populations provide predictable and sustainable benefits with minimal long-term cost to society. The protection and rehabilitation of native and naturalized species and genetic stocks is an important element in securing biodiversity. A number of exotic species are now self-sustaining and must be recognized and managed as part of the fish community. These include rainbow smelt (*Osmerus mordax*), alewife (*Alosa pseudoharengus*), common carp (*Cyprinus carpio*), white perch (*Morone americana),* round goby (*Neogobius melanostomus*), and tubenose goby (*Proterorhinus marmoratus*) (Emery 1985; Mills et al. 1993; 1994).

- *Rare and Endangered Species*

Rare and endangered native aquatic species add to the richness of a fish community and biodiversity, and should be protected in recognition of their intrinsic value and ecological significance.

- *Knowledge is Essential*

Good fisheries management is scientifically based and relies on the acquisition and use of the best available knowledge. Efforts should be made to incorporate the most recent and accurate information, advanced technologies and methodologies in the coordinated management of fisheries in the St. Clair System.

- *Fish Provide Societal Benefits*

Resource management decisions, including allocation, while based on ecological factors, should recognize the social, cultural and economic benefits and costs to society, both present and future.

- *Recognition of Migratory Species and Discrete Stocks*

Stocks are the basic population unit for conservation and management, where it is feasible to identify and monitor them. Fish managers should recognize the migratory nature of certain fish stocks which may span various waterbodies and management jurisdictions (e.g. walleye, Ferguson and Derksen 1971; Todd and Haas 1993).

- *Impact of Exotic Species*

Exotic species have established populations throughout the Great Lakes by means of both intentional and unintentional introductions, and must be recognized as part of the existing fish community in the St. Clair System. For years, intentional introductions of exotic species have been used successfully in fisheries management as well as biological control programs (e.g. Pacific salmon). However, not all introductions have been intentional or desirable. Many invasive species have been found to have significant negative impacts on native fauna, and have imposed apparent irreversible changes to the aquatic ecosystem (e.g. white perch (Boileau 1985), ruffe (*Gymnocephalus cernuus*) (Gunderson et al. 1998), round goby (Jude et al. 1992), and zebra mussels (*Dreissena polymorpha*) (Nalepa and Schloesser 1993)). Therefore, future efforts to introduce exotic species for management purposes should be well researched, and all measures should be taken to avoid unintentional introductions.

3.0 DESCRIPTION OF THE ST. CLAIR SYSTEM

3.1 Watershed

The St. Clair System connects Lake Huron and Lake Erie via the St. Clair River, Lake St. Clair, and the Detroit River (Figure 1). The watershed of the St. Clair System (Figure 2 and 3) encompasses 17,669 km^2 (6,832 mi^2) of which 7,223 km^2 (2,789 mi^2) is in Michigan and 10,446 km^2 (4,033 mi^2) is in Ontario (OMNR Provincial Geomatics Service Centre). The St. Clair System includes the St. Clair and Detroit River watersheds, along with the Lake St. Clair watershed. The system supports a valuable fishery and provides unique habitat for fish and wildlife. In fact, as the St. Clair River enters Lake St. Clair, it forms the largest delta system within the Great Lakes.

Natural shoreline areas remain within the St. Clair River Delta and along the northern and eastern Canadian shore of Lake St. Clair, but most of the natural shoreline on the U.S. side of the St. Clair System has been stabilized with steel sheeting and fill materials, and a significant area of the Canadian shoreline has been diked. Shipping channels connecting the St. Clair and Detroit Rivers are dredged to permit the passage of large lake and ocean going freighters (Bolsenga and Herdendorf 1993). These navigation channels represent a vital link in the Great Lakes-St. Lawrence transportation system. In recent years, waterborne commerce on Lake St. Clair has ranged between 61 and 71 million tonnes (60 to 70 million tons), spread over an average of 3,000 vessel movements.

The human population within the Michigan watershed counties (Lapeer, Macomb, Oakland, Sanilac, St. Clair, Wayne) is over 4.3 million (U.S. Census data, 2000), and approximately 3 million people in southeast Michigan use the St. Clair System as a source of drinking water (SWDIS/STATE) The human population living in the Canadian watershed counties (Essex, Kent, Lambton, Middlesex and Elgin) is 1.1 million (Statistics Can. 2001). From a recreational perspective, Lake St. Clair is among the most heavily used portions of the Great Lakes. More than 150,000 boats are registered in the three U.S. counties adjacent to Lake St. Clair, which include more than 200 marinas. The annual economic value of boating-related activities in the three-county area is estimated to be more than $260 million (Lake St. Clair Conference Summary 1999).

3.2 St. Clair River

The St. Clair River is approximately 70 kilometers (43.5 miles) in length, has a maximum natural depth of 30.5 m (100 ft), a mean depth of 11 m (36.1 ft) and a surface area of 37.7 km^2 (14.6 mi^2). The watershed encompasses a total of 3,290 km^2 (1,270 mi^2) and contains three major sub-watersheds, including those of the Black, Belle, and Pine Rivers (Table 1). The St. Clair River is listed as an Area of Concern (International Joint Commission 1989) (Figure 1), and its shores are developed for residential and industrial use. As the St. Clair River enters Lake St. Clair it divides into a number of channels to form a large delta marsh. The historical mean discharge of the river is approximately 5,100 m^3/s (181,870 ft^3/s) with current velocities exceeding 1.4 m/s (4.6 ft/s) (Derecki 1984a; Griffiths et al. 1991).

3.3 Lake St. Clair

Lake St. Clair (Figure 4) is 38.6 km (24 miles) wide and 41.8 km (26 miles) long with a surface area of 1,100 km^2 (425 mi^2) (Bolsen et al. 1993). Approximately one-third of its surface area is Michigan waters (520 km^2 (201 mi^2)) and two-thirds Ontario waters (750 km^2 (290 mi^2)). Lake St. Clair is shallow with an average depth of 3.0 m (9.8 ft), maximum natural depth of 6.4 m (21 ft), and maximum dredged depth of 8.0 m (26.2 ft) within the shipping channel measured from Low Water Datum for Lake St. Clair (NOAA 1997). The lake receives the majority of its inflow from the St. Clair River (97%). Other rivers which discharge to the lake include the Clinton (listed as an AOC), Sydenham and Thames. Average hydraulic retention time of the lake is approximately seven days (Bolsenga and Herdendorf 1993).

Compared with the Great Lakes, Lake St. Clair is much shallower and more vulnerable to large seasonal and annual (cyclical) changes in water level and depth. As well, events like ice jams in the St. Clair River and standing waves (seiches) can rapidly drop water levels in the lake. Historic (1918-99) water levels have varied from 174.2m (571.5 ft) to 175.9 m (577 ft) above sea level, a range of 1.6m (5.2 ft), or 48% of the lake's mean depth. Water levels were mainly below the long-term mean during the 1920's, 1930's and early 1940's. Above average levels were characteristic of the late 40's and 50's, while the 1960's were typified by below average water levels. From 1970-99, water levels were above the long-term mean of 175 m (574.2 ft). During this period however, the annual mean level has varied ~ 0.8m (2.6 ft), being high in 1973, '86, and '97 and low in 1978, '90 and '95. Regional trends in precipitation and ice cover are considered the primary factors in the both the long-term and annual cycles in water levels.

The annual range of water levels has also varied historically. From 1918-1960, annual ranges exceeding 0.6 m (1.9 ft) (18% of lake mean depth) occurred half the time (21 of 43 years). However, after 1960 the annual range has only exceeded 0.6 m (1.9 ft) on two occasions (1996 and 1998). This reduction in the annual range of water levels likely has impacted the plant community in the shallow zones around the lake by discouraging emergent macrophyte growth.

Lake St. Clair's nearshore areas are characterized by large shallow littoral zones, which change significantly in response to potentially small water level variations. The presence of shallow bars at the offshore area of the littoral zone (about 3 km (1.9 miles) offshore) promote threshold effect changes. When water levels drop below a certain threshold, wave energy from storm events is effectively dissipated at the offshore bar, with significantly reduced re-suspension of sediments and increased water transparency in the littoral zone. This phenomenon is especially relevant to the east and north shore littoral zones due to prevailing southwest winds. Increased water transparency extends the euphotic zone, and triggers significant increases in the density and distribution of macrophytes in the expansive shallow littoral zones of Lake St. Clair, which influences the fish community.

Severe drought conditions experienced in 1997 and 1998 initiated a lowering of lake levels. Subsequent limited winter ice cover, ascribed to climate warming, was credited with increasing winter evaporative losses and sustaining lower water levels through the 1990's. This, coupled with below normal precipitation after 1997 has precipitously dropped water levels approximately 1.0 m (3.3 ft) from 1997 – 2000. This represents a loss of 1/3 of the lake's mean water depth in a span of 4 years. The effects of climate warming (reduced winter ice cover, higher incidence of drought periods,…) are speculated (MacLennan et al. 2002) to be particularly important to the Lake St. Clair ecosystem and will likely exacerbate changes seen in the 1990's.

Solid ice cover on Lake St. Clair has declined over the past three decades. Data recorded by observers at NOAA/NOS water level gauge sites on Lake St. Clair indicate that solid ice was present an average of 62 days each year during the 1960's and 1970's (National Snow and Ice Data Center, University of Colorado, Boulder, CO). Average days with solid ice cover declined to 52 for the decade of the 1980's and declined to only 42 days for the period from 1990 to 1997. The decreased period of ice cover has occurred on all the Great Lakes and has resulted in increased evaporation during late fall and early winter and is thought by hydrologists to be an important factor in water level declines observed across the Great Lakes in the late 1990s (MacLennan et al. 2002).

3.4 Detroit River

The Detroit River is approximately 50 kilometers (31 miles) in length, and is dredged to maintain a depth of 8.2 m (27 ft) in the shipping channels. Before the completion of the navigation system in 1969, natural water depths averaged 6.0 to 7.6 m (19.7 to 25 ft) (Manny et al. 1988). The Detroit River watershed covers approximately 1,976 km^2 (763 mi^2) and includes the Rouge River sub-watershed. Both the Detroit and Rouge Rivers are IJC AOC's (International Joint Commission 1989). Current velocities in the Detroit River exceed 1.7 m/s (5.6 ft/s) (Quinn and Kelley 1983), the average flushing time is 20 hours and mean discharge is 5,200 m^3/s (183,643 ft^3/s) (Derecki 1984b). The upper river consists of a single, well-defined channel about 700 to 1,000 m (2,297 to 3281 ft) wide (Derecki 1984b), while a number of islands divide the lower river into distinct channels, which have been dredged for navigational purposes. Limited natural wetland areas remain along the Canadian portion of the lower river. Nearly all of the shoreline on the US side of the river has been artificially hardened (sheetpile and concrete). Only one significant area of wetland remains on the US side of the river (Humbug Marsh).

4.0 THE FISHERY AND FISH COMMUNITY - PAST & PRESENT

4.1 Tribal Fisheries

While no records of any tribal fishery exist for Michigan waters of the St. Clair System, several tribal fisheries have been active for many years in Ontario waters. Tribal fisheries currently exist on Lake St. Clair and the St. Clair River at Walpole Island; at Moravian, Oneida, and Muncey on the Thames River; and the Sarnia Indian Reservation on the St. Clair River. The majority of the harvest has been walleye (*Stizostedion vitreum)* taken by large dip nets and roll nets during their spring spawning migration in the Thames River (Young et al. 1979). The average annual native harvest of walleye from the Thames River has been estimated at 60,000 kg (132,277 lbs) in the 1970’s, 30,000 kg (66,140 lbs) in the early 1980’s, and 13,000 kgs (28,660 lbs) in the mid 1990’s (MacLennan et al. 2002). While limited knowledge exists about the Walpole subsistence effort and harvest from Lake St. Clair since 1970, they are believed to be low relative to sport harvest yields.

