STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-4

Study No.: 466 **Title:** Fish community status in Saginaw Bay, Lake Huron

Period Covered: September 30, 2002 to October 1, 2003

Study Objective: To collect growth, abundance and other biological data with which to assess responses of the Saginaw Bay fish community to changing environmental and biological conditions.

Summary: In 2002, 43 trawl tows and 18 gillnet lifts were made in Saginaw Bay. All netting was performed in September and divided between the inner and outer bay areas. This report summarizes the results of trawl tows and gillnet lifts and compares them with data from prior surveys. Gillnetting in 2002 again affirmed the strength of the 1998 year class in walleye, yellow perch, and channel catfish. Overall abundance of walleyes as indicated by gillnet catch rate was unchanged in 2002. Abundance of age-1 walleyes in the 2002 gillnet catch suggests a moderate to strong 2001 year class is recruiting. Yellow perch abundance declined due partly to lower recruitment levels. Walleyes continue to grow very fast in the bay, with age-3 fish averaging 127% of the state average. Yellow perch growth rate continued to improve in 2002 based on the gillnet sample and now exceeds the state average. Walleye diet included a greater proportion of gizzard shad than in past years. The 2002 trawl catch rates for soft-rayed forage species continued a trend of higher values since 1997. In particular, spottail shiner, trout-perch, and round goby catch rates remained high in 2002. Trawling indicated yellow perch recruitment in 2002 was low again, the seventh weak year class in the last 11 years. Based on trawl catch rates, the 2002 walleye year class is one of the better year classes in the last 16 years. Growth rates of yellow perch caught in the trawl have slowed, but remained well above those observed before 1993. While no Eurasian ruffe have yet appeared in the trawl catch, round gobies were captured at trawl sites around the bay. Field sampling was conducted as scheduled during 2003. Data for 2003 have not yet been summarized.

Findings: Jobs 1, 2, and 3 were scheduled for 2002-03, and progress is reported below.

Job 1. Title: Relative abundance and community structure.–Gillnetting was performed in 2002 and 2003, with a total of 18 lifts made each year (Table 1). Sampling effort was divided between the inner and outer bay environments (Table 2). In 2002, 1,606 fish were collected comprising 20 species. Previously in this study, gillnet catch-per-unit-effort (CPUE) was expressed without the 38.1 mm mesh catch included. That mesh size, added in 1993, was omitted from CPUE calculations so as to maintain comparability among years. This year, with nine years of catch data from the 38.1 mm mesh size, gillnet CPUE is again expressed both without (Table 3) and with the 38.1 mm mesh catch (Table 4). Inclusion of the smallest mesh size in CPUE expressions mainly affected small species like yellow perch, white perch, gizzard shad, and round gobies (see Table 5 for a complete list of common and scientific names of fishes mentioned in this report).

Walleye CPUE remained largely unchanged in 2002 (tables 3 and 4). Walleye abundance is believed to be recruitment limited, with all current forms of recruitment contributing at their fullest level possible given the limitations they face (Fielder 2002). Yellow perch CPUE has

declined as the strong 1998 year class has diminished, probably largely from harvest but also other mortality sources (tables 3 and 4). On the whole, gillnet CPUE was down for many species in 2002 compared to past years and fewer species were represented overall.

The strength of the record 1998 walleye year class was still evident in the 2002 age structure (Table 6). Both percent and CPUE of age-1 walleyes (our principle index of walleye recruitment) in 2002 indicates a moderate to strong 2001 year class, perhaps on the scale of the 1997 year class, which was regarded as strong but paled by comparison to the record 1998 year class. This finding is consistent with the 2001 trawl catch rate of age-0 walleye which ranked 6th out of the last 16 years.

Walleye continue to grow extremely fast in Saginaw Bay (Table 7) which is a reflection of their low overall density relative to the abundant prey base (Fielder 2000). Age-3 walleyes grew at 127% of the state average growth rate. A walleye recovery plan was recently developed for Saginaw Bay and adopted walleye growth rate as one of the principle means with which to gauge recovery efforts (Fielder and Baker In Press). The target established is to have the walleye population increase such that the growth rate of age-3 fish eventually declines to 110% of the state average rate. That plan was developed utilizing many of the findings of this study and continued work will serve as an important measure of recovery progress in future years.

Yellow perch too have continued to show improved growth rate in Saginaw Bay (Table 7). After many years of slow growth, growth rate has reached and exceeded the state average rate. This is believed to be a result of an overall decline in abundance fueled by lower recruitment in recent years.

Walleye diet in 2002 shifted from a predominance of alewives to a mix of alewives and gizzard shad (Table 8). In past years, usually one of the clupeids dominated, either alewives or shad, probably a reflection of relative abundance in the pelagic fish community. This year of shared incidence in the diet may signal a shift or transition in dominance. Trawling confirmed an increase of gizzard shad in 2002. Relative weight and stock density indices for walleyes and yellow perch are presented in tables 9 and 10. Proportional stock density of walleyes declined in 2002, probably a reflection of the slow depletion of the 1998 year class and the recruitment of a moderately strong 2001 year class.

Age structure of yellow perch in the gillnet collection for 2002 followed a pattern similar to that of walleye (Table 11). The strength of the 1998 year class is still apparent but no longer dominates the overall age structure. Like walleye, there appears to be a strong 2001 year class recruiting, which is consistent with the 2001 age-0 trawling CPUE.

