STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-3

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

Period Covered: September 30, 2001 to October 1, 2002

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 2001, 33 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. The 2001 trawl catch rates for soft-rayed forage species continued a trend of higher values since 1997. In particular, alewife, spottail shiner, and trout-perch catch rates remained high in 2001. Trawling indicated yellow perch recruitment in 2001 was the highest since 1989. Based on trawl catch rates, the 2000 walleye year class is much less abundant than the record 1998 year class, and below average for the period from 1986 to 1999. 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. Round goby catch rates increased nearly 100x from 1999 to 2001. Gillnetting in 2001 again affirmed the strength of the 1998 walleye year class. That single year class comprised over 32% of the walleye gillnet catch in 2001. The 1997 walleye year class that was originally strong is now largely depleted. The catch rate of walleyes in 2001 was higher than 2000 but remained relatively low. Despite the strong 1998 year class, growth rate of walleyes remained strong in 2001. Yellow perch catch rate in gillnets increased greatly in 2001, and is also attributed to strong 1997 and 1998 year classes. Yellow perch growth rate based on specimens from gillnet catch again increased to (or beyond) the state average. Field sampling was conducted as scheduled during 2002. Data for 2002 have not yet been summarized.

Findings: Jobs 1, 2, and 3 were active this year, and progress is reported below.

Job 1. Title: Relative abundance and community structure.–Gillnetting was performed in 2001 and 2002, 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 2001, 2,224 fish were collected comprising 27 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 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 (see Table 5 for a complete list of common and scientific names of fishes mentioned in this report), white perch, gizzard shad, and round goby.

Walleye CPUE rebounded slightly in 2001 from its lowest level the previous year (2000) (Tables 3 and 4; Fielder et al. 2000). Declines in gillnet CPUE during the early 1990s were attributed partly to changes in gear efficiency (Fielder et al. 2000). Trends in abundance since 1994 through 1999 appeared to largely reflect a static walleye population and this was mirrored by trends in the sport fishery as well. The marked drop in abundance in 2000, however, reflected the effects of at least three weak year classes exerting their effect on the population. The slight rise in CPUE in 2001 is due principally to the recruitment of the 1997 and 1998 year classes, both of which were strong. Trends in abundance for other notable species included a substantial increase in yellow perch CPUE. This is attributed to strong 1997 and 1998 year classes as well. Other species that increased in 2001 included channel catfish, freshwater drum, and white sucker (Tables 3 and 4). White perch declined in 2001.

The record 1998 walleye year class remained strong in 2001, accounting for over 32% of the entire gillnet catch (Table 6). The 1997 walleye year class was also very strong but has now greatly diminished. The sport fishery has been depending heavily on these two year classes since they first recruited to the 381 mm (15 inch) minimum length limit. The fishery's dependence on these two strong year class has been intensified by weakness of the 1992, 1993, and 1996 year classes. Walleye survival in 2001 actually increased over that of 2000 to 55% (see Federal Aid Performance Report for Study 436). The strong 1997 and 1998 year classes, however, have not fully been represented so far in the tagging operation that was used to estimate survival. It appears that the 1999 year class was weak and the 2000 year class was moderate (Table 6). The 2002 survey data (collected in September of 2002) have not yet been analyzed but early indications are that the 2001 walleye year class is at least moderate in strength. The weak year classes of 1992, 1993, and 1996 have shown slightly stronger than expected in the gillnet catch in recent years which may reflect immigration of Lake Erie walleyes, or might be attributed to aging error as walleye scales are more difficult to accurately age as they get older.

Walleye growth rate continued to be well above state and Saginaw Bay historical averages in 2001 (Table 7). Despite the strength of the 1997 and 1998 year classes, walleyes from those cohorts grew very fast. Age-3 walleyes in 2001 (1998 year class) grew at 128% of the state average rate. The Lake Huron Basin Team recently adopted a walleye recovery goal for walleye density such that the growth rate of age-3 fish would decline to 110% of the state average rate. Clearly, the walleye population based on this criterion is still well below carrying capacity of the habitat and prey base. Based on the findings of this and other Federal Aid studies, a plan for the further recovery of walleye in Saginaw bay has been formulated and proposed within the Fisheries Division of the Michigan DNR. If implemented, this study will serve as one of the principle measures of effects of management initiatives and progress towards recovery objectives.

