STUDY FINAL REPORT

State: Michigan **Project No.:** F-53-R-15

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

Period Covered: April 1, 1998 to September 30, 1999

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: Between 1989 and 1999, 508 trawl tows and 172 gill net sets were carried out. Data collection has been standardized across years to allow comparisons. Data were analyzed for trends, and as indicators of the effects of management actions and environmental changes. During the ten years of data collection, relative abundance of walleye in the gill-net catch has declined. Similar declines, however, have not occurred in the sport angler catch rate. It is believed that declines in gill-net catch rate may be due to gear avoidance resulting from increased water clarity. Another possible reason for a lack of decline in angler catch rates is compensating immigration to the bay from Lakes Erie and St. Clair during the summer months. Frequency of gizzard shad in walleye diet has declined in recent years, and alewife have become more common. The gill-net catch rate of walleye has stabilized since 1993. Of the 1998 catch, 33.2% were yearlings, indicating a strong 1997 year class. The bay was stocked with walleye fingerlings that year. Mean age of the walleye population declined in 1998, probably reflecting the abundance of yearlings. Measurements of growth rate of walleye in Saginaw Bay indicated a slight decline in 1998 for ages 7 and older fish. Those growth rates are now nearer the state average. Abundance of yellow perch in the gill net catch (which is most sensitive to adult abundance) declined to its lowest level since 1991. Despite the decline, no obvious improvements were apparent in growth rate based on the gill net data. The 1998 trawl catch rates for several species were the highest observed during this time period. In particular, rainbow smelt and spottail shiner CPUE values were much higher than for any other year. Trawling indicated that yellow perch recruitment improved from 1996 and remained well above the poor recruitment period of 1992-94. Growth rates of yellow perch caught in the trawl remained well above those observed before 1993. Field sampling was conducted as scheduled during 1999. While no ruffe have yet appeared in the trawl catch, round gobies were captured in 1999 by trawling and gill netting at locations near Tawas, Linwood, Bay City, Fish Point, North Island, and Oak Point. A nine-year summary research report is in press.

Job 1. Title: Relative abundance and community structure.

Findings: A total of 18 gillnet sets were carried out each year in 1998 and 1999 (Table 1). Netting was divided between inner and outer bay environments (Table 2). Results from the 1999 netting are not yet available.

The overall abundance of walleye (see Table 3 for a complete list of scientific names for all species mentioned in this report) in 1998, as indicated by the gillnet catch, increased slightly from 1997 but is still within the range observed since 1994 (Table 4). This increase does little to reverse the declining trend in CPUE since the greater values of the early 1990s. The significance

of this trend in abundance continues to be discussed. It is unclear if the declines since 1991 are reflective of true changes of walleye abundance. Trends in the sport fishery have not fully mirrored these declines. Based on the expanded sampling conducted in 1995 and 1996 (Tables 1 and 2), it does not appear that greater concentrations of walleye occur in shallow depths nor the outer bay environments, although those areas were not appreciably sampled prior to 1995 and their usage was not fully known. Increased water clarity due to zebra mussel (*Dreissena polymorpha*) colonization may be increasing gear avoidance by walleye. Also, tag returns indicate substantial immigration from Lakes Erie and St. Clair during the summer months. This may dilute or confound trends in abundance of local walleye as the timing of this survey may allow for capture of non-resident walleye.

Analysis of the walleye catch by age again indicates three weak year classes (1992, 1993 and 1996) (Table 5). The first two year classes are fully recruited to the fishery and may be partially accounting for declines in the gillnet CPUE. The percentage of yearling walleye is one measure of recruitment and was 33.2% in 1998. This suggests a very strong 1997 year class. There have now been two non-stocked years in the alternate-year stocking evaluation conducted under Study 468 (1993 and 1996) and both are weak. However, the weak year class of 1992 was stocked. The 1997 stocking was performed with fingerlings marked with oxytetracycline. Based on abundance of age-1 fish in 1998, it appears that the 1997 year class is strong and at least 50% of it can be attributed to stocking according to oxytetracycline marking results (see Study 468). Walleye mean age decreased in 1998 probably reflecting the abundance of yearlings (Table 5).