4.2 Recreational Fisheries

An important recreational fishery had developed in the St. Clair System by the early 1900’s. While there are no records of effort and harvest prior to 1942, a large resort industry that catered to anglers and hunters had developed in the St. Clair Flats area by 1900. Numerous photographs dating to the early 1900’s illustrate sport catches of smallmouth bass *(Micropterus dolomieui)*, muskellunge (*Esox masquinongy)*, northern pike *(Esox lucius)*, and walleye. A creel survey conducted from May to October, 1942 and 1943, indicated that the sport fishery in Michigan waters of the St. Clair System exceeded 1 million angler hours with a yield in excess of 135,930 kgs (299,674 lbs) (Krumholz and Carbine 1943a, Krumholz and Carbine 1943b). Yellow perch *(Perca flavescens)*, walleye, and smallmouth bass were the most abundant species in the harvest. After World War II, the recreational fishing industry expanded greatly due to increases in the availability of outboard motors, leisure time, and human population within the watershed. By the 1960’s, fishing effort and harvest in the St. Clair System had increased greatly. The Michigan Department of Natural Resources (MDNR) estimated over 1.3 million yellow perch were harvested in a three month period in 1966 from Lake St. Clair alone (Johnson 1977). Ontario angling effort on Lake St. Clair exceeded 500,000 hours in 1969 (Johnson 1977). The intensity of the sport fishery continued to increase through the 1970’s and 1980’s. In 1980-1983 and 1986-1989, the mean angler effort for the Ontario waters of Lake St. Clair was approximately 411,000 angler hours with walleye, yellow perch, smallmouth bass, and muskellunge dominating the harvest (OMNR unpublished data). In 1984 and 1985, the mean angler effort for the Michigan waters of the St. Clair System exceeded 4 million angler hours (Haas et al 1985) with yellow perch dominating the Lake St. Clair harvest. White bass (*Monroe chrysops*) were the most abundant species harvested from the Detroit River and walleye dominated the St. Clair River harvest. Muskellunge, smallmouth bass, yellow perch and walleye are the dominant components of the current Lake St. Clair fishery.

Reduced ice cover on Lake St. Clair during the 1990’s has reduced winter fishing effort on both sides of the lake. This reduction in effort has likely lowered exploitation on yellow perch and walleye, the two principle species in the winter fishery.

The most recent sport catch data is from the Detroit River during spring 2000. Conservative estimates are that anglers fishing the Michigan waters of the Detroit River fished for 345,000 angler hours and harvested 97,000 walleye during just a nine-week survey period.

4.3 Commercial Fisheries

Historically, lake whitefish *(Coregonus clupeaformis)* and lake herring *(Coregonus artedi)*, both native cold-water species, were harvested in significant quantities in Lake St. Clair. Catches of lake herring decreased greatly in the 1890's, while catches of lake whitefish declined shortly thereafter. A smallmouth bass commercial fishery occurred from 1875 to 1901 (Van Oosten 1938). Commercial fishing was banned in Michigan waters of Lake St. Clair in 1908 (Johnson 1977). Walleye production by the commercial fishery had declined by the 1900's (Van Oosten 1938) but increased significantly during the 1960's (Johnson 1977; Baldwin et al. 1979). Sauger (*Stizostedion canadense*) declined in abundance through the 1950's and were rare in the harvest and the fish community after 1960 (Baldwin et al. 1979; Nepszy et al. 1991). Yellow perch landings peaked in the 1880's, declined in the 1890's and increased again during the mid-1960's (Christie 1974). All commercial fishing was banned in Lake St. Clair in 1970 due to mercury contamination. After the mercury contamination abated, a reduced commercial fishery was restored in the Ontario waters of the lake in 1980. A small commercial fishery using hooklines for lake sturgeon (*Acipenser fulvescens*), seines for common carp, and trap nets for a variety of coarse fish and panfish species existed in Ontario waters of Lake St. Clair through 2001. A larger commercial fishery in the Ontario waters of southern Lake Huron has been shown to harvest walleyes of the Thames River stock (McParland and Ferguson 1999). The abundant and diverse forage fish community of the St. Clair System has supported local commercial baitfish businesses for decades. Spottail shiners (*Notropis hudsonius*), emerald shiners (*Notropis atherinoides*), and mimic shiners (*Notropis volucellus*) are captured live and sold at numerous bait shops in the watershed.

In the late 1800's-early 1900's the Detroit River lake herring fishery collapsed and the lake whitefish fishery had ceased by 1920 (Christie 1974). Commercial catches of lake sturgeon had collapsed by 1900. Small commercial fisheries for walleye, yellow perch and common carp continued until the Second World War. Since 1970, no commercial fishery has operated on the Detroit River.

The St. Clair River supported a setline fishery for lake sturgeon in the late 1800's, with caviar processed at a factory in Algonac, Michigan (Post 1890). A small commercial fishery existed in the St. Clair River at the turn of the century. It harvested primarily walleye by means of seines and troll lines (Christie 1974; Nepszy et al. 1991). Since 1970, no commercial fishery has operated on the St. Clair River.

4.4 Fish Community

Based on commercial and recreational fishing records, it is clear that the structure of the fish community in the St. Clair System has changed significantly since the late 1800's. Lake sturgeon abundance was greatly reduced by the early 1900's, lake whitefish and lake herring had essentially disappeared from the system by 1920, and sauger gradually disappeared from the system through the 1960's. In contrast, alewife and rainbow smelt colonized the system and were well established by the 1950's, and rainbow trout (*Oncorhynchus mykiss*), brown trout (*Salmo trutta*), and chinook salmon (*Oncorhynchus tshawytscha*) were established through stocking in the 1970's**.** White perch colonized the system in the 1980's, while round gobies became abundant throughout the system in the 1990's. Walleye, yellow perch, smallmouth bass, and muskellunge have undergone shifting abundances through the last century, but have remained dominant components of the fish community.

Early changes in the fish community have been largely attributed to exploitation by commercial and recreational fisheries, construction of dams on important tributaries, extensive nearshore modification (diking and draining of wetlands, breakwall construction, etc.), and degraded water quality associated with human activities in the watershed (Bogue 2000). Since the late 1970's, fish community changes in the St. Clair System have been associated with improving water quality and unintentional nuisance aquatic species introductions (Christie 1974; Jude and Leach 1993; Kelso et al. 1996). In particular, increased light penetration, due to zebra mussel filtration and a reduction in algal blooms, has promoted the growth of aquatic plants across wide areas of Lake St. Clair. This change has been accompanied by an increase in the abundance of muskellunge and smallmouth bass, along with a decrease in the number of walleye within the lake. The present fish community is also influenced by an intensive recreational fishery, continuing loss of coastal wetland and shallow nearshore habitats, and nutrient inputs (Danzmann et all 1992; Jude and Leach 1993). Although there is still limited supporting data, it is also believed that contaminants may have some impact on fish population dynamics (Suns et al. 1985).

The present fish community in the St. Clair System is a dynamic and diverse mixture of warmwater and coolwater species (Figure 5, Tables 2 – 4). A number of species are found at the northern limits of their ranges and are not found elsewhere in Canada. Populations of several fish species listed as either threatened or endangered by the State of Michigan or Province of Ontario inhabit the St. Clair System (Table 5). The St. Clair System supports a walleye population that migrates freely between Lake Erie and Lake Huron (Todd and Haas 1993). Recent lake sturgeon studies by the MDNR have also documented movement of adult lake sturgeon between Lake Huron, Lake St. Clair, and Lake Erie. During fall, winter, and spring, coldwater salmonine species, including lake whitefish, chinook salmon, rainbow trout, brown trout, and lake trout (*Salvelinus namaycush*) move from southern Lake Huron into the St. Clair River. Within the St. Clair System, seasonal spawning movements result in dynamic annual fluctuations in local abundances of walleye, lake sturgeon, smallmouth bass, white bass, yellow perch, northern pike, and rainbow smelt. Clearly, the Detroit and St. Clair Rivers serve as avenues for the continued interchange of stocks between Lake St. Clair, Lake Erie, and Lake Huron.

From an ecological standpoint, the trophic structure of the Lake St. Clair fish community has shown remarkable stability. Collectively, walleye, muskellunge, smallmouth bass, and northern pike have sustained an ecological function as important predators, despite changes in their habitat, relative abundance, and forage patterns over the last 30 years. A diverse assemblage of native and introduced fish species has provided a stable forage base for these predator populations. In addition, burrowing mayflies have been abundant in Lake St. Clair throughout the last 100 years, providing an important energy source for the fish community.

Environmental changes in Lake St. Clair have significantly influenced fish community composition. Lake St. Clair, particularly the southeast (Ontario) waters, underwent dramatic environmental, ecological and fish community change in the 1980’s and 1990’s. Water transparency increased 2-3 fold across large areas (July-August mean Secchi Disc depth increased from 1.4 to 2.8m (4.6 to 9.2 ft)), a process driven by effects of exotic zebra mussel and changes in climate and water level. In response to an expanded euphotic zone, aquatic macrophytes increased in density, nearly 5 fold in some areas, and vastly extended their spatial distribution off the east shore and along the south shore (MacLennan 1997). Increased macrophytes provided additional high quality spawning and feeding habitat and promoted increased abundance of smallmouth bass and muskellunge. Walleye abundance and spatial distribution significantly declined and was attributed to a major reduction of optimal habitat volume for walleye (combined with poor recruitment after 1986). The abundance of muskellunge and smallmouth bass tripled, replacing walleye as dominant piscivores in the fish community. Changes in the environment of Lake St. Clair in the 1990's, especially for the Ontario waters, have been rapid and appear to favor an esocid-centrarchid community over one dominated by walleye. The environmental and fish community conditions in the 1990's reflect a former state that prevailed in the 1940's and 1950's.

Managers need to recognize that both anthropogenic (man induced) and natural factors are intertwined in driving “change” in a complex and dynamic ecosystem like Lake St. Clair. Man-induced changes, such as the introduction of exotic species (eg. zebra mussel), have initiated environmental and ecological change, such as increased water transparency and aquatic macrophyte abundance and a shift in trophic energy. Other natural factors, such as changing climate or water levels, are ongoing and may magnify or mask the effects of man-induced change. These anthroprogenic and natural changes to the environment and ecology of Lake St. Clair can favor different fish community assemblages. Discerning the relative influence of the various factors involved in fish community changes can be both challenging and problematic. Both anthropogenic and natural changes in this dynamic and complex system may modify the scope for future management and remediation, and challenge attempts to bring predictability to the fish community.

5.0 ST. CLAIR SYSTEM FISH COMMUNITY GOAL AND OBJECTIVES

The SGLFMP (GLFC 1997 Revision) goal statement was used as a basis in formulating a specific goal for the St. Clair System. The historical role of percids, centrarchids, esocids, and salmonines and the more recent fisheries dominated by walleye, smallmouth bass, and muskellunge as top predators in the system both in the sport and commercial fisheries led to a specific focus on a diverse community with these species as top predators. It was recognized that the fish community is supported by naturally reproducing fish species and a healthy ecosystem is essential to maintaining natural stocks. We agree with the Costanza and Mageau (1999) definition of a healthy ecosystem as one that is sustainable, or able to maintain its structure and function over time, in the face of external stress.

5.1 St. Clair System Fish Community Goal

The Lake St. Clair and Connecting Waters Fish Community Goal Task Group recommends that the following fish community goal be adopted for the St. Clair System:

> "To ensure a diverse balanced fish community supported by a healthy ecosystem with percids, centrarchids, and esocids as top predators based on a foundation of self-sustaining stocks and provide an optimum contribution of fish, diverse fishing opportunities and associated benefits to meet societal needs."

5.2 St. Clair System Fish Community Objectives

Fish community objectives for the St. Clair System and objectives for selected trophic components of the fish community are presented below. There are major obstacles preventing the development of quantifiable objectives at the present time. These include the lack of a complete and annual creel survey, unknown population numbers for most species, incomplete understanding of the effects of exotic species, ongoing and confounding effects of changing water levels and climate on the fauna and flora, unknown impacts from pollutants and many more information gaps. These data gaps restrict our ability to predict fish community responses to both intentional and unintentional man-induced changes. Therefore, in light of the uncertainty associated with quantified species objectives, the following objectives are intentionally qualitative.

5.2.1 *General Fish Community Objectives*

- Protect and restore fisheries habitat in the St. Clair System while maintaining the natural variation in the composition, structure, and function of aquatic habitat in the St. Clair System.

- Maintain a diverse fish community composed of self-sustaining populations.

- Manage exploitation of fishable stocks to maintain self-sustaining status while optimizing benefits to society.

- Reduce contaminants in all fish species to levels below consumption advisory levels (Table 6).

- Prevent unintentional introduction of exotic species.

5.2.2 *Specific Fish Community Objectives*

The abundance and distribution of fish species within the St. Clair System varies spatially and temporally, on both a seasonal and annual basis. While these changes represent variation in the structure of the fish community, the function of the ecosystem has remained remarkably stable. For example, walleye, muskellunge and smallmouth bass, in combination, have sustained an ecological function as important piscivores, despite changes in their habitat, forage patterns, and relative abundance over the last 30 years. We have developed objectives for trophic groups of fish within the St. Clair System, by classifying fish species into functional groups based on adult foraging behaviour. The trophic groups are piscivores, benthivores/omnivores, and planktivores. Two additional groups were included to address species of special concern (restoration/protection species) and salmonines.

