1999 Activities of the Central Great Lakes Bi-National Lake Sturgeon Group

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Preface

In recent years, interest in the status of lake sturgeon in the Great Lakes basin has been increasing for all natural resource agencies involved in fisheries management. Federal, state, and provincial agencies have initiated status surveys and are in various stages of development of recovery or management plans for waters under their jurisdiction. Fish community objectives (FCO) for Lake Huron call for the recovery of lake sturgeon to levels allowing removal from threatened status. Although lake sturgeon are not identified specifically in Lake Erie FCO, they are considered an important native species with efforts underway to develop strategies for enhancement and management. The Province of Ontario is seeking biological information to aid in the protection of stocks in waters under it's jurisdiction. Ecosystem management goals and objectives developed by the Service's Great Lakes Basin Ecosystem Team contain several references to lake sturgeon and the need to inventory, protect, and restore the species to greater levels of abundance.

In 1995, the Alpena Fishery Resources Office (FRO) assumed the lead role in assembling resource personnel from federal, state, and provincial agencies for the development of a collaborative effort to better define the population status of lake sturgeon in Lakes Huron and Erie and their connecting waterways. These efforts resulted in the creation of the Central Great Lakes Bi-National Lake Sturgeon Group (CGLBLSG). The Alpena FRO has agreed to compile an annual report summarizing activities of agencies and organizations participating in the CGLBLSG. Following is a summary of 1999 activities with planned activities for 2000. The purpose of this report is to inform all interested parties of the ongoing lake sturgeon efforts in Lakes Huron and Erie and their connecting waterways. Previous years' reports for this group can be found on the Alpena FRO home page (midwest.fws.gov/alpena/index.htm) under station reports.

LAKE HURON

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General

Assessment of lake sturgeon stocks in Ontario waters of Lake Huron has been on-going since 1995. With each additional year, more and more information is becoming available regarding this intriguing species. This update is an attempt to summarize the work that was conducted under the direction of the Lake Huron Management Unit, Owen Sound during the 1998 and 1999 open water seasons.

As in the past, most of the lake sturgeon sampled during this project were initially captured by commercial fishermen on Lake Huron. In 1998 and 1999 additional samples were obtained from two new sources. In 1998, a new commercial fisherman in southern Georgian Bay began providing information on what appears to be a significant stock of lake sturgeon in the extreme southeastern region of the Bay. In 1999, field technicians were able to sample and release several lake sturgeon while on board this commercial tug. The second source of information originates from the Mississaugi River in northern Lake Huron. In the spring of 1999, the Mississaugi First Nation, with the assistance of the Lake Huron Management Unit, conducted an assessment of a spawning location in the Mississaugi River, including the capture, sampling and release of lake sturgeon in the river.

For the first time in Ontario waters, recaptures from the recreational fishery were reported to this office. In two instances, recreational anglers incidentally captured lake sturgeon while fishing for walleye in the north channel region. In another instance, a recreational fisherman was fishing for lake sturgeon in the Mississaugi River itself and captured a tagged lake sturgeon. All fish were reported and released back into their waters.

As in previous years, LHMU staff sampled the majority of the fish handled in southern Lake Huron. Almost all of these fish are captured incidentally while fishing trap nets for walleye in the extreme southern regions of the lake. In Georgian Bay, all lake sturgeon were sampled by LHMU staff. These fish were incidentally caught in large mesh (114-127mm) commercial gill nets and subsequently released. In the North Channel, most of the lake sturgeon were sampled by commercial fishermen, under the direction of LHMU

staff. The majority of these lakes sturgeon were also captured incidentally while commercially fishing for lake whitefish and yellow perch.

Results

A total of 586 lake sturgeon were sampled in 1998 and 568 in 1999. This brings the total number of fish handled over the life of the project to 2,171. Once again, the majority of the lake sturgeon sampled were tagged and returned to the lake (Table 1). In 1998, 29 fish were recaptured which had been previously tagged. Twenty of those fish had been tagged in previous years while nine of them had been tagged earlier in 1998. In 1999, a total of 37 fish were recaptured, 20 of which had been tagged in previous years and 17 earlier in 1999.

Table 1. Summary of lake sturgeon captured and tagged in Ontario waters of Lake Huron. (values in parenthesis are numbers tagged).