Channel catfish age structure in 2002 was strongly dominated by the 1998 year class, similar to other coolwater species in Saginaw Bay (Table 12). Channel catfish continue to grow slowly, a trend that has been occurring for some years. Haak (1987) speculated that it was probably due to both intra and interspecific competition within the bay. Generally, however, the bay is characterized by an overabundance of prey fish and is regarded as being underutilized by predators (Fielder 2000, Fielder and Baker In Press, Haas and Schaeffer 1992). Length / weight and Von Bertalanffy equations are provided in Table 13 for select species.

A total of 37 trawl hauls were made on the waters of inner Saginaw Bay in 2002 (Table 14) which collected 96,643 fish. Trawl CPUE for fish species commonly captured in Saginaw Bay fall trawls is summarized in Table 15. Spottail shiners were the most abundant species in the trawls, continuing a pattern of elevated abundance since 1997. The 2002 trout-perch catch rate (411), while much lower than the peak rate of 1998, remains well above the levels observed in

Saginaw Bay in the 1970s and 1980s. Round gobies were the third most abundant species captured in the trawls. Round goby abundance increased rapidly after 1999, the year they first showed up in the Bay trawl sampling, but CPUE leveled in 2002. Since nearly all alewives captured with trawls in Saginaw Bay are age-0 fish, the reduced catch rate in 2002 is an indication of a weaker cohort. The soft-rayed forage index value (sum of catch rates for alewives, emerald shiner, gizzard shad, rainbow smelt, round gobies, spottail shiner, and trout-perch) in 2002 remained well above the values observed prior to 1997. Yellow perch CPUE declined, mainly due to the low abundance of age-0 fish in 2002 (Table 16). In fact, the 2002 yellow perch cohort is one of seven weak year classes over the last 11 years. Age-0 walleye catch rates in 2002 were the second highest recorded since 1986, suggesting a good year class could result (Table 17). Trawl and gillnet monitoring of yearling walleye abundance in 2003 will provide better evaluation of walleye recruitment success in 2002. White perch CPUE declined for the second year in a row in 2002, continuing a pattern of oscillating abundance since they colonized the bay in the late 1980s (Table 18).

Round goby CPUE was 89 times higher in 2002 than in 1999, the year they were first observed in trawl samples in Saginaw Bay (Table 15). Examination of stomachs of fish caught in trawls in 2002 indicated that channel catfish, yellow perch, and freshwater drum are frequently preying on round gobies in Saginaw Bay. Impacts of round gobies on the fish community of Saginaw Bay will be evaluated with data collected during this study. The exotic Eurasian ruffe has been collected from Thunder Bay within the Lake Huron watershed but has not yet been documented from Saginaw Bay.

Mean length-at-age for yellow perch captured in trawls indicates improved growth rates since the mid-1990s (Table 19). Yellow perch growth in Saginaw Bay is believed to be density dependent (Haas and Schaeffer 1992). This improvement in growth is likely a density-dependent response to the dramatic decline in yellow perch abundance since 1989. An improvement in food resources may also be involved. Zebra mussels first became abundant throughout Saginaw Bay in 1992. The subsequent redirection of energy into benthic production may be contributing to improved yellow perch growth. Rautio (1995) demonstrated that yellow perch experienced improved growth in the presence of zebra mussels, likely as a result of a more diverse benthic macroinvertebrate community.

Trawling was conducted during September 2003. A total of 30 trawl hauls were made in the inner bay quadrants. No trawl hauls were made at outer bay sites in 2003 due to inclement weather. Lab processing of 2003 trawl and gillnet samples as well as data entry and analysis will be conducted during the winter and spring of 2004.

Job 2. Title: <u>Process and analyze the data.</u>–Analysis of the study data has been performed by Michigan Department of Natural Resources, Fisheries Division personnel from the Alpena Fisheries Research Station, and the Lake St. Clair Fisheries Research Station. Processing of diet samples collected in trawls during 2001 and 2002 are nearly complete, as a result of assistance in lab processing from the USGS, Great Lake Science Center personnel.

Job 3. Title: <u>Prepare annual, final, and other reports</u>.–This Performance Report summarizes data from 2002, and those reported previously in performance reports since 1998, under Fielder et al. (2000), and fulfills the requirements of Job 3.

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Table 1.–Number of fall gillnet sets (by location) for Saginaw Bay, Lake Huron, 1990-2003.

Station	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Pt. Lookout	–	–	1	1	1	4	3	1	1	1	1	1	1	1
AuGres River	–	2	1	–	1	1	1	1	1	1	1	1	1	1
Pt. AuGres	–	2	2	2	2	6	6	2	2	2	2	2	2	2
Black Hole	3	2	2	2	2	6	5	2	2	2	2	2	2	2
Coreyon Reef	2	2	2	2	2	3	2	2	2	2	2	2	2	2
Fish Pt.	–	–	–	2	2	3	5	2	2	2	2	2	2	2
North Island	–	–	–	–	1	6	5	2	2	2	2	2	2	2
Oak Pt.	–	–	–	1	1	6	5	2	2	2	2	2	2	2
Charity Is.	–	–	–	–	–	3	2	2	2	2	2	2	2	2
Tawas	–	–	–	–	–	2	2	2	2	2	2	2	2	2
Total	5	8	8	9	12	40	36	18	18	18	18	18	18	18

Table 2.–Number of fall gillnet sets in Saginaw Bay, Lake Huron, divided by inner and outer bay environments for 1990-2003.

Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
Inner	5	8	7	7	10	28	24	11	11	11	11	11	11	11
Outer	0	0	1	2	2	12	12	7	7	7	7	7	7	7
Total	5	8	8	9	12	40	36	18	18	18	18	18	18	18

Table 3.–Mean catch per unit of effort (CPUE; number per 305 m gillnet) by species for Saginaw Bay, 1994-2002, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995.

	1994 (3,355m) 11 sets		1995 (3,660m) 12 sets		1996 (4,270m) 14 sets		1997 (4,270m) 14 sets		1998 (4,270m) 14 sets		1999 (4,270m) 14 sets		2000 (4,270m) 14 sets		2001 (4,270m) 14 sets		2002 (4,270m) 14 sets	
	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE
Alewife	8	0.7	0	0	1	0.1	0	0	0	0	1	0.7	0	0	1	0.1	0	0
Bigmouth buffalo	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	0	0	0	0	0	1	0.7	0	0	1	0.1	10	0.7
Bowfin	0	0	0	0	1	0.1	1	0.1	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	3	0.2
Burbot	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.1	0	0
Carp	13	1.2	3	0.2	9	0.6	1	0.1	1	0.1	23	1.6	2	0.1	2	0.1	12	0.9
Channel catfish	40	3.6	17	1.4	123	8.8	68	4.9	94	6.7	214	15.3	123	8.8	150	10.7	180	12.9
Chinook salmon	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	7	0.5	3	0.2
Freshwater drum	86	7.8	105	8.8	398	28.4	266	19.0	67	4.8	244	17.4	183	13.1	19	13.6	123	8.8
Gizzard shad	45	4.1	47	3.9	207	14.8	31	2.2	560	40.0	167	11.9	24	1.7	57	4.1	98	7.0
Goldfish	0	0	0	0	3	0.2	1	0.1	0	0	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	0	0	1	0.1	0	0	2	0.1	0	0	0	0	0	0
Lake whitefish	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	2	0.1	0	0
Longnose gar	0	0	0	0	2	0.1	0	0	3	0.2	1	0.7	3	0.2	1	0.1	0	0
Longnose sucker	3	0.3	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	0	0	0	0
Northern pike	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	8	0.6	2	0.1	10	0.7
Northern redhorse	0	0	2	0.2	11	0.8	2	0.1	5	0.4	3	0.2	3	0.2	0	0	3	0.2
Quillback	4	0.4	10	0.8	16	1.1	10	0.7	0	0	42	3.0	27	1.9	24	1.7	20	1.4
Rainbow smelt	2	0.2	0	0	0	0	21	1.5	0	0	2	0.1	0	0	3	0.2	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	4	0.3	0	0	2	0.1	7	0.5	1	0.1	0	0	10	0.7
Round whitefish	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	4	0.3	0	0
Smallmouth bass	0	0	3	0.2	2	0.1	0	0	2	0.1	0	0	0	0	0	0	3	0.2
Stone cat	3	0.3	3	0.2	14	1.0	5	0.4	3	0.2	0	0	2	0.1	7	0.5	2	0.1
Walleye	163	14.8	161	13.4	180	12.9	158	11.3	176	12.6	154	11.0	99	7.1	114	8.1	112	8.0
White bass	1	0.1	13	1.1	7	0.5	9	0.6	11	0.8	8	0.6	3	0.2	2	0.1	10	0.7
White perch	318	28.9	105	8.8	398	28.4	266	19.0	47	3.36	285	20.4	325	23.2	179	12.8	143	10.2
White sucker	443	40.3	218	18.2	464	33.1	263	18.8	258	18.4	284	20.3	165	11.8	182	13.0	121	8.6
Yellow perch	343	31.2	313	26.4	832	59.4	430	30.7	173	12.4	313	22.4	204	14.6	672	48.0	175	12.5

Table 4.–Mean catch per unit of effort (CPUE; number per 335 m gillnet) by species for Saginaw Bay, 1994-2002, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995. Includes 38mm (1½ inch) mesh panel.

