

## STUDY FINAL REPORT

State: Michigan

Project No.: F-53-R-15

Study No.: 436

Title: Vital Statistics of walleye in Saginaw Bay

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

**Study Objective:** To determine exploitation, abundance, growth, mortality, movement, and recruitment for the walleye population in Saginaw Bay.

**Summary:** Keller et al. (1987) and Mrozinski et al. (1991) summarized the results through 1988 of this study and related studies on Saginaw Bay. The reintroduction of walleye to Saginaw Bay began with the stocking of 5,500 walleye fry in 1972. Fingerling stocking began in 1974 and replaced fry stocking after 1982 (Table 1). The walleye population response to stocking was evidenced by: a sudden increase in commercial trapnetters' incidental catch of small walleyes, beginning in 1979; a dramatic increase in the sport harvest, beginning in 1984; and an increase in the Tittabawassee River spawning run, beginning in 1981.

In 1999, 645,951 fingerling walleye were stocked in Saginaw Bay. An average of 738,150 walleye fingerlings was stocked annually (for years that received stocking) during the period 1981-99 (Table 1). In 1993 and 1996, however, no walleye were reared for Saginaw Bay. Stocking was interrupted so that the contribution of wild fish to the bay could be evaluated.

In 1998 and 1999, 2,490 and 2,999 walleye were tagged at Dow Dam (Tittabawassee River) respectively. In addition, 2,994 (in 1998) and 2,997 (in 1999) were tagged in the Flint River, bringing the bay area total to date to 67,797. The Flint River returns, however, are being analyzed separately from the other returns.

Mean age of male and female walleyes tagged in 1998 was 7.6 and 7.0 years, respectively, reversing the long running increase in mean age since tagging began. As noted in previous years, the 1992 and 1993 year classes (age 5 & 6 in the 1998 run) were relatively weak. From 1983 through 1985, age 5 walleyes comprised an average of 28% of the run and never less than 16%. For 1998, however, age 5 walleye comprised only 7% (sexes combined).

The mean survival for walleyes tagged at Dow Dam since 1984 was estimated to be 66%. The 95% confidence interval of the estimate was: 64% < S < 68%. Annual exploitation rate was estimated to be 7.9%.

### **Job 1. Title: Tag walleyes.**

**Findings:** Since 1981, 67,797 walleyes have been tagged on the jaw with serially-numbered monel tags (Table 2). Most tagging was done below Dow Dam on the Tittabawassee River, where a large spawning run has developed since 1981. Some walleyes were tagged at other locations during supplemental surveys. Most recently (since 1997), the Flint River run of walleye was also tagged to compare and contrast with the Tittabawassee River results.

Walleyes were collected with 230-volt DC electrofishing gear. We used a single boat and one or two tagging crews. Over 1,000 walleye were typically tagged per day.

In 1998, 2,490 walleyes were tagged and in 1999, 2,999 were tagged in the Tittabawassee River below Dow Dam in approximately four days of effort each year. Fish were measured to 0.1 inch in 1998 and to the nearest mm in 1999. Samples were externally sexed: mature males were ripe and could be identified easily; fish classified as females could have included some immature individuals of both sexes. Scales were taken from all walleyes tagged. A subsample of these scales from the height of the run was aged. Ages from the Flint River operation and from both locations in 1999 are still being analyzed. The following results are specific to the Tittabawassee River location unless otherwise specified.

**Job 2. Title: Determine age and growth.**

**Findings:** Each year, scale samples were collected from subsamples per size group to determine growth and age structure of the walleye population. Scales were taken from a random subsample of tagged walleyes from 1981 through 1984. From 1984 through 1993, scales were subsampled on a stratified-random basis. Ages from the latter period were weighted by length-frequency data from the tagged-fish database to estimate the age composition of the entire tagged sample. Beginning in 1994, all scales collected from a single day's tagging effort were aged as a representative sample for age and growth data. The number of fish used in age determinations was 1,248 in 1998. Average lengths of walleyes tagged through 1999 are given by sex and year in Table 3. The estimated age distribution of fish tagged during spring 1987 - 1998 is given in Table 4.