Alewives continued to dominate the diet of walleyes in 2001 (Table 8) to the exclusion of many otherwise available and abundant prey resources. Walleye condition generally increased across size ranges in 2001 and was very high overall (Table 9). The proportional stock density (PSD) of walleye remained high in 2001 (Table 10).

Yellow perch age structure from the gillnet catch also indicated strong 1997 and 1998 year classes (Table 11). Curiously the relative abundance of the 1997 year class (age-4s in 2001) was greater than the previous year. This, coupled with the strength of the 1998 year class, made for a substantial rise in overall yellow perch CPUE (Tables 3 and 4). Mean age of yellow perch decreased slightly in 2001. The yellow perch PSD increased in 2001 probably reflecting the strong showing of the 1997 and 1998 year classes (Table 10). Yellow perch total annual mortality rate was estimated at 58% in 2001 using the Robson-Chapman method, a moderate rate for an exploited perch population. Yellow perch growth rate, derived from gillnet samples, has improved to meet or exceed the state average rate (Table 7). This trend of improved growth was confirmed by the trawl data. Condition of yellow perch rose substantially in 2001, a change consistent with improved growth (Table 9).

Like yellow perch and walleyes, the 1998 channel catfish year class appeared strong in 2001 (Table 12). Channel catfish growth rate remained slow in 2001, well below the state average (Table 12). A fundamental difference in forage habits or physiology must exist between walleye, which grow very well in Saginaw Bay, and channel catfish, which continually exhibit slow growth. Possible aging errors may also exist in the channel catfish ages. Channel catfish exhibited a total annual mortality rate of 55%. The length/weight relationship and von Bertalanffy growth equation for channel catfish and other select species is presented in Table 13.

A total of 27 trawl hauls were made on the waters of inner Saginaw Bay in 2001 (Table 14), collecting 77,275 fish. Trawl CPUE is summarized in Table 15. Alewives were the most abundant species in the trawls, nearly equaling the peak catch rate of 1998. Since nearly all alewives captured with trawls in Saginaw Bay were age-0 fish, the high catch rate in 2001 was an indication of a cohort similar in strength to the 1998 year class. Spottail shiner catch rates declined slightly, but remained much higher than the catch rates observed prior to 1997. The 2001 trout-perch catch rate (422), while much lower than the peak rate of 1998, remains well above the levels observed in Saginaw Bay in the 1970s and 1980s. Similar to alewives, rainbow smelt catch rates in the Bay varied greatly between years and consisted mainly of age-0 smelt. In 2001, the rainbow smelt CPUE remained at a level typical of most of the 1990s. 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) was the third highest since 1991. A trend of high soft-rayed forage index values has continued since 1997. Yellow perch CPUE increased, mainly due to the highest age-0 CPUE since 1989 (Table 16). Age-0 walleye catch rates increased from 2000, but remained near the average for the period from 1986 to 2001 (Table 17). White perch CPUE declined from 2000, continuing a pattern of oscillating abundance since they colonized the bay in the late 1980's (Table 18).

The exotic round goby was collected with trawls from all grids sampled during September 2001. Round goby CPUEs were 96 times higher in 2001 than in 1999, the year they first were seen in trawl samples on Saginaw Bay (Table 15). Examination of stomachs of fish caught in trawls in 2001 indicated that channel catfish, yellow perch, and freshwater drum frequently prey on round gobies. 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 indicated improved growth rates since the mid-1990's (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 macrovinvertebrate community.

Trawling was conducted during September 2002. A total of 37 trawl hauls were made in the inner bay quadrants. An additional six trawl hauls were made at two sites in the outer bay. Lab processing of 2002 trawl and gillnet samples as well as data entry and analysis will be conducted during the winter and spring of 2003.

