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Abstract.–The 1992, 1993, and 1994 walleye *Stizostedion vitreum* spawning runs in the lower Huron River, a Michigan Lake Erie tributary, were surveyed using DC electrofishing equipment. A total of 1,573 walleye were collected during 52.6 hours of shocking, for a catch per effort of 29.9 walleye per hour. Annual population estimates for 1992, 1993, and 1994 were 3,424, 7,821, and 5,180, respectively. These were generated using the Schnabel method based on recaptures of tagged walleye. Females predominated, accounting for 55% to 68% of the catch annually. Visible signs of lymphocystis infection ranged from 10.2% to 17.9% of the fish examined. No walleye have been stocked in the lower Huron River. Age distribution indicated strong walleye year classes in 1985, 1986, 1990, and a poor year class in 1992. This pattern closely reflected documented strength and weakness of walleye year classes in Lake Erie. Collection of previously tagged fish indicates a portion of this population returns annually, suggesting a discrete stock. The dam and weir in the city of Flat Rock prevent walleye movement upstream. Stock assessment efforts on small tributaries, such as this one, will provide a broader understanding of walleye population dynamics in Lake Erie.

The Huron River originates in Oakland County and flows southwest, then southeast approximately 218 km to Lake Erie. It is a highly fragmented river system with 98 known dams, 19 of which are located on the mainstem (Hay-Chmielewski et al. 1995). The first encountered barriers, traveling upstream approximately 16 km from the mouth, are located in the city of Flat Rock. Here a series of two barriers exist, a water level control dam for the Flat Rock Impoundment (head about 4 m) preceded first by a low head weir (head about 1.3 m) that is subject to seasonal flooding. The low head weir may be a physical barrier to walleye movement upstream.

Anecdotal reports of spawning walleye in the lower Huron River have been common since the 1970s. Although walleye are stocked sporadically in some Huron River impoundments, no walleye have been stocked in the lower Huron River in recent times. In 1978, Merna and Schneider (Fisheries Division, Michigan Department of Natural Resources (MDNR) files) documented the presence of a "substantial" walleye spawning run during an electrofishing survey below the Flat Rock Dam. Conservation officers had also observed numerous walleye taken illegally from the Huron River with dip nets during the sucker run (R. J. Spitler, MDNR Livonia; personal communication). As a result, sucker fishing with dip nets has been prohibited in the lower Huron River since 1986. MDNR workers conducting on-site creel surveys at Flat Rock from 1988 to 1992 observed many walleye caught and released by steelhead anglers during mid to late March each year. The objectives of this assessment were to document the abundance of walleye in this self-sustaining spawning run and their biological characteristics and to facilitate the investigation of their subsequent movement and exploitation.

Methods

Walleye were collected using a pulsed DC electrofishing boat (60 pulses per second, 7-10 amperes). The only suitable boat ramp was at the MDNR facility near the mouth of the river at Pte. Mouillee. Collecting effort was focused on the stretch of river from Telegraph road to south Rockwood (Figure 1) after initial shocking determined that catch rates below south Rockwood were low. Travel time from the ramp at Pte. Mouillee upstream to Telegraph road was about 40 minutes. Collections were done each spring from 17 March 1992 through 12 April 1994. All electrofishing took place during daylight between 0900 and 0300. As catch rates increased, a separate tagging boat was deployed to increase electrofishing time. Fish under 600 mm were tagged on the lower jaw with size 10 or 12 monel metal trap tags affixed by overlapping the tag snugly around the dentary bone. Fish over 600 mm were tagged with size 12 monel metal strap tags affixed around both the maxillary and premaxillary bones. All tags were inscribed with the Mt. Clemens MDNR address and an individual tag number. Fish recaptured the same day were not recorded as recaptured. Length, weight, scale sample (for age analysis), sex and reproductive condition, presence of previous tags, and lymphocystis occurrence were recorded. Other fish species observed were recorded but their abundances were not noted. Weather conditions, water temperature, water clarity, water level and electrofishing effort were recorded on a daily basis.

