STUDY PERFORMANCE REPORT

State: Michigan | **Project No.:** F-81-R-5

Study No.: 230466 | **Title:** Fish community status in Saginaw Bay, Lake Huron

Period Covered: October 1, 2003 to September 30, 2004

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 2003, 30 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 gillnet lifts and trawl tows, and compares them with data from prior surveys. Gillnetting and trawling in 2003 collected a record number of age-0 walleye and yellow perch recruits (See Table 1 for a complete listing of the common and scientific names of fishes and aquatic organisms mentioned in this report). The catch-per-unit-of-effort (CPUE) of age-0 walleye in the gillnets was 5.5 which was 7.8 times the previous record age-0 CPUE (from 1998 year class). Analysis for presence of oxytetracycline marks indicate that no more than 28% of the record 2003 walleye year class stemmed from stocking. The 2003 trawl catch rates for soft-rayed forage species continued a trend of higher values since 1997. In particular, spottail shiner, trout-perch, alewife, and smelt catch rates remained high in 2003. Trawl CPUE for age-0 yellow perch and walleye in 2003 were the highest recorded since monitoring began in 1971. However, age-0 yellow perch mean length was the lowest recorded for this period, increasing the likelihood for severe over-winter mortality during winter 2003-04. Growth rates of older yellow perch remained above those observed before 1993 for both trawl and gillnet collections. Age-3 walleye collected in the gillnets grew at 128% of the state average growth rate. Round gobies were captured at trawl sites around the bay and have become a part of the diet for channel catfish, freshwater drum, and yellow perch. Field sampling was conducted as scheduled during 2004. Data for 2004 have not yet been summarized.

Findings: Jobs 1 through 3 were scheduled for 2003-04, and progress is reported below.

Job 1. Title: <u>Relative abundance and community structure.</u>–Gillnetting was performed in 2003 and 2004, with a total of 18 lifts made each year (Table 2). Sampling effort was divided between the inner and outer bay environments (Table 3). In 2003, 2,178 fish were collected comprising 19 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. For 2003, with ten years of catch data from the 38.1 mm mesh size, gillnet CPUE is expressed both without (Table 4) and with the 38.1 mm mesh catch (Table 5). Inclusion of the smallest mesh size in CPUE expressions mainly affected small species like yellow perch, white perch, gizzard shad, and round gobies.

Walleye CPUE was substantially greater in 2003 (tables 4 and 5) than in recent years. This increase was driven primarily by a very large catch of age-0 walleyes stemming from the 2003 year class as well as a strong showing from walleyes ages-1 through 3 (Table 6). The very large 2003 walleye year class constitutes a new record as detected at the age-0 life stage for this survey series, exceeding the previous record from 1998 by 7.8 times. In the past, walleye abundance was believed to be recruitment limited with most recruitment from stocking rather than reproduction (Fielder 2002). Analysis of 2003 age-0 walleyes for oxytetracycline marks (induced by immersion on the hatchery fish prior to release) indicated that no more than 28% of the year class could be attributed to stocking. This represents a significant departure from past trends where hatchery fish normally comprised about 80% of each year class. Circumstances that led to the substantial production of walleyes appeared to also provide for the record perch production (see trawling section to follow). The 2002 walleye year class (as indicated by the age-1 CPUE) also appeared to be relatively strong (Table 6). The gillnet catch rate of age-1 walleyes in 2004 will be a more definitive measure of the true walleye year class strength for 2003 as that measure will account for any over-winter mortality that the year class will incur.

Walleye growth rate continued to be very fast in Saginaw Bay in 2003 (Table 7). Age-3 walleye average mean total length was 128% of the state average. Walleye diet in 2003 was again dominated by clupeids, principally alewives, however yellow perch (mostly age-0) figured more prominently than in years past (Table 8). Condition of walleyes as indicated by mean relative weight was little changed in 2003 (Table 9). Proportional stock density of the walleye population was still heavily weighted towards large individuals but the 2003 values continued a trend of decline compared to some previous years (Table 10).