	1994 (3,685m) 11 sets		1995 (4,020m) 12 sets		1996 (4,690m) 14 sets		1997 (4,690m) 14 sets		1998 (4,690m) 14 sets		1999 (4,690m) 14 sets		2000 (4,690m) 14 sets		2001 (4,690m) 14 sets		2002 (4,690m) 14 sets	
	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE	Total catch	CPUE
Alewife	8	0.7	0	0	1	0.1	0	0	0	0	1	0.1	0	0	3	0.2	0	0
Bigmouth buffalo	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Black crappie	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bowfin	0	0	1	0.1	1	0.1	1	0.1	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	3	0.2
Burbot	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.7	0	0
Carp	12	1.1	3	0.2	9	0.6	1	0.1	1	0.1	22	1.6	2	0.1	3	0.2	12	0.9
Channel catfish	50	4.6	17	1.4	136	9.7	72	5.1	99	7.1	218	15.6	124	8.9	151	10.8	183	13.1
Chinook salmon	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	0	0	4	0.3
Freshwater drum	98	8.9	38	3.2	60	4.3	72	5.1	71	5.1	245	17.5	183	13.1	194	13.9	126	9.0
Gizzard shad	199	18.1	47	3.9	351	25.1	260	18.6	859	61.4	224	16.0	44	3.1	154	11.0	204	14.6
Goldfish	0	0	3	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	0	0	0	0	0	0	2	0.1	0	0	1	0.1	0	0
Lake whitefish	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	4	0.3	0	0
Longnose gar	0	0	0	0	2	0.1	1	0.1	3	0.2	1	0.1	3	0.2	1	0.1	0	0
Longnose sucker	8	0.7	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	0	0	0	0
Northern pike	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	9	0.6	2	0.1	2	0.1
Northern redhorse	0	0	2	0.2	11	0.8	2	0.1	5	0.1	3	0.2	3	0.2	5	0.4	3	0.2
Quillback	10	0.9	10	0.8	16	1.1	10	0.7	1	0.1	42	3.0	27	1.9	24	1.7	20	1.4
Rainbow smelt	2	0.2	0	0	0	0	22	1.6	0	0	2	0.1	0	0	5	0.4	0	0
Rainbow trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	4	0.3	0	0	2	0.1	7	0.5	1	0.1	0	0	10	0.7
Round goby	0	0	0	0	0	0	0	0	0	0	1	0.1	5	0.4	6	0.4	10	0.7
Round whitefish	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	7	0.5	0	0
Smallmouth bass	0	0	3	0.2	2	0.1	0	0	3	0.2	0	0	0	0	2	0.1	3	0.2
Stone cat	5	0.4	3	0.2	15	1.1	5	0.4	3	0.2	0	0	2	0.1	7	0.5	2	0.1
Walleye	179	16.2	165	13.8	180	12.9	159	11.4	184	13.1	181	12.9	99	7.1	123	8.8	119	8.5
White bass	3	0.3	15	1.2	7	0.5	17	1.2	27	1.9	9	0.6	3	0.2	3	0.2	10	0.7
White crappie	0	0	0	0	0	0	0	0	1	0.1	0	0	0	0	1	0.1	10	0.7
White perch	432	39.3	128	10.7	462	33.0	303	21.6	52	3.7	409	29.2	360	25.7	203	14.5	150	10.7
White sucker	473	43.0	217	18.1	467	33.4	264	18.9	261	18.6	296	21.1	165	11.8	186	13.3	126	9.0
Yellow perch	535	48.6	444	37.0	1,485	106.1	900	64.3	500	35.7	1,124	80.3	581	41.5	1,006	71.9	451	32.2

Table 5.–Common and scientific names of fishes and other aquatic organisms mentioned in this report.

Common name	Scientific name
Alewife	*Alosa pseudoharengus*
Bigmouth buffalo	*Ictiobus cyprinellus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bowfin	*Amia calva*
Brown trout	*Salmo trutta*
Burbot	*Lota lota*
Channel catfish	*Ictalurus punctatus*
Chinook salmon	*Oncorhynchus tshawytscha*
Common carp	*Cyprinus carpio*
Emerald shiner	*Notropis atherinoides*
Eurasian ruffe	*Gymnouphalus cernuus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Goldfish	*Carassius auratus*
Johnny darter	*Etheostoma nigrum*
Lake trout	*Salvelinus namaycusn*
Lake whitefish	*Coregonus clupeaformis*
Longnose gar	*Lepisosteus osseus*
Longnose sucker	*Catostomus catostomus*
Ninespine stickleback	*Pungitius pungitius*
Northern pike	*Esox lucius*
Northern redhorse	*Moxostoma macrolepidotum*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*
Rainbow smelt	*Osmerus mordax*
Rainbow trout	*Oncorhyhus mykiss*
Rockbass	*Ambloplites rupestris*
Round goby	*Neogobius melanostomus*
Round whitefish	*Prosopium cylindraceum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Smallmouth bass	*Micropterus dolomievi*
Spottail shiner	*Notropis hudsonius*
Stone cat	*Noturus flavus*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Sander vitreus*[1]
White bass	*Morone chrysops*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*
Zebra mussel	*Dreissena polymorpha*

[1] Formerly known as *Stizostedion vitreum*

Table 6.–Catch and percent contribution of walleye year classes to fall gillnet survey catches, Saginaw Bay, Lake Huron, 1997-2002. Catch-per-unit-effort (CPUE) is catch per 335m, N in parentheses.

Year class	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
	1997[1](18)			1998[1](18)			1999[1](18)		
1999	–	–	–	–	–	–	0	0.4	0.1
1998	–	–	–	0	5.2	0.7	1	52.8	6.8
1997	0	1.0	0.1	1	33.2	4.2	2	17.3	2.2
1996	1	2.5	0.3	2	1.3	0.2	3	1.3	0.2
1995	2	16.9	1.9	3	10.5	1.3	4	4.3	0.6
1994	3	28.9	3.2	4	18.8	2.4	5	6.1	0.8
1993	4	4.0	0.4	5	5.7	0.7	6	2.6	0.3
1992	5	5.0	0.6	6	4.4	0.6	7	6.1	0.8
1991	6	10.9	1.2	7	7.4	0.9	8	3.9	0.5
1990	7	8.5	0.9	8	6.1	0.8	9	2.6	0.3
1989	8	10.9	1.2	9	3.1	0.4	10	1.7	0.2
1988	9	8.5	0.9	10	3.5	0.4	11	0.9	0.1
1987	10	2.0	0.2	11	0.4	0.1	12	–	–
1986	11	0.5	0.1	12	0.4	0.1	13	–	–
1985	12	0.5	0.1	–	–	–	–	–	–
Mean	4.8			3.7			2.8		
Total		100	11.1		100	13.0		100	12.8
	2000[1](18)			2001[1](18)			2002[1](18)		
2002	–	–	–	–	–	–	0	4.7	0.3
2001	–	–	–	0	11.5	0.8	1	35.7	2.6
2000	0	–	–	1	13.7	1.0	2	14.0	1.0
1999	1	5.9	0.4	2	13.0	0.9	3	8.5	0.6
1998	2	46.2	3.0	3	32.5	2.4	4	17.8	1.4
1997	3	16.0	1.1	4	4.6	0.3	5	5.4	0.4
1996	4	0.8	0.1	5	2.3	0.2	6	3.9	0.3
1995	5	6.7	0.4	6	6.1	0.4	7	2.3	0.2
1994	6	3.4	0.2	7	3.1	0.2	8	2.3	0.2
1993	7	3.4	0.2	8	4.6	0.3	9	3.1	0.2
1992	8	11.8	0.8	9	5.3	0.4	10	0.8	0.1
1991	9	4.2	0.3	10	1.5	0.1	11	1.5	0.1
1990	10	1.7	0.1	11	1.5	0.1	12	–	–
1989	11	–	–	12	–	–	13	–	–
1988	12	–	–	13	–	–	14	–	–
Mean	2.6			3.4			3.0		
Total		100	6.6		100	7.3		100	7.2