Over the period of this study, average age and average length of walleyes has generally increased. Initially, increasing age reflected the recovery and maturing of the spawning population. Mean age of male and female walleyes tagged peaked in 1997 at 7.9 years. Mean age declined in 1998 due partly to an abundance of age 3 fish. From 1983-1995, age 5 walleyes made up an average of 28% of the run and never composed less than 16%. For 1998, however, age 5 walleyes made up an average of only 7.0% of the spawning run (Table 4). The 1992 and 1993 year classes appear to be weak. Similarly, the 1992 and 1993 year classes show weakly in the age structure of the walleyes harvested from the bay's open water fishery (Table 5). The 1996 nonstocked year class has not yet fully recruited to the spawning run.

Growth of walleye continues to be rapid (Table 6). Its expected that if the walleye population ever approaches the bay's carrying capacity, then growth rates will decline.

**Job 3. Title: Collect tag returns.**

**Findings:** As of April 1, 1998, 73 tag returns from fish caught in tagging year 1998 had been processed and entered in the database. A total of 67,797 walleye have been tagged, of which 48,351 were tagged during spring 1984 - 1998 below Dow Dam. The tag return matrix for the fish tagged at Dow Dam is given in Table 7.

Using the tag-recovery program ESTIMATE, Model 1 (for year-specific survival, fishing, and reporting rates) (Brownie et al. 1985), the following means were estimated for the period of 1984 through 1998:

Mean recovery rate (percent)	3.35
95% confidence interval	3.22-3.49
Mean survival rate (percent)	66.0
95% confidence interval	64.3-67.6
Mean adult life span after tagging (years)	2.40
95% confidence interval	2.26-2.56

Recovery rates peaked in 1992 at 5.4% and declined to 2.0% in 1995. The recovery rate for 1998 is conservative because not all tags for the 1998 tagging year had been received at the time the model was run. These trends in recovery rate suggest vulnerability to angling may have changed, which could explain some of the variation in harvest measured by Study 427. Harvest peaked in 1993 and remained well below that level since. Walleye harvest has again begun to increase since 1996 (Table 5). Tag recovery rates have roughly paralleled trends in harvest and effort. Total mortality rate (1-S) is summarized in Table 5.

A study of tag returns from Lake Erie using \$100.00 reward tags estimated a correction factor for nonresponse of 2.68 (R. Haas, Michigan Department of Natural Resources, Study 460). This latter correction factor gives an annual exploitation rate on Saginaw Bay of 7.9% for 1998 (Table 5).

Movement of walleye based on tag returns was summarized through 1997 recently and reported by Fielder et al. (In Press).

**Job 4. Title: Prepare annual reports.**

**Findings:** This annual progress report was prepared. A research report summarizing tag returns and movement of walleye is currently in press and spans the period of 1989 through 1997. This study (Study 436) is being renewed.

Fielder, D. G., J. R. 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.

**Literature Cited:**

Brownie, C., D. R. Anderson, K. P. Burnham, and D. S. Robson. 1985. Statistical inference from band recovery data: a handbook. U. S. Fish and Wildlife Service, Resource Publication No. 156.

Fielder, D. G., J. E. Johnson, J. R. Weber, M. V. Thomas, and R. C. Haas. In Press. Fish population survey of Saginaw Bay, Lake Huron, 1989 - 1997. Michigan Department of Natural Resources, Fisheries Research Report. Ann Arbor.

Keller, M., J. C. Schneider, L. E. Mrozinski, R. C. Haas, and J. R. Weber. 1987. History, status, and management of fishes in Saginaw Bay, Lake Huron, 1891-1986. Michigan Department of Natural Resources, Fisheries Technical Report 87-2, Ann Arbor.

Mrozinski, L. E., J. C. Schneider, R. C. Haas, and R. E. Shepherd. 1991. Rehabilitation of walleye in Saginaw Bay, Lake Huron. Pages 63-84 in P. J. Colby, C. A. Lewis, and R. L. Eshenroder, Editors. Status of walleye in the Great Lakes: case studies prepared for the 1989 workshop. Great Lakes Fishery Commission, Special Publication 91-1, Ann Arbor.