Yellow perch CPUE remained largely unchanged in the gillnet sample in 2003 (tables 4 and 5). The majority of perch were from the 2001 year class Table 11). The large 2003 yellow perch year class detected by the trawling was not recruited to the gillnet gear in 2003.

Growth rate of yellow perch in 2003 was just slightly better than the state average but not as high as in 2002 (Table 7). On the whole, yellow perch growth rate is improved over the slower growth that dominated the 1990s. The improved growth rate is believed to be a result of lower perch abundance. The emergence of the large 2003 year class makes continued good growth uncertain. Condition of yellow perch as indicated by relative weight remained similar to recent years and was acceptable overall (Table 9). The size structure of the yellow perch population was within the range recommended for proportional stock density (Table 10).
Abundance of channel catfish was unchanged in 2003 as indicated by the gillnet catch rate (Tables 4 and 5). The age structure of the channel catfish population in 2003 was dominated by age-4 and 5 members, which trace back to the 1999 and 1998 year classes respectively (Table 12). Channel catfish continued to grow below the state average rate and growth changed little in 2003 compared to recent years. Haak (1987) speculated that slow growth of Saginaw Bay catfish was probably due to both intra and interspecific competition within the bay.

Generally, however, the bay is characterized by an overabundance of prey fish which are underutilized by predators (Fielder 2000; Fielder and Baker 2004; Haas and Schaeffer 1992). Length / weight regression and Von Bertalanffy equations are provided in Table 13 for select species.

A total of 30 trawl hauls were made on the waters of inner Saginaw Bay in 2003 (Table 14) which collected 152,708 fish. Trawl CPUE for Saginaw Bay is summarized in Table 15. Yellow perch were the most abundant species in the trawls with a record CPUE of 2,410. Spottail shiner were the second most abundant species, continuing a pattern of elevated abundance since 1997. Since nearly all alewives captured with trawls in Saginaw Bay are age-0 fish, the increased catch rate (831) in 2003 is an indication of a stronger cohort. The 2003 trout-perch catch rate (529), while much lower than the peak rate of 1998, remains well above the levels observed in Saginaw Bay in the 1970s and 1980s. Round goby CPUE declined for the second consecutive year. Round goby abundance increased rapidly after 1999, the year they first appeared in the bay trawl samples, but CPUE leveled in 2002 and declined by about 40% in 2003. The factors behind this decline are unknown. 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 2003 was 3,316 fish per 10 minute tow, and remained well above the values observed prior to 1997. The record CPUE for yellow perch was a direct result of spectacularly high recruitment in 2003, as evidenced by the age-0 CPUE of 2,390 (Table 16). It is noteworthy that the 2003 cohort also had the lowest mean total length (69.7 mm) for the time series. This small size could lead to high levels of over-winter mortality. Walleye recruitment was also extraordinarily high, with an age-0 walleye CPUE of 40.8 (Table 17). This value is nearly 5x higher than the previous high recorded in 1998 (8.55), suggesting a strong year class could result (Table 17). Trawl and gillnet surveys in 2004 will provide an evaluation of the survival of the 2003 yellow perch and walleye cohorts through the winter of 2003-04. White perch CPUE rebounded in 2003, continuing a pattern of oscillating abundance since they colonized the bay in the late 1980's (Table 18).

The decline in round goby CPUE in 2002 and 2003 may signal the incorporation of this exotic species into the food web of Saginaw Bay. Examination of stomachs of fish caught in trawls in 2002 and 2003 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 in Saginaw Bay.

Mean length-at-age for age-1 and older yellow perch captured in trawls indicates 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 macroinvertebrate community.

Trawling was conducted during September 2004. A total of 36 trawl hauls were made in the inner bay quadrants. Lab processing of 2004 trawl and gillnet samples as well as data entry and analysis will be conducted during the winter and spring of 2005.

Job 2. Title: Process and analyze the data.–Analysis of the study data has been performed by personnel from the Alpena Fisheries Research Station, and the Mt. Clemens Fisheries Research Station. We summarized data from 2003, compiled them with those reported previously in performance reports since 1998, under Fielder et al. (2000), and fulfills the requirements of Job 3. Processing of diet samples collected in trawls during 2002 and 2003 is 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 was prepared as scheduled.