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 Mt. Clemens Fisheries Research Station. Processing of diet samples collected in trawls during 1999, 2000, and 2001 are nearly complete, as a result of assistance in lab processing from the USGS Great Lake Science Center personnel.

Job 3. Title: Prepare annual, final and other reports.–This Performance Report summarizes data from 2001, 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, 1990-2002.

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

Location	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
Inner	5	8	7	7	10	28	24	11	11	11	11	11	11
Outer	0	0	1	2	2	12	12	7	7	7	7	7	7
Total	5	8	8	9	12	40	36	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, 1993-2001, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995. Netting efforts in 1993, 1994, and 1995 were 11 sets, 3,050m; 11 sets, 3,355m; and 12 sets, 3,660m; respectively. Netting efforts in 1996-2001 were standardized at 14 sets, 4,270m. TC = Total catch.

	1993		1994		1995		1996		1997		1998		1999		2000		2001	
	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE
Alewife	0	0	8	0.7	0	0	1	0.1	0	0	0	0	1	0.7	0	0	1	0.1
Bigmouth buffalo	7	0.7	1	0.1	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	1	0.7	0	0	1	0.1
Bowfin	0	0	0	0	0	0	1	0.1	1	0.1	0	0	0	0	0	0	0	0
Brown trout	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1
Burbot	3	0.3	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.1
Carp	5	0.5	13	1.2	3	0.2	9	0.6	1	0.1	1	0.1	23	1.6	2	0.1	2	0.1
Channel catfish	58	5.8	40	3.6	17	1.4	123	8.8	68	4.9	94	6.7	214	15.3	123	8.8	150	10.7
Chinook salmon	5	0.5	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	7	0.5
Freshwater drum	53	5.3	86	7.8	105	8.8	398	28.4	266	19.0	67	4.8	244	17.4	183	13.1	19	13.6
Gizzard shad	92	9.2	45	4.1	47	3.9	207	14.8	31	2.2	560	40.0	167	11.9	24	1.7	57	4.1
Goldfish	0	0	0	0	0	0	3	0.2	1	0.1	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.1	0	0	0	0
Lake whitefish	1	0.1	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	2	0.1
Longnose gar	0	0	0	0	0	0	2	0.1	0	0	3	0.2	1	0.7	3	0.2	1	0.1
Longnose sucker	1	0.1	3	0.3	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	0	0
Northern pike	0	0	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	8	0.6	2	0.1
Northern redhorse	0	0	0	0	2	0.2	11	0.8	2	0.1	5	0.4	3	0.2	3	0.2	0	0
Quillback	3	0.3	4	0.4	10	0.8	16	1.1	10	0.7	0	0	42	3.0	27	1.9	24	1.7
Rainbow smelt	5	0.5	2	0.2	0	0	0	0	21	1.5	0	0	2	0.1	0	0	3	0.2
Rainbow trout	3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	0	0	4	0.3	0	0	2	0.1	7	0.5	1	0.1	0	0
Round whitefish	3	0.3	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	4	0.3
Smallmouth bass	1	0.1	0	0	3	0.2	2	0.1	0	0	2	0.1	0	0	0	0	0	0
Stone cat	4	0.4	3	0.3	3	0.2	14	1.0	5	0.4	3	0.2	0	0	2	0.1	7	0.5
Walleye	380	38.0	163	14.8	161	13.4	180	12.9	158	11.3	176	12.6	154	11.0	99	7.1	114	8.1
White bass	10	1.0	1	0.1	13	1.1	7	0.5	9	0.6	11	0.8	8	0.6	3	0.2	2	0.1
White perch	28	2.8	318	28.9	105	8.8	398	28.4	266	19.0	47	3.36	285	20.4	325	23.2	179	12.8
White sucker	358	35.8	443	40.3	218	18.2	464	33.1	263	18.8	258	18.4	284	20.3	165	11.8	182	13.0
Yellow perch	621	62.1	343	31.2	313	26.4	832	59.4	430	30.7	173	12.4	313	22.4	204	14.6	672	48.0

Table 4.–Mean catch per unit of effort (CPUE; number per 335 m gillnet) by species for Saginaw Bay, 1994-2001, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995. Includes 38mm (1½ inch) mesh panel. Netting efforts in 1994, and 1995 were 11 sets, 3,685m and 12 sets, 4,020m; respectively. Netting efforts in 1996-2001 were standardized at 14 sets, 4,690m. TC = Total catch.