[1] Data based on expanded netting effort catch to provide a larger sample size and therefore may differ slightly from value reported in tables 3 & 4, which are based solely on catch from traditional netting locations.

Table 7.–Mean length (mm) at age of walleyes and yellow perch from Saginaw Bay, Lake Huron, from fall gillnet data for 1994-2002, compared with Michigan average lengths from August-September catches. Saginaw Bay historic average for 1926-38 is also included for walleyes[2]. Standard error of the mean in parentheses. No means included for sample sizes less than 5 specimens. Growth Index is calculated with methodology from Schneider et al. (2000) and is expressed in inches.

Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	Michigan average[1]	Bay historic average[2]
Walleye											
0	207 (10.4)	224 (4.6)	– –	– –	227 (4.0)	– –	– –	200 (2.0)	203 (2.0)	180	–
1	348 (8.8)	346 (3.0)	352 (4.9)	330 (13.5)	341 (2.1)	360 (1.4)	333 (3.9)	350 (3.0)	344 (3.0)	250	254
2	426 (13.9)	– –	437 (3.7)	419 (4.2)	– –	438 (4.0)	436 (3.2)	426 (3.0)	434 (4.0)	338	320
3	473 (6.0)	470 (3.8)	478 (11.6)	468 (3.8)	482 (12.7)	– –	497 (7.0)	496 (4.0)	490 (8.0)	386	371
4	521 (5.3)	501 (7.2)	537 (16.4)	504 (5.6)	508 (11.0)	505 (10.0)	– –	524 (10.0)	504 (13.0)	437	411
5	537 (5.1)	543 (4.3)	517 (9.0)	536 (11.6)	496 (21.0)	544 (6.6)	512 (17.1)	– –	567 (13.0)	472	457
6	564 (6.0)	555 (5.3)	582 (8.6)	547 (6.2)	565 (8.2)	570 (14.0)	– –	553 (13.0)	588 (29.0)	516	483
7	613 (15.7)	572 (8.3)	568 (6.5)	576 (11.9)	551 (7.0)	560 (13.0)	– –	– –	– –	541	505
8	612 (17.0)	590 (12.2)	579 (14.2)	586 (12.9)	570 (9.2)	563 (17.7)	581 (13.8)	552 (9.0)	– –	561	533
9	– –	– –	619 (27.4)	579 (11.5)	612 (23.0)	588 (8.0)	576 (33.2)	578 (13.0)	– –	582	582
10	– –	– –	– –	– –	624 (22.5)	– –	– –	– –	– –	–	–
Growth index	+2.60	+2.23	+2.54	+2.00	+2.08	+2.45	+2.25	+2.09	+3.07		-0.60
Yellow perch											
0	– –	– –	– –	– –	– –	– –	– –	91 (7.0)	– –	84	–
1	– –	148 (0.9)	150 (2.2)	141 (1.2)	153 (1.9)	149 (1.2)	149 (5.6)	147 (1.0)	152 (1.0)	127	–
2	148 (1.6)	161 (2.3)	151 (1.0)	155 (1.1)	154 (1.0)	159 (0.9)	157 (0.8)	174 (2.0)	188 (3.0)	160	–
3	176 (3.3)	187 (3.5)	184 (1.8)	189 (2.2)	172 (1.9)	184 (2.5)	175 (1.6)	189 (2.0)	227 (2.0)	183	–
4	198 (1.8)	205 (2.3)	196 (1.6)	202 (1.9)	198 (4.6)	199 (2.2)	194 (2.2)	215 (2.0)	247 (3.0)	208	–
5	214 (2.1)	220 (4.6)	211 (1.9)	227 (3.3)	217 (2.4)	212 (2.2)	211 (3.1)	245 (3.0)	277 (7.0)	234	–
6	243 (8.1)	248 (9.2)	232 (4.4)	239 (4.4)	235 (5.2)	226 (2.4)	230 (3.8)	267 (11.0)	296 (16.0)	257	–
7	– –	– –	244 (7.2)	247 (6.4)	251 (6.5)	252 (4.9)	250 (3.2)	288 (10.0)	– –	277	–
8	– –	– –	– –	256 (16.5)	– –	269 (6.5)	264 (4.7)	– –	– –	292	–
9	– –	– –	– –	– –	– –	284 (6.6)	– –	– –	– –	302	–
Growth index	-0.49	0.00	-0.31	-0.46	-0.37	-0.46	-0.53	+0.42	+1.42		–

[1] From Schneider et al. (2000).
[2] From Hile (1954).