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Table 1.–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	*Gymnocephalus cernuus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Goldfish	*Carassius auratus*
Johnny darter	*Etheostoma nigrum*
Lake trout	*Salvelinus namaycush*
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	*Oncorhynchus mykiss*
Rock bass	*Ambloplites rupestris*
Round goby	*Neogobius melanostomus*
Round whitefish	*Prosopium cylindraceum*
Shorthead redhorse	*Moxostoma macrolepidotum*
Smallmouth bass	*Micropterus dolomieu*
Spottail shiner	*Notropis hudsonius*
Stonecat	*Noturus flavus*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Sander vitreus*
White bass	*Morone chrysops*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*
Zebra mussel	*Dreissena polymorpha*

Table 2.–Number of fall gillnet sets (by location) for Saginaw Bay, Lake Huron, 1991-2004.

Station	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Pt. Lookout	–	1	1	1	4	3	1	1	1	1	1	1	1	1
Au Gres River	2	1	–	1	1	1	1	1	1	1	1	1	1	1
Pt. Au Gres	2	2	2	2	6	6	2	2	2	2	2	2	2	2
Black Hole	2	2	2	2	6	5	2	2	2	2	2	2	2	2
Coreyon Reef	2	2	2	2	3	2	2	2	2	2	2	2	2	2
Fish Pt.	–	–	2	2	3	5	2	2	2	2	2	2	2	2
North Island	–	–	–	1	6	5	2	2	2	2	2	2	2	2
Oak Pt.	–	–	1	1	6	5	2	2	2	2	2	2	2	2
Charity Is.	–	–	–	–	3	2	2	2	2	2	2	2	2	2
Tawas	–	–	–	–	2	2	2	2	2	2	2	2	2	2
Total	8	8	9	12	40	36	18	18	18	18	18	18	18	18

Table 3.–Number of fall gillnet sets in Saginaw Bay, Lake Huron, divided by inner and outer bay environments for 1991-2004.

Location	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
Inner	8	7	7	10	28	24	11	11	11	11	11	11	11	11
Outer	0	1	2	2	12	12	7	7	7	7	7	7	7	7
Total	8	8	9	12	40	36	18	18	18	18	18	18	18	18

Table 4.–Mean catch per unit of effort (CPUE; number per 305 m gillnet) by species for Saginaw Bay, 1995-2003, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995.

	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		2003 (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	0	0	1	0.1	0	0	0	0	1	0.7	0	0	1	0.1	0	0	0	0
Bigmouth buffalo	0	0	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	1	0.7	0	0	1	0.1	10	0.7	0	0
Bowfin	0	0	1	0.1	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	3	0.2	1	0.1
Burbot	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.1	0	0	0	0
Carp	3	0.2	9	0.6	1	0.1	1	0.1	23	1.6	2	0.1	2	0.1	12	0.9	4	0.3
Channel catfish	17	1.4	123	8.8	68	4.9	94	6.7	214	15.3	123	8.8	150	10.7	180	12.9	155	11.1
Chinook salmon	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	7	0.5	3	0.2	0	0
Freshwater drum	105	8.8	398	28.4	266	19.0	67	4.8	244	17.4	183	13.1	19	13.6	123	8.8	96	6.9
Gizzard shad	47	3.9	207	14.8	31	2.2	560	40.0	167	11.9	24	1.7	57	4.1	98	7.0	29	2.1
Goldfish	0	0	3	0.2	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	1	0.1	0	0	2	0.1	0	0	0	0	0	0	0	0
Lake whitefish	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	2	0.1	0	0	0	0
Longnose gar	0	0	2	0.1	0	0	3	0.2	1	0.7	3	0.2	1	0.1	0	0	4	0.3
Longnose sucker	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	0	0	0	0	0	0
Northern pike	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	8	0.6	2	0.1	10	0.7	5	0.4
Northern redhorse	2	0.2	11	0.8	2	0.1	5	0.4	3	0.2	3	0.2	0	0	3	0.2	3	0.2
Quillback	10	0.8	16	1.1	10	0.7	0	0	42	3.0	27	1.9	24	1.7	20	1.4	21	1.5
Rainbow smelt	0	0	0	0	21	1.5	0	0	2	0.1	0	0	3	0.2	0	0	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	4	0.3	0	0	2	0.1	7	0.5	1	0.1	0	0	10	0.7	0	0
Round whitefish	1	0.1	0	0	0	0	0	0	0	0	0	0	4	0.3	0	0	0	0
Smallmouth bass	3	0.2	2	0.1	0	0	2	0.1	0	0	0	0	0	0	3	0.2	0	0
Stone cat	3	0.2	14	1.0	5	0.4	3	0.2	0	0	2	0.1	7	0.5	2	0.1	1	0.1
Walleye	161	13.4	180	12.9	158	11.3	176	12.6	154	11.0	99	7.1	114	8.1	112	8.0	315	22.5
White bass	13	1.1	7	0.5	9	0.6	11	0.8	8	0.6	3	0.2	2	0.1	10	0.7	22	1.6
White perch	105	8.8	398	28.4	266	19.0	47	3.36	285	20.4	325	23.2	179	12.8	143	10.2	300	21.4
White sucker	218	18.2	464	33.1	263	18.8	258	18.4	284	20.3	165	11.8	182	13.0	121	8.6	266	19.0
Yellow perch	313	26.4	832	59.4	430	30.7	173	12.4	313	22.4	204	14.6	672	48.0	175	12.5	257	18.4