A total of 27 trawl hauls were carried out in September 1998 and 28 in September 1999 (Table 6). Lab processing of samples as well as data entry and analysis will be conducted during the winter and spring of 2000. In all, trawling collected over 95,000 fish in 1998. Trawl CPUE is summarized in Table 7. Alewife and trout-perch catch rates were higher in 1998 than for any other year in the time period. While alewife catch rates have tended to fluctuate, trout-perch catch rates have increased steadily during the 1990's. While the factors behind this trend are uncertain, it may be related to zebra mussel driven shift in energy flow from the pelagic portion to the benthic portion of the Saginaw Bay food web. Spottail shiner catch rates in 1998 were lower than for 1997, but remained well above any other year since 1990. Similar to alewife, rainbow smelt catch rates in the Bay have varied greatly between years. In 1998, the rainbow smelt CPUE returned to the low levels similar to those in 1994-1996, after a record high CPUE in 1997. Yellow perch CPUE increased for the second year, mainly due to an increase in age-0 CPUE, which was highest index value since 1989 (Table 8). White perch CPUE decreased slightly in 1998, remaining well below the record high in 1989 (Table 9).

The exotic species eurasian ruffe and round goby have both been collected from locations within the Lake Huron watershed. Although eurasion ruffe have not yet been captured in Saginaw Bay, the exotic round goby was collected with trawls and gill nets during September 1999 at sites near Tawas, Linwood, Bay City, Fish Point, North Island, and Oak Point. Future impacts of round goby on the fish community of Saginaw Bay will be evaluated with data collected during this study.

Mean length at age for yellow perch captured in trawls indicates growth has improved substantially (Table 10). Both males and females of all ages have experienced faster growth since 1993. 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. In fact, the yellow perch diet in 1997 (Table 11) appeared to be shifting away from planktonic food items to benthic food items, which in general are larger items. In particular, frequency of occurrence for most zooplankton types declined in 1997, while frequency of occurrence for pelecepods, gastropods, amphipods, tricoptera, and fish were higher than the levels seen for those taxa in the 1980's. Processing of age and diet samples collected in 1998 is underway.

Growth rates of walleye through age 6, collected in the gillnet samples, remains very fast compared to the state average (Table 12) suggesting the walleye population in Saginaw Bay is well below carrying capacity. Growth rate for walleye age 7 and older is closer to the state average but still greater than the historic growth rate. Gill net caught yellow perch do not indicate any improved growth over 1997 in contrast to the trawl data (Table 12). Condition of walleye, as indicated by relative weight, did not change appreciably from 1997 and remains good; however, yellow perch condition declined (Table 13). The proportional stock density (PSD) of walleye in Saginaw Bay remained high in 1998 but decreased substantially since previous years, which is attributed to the strong 1997 year class (Table 14). The walleye population in Saginaw Bay continues to function like a trophy fishery where abundance is relatively low and growth rates are fast. Walleye food habits were again dominated by alewives in September of 1998 (Table 15).

Yellow perch abundance, as indicated by the 1998 gillnet CPUE, declined to its lowest level since 1991 (Table 4). The 1994 and 1995 year classes that appeared strong in 1997 now appear less abundant (Table 16). Despite the lower catch rate, there were no obvious changes in yellow perch growth rate in 1998 based on the gill net data (Table 12). Population size structure, as indicated by proportional stock density, continues to be dominated by smaller individuals (Table 14). White perch age structure indicates continued recruitment (Table 16), but overall abundance in the gill net catch has declined to its lowest level since 1993 (Table 4) but was more stable in the trawl catch which is more sensitive to younger age groups (Table 9). This suggests that white perch may be experiencing poor survival from age-0 to adult ages. Channel catfish age structure appears similar to 1997 with no apparent difference in growth rate (Table 17). The channel catfish age structure suggests a swift decline of older members, characteristic of a high mortality rate. The length and weight relationship for select species is presented in Table 18.

Job 2. Title: <u>Process and analyze the data.</u>

Findings: Analysis of the study data has been performed by Michigan Department of Natural Resources Fisheries Division personnel from the Alpena Great Lakes Fisheries Research Station, Mt. Clemens Great Lakes Fisheries Research Station and the Bay City District Office.

Job 3. Title: <u>Prepare annual, final and other reports</u>.