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**Date:** September 30, 1999

Table 1.-Number of walleye stocked in Saginaw Bay and tributaries, 1972-99.

Year	Fry	Fingerlings
1972	50,000,000	0
1973	50,000,000	0
1974	0	5,500
1975	300,000	0
1976	300,000	0
1977	400,000	4,070
1978	0	25,000
1979	300,000	334,427
1980	0	9,989
1981	800,000	294,656
1982	0	269,540
1983	0	869,000
1984	0	947,796
1985	0	954,218
1986	0	871,263
1987	0	632,204
1988	0	345,537
1989	0	834,375
1990	0	850,085
1991	0	622,687
1992	0	787,675
1993	0	0
1994	1,100,000	1,282,992
1995	0	717,519
1996	0	0
1997	0	1,006,377
1998	300,000	1,106,000
1999	0	645,951
<b>Totals</b>	<b>103,500,000</b>	<b>13,416,861</b>

Table 2.-Number of walleye tagged, by site, 1981-99.

Site	Year																			Total
	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
<b>Tittabawassee River</b>																				
Dow Dam	400	722	3,436	3,548	3,335	2,923	6,020	4,036	2,494	2,488	3,079	2,995	2,989	2,999	2,970	2,992	2,993	2,490	2,999	55,908
Sanford Dam	---	---	---	---	531	608	---	---	497	---	---	---	---	---	---	---	---	---	---	1,636
<b>Other rivers</b>																				
Kawkawlin River	---	---	126	112	---	---	56	---	74	---	---	---	---	---	---	---	---	---	---	368
AuGres River	---	---	---	---	174	59	215	---	---	---	---	---	---	---	---	---	---	---	---	448
Saginaw River	---	---	---	---	---	---	---	115 <sup>1</sup>	---	418	---	---	---	---	---	---	---	---	---	533
Flint River <sup>2</sup>	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2,994	2,997	5,991
<b>Saginaw Bay</b>																				
Consumers Power	---	---	10	---	---	0	---	---	207	---	---	---	---	---	---	---	---	---	---	217
Pt. AuGres	---	---	---	343	60	511	---	---	---	---	---	---	---	---	---	---	---	---	---	914
Catfish Hole <sup>3</sup>	---	---	---	---	---	529	---	---	---	---	---	---	---	---	---	---	---	---	---	529
Pinconning	---	---	---	56	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	56
Sand Point	---	---	---	89	---	---	1,108	---	---	---	---	---	---	---	---	---	---	---	---	1,197
<b>Total</b>	400	722	3,572	4,148	4,100	4,630	7,399	4,151	3,272	2,906	3,079	2,995	2,989	2,999	2,970	2,992	2,993	5,987	5,996	67,797

<sup>1</sup>Tagged on May 7, 1988, in Saginaw River at Wickes Park during a walleye tournament.

<sup>2</sup>Returns analyzed and reported separately and not included in estimate model analysis.

<sup>3</sup>A 19-foot deep depression about seven miles southwest of Pt. AuGres in Grid 1507 (includes 98 tagged).

Table 3.—Average total length (inches) of walleye collected by electrofishing below Dow Dam, Tittabawassee River, March-April 1981-1999.

Year	Female		Male		Total	
	Length	Number	Length	Number	Length	Number
1981	20.8	87	13.8	272	---	399
1982	20.3	179	17.8	513	---	697
1983	21.6	2,082	19.6	1,300	---	3,413
1984	23.0	1,052	18.6	2,421	---	3,540
1985	20.9	1,322	18.0	1,662	---	2,984
1986	21.1	1,370	18.3	2,023	---	3,574
1987	21.5	1,736	18.6	3,829	19.1	5,976
1988	22.9	549	18.8	3,338	19.3	4,033
1989	22.1	1,774	19.1	1,244	20.8	3,064
1990	22.9	972	19.4	1,481	20.8	2,467
1991	23.0	2,232	19.2	843	22.0	3,079
1992	24.0	1,491	19.8	1,497	21.9	2,995
1993	22.9	1,323	19.2	1,666	20.9	2,989
1994	23.6	1,452	20.9	1,534	22.2	2,999
1995	23.2	962	21.2	2,003	21.9	2,970
1996	24.7	1,376	21.9	1,614	23.2	2,992
1997	24.8	1,905	21.8	1,088	23.8	2,993
1998	23.2	1,170	21.4	1,311	22.2	2,489
1999	24.4	957	21.6	2,031	22.4	2,995

Table 4.—Age composition (percent) of walleye sampled from Saginaw Bay tributaries during spring electrofishing, 1987-1998.