Table 8.–Incidence of void stomachs and percent-abundance of food items found in stomachs of walleyes from fall gillnets in Saginaw Bay, 1989-2002.

Year	Stomachs examined	% void	Unidentified fish remains	Percent-Abundance									
				Gizzard shad	Yellow perch	Spottail shiner	Rainbow smelt	Alewife	Ninespine stickleback	White sucker	Round goby	White perch	Channel catfish
1989	257	26	27	63	0	0	<1	8	1	0	0	<1	0
1990	508	37	22	76	0	0	<1	1	<1	0	0	<1	0
1991	669	36	34	63	<1	<1	0	2	0	<1	0	0	0
1992	171	56	62	2	2	2	14	17	0	2	0	0	0
1993	371	52	39	59	0	0	<1	2	0	0	0	0	0
1994	84	45	24	70	3	3	0	0	0	0	0	0	0
1995	291	45	31	28	1	<1	0	37	0	<1	0	1	0
1996	148	61	72	23	4	0	0	1	0	0	0	0	0
1997	204	35	59	12	3	7	0	17	0	0	0	2	0
1998	234	47	40	2	1	2	0	54	0	0	0	0	1
1999	231	49	36	<1	8	13	<1	41	0	0	0	<1	0
2000	119	48	57	9	2	1	0	22	0	0	1	1	8
2001	114	57	27	<1	2	<1	0	59	0	0	0	9	0
2002	129	63	49	23	0	0	0	20	0	0	8	0	0

Table 9.–Mean relative weight by length class[1] and all sizes combined for walleyes and yellow perch collected in gillnets during fall 1989-2002 from Saginaw Bay, Lake Huron. N=sample size for that year.

Year	Stock-quality	Quality-preferred	Preferred-memorable	All sizes combined	N
			Walleye		
1989	100	95	95	96	259
1990	98	102	97	98	508
1991	95	96	95	96	689
1992	87	88	90	89	171
1993	91	91	88	90	382
1994	88	88	90	88	155
1995	92	93	92	95	302
1996	90	92	90	90	267
1997	95	90	92	91	204
1998	91	89	88	90	231
1999	88	90	86	88	231
2000	107	90	81	88	116
2001	103	96	92	94	114
2002	87	86	88	87	127
			Yellow perch		
1989	NA	NA	NA	NA	NA
1990	98	97	92	97	101
1991	82	80	83	81	231
1992	82	86	86	84	202
1993	96	95	94	96	218
1994	99	96	92	96	203
1995	91	87	90	89	501
1996	96	93	90	95	1658
1997	94	95	93	94	962
1998	87	85	86	86	348
1999	79	90	87	82	528
2000	90	86	90	89	358
2001	103	97	92	100	825
2002	95	101	92	96	458

[1]See Table 10 for explanation of size classes.

Table 10.–Walleye and yellow perch proportional stock density (PSD)[1] and relative stock density (RSD-P, RSD-M)[2] in parentheses from fall gill-net data, 1994-2002 from Saginaw Bay, Lake Huron.

Species	1994	1995	1996	1997	1998	1999	2000	2001	2002
Walleye	96 (58,5)	76 (55,3)	83 (46,6)	96 (51,8)	63 (47,3)	55 (25,3)	93 (34,3)	85 (48,4)	60 (31,3)
Yellow perch	73 (9,1)	38 (6,1)	22 (2,0)	33 (5,1)	26 (3,0)	23 (4,1)	25 (7,1)	46 (9,2)	36 (14,2)

[1] Stock and quality size for walleye is 250mm and 380mm, respectively, yellow perch: 130mm and 200mm. Range of PSD values suggested as indicative of balance when the population supports a substantial fishery is 30-60 for walleye and 30-50 for yellow perch (Anderson and Weithman 1978).

[2] Preferred size for walleye is 510mm, memorable size is 630mm. For yellow perch, it is 250mm and 300mm, respectively (Anderson and Gutreuter 1983).

Table 11.–Age composition of yellow perch from the gillnet catch, Saginaw Bay, Lake Huron, 1993-2002.

	Survey Year									
Age	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
0	–	–	–	–	1	1	2	–	16	–
1	5	–	93	34	32	8	198	38	90	264
2	11	6	44	193	135	83	138	123	96	45
3	80	29	47	91	164	51	45	71	197	57
4	71	98	101	85	66	29	49	37	103	72
5	28	82	32	82	43	42	56	37	30	17
6	16	21	10	31	25	17	44	24	13	8
7	5	1	–	12	14	5	19	11	6	1
8	2	23	1	2	8	4	10	7	4	–
9	1	–	1	–	–	–	5	4	1	–
10	–	–	–	–	1	–	2	1	–	–
11	–	–	–	–	–	–	1	–	1	–
Number aged	218	241	328	531	488	240	569	353	557	464
Mean age	3.84	4.73	3.20	3.26	3.25	3.43	2.88	3.27	2.89	2.05

Table 12.–Age composition (percent) and mean length (mm) at age for channel catfish 1998-2002, Saginaw Bay. Sample size in parentheses. Means limited to sample sizes of at least five fish. State average is a mid-growing season average[1]. Growth index is calculated with the methodology from Schneider et al. (2000) and is expressed in inches.