Findings: This annual report summarizes data from 1998 and part of 1999, and those reported previously in performance reports since 1991, and fulfills the requirements of Job 3. A nine-year project summary research report is in press.

Fielder, D. G., J. Weber, M. V. Thomas, and R. C. Haas, In Press. Fish Population Survey of Saginaw Bay, Lake Huron, 1989-97. Michigan Department of Natural Resources, Fisheries Research Report, Ann Arbor, Michigan.

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Prepared by: David Fielder and Mike Thomas
Date: September 30, 1999

Table 1.–Number of fall gill-net sets by location for Saginaw Bay, Lake Huron, 1990-99.

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

Table 2.–Number of fall gill-net sets in Saginaw Bay, Lake Huron, divided by inner and outer bay environments for 1990-99.

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

Table 3.–Common and scientific names of fishes mentioned in this report.

Common name	Scientific name
Alewife	*Alosa pseudoharengus*
Bluegill	*Lepomis macrochirus*
Burbot	*Lota lota*
Channel catfish	*Ictalurus punctatus*
Common carp	*Cyprinus carpio*
Emerald shiner	*Notropis atherinoides*
Eurasian ruffe	*Gymnouphalus cernuus*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cepedianum*
Johnny darter	*Etheostoma nigrum*
Lake whitefish	*Coregonus clupeaformis*
Ninespine stickleback	*Pungitius pungitius*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Quillback	*Carpiodes cyprinus*
Rainbow smelt	*Osmerus mordax*
Round goby	*Neogobius melanostomus*
Shorthead redhorse	*Moxostoma macrolepidotum*
Spottail shiner	*Notropis hudsonius*
Trout-perch	*Percopsis omiscomaycus*
Walleye	*Stizostedion vitreum*
White bass	*Morone chrysops*
White perch	*Morone americana*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

Table 4.–Total catch and mean catch per unit of effort (CPUE; number per 305 m gill net) by species for Saginaw Bay 1990-1998.

	1990 (1,524m) 5 sets		1991 (2,440m) 8 sets		1992 (2,440m) 8 sets		1993 (3,050m) 11 sets		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	
Species	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	0	0	0	0	0	0	8	0.7	0	0	1	0.1	0	0	0	0
Bigmouth buffalo	0	0	0	0	3	0.4	7	0.7	1	0.1	0	0	0	0	0	0	0	0
Black crappie	1	0.2	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Bowfin	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	1	0.1	0	0
Brown trout	0	0	1	0.1	2	0.2	1	0.1	0	0	0	0	0	0	0	0	0	0
Burbot	0	0	0	0	0	0	3	0.3	1	0.1	2	0.2	1	0.1	2	0.1	1	.1
Carp	7	1.4	1	0.1	17	2.1	5	0.5	13	1.2	3	0.2	9	0.6	1	0.1	1	.1
Channel catfish	97	19.4	122	15.2	26	3.2	58	5.8	40	3.6	17	1.4	123	8.8	68	4.9	94	6.7
Chinook salmon	0	0	0	0	6	0.8	5	0.5	1	0.1	3	0.2	1	0.1	0	0	1	.1
Freshwater drum	63	12.6	27	3.4	89	11.1	53	5.3	86	7.8	105	8.8	398	28.4	266	19.0	67	4.8
Gizzard shad	112	22.4	357	44.6	21	2.6	92	9.2	45	4.1	47	3.9	207	14.8	31	2.2	560	40.0
Goldfish	1	0.2	0	0	0	0	0	0	0	0	0	0	3	0.2	1	0.1	0	0
Lake trout	0	0	0	0	1	0.1	0	0	0	0	0	0	0	0	1	0.1	0	0
Lake whitefish	0	0	0	0	4	0.5	1	0.1	0	0	1	0.1	0	0	2	0.1	0	0
Longnose gar	0	0	0	0	0	0	0	0	0	0	0	0	2	0.1	0	0	3	0.2
Longnose sucker	0	0	0	0	0	0	1	0.1	3	0.3	0	0	2	0.1	2	0.1	0	0
Northern pike	8	1.6	4	0.5	6	0.8	0	0	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2
Northern redhorse	1	0.2	7	0.9	0	0	0	0	0	0	2	0.2	11	0.8	2	0.1	5	0.4
Quillback	20	4.0	8	1.0	3	0.4	3	0.3	4	0.4	10	0.8	16	1.1	10	0.7	0	0
Rainbow smelt	5	1.0	0	0	6	0.8	5	0.5	2	0.2	0	0	0	0	21	1.5	0	0
Rainbow trout	0	0	0	0	1	0.1	3	0.3	0	0	0	0	0	0	0	0	0	0
Rock bass	0	0	0	0	1	0.1	0	0	0	0	0	0	4	0.3	0	0	2	0.1
Round whitefish	0	0	0	0	0	0	3	0.3	0	0	1	0.1	0	0	0	0	0	0
Smallmouth bass	0	0	1	0.1	0	0	1	0.1	0	0	3	0.2	2	0.1	0	0	2	0.1
Stone cat	4	0.8	3	0.4	2	0.2	4	0.4	3	0.3	3	0.2	14	1.0	5	0.4	3	0.2
Tiger musky	0	0	5	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Walleye	508	101.6	689	86.1	171	21.4	380	38.0	163	14.8	161	13.4	180	12.9	158	11.3	176	12.6
White bass	20	4.0	21	2.3	14	1.8	10	1.0	1	0.1	13	1.1	7	0.5	9	0.6	11	0.8
White perch	92	18.4	229	28.6	15	1.9	28	2.8	318	28.9	105	8.8	398	28.4	266	19.0	47	3.36
White sucker	405	81.0	499	62.4	975	121.9	358	35.8	443	40.3	218	18.2	464	33.1	263	18.8	258	18.4
Yellow perch	575	115.0	427	5.4	267	33.4	621	62.1	343	31.2	313	26.4	832	59.4	430	30.7	173	12.4