The Schnabel method (Ricker 1975) was used to estimate the total number of walleye in the Huron River spawning run. Migration was assumed negligible during the course of the spawning run resulting in a "closed" population of spawners. Sampling of the spawning run each year occurred over 7-9 days. The Schnabel method uses multiple censuses with replacement, and input data include total number marked in the population, number marked each day, and number recaptured each day. These are input into the equation

$$N = \Sigma(C_t M_t) / \Sigma R_t \ ;$$

where M_t is the total marked fish at large at the start of day t; C_t is the total sample taken on day t; and R_t is the number of recaptures in sample C_t. This method was applied to the population marked and recaptured in each year.

Results

Water temperatures ranged from 2.2 to 7.8°C and weather conditions varied from cold and windy days with snow flurries to calm and warm days. Water levels varied considerably during the sampling periods. Daily fluctuations of 0.6 m were observed. In general, water levels were categorized as low in 1992, high in 1993, and moderate in 1994. Low water levels increased shocking efficiency but limited boat access to portions of the river. No noticeable difference in water clarity was observed.

Twenty-nine species were observed while electrofishing (Table 1). Species observed on a daily basis included white sucker, walleye, redhorse, steelhead, and common carp. Uncommon or rare species that were observed during this assessment included sauger (6 collected), sauger x walleye hybrid (1 collected), and spotted sucker.

A total of 1,573 walleye were collected during 52.6 hours of shocking (Table 2). Catch per hour of shocking (CPUE) varied from a minimum of 2 to a maximum of 75. Mean CPUE was highest (44.3) in 1992 and lowest (22.1) in 1993. Females accounted for 55% of the total catch in 1992, 61% in 1993, and 68% in 1994. For all three years, mean length of females exceeded that of males (Table 2). Females at a given age were consistently larger than males of the same age (Table 3). No change in growth rate was evident across the three years of the survey period.

Age composition of the spawning run varied considerably across the three years of assessment (Table 4). In 1992, age 6 and 7 fish, corresponding to the 1986 and 1985 year classes, dominated the catch for both sexes. In 1993, males from the 1990 year class (age 3) recruited into the run and accounted for 65% of the males collected, while age 7 and 8 fish still dominated the catch for females. In 1994, age 3 and 4 males accounted for 80% of the males caught. As females from the 1990 year class matured and entered the spawning run, the age composition of females in the run shifted, with age 4 females accounting for 36% of the females caught.

During all three years, we collected walleye that had been tagged in previous years. In 1992, thirty-three walleye were recaptured from the 1992 assessment. One additional walleye was captured with an Ontario Ministry of Natural Resources tag. It was originally caught at the mouth of the Thames River, tagged, then transported and released at Big Creek near Delhi, Ontario. In 1993, there were eleven fish recaptured from the 1993 tagging group and 9 recaptured from the 1992 group. In 1994, 26 walleye were recaptured from 1994, 11 from 1993, and 11 from 1992. One additional walleye was also collected that was originally tagged in Lake Erie (Raisin River site) by MDNR Mt. Clemens personnel.

The number of walleye in the Huron River spawning run was estimated for each year of the assessment (Table 5). The run was estimated to number 3,424 fish in 1992, 7,821 fish in 1993, and 5,180 fish in 1994. Confidence limits for these abundance estimates overlapped, indicating no significant difference in population among years (Table 5).

The rate of visible external lymphocystis infection for walleye ranged from 10.2% to 17.9% for the years of assessment (Table 2). Thirty walleye were recaptured at least one year after initial tagging. Of these thirty fish, six exhibited a change in external lymphocystis condition (Table 6). Two fish that had lacked any external signs at the time of tagging had visible lymphocystis when recaptured. Four fish that had visible lymphocystis at the time of tagging showed no external evidence of the condition when recaptured. The overall infection rate for this group of 30 fish decreased from 20% at the time of tagging, to 13% at the time of recapture.

Discussion

Biological characteristics

Electrofishing catch rates in the Huron River ranged from 22 to 44 walleye per hour during the study. These values were low compared to the CPUE of 94 walleye per hour reported for the Clinton River (Thomas 1995). Walleye in the Huron River were collected from several miles of river, while collections in the Clinton River were limited to a one-half mile reach of the spillway. This suggests spawning walleye densities in the Huron River were lower than in the Clinton River. Also, the low CPUE of walleye experienced below Rockwood tends to support the assumption most walleye spawning activity occurred upstream.