Table 5.–Mean catch per unit of effort (CPUE; number per 335 m gillnet) by species for Saginaw Bay, 1995-2003, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995. Includes 38mm (1½ inch) mesh panel.

	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		2003 (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	0	0	1	0.1	0	0	0	0	1	0.1	0	0	3	0.2	0	0	0	0
Bigmouth buffalo	0	0	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	1	0.1	1	0.1	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	3	0.2	1	0.1
Burbot	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0	1	0.7	0	0	0	0
Carp	3	0.2	9	0.6	1	0.1	1	0.1	22	1.6	2	0.1	3	0.2	12	0.9	9	0.6
Channel catfish	17	1.4	136	9.7	72	5.1	99	7.1	218	15.6	124	8.9	151	10.8	183	13.1	159	11.4
Chinook salmon	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0	0	0	4	0.3	0	0
Freshwater drum	38	3.2	60	4.3	72	5.1	71	5.1	245	17.5	183	13.1	194	13.9	126	9.0	97	6.9
Gizzard shad	47	3.9	351	25.1	260	18.6	859	61.4	224	16.0	44	3.1	154	11.0	204	14.6	140	10.0
Goldfish	3	0.2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	0	0	0	0	2	0.1	0	0	1	0.1	0	0	0	0
Lake whitefish	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1	4	0.3	0	0	0	0
Longnose gar	0	0	2	0.1	1	0.1	3	0.2	1	0.1	3	0.2	1	0.1	0	0	5	0.4
Longnose sucker	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1	0	0	0	0	1	0.1
Northern pike	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	9	0.6	2	0.1	2	0.1	6	0.4
Northern redhorse	2	0.2	11	0.8	2	0.1	5	0.1	3	0.2	3	0.2	5	0.4	3	0.2	3	0.2
Quillback	10	0.8	16	1.1	10	0.7	1	0.1	42	3.0	27	1.9	24	1.7	20	1.4	22	1.6
Rainbow smelt	0	0	0	0	22	1.6	0	0	2	0.1	0	0	5	0.4	0	0	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	4	0.3	0	0	2	0.1	7	0.5	1	0.1	0	0	10	0.7	0	0
Round goby	0	0	0	0	0	0	0	0	1	0.1	5	0.4	6	0.4	10	0.7	1	0.1
Round whitefish	1	0.1	0	0	0	0	0	0	0	0	0	0	7	0.5	0	0	0	0
Smallmouth bass	3	0.2	2	0.1	0	0	3	0.2	0	0	0	0	2	0.1	3	0.2	0	0
Stone cat	3	0.2	15	1.1	5	0.4	3	0.2	0	0	2	0.1	7	0.5	2	0.1	4	0.3
Walleye	165	13.8	180	12.9	159	11.4	184	13.1	181	12.9	99	7.1	123	8.8	119	8.5	388	27.7
White bass	15	1.2	7	0.5	17	1.2	27	1.9	9	0.6	3	0.2	3	0.2	10	0.7	77	5.5
White crappie	0	0	0	0	0	0	1	0.1	0	0	0	0	1	0.1	10	0.7	1	0.1
White perch	128	10.7	462	33.0	303	21.6	52	3.7	409	29.2	360	25.7	203	14.5	150	10.7	345	24.6
White sucker	217	18.1	467	33.4	264	18.9	261	18.6	296	21.1	165	11.8	186	13.3	126	9.0	267	19.1
Yellow perch	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	590	42.1