Table 5.–Percent contribution of year classes and CPUE (catch per 305 m gill net) of walleye from fall gill-net surveys, Saginaw Bay, Lake Huron, 1993-98. Mean ages with no letter in common are significantly different.

Year class	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
		1993[1]			1994			1995[2]	
1995	---	---	---	---	---	---	0	3.3	0.4
1994	---	---	---	0	3.0	0.2	1	23.5	2.7
1993	0	---	---	1	4.2	0.7	2	0.7	0.1
1992	1	3.8	1.6	2	7.9	1.2	3	8.6	1.0
1991	2	28.7	11.8	3	19.4	2.7	4	16.9	2.0
1990	3	17.9	7.4	4	21.8	3.2	5	18.5	2.1
1989	4	20.9	8.6	5	15.8	2.5	6	12.9	1.5
1988	5	8.1	3.3	6	15.8	2.4	7	8.3	0.9
1987	6	6.5	2.6	7	9.1	1.4	8	5.6	0.6
1986	7	7.9	3.2	8	3.0	0.5	9	0.7	0.1
1985	8	4.9	2.0	9	---	---	10	0.3	<0.1
1984	9	0.8	0.3	10	---	---	11	0.7	0.1
1983	10	---	---	11	---	---	12	---	---
1982	11	---	---	12	---	---	13	---	---
1981	12	0.3	0.1	13	---	---	14	---	---
Mean	3.9			4.3			4.1		
Total		100	42.3		100	14.8		100	11.5
		1996[2]			1997[2]			1998[2]	
1998	---	---	---	---	---	---	0	5.2	0.7
1997	---	---	---	0	1.0	0.1	1	33.2	4.2
1996	0	---	---	1	2.5	0.2	2	1.3	0.2
1995	1	17.6	1.9	2	16.9	1.7	3	10.5	1.3
1994	2	28.0	3.0	3	28.9	2.9	4	18.8	2.4
1993	3	4.6	0.5	4	4.0	0.4	5	5.7	0.7
1992	4	3.1	0.3	5	5.0	0.5	6	4.4	0.6
1991	5	11.9	1.3	6	10.9	1.1	7	7.4	0.9
1990	6	12.3	1.3	7	8.5	0.8	8	6.1	0.8
1989	7	11.1	1.2	8	10.9	1.1	9	3.1	0.4
1988	8	5.4	0.6	9	8.5	0.8	10	3.5	0.4
1987	9	4.6	0.5	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	13	---	---
1984	12	---	---	13	---	---	14	---	---
Mean	4.1			4.8			3.7		
Total		100	10.6		100	10.1		100	13.0

[1] Age distribution includes one age-13 fish, eleven walleyes unaged. Percent contribution based on aged fish only.