	1998		1999		2000		2001		2002		
Age	Percent	Mean length	Percent	Mean length	Percent	Mean length	Percent	Mean length	Percent	Mean length	State average[1]
0	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
1	3.6 (2)	–	6.3 (5)	174	0.0 (0)	–	0.0 (0)	–	– –	–	165
2	14.3 (8)	279	0.0 (0)	–	21.7 (13)	231	5.0 (3)	–	1.1 (1)	–	284
3	46.4 (26)	310	6.3 (5)	310	8.3 (5)	256	45.0 (27)	293	5.6 (5)	330	345
4	14.3 (8)	340	66.3 (53)	343	10.0 (6)	324	8.0 (5)	333	61.1 (55)	330	401
5	3.6 (2)	403	5.0 (4)	–	35.0 (21)	358	20.0 (12)	372	1.1 (1)	–	450
6	0.0 (0)	–	7.5 (6)	432	11.7 (7)	373	17.0 (10)	403	10.0 (9)	412	490
7	5.4 (3)	–	1.3 (1)	–	5.0 (3)	–	3.0 (2)	–	13.3 (12)	449	523
8	0.0 (0)	–	3.8 (3)	–	0.0 (0)	–	2.0 (1)	–	4.5 (4)	–	559
9	3.6 (2)	–	1.3 (1)	–	5.0 (3)	–	0.0 (0)	–	3.3 (3)	–	589
10	3.6 (2)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	605
11	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
12	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
13	0.0 (0)	–	0.0 (0)	–	1.7 (1)	–	0.0 (0)	–	– –	–	–
14	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
15	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
16	0.0 (0)	–	0.0 (0)	–	1.7 (1)	–	0.0 (0)	–	– –	–	–
17	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
18	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
19	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	– –	–	–
Total	100 (56)	327	100 (80)	329	100 (60)	328	100 (60)	326	100 (90)	349	
Average age	4.18		4.43		4.80			4.15		4.88	
Growth index		-1.44		-1.38		-3.34		-2.82		-2.32	

[1]State average from Schneider et al. (2000)

Table 13.–Length-weight regression equations and von Bertalanffy growth equations for select species. Length/weight equations are based on 2001 fall gillnet collections in Saginaw Bay, Lake Huron. Length/weight equation Logs are base 10, weight (wt) is in grams, and 1ength (len) is in mm. Von Bertalanffy equations are based on mean length-at-age data from the fall gillnet collections 1998-2002 where 't' is age in years.

Species	Length/Weight Equation	Len/Wt r^2	Von Bertalanffy Equation	K	L∞	t_o
Walleye	log(wt)=3.062 log(len)-5.205	0.97	$L_t=619[1-e^{-0.3331(t+2.09)}]$	0.3331	619	-2.09
Yellow perch	log(wt)=3.137 log(1en)-5.208	0.92	$L_t=278[1-e^{-0.2450(t+2.19)}]$	0.2450	278	-2.19
Channel catfish	log(wt)=3.390 log(1en)-6.067	0.98	$L_t=670[1-e^{-0.1312(t+1.57)}]$	0.1312	670	-1.57

Table 14.–Location of trawl stations and number of tows performed in Saginaw Bay, 1990-2003. All sampling was conducted in fall except where indicated otherwise.

Quadrant Location	Site description	1990	1991	1992	1993	1994	1995[1]	1996	1997	1998	1999	2000	2001	2002	2003
Northeast	North Island & Wildfowl Bay	5	4	16	5	6	6	6	13	13	9	9	3	10	4
Southeast	Fish Point	4	4	6	5	3	9	6	16	12	15	6	3	7	9
Southwest	Pinconning	4	4	3	13	13	9	12	15	17	20	6	9	10	7
Northwest	AuGres	3	4	11	15	10	15	6	23	22	20	6	12	10	10
Total		16	16	36	38	32	39	30	31	27	27	33	33[2]	43[2]	30
Study total															686[3]

[1] Total for northwest quadrant includes six experimental trawls near Charity Islands
[2] Total number of tows includes 6 tows made at Outer Bay sites.
[3] Study total includes 15 tows from 1989.

Table 15.–Mean catch-per-unit effort of fish collected from trawling in Saginaw Bay, Lake Huron, during fall 1990-2002. Total number of tows is in parentheses. Soft-rayed forage index value is the sum of catch rates for alewife, emerald shiner, gizzard shad, rainbow smelt, round goby, spottail shiner, and trout-perch. See Table 3 for complete listing of scientific names for each species.

Species	1991 (16)	1992 (37)	1993 (38)	1994 (32)	1995 (39)	1996 (30)	1997 (31)	1998 (27)	1999 (27)	2000 (30)	2001 (27)	2002 (35)
Alewife	80	302	191	48	307	99	301	1,590	82	337	1,242	348
Bluegill	0	0	0	<1	0	<1	0	0	0	0	0	0
Burbot	0	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	<1	<1	1	6	3	6	2	3	4	6	7	5
Common carp	3	3	3	9	7	4	4	7	6	6	9	6
Emerald shiner	15	9	1	0	0	1	13	1	1	1	1	1
Freshwater drum	25	3	9	28	28	16	5	26	9	16	10	11
Gizzard shad	50	<1	19	8	6	23	18	23	3	3	9	19
Johnny darter	<1	12	10	11	29	21	20	5	6	4	1	<1
Lake whitefish	0	<1	0	0	1	<1	1	0	<1	<1	0	1
Pumpkinseed	<1	0	0	0	0	<1	0	0	2	0	0	<1
Quillback	<1	<1	1	1	1	1	<1	0	4	1	4	2
Rainbow smelt	44	280	468	58	22	15	1,585	70	32	390	496	147
Rock bass	0	0	0	0	0	<1	0	<1	5	<1	0	<1
Round goby	0	0	0	0	0	0	0	0	4	127	385	356
Shorthead redhorse	0	0	0	<1	0	0	0	0	<1	0	0	<1
Spottail shiner	124	182	97	204	373	209	809	665	1,935	1,011	863	967
Trout perch	166	200	416	513	514	474	733	1,730	406	619	422	411
Walleye	6	1	1	1	1	1	3	10	7	2	2	4
White bass	6	<1	2	6	1	<1	4	2	<1	<1	0	<1
White perch	404	92	28	183	528	277	416	346	141	895	544	339
White sucker	12	8	10	10	7	8	28	12	10	7	24	26
Yellow perch	177	70	38	24	126	85	122	170	90	37	145	66
Soft-rayed forage index value	479	973	1,192	831	1,222	821	3,459	4,079	2,463	2,488	3,418	2,249