Table 6.–Catch and percent contribution of walleye year classes to fall gillnet survey catches, Saginaw Bay, Lake Huron, 1998-2003. Catch-per-unit-effort (CPUE) is catch per 335 m, N in parentheses.

Year class	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
	1998 [a](18)			1999 [a](18)			2000 [a](18)		
2000	–	–	–	–	–	–	0	–	–
1999	–	–	–	0	0.4	0.1	1	5.9	0.4
1998	0	5.2	0.7	1	52.8	6.8	2	46.2	3.0
1997	1	33.2	4.2	2	17.3	2.2	3	16.0	1.1
1996	2	1.3	0.2	3	1.3	0.2	4	0.8	0.1
1995	3	10.5	1.3	4	4.3	0.6	5	6.7	0.4
1994	4	18.8	2.4	5	6.1	0.8	6	3.4	0.2
1993	5	5.7	0.7	6	2.6	0.3	7	3.4	0.2
1992	6	4.4	0.6	7	6.1	0.8	8	11.8	0.8
1991	7	7.4	0.9	8	3.9	0.5	9	4.2	0.3
1990	8	6.1	0.8	9	2.6	0.3	10	1.7	0.1
1989	9	3.1	0.4	10	1.7	0.2	11	–	–
1988	10	3.5	0.4	11	0.9	0.1	12	–	–
1987	11	0.4	0.1	12	–	–	13	–	–
1986	12	0.4	0.1	13	–	–	14	–	–
Mean	3.7			2.8			2.6	–	–
Total		100	13.0		100	12.8		100	6.6

Year class	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
	2001 [a](18)			2002 [a](18)			2003 [a](18)		
2003	–	–	–	–	–	–	0	24.7	5.5
2002	–	–	–	0	4.7	0.3	1	27.2	6.0
2001	0	11.5	0.8	1	35.7	2.6	2	18.0	4.0
2000	1	13.7	1.0	2	14.0	1.0	3	5.0	1.1
1999	2	13.0	0.9	3	8.5	0.6	4	6.7	1.5
1998	3	32.5	2.4	4	17.8	1.4	5	8.2	1.8
1997	4	4.6	0.3	5	5.4	0.4	6	5.0	1.1
1996	5	2.3	0.2	6	3.9	0.3	7	3.0	0.7
1995	6	6.1	0.4	7	2.3	0.2	8	2.0	0.4
1994	7	3.1	0.2	8	2.3	0.2	9	0.2	0.1
1993	8	4.6	0.3	9	3.1	0.2	10	–	–
1992	9	5.3	0.4	10	0.8	0.1	11	–	–
1991	10	1.5	0.1	11	1.5	0.1	12	–	–
1990	11	1.5	0.1	12	–	–	13	–	–
1989	12	–	–	13	–	–	14	–	–
1988	13	–	–	14	–	–	15	–	–
Mean	3.4			3.0			2.2		
Total		100	7.3		100	7.2		100	22.3

