STUDY PERFORMANCE REPORT

State: Michigan **Project No.:** F-81-R-2

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

Period Covered: September 30, 2000 to October 1, 2001

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 2000, 33 trawl tows and 18 gillnet lifts were made on Saginaw Bay. All netting was performed in September and divided between the inner and outer bay areas. This report summarizes the results of these trawl tows and gillnet lifts and compares them with data from prior surveys. The 2000 trawl catch rates for several species were the highest observed since 1990. In particular, spottail shiner CPUE values were much higher than for any other year. Trawling indicated yellow perch recruitment in 2000 was lowest since 1994. 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. Gillnetting in 2000 again affirmed the strength of the 1998 walleye year class. That year class, along with the 1997 cohort, comprised 62% of the walleye gillnet catch in 2000. These two strong year classes are now crucial to the fishery particularly since 1992, 1993, and 1996 year classes were relatively weak. The catch rate of walleyes in 2000 dropped to its lowest level yet. Despite the strong 1998 year class, growth rate of walleyes remained strong in 2000. Yellow perch catch rate in gillnets declined in 2000 but was still within the range observed for recent years. Yellow perch growth rate based on specimens from gillnet catch remained slightly below the state average. Similar to walleyes, age-2 and age-3 yellow perch made a strong showing in the 2000 gillnet catch, suggesting strong year classes in 1998 and 1997. On the whole, yellow perch recruitment continues to be low and may signal problems for the future of that fishery if recruitment does not improve soon. Field sampling was conducted as scheduled during 2001, including at least 24 trawl tows and 18 gillnet lifts. Data for 2001 have not yet been summarized.

Job 1. Title: Relative abundance and community structure.

Findings: Gillnetting was performed in 2000 and 2001, 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 2000, 1,813 fish were collected comprising 21 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 eight 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, white

perch, gizzard shad, and round goby (see Table 5 for a complete list of common and scientific names of fishes mentioned in this report),.

Walleye CPUE dropped to its lowest level since the beginning of the study (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 from 1994 through 1999 appeared to 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, reflects the effects of at least three weak year classes now fully exerting their effect on the population. Trends in abundance for other notable species included a decrease in yellow perch abundance in 2000 compared to 1999 (although still within the range observed for recent years). Other species that declined in 2000 included channel catfish, freshwater drum, and gizzard shad (Tables 3 and 4).

The record 1998 year class of walleye remained strong in 2000 (Table 6). This year class along with the strong 1997 year class comprised more than 62% of the walleye gillnet catch. Given the overall static gillnet CPUE, it is apparent that the walleye population, and probably the fishery, are now heavily dependent on these two year classes. Gillnet data collected during the 2001 survey have not yet been fully analyzed, but early indications suggested the 1999 and 2000 year classes are only moderate to weak. Other weak walleye year classes affecting the fishery are 1992, 1993, and 1996 (Table 6; Fielder et al. 2000). The improvement in relative abundance of the 1992 year class in the 2000 (at age 8) gillnet catch may reflect the contribution of immigration from Lake Erie walleye populations or might be attributed to aging error as walleye scales are more difficult to accurately age for older fish.

For the first time in this study, total annual mortality rate was estimated for walleye using the Robson-Chapman method (Van Den Avyle and Hayward 1999). The method assumes equal recruitment among years and thus is not a good fit for the Saginaw Bay walleye population. The value estimated (38% in 2000), however, does allow some comparison to that generated under study 436. The latter effort employs the superior recruitment-independent estimation technique based on tag returns over time from the computer program ESTIMATE (Brownie et al. 1985). The estimate from the Robson-Chapman method compares closely with the long-term average total mortality rate reported based on the ESTIMATE analysis (38% vs. 34%). However, the year-specific value generated based on the tag returns in 2000 was 52%. The latter value is likely more accurate for the actual year of 2000.