[2] Data based on expanded netting effort catch to provide a larger sample size. Total catch per 305m therefore differs slightly from value reported in Table 4 which is based solely on catch from traditional netting locations.

Table 6.–Location of trawl stations and number of tows performed in Saginaw Bay, 1991-1999. All sampling was conducted in fall except where indicated otherwise.

Quadrant Location	Site description	1991	1992[1]	1993[2]	1994	1995[3]	1996	1997[5]	1998[5]	1999[5]
Northeast	North Island & Wildfowl Bay	4	24	14	6	6	6	13	13	9
Southeast	Fish Point	4	19	13	3	9	6	16	12	15
Southwest	Pinconning	4	27	20	13	9	12	15	17	20
Northwest	AuGres	4	21	25	10	15	6	23	22	21
Total		16	91	72	32	39	30	68	64	65
Study total										508[4]

[1] Total number of tows includes 27 from each of May and July.
[2] Total number of tows includes 34 from July.
[3] Total for northwest quadrant includes 6 experimental trawls near Charity Islands
[4] Total for study includes 15 tows from 1989.
[5] Total number of tows includes 37 from July.

Table 7.–Mean catch-per-unit-of-effort (CPUE) of fish collected from fall trawling in Saginaw Bay, Lake Huron, 1990 through 1998. Total number of tows are in parentheses. See table 4 for complete listing of scientific names for each species.

Species	1990 (16)	1991 (16)	1992 (37)	1993 (38)	1994 (32)	1995 (39)	1996 (30)	1997 (31)	1998 (27)
Gizzard shad	45.1	49.4	0.3	19.3	8.5	6.2	22.9	17.8	22.7
Alewife	16.1	80.0	302.5	191.2	48.3	306.8	98.7	300.7	1,590.1
Rainbow smelt	47.1	43.7	280.2	467.9	57.9	22.4	15.2	1,584.6	70.0
Trout perch	133.1	165.5	199.9	416.4	512.5	513.5	474.1	733.3	1,729.8
Spottail shiner	194.5	124.1	182.0	96.8	203.5	372.6	209.5	808.5	665.0
Yellow perch	148.7	176.5	69.3	37.8	24.0	125.8	85.0	121.8	170.4
White sucker	11.1	12.3	7.6	10.3	9.8	7.0	7.7	28.3	12.4
Johnny darter	1.3	0.5	11.5	10.3	10.8	28.9	20.7	20.0	5.2
White perch	671.2	403.9	91.5	27.9	183.0	528.2	277.2	416.4	345.8
Walleye	1.5	5.5	1.1	1.3	1.2	0.9	1.3	2.9	9.7
White bass	3.6	6.0	0.1	1.8	6.1	1.0	0.4	4.1	2.0
Carp	5.3	3.1	2.9	3.3	8.8	6.9	4.4	4.5	7.5
Freshwater drum	23.1	24.6	2.8	8.7	27.8	28.3	16.3	4.6	26.2
Channel catfish	4.7	0.4	0.3	0.9	6.0	3.3	6.3	2.3	2.9
Bluegill	0.1	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.0
Quillback	0.3	0.4	0.1	0.6	0.6	0.6	0.6	0.1	0.0
Lake whitefish	0.2	0.0	0.1	0.0	0.0	0.8	0.1	1.4	0.0
Pumpkinseed	0.2	0.2	0.0	0.0	0.0	0.0	0.1	0.0	0.0
Emerald shiner	44.9	14.8	9.3	0.7	0.0	0.0	0.9	12.6	1.4
Burbot	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shorthead redhorse	0.0	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0

Table 8.–Number of young-of-the-year yellow perch caught per ten-minute trawl tow (CPUE) from Saginaw Bay, Lake Huron and their mean total length, fall 1970-1998.[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	117.3
1996	37.3	81.9
1997	83.3	73.8
1998	112.5	76.1

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

Table 9.–White perch catch and catch per unit effort from trawling effort, fall 1985-1998, 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

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

Table 10.–Mean length (mm) at age for yellow perch from fall Saginaw Bay trawls, 1986-1997[1].