[a] 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 1995-2003, compared with Michigan average (Schneider et al. 2000) lengths from August-September catches. Saginaw Bay historic average (Hile 1954) for 1926-38 is also included for walleyes. 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	1995	1996	1997	1998	1999	2000	2001	2002	2003	Michigan average	Bay historic average
					Walleye						
0	224 (4.6)	– –	– –	227 (4.0)	– –	– –	200 (2.0)	203 (2.0)	193 (3.0)	180	–
1	346 (3.0)	352 (4.9)	330 (13.5)	341 (2.1)	360 (1.4)	333 (3.9)	350 (3.0)	344 (3.0)	349 (2.0)	250	254
2	– –	437 (3.7)	419 (4.2)	– –	438 (4.0)	436 (3.2)	426 (3.0	434 (4.0)	434 (5.0)	338	320
3	470 (3.8)	478 (11.6)	468 (3.8)	482 (12.7)	– –	497 (7.0)	496 (4.0)	490 (8.0)	494 (8.0)	386	371
4	501 (7.2)	537 (16.4)	504 (5.6)	508 (11.0)	505 (10.0)	– –	524 (10.0)	504 (13.0)	515 (6.0)	437	411
5	543 (4.3)	517 (9.0)	536 (11.6)	496 (21.0)	544 (6.6)	512 (17.1)	– –	567 (13.0)	548 (5.0)	472	457
6	555 (5.3)	582 (8.6)	547 (6.2)	565 (8.2)	570 (14.0)	– –	553 (13.0)	588 (29.0)	554 (7.0)	516	483
7	572 (8.3)	568 (6.5)	576 (11.9)	551 (7.0)	560 (13.0)	– –	– –	– –	559 (9.0)	541	505
8	590 (12.2)	579 (14.2)	586 (12.9)	570 (9.2)	563 (17.7)	581 (13.8)	552 (9.0)	– –	599 (17.0)	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	+2.23	+2.54	+2.00	+2.08	+2.45	+2.25	+2.09	+3.07	+2.47		-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)	154 (1.0)	127	–
2	161 (2.3)	151 (1.0)	155 (1.1)	154 (1.0)	159 (0.9)	157 (0.8)	174 (2.0)	188 (3.0)	181 (2.0)	160	–
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)	217 (2.0)	183	–
4	205 (2.3)	196 (1.6)	202 (1.9)	198 (4.6)	199 (2.2)	194 (2.2)	215 (2.0)	247 (3.0)	237 (5.0)	208	–
5	220 (4.6)	211 (1.9)	227 (3.3)	217 (2.4)	212 (2.2)	211 (3.1)	245 (3.0)	277 (7.0)	244 (5.0)	234	–
6	248 (9.2)	232 (4.4)	239 (4.4)	235 (5.2)	226 (2.4)	230 (3.8)	267 (11.0)	296 (16.0)	248 (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	0.00	-0.31	-0.46	-0.37	-0.46	-0.53	+0.42	+1.42	+0.74		–

Table 8.–Incidence of void stomachs and percent-composition of food items found in stomachs of walleyes from fall gillnets in Saginaw Bay, 1989-2003.

				Percent composition									
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
2002	129	63	49	23	0	0	0	20	0	0	8	0	0
2003	363	57	17	21	18	0	0	42	0	2	0	0	0

Table 9.–Mean relative weight by length class[a] and all sizes combined for walleyes and yellow perch collected in gillnets during fall 1989-2003 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
2003	90	90	86	90	382
			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	1,658
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
2003	90	93	90	91	399

[a] Size classes are defined in Table 10.

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, 1995-2003 from Saginaw Bay, Lake Huron.

Species	1995	1996	1997	1998	1999	2000	2001	2002	2003
Walleye	76(55,3)	83(46,6)	96(51,8)	63(47,3)	55(25,3)	93(34,3)	85(48,4)	60(31,3)	65(30,1)
Yellow perch	38(6,1)	22(2,0)	33(5,1)	26(3,0)	23(4,1)	25(7,1)	46(9,2)	36(14,2)	41(7,1)

[a] Stock and quality size for walleye is 250mm and 380mm, respectively, yellow perch: 130mm and 200mm. Range of PSD values indicative of balance when the population supports a substantial fishery is 30-60 for walleyes and 30-50 for yellow perch (Anderson and Weithman 1978).
[b] Preferred size for walleyes 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, 1994-2003.