Females predominated the catch in the Huron River, accounting for 55 - 68% of the catch annually. This is quite different from the sex ratios encountered in the Clinton River walleye spawning run which ranged from 15 - 43 % females (Thomas 1995). Reasons for this difference are not obvious.

Mean length at age for both male and female walleye from the Huron River were similar to those reported from trap nets at Monroe sites during the study period (Thomas and Haas 1994). Mean length at age of females collected from the Clinton River were considerably less than those sampled from the Huron River. Haas et al. (1988) also found that walleye from Lake Erie were significantly larger than the same age fish from Lake St. Clair.

Age distribution of walleye collected in this study indicated that the 1985, 1986, and 1990 year classes were relatively strong. A lack of age-2 males in 1994 indicated that the 1992 year class was likely poor. Similarly, the 1985 and 1986 year classes for Lake Erie walleye were very strong (Thomas and Haas 1994), while the 1992 year class was among the poorest on record (Thomas and Haas 1995).

Lymphocystis

The unsightly look of a lymphocystis infected fish often generates public concern for fish health and water quality. Lymphocystis is a viral disease that results in wart-like protuberances or lesions on the skin and fins and is particularly associated with the Percidae and Centrarchidae families. The disease is spread by the bursting and/or sloughing of host cells, releasing virus particles into the water column (Allison et al. 1977). Infection rates tend to be higher during spring spawning runs, and gradually diminish by fall and winter. Smith et al. (1992) found no correlation between industrial water contamination and susceptibility of walleye to lymphocystis.

The documented occurrence of lymphocystis infection in walleye from the Huron River (10.2% - 17.9%) appears to be consistent with that observed in spring walleye collections from the Great Lake waters of southeast Michigan. Thomas (1995) found infection occurrences of 20% in the spawning run of walleye from the Clinton River. Smith et al. (1992) reported an incidence rate of 9% from the Thames River in the Canadian waters of Lake St Clair. Elsewhere in Michigan, Baker (MDNR, Bay City, personal communication) found occurrences from 1984 to 1991 to range from 9.5% to 14.4% for the spawning run of walleye in the Tittabawassee River. In northern Green Bay, Lake Michigan, infection rates have ranged from 3% to 15% during spawning runs since 1988 (P. J. Schneeberger, MDNR, Marquette; personal communication).

The collection of tagged and infected walleye from 1992 - 1994 in the Huron River demonstrated some of the temporal characteristics of lymphocystis. Over the 3-year assessment period, 73% of the tagged walleye re-examined one or two years later showed no evidence of lymphocystis. Over a 2-year period, 13% lost the infection, 7% inherited symptoms, and 7% sustained an infected condition.

Population estimates

Estimates of the number of walleye in 1992, 1993, and 1994 spawning runs in the Huron River are tenuous due to free movement in and out of the river. Non-randomness of collection locations further compounds the problem. However, the general magnitude of the run may be roughly estimated from analysis of the numbers of walleye marked and subsequently recaptured during each assessment period.

While estimates of the run size varied from year to year, the general magnitude appears consistent (Table 5). Walleye spawning runs in the Thames River, Ontario and the Maumee River, Ohio are believed to number in the millions. The Huron River run is small but still a contributor to the Lake Erie fishery. This spawning run has sustained itself without the aid of stocking. Thomas (1995) estimated the walleye spawning run in the Clinton River, a stocked Lake St. Clair tributary, to be of similar magnitude.

Tagging study

In addition to allowing an estimate of the Huron River walleye population size each year, tagging of Huron River walleye in 1992, 1993, and 1994 also provided information on the temporal and geographical distribution of angler harvest. Thomas and Haas (1994) reported the recapture distribution of walleye tagged in the Huron River in 1992 and 1993 was as follows: St. Clair River, 24.3%; Lake St. Clair, 8.1%; Detroit River, 27.0%; Western Basin-Lake Erie, 24.3%; Lake Erie-Total, 35.1%. They also reported that recaptures occurred from March through July, with 43% of all recaptures caught in May. The geographical distribution of recaptures in 1994 changed slightly, with more recaptures reported from Lake Erie. In 1994, the St. Clair River, Lake St. Clair, the Detroit River, and Lake Erie-Total, accounted for 10.5%, 13.2%, 15.8%, and 57.8%, respectively (Thomas and Haas 1995). Thomas and Haas (1995) noted a similar trend for recapture of walleye tagged in Lake Erie near Monroe, Michigan since 1989. They speculated that an increase in angler effort and access in the Lake Erie's Central Basin was a factor in this trend. In 1994, tags were reported during all months, except September and November, with May (23.7%), June (23.7%), and July (28.9%) combining for 76% of the recoveries.