- *Piscivores*

Maintain self-sustaining populations and facilitate optimum use of favorable habitat by predators such as walleye, muskellunge, northern pike, longnose gar (Lepisosteus osseus), largemouth bass (Micropterus salmoides), smallmouth bass, and yellow perch to fulfill piscivore functions in the ecosystem and provide quality fishing opportunities.

Walleye, smallmouth bass, and esocids are dominant predators and provide an important community function by exerting a regulatory influence on the abundance of other species in the ecosystem. Individually they support significant components of the angler fishery (effort and catch) and collectively represent approximately 70% of angler effort and 40% of the catch (MacLennan 2003).

Walleye

Walleye stocks in Lake St. Clair support significant native and sport fisheries within the lake and its tributaries and are exploited by a commercial fishery in southern Lake Huron. From the late 1970's through the 1980's, the walleye fishery in the Ontario waters of Lake St. Clair supported an average annual May to August angler effort of 290,00 rod-hours, catch and harvest of 103,150 and 92,800 fish, yield of 0.67 kg/ha (0.6 lb/ac) and catch rate of 0.37 fish/rod-hour (OMNR 1990).

The abundance, age structure, and distribution of walleye stocks in Lake St. Clair have undergone significant change in the last 30 years, particularly in Ontario waters. Ontario indices of relative abundance from index trapnetting and angler surveys and diaries indicated that adult walleye abundance was low during the early 1970s, then doubled in the late 1970s where it remained relatively high through the 1980s. A very strong 1977 year-class initiated the increase with very strong year-classes in 1980 and 1982 followed by strong year-classes in 1984-86 building the population. Through the 1980’s, walleye population levels were possibly at one of the highest levels recorded.

During the 1990s, a significant and rapid decline in walleye stocks occurred, particularly in Ontario waters with indices of relative abundance from index netting and sport fishery surveys dwindling to between one half and one quarter of the previous 20 year average (OMNR, unpublished data). The structure of Ontario walleye stocks also exhibited a change with mean age of walleye caught in index netting increasing after 1987. Declining population abundance associated with a progressive shift to older fish was symptomatic of an extended period of poor recruitment. Mean annual catch of yearling walleye in Ontario index trapnets confirmed that poor year-classes had occurred from 1987 to 1999. Thus, poor recruitment appeared to be an important factor in the significant and progressive decline of adult walleye abundance in the Ontario waters of Lake St. Clair during the 1990's.

Catch-at-age-analysis, and tagging studies of the Lake St. Clair and Thames River spawning stocks indicated that survival was high (68%) and exploitation rate low (7.5%) during the 1980s. More recent values are not available, but major declines in fishing effort in the 1990's for walleye suggests exploitation in the 1990's would have been low. These observations indicated that exploitation was not likely a major factor contributing to low walleye recruitment.

White perch, a potential predator on walleye eggs and young walleye, colonized Lake St. Clair in 1977 and became the most abundant species in Ontario index catches in 1987. The reported interaction of white perch with walleye in the Bay of Quinte and the timing of their colonization in Lake St. Clair supported speculation that white perch could have been a factor in the poor recruitment of walleye through competition, if not direct predation. Roseman (2000) found that white perch were the most important predator of walleye eggs on Lake Erie reefs during 4 of 5 years studied in the late 1990's. Schaeffer and Margraf (1987) found that the exotic white perch were consuming large numbers of walleye eggs on migratory spawning grounds in the Sandusky River, Ohio, 45 km (28 mi) upstream from Lake Erie. However, the decline in white perch abundance in the late 1980s and early 1990s, concurrent with that of walleye, suggests white perch may have had little influence on walleye recruitment, at least in the 1990's. Muskellunge and smallmouth bass abundance increased dramatically after the late 1980s with their populations doubling or tripling by the late 1990s based on changes in angler and index netting annual indices of abundance data. This was suspected, but not determined, to have increased predation mortality on juvenile walleye, the segment of the population experiencing low survival, resulting in poor walleye recruitment. It has been observed in the past fish community of Lake St. Clair (e.g., 1940s and 1950s), and in other lakes (Krishka et al. 1996), that when habitat or other conditions favoured increased abundance of muskellunge and smallmouth bass, walleye abundance was low.

Zebra mussel colonized Lake St. Clair in the late 1980's, resulting in significant ecological changes about the same time that walleye exhibited reduced abundance and poor recruitment. Prior to zebra mussel colonization, water transparency in the Ontario waters of Lake St. Clair was relatively consistent and low, with Secchi disc depth varying from 1 to 2m (3.3 to 6.6 ft), with an average of 1.4m (4.6 ft). These conditions offered ideal habitat for walleye which were ubiquitous in distribution (MacLennan 1994). After zebra mussel colonization, water transparency and Secchi disc depth increased 2-3 fold and exceeded 4.0m (13.1 ft) in many areas rendering these areas less ideal for walleye. Tag recoveries of Thames River walleye, the primary spawning stock in Lake St. Clair, indicated a change in the distribution of walleye both within Lake St. Clair and between its connecting waters. Walleye tagged in 1980-82 (pre-zebra mussel) were recovered from many areas in Lake St. Clair and in about equal proportions from Lake St. Clair (52% of recoveries) and the St. Clair River and lower Lake Huron (48% of recoveries). After zebra mussel colonization, walleye tagged in 1993 were primarily recovered in association with the deep shipping channel in the center of Lake St. Clair with Lake St. Clair contributing fewer recoveries (31%) compared to the St. Clair River and lower Lake Huron (69% of recoveries). Emigration of walleye to adjoining waterbodies, representing a 42% drop in the proportion of walleye recoveries from Lake St. Clair, would account for the fairly rapid decline in walleye stocks in Lake St. Clair after 1988. Optimal habitat volume for walleye had been significantly reduced in Lake St. Clair, resulting in a modified (confined) distribution within the lake and emigration out of the lake. Emigration of walleye to adjoining waterbodies in the early 1990's with poor recruitment through the 1990's appear to be primary factors in the significant decline of walleye in the Ontario waters of Lake St. Clair during this period.

It has been concluded that many factors were influencing low walleye recruitment and decreased abundance from the late 1980's through the 1990's. The least significant factor was likely exploitation, while the most significant were likely the fish community and habitat changes associated with the invasion of zebra mussels.

To ensure that self-sustaining stocks of walleye are maintained, it is critical that the importance of discrete walleye stocks be recognized. We must also recognize the presence of transient walleye from Lake Erie. Tagging and genetic evidence indicate that there is considerable movement and interchange of walleye between the St. Clair/Detroit River system and Lakes Huron and Erie (Todd and Haas 1993; Thomas and Haas 1998). Recruitment of walleye in Lake St. Clair can be highly variable with a noticeable lack of strong year-classes since 1986 (MacLennan and Bryant 1990; Thomas and Haas 1998). Timely and reliable estimates of abundance will be required on a regular basis to support prediction of future walleye abundance in the St. Clair System. Therefore, an understanding of the proportional stock contribution and recruitment dynamics of walleye in the St. Clair System are needed to develop adequate quantifiable objectives and support effective management of this species. Monitoring of predator populations is also desirable to ensure that community changes are detected soon enough to allow timely regulation changes.

Smallmouth Bass

Smallmouth bass represent a significant component of the recreational fishery of Lake St. Clair and the Detroit River. Prominence of smallmouth bass in the fish community and fishery has significantly increased during the 1990's. From the late 1970's through the 1980's, the smallmouth bass fishery in the Ontario waters of Lake St. Clair supported an average annual June to August angler effort of 26,500 rod-hours, catch and harvest of 14,300 and 7,800 fish, yield of 0.064 kg/ha (0.06 lb/ac) and catch rate of 0.36 fish/rod-hour (OMNR, unpublished data). In the 1990’s a dramatic increase occurred with annual angler effort (55,900 rod-hours) and average catch rate (.636 fish/rod-hour) doubling, while harvest (20,000 fish) and yield (0.19 kg/ha (0.17 lb/ac)) tripled and catch (55,700 fish) quadrupled. The growing popularity of bass fishing in the 1990's has given rise to a burgeoning pre-season fishery with concerns for smallmouth bass mortality (hooking) and reproductive loss (by removal of guarding males off nests). However, smallmouth bass stocks appear to have been resilient to this. Indices of relative abundance for smallmouth bass in Ontario Ministry of Natural Resources (OMNR) fall index trapnet catches had increased, suggesting a doubling of the stock from the 1980's to the 1990's. The population appeared to be supported by a number of large year-classes that emerged in the late 1980’s and through the 1990’s. Trophy size individuals had become increasingly common during the 1990’s. The MDNR Master Angler Program saw a progressive increase in smallmouth bass entries from Lake St. Clair through the 1990’s, with the most pronounced increase occurring after 1995. The increase in occurrence of large smallmouth bass was attributed to both an increase in survival, and thus, the number of older smallmouth bass, along with an increase in individual growth rates.

The enhancement of smallmouth bass stocks in Lake St. Clair during the 1990’s can be linked to a number of factors. The increase in water transparency and attendant macrophyte density for Lake St. Clair in the 1990’s contributed more favorable habitat for smallmouth bass. An increase in the condition, survival and abundance of benthivores, including smallmouth bass, was predicted as a consequence of the shift in the trophic energy in Lake St. Clair due to colonization by zebra mussel. Large numbers of crayfish and round goby (an exotic species) are consuming the abundant zebra mussel and adding to the diet of smallmouth bass.

Muskellunge

The Lake St. Clair muskellunge population is one of the few remaining self-sustaining populations in the Great Lakes. Muskellunge currently support a significant and growing recreational fishery in Ontario and Michigan waters of Lake St. Clair. In 1989, for the Ontario waters of Lake St. Clair, muskellunge represented 10 % of the total summer fishery effort with 34,000 rod-hours and catch of 2,000 fish (MacLennan and Bryant 1990), which in 2002 increased to 22 %, 43,000 rod-hours and 7,200 fish, respectively (MacLennan 2003).

An increase in the Ontario and Michigan minimum size limit from 76 to 102 cm (30 to 40 inches) in 1987 along with a growing "catch and release" ethic appears to have afforded important protection to the muskellunge stocks in Lake St. Clair (MacLennan 1996) and contributed to more than a doubling in stock size during the 1990's. Changes in the habitat of Lake St. Clair, favorable to muskellunge also occurred after 1987. The density of musk grass (*Chara spp.*), a primary substrate for spawning muskellunge (Dombeck et al 1984) had dramatically increased over extensive areas of Lake St. Clair based on macrophyte surveys comparing the mid 1980's to 1990's (MacLennan 1997). Overall macrophyte density in the Ontario waters had increased 5 fold, providing both nursery and adult habitat. Muskellunge were not only more abundant in the lake, but more ubiquitous in distribution. While there has been concern that the increase in muskellunge density may exceed availability of abundant preferred food, recent evidence suggests growth rates remain high (OMNR, unpublished data). The management objective to provide trophy muskellunge fishing opportunities (fish greater than 16 kg (35.3 lbs) and 102 cm (40 inches)) from a stable self-sustaining population appear to have been realized through the 1990's.

<u>Yellow perch</u>
Yellow perch have been an important component of the recreational fishery in the St. Clair System for decades. Johnson (1977) found the yellow perch population of Lake St. Clair remained relatively unchanged from 1970 to 1976. Henderson and Nepszy (1988) documented a decline in abundance from 1969 to 1971, a low period during the 1970’s, followed by increased abundance from 1980 to 1984. Yellow perch catch rates (number per net night) in OMNR fall index trapnets increased 30% at the northeast site but decreased 80% at the southeast site from the 1980’s to the mid 1990’s, suggesting a shift in distribution. Ontario yellow perch angler effort doubled and catch rates increased 40% in the late 1990's’compared to the 1980's (OMNR, 2000). OMNR trapnet and MDNR trawl catches have indicated a number of strong year classes were produced in the 1990’s (1991, 1993, 1994, 1995, and 1998). Yellow perch populations typically benefit from increased macrophyte abundance as occurred during the 1990's. Lake St. Clair yellow perch exhibited increased size at age in the early 1990's compared to the 1980's in Ontario trapnets and growth rates above the Michigan average and higher than that observed for Saginaw Bay or Lake Erie’s western basin. Synnestvedt (1997) found that Lake St. Clair yellow perch benefited from a diet rich in invertebrates, especially amphipods and mayflies (*Hexagenia spp*). Griffiths (1993) found higher abundance of the amphipod *Gammarus* after zebra mussel colonization of Lake St. Clair. Reduced ice cover on Lake St. during the 1990’s probably resulted in lower exploitation pressure on yellow perch, a principle species in the winter fishery.

- <u>*Benthivores/Omnivores*</u>

Maintain abundant populations of native benthivores/omnivores to provide diverse fishing opportunities and support abundant predator species.