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

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

Table 11.–Frequency of occurrence for food items in yellow perch from Saginaw Bay fall trawl surveys, 1986 to 1997.

	Survey year									Grand
Taxa	1986	1987	1988	1991	1992	1994	1995	1996	1997	total
Bosmina	5.50	1.59	3.37	2.73	17.65	5.81	0.80	1.72	1.16	3.61
Daphnia	1.26	0.32	0.59	0.00	1.96	0.00	0.00	0.00	0.00	0.61
Chydorid	67.14	25.50	27.16	19.09	61.76	41.86	8.00	18.97	13.87	34.96
Macrothricid	13.99	4.44	13.48	16.36	27.45	18.60	12.80	5.17	2.89	11.22
Leptadora	0.16	2.01	0.10	0.00	0.00	0.00	0.00	0.00	4.62	0.67
Copepod	37.58	51.32	45.49	57.27	46.08	39.53	41.60	53.45	30.64	46.05
Ostracod	27.36	25.61	34.39	39.09	63.73	45.35	48.80	50.86	45.66	32.92
Sida	23.27	16.51	3.17	1.82	38.24	24.42	3.20	8.62	6.36	13.17
BC	0.00	0.00	0.00	0.00	21.57	13.95	20.80	0.00	1.16	1.92
All plankton	73.27	62.54	59.66	65.45	78.43	68.60	78.40	63.79	47.98	65.26
Pelecepod	7.39	3.60	3.77	9.09	3.92	0.00	5.60	11.21	14.45	4.89
Gastropod	3.30	0.74	0.50	0.00	0.00	0.00	0.80	0.86	2.31	1.12
Zebra mussel	0.00	0.00	0.00	0.91	16.67	20.93	1.60	12.93	4.62	1.69
Isopod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.86	1.16	0.03
Hydracarina	8.49	2.54	9.42	0.91	2.94	1.16	0.80	0.00	1.16	5.72
Amphipod	4.40	1.90	1.29	0.00	28.43	15.12	0.00	4.31	36.42	3.39
Total "Others"	19.18	8.57	13.97	10.91	41.18	33.72	8.80	21.55	49.71	14.80
Ephemerida	3.46	0.21	0.69	0.00	0.00	0.00	0.00	1.72	0.00	1.05
Tricoptera	5.82	1.38	0.10	0.00	4.90	6.98	8.00	29.31	10.98	3.39
Chironomid pupae	28.30	30.16	33.89	3.64	25.49	3.49	12.80	26.72	11.56	28.35
Chironomid larvae	66.67	78.41	77.40	71.82	69.61	47.67	60.00	68.10	46.82	73.22
All insects	71.07	82.33	81.27	72.73	80.39	54.65	67.20	75.00	56.07	77.66
All fish	18.08	7.41	7.33	10.00	10.78	9.30	12.00	16.38	21.97	10.32
Non-empty stomachs	636	945	1009	110	102	86	125	116	173	3129

Table 12.–Mean length at age of walleye and yellow perch, by year from Saginaw Bay, Lake Huron. Data were from fall gill-net surveys during 1990-98, and are compared with Michigan average lengths from October -December catches. Bay historic average for 1926-1938 is also shown for walleye[2]. Standard error of the mean in parentheses. No means included for sample sizes less than 5 specimens.