	Survey Year									
Age	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
0	–	–	–	1	1	2	–	16	–	–
1	–	93	34	32	8	198	38	90	264	61
2	6	44	193	135	83	138	123	96	45	221
3	29	47	91	164	51	45	71	197	57	58
4	98	101	85	66	29	49	37	103	72	30
5	82	32	82	43	42	56	37	30	17	23
6	21	10	31	25	17	44	24	13	8	6
7	1	–	12	14	5	19	11	6	1	1
8	23	1	2	8	4	10	7	4	–	1
9	–	1	–	–	–	5	4	1	–	–
10	–	–	–	1	–	2	1	–	–	–
11	–	–	–	–	–	1	–	1	–	–
Number aged	241	328	531	488	240	569	353	557	464	401
Mean age	4.73	3.20	3.26	3.25	3.43	2.88	3.27	2.89	2.05	2.40

Table 12.–Age composition (percent) and mean length (mm) at age for channel catfish 1998-2003, Saginaw Bay. Sample size in parenthesis. Means limited to sample sizes of at least five fish. State average (Schneider et al. 2000) is for mid-growing season. Growth index is calculated with the methodology from Schneider et al. (2000) and is expressed in inches.

	1998		1999		2000		2001		2002		2003		
Age	Percent	Mean 1ength	Percent	Mean 1ength	Percent	Mean length	Percent	Mean length	Percent	Mean length	Percent	Mean length	State average
0	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
1	3.6 (2)	–	6.3 (5)	174	0.0 (0)	–	0.0 (0)	–	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)	–	0.0 (0)	–	284
3	46.4 (26)	310	6.3 (5)	310	8.3 (5)	256	45.0 (27)	293	5.6 (5)	330	4.2 (3)	375	345
4	14.3 (8)	340	66.3 (53)	343	10.0 (6)	324	8.0 (5)	333	61.1 (55)	330	56.3 (40)	359	401
5	3.6 (2)	403	5.0 (4)	–	35.0 (21)	358	20.0 (12)	372	1.1 (1)	–	29.6 (21)	384	450
6	0.0 (0)	–	7.5 (6)	432	11.7 (7)	373	17.0 (10)	403	10.0 (9)	412	4.2 (3)	411	490
7	5.4 (3)	–	1.3 (1)	–	5.0 (3)	–	3.0 (2)	–	13.3 (12)	449	0.0 (0)	–	523
8	0.0 (0)	–	3.8 (3)	–	0.0 (0)	–	2.0 (1)	–	4.5 (4)	–	2.8 (2)	453	559
9	3.6 (2)	–	1.3 (1)	–	5.0 (3)	–	0.0 (0)	–	3.3 (3)	–	1.4 (1)	522	589
10	3.6 (2)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	1.4 (1)	528	605
11	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
12	0.0 (0)	–	0.0 (0)	–	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)	–	0.0 (0)	–	0.0 (0)	–	–
14	0.0 (0)	–	0.0 (0)	–	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)	–	0.0 (0)	–	0.0 (0)	–	–
16	0.0 (0)	–	0.0 (0)	–	1.7 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
17	0.0 (0)	–	0.0 (0)	–	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)	–	0.0 (0)	–	0.0 (0)	–	–
19	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
Total	100 (56)		100 (80)		100 (60)		100 (60)		100 (90)		100 (71)		
Average age	4.18 yrs	327	4.43 yrs	329	4.80 yrs	328	4.15 yrs	326	4.88 yrs	349	4.63 yrs	377	
Growth index		-1.44		-1.38		-3.34		-2.82		-2.32		-2.12	

Table 13.–Length-weight regression equations and von Bertalanffy growth equations for select species. Length/weight equations are based on 2003 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 1998-2003 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)-5.198	0.99	$L_t=628[1-e^{-0.3154(t+1.24)}]$	0.3154	628	-1.24
Yellow perch	log(wt)=3.421 log(1en)-5.875	0.87	$L_t=368[1-e^{-0.1164(t+3.15)}]$	0.1164	368	-3.15
Channel catfish	log(wt)=3.235 log(1en)-5.689	0.96	$L_t=572[1-e^{-0.1876(t+0.72)}]$	0.1876	572	-0.72

Table 14.–Location of trawl stations and number of tows performed in Saginaw Bay, 1990-2004. All sampling was conducted in fall except where indicated otherwise.