Walleye growth rate continued to be well above state and Saginaw Bay historical averages (Table 7). Despite the abundance of age-1 and age-2 walleyes in 2000, their growth rates have remained well above the state average. Age-3 walleyes in 2000 grew at 129% 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 these criteria is still well below the carrying capacity of the habitat and forage base. Alewives, gizzard shad, and white perch comprised the majority of prey items found in walleye stomachs in 2000 (Table 8). Walleye condition overall remained unchanged in 2000 but increased markedly for stock to quality sized segment of the population (Table 9). The proportional stock density (PSD) of walleye increased sharply in 2000 reflecting the abundance of age-2 and age-3 fish (Table 10).

Yellow perch age structure from the gillnet catch also indicated a strong 1998 year class (Table 11). Mean age of yellow perch increased in 2000. Their PSD remained largely unchanged (Table 10). As with walleye, yellow perch recruitment variability necessitates caution in the interpretation of mortality estimates derived by catch-curves. Yellow perch total annual

mortality rate was estimated at 46% in 2000 using the Robson-Chapman method, a relatively low rate for an exploited perch population. Yellow perch growth rate derived from gillnet samples continued to remain slightly below the state average (Table 7). Condition of yellow perch increased slightly in 2000 (Table 9). The 1998 year class also remained strong for white perch in 2000. White perch exhibited a high total annual mortality rate in 2000 of 86%.

The 1995 channel catfish year class remained strong in 2000 (Table 12). Channel catfish growth rate declined further in 2000, 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 45%. 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 2000 (Table 14). We collected over 100,000 fish. Trawl CPUE is summarized in Table 15. Spottail shiner catch rates declined by nearly 50%, but remained the highest for any single species in 2000. Alewife and trout-perch catch rates both increased. Since nearly all alewives captured with trawls in Saginaw Bay are age-0 fish, the higher catch rate in 2000 is an indication of a cohort stronger than the 1999 year class. The 2000 trout-perch catch rate (619), while much lower than in 1998, remains well above the levels observed in Saginaw Bay in the 1970s and 1980s. While the factors behind this trend are uncertain, we believe it is related to a zebra mussel-driven shift in energy flow from the pelagic portion to the benthic portion of the Saginaw Bay food web. Similar to alewives, rainbow smelt catch rates in the Bay varied greatly between years and consisted mainly of age-0 smelt. In 2000, the rainbow smelt CPUE remained at a level typical of most of the 1990s. Yellow perch CPUE decreased, mainly due to the lowest age-0 CPUE since 1994 (Table 16). Age-0 walleye catch rates declined from the record high in 1998 to a level below average for the period from 1986 to 2000 (Table 17). White perch CPUE increased to the highest point observed since 1989 (Table 18), reflecting a strong 2000 cohort.

The exotic round goby was collected with trawls from all grids sampled during September 2000. Round goby CPUEs were 31 times higher in 2000 than in 1999, the year they first were seen in trawl samples on Saginaw Bay (Table 15). 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.

After a period of improved growth rates in the mid-1990s, mean length at age for yellow perch captured in trawls appeared to decline (Table 19). While mean length at age remained elevated for males and females age-4 and older, the mean length at age for ages 1-3 declined in 1998. Yellow perch growth in Saginaw Bay is believed to be density dependent (Haas and Schaeffer 1992). The stronger yellow perch cohorts produced in 1995, 1997, and 1998 may be the factor behind this apparent decline in growth for young perch. Even with this recent slow down, yellow perch growth rates remain above those observed in the 1980s and early 1990s. 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. However,

diet samples collected through the 1990's have not clearly documented such a shift (Table 20). Processing of diet samples collected in 1999 and 2000 is nearing completion.

Trawling is scheduled for September 2001. Lab processing of samples as well as data entry and analysis will be conducted during the winter and spring of 2002.

Job 2. Title: Process and analyze the data.

Findings: 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 age and diet samples collected in trawls during 1999, and 2000 are nearly complete, as a result of assistance in lab processing from the USGS Great Lake Science Center personnel. Analysis of data and samples collected with gillnets in 2001 is also underway.

Job 3. Title: Prepare annual, final and other reports.