The benthivore/omnivore guild of the Lake St. Clair fish community is a critical component of the food web, linking benthic production to piscivore production. Diverse and abundant populations of large, long-lived benthivores stabilizes energy cycling, enhancing the stability and resilience of the system. The rich benthic fauna of Lake St. Clair supports abundant populations of benthivores and omnivores. These include both recreationally (rock bass (*Ambloplites rupestris*), channel catfish (*Ictalurus punctatus*), pumpkinseed (*Lepomis gibbosus*) and commercially (lake sturgeon) important species. Other benthic species such as freshwater drum (*Aplodinotus grunniens*), white perch, quillback (*Carpiodes cyprinus*), silver redhorse (*Moxostoma anisurum*), shorthead redhorse (*Moxostoma macrolepidotum*), trout-perch (*Percopsis omiscomaycus*), logperch (*Percina caprodes*), and johnny darter (*Etheostoma nigrum*) also contribute to the diet of larger piscivores in the system. Lake sturgeon will be further addressed in the restoration/preservation species section below.

<u>Channel Catfish</u>
Channel catfish are one of the last species still commercially fished on Lake St. Clair. The species remains underutilized by the recreational fishery. Based on MDNR trap net and trawl catches, the channel catfish population of the lake in the early 2000's appears to be of low density, and dominated by old, large individuals. Individual fish exceeding 71 cm (28 inches) in total length are not unusual. The potential exists for development of a trophy channel catfish sport fishery, but angler interest is lacking in Michigan possibly due to current consumption advisories.

- *<u>Planktivores</u>*

Maintain self-sustaining populations of planktivores at a level adequate for self-sustaining predator populations and for utilization by man e.g. harvest of bait fish.

Although the Lake Huron water mass that dominates much of Lake St. Clair is relatively plankton poor, planktivores such as emerald shiner, alewife, gizzard shad (*Dorosoma cepedianum*), and rainbow smelt are present in the St. Clair System. These species provide an important linkage in the food web between the lower trophic levels (algae and zooplankton) and the upper trophic levels (piscivores).

<u>Spottail Shiners and Mimic Shiners</u>
Both spottail and mimic shiners are commercially harvested from Lake St. Clair and sold as live bait. The impact of the commercial harvest on the lakewide abundance of these species is unknown. The economic value of the commercial harvest is likewise unknown.

- *<u>Restoration/Protection Species</u>*

Maintain and restore self-sustaining populations of lake sturgeon and manage other rare and endangered species to the extent they become significant factors in the St. Clair System wherever possible and such that no more species become extinct in the system.

Interest in the status of lake sturgeon in the Great Lakes basin has been increasing within all natural resource agencies involved in fisheries management in the 1990s. Federal, state, and provincial agencies have initiated status surveys and are in various stages of development of recovery and management plans for waters under their jurisdiction (McClain et al. 1996). Recent research efforts by MDNR, United States Fish and Wildlife, United States Geological Survey, and OMNR agency staff have documented the presence of a substantial self-sustaining lake sturgeon population that resides within and migrates through the St. Clair System. Continued research efforts and the development of a comprehensive recovery and management plan for lake sturgeon in the St. Clair System will facilitate the maintenance of self-sustaining populations at levels to serve as a potential source of fish and/or eggs for future rehabilitation efforts in other waterbodies.

Restoration of lake whitefish and lake herring populations would enhance the diversity of the fish community in the St. Clair System as well as the available fishing opportunities. However, physical and climatological changes likely have resulted in temperature regimes not appropriate for these cold water species to survive year around in the St. Clair System. Similarly, the environmental conditions that supported sauger through the early 1900's are no longer present, and sauger restoration may not be possible.

As of March 1999, the only endangered species recently collected in the St. Clair System has been the river darter (*Percina shumardi*). Threatened species, other than lake sturgeon, recently collected include the eastern sand darter (*Ammocrypta pellucida*), mooneye (*Hiodon tergisus*), and channel darter (*Percina copelandi*). While most of these species do not play a major role in the fish community, their presence does serve to maintain species diversity in the system. The populations present could also serve as a source to repopulate other areas where they have disappeared. Monitoring of these and any other endangered and/or threatened fish species found in the St. Clair System should continue to be a part of fish community sampling to detect variations in abundance due to the changing habitat and environmental parameters in the System.

- *Salmonines*

Maintain existing favorable habitat conditions for pacific salmon, rainbow trout, and brown trout.

The Detroit River and Lake St. Clair are not felt to be suitable for year round survival of salmonines and therefore have a limited role in the fish community. There is however a seasonal fishery for salmonines in the Upper St. Clair River that is believed to be largely dependent on hatchery reared fish released at numerous locations throughout the Lake Huron Basin. While it is recognized that substantial fishing opportunities are provided by this fishery, the impact of these planted fish upon the native fish community should be determined by monitoring their abundance and conducting diet studies.

5.2.3 *Ecosystem Objectives/Direction*

The status of fish stocks (population dynamics, stock abundance, community composition) are closely linked to ecological factors (predation, competition, environmental regime shifts and habitat alteration). Scientists and fisheries managers have long appreciated the importance of quantifying ecological processes relative to fishing, but the tools to implement these considerations have been lacking (Link 2002a). Recognizing what we know about the importance of ecological processes to the maintenance of fish stocks and thus achievement of fisheries objectives, we need to start to consider "Ecosystem Objectives".

Ecosystem objectives could include explicit recognition of the association between fish and their abiotic (environmental, habitat) and biotic (trophodynamic) requirements. We have briefly addressed abiotic ecosystem objectives in the General Fish Community Objectives section (5.2.1) by the statement: "Protect and restore habitat supporting fisheries in the St. Clair System ...". However, this would need to be interpreted in a broad ecological sense, that is, the habitat requirements that support the various life history requirements of the fish species under consideration and their prey, competitors, etc.. In a pragmatic sense, this will be challenging due to the diversity and dynamics of these relations and be hampered by information constraints and priorities.

We have encouraged recognition of biotic ecosystem objectives in our treatment of individual species by identifying trophic groups and their ecological significance in Section 5.2.2. Inclusion of objectives such as: "maintaining self-sustaining populations of planktivores at a level adequate to sustain predator populations" would explicitly recognize this ecological relation.

One explicit consideration of ecosystem based fishery management should be biomass tradeoffs (Link 2002b). It is energetically impossible to simultaneously maximize yield for multiple species. In Lake St. Clair, for example, in the 1990's and in the past (1940's and 1950's), a high abundance of muskellunge appeared to be associated with low abundance of walleye, which may reflect both habitat conditions favoring esocids (clear water and extensive macrophytes) while disfavoring walleye (not sufficiently turbid), and direct predation of muskellunge on young (yearling and younger) walleye (MacLennan et al. 2002).

Another objective of ecosystem based fishery management could be to conserve biodiversity. If extended to the aquatic community at large, this would recognize the current tenuous state of Lake St. Clair's unionid community.

It has been reduced from a diverse assemblage of 18 native species in the 1980's to one exotic species in the 1990's by colonization of the zebra mussel (Nalepa et al. 1996).

Further to the above approaches, inclusion of ecosystem objectives may be considered in a more holistic fashion, such as establishing objectives for ecosystem health or integrity (sustainability). These concepts are difficult to define and measure. Link (2002b) provides examples of ecosystem emergent properties that can be measured and perhaps serve as proxies for decision criteria in fisheries management, such as, System Analysis - resilience, persistence, stability...; Aggregate Metrics - ascendancy, redundancy, guild composition... ; Food Web Metrics - connectivity, modal chain length, predator/prey ratio... ; Community Metrics - diversity indices, size spectra, species richness... .

Future implementation of ecosystem objectives into fisheries objectives and management will be advanced by the following actions (Link 2002b). First, continued dialogue to clearly define fishery goals in an ecosystem context. Second, exploration of ecosystem metrics and indicators to determine if there are ecosystem analogues to single species reference points, standards and similar control rules. Third, development and application of more appropriate theory, models and methods at the aggregate and system level. Fourth, expansion of monitoring programs to include habitat characterization, environmental variables, food habits and non-target species. While advancing inclusion of ecosystem objectives in fisheries management plans, we should continue to recognize the value of classical single species objectives and management.

6.0 IMPEDIMENTS AND ISSUES TO ATTAINMENT OF FISH COMMUNITY GOAL

The major issues which may serve as impediments to attainment of the fish community goal and objectives by producing negative impacts on the fish community are identified as follows:

1. Contaminants; both direct effects upon fish health and indirect effects upon fishing activities via consumption guidelines and negative publicity that inhibit full utilization of fisheries resources in the St. Clair System (Table 6).

2. Loss of habitat and productivity due to shoreline alterations, water level fluctuations, dredging and deposition of dredged materials reduce the potential productive capacity of habitats in the St. Clair System.

3. Exotic species invasions have altered the fish community and nutrient cycling pathways in the St. Clair System. Examples include the white perch, round goby, planted salmonines, zebra mussel, and the possible future invasion of ruffe in the system. Diet studies and knowledge transfers will be important to reveal the trophic interactions and significance of these exotic organisms on the population and community dynamics of indigenous species in the system.

4. Water quality degradation from municipal, industrial, and agricultural sources that impact the aquatic community.

5. Inadequate information and resources for management agencies to conduct programs and measure progress towards objectives. This is particularly acute in regard to the void of information available for Ontario waters of the St. Clair and Detroit Rivers which not only precludes assessment of progress towards objectives, but also imposes difficulty for the establishment of quantifiable fish species objectives in these waters. Timely and reliable indices of recruitment and abundance are needed on a regular basis to support effective management and rehabilitation of the fish community in the St. Clair System.

6. Information on exploitation is inadequate. Recreational fishing pressure in the St. Clair System is very large, exceeding 4 million angler hours in Michigan waters alone in 1983 and 1984 (Haas et. al. 1985). Creel surveys conducted at regular time intervals are needed to provide a reflection of changes in fish community composition as well as the desires of recreational fisherman.

7. Potentially significant biodiversity and ecological changes have occurred in Lake St. Clair during the 1990's that may have implications on the long-term stability of the ecosystem. Colonization of Lake St. Clair by zebra mussel in the 1990's resulted in extirpation of the 18 long standing native unionid species that were present in 1986 (Nalepa et al. 1996). The functional mussel community has changed from a slow-growing, stable community with a relatively minor influence on the ecosystem to a community consisting of a single taxon with a relatively rapid turnover rate that strongly affects ecosystem dynamics and may predispose the ecosystem to other perturbations. The implication of this ecosystem change on ecological health (stability) needs to be monitored and better understood.

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8.0 LITERATURE CITED

Baldwin, N.S., R.W. Saalfeld, M.A. Ross and H.J. Buettner. 1979. Commercial fish production in the Great Lakes 1867-1977. Great Lakes Fishery Commission Technical Report No. 3, Ann Arbor, MI. 187 pp.

Bogue, M.B. 2000. Fishing the Great Lakes: an environmental history, 1783-1933. University of Wisconsin Press, Madison.

Boileau, M.G. 1985. The expansion of white perch *Morone americana*, in the lower Great Lakes. Fisheries 10(1):6-10.

Bolsenga, S.J., and C.E. Herdendorf (editors). 1993. Lake Erie and Lake St. Clair Handbook. Wayne State University Press, Detroit, MI. 466 pp.

Busiahn, T.R. (ed). 1990. Fish community objectives for Lake Superior. Great Lakes Fish. Comm. Spec. Pub. 90-1. 23p.

Christie, W.J. 1974. Changes in the fish species composition of the Great Lakes. Journal of the Fisheries Research Board of Canada 31:827-854.

Costanza, R., and M. Mageau. 1999. What is a healthy ecosystem? Aquatic Ecol. 33:105-15.

Danzmann, R.G., D.S. McLennan, D.G. Hector, P.D.N. Hebert, and J. Kolaska. 1992. Community structure of Lake St. Clair fishes based upon catchability studies from 1977 to 1988. Journal of Great Lakes Research 18:11-21.

Derecki, J.A. 1984a. St. Clair River physical and hydraulic characteristics. National Oceanic and Atmospheric Administration, GLERL Contrib. No. 413. Ann Arbor, Mich. 10 pp.

Derecki, J.A. 1984b. Detroit River, physical and hydrological characteristics. National Oceanographic and Atmospheric Administration, Great Lakes Environmental Research Laboratory, GLERL Contribution No. 417. Ann Arbor. 11pp.

DesJardine, R. L., T. K. Gorenflo, R. N. Payne, and J. D. Schrouder. 1995. Fish-community objectives for Lake Huron. Great Lakes Fish. Comm. Spec. Pub. 95-1. 38p.