Quadrant Location	Site description	1991	1992	1993	1994	1995[a]	1996	1997	1998	1999	2000	2001	2002	2003	2004
Northeast	North Island & Wildfowl Bay	4	16	5	6	6	6	13	13	9	9	3	10	4	9
Southeast	Fish Point	4	6	5	3	9	6	16	12	15	6	3	7	9	9
Southwest	Pinconning	4	3	13	13	9	12	15	17	20	6	9	10	7	9
Northwest	Au Gres	4	11	15	10	15	6	23	22	20	6	12	10	10	9
Total		16	36	38	32	39	30	31	27	27	33	33[b]	43[b]	30	42[b]
Study total															728[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] 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 1990-2003. 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 1 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)	2003 (27)
Alewife	80	302	191	48	307	99	301	1,590	82	337	1,242	348	831
Bluegill	0	0	0	<1	0	<1	0	0	0	0	0	0	0
Burbot	0	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	3
Common carp	3	3	3	9	7	4	4	7	6	6	9	6	4
Emerald shiner	15	9	1	0	0	1	13	1	1	1	1	1	1
Freshwater drum	25	3	9	28	28	16	5	26	9	16	10	11	9
Gizzard shad	50	<1	19	8	6	23	18	23	3	3	9	19	20
Johnny darter	<1	12	10	11	29	21	20	5	6	4	1	<1	0
Lake whitefish	0	<1	0	0	1	<1	1	0	<1	<1	0	1	<1
Pumpkinseed	<1	0	0	0	0	<1	0	0	2	0	0	<1	0
Quillback	<1	<1	1	1	1	1	<1	0	4	1	4	2	3
Rainbow smelt	44	280	468	58	22	15	1,585	70	32	390	496	147	431
Rock bass	0	0	0	0	0	<1	0	<1	5	<1	0	<1	<1
Round goby	0	0	0	0	0	0	0	0	4	127	385	356	164
Shorthead redhorse	0	0	0	<1	0	0	0	0	<1	0	0	<1	0
Spottail shiner	124	182	97	204	373	209	809	665	1,935	1,011	863	967	1340
Trout perch	166	200	416	513	514	474	733	1,730	406	619	422	411	529
Walleye	6	1	1	1	1	1	3	10	7	2	2	4	42
White bass	6	<1	2	6	1	<1	4	2	<1	<1	0	<1	13
White perch	404	92	28	183	528	277	416	346	141	895	544	339	474
White sucker	12	8	10	10	7	8	28	12	10	7	24	26	38
Yellow perch	177	70	38	24	126	85	122	170	90	37	145	66	2,410
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	3,316

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 1970-2003[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
2002	30.7	76.3
2003	2,389.6	69.7

[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 2003.

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
2003	1,114	27	40.80

Table 18.–White perch catch from trawling effort, fall 1985-2003, 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	0.4
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
2003	12,043	27	240	473.7	50.2

[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, 1986-2002[a].

	Survey year																	
Age	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
	Males																	
1	118	120	119	120	124	124	124	131	145	135	132	131	123	136	140	137	129	138
2	137	137	137	141	146	146	149	155	159	169	166	166	146	154	157	170	166	165
3	154	152	150	157	165	167	164	178	176	179	189	195	172	155	169	182	186	181
4	184	168	164	170	175	184	181	194	191	192	200	202	202	183	172	192	202	223
5	199	190	177	185	186	201	187	202	200	203	211	219	211	196	210	237	217	233
6	209	189	201	194	195	212	209	213	200	211	219	219	219	–	218	264	–	244
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	140
2	145	143	143	149	157	155	159	169	172	179	183	179	145	160	171	179	211	181
3	173	166	160	169	176	179	173	188	195	193	203	210	179	178	186	198	220	203
4	197	190	183	184	201	202	204	210	214	211	220	232	208	177	174	216	242	255
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	–	–	–

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