Findings: This Performance Report summarizes data from 2000, 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, 1990-2001.

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

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

Table 3.–Mean catch per unit of effort (CPUE; number per 305 m gillnet) by species for Saginaw Bay, Lake Huron, 1992-2000, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995.

	1992 (2,440 m) 8 sets		1993 (3,050 m) 11 sets		1994 (3,355 m) 11 sets		1995 (3,660 m) 12 sets		1996 (4,270 m) 14 sets		1997 (4,270 m) 14 sets		1998 (4,270 m) 14 sets		1999 (4,270 m) 14 sets		2000 (4,270 m) 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	8	0.7	0	0	1	0.1	0	0	0	0	1	0.7	0	0
Bigmouth buffalo	3	0.4	7	0.7	1	0.1	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	1	0.7	0	0
Bowfin	0	0	0	0	0	0	0	0	1	0.1	1	0.1	0	0	0	0	0	0
Brown trout	2	0.2	1	0.1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burbot	0	0	3	0.3	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0
Carp	17	2.1	5	0.5	13	1.2	3	0.2	9	0.6	1	0.1	1	0.1	23	1.6	2	0.1
Channel catfish	26	3.2	58	5.8	40	3.6	17	1.4	123	8.8	68	4.9	94	6.7	214	15.3	123	8.8
Chinook salmon	6	0.8	5	0.5	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0
Freshwater drum	89	11.1	53	5.3	86	7.8	105	8.8	398	28.4	266	19.0	67	4.8	244	17.4	183	13.1
Gizzard shad	21	2.6	92	9.2	45	4.1	47	3.9	207	14.8	31	2.2	560	40.0	167	11.9	24	1.7
Goldfish	0	0	0	0	0	0	0	0	3	0.2	1	0.1	0	0	0	0	0	0
Lake trout	1	0.1	0	0	0	0	0	0	0	0	1	0.1	0	0	2	0.1	0	0
Lake whitefish	4	0.5	1	0.1	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1
Longnose gar	0	0	0	0	0	0	0	0	2	0.1	0	0	3	0.2	1	0.7	3	0.2
Longnose sucker	0	0	1	0.1	3	0.3	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1
Northern pike	6	0.8	0	0	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	8	0.6
Northern redhorse	0	0	0	0	0	0	2	0.2	11	0.8	2	0.1	5	0.4	3	0.2	3	0.2
Quillback	3	0.4	3	0.3	4	0.4	10	0.8	16	1.1	10	0.7	0	0	42	3.0	27	1.9
Rainbow smelt	6	0.8	5	0.5	2	0.2	0	0	0	0	21	1.5	0	0	2	0.1	0	0
Rainbow trout	1	0.1	3	0.3	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Rock bass	1	0.1	0	0	0	0	0	0	4	0.3	0	0	2	0.1	7	0.5	1	0.1
Round whitefish	0	0	3	0.3	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0
Smallmouth bass	0	0	1	0.1	0	0	3	0.2	2	0.1	0	0	2	0.1	0	0	0	0
Stone cat	2	0.2	4	0.4	3	0.3	3	0.2	14	1.0	5	0.4	3	0.2	0	0	2	0.1
Walleye	171	21.4	380	38.0	163	14.8	161	13.4	180	12.9	158	11.3	176	12.6	154	11.0	99	7.1
White bass	14	1.8	10	1.0	1	0.1	13	1.1	7	0.5	9	0.6	11	0.8	8	0.6	3	0.2
White perch	15	1.9	28	2.8	318	28.9	105	8.8	398	28.4	266	19.0	47	3.36	285	20.4	325	23.2
White sucker	975	121.9	358	35.8	443	40.3	218	18.2	464	33.1	263	18.8	258	18.4	284	20.3	165	11.8
Yellow perch	267	33.4	621	62.1	343	31.2	313	26.4	832	59.4	430	30.7	173	12.4	313	22.4	204	14.6

Table 4.–Mean catch per unit of effort (CPUE; number per 335 m gillnet) by species for Saginaw Bay, Lake Huron, 1993-2000, at traditional netting locations. Table omits four net lifts from Charity Islands and Tawas Bay added in 1995. Includes 38mm (1½ inch) mesh panel.