Dombeck, M. P., B. W. Menzel and P. N. Hinz. 1984. Muskellunge spawning habitat and reproductive success. Trans. Am. Fish. Soc. 113: 205-216.

Emery, L. 1985. Review of fish species introduced into the Great Lakes, 1819-1974. Great Lakes Fishery Commission, Technical Report 45. Ann Arbor, MI. 51 pp.

Eshenroder, R. L., M.E. Holey, T. K., Gorenflo, and R. D. Clark, Jr. 1995. Fish-community Objectives for Lake Michigan. Great Lakes Fish. Comm. Spec. Pub. 95-3. 56p.

Ferguson, R.G., and A.J. Derksen. 1971. Migrations of adult and juvenile walleyes in southern Lake Huron, Lake St. Clair, Lake Erie, and connecting waters. J. Fish. Res. Board Can. 28:1133-1142.

Great Lakes Fishery Commission. 1993. Workshop on Environmental Objectives.

Great Lakes Fishery Commission. 1997. A Joint Strategic Plan for Management of Great Lakes Fisheries. Ann Arbor, MI.

Griffiths, R.W., S. Thornley, and T.A. Edsall. 1991. Limnological aspects of the St. Clair River. *Hydrobiologia* 219:97-123.

Griffiths, R.W. 1993. Effects of zebra mussels (Dreissena polymorpha) on the benthic fauna of Lake St. Clair. Pages 415-437 *In* Zebra Mussels: Biology, impacts, and controls. T. F. Nalepa and D.W. Schloesser, Eds. Lewis Publishers, Ann Arbor, MI.

Gunderson, J.L., M.R. Klepinger, C.R. Bronte, and J.E. Marsden. 1998. Overview of the international symposium on Eurasian ruffe (*Gymnocephalus cernus*) Biology, Impacts, and Control. Journal of Great Lakes Research 24:165-169.

Haas, R.C., W.C. Bryant, K.D. Smith, and A.J. Nuhfer. 1985. Movement and harvest of fish in Lake St. Clair, St. Clair River, and Detroit River. Michigan Department of Natural Resources, Final Report, Winter Navigation Study, US Army Corps of Engineers. Ann Arbor.

Hayes, D.B., W.W. Taylor, and E.L. Mills. 1993. Natural Lakes and Impoundments. Pages 493-516. *In* C.C. Kohler and W.A. Hubert (Editors) Inland Fisheries management in North America. American Fisheries Society, Bethesda, MD. 594 pp.

Heathcote, I.W. 1998. Integrated Watershed Management. Wiley and Sons. New York, NY. 414 pp.

Henderson, B. A. and S. J. Nepszy. 1988. Recruitment of yellow perch (Perca flavescens) affected by stock size and water temperature in lakes Erie and St. Clair, 1965-85. J. Great Lakes Res. 14(2):205-215.

International Joint Commission. 1989. Revised Great Lakes Water Quality Agreement of 1978. Agreement, with Annexes and terms of reference, between the United States and Canada signed at Ottawa November 22, 1978 and phosphorus load reduction supplement signed October 16, 1983 as amended by protocol signed November 18, 1987.

Johnson, D.A. 1977. Population dynamics of walleye and yellow perch in Lake St. Clair, especially during 1970-76. Can. J. of Fish. and Aquatic Sciences 34:1869-1877.

Jude, D.J., R.H. Reider, and G.R. Smith. 1992. Establishment of Gobiidae in the Great Lakes basin. Canadian Journal of Fisheries and Aquatic Sciences 49:416-421.

Jude, D.J., and J. Leach. 1993. The Great Lakes Fisheries. Pages 517-545. *In* C.C. Kohler and W.A. Hubert (Editors) Inland Fisheries management in North America. American Fisheries Society, Bethesda, MD. 594 pp.

Kelso, J.R.M., R.J. Stedman, and S. Stoddard. 1996. Historical causes of change in Great Lakes fish stocks and the implications for ecosystem rehabilitation. Canadian Journal of Fisheries and Aquatic Sciences 53(Supp. 1):10-19.

Koonce, J.F. Great Lakes Fishery Commission ecosystem partnership coordination. June 1994.

Krishka, B. A., R. F. Cholmondeley, A. J. Dextrase, and P. J. Colby. 1996. Impacts of introductions and removals on Ontario percid communities. Percid Community Synthesis, Introductions and Removals Working Group, Ont. Min. Nat. Resour. Peterborough. 111 p.

Krumholz, L.A. and W.F. Carbine. 1943a. Results of the cooperative creel census on the connecting waters between Lake Huron and Lake Erie in 1942. Michigan Department of Natural Resources Fisheries Research Report No. 879. 23 p.

Krumholz, L.A. and W.F. Carbine. 1943b. Results of the cooperative creel census on the connecting waters between Lake Huron and Lake Erie in 1943. Michigan Department of Natural Resources Fisheries Research Report No. 997. 24 p.

Lake St. Clair Conference Summary. 1999. Lake St. Clair: Its Current State and Future Prospects. November 30 – December 1, 1999. Thomas Edison Inn, Port Huron, Michigan.

Le Cren, E.D. 1972. Fish production in freshwaters. Symposium of the Zoological Society of London 29:115-133.

Link, J. S. 2002a. Ecological considerations in fisheries management: when does it matter? Fisheries 27(4): 10-17.

Link, J. S. 2002b. What does ecosystem-based fisheries management mean? Fisheries 27(4): 18-21.

Manny, B.A., T.A. Edsall, and E. Jaworski. 1988. The Detroit River, Michigan: an ecological profile. U.S. Fish and Wildlife Service Biological Report 85(7.17). 86pp.

MacClain, J.R., L. Mohr, R.C. Haas, M. Thomas, C. Lowie, D. MacLennan, and D. Davies. 1996. Summary of 1996 activities of the interbasin lake sturgeon work group in waters of Lake Huron, St. Clair, and Erie. 11 pp.

MacLennan, D. S. 1994. Impact of zebra mussel on the abundance and distribution of walleye in Lake St. Clair. International Association for Great Lakes Research Program and Abstracts, 37th Conference June 5-9, 1994, Windsor

MacLennan, D. S. 1996. Changes in the muskellunge fishery and population of Lake St. Clair after an increase in the minimum size limit. P19-27. *In* S.J. Kerr and C. H. Olver, [eds.]. Proceedings of the "Managing Muskies in the '90s" Workshop. Ontario Ministry of Natural Resources and Muskies Canada Inc. Kemptville, Ontario

MacLennan, D. S. 1997 Distribution and relative abundance of submerged aquatic macrophytes and fish in Lake St. Clair's nearshore Canadian waters in the mid 1980's and 1990's. Lake St. Clair Fisheries Assessment Unit report, Ontario Ministry of Natural Resources.

MacLennan, D.S. 2003. Summer angler fishery survey in the Canadian waters of Lake St. Clair, 2002. Ontario Ministry of Natural Resources. Lake Erie - St. Clair Fisheries Assessment Unit Summary Report, 2003 (in preparation).

MacLennan, D. and B. Bryant. 1990. State of the Lake Report for: Lake St. Clair, St. Clair and Detroit Rivers. GLFC Special Report, Ann Arbor, MI. 13 pp.

MacLennan, D. S., R. C. Haas, M. V. Thomas. 2002. Lake St. Clair: A Case History of Change 1970-1999. SCOL-2 manuscript (in preparation).

McParland, T.L. and M.M. Ferguson. 1999. Genetic population structure and mixed-stock analysis of walleyes in the Lake Erie-Lake Huron Corridor using allozyme and mitochondrial DNR markers. Transactions of the American Fisheries Society 128:1055-1067.

Mills, E.L., J.H. Leach, J.T. Carlton, and C.L. Secor. 1993. Exotic species in the Great Lakes: a history of biotic crises and anthropogenic introductions. Journal of Great Lakes Research. 19:1-54.

Mills, E.L., J.H. Leach, J.T. Carlton, and C.L. Secor. 1994. Exotic species and the integrity of the Great Lakes: Lessons from the past. BioScience 44:666-672.

Nalepa, T. F., D. J. Hartson, G. W. Gostenik, D. L. Fanslow, and G. A. Lang. 1996. Changes in the freshwater mussel community of Lake St. Clair: from Unionidae to Dreissena polymorpha in eight years. J. Great Lakes Research 22(2):354-369. International Association of Great Lakes Research.

Nalepa, T.F., and D.W. Schloesser. Editors. 1993. Zebra Mussels: Biology, Impacts, and Controls. Lewis Publishers/CRC Press. Boca Raton, FL.

National Snow and Ice Data Center, University of Colorado, Boulder Colorado.

Nepszy, S.J., D.H. Davies, D. Einhouse, R.W. Hatch, G. Isbell, D. MacLennan, and K.M. Muth. 1991. Walleye in Lake Erie and Lake St. Clair. Pages 145-168. In P.J. Colby, C.A. Lewis, and R.L. Eshenroder (editors). Status of Walleye in the Great lakes: Case Studies Prepared for the 1989 Workshop. Great Lakes Fishery Commission Special Publication 91-1. Ann Arbor, MI. 222 pp.

NOAA 1997. United States Coast Pilot. U. S. Dept. Commerce, NOAA, 27th edition, 399pp.

(OMNR) Ontario Ministry of Natural Resources. 1982. Southern Ontario Coordinated Program Strategy (SOCPS). Policy and Planning Guidelines, Queen's Park, Toronto.

(OMNR) Ontario Ministry of Natural Resources. 1990. Lake St. Clair Fisheries Report 1989. Lake Erie Committee Meeting, GLFC, Ont. Min. of Nat. Res.

(OMNR) Ontario Ministry of Natural Resources. 1992. Strategic Plan For Ontario Fisheries - SPOF II. Queen's Printer for Ontario, Toronto.

(OMNR) Ontario Ministry of Natural Resources, unpublished data)

OMNR, 2000 (Need Reference Pg 19).

(OMNR) Ontario Ministry of Natural Resources. Provincial Geomatics Service Centre. Science and Information Resources Division.

Post, H. 1890. The sturgeon: some experiments in hatching. Transactions of the American Fisheries Society 19:36-40.

Quinn, F.H., and R.N. Kelley. 1983. Great lakes monthly hydrologic data. NOAA data Report ERL GLERL-26. National Technical Information Service, Springfield, VA. 79 pp.

Roseman, E. F. 2000. Physical and biological processes influencing walleye early life history in western Lake Erie. Doctoral dissertation. Department of Fisheries and Wildlife, Michigan State University, East Lansing, MI.

Ryan, P.A., R. Knight, R. MacGregor, G. Towns, R. Hoopes, and W. Culligan. 2003. Fish-community goals and objectives for Lake Erie. Great Lakes Fish. Comm. Spec. Publ. 03-02. 56p.

Schaeffer, J. S. and F. J. Margraf 1987. Predation on fish eggs by white perch, Morone americana, in western Lake Erie. Environmental Biology of Fishes, Vol. 18, No. 1, pp. 77-80.

SDWIS/STATE (Safe Drinking Water Information System/State Version. Michigan Department of Environmental Quality (MDEQ) in-house database.

Statistics Canada, 2001. 2001 Population and Dwelling Counts for Census Divisions. http://www12.statcan.ca/english/census01/products/standard/popdwell/Table-CD-P.cfm?PR=35

Stewart, T.J., R.E. Lange, S.D. Orsatti, C.P. Schneider, A. Mathers, M.E. Daniels. 1999. Fish-community objectives for Lake Ontario. Great Lakes Fish. Comm. Spec. Pub. 99-1. 56p.

Suns, K., G. Crawford, and D. Russel. 1985. Organochlorine and mercury residues in young-of-the-year spottail shiners from Detroit River, lake St. Clair, and Lake Erie. Journal of Great lakes Research 11:347-352.

Synnestvedt, S. 1997. The importance of large benthic invertebrates to the diet and growth of yellow perch in Lake St. Clair, Michigan. Fisheries Division Research Report #2031. Ann Arbor.

Thomas, M. and R. Haas. 1998. Status of the fisheries in Michigan waters of Lake Erie and Lake St. Clair. Michigan Department of Natural Resources, Lansing, MI. 18 pp.

Todd, T.N. and R.C. Haas. 1993. Genetic and tagging evidence for movement of walleyes between Lake Erie and Lake St. Clair. Journal of Great Lakes Research 19:445-452.

US EPA. 1997. Community-based environmental protection: a resource book for protecting ecosystems and communities. Report No. EPA 230-B-96-003. Washington, D.C. 73 pp.