Discreteness of the Huron River stock

Different stocks of fish may exhibit different movement patterns, growth, mortality, and exploitation rates, and they may respond differently to environmental perturbations (Colby and Nepszy 1981, Ihssen et al. 1981). Based on the areal distribution of reported tag recoveries by anglers, Thomas and Haas (1994) suggested that the Huron River spawning run could represent a genetically distinct stock of walleye. Recapture of walleye previously tagged in the Huron River, during subsequent Huron River spawning runs, also suggests that a substantial component of the run returns to the Huron River each spawning season. This homing further supports that concept of a Huron River walleye stock. However, similar growth characteristics and year class strength between the Huron River and Lake Erie walleye may indicate that little genetic discreteness exists for this population. Further genetic studies utilizing recent molecular techniques could more adequately address the question of genetic discreteness.

Management of discrete spawning stocks of walleye is an important component of a new interagency initiative for walleye management in Lake Erie (Knight et al. 1995). This initiative emphasizes the need to identify and assess status of large spawning stocks, such as in the Maumee River, and relatively small spawning stocks, such as in the Huron River. Assessment efforts, such as this one, on as many separate spawning stocks as possible, will provide a broader understanding of walleye population dynamics in Lake Erie.

Sauger and Saugeye

Historically, sauger were an important component of the Lake Erie percid community. Commercial fishing records indicate that production of sauger exceeded walleye from 1915 to 1935. However, by 1960, sauger were virtually extinct from Lake Erie (Nepszy 1977). In an effort to reestablish sauger in western Lake Erie, the Ohio Department of Natural Resources stocked sauger fry in Sandusky Bay from 1974 to 1976 (Rawson and Scholl 1978). Since then, sauger have been sporadically collected in very low numbers during spring netting surveys in Michigan waters of Lake Erie. The Huron River assessment collection of six saugers in three years suggests that a small number of sauger enter the Huron River each spring. These fish may represent a small self-sustaining population.

Naturally produced hybrids of sauger and walleye, referred to as saugeye have also been collected in low numbers during spring netting surveys in Michigan waters of Lake Erie. Regier et al. (1969) suggested that introgressive hybridization with walleye may have ultimately eliminated the pure sauger strain in Lake Erie in the 1940's and 1950's. However, Billington et al. (1988) indicated that mitochondrial DNA analysis of walleye from Lake Erie provided no evidence of introgressive hybridization with sauger. Nonetheless, the low incidence of sauger and saugeye in the Huron River during the walleye spawning run suggests that hybridization may be a factor in the low abundance of sauger in Lake Erie and its tributaries.

Implications of the dams at Flat Rock

The Flat Rock dam and weir pose the first physical barriers to potamodromous fish on the Huron River. Steelhead stocking has created a popular spring and fall fishery at the city park located near the dam. Seelbach et al. (1994) reported an average of 24,000 angler hours were spent annually on the Huron River steelhead fishery from 1989 to 1993 in the Flat Rock vicinity. This steelhead fishery prompted the construction of a fish ladder at Flat Rock dam. However, since the low head weir below Flat Rock dam barricades upstream movement of walleye (Leonardi 1993, MDNR files), we expect that the fish ladder will not benefit walleye. Both barriers in fact inundate rare high-gradient bedrock that is ideal habitat for walleye spawning (R.C. Haas, DNR, Mt. Clemens; personal communication). We favor the option of removing the weir and dam suggested by Hay-Chmeilewski et al. (1995) to restore habitat continuity and valuable bedrock spawning habitat.