	1993 (3,350 m) 10 sets		1994 (3,685 m) 11 sets		1995 (4,020 m) 12 sets		1996 (4,690 m) 14 sets		1997 (4,690 m) 14 sets		1998 (4,690 m) 14 sets		1999 (4,690 m) 14 sets		2000 (4,690 m) 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
Alewife	0	0	8	0.7	0	0	1	0.1	0	0	0	0	1	0.1	0	0
Bigmouth buffalo	4	0.4	1	0.1	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	0	0	1	0.1	1	0.1	1	0.1	0	0	0	0	0	0
Brown trout	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Burbot	3	0.3	1	0.1	2	0.2	1	0.1	2	0.1	1	0.1	0	0	0	0
Carp	5	0.5	12	1.1	3	0.2	9	0.6	1	0.1	1	0.1	22	1.6	2	0.1
Channel catfish	60	6.0	50	4.6	17	1.4	136	9.7	72	5.1	99	7.1	218	15.6	124	8.9
Chinook salmon	5	0.5	1	0.1	3	0.2	1	0.1	0	0	1	0.1	0	0	0	0
Freshwater drum	52	5.2	98	8.9	38	3.2	60	4.3	72	5.1	71	5.1	245	17.5	183	13.1
Gizzard shad	164	16.4	199	18.1	47	3.9	351	25.1	260	18.6	859	61.4	224	16.0	44	3.1
Goldfish	0	0	0	0	3	0.2	0	0	0	0	0	0	0	0	0	0
Lake trout	0	0	0	0	0	0	0	0	0	0	0	0	2	0.1	0	0
Lake whitefish	3	0.3	0	0	1	0.1	0	0	2	0.1	0	0	0	0	1	0.1
Longnose gar	0	0	0	0	0	0	2	0.1	1	0.1	3	0.2	1	0.1	3	0.2
Longnose sucker	1	0.1	8	0.7	0	0	2	0.1	2	0.1	0	0	0	0	1	0.1
Northern pike	0	0	5	0.4	4	0.3	1	0.1	1	0.1	3	0.2	2	0.1	9	0.6
Northern redhorse	0	0	0	0	2	0.2	11	0.8	2	0.1	5	0.1	3	0.2	3	0.2
Quillback	4	0.4	10	0.9	10	0.8	16	1.1	10	0.7	1	0.1	42	3.0	27	1.9
Rainbow smelt	5	0.5	2	0.2	0	0	0	0	22	1.6	0	0	2	0.1	0	0
Rainbow trout	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
Round goby	0	0	0	0	0	0	0	0	0	0	0	0	1	0.1	5	0.4
Round whitefish	3	0.3	0	0	1	0.1	0	0	0	0	0	0	0	0	0	0
Smallmouth bass	1	0.1	0	0	3	0.2	2	0.1	0	0	3	0.2	0	0	0	0
Stone cat	4	0.4	5	0.4	3	0.2	15	1.1	5	0.4	3	0.2	0	0	2	0.1
Walleye	380	38.0	179	16.2	165	13.8	180	12.9	159	11.4	184	13.1	181	12.9	99	7.1
White bass	10	1.0	3	0.3	15	1.2	7	0.5	17	1.2	27	1.9	9	0.6	3	0.2
White crappie	0	0	0	0	0	0	0	0	0	0	1	0.1	0	0	0	0
White perch	32	3.2	432	39.3	128	10.7	462	33.0	303	21.6	52	3.7	409	29.2	360	25.7
White sucker	360	36.0	473	43.0	217	18.1	467	33.4	264	18.9	261	18.6	296	21.1	165	11.8
Yellow perch	1,150	115.1	535	48.6	444	37.0	1,485	106.1	900	64.3	500	35.7	1,124	80.3	581	41.5

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	*Oncorhynchus 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, 1995-2000. Catch-per-unit-effort (CPUE) is catch per 335 m, N in parentheses.