U.S. Census Bureau. County and City Data Book: 2000. http://www.census.gov/prod/2002pubs/00ccdb/cc00_tabB1.pdf

Weeks, W.W. 1997. Beyond the Ark: Tools for an Ecosystem Approach to Conservation. Island Press., Washington, D.C. 172 pp.

Van Oosten, J. 1938. Michigan's commercial fisheries of the Great Lakes. Michigan Historical Magazine 22(1):107-145.

Young, J., J. Johnson, G. Himburg, R. Loblaw, and D. MacLennan, 1979. Rationalization of Lake St. Clair Fisheries. Ontario Ministry of Natural Resources, Chatham District Office. 43pp.

Table 1. Watershed size and mean discharge for St. Clair System tributaries.

	Watershed Area				**Mean Discharge**	
Waterbody	km²	mi²	Hectares	Acres	m^3/s	ft^3/s
Michigan						
Black River	1,839.7	710.3	183,974	454,594	8.6	304.4
Upper St. Clair River	55.5	21.4	5,555	13,726		
Pine River	504.0	194.6	50,401	124,540		
Belle River	588.6	227.3	58,860	145,440		
Anchor Bay	392.4	151.5	39,243	96,967		
Clinton River	2,064.3	797.0	206,436	510,097	16.0	565.9
Lake. St. Clair	264.9	102.3	26,492	65,460		
Rouge River	1,181.6	456.2	118,166	291,984	2.8	100.0
Lower Detroit River	332.0	128.2	33,205	82,047		
Michigan total	7,223.0	2,788.8	722,332	1,784,858		
Ontario						
Upper St. Clair River	185.1	71.4	18,505	45,726		
Sydenham River	3,093.6	1,194.4	309,360	764,419		
Lower St. Clair River	117.0	45.2	11,704	28,919		
East Lake. St. Clair	87.6	33.8	8,761	21,649		
Thames River	5,870.1	2,266.4	587,016	1,450,496	56.5	1,996.2
Ruscom River	210.4	81.2	21,038	51,984		
Belle River	150.2	58.0	15,020	37,114		
Puce River	269.8	104.2	26,978	66,661		
Detroit River	462.9	178.7	46,290	114,385		
Ontario total	10,446.7	4,033.3	1,044,672	2,581,353		
St. Clair River					5,150.0	181,870.0
Detroit River					5,200.0	183,643.0

Table 2. Relative abundance for species in the St. Clair River (SCR), Lake St. Clair (LSC), and Detroit River (DR) grouped by trophic status. Categories of relative abundance[1] are DM (Dominant), VA (very abundant), A (abundant), C (common), and P (present).

Species and groups	Trophic status	SCR	LSC	DR
banded killifish	Benthivore	-	C	P
blackside darter	Benthivore	-	P	-
bluegill	Benthivore	C	A	A
bowfin	Benthivore	C	C	C
brindled madtom	Benthivore	-	P	-
bullhead (mixed species.)	Benthivore	-	C	P
channel catfish	Benthivore	-	A	-
channel darter	Benthivore	-	P	-
common carp	Benthivore	VA	C	VA
crappie (mixed species)	Benthivore	-	C	C
eastern sand darter	Benthivore	-	P	-
freshwater drum	Benthivore	A	VA	C
goldfish	Benthivore	C	P	C
green sunfish	Benthivore	-	P	-
greenside darter	Benthivore	-	P	-
Iowa darter	Benthivore	-	P	-
johnny darter	Benthivore	-	C	A
lake sturgeon	Benthivore	-	C	-
lake whitefish	Benthivore	-	P	-
logperch	Benthivore	C	A	A
pumpkinseed	Benthivore	C	A	C
quillback	Benthivore	P	C	P
rainbow darter	Benthivore	-	P	-
river darter	Benthivore	-	P	-
rock bass	Benthivore	VA	VA	VA
round goby	Benthivore	C	VA	-
slimy sculpin	Benthivore	-	P	-
stonecat	Benthivore	-	P	-
sucker family	Benthivore	VA	A	A
tadpole madtom	Benthivore	-	P	-
threespine stickleback	Benthivore	C	P	-
trout-perch	Benthivore	-	DM	-
tubenose goby	Benthivore	-	C	-
white perch	Benthivore	C	VA	VA
brown trout	Piscivore	C	P	-
chinook salmon	Piscivore	P	P	-
largemouth bass	Piscivore	VA	C	A
longnose gar	Piscivore	C	P	C
mooneye	Piscivore	-	P	-
muskellunge	Piscivore	-	C	P
northern pike	Piscivore	C	C	C
rainbow trout	Piscivore	P	P	-
silver lamprey	Piscivore	-	P	-
smallmouth bass	Piscivore	A	VA	VA
walleye	Piscivore	A	VA	C
white bass	Piscivore	C	C	C

yellow perch	Piscivore	VA	DM	VA
alewife	Planktivore	DM	VA	DM
bluntnose minnow	Planktivore	VA	A	VA
brook silverside	Planktivore	P	P	DM
brook stickleback	Planktivore	-	P	-
common shiner	Planktivore	VA	P	A
creek chub	Planktivore	C	P	-
emerald shiner	Planktivore	VA	VA	DM
gizzard shad	Planktivore	C	A	VA
hornyhead chub	Planktivore	C	P	A
mimic shiner	Planktivore	C	DM	-
rainbow smelt	Planktivore	C	VA	-
sand shiner	Planktivore	-	P	-
spotfin shiner	Planktivore	C	P	-
spottail shiner	Planktivore	VA	DM	DM

[1]Abundance classification criteria based on percent catch from MDNR adult fish community monitoring 1997-2002 and OMNR adult fish community monitoring 1974-1998; >10% catch (DM); 1-10% catch (VA); 0.5-1.0% (A); 0.1-0.5% catch (C); <0.1% catch (P). Species without abundance classification were not represented in monitoring catches.

Table 3. Lake St. Clair and Detroit River mean annual harvest for Michigan and Ontario in thousands of kilograms (thousands of pounds in parentheses).

Species	**Historic Harvest[6] 1899-08**	**Recent Harvest[7] 1980-1989**	**Change in Harvest**
walleye	145.9 (321.6)	333.8 (735.9)	187.9 (414.3)
yellow perch	29.8 (65.6)	129.7 (286.0)	99.9 (220.4)
lake sturgeon	24.5 (54.0)	0.1 (0.3)	-24.4 (-53.7)
lake herring	3.3 (7.2)	0.0 (0.0)	-3.3 (-7.2)
lake whitefish	21.4 (47.2)	0.0 (0.0)	-21.4 (-47.2)
channel catfish	18.5 (40.8)	59.9 (132)	41.4 (91.2)
suckers	10.6 (23.4)	14.0 (30.8)	3.4 (7.4)
northern pike	14.8 (32.6)	7.1 (15.6)	-7.7 (-17.0)
smallmouth bass	1.5 (3.3)	22.8 (50.2)	21.3 (46.9)
white bass	not recorded	218.9 (482.7)	-
lake trout	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
other salmonids	not recorded	0.0 (0.0)	-
Other species[8]	323.0 (712.1)	151.5 (334.0)	-171.5 (-378.2)
Total for individual reported species	270.3 (595.7)	786.3 (1733.5)	297.1 (655.0)[9]

6 Historic harvest from Baldwin et al, 1979.
7 Michigan harvest from Haas et.al. 1985; Ontario harvest from sport and commercial catch data.
8 Other species includes freshwater drum, rock bass, pumpkinseed, common carp, muskellunge, crappie, bluegill, pumpkinseed, and others not recorded by species.
9 Excludes white bass catch.

Table 4. St. Clair System annual sport fishery harvest by jurisdiction in thousands of kilograms (thousands of pounds in parentheses).

	ST. CLAIR RIVER			ST. CLAIR RIVER DISTRIBUTARY MARSH		
	Michigan	Ontario	Combined	Michigan	Ontario	Combined
PISCIVORES						
muskellunge						
northern pike				0.74 (1.63)		0.74 (1.63)
salmonines				0.56 (1.24)		0.56 (1.24)
smallmouth bass	0.61 (1.34)		0.61 (1.34)	2.26 (4.99)		2.26 (4.99)
walleye	57.88 (127.61)		57.88 (127.61)	32.45 (71.54)		32.45 (71.54)
white bass	1.53 (3.38)		1.53 (3.38)	0.11 (0.25)		0.11 (0.25)
BENTHIVORES						
bluegill				0.23 (0.51)		0.23 (0.51)
bullheads						
channel catfish						
common carp						
crappie				0.16 (0.34)		0.16 (0.34)
freshwater drum	3.24 (7.15)		3.24 (7.15)	0.25 (0.55)		0.25 (0.55)
lake sturgeon						
pumpkinseed				0.08 (0.17)		0.08 (0.17)
rock bass	0.29 (0.65)		0.29 (0.65)	0.82 (1.81)		0.82 (1.81)
suckers						
white perch						
yellow perch	0.82 (1.81)		0.82 (1.81)	0.55 (1.21)		0.55 (1.21)

	LAKE ST. CLAIR			DETROIT RIVER		
	Michigan	Ontario	Combined	Michigan	Ontario	Combined
PISCIVORES						
muskellunge		2.50 (5.51)	2.50 (5.51)			
northern pike	5.02 (11.07)	1.17 (2.57)	6.19 (13.64)			
salmonines		0.10 (0.21)	0.01 (0.21)			
smallmouth bass	10.94 (24.12)	4.61 (10.16)	15.55 (34.28)	3.50 (7.72)	0.19 (0.42)	3.70 (8.15)
walleye	74.05 (163.26)	63.63 (140.29)	137.34 (302.78)	91.90 (202.59)	15.39 (33.92)	107.28 (236.51)
white bass	15.19 (33.48)	2.23 (4.92)	17.42 (38.41)	266.82 (588.23)	21.75 (47.95)	288.57 (636.18)
BENTHIVORES						
bluegill	0.28 (0.62)	1.20 (2.64)	1.48 (3.26)			
bullheads						
channel catfish		2.20 (4.86)	2.20 (4.86)			
common carp						
crappie	1.31 (2.89)	0.98 (2.17)	2.29 (5.06)			
freshwater drum	5.08 (11.21)	1.95 (4.29)	7.03 (15.51)	26.65 (58.75)	3.28 (7.24)	29.93 (65.99)
lake sturgeon						
pumpkinseed	3.30 (7.27)	0.54 (1.19)	3.83 (8.45)			
rock bass	9.46 (20.86)	1.00 (2.21)	10.46 (23.07)	11.56 (25.48)	0.63 (1.40)	12.19 (26.87)
suckers						

white perch						
yellow perch	82.93 (182.84)	16.22 (35.76)	99.15 (218.60)	13.90 (30.65)	0.91 (2.00)	14.81 (32.65)

Note:
Lake St. Clair - Ontario - L.S.C.F.A.U. (1980 - 1989 Annual Average - Summer and Winter).
Detroit River - Ontario = L.E.F.A.U. (1978 - 1980 Annual Average - Summer - lower Detroit River).
Michigan Waters of St. Clair River, Lake St. Clair, and Detroit River (Michigan DNR Winter Navigation study, 1983 - 1985).
Ontario fall index netting survey length-weight data used to estimate harvest weights for Ontario sportfishing surveys.
Michigan sport fishery harvest estimates determined by a combination of aerial survey counts and complete trips (shore based) interviews.
Ontario sport fishery harvest estimates determined by roving on-water surveys.

Table 5. Michigan and Ontario threatened or endangered fish species known to exist in the St. Clair System.

Species	**Michigan Status**	**Ontario Status**
river darter	Endangered	Not at risk
channel darter	Endangered	Threatened
eastern sand darter	Threatened	Threatened
mooneye	Threatened	Not assessed
lake sturgeon	Threatened	Not at risk

Table 6. Ontario and Michigan Fish Consumption Advisories for the St. Clair River, Lake St. Clair, and the Detroit River.