	Age														Mean age
	1	2	3	4	5	6	7	8	9	10	11	12	13	14 <sup>+</sup>	
1987	---	10.4	1.9	46.9	29.9	5.0	3.7	1.9	0.3	---	---	---	---	---	4.4
1988															
Female	---	---	4.0	18.5	32.8	25.7	10.5	5.7	3.0	---	---	---	---	---	5.5
Male	---	0.5	29.5	22.8	25.5	14.5	3.8	2.3	1.1	---	---	---	---	---	4.5
1989															
Female	---	---	1.5	41.4	27.3	23.1	5.7	1.1	---	---	---	---	---	---	4.9
Male	---	0.8	5.8	58.5	20.4	8.2	4.4	1.2	0.6	---	---	---	---	---	4.5
1990															
Female	---	0.1	0.1	1.2	37.1	34.7	22.9	3.6	0.4	---	---	---	---	---	5.9
Male	---	3.1	5.0	14.0	49.2	21.1	7.1	0.5	0.1	---	---	---	---	---	5.0
1991															
Female	---	---	0.1	18.8	19.2	45.7	11.5	2.6	1.5	0.6	---	---	---	---	5.7
Male	---	0.1	43.8	9.6	19.6	20.5	3.6	2.6	0.2	---	---	---	---	---	4.4
1992															
Female	---	0.1	0.0	9.4	14.5	12.1	17.9	13.7	10.2	12.9	4.6	3.0	1.7	0.2	7.5
Male	---	0.6	19.5	30.8	17.4	17.6	11.4	1.0	1.0	0.3	0.4	---	---	---	4.8
1993															
Female	---	---	1.6	13.7	31.8	11.7	18.6	14.6	6.5	1.2	0.3	---	---	---	6.1
Male	---	---	33.3	25.6	14.2	12.6	9.0	2.9	1.1	1.3	---	---	---	---	4.6
1994															
Female	---	---	1.3	17.3	32.7	16.0	7.7	12.2	7.7	1.9	1.3	0.6	---	---	6.0
Male	---	---	4.9	18.9	12.8	10.4	13.4	17.1	12.8	4.9	1.2	---	---	---	6.5
1995															
Female	---	---	---	9.4	53.1	13.4	9.1	7.1	3.9	2.4	1.2	0.4	---	---	5.8
Male	---	---	1.3	9.0	20.5	21.0	12.7	14.0	12.5	7.6	0.7	0.4	0.2	---	6.7
1996															
Female	---	---	---	0.2	9.1	18.4	22.6	13.1	12.6	15.9	6.9	1.3	---	---	7.8
Male	---	---	0.6	0.8	6.3	16.1	18.9	21.9	18.4	13.0	3.1	0.9	---	---	7.8
1997															
Female	---	---	0.4	4.1	1.3	11.8	26.8	22.9	12.4	8.4	7.1	4.9	---	---	7.9
Male	---	---	---	1.5	0.3	15.2	23.6	27.3	16.1	9.2	4.0	2.0	---	0.6	7.9
1998															
Female	---	---	1.7	22.8	11.0	6.6	11.3	19.6	12.8	7.3	4.0	2.7	0.3	---	7.0
Male	---	---	6.8	9.3	3.4	4.8	16.4	22.7	17.7	10.3	6.2	1.5	0.9	---	7.6

Table 5.—Walleye year class percent composition in Saginaw Bay sport fishery, harvest (2 SE of the mean), adjusted annual exploitation rate, and total annual mortality rate, 1989 through 1998.