	1995	**1996**	**1997**	**1998**	**1999**	**TOTAL**
North Channel	114 (85)	125 (89)	131 (79)	79 (47)	151 (96)	600 (396)
Mississaugi River					48 (46)	48 (46)
Northern Lake Huron					3 (3)	3 (3)
Southern Lake Huron	103 (44)	58 (31)	486 (289)	507 (311)	359 (164)	1513 (839)
Georgian Bay					7 (7)	7 (7)
TOTAL	217(129)	183(120)	617 (368)	586 (358)	568 (316)	2171 (1291)

Recapture information from all 5 years of this project were evaluated and several interesting patterns appeared (Figure 1). First of all, in all years of this study, the majority of recaptures occurred in subsequent years of the study. In other words once tagged and released, it appeared that most fish left the general vicinity or were at least less prone to the fishing gear in the area. Secondly, a large number of lake sturgeon in the north channel were recaptured within 10 days of being tagged. This would suggest that the sturgeon in this region of Lake Huron are more localized and less likely to move significant distances. Thirdly, North Channel lake sturgeon recapture rates were much higher than in southern Lake Huron. This is another indicator that sturgeon in the North Channel may be more likely to remain in the North Channel versus sturgeon in southern Lake Huron which may be more prone to movement in and out of the region. The greater recapture rates in the north channel may also simply be a reflection of smaller sample size in the north than in southern Lake Huron. Finally, in both locations, there were recaptures which occurred anywhere from 3 to 6 months following tagging. These cases represent fish found in relatively the same location in a new season, generally within the same year. In other words, a lake sturgeon caught in the early summer and then recaptured in the same region in the fall.

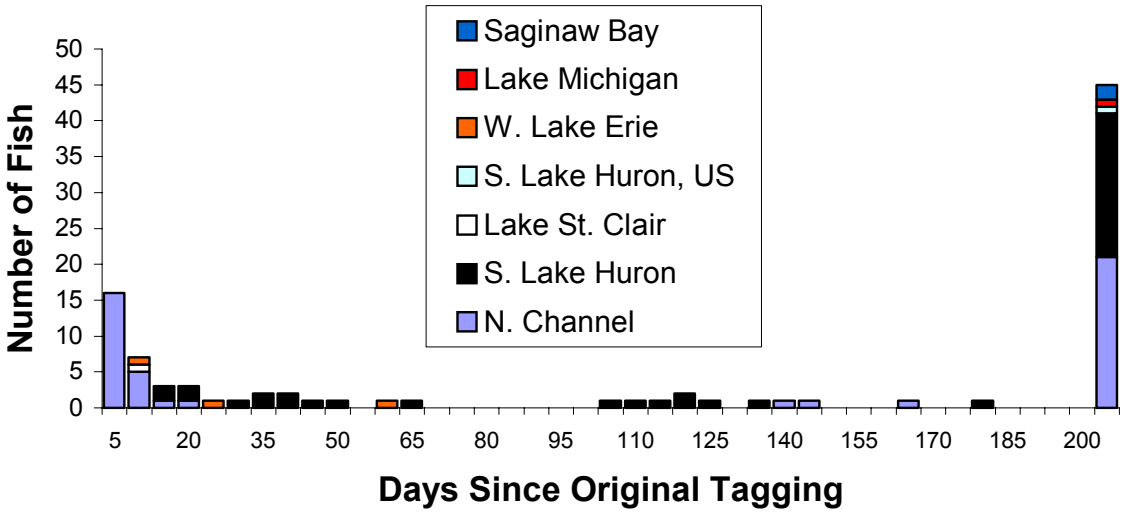

Figure 1. Time from tagging to recapture of lake sturgeon in Lake Huron. Location shown is recapture location

One other interesting piece of information gleaned from the tagging data is that virtually all recaptures downstream of southern Lake Huron occurred very quickly, ie. within one to several weeks. Conversely, all recaptures upstream of southern Lake Huron occurred at a minimum of over a year later.

It should be noted that due to the nature of the commercial fishery however, this information might be slightly biased. Commercial fishing effort has remained quite similar throughout the study and given the incidental nature of the harvests, I think that the overall patterns presented here for lake sturgeon captures and recaptures do represent what is happening in the lake in terms of movement.

In terms of biological sampling, similar data were collected in 1998 and 1999 as was in previous years. In 1998, the largest sturgeon handled was a 45 year old female which was caught in southern Lake Huron. This fish weighed 35.2 kg and was 1.664 m in total length. A 29 year old sturgeon was also captured in the north channel. No weight was available for this fish, however given its total length of 1.785 m, it is estimated that the fish weighed between 30 and 35kg.

Smaller, young fish were captured in the North Channel in 1998, with the average age of all lake sturgeon sampled being 7.5yr in the North Channel and 15.2yr in southern Lake Huron. This is also reflected in the mean size data from both locations (Table 2). The smallest fish captured in 1998 were a 2 year old sturgeon sampled in southern Lake

Huron and a 2 year old sampled in the North Channel. They weighed 260g and 500g respectively, with total lengths of 425 mm and 490 mm, respectively.

Table 2. General descriptive biological statistics from lake sturgeon sampled in Lake Huron, 1998 and 1999.