	1994		1995		1996		1997		1998		1999		2000		2001	
	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE	TC	CPUE
Alewife	8	0.7	0	0	1	0.1	0	0	0	0	1	0.1	0	0	3	0.2
Bigmouth buffalo	1	0.1	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
Bowfin	0	0	1	0.1	1	0.1	1	0.1	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
Burbot	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.7
Carp	12	1.1	3	0.2	9	0.6	1	0.1	1	0.1	22	1.6	2	0.1	3	032
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
Chinook salmon	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	0	0
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
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
Goldfish	0	0	3	0.2	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
Lake whitefish	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	4	0.3
Longnose gar	0	0	0	0	2	0.1	1	0.1	3	0.2	1	0.1	3	0.2	1	0.1
Longnose sucker	8	0.7	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	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
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
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
Rainbow smelt	2	0.2	0	0	0	0	22	1.6	0	0	2	0.1	0	0	5	0.4
Rainbow trout	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
Round goby	0	0	0	0	0	0	0	0	0	0	1	0.1	5	0.4	6	0.4
Round whitefish	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0	7	0.5
Smallmouth bass	0	0	3	0.2	2	0.1	0	0	3	0.2	0	0	0	0	2	0.1
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
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
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
White crappie	0	0	0	0	0	0	0	0	1	0.1	0	0	0	0	1	0.1
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
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
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

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*
Tiger musky	*Esox masquinongy*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Stizostedion vitreum*
White bass	*Morone chrysops*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*
Zebra mussel	*Dreissena polymorpha*

Table 6.–Catch and percent contribution of walleye year classes from fall gillnet surveys, Saginaw Bay, Lake Huron, 1996-2001. Catch-per-unit-effort (CPUE) is catch per 335m, N in parentheses.

	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
Year class	1996[a](21.3)			1997[a](18)			1998[a](18)		
1998	–	–	–	–	–	–	0	5.2	0.7
1997	–	–	–	0	1.0	0.1	1	33.2	4.2
1996	0	0	0.0	1	2.5	0.3	2	1.3	0.2
1995	1	17.6	2.2	2	16.9	1.9	3	10.5	1.3
1994	2	28.0	3.4	3	28.9	3.2	4	18.8	2.4
1993	3	4.6	0.6	4	4.0	0.4	5	5.7	0.7
1992	4	3.1	0.4	5	5.0	0.6	6	4.4	0.6
1991	5	11.9	1.5	6	10.9	1.2	7	7.4	0.9
1990	6	12.3	1.5	7	8.5	0.9	8	6.1	0.8
1989	7	11.1	1.4	8	10.9	1.2	9	3.1	0.4
1988	8	5.4	0.7	9	8.5	0.9	10	3.5	0.4
1987	9	4.6	0.6	10	2.0	0.2	11	0.4	0.1
1986	10	1.5	0.2	11	0.5	0.1	12	0.4	0.1
1985	11	–	–	12	0.5	0.1	–	–	–
1984	12	–	–	13	–	–	–	–	–
1983	13	–	–	14	–	–	–	–	–
Mean	4.1			4.8			3.7		
Total		100	12.3		100	11.1		100	13.0
	1999[a](18)			2000[a](18)			2001[a](18)		
	–	–	–	–	–	–	0	11.5	0.8
2000	–	–	–	0	–	–	1	13.7	1.0
1999	0	0.4	0.1	1	5.9	0.4	2	13.0	0.9
1998	1	52.8	6.8	2	46.2	3.0	3	32.5	2.4
1997	2	17.3	2.2	3	16.0	1.1	4	4.6	0.3
1996	3	1.3	0.2	4	0.8	0.1	5	2.3	0.2
1995	4	4.3	0.6	5	6.7	0.4	6	6.1	0.4
1994	5	6.1	0.8	6	3.4	0.2	7	3.1	0.2
1993	6	2.6	0.3	7	3.4	0.2	8	4.6	0.3
1992	7	6.1	0.8	8	11.8	0.8	9	5.3	0.4
1991	8	3.9	0.5	9	4.2	0.3	10	1.5	0.1
1990	9	2.6	0.3	10	1.7	0.1	11	1.5	0.1
1989	10	1.7	0.2	11	–	–	12	–	–
1988	11	0.9	0.1	12	–	–	13	–	–
1987	12	–	–	13	–	–	14	–	–
1986	13	–	–	14	–	–	15	–	–
Mean	2.8			2.6			3.4		
Total		100	12.8		100	6.6		100	7.3