Year class	Creel survey year										Mean
	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	
1981	---	---	0.8	1.3	0.6	0.2	---	---	---	---	---
1982	5.1	---	2.4	3.1	2.1	---	0.7	0.2	---	---	---
1983	5.1	---	6.5	4.5	4.1	1.8	1.4	2.2	0.6	---	---
1984	13.6	---	8.4	4.9	4.8	4.4	4.2	2.7	2.4	0.2	---
1985	28.8	---	14.5	10.7	12.7	8.4	8.7	7.7	3.6	1.2	---
1986	45.7	---	16.1	18.3	10.6	11.6	9.7	10.2	6.7	2.5	---
1987	1.7	---	12.0	11.6	7.6	9.2	8.3	6.2	6.1	3.5	---
1988	---	---	20.2	16.5	14.1	13.8	11.1	7.0	6.7	3.7	---
1989	---	---	19.1	24.6	23.0	17.6	16.3	11.7	5.2	9.6	---
1990	---	---	---	4.5	15.5	14.8	12.7	9.2	9.7	11.3	---
1991	---	---	---	---	4.9	17.8	20.3	19.0	18.2	12.5	---
1992	---	---	---	---	---	0.4	6.4	6.7	11.5	8.0	---
1993	---	---	---	---	---	---	0.2	1.2	1.2	3.3	---
1994	---	---	---	---	---	---	---	15.7	25.2	28.1	---
1995	---	---	---	---	---	---	---	---	3.0	15.4	---
1996	---	---	---	---	---	---	---	---	---	0.6	---
1997	---	---	---	---	---	---	---	---	---	---	---
1998	---	---	---	---	---	---	---	---	---	---	---
No. aged	59	---	491	224	631	500	424	401	330	512	---
Harvest <sup>1</sup>	56,337 (10,580)	---	61,028 (10,817)	64,447 (8,702)	125,160 (18,357)	68,170 (11,907)	47,887 (9,208)	47,566 (9,990)	78,128 (15,109)	80,366 (11,614)	69,771
Exploitation	9.5	6.5	7.2	14.5	13.1	7.4	5.3	6.6	7.2	7.9	8.5
Total mortality <sup>2</sup>	28.5	27.9	39.3	41.2	35.7	19.7	36.0	15.5	34.4	---	28.9

<sup>1</sup> From previous MDNR creel survey reports.<sup>2</sup> Annual rate for last year cannot yet be calculated.

Table 6.—Mean total length (inches) at age of walleye from tagging operation, Tittabawassee River, spring 1992-1998.

Year class	Age	Male		Female		Age	Male		Female		
		Length	Number	Length	Number		Length	Number	Length	Number	
1992						1993					
1992	---	---	---	---	---	---	---	---	---	---	
1991	---	---	---	---	---	---	---	---	---	---	
1990	2	14.6	9	---	0	3	16.4	29	21.6	1	
1989	3	17.2	21	---	0	4	18.4	20	18.4	17	
1988	4	18.9	18	20.4	20	5	20.6	11	21.5	24	
1987	5	20.1	10	21.6	16	6	21.8	13	23.5	9	
1986	6	21.7	14	23.3	8	7	22.3	13	25.1	18	
1985	7	22.8	16	23.4	11	8	24.2	13	25.8	18	
1984	8	24.0	8	25.0	7	9	24.0	5	26.8	11	
1983	9	24.2	3	26.0	8	10	22.8	2	28.2	6	
1982	10	24.6	3	26.8	15	11	---	0	29.1	3	
1981	11	25.7	4	27.2	8	12	19.7	1	---	0	
1980	12	---	0	28.5	8	---	---	---	---	---	
1979	13	---	0	28.6	6	---	---	---	---	---	
1978	14	---	0	28.6	1	---	---	---	---	---	
<b>Total number</b>			106		108			107			
1994						1995					
1992						3	16.8	7	---	0	
1991	3	16.3	8	17.1	2	4	18.4	49	20.0	24	
1990	4	18.2	31	20.2	27	5	19.9	111	22.1	135	
1989	5	19.6	21	21.7	51	6	20.7	114	22.9	34	
1988	6	20.8	17	23.2	25	7	21.4	69	24.0	23	
1987	7	21.7	22	24.6	12	8	22.2	76	24.7	18	
1986	8	22.2	28	25.3	19	9	22.7	68	27.3	10	
1985	9	22.6	21	25.3	12	10	23.7	41	25.5	6	
1984	10	23.6	8	25.2	3	11	23.6	4	28.3	3	
1983	11	24.8	2	27.5	2	12	23.9	2	28.2	1	
1982	12	---	0	29.7	1	13	25.6	1	---	0	
1981	---	---	---	---	---	14	---	---	---	---	
1980	---	---	---	---	---	---	---	---	---	---	
1979	---	---	---	---	---	---	---	---	---	---	
1978	---	---	---	---	---	---	---	---	---	---	
<b>Total number</b>			158		154			542		254	