	Southern Lake Huron		**North Channel**	
	1998	1999	1998	1999
Mean Total Length (mm)	1106	1161	837	811
Median Total Length (mm)	1104	1173	778	688
Total Length Range (mm)	425 - 1664	405 - 1660	490 - 1785	430 - 1663
Mean Round Weight (kg)	9.00	10.17	3.74	9.93
Median Round Weight (kg)	7.93	9.29	2.50	5.00
Round Weight Range (mm)	0.26 - 35.15	0.45 – 35.61	0.50 – 23.59	0.80 – 24.00
Mean Age (yr)	15.19		7.47	
Median Age (yr)	14.0		6.0	
Age Range (yr)	1 - 45		2 - 29	

In 1999, the largest fish handled was a 35.6 kg female once again captured in southern Lake Huron. This fish was 1.574 m in total length. No ages are available for 1999 fish at this time. A 24.0 kg lake sturgeon was sampled in the North Channel; it had a total length of 1.663 m. Several small fish were captured in both locations in 1999, all of which were less than 500 mm in total length and generally weighed less than 500 g. The average size of lake sturgeon sampled in 1999 was almost identical to those sampled in 1998. Because age data is not available, it is impossible to determine if growth rates have changed over this time period. However, given the life history characteristics of this species, it is highly unlikely that growth rates would have changed significantly in one year.

A new piece of information which was collected in 1998 and 1999 was female ovary weight. Because some of the lake sturgeon collected by the commercial fishermen are of legal harvestable size, it was noted that this presented the opportunity to collect other "non-standard" biological data which is not normally available to field biologists. In these two years, LHMU staff collected and weighed mature female ovaries from harvested females. This information was only collected in southern Lake Huron.

A total of 19 mature ovaries were extracted and weighed. They ranged in size from 1.62 to 10.43 kg, the average being 4.68 kg (Fig. 2). In terms of percent body weight, the mature ovaries inspected in these fish made up on average, 18.8% of the total body weight of the female. This ranged from as little as 11% to over 34% (Fig 3). It appears that as females get larger, the percent body weight allotted to ovaries in fact increases.