[a] Data based on expanded netting effort catch to provide a larger sample size and therefore differs 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 1994-2001, compared with Michigan average lengths from August-September catches. Saginaw Bay historic average for 1926-38 is also included for walleyes[b]. 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).

Age	1994	1995	1996	1997	1998	1999	2000	2001	Michigan average[a]	Bay historic average[b]
Walleye										
0	207 (10.4)	224 (4.6)	– –	– –	227 (4.0)	– –	– –	200 (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)	250	254
2	426 (13.9)	– –	437 (3.7)	419 (4.2)	– –	438 (4.0)	436 (3.2)	426 (3.0	338	320
3	473 (6.0)	470 (3.8)	478 (11.6)	468 (3.8)	482 (12.7)	– –	497 (7.0)	496 (4.0)	386	371
4	521 (5.3)	501 (7.2)	537 (16.4)	504 (5.6)	508 (11.0)	505 (10.0)	– –	524 (10.0)	437	411
5	537 (5.1)	543 (4.3)	517 (9.0)	536 (11.6)	496 (21.0)	544 (6.6)	512 (17.1)	– –	472	457
6	564 (6.0)	555 (5.3)	582 (8.6)	547 (6.2)	565 (8.2)	570 (14.0)	– –	553 (13.0)	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		-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)	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)	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)	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)	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)	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)	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		–

[a] From Schneider et al. (2000).
[b] 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, 1989-2001.

			Percent-Abundance										
Year	Stomachs examined	% void	Unidentified fish remains	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

Table 9.–Mean relative weight by length class[a] and all sizes combined for walleyes and yellow perch collected in gillnets during fall 1989-2001 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
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

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

Table 10.–Walleye and yellow perch proportional stock density (PSD)[a] and relative stock density (RSD-P and RSD-M)[b] in parentheses from fall gill-net data, 1993-2001 from Saginaw Bay, Lake Huron.

Species	1993	1994	1995	1996	1997	1998	1999	2000	2001
Walleye	93(40,3)	96(58,5)	76(55,3)	83(46,6)	96(51,8)	63(47,3)	55(25,3)	93(34,3)	85(48,4)
Yellow perch	45(3,0)	73(9,1)	38(6,1)	22(2,0)	33(5,1)	26(3,0)	23(4,1)	25(7,1)	46(9,2)

[a] 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).
[b] 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, 1993-2001.

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

Table 12.–Age composition (percent) and mean length (mm) at age for channel catfish 1997-2000, Saginaw Bay. Sample size in parentheses. Means limited to sample sizes of at least five fish. State average is a mid-growing season average[a]. Growth index is calculated with the methodology from Schneider et al. (2000).