	Age	Percent	CPUE	Age	Percent	CPUE	Age	Percent	CPUE
Year class	1995[a] (23.9)			1996[a] (21.3)			1997[a] (18)		
1997	–	–	–	–	–	–	0	1.0	0.1
1996	–	–	–	0	0	0.0	1	2.5	0.3
1995	0	3.3	0.4	1	17.6	2.2	2	16.9	1.9
1994	1	23.5	3.0	2	28.0	3.4	3	28.9	3.2
1993	2	0.7	0.1	3	4.6	0.6	4	4.0	0.4
1992	3	8.6	1.2	4	3.1	0.4	5	5.0	0.6
1991	4	16.9	2.1	5	11.9	1.5	6	10.9	1.2
1990	5	18.5	2.3	6	12.3	1.5	7	8.5	0.9
1989	6	12.9	1.6	7	11.1	1.4	8	10.9	1.2
1988	7	8.3	1.0	8	5.4	0.7	9	8.5	0.9
1987	8	5.6	0.7	9	4.6	0.6	10	2.0	0.2
1986	9	0.7	0.1	10	1.5	0.2	11	0.5	0.1
1985	10	0.3	<0.1	11	–	–	12	0.5	0.1
1984	11	0.7	0.1	12	–	–	13	–	–
1983	12	–	–	13	–	–	14	–	–
Mean	4.1			4.1			4.8		
Total		100	12.6		100	12.3		100	11.1
	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					
Total		100	13.0		100	12.8	2.6	100	6.6

[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 1993-2000, 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	1993	1994	1995	1996	1997	1998	1999	2000	Michigan average[a]	Bay historic average[b]
Walleye										
0	– –	207 (10.4)	224 (4.6)	– –	– –	227 (4.0)	– –	– –	180	–
1	306 (7.7)	348 (8.8)	346 (3.0)	352 (4.9)	330 (13.5)	341 (2.1)	360 (1.4)	333 (3.9)	250	254
2	410 (3.4)	426 (13.9)	– –	437 (3.7)	419 (4.2)	– –	438 (4.0)	436 (3.2)	338	320
3	465 (4.9)	473 (6.0)	470 (3.8)	478 (11.6)	468 (3.8)	482 (12.7)	– –	497 (7.0)	386	371
4	516 (4.3)	521 (5.3)	501 (7.2)	537 (16.4)	504 (5.6)	508 (11.0)	505 (10.0)	– –	437	411
5	537 (4.8)	537 (5.1)	543 (4.3)	517 (9.0)	536 (11.6)	496 (21.0)	544 (6.6)	512 917.1)	472	457
6	552 (5.7)	564 (6.0)	555 (5.3)	582 (8.6)	547 (6.2)	565 (8.2)	570 (14.0)	– –	516	483
7	580 (9.5)	613 (15.7)	572 (8.3)	568 (6.5)	576 (11.9)	551 (7.0)	560 (13.0)	– –	541	505
8	601 (10.4)	612 (17.0)	590 (12.2)	579 (14.2)	586 (12.9)	570 (9.2)	563 (17.7)	581 (13.8)	561	533
9	– –	– –	– –	619 (27.4)	579 (11.5)	612 (23.0)	588 (8.0)	576 33.2)	582	582
10	– –	– –	– –	– –	– –	624 (22.5)	– –	– –	–	–
Growth index	+1.68	+2.60	+2.23	+2.54	+2.00	+2.08	+2.45			-0.60
Yellow perch										
0	– –	– –	– –	– –	– –	– –	– –	– –	84	–
1	153 (11.0)	– –	148 (0.9)	150 (2.2)	141 (1.2)	153 (1.9)	149 (1.2)	149 (5.6)	127	–
2	185 (8.2)	148 (1.6)	161 (2.3)	151 (1.0)	155 (1.1)	154 (1.0)	159 (0.9)	157 (0.8)	160	–
3	189 (2.3)	176 (3.3)	187 (3.5)	184 (1.8)	189 (2.2)	172 (1.9)	184 (2.5)	175 (1.6)	183	–
4	195 (2.8)	198 (1.8)	205 (2.3)	196 (1.6)	202 (1.9)	198 (4.6)	199 (2.2)	194 (2.2)	208	–
5	208 (3.4)	214 (2.1)	220 (4.6)	211 (1.9)	227 (3.3)	217 (2.4)	212 (2.2)	211 (3.1)	234	–
6	213 (5.2)	243 (8.1)	248 (9.2)	232 (4.4)	239 (4.4)	235 (5.2)	226 (2.4)	230 (3.8)	257	–
7	216 (8.1)	– –	– –	244 (7.2)	247 (6.4)	251 (6.5)	252 (4.9)	250 (3.2)	277	–
8	– –	– –	– –	– –	256 (16.5)	– –	269 (6.5)	264 (4.7)	292	–
9	– –	– –	– –	– –	– –	– –	284 (6.6)	– –	302	–
Growth index	-0.48	-0.49	0.00	-0.31	-0.46	-0.37	-0.46	-0.53		–