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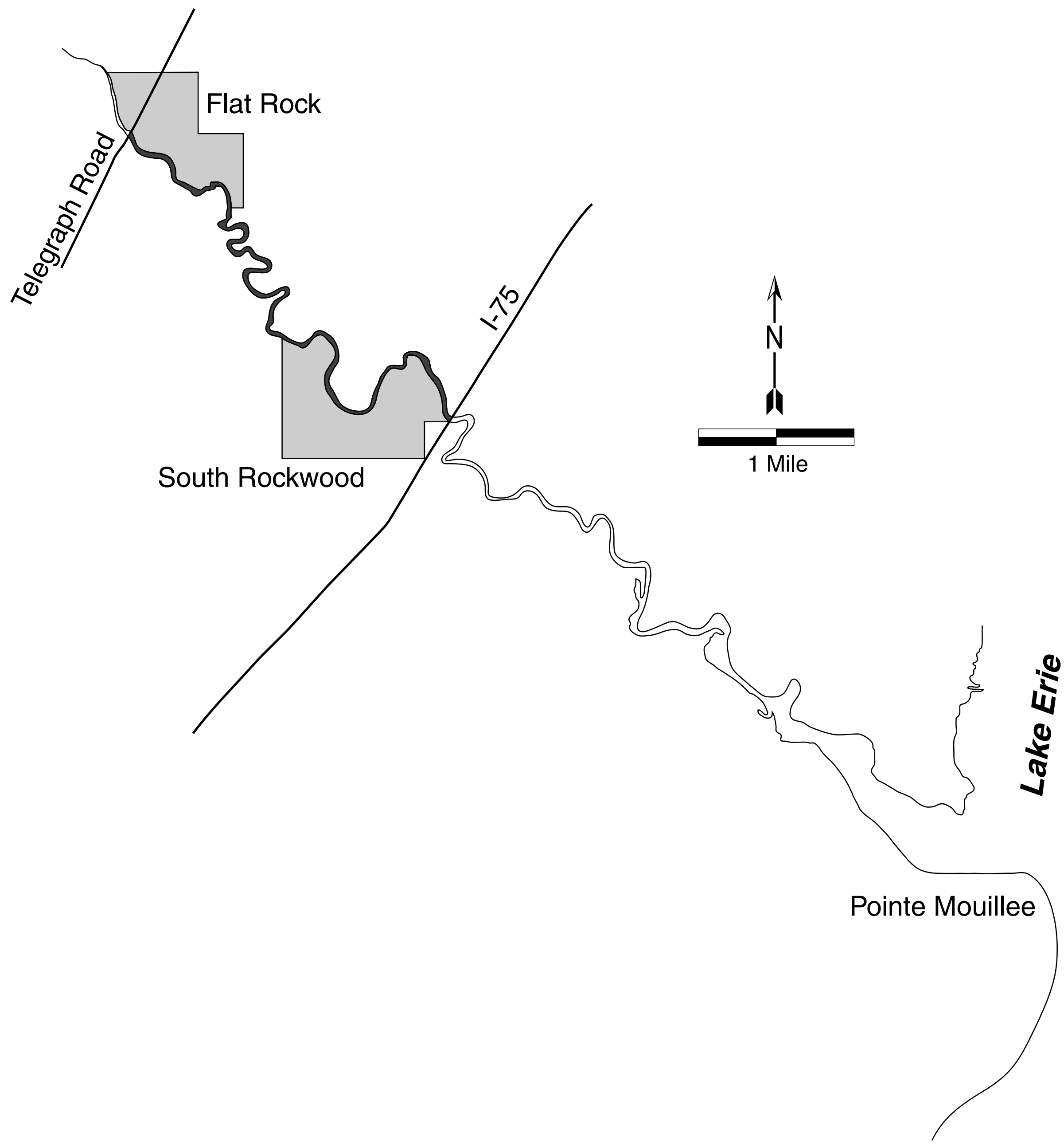

Figure 1.–The Huron River walleye assessment study area from the mouth to Telegraph Road. Most walleye tagging was conducted between Telegraph Road and I-75 due to the low catch rates below South Rockwood.

Table 1.–Fish taxa observed in the Huron River during 1992-1994 electrofishing surveys.