WATERBODY	SPECIES	ONTARIO CONSUMPTION ADVISORIES		MICHIGAN CONSUMPTION ADVISORIES	
		Women of Child Bearing Age and Children Under 15	*All Others*	*Women of Child Bearing Age and Children Under 15*	*All Others*
Detroit River (Upper and Lower River Combined)	walleye	Limited and Restricted over 25 cm (10 in)	Limited and Restricted over 25 cm (10 in)	Limited over 30 cm (12 in)	Limited over 55cm (22 in)
	northern Pike	Limited over 35 cm (14 in)	Limited over 35 cm (14 in)	Limited over 55cm (22 in)	Unlimited Consumption
	yellow perch	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)	Unlimited Consumption
	white perch	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)		
	white bass	Limited and Restricted over 20 cm (8 in)	Limited over 20 cm (8 in)		
	rock bass	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	channel catfish	Limited and Restricted over 25 cm (10 in)	Limited over 25 cm (10 in)		
	common carp	Restricted over 35 cm (14 in)	Limited over 35 cm (14 in)	Restricted over 15 cm (6 in)	Restricted over 15 cm (6 in)
	redhorse			Limited and Restricted over 15 cm (6 in)	Unlimited Consumption
	freshwater drum	Limited and Restricted over 20 cm (8 in)	Limited over 20 cm (8 in)	Limited over 15 cm (6 in)	Limited over 35cm (14 in)
Lake St. Clair	walleye	Limited and Restricted over 25 cm (10 in)	Limited and Restricted over 25 cm (10 in)	Limited over 30 cm (12 in)	Limited over 55 cm (22 in)
	northern pike	Limited and Restricted over 30 cm (12 in)	Limited over 30 cm (12 in)	Limited over 65 cm (26 in)	Limited over 65 cm (26 in)
	muskellunge			Restricted over 75 cm (30 in)	Restricted over 75 cm (30 in)
	lake sturgeon			Limited over 75 cm (30 in)	Unlimited Consumption
	smallmouth bass	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 35 cm (14 in)	Limited over 35 cm (14 in)
	largemouth bass	Limited and Restricted over 15 cm (6 in)	Limited and Restricted over 15 cm (6 in)	Limited over 35 cm (14 in)	Limited over 35 cm (14 in)
	yellow perch	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)		
	white perch	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 25 cm (10 in)	Limited over 25 cm (10 in)
	white bass	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 30 cm (12 in)
	rock bass	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	clack crappie	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	pumpkinseed	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)		
	bluegill	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)	Unlimited Consumption
	brown bullhead	Limited and Restricted over 25 cm (10 in)	Limited over 25 cm (10 in)	Limited over 35 cm (14 in)	Limited over 35 cm (14 in)
	channel catfish	Limited and Restricted over 35 cm (14 in)	Limited over 35 cm (14 in)	Limited and Restricted over 30 cm (12 in)	Limited over 55cm (22 in)
	common carp	Limited and Restricted over 25 cm (10 in)	Limited over 25 cm (10 in)	Limited over 18 cm (45 in)	Unlimited Consumption
	freshwater drum	Limited over 20 cm (8 in)	Limited over 20 cm (8 in)		
	white sucker	Limited and Restricted over 20 cm (8 in)	Limited over 20 cm (8 in)		
	quillback	Limited and Restricted over 35 cm (14 in)	Limited over 35 cm (14 in)	Limited over 18 cm (45 in)	Limited over 18 cm (45 in)
St. Clair River (Upper, Middle and Lower Combined)	walleye	Limited and Restricted over 20 cm (8 in)	Limited and Restricted over 20 cm (8 in)	Limited over 30 cm (12 in)	Unlimited Consumption
	northern pike	Limited and Restricted over 20 cm (8 in)	Limited over 20 cm (8 in)		
	smallmouth bass	Limited over 15 cm (6 in)	Limited over 15 cm (6 in)		
	yellow perch	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	rock bass	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	bluegill	Limited and Restricted over 15 cm (6 in)	Limited over 15 cm (6 in)		
	common carp	Limited and Restricted over 35 cm (14 in)	Limited over 35 cm (14 in)	Limited and Restricted over 30 cm (12 in)	Limited over 55 cm (22 in)
	freshwater drum	Limited and Restricted over 20 cm (8 in)	Limited and Restricted over 20 cm (8 in)	Limited over 35 cm (14 in)	Limited over 35 cm (14 in)
	white sucker	Limited and Restricted over 20 cm (8 in)	Limited over 20 cm (8 in)		
	redhorse	Limited and Restricted over 25 cm (10 in)	Limited over 25 cm (10 in)		
	gizzard shad	Restricted over 30 cm (12 in)	Limited over 30 cm (12 in)	Limited and Restricted over 15 cm (6 in)	Limited over 25 cm (10 in)
	lake trout	Restricted over 55 cm (22 in)	Limited over 55 cm (22 in)		
	chinook salmon	Restricted over 75 cm (30 in)	Limited over 75 cm (30 in)		

Ontario advisories summarized from Ontario Ministry of the Environment. 2001. Guide to Eating Ontario Sport Fish 2001-2002, Twenty-first Edition, Revised. Queen's Printer for Ontario, Toronto.
Michigan advisories summarized from Michigan Department of Community Health. 2002. 2002 Michigan Family Fish Consumption Guide. 45 pp.
Limited consumption - maximum of 0.5, 1, 2, 4, and/or 8 meals per month . Restricted consumption - do not eat.

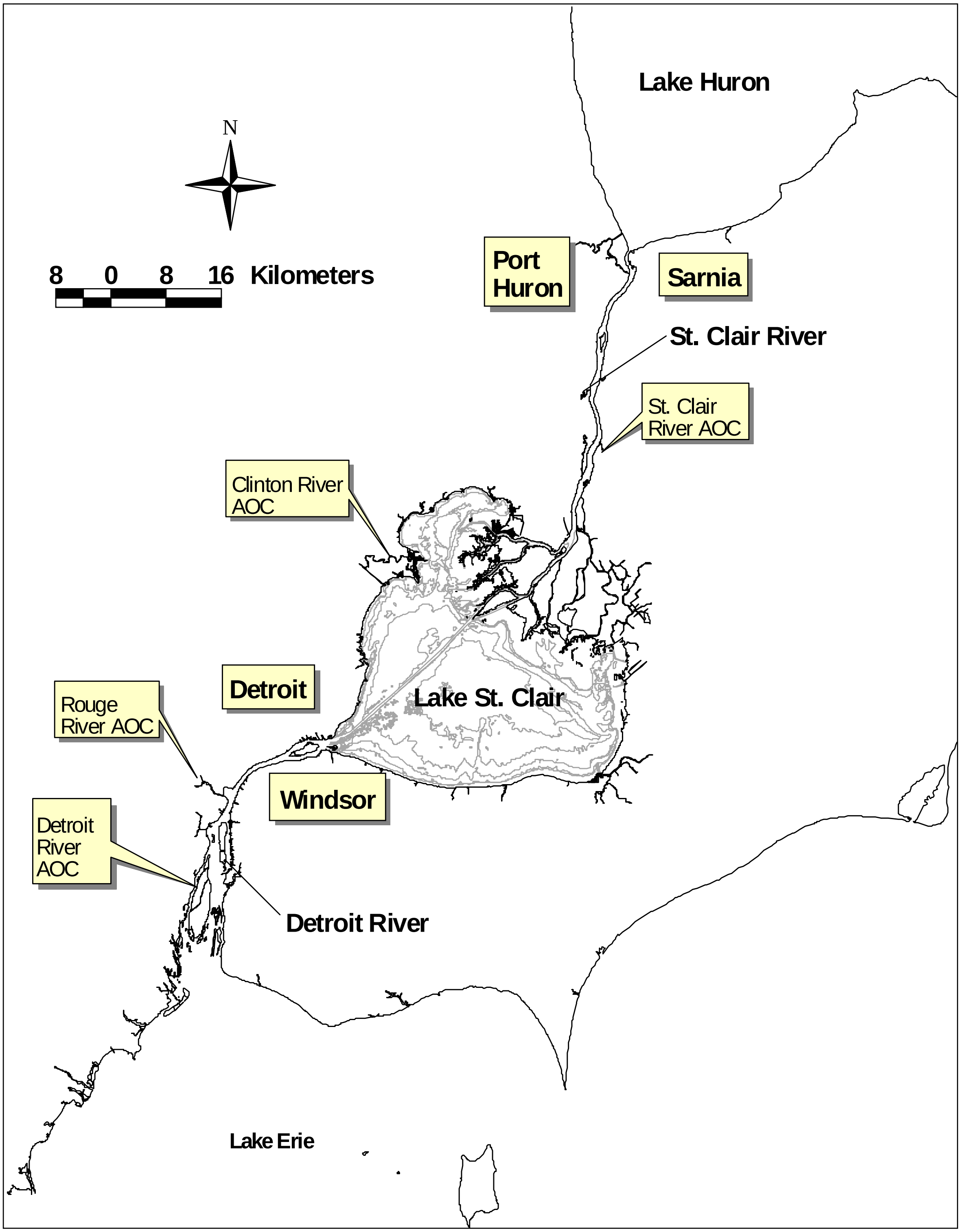


Figure 1. Detail map of the St. Clair System, including the St. Clair River, Lake St. Clair, and Detroit River showing Areas of Concern (AOC) identified by the International Joint Commission.

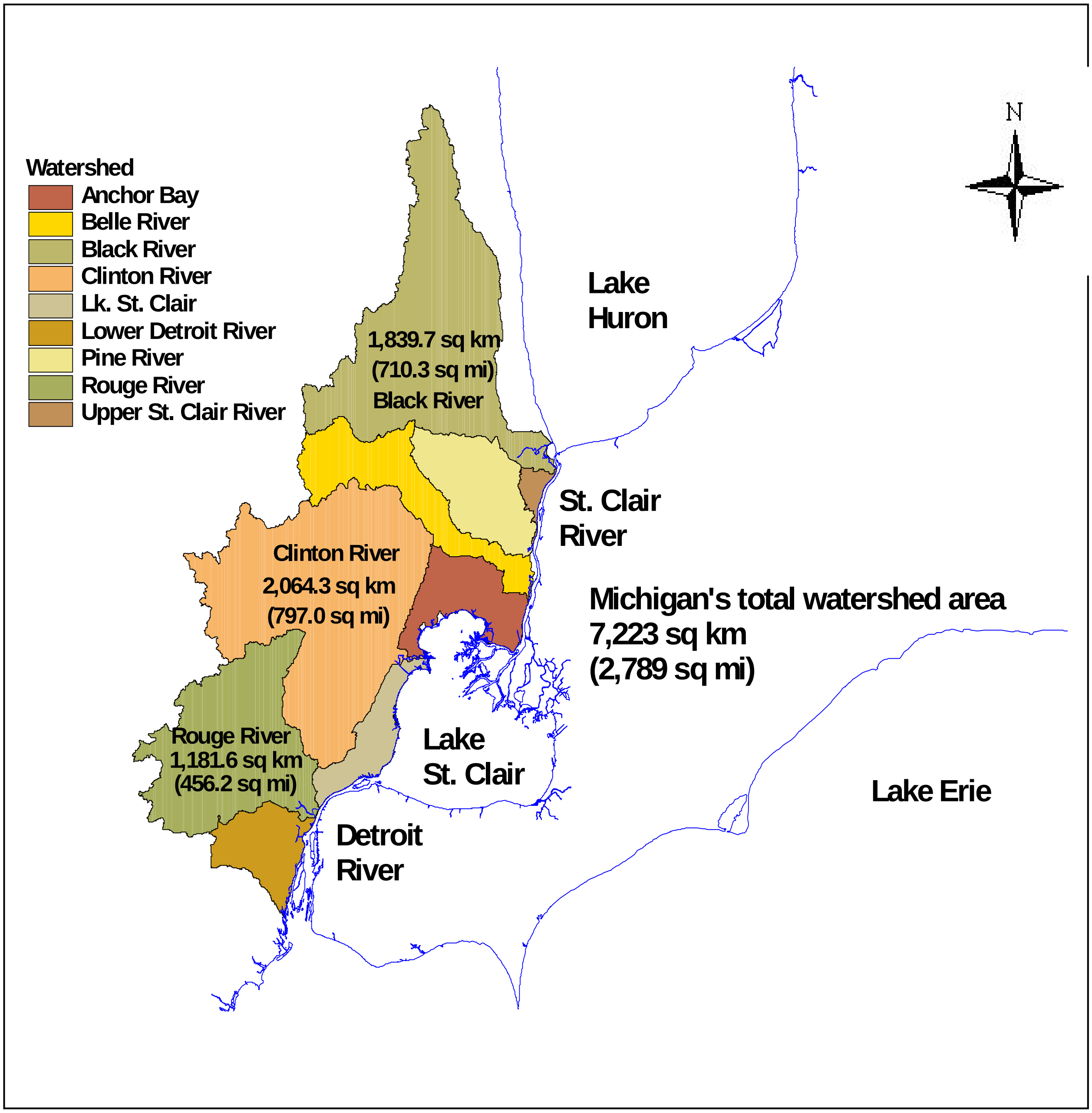


Figure 2. St. Clair System watersheds in Michigan.