[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, Lake Huron, 1989-2000.

				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

Table 9.–Mean relative weight by length class[a] and all sizes combined for walleyes and yellow perch collected in gillnets during fall 1989-2000 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
			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

[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, 1993-2000 from Saginaw Bay, Lake Huron.

Species	1993	1994	1995	1996	1997	1998	1999	2000
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)
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)

[a] Stock and quality size for walleye is 250 mm and 380 mm, respectively, yellow perch: 130 mm and 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).

[b] 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 11.–Age composition of white perch and yellow perch from the gillnet catch, Saginaw Bay, Lake Huron, 1993-2000.

Age	White perch								Yellow perch							
	1993	1994	1995	1996	1997	1998	1999	2000	1993	1994	1995	1996	1997	1998	1999	2000
0	–	27	3	–	2	8	8	7	–	–	–	–	1	1	2	–
1	5	151	57	102	43	5	209	68	5	–	93	34	32	8	198	38
2	15	15	1	31	55	2	4	92	11	6	44	193	135	83	138	123
3	4	11	–	3	21	3	1	2	80	29	47	91	164	51	45	71
4	3	4	–	2	4	–	1	1	71	98	101	85	66	29	49	37
5	1	6	–	–	1	–	1	–	28	82	32	82	43	42	56	37
6	–	–	–	–	1	3	–	1	16	21	10	31	25	17	44	24
7	–	–	–	–	2	–	–	1	5	1	–	12	14	5	19	11
8	–	–	–	–	–	–	–	1	2	23	1	2	8	4	10	7
9	–	–	–	–	–	–	–		1	–	1	–	–	–	5	4
10	–	–	–	–	–	–	–		–	–	–	–	1	–	2	1
11	–	–	–	–	–	–	–		–	–	–	–	–	–	1	–
Number aged	28	214	61	138	129	21	224	173	218	241	328	531	488	240	569	353
Mean age	2.29	1.67	0.97	1.31	1.99	1.71	1.02	1.64	3.84	4.73	3.20	3.26	3.25	3.43	2.88	3.27