	Survey Year									Michigan	Bay historic
Age	1990	1991	1992	1993	1994	1995	1996	1997	1998	average[1]	average
					Walleye						
0	228 (2.8)	238 (3.0)	--- ---	--- ---	207 (10.4)	224 (4.6)	--- ---	--- ---	227 (4.0)	180	---
1	348 (1.3)	361 (2.5)	320 (2.6)	306 (7.7)	348 (8.8)	346 (3.0)	352 (4.9)	330 (13.5)	341 (2.1)	264	254
2	444 (3.6)	444 (1.4)	438 (4.3)	410 (3.4)	426 (13.9)	--- ---	437 (3.7)	419 (4.2)	--- ---	353	320
3	495 (6.0)	504 (3.3)	500 (5.0)	465 (4.9)	473 (6.0)	470 (3.8)	478 (11.6)	468 (3.8)	482 (12.7)	401	371
4	537 (5.5)	536 (4.5)	535 (6.1)	516 (4.3)	521 (5.3)	501 (7.2)	537 (16.4)	504 (5.6)	508 (11.0)	447	411
5	553 (5.4)	557 (4.3)	548 (6.8)	537 (4.8)	537 (5.1)	543 (4.3)	517 (9.0)	536 (11.6)	496 (21.0)	488	457
6	552 (9.2)	571 (4.9)	588 (12.2)	552 (5.7)	564 (6.0)	555 (5.3)	582 (8.6)	547 (6.2)	565 (8.2)	523	483
7	580 (17.0)	590 (9.3)	611 (11.6)	580 (9.5)	613 (15.7)	572 (8.3)	568 (6.5)	576 (11.9)	551 (7.0)	549	505
8	--- ---	611 (8.7)	638 (9.8)	601 (10.4)	612 (17.0)	590 (12.2)	579 (14.2)	586 (12.9)	570 (9.2)	569	533
9	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	619 (27.4)	579 (11.5)	612 (23.0)	586	582
10	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	624 (22.5)	---	---
Mean	443	472	483	483	506	480	487	502			
					Yellow Perch						
0	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	84	---
1	--- ---	--- ---	--- ---	153 (11.0)	--- ---	148 (0.9)	150 (2.2)	141 (1.2)	153 (1.9)	133	---
2	--- ---	--- ---	176 (3.6)	185 (8.2)	148 (1.6)	161 (2.3)	151 (1.0)	155 (1.1)	154 (1.0)	165	---
3	196 (7.0)	197 (2.3)	196 (2.6)	189 (2.3)	176 (3.3)	187 (3.5)	184 (1.8)	189 (2.2)	172 (1.9)	191	---
4	204 (2.6)	208 (2.2)	211 (3.2)	195 (2.8)	198 (1.8)	205 (2.3)	196 (1.6)	202 (1.9)	198 (4.6)	216	---
5	217 (4.4)	220 (4.1)	235 (5.6)	208 (3.4)	214 (2.1)	220 (4.6)	211 (1.9)	227 (3.3)	217 (2.4)	240	---
6	218 (4.9)	218 (5.9)	237 (9.4)	213 (5.2)	243 (8.1)	248 (9.2)	232 (4.4)	239 (4.4)	235 (5.2)	262	---
7	213 (3.7)	--- ---	--- ---	216 (8.1)	--- ---	--- ---	244 (7.2)	247 (6.4)	251 (6.5)	282	---
8	244 (16.7)	--- ---	--- ---	--- ---	--- ---	--- ---	--- ---	256 (16.5)	--- ---	295	---

[1] From Merna et al. (1981).
[2] From Hile (1954).

Table 13.–Mean relative weight by length classes and all sizes combined for walleye and yellow perch collected in gill-nets from the falls of 1989 through 1998 from Saginaw Bay, Lake Huron. N=sample size for that year.

Year	Length classes: Stock-quality[1]	Quality-preferred[1]	Preferred-memorable[2]	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
			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

[1] Stock and quality size for walleye is 250 mm, 380 mm, respectively, yellow perch: 130 mm, 200 mm. 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 510 mm, memorable size is 630 mm. For yellow perch it is 250 mm and 300 mm, respectively (Anderson and Gutreuter 1983).

Table 14.–Walleye and yellow perch proportional stock density (PSD)[1] and relative stock density (RSD-P and RSD-M)[2] in parentheses from fall gill-net data for 1991 through 1998 from Saginaw Bay, Lake Huron.

Species	1991	1992	1993	1994	1995	1996	1997	1998
Walleye	79(40,3)	81(46,8)	93(40,3)	96(58,5)	76(55,3)	83(46,6)	96(51,8)	63(47,3)
Yellow perch	69(12,0)	62(18,4)	45(3,0)	73(9,1)	38 (6,1)	22 (2,0)	33 (5,1)	26 (3,0)

[1] Stock and quality size for walleye is 250 mm, 380 mm, respectively, yellow perch: 130 mm, 200 mm. 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 510 mm, memorable size is 630 mm. For yellow perch it is 250 mm and 300 mm, respectively (Anderson and Gutreuter 1983).