Table 16.–Number of young-of-the-year yellow perch caught per ten-minute tow (CPUE) from Saginaw Bay, Lake Huron and their mean total length, fall 1970-2002[1].

Year	CPUE	Mean total length (mm)
1970	29.5	96.5
1971	20.2	91.4
1972	13.9	83.8
1973	30.6	91.4
1974	27.9	88.9
1975	247.9	88.9
1976	11.1	91.4
1977	52.9	91.4
1978	99.8	86.4
1979	166.7	78.7
1980	39.0	86.4
1981	71.3	83.8
1982	686.7	76.2
1983	251.9	76.2
1984	171.0	78.7
1985	147.8	78.7
1986	71.4	73.7
1987	131.5	81.3
1988	56.6	76.2
1989	252.8	71.1
1990	39.0	79.5
1991	110.8	70.2
1992	7.1	76.2
1993	0.5	90.7
1994	3.9	85.0
1995	98.9	72.8
1996	37.3	81.9
1997	83.3	73.8
1998	112.5	76.1
1999	19.8	92.4
2000	8.6	83.2
2001	117.2	76.8
2002	30.7	76.3

[1] Data prior to 1990 from Haas and Schaeffer (1992).

Table 17.–Number of age-0 walleyes caught, number of trawl tows, and age-0 walleye catch rate (expressed as mean catch per 10-minute tow) for fall trawls on Saginaw Bay from 1986 to 2002.

Year	Number of age-0 walleyes captured	Number of trawl tows	Age-0 walleye catch rate
1986	20	53	0.43
1987	34	86	0.46
1988	39	80	0.59
1989	19	15	1.27
1990	0	16	0.00
1991	28	16	1.89
1992	6	37	0.16
1993	1	38	0.02
1994	22	35	0.64
1995	14	39	0.36
1996	0	30	0.00
1997	83	34	2.18
1998	149	27	8.55
1999	20	27	0.74
2000	5	30	0.30
2001	27	26	0.98
2002	84	35	2.54

Table 18.–White perch catch from trawling effort, fall 1985-2002, Saginaw Bay, Lake Huron[1].

Year	Total catch	Number of tows	Number of minutes	Number per tow	Number per minute
1985	0	NA	NA	–	–
1986	606	167	1,457	3.6	0.4
1987	7,514	252	2,321	29.8	3.2
1988	41,427	248	2,181	167.0	19.0
1989	34,817	15	150	2,321.1	232.1
1990	10,739	16	158	671.2	69.0
1991	6,463	16	149	403.9	43.5
1992	3,295	36	360	91.5	9.2
1993	1,076	38	419	27.9	2.6
1994	6,062	32	320	183.0	18.9
1995	19,002	36	360	528.2	52.8
1996	8,130	30	306	277.2	26.6
1997	12,873	31	320	416.4	40.2
1998	7,415	27	245	345.8	30.3
1999	2,400	27	170	141.2	14.1
2000	26,559	30	270	894.8	98.4
2001	12,601	25	210	484.6	60.0
2002	10,508	35	318	339.7	33.0

[1] Data prior to 1990 from Haas and Schaeffer (1992).

Table 19.–Mean length (mm) at age for yellow perch from fall Saginaw Bay trawls, 1986-2002[1].

Age	Survey year																
	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Males																	
1	118	120	119	120	124	124	124	131	145	135	132	131	123	136	140	137	129
2	137	137	137	141	146	146	149	155	159	169	166	166	146	154	157	170	166
3	154	152	150	157	165	167	164	178	176	179	189	195	172	155	169	182	186
4	184	168	164	170	175	184	181	194	191	192	200	202	202	183	172	192	202
5	199	190	177	185	186	201	187	202	200	203	211	219	211	196	210	237	217
6	209	189	201	194	195	212	209	213	200	211	219	219	219	–	218	264	–
7	249	223	211	210	210	242	224	262	222	236	247	234	236	–	238	–	–
Females																	
1	121	122	123	123	126	127	127	132	148	142	137	136	129	140	143	140	135
2	145	143	143	149	157	155	159	169	172	179	183	179	145	160	171	179	211
3	173	166	160	169	176	179	173	188	195	193	203	210	179	178	186	198	220
4	197	190	183	184	201	202	204	210	214	211	220	232	208	177	174	216	242
5	233	214	207	208	215	221	236	242	235	225	233	230	227	203	203	228	–
6	265	226	217	222	235	246	249	245	246	247	260	286	250	252	231	–	255
7	222	256	245	246	246	273	244	283	296	276	–	279	–	240	233	–	–

[1] Data prior to 1990 from Haas and Schaeffer (1992).