Table 12.–Age composition (percent) and mean length (mm) at age for channel catfish 1997-2000, Saginaw Bay, Lake Huron. 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		
Age	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)	–	–
1	0.0 (0)	–	3.6 (2)	–	6.3 (5)	174	0.0 (0)	–	165
2	27.8 (15)	236	14.3 (8)	279	0.0 (0)	–	21.7 (13)	231	284
3	24.1 (13)	328	46.4 (26)	310	6.3 (5)	310	8.3 (5)	256	345
4	7.4 (4)	–	14.3 (8)	340	66.3 (53)	343	10.0 (6)	324	401
5	11.1 (6)	404	3.6 (2)	403	5.0 (4)	–	35.0 (21)	358	450
6	13.0 (7)	411	0.0 (0)	–	7.5 (6)	432	11.7 (7)	373	490
7	5.6 (3)	–	5.4 (3)	–	1.3 (1)	–	5.0 (3)	–	523
8	1.9 (1)	–	0.0 (0)	–	3.8 (3)	–	0.0 (0)	–	559
9	0.0 (0)	–	3.6 (2)	–	1.3 (1)	–	5.0 (3)	–	589
10	0.0 (0)	–	3.6 (2)	–	0.0 (0)	–	0.0 (0)	–	605
11	1.9 (1)	–	0.0 (0)	–	1.3 (1)	–	0.0 (0)	–	–
12	3.7 (2)	–	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	–
13	3.7 (2)	–	0.0 (0)	–	0.0 (0)	–	1.7 (1)	–	–
14	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)	–	–
16	0.0 (0)	–	0.0 (0)	–	0.0 (0)	–	1.7 (1)	–	–
17	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)	–	–
19	0.0 (0)	–	1.8 (1)	–	0.0 (0)	–	0.0 (0)	–	–
Total	100 (54)	348	100 (56)	327	100 (80)	329	100 (60)	328	
Average age	4.57		4.18		4.43		4.80		
Growth index		-1.85		-1.44		-1.38		-3.34	

[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 2000 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 1997-2000 where 't' is age in years.

Species	Length/Weight Equation	Len/Wt r^2	Von Bertalanffy Equation	K	L∞	t_o
Walleye	log(wt)=2.735 log(len)-4.328	0.71	$L_t=617[1-e^{-0.3165(t+2.12)}]$	0.3165	617	-2.12
Yellow perch	log(wt)=3.288 log(1en)-5.589	0.81	$L_t=668[1-e^{-0.0359(t+5.61)}]$	0.0359	668	-5.61
White perch	log(wt)=2.527 log(1en)-3.741	0.82	$L_t=504[1-e^{-0.1103(t+2.75)}]$	0.1103	504	-2.75
Channel catfish	log(wt)=3.060 log(1en)-5.229	0.95	$L_t=1241[1-e^{-0.0491(t+3.83)}]$	0.0491	1241	-3.83

Table 14.–Location of trawl stations and number of tows performed in Saginaw Bay, Lake Huron, 1990-2000. 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[b]
Northeast	North Island & Wildfowl Bay	5	4	16	5	6	6	6	13	13	9	9
Southeast	Fish Point	4	4	6	5	3	9	6	16	12	15	6
Southwest	Pinconning	4	4	3	13	13	9	12	15	17	20	6
Northwest	AuGres	3	4	11	15	10	15	6	23	22	20	6
Total		16	16	36	38	32	39	30	31	27	27	33
Study total												580[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, 1990-2000 based on fall data only. Total number of tows is in parentheses. 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)
Alewife	80	302	191	48	307	99	301	1,590	82	337
Bluegill	0	0	0	<1	0	<1	0	0	0	0
Burbot	0	0	0	0	0	0	0	0	0	0
Channel catfish	<1	<1	1	6	3	6	2	3	4	6
Common carp	3	3	3	9	7	4	4	7	6	6
Emerald shiner	15	9	1	0	0	1	13	1	1	1
Freshwater drum	25	3	9	28	28	16	5	26	9	16
Gizzard shad	50	<1	19	8	6	23	18	23	3	3
Johnny darter	<1	12	10	11	29	21	20	5	6	4
Lake whitefish	0	<1	0	0	1	<1	1	0	<1	<1
Pumpkinseed	<1	0	0	0	0	<1	0	0	2	0
Quillback	<1	<1	1	1	1	1	<1	0	4	1
Rainbow smelt	44	280	468	58	22	15	1,585	70	32	390
Rock bass	0	0	0	0	0	<1	0	<1	5	<1
Round goby	0	0	0	0	0	0	0	0	4	127
Shorthead redhorse	0	0	0	<1	0	0	0	0	<1	0
Spottail shiner	124	182	97	204	373	209	809	665	1,935	1,011
Trout perch	166	200	416	513	514	474	733	1,730	406	619
Walleye	6	1	1	1	1	1	3	10	7	2
White bass	6	<1	2	6	1	<1	4	2	<1	<1
White perch	404	92	28	183	528	277	416	346	141	895
White sucker	12	8	10	10	7	8	28	12	10	7
Yellow perch	177	70	38	24	126	85	122	170	90	37

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 1970-2000[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

[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, Lake Huron from 1986 to 2000.