Common name	Scientific name
Bigmouth buffalo	*Ictiobus cyprinellus*
Black crappie	*Pomoxis nigromaculatus*
Bluegill	*Lepomis macrochirus*
Bowfin	*Amia calva*
Central mudminnow	*Umbra limi*
Common carp	*Cyprinus carpio*
Freshwater drum	*Aplodinotus grunniens*
Gizzard shad	*Dorosoma cependianum*
Grass pickerel	*Esox americanus*
Largemouth bass	*Micropterus salmoides*
Logperch	*Percina caprodes*
Muskellunge	*Esox masquinongy*
Northern pike	*Esox lucius*
Pumpkinseed	*Lepomis gibbosus*
Quillback carpsucker	*Carpoides cyprinus*
Rock bass	*Ambloplites rupestris*
Sauger	*Stizostedion canadense*
Sauger x walleye hybrid	*Stizostedion canadense x S. vitreum*
Smallmouth bass	*Micropterus dolomieui*
Spotted sucker	*Minytrema melanops*
Steelhead	*Oncoryhnchus mykiss*
Unidentified bullhead	*Ameirus* spp.
Unidentified redhorse	*Moxostoma* spp.
Unidentified shiner	*Notropis* spp.
Walleye	*Stizostedion vitreum*
White bass	*Morone chrysops*
White perch	*Morone americanus*
White sucker	*Catostomus commersoni*
Yellow perch	*Perca flavescens*

Table 2.–Results of electrofishing collections from the Huron River during 1992-1994.

	1992	1993	1994
Sampling period	17 to 31 Mar	22 Mar to 12 Apr	22 Mar to 5 Apr
Days sampled	7	9	7
Walleye collected	535	454	584
Shocking time (h)	13.7	20.8	18.1
Catch per hour ($\bar{x}$ ± SD)	44.3 ± 19.6	22.1 ± 15.9	33.9 ± 22.2
Percent female	55	61	68
Mean length (mm) - females	600	600	579
Mean length (mm) - males	496	446	451
Percent with lymphocystis	17.9	10.2	14.4
Walleye tagged and released	501	442	557
Tagged walleye recovered	33	20[1]	48[2]

[1] includes nine recovered with 1992 Huron River tags
[2] includes eleven recovered with 1993 Huron River tags and eleven with 1992 Huron River tags

Table 3.–Mean length at age (mm) and age frequency for walleye collected in the Huron River from 1992 to 1994.

Age	1992 Length (mm)	1992 Number	1993 Length (mm)	1993 Number	1994 Length (mm)	1994 Number
			Males			
2	382	6	362	3	—	0
3	424	11	416	108	401	41
4	453	17	464	14	449	90
5	473	22	498	9	490	5
6	494	74	504	8	484	9
7	518	52	516	10	527	7
8	553	18	559	5	544	5
9	570	8	555	7	548	6
10	523	5	558	1	585	1
			Females			
3	471	3	451	6	427	2
4	505	17	510	32	503	123
5	530	16	536	30	534	32
6	579	88	568	23	567	20
7	608	64	611	67	593	22
8	638	37	639	41	627	52
9	674	21	662	22	660	49
10	668	23	685	18	665	24
11	—	0	674	11	690	12
12	—	0	662	3	705	7
13	—	0	752	1	696	1

Table 4.–Age composition of walleye collected in the Huron River from 1992 to 1994.

Age	1992		1993		1994	
	Percent	Number	Percent	Number	Percent	Number
			Males			
2	3	6	2	3	—	0
3	5	11	65	108	25	41
4	8	17	8	14	55	90
5	10	22	5	9	3	5
6	34	74	5	8	5	9
7	24	52	6	10	4	7
8	8	18	3	5	3	5
9	4	8	4	7	4	6
10	2	5	1	1	1	1
Unknown	2	4	1	2	—	0
Total	100	217	100	167	100	164
			Females			
3	1	3	2	6	1	2
4	6	17	13	32	35	123
5	6	16	12	30	9	32
6	33	88	9	23	6	20
7	23	64	26	67	6	22
8	14	37	16	41	15	52
9	8	21	9	22	14	49
10	9	23	7	18	7	24
11	—	0	4	11	3	12
12	—	0	1	3	2	7
13	—	0	<1	1	<1	1
Unknown	—	0	<1	2	2	91
Total	100	269	100	256	100	353

Table 5.–Population estimates using the Schnabel method for data from 1992 to 1994 electrofishing in the Huron River, near Flat Rock.