Table 15.–Food habits (incidence and numeric frequency of each item) of walleye from fall gill-nets from Saginaw Bay, Lake Huron, 1989-98. See Table 3 for a complete listing of scientific names for each species.

	Incidence		Frequency										
Year	No. stomachs examined	No. void	Unidentified fish remains	Gizzard shad	Yellow perch	Spottail shiner	Emerald shiner	Rainbow smelt	Alewife	Ninespine stickleback	White sucker	White perch	Channel catfish
1989	257	66	105	242	0	0	0	1	30	3	0	1	0
1990	508	190	115	400	0	0	0	1	5	1	0	1	0
1991	669	240	199	368	2	2	0	0	9	0	1	0	0
1992	171	95	40	1	1	1	0	9	11	0	1	0	0
1993	371	195	88	134	0	0	0	1	4	0	0	0	0
1994	84	44	17	50	2	2	0	0	0	0	0	0	0
1995	291	131	128	115	6	2	0	0	152	0	2	3	0
1996	148	91	41	13	2	0	0	0	1	0	0	0	0
1997	204	72	90	19	5	9	0	0	26	0	0	3	0
1998	234	111	98	4	3	4	1	0	131	0	0	0	1

Table 16.–Age composition of white perch and yellow perch from the gill-net catch, Saginaw Bay, Lake Huron, 1992-1998.[1]

	White perch							Yellow perch						
Age	1992	1993	1994	1995	1996	1997	1998	1992	1993	1994	1995	1996	1997	1998
0	---	---	27	3	---	2	8	---	---	---	---	---	1	1
1	13	5	151	57	102	43	5	1	5	---	93	34	32	8
2	2	15	15	1	31	55	2	8	11	6	44	193	135	83
3	---	4	11	---	3	21	3	61	80	29	47	91	164	51
4	---	3	4	---	2	4	---	69	71	98	101	85	66	29
5	---	1	6	---	---	1	---	37	28	82	32	82	43	42
6	---	---	---	---	---	1	3	20	16	21	10	31	25	17
7	---	---	---	---	---	2	---	4	5	1	---	12	14	5
8	---	---	---	---	---	---	---	1	2	23	1	2	8	4
Number aged	15	28	214	61	138	129	21	202	218	241	328	531	488	240
Mean age	1.13	2.29	1.67	0.97	1.31	1.99	1.71	4.09	3.84	4.73	3.20	3.26	3.25	3.43

Table 17.–Percent age and mean length (in mm) at age for channel catfish 1997 and 1998, Saginaw Bay. Number sampled in parenthesis. Means limited to sample sizes of at least five fish.

	1997		1998	
Age	Percent	Mean Length	Percent	Mean Length
0	0.0 (0)	---	1.8 (1)	---
1	0.0 (0)	---	3.6 (2)	---
2	27.8 (15)	236	14.3 (8)	279
3	24.1 (13)	328	46.4 (26)	310
4	7.4 (4)	---	14.3 (8)	340
5	11.1 (6)	404	3.6 (2)	403
6	13.0 (7)	411	0.0 (0)	---
7	5.6 (3)	---	5.4 (3)	---
8	1.9 (1)	---	0.0 (0)	---
9	0.0 (0)	---	3.6 (2)	---
10	0.0 (0)	---	3.6 (2)	---
11	1.9 (1)	---	0.0 (0)	---
12	3.7 (2)	---	0.0 (0)	---
13	3.7 (2)	---	0.0 (0)	---
14	0.0 (0)	---	0.0 (0)	---
15	0.0 (0)	---	0.0 (0)	---
16	0.0 (0)	---	0.0 (0)	---
17	0.0 (0)	---	0.0 (0)	---
18	0.0 (0)	---	1.8 (1)	---
19	0.0 (0)	---	1.8 (1)	---
Total	100 (54)	348	100 (56)	327

Table 18.–Length/weight regression equations for select species based on 1998 fall gill-net collections in Saginaw Bay, Lake Huron. Logs are base 10 and weight (wt) is in grams, 1ength (len) is in mm.

Species	Equation	r^2
Walleye	log(wt)=3.012 log(len)-5.063	0.96
Yellow perch	log(wt)=2.912log(1en)-4.730	0.74
White perch	log(wt)=2.517log(1en)-3.684	0.83