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

Table 18.–White perch catch from trawling effort, fall 1985-2000, 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

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

Table 19.–Mean length (mm) at age for yellow perch from fall Saginaw Bay, Lake Huron trawls in 1986-98[a].

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

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

Table 20.–Frequency of occurrence for food items in yearling or older yellow perch from Saginaw Bay, Lake Huron fall trawl surveys in 1986-98 (expressed as percent of non-empty stomachs containing the food item).

	Survey year										Grand
Taxa	1986	1987	1988	1991	1992	1994	1995	1996	1997	1998	total
Bosmina	4.72	0.37	2.39	1.28	16.28	4.62	0.80	0.00	0.00	0.00	2.39
Daphnia	1.37	0.00	0.43	0.00	1.16	0.00	0.00	0.00	0.00	0.00	0.45
Chydorid	64.54	16.52	20.11	17.95	60.47	27.69	4.12	14.43	5.22	11.86	28.02
Macrothricid	10.20	1.73	10.11	39.10	25.58	4.62	5.15	3.09	0.00	4.24	8.69
Leptadora	0.15	1.85	0.11	0.00	0.00	0.00	0.00	0.00	0.75	0.00	0.57
Copepod	29.22	42.29	39.67	62.18	46.51	27.69	28.87	50.52	17.16	27.12	37.79
Ostracod	23.90	20.84	32.61	63.46	66.28	33.85	40.21	48.45	35.07	33.90	31.10
Sida	21.31	10.97	2.83	1.28	38.37	16.92	1.03	9.28	3.73	6.78	10.32
BC	0.00	0.00	0.00	0.00	11.63	16.92	25.77	0.00	1.49	0.00	1.53
All plankton	69.25	55.36	54.67	6.67	74.42	56.92	74.23	58.76	38.06	49.15	58.90
Pelecepod	8.07	4.19	4.02	24.36	4.65	0.00	7.22	13.40	17.91	21.19	7.48
Gastropod	3.65	0.74	0.54	0.00	0.00	0.00	1.03	1.03	2.99	0.00	1.31
Zebra mussel	0.00	0.00	0.00	1.28	19.77	27.69	2.06	14.43	5.97	9.32	2.29
Isopod	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49	0.00	0.06
Hydracarina	9.13	2.84	11.52	1.92	3.49	1.54	1.03	0.00	1.49	0.00	6.34
Amphipod	3.65	1.97	1.30	0.00	26.74	13.85	0.00	4.12	37.31	5.08	4.58
Total "Others"	19.94	9.49	16.30	26.28	41.86	38.46	11.34	24.74	56.72	33.05	19.42
Ephemerida	3.50	0.25	0.65	0.00	0.00	0.00	0.00	2.06	0.00	0.00	1.05
Tricoptera	9.59	1.60	0.11	0.64	3.49	9.23	10.31	32.99	12.69	1.69	4.71
Chironomid Pupae	33.49	31.44	36.74	7.69	25.58	3.08	15.46	23.71	9.70	16.10	29.26
Chironomid larvae	68.80	80.02	81.85	85.90	73.26	44.62	56.70	68.04	40.30	62.71	74.15
All insects	73.67	83.72	85.33	87.18	80.23	52.31	65.98	74.23	50.00	64.41	78.51
All fish	21.61	8.26	8.80	11.54	11.63	12.31	15.46	19.59	28.36	22.03	13.50
Non-empty stomachs	765	992	1131	234	105	88	127	117	173	158	3890