	1997		1998		1999		2000		2001		
Age	Percent	Mean length	Percent	Mean length	Percent	Mean length	Percent	Mean length	Percent	Mean length	[a]State average
0	0.0 (0)	–	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
1	0.0 (0)	–	3.6 (2)	–	6.3 (5)	174	0.0 (0)	–	0.0 (0)	–	165
2	27.8 (15)	236	14.3 (8)	279	0.0 (0)	–	21.7 (13)	231	5.0 (3)	–	284
3	24.1 (13)	328	46.4 (26)	310	6.3 (5)	310	8.3 (5)	256	45.0 (27)	293	345
4	7.4 (4)	–	14.3 (8)	340	66.3 (53)	343	10.0 (6)	324	8.0 (5)	333	401
5	11.1 (6)	404	3.6 (2)	403	5.0 (4)	–	35.0 (21)	358	20.0 (12)	372	450
6	13.0 (7)	411	0.0 (0)	–	7.5 (6)	432	11.7 (7)	373	17.0 (10)	403	490
7	5.6 (3)	–	5.4 (3)	–	1.3 (1)	–	5.0 (3)	–	3.0 (2)	–	523
8	1.9 (1)	–	0.0 (0)	–	3.8 (3)	–	0.0 (0)	–	2.0 (1)	–	559
9	0.0 (0)	–	3.6 (2)	–	1.3 (1)	–	5.0 (3)	–	0.0 (0)	–	589
10	0.0 (0)	–	3.6 (2)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	605
11	1.9 (1)	–	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	0.0 (0)	–	–
12	3.7 (2)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
13	3.7 (2)	–	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)	–	0.0 (0)	–	–
15	0.0 (0)	–	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	0.0 (0)	–	–
16	0.0 (0)	–	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)	–	0.0 (0)	–	–
18	0.0 (0)	–	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
19	0.0 (0)	–	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
Total	100 (54)	348	100 (56)	327	100 (80)	329	100 (60)	328	100(60)	326	
Average age	4.57		4.18		4.43		4.80			4.15	
Growth index		-1.85		-1.44		-1.38		-3.34		-2.82	

[a]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 1997-2001 where 't' is age in years.

Species	Length/Weight Equation	Len/Wt r^2	Von Bertalanffy Equation	K	L∞	t_o
Walleye	log(wt)=3.055 log(len)-5.155	0.96	$L_t=650[1-e^{-0.2545(t+1.32)}]$	0.2545	650	-1.32
Yellow perch	log(wt)=2.736 log(1en)-4.262	0.85	$L_t=452[1-e^{-0.0711(t+4.13)}]$	0.0711	452	-4.13
White perch	log(wt)=2.657 log(1en)-3.888	0.73				
Channel catfish	log(wt)=1.892 log(1en)-2.173	0.91	$L_t=742[1-e^{-0.1103(t+1.49)}]$	0.1103	742	-1.49

Table 14.–Location of trawl stations and number of tows performed in Saginaw Bay, 1990-2002. All sampling was conducted in fall except where indicated otherwise.

Quadrant Location	Site description	1990	1991	1992	1993	1994	1995[a]	1996	1997	1998	1999	2000	2001	2002
Northeast	North Island & Wildfowl Bay	5	4	16	5	6	6	6	13	13	9	9	3	10
Southeast	Fish Point	4	4	6	5	3	9	6	16	12	15	6	3	7
Southwest	Pinconning	4	4	3	13	13	9	12	15	17	20	6	9	10
Northwest	AuGres	3	4	11	15	10	15	6	23	22	20	6	12	10
Total		16	16	36	38	32	39	30	31	27	27	33	33[b]	43[b]
Study total													613[c]	656[c]

[a] Total for northwest quadrant includes six experimental trawls near Charity Islands
[b] Total number of tows includes 6 tows made at Outer Bay sites.
[c] Total for study includes 15 tows from 1989.