Table 6 continued, next page.

Table 6.—Continued.

Year class	Age	Male		Female		Age	Male		Female	
		Length	Number	Length	Number		Length	Number	Length	Number
		1996				1997				
1994						3	---	0	20.5	2
1993	3	17.5	4	---	0	4	20.0	5	20.8	19
1992	4	17.8	5	21.1	1	5	20.2	1	21.9	6
1991	5	19.6	41	21.7	41	6	20.5	53	23.0	55
1990	6	20.5	104	23.3	83	7	21.1	82	24.2	125
1989	7	21.3	122	24.1	102	8	21.8	95	24.9	107
1988	8	22.2	142	25.0	59	9	22.7	56	26.3	58
1987	9	23.0	119	26.5	57	10	23.4	32	26.8	39
1986	10	23.2	84	27.1	72	11	23.6	14	27.1	33
1985	11	24.3	20	28.1	31	12	24.8	7	28.1	23
1984	12	24.9	6	28.3	6	13	---	0	---	0
1983	---	---	---	---	---	14	26.8	1	---	0
1982	---	---	---	---	---	15	---	0	---	0
1981	---	---	---	---	---	16	21.5	1	---	0
<b>Total number</b>			647		452			347		467

Year class	Age	Male		Female	
		Length	Number	Length	Number
		1998			
1995	3	17.0	44	19.5	10
1994	4	18.8	60	20.6	137
1993	5	19.9	22	22.0	66
1992	6	20.7	31	23.0	40
1991	7	21.4	106	24.1	68
1990	8	22.1	147	25.0	118
1989	9	23.0	115	25.8	77
1988	10	23.4	67	26.4	44
1987	11	24.0	40	27.6	24
1986	12	24.0	10	27.0	16
1985	13	24.9	6	---	---
1984	14	---	---	---	---
1983	15	---	---	---	---
1982	---	---	---	---	---
<b>Total number</b>			648		600

Table 7.-Tag return matrix for walleye tagged at Dow Dam during spring, 1984-1998.

Tag year	Number tagged	Recovery year																	Total returns	Estimated recovery rate
		1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998				
1984	3,548	69	88	66	56	32	21	9	7	5	5	1	1	1	1	1	363	1.94		
1985	3,335	112	97	62	34	12	5	4	7	3	0	0	0	0	0	0	337	3.21		
1986	2,923	118	89	36	18	16	10	19	23	12	6	5	0	2	0	0	308	4.01		
1987	6,020	308	117	64	23	19	26	20	15	11	7	1	0	2	4	4	583	4.80		
1988	4,036	161	85	32	26	20	15	11	7	1	4	0	0	0	0	0	362	3.84		
1989	2,494	68	44	34	49	18	8	5	3	4	4	1	234	3.39						
1990	2,488	59	52	51	33	9	6	4	1	220	2.40									
1991	3,079	71	109	49	16	9	11	12	4	281	2.59									
1992	2,995	165	83	30	21	14	10	11	334	5.44										
1993	2,989	150	52	18	12	287	4.83													
1994	2,999	76	52	31	24	18	12	287	4.83											
1995	2,970	53	52	45	37	15	225	2.64												
1996	2,992	72	51	47	27	178	2.05													
1997	2,993	87	76	44	192	2.58														
1998	2,490	87	67	154	3.20															
<b>Mean</b>	<b>3,223</b>																	<b>3.35</b>		
<b>Total</b>	<b>48,351</b>																<b>4,131</b>			