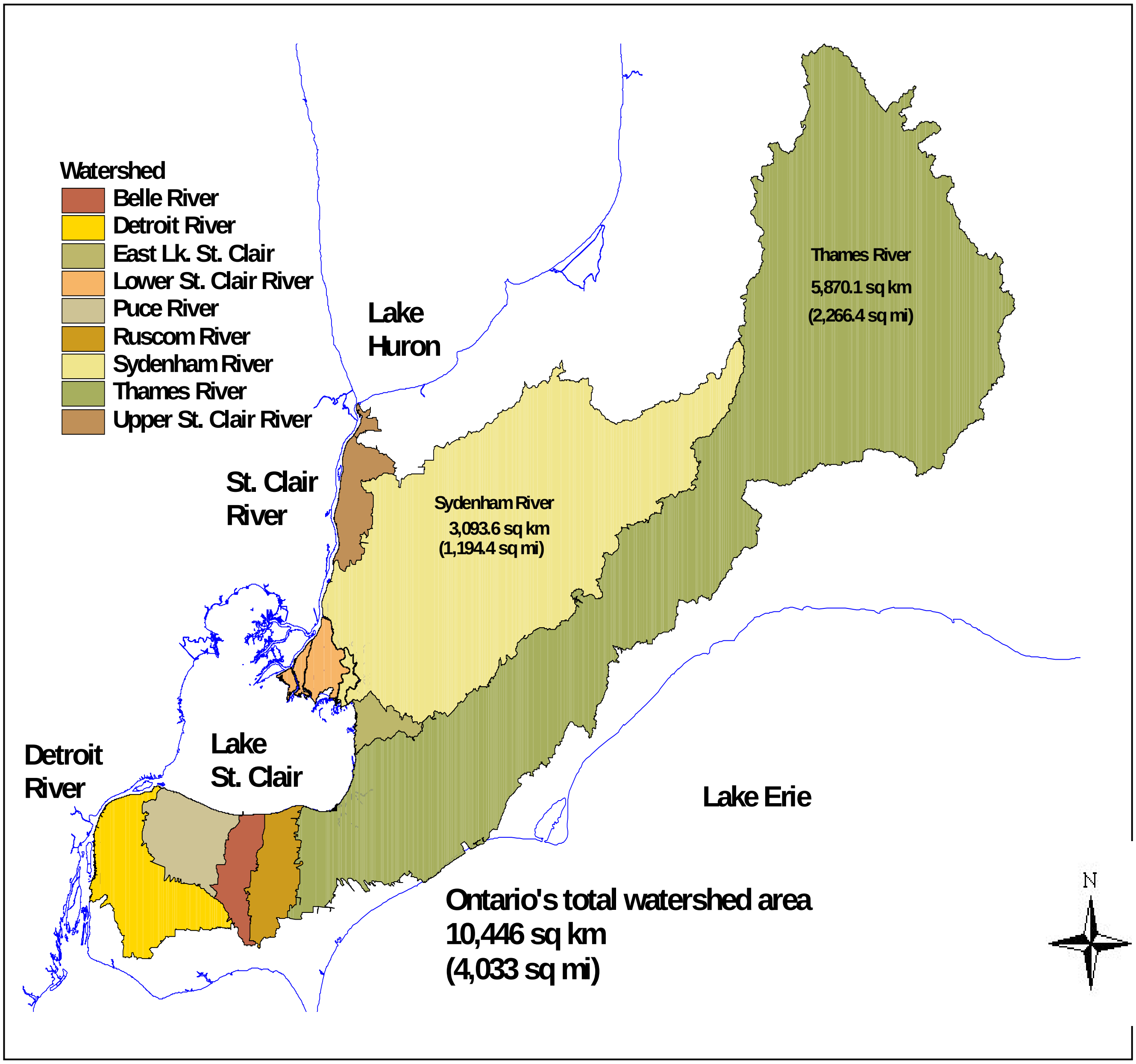


Figure 3. St. Clair System watersheds in Ontario.

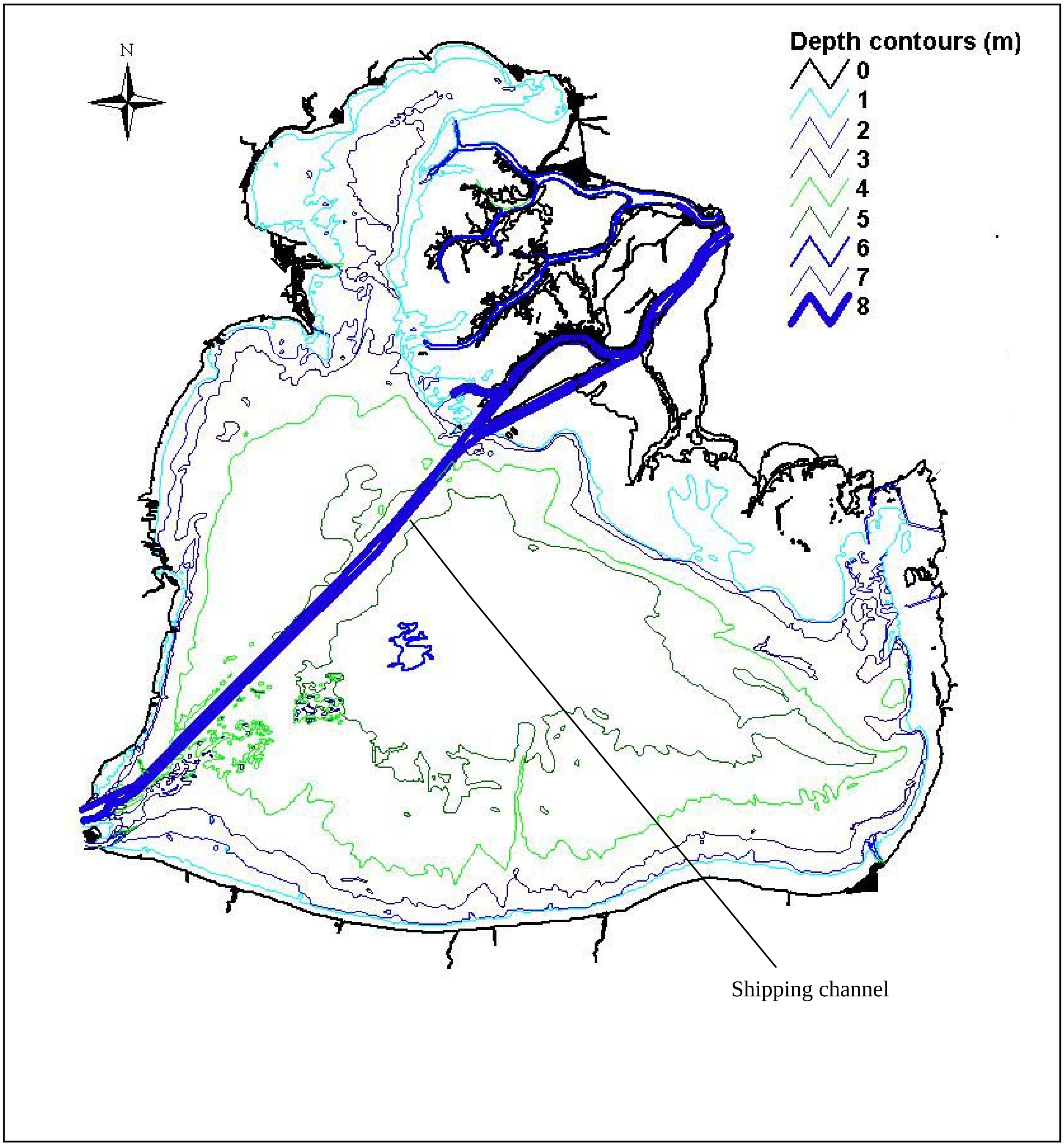
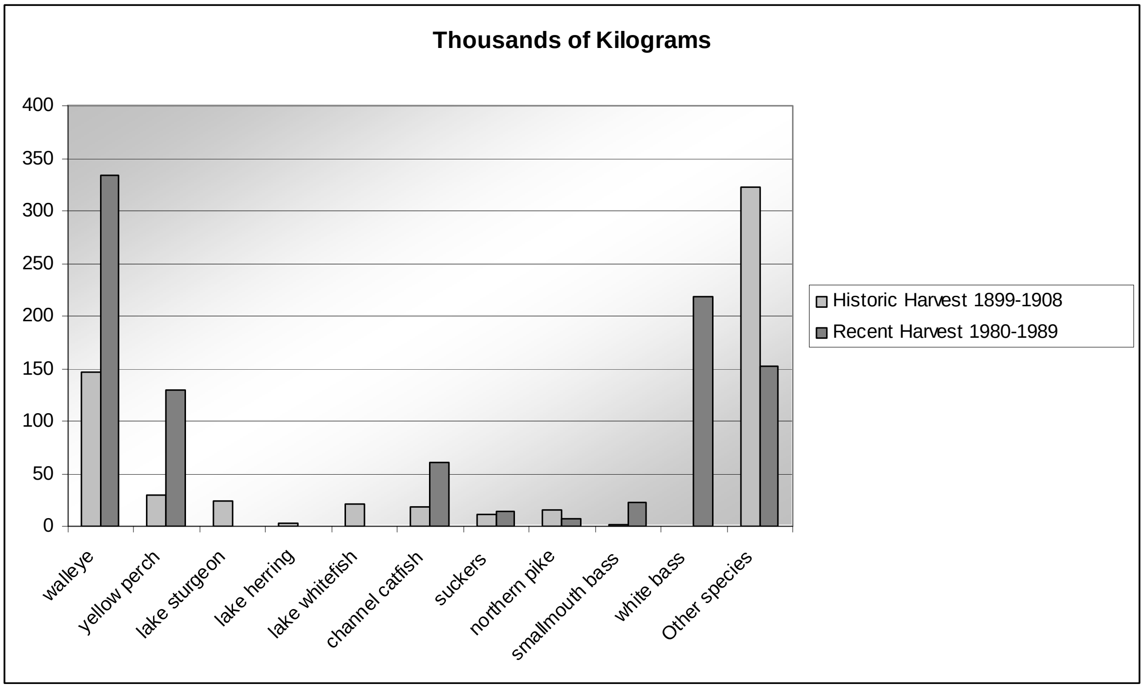


Figure 4. Bathymetric map of Lake St. Clair.



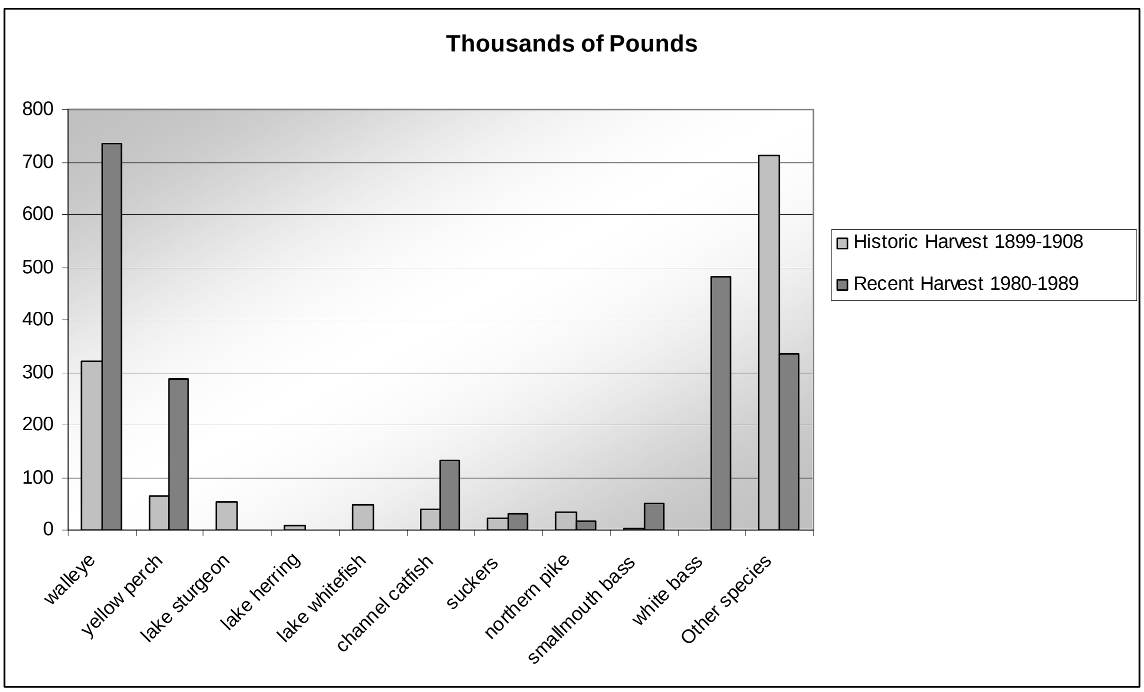


Figure 5. Lake St. Clair and Detroit River mean annual harvest for Michigan and Ontario