Table 15.–Mean catch-per-unit-effort of fish collected from trawling in Saginaw Bay, Lake Huron, 1990-2001 based on fall data only. 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)
Alewife	80	302	191	48	307	99	301	1,590	82	337	1,242
Bluegill	0	0	0	<1	0	<1	0	0	0	0	0
Burbot	0	0	0	0	0	0	0	0	0	0	0
Channel catfish	<1	<1	1	6	3	6	2	3	4	6	7
Common carp	3	3	3	9	7	4	4	7	6	6	9
Emerald shiner	15	9	1	0	0	1	13	1	1	1	1
Freshwater drum	25	3	9	28	28	16	5	26	9	16	10
Gizzard shad	50	<1	19	8	6	23	18	23	3	3	9
Johnny darter	<1	12	10	11	29	21	20	5	6	4	1
Lake whitefish	0	<1	0	0	1	<1	1	0	<1	<1	0
Pumpkinseed	<1	0	0	0	0	<1	0	0	2	0	0
Quillback	<1	<1	1	1	1	1	<1	0	4	1	4
Rainbow smelt	44	280	468	58	22	15	1,585	70	32	390	496
Rock bass	0	0	0	0	0	<1	0	<1	5	<1	0
Round goby	0	0	0	0	0	0	0	0	4	127	385
Shorthead redhorse	0	0	0	<1	0	0	0	0	<1	0	0
Spottail shiner	124	182	97	204	373	209	809	665	1,935	1,011	863
Trout-perch	166	200	416	513	514	474	733	1,730	406	619	422
Walleye	6	1	1	1	1	1	3	10	7	2	2
White bass	6	<1	2	6	1	<1	4	2	<1	<1	0
White perch	404	92	28	183	528	277	416	346	141	895	544
White sucker	12	8	10	10	7	8	28	12	10	7	24
Yellow perch	177	70	38	24	126	85	122	170	90	37	145
Soft-rayed forage index value	479	973	1,192	831	1,222	821	3,459	4,079	2,463	2,488	3,418

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 1970-2001[a].

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

[a] 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 2001.

Year	Number of age-0 walleyes captured	Number of trawl tows	Age-0 walleyes 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

Table 18.–White perch catch from trawling effort, fall 1985-2001, Saginaw Bay, Lake Huron[a].

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	0.42
1987	7,514	252	2,321	29.8	3.24
1988	41,427	248	2,181	167.0	18.99
1989	34,817	15	150	2,321.1	232.11
1990	10,739	16	158	671.2	68.97
1991	6,463	16	149	403.9	43.52
1992	3,295	36	360	91.5	9.15
1993	1,076	38	419	27.9	2.57
1994	6,062	32	320	183.0	18.94
1995	19,002	36	360	528.2	52.78
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

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

Table 19.–Mean length (mm) at age for yellow perch from fall Saginaw Bay trawls, 1986-2001[a].

	Survey year															
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001
	Males															
Age-1	118	120	119	120	124	124	124	131	145	135	132	131	123	137	142	137
Age-2	137	137	137	141	146	146	149	155	159	169	166	166	146	163	159	170
Age-3	154	152	150	157	165	167	164	178	176	179	189	195	172	189	177	182
Age-4	184	168	164	170	175	184	181	194	191	192	200	202	202	219	185	192
Age-5	199	190	177	185	186	201	187	202	200	203	211	219	211	212	253	237
Age-6	209	189	201	194	195	212	209	213	200	211	219	219	219	–	215	264
Age-7	249	223	211	210	210	242	224	262	222	236	247	234	236	–	–	–
	Females															
Age-1	121	122	123	123	126	127	127	132	148	142	137	136	129	140	142	140
Age-2	145	143	143	149	157	155	159	169	172	179	183	179	145	179	174	179
Age-3	173	166	160	169	176	179	173	188	195	193	203	210	179	207	206	198
Age-4	197	190	183	184	201	202	204	210	214	211	220	232	208	238	218	216
Age-5	233	214	207	208	215	221	236	242	235	225	233	230	227	–	–	228
Age-6	265	226	217	222	235	246	249	245	246	247	260	286	250	–	244	–
Age-7	222	256	245	246	246	273	244	283	296	276	–	279	–	–	–	–

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