Year	Population estimate	Lower 95% CI	Upper 95% CI
1992	3,424	2,401	5,965
1993	7,821	4,500	29,826
1994	5,180	3,500	9,959

Table 6.–Incidence of lymphocystis in 30 tagged walleye released in the Huron River in 1992 or 1993 and recaptured one to two years later.

Lymphocystis condition at capture	Lymphocystis condition at recapture			
	Absent	Present	Total	Percent
Absent	22	2	24	80.0
Present	4	2	6	20.0
Total	26	4		
Percent	86.7	13.3		

References

Allison, L.N., J.G. Hnath, and W.G. Yoder. 1977. Manual of common diseases, parasites, and anomalies of Michigan fishes. Michigan Department of Natural Resources, Fisheries Management Report No. 8, Lansing.

Billington, N., P.D.N. Hebert, and R.D. Ward. 1988. Evidence of introgressive hybridization in the genus *Stizostedion*: interspecific transfer of mitochondrial DNA between sauger and walleye. Canadian Journal of Fisheries and Aquatic Sciences 45:2035-2041.

Colby, J.P., and S.J. Nepszy. 1981. Variation among stocks of walleye (*Stizostedion vitreum vitreum*): management implications. Canadian Journal of Fisheries and Aquatic Sciences 38:1814-1831.

Haas, R.C., M.C. Fabrizio, and T.N. Todd. 1988. Identification, movement, growth, mortality, and exploitation of walleye stocks in Lake St. Clair and the western basin of Lake Erie. Michigan Department of Natural Resources, Fisheries Research Report No. 1954, Ann Arbor.

Hay-Chmielewski, E.M., P.W. Seelbach, G.E. Whelan, and D.B. Jester Jr. 1995. Huron River assessment. Michigan Department of Natural Resources, Fisheries Division, Special Report No. 16, Ann Arbor.

Ihssen, P. E., H.E. Booke, J.M. Casselman, and J.M. Utter. 1981. Stock identification: materials and methods. Canadian Journal of Fisheries and Aquatic Sciences 38:1838-1855.

Knight, R., D. Einhouse, B. Haas, B. Henderson, R. Kenyon, K. Muth, S. Nepszy, M. Thomas, and M. Turner. 1995. Report of the Lake Erie walleye task group. Great Lakes Fisheries Commission, Ann Arbor.

Nepszy, S.J. 1977. Changes in percid populations and species interactions in Lake Erie. Journal of Fisheries Research Board of Canada 34:1861-1868.

Rawson, M.R., and R.L. Scholl. 1978. Re-establishment of sauger in western Lake Erie. Pages 261-265 *in* R.L. Kendall, editor. Selected coolwater fishes of North America. American Fisheries Society Special Publication No. 11. Washington, D.C.

Regier, H.A., V.C. Applegate, and R.A. Ryder. 1969. The ecology and management of the walleye in western Lake Erie. Great Lakes Fisheries Commission Technical Report 15, Ann Arbor, Michigan.

Ricker, W.E. 1975. Computation and interpretation of biological statistics of fish populations. Bulletin 191 of the Fisheries Research Board of Canada, Ottawa, Canada.

Thomas, M.V., and R.C. Haas. 1994. Status of yellow perch and walleye in Michigan waters of Lake Erie, 1989-1993. Michigan Department of Natural Resources, Fisheries Research Report 2011, Ann Arbor.

Thomas, M.V., and R. C. Haas. 1995. Dynamics of the Lake Erie walleye and yellow perch populations and fisheries. Michigan Department of Natural Resources, Study 466. Annual Performance Report, Ann Arbor.

Thomas, M.V. 1995. An assessment of the Clinton River walleye population. Michigan Department of Natural Resources, Fisheries Technical Report 95-2, Ann Arbor.

Smith, I.R., A.F. Johnson, D. MacLennan, and H. Manson. 1992. Chemical contaminants, lymphocystis, and dermal sarcoma in walleyes spawning in the Thames River, Ontario. Transactions of the American Fisheries Society, 121:608-616.

Seelbach, P.W., J.L. Dexter, and N.D. Ledet. 1994. Performance of steelhead smolts stocked in southern Michigan warmwater rivers. Michigan Department of Natural Resources, Fisheries Research Report 2003, Ann Arbor.