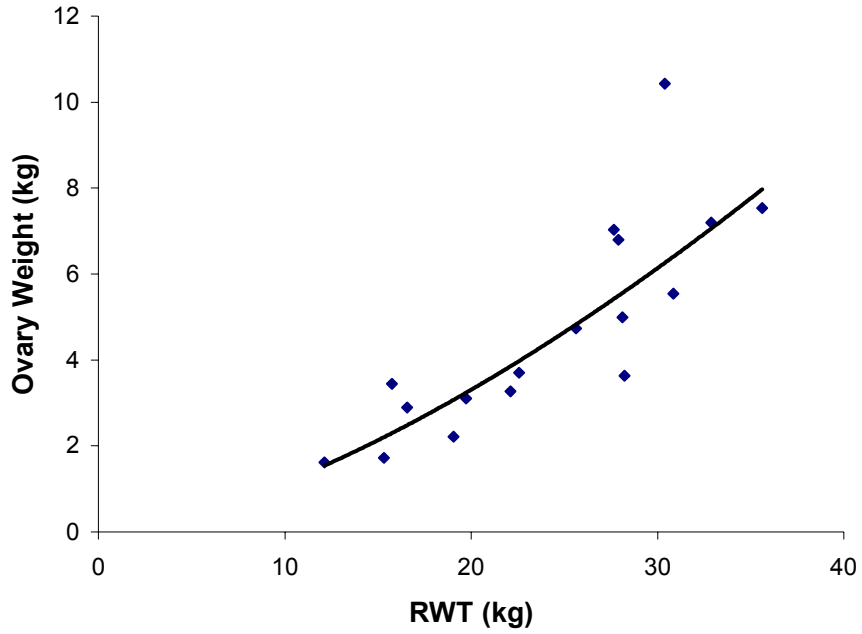

Figure 2. Ovary weight in female lake sturgeon in Lake Huron 1998-1999

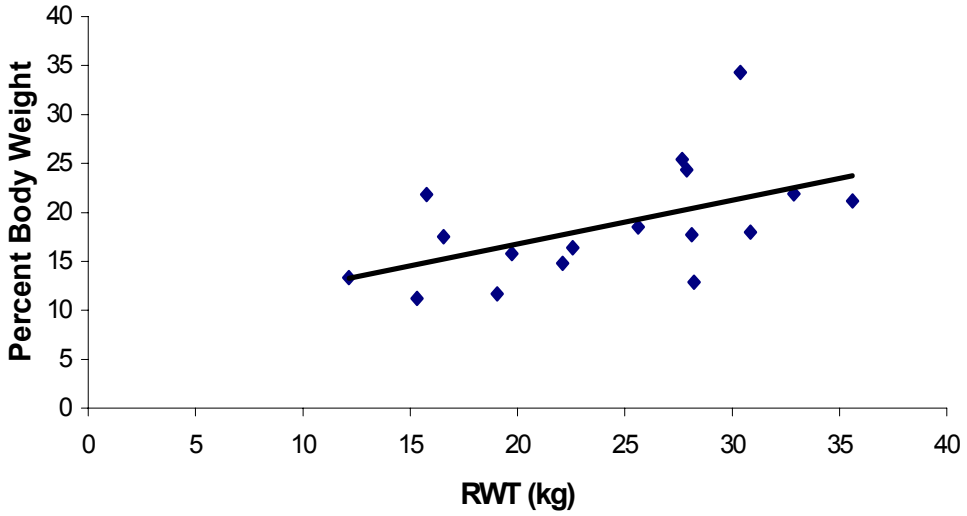

Figure 3. Percent body weight comprised of ovary tissue in lake sturgeon in Lake Huron, 1998-1999.

In 1998 a total of 114 sturgeon were sexed, 101 of them from southern Lake Huron. Interestingly, only about 34% of the fish sexed were females, the remainder were

determined to be males. This is in contrast to 1999 when 204 lake sturgeon were sexed and just over 55% of those were females. Compared to previous year's results, it is difficult to determine any pattern in sex ratios of fish sampled. This may in part be due to the source of the fish, the commercial fishery. If these are mixed stocks that are being targeted, then annual variation may be enough to explain changes in sex ratios. Regardless, it still appears that mixed stock assessment produces different sex ratio results than spawning stock assessment.

Age of maturity is another aspect of the life history of lake sturgeon that the LHMU has investigated throughout this study. In 1998, the minimum age of maturity (or estimate of age at first maturity) for males in southern Lake Huron was 11yrs, similar to that from sturgeon seen over the previous 3 years. In the North Channel it was slightly earlier at 10 yrs, once again similar to that from sturgeon seen in that region in previous years. It is interesting to note that results from 1995 to 1998 suggest that males mature approximately 2 years earlier in the North Channel than they do in southern Lake Huron. This is the same for females. In 1998, female lake sturgeon in southern Lake Huron were reaching maturity at age 15. In the North Channel, age at first maturity was estimated to be 12 years of age, a full 3 years sooner than females in the southern region of the lake. These data require further investigation to substantiate this difference in regional life history strategy.

Summary

The lake sturgeon assessment program in Lake Huron continues to grow and 1998 and 1999 were no exception, providing more and new extremely valuable information. The 1999 sampling year brings to an end a 5-year plan to collect basic biological data from lake sturgeon in Lake Huron. A new directive is being formulated for the next 5 years in Ontario waters of Lake Huron. The new directive will hopefully be integrated with other management agencies on Lake Huron.

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The Lake Huron Management Unit operational plans include continued sampling of lake sturgeon. Much of the same information will be collected in the forthcoming years, although perhaps limited in some areas. More importantly, however, will be the focus on answering some of the questions arising from the analysis of the last 5 years worth of data.

New directions will hopefully include more work in the following areas:

- investigation of lake sturgeon numbers/stocks in Georgian Bay,
- identification and assessment of more spawning stocks in Lake Huron
- continued investigation of movement and migration of lake sturgeon throughout the lake and the Great Lakes
- increased analysis of population dynamics parameters such as mortality estimates, growth, population size etc. using mark recapture data.

- Genetic characterization of both spawning aggregations and mixed stock populations around the lake.

None of the above work will be possible without the continued support of the commercial fishing industry on Lake Huron, First Nations around the lake, International partners such as the U.S. Fish and Wildlife Service, and the numerous volunteers who continue to participate in field operations. Much work will be needed to keep existing partnerships and also foster new ones as they arise.

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1999

Lake sturgeon monitoring continued in 1999 for the fifth straight year. Similar to previous years, all lake sturgeon were collected by commercial fishers as by-catch in their trap net fishery. Lake sturgeon are often encountered by Lake Huron commercial fishers during normal fishing operations. This has allowed Alpena FRO staff an opportunity to obtain information from this prehistoric fish. Total length (TL), fork length (FL), and girth were measured for all captured lake sturgeon. The leading (marginal) ray of the left pectoral fin was removed from each fish to provide estimates of age. The distal portion of the fin ray is being utilized for genetic analysis. All fish were tagged in the left operculum with a serially numbered Monel self-piercing animal ear tag (National Band and Tag CO., Newport, Kentucky). All lake sturgeon were handled by the commercial fishers, including data collection and fish tagging. All materials necessary to collect the biotic information was provided by the Alpena FRO. Each fisher was provided a box containing instructions for fish tagging and fin ray removal, tags and an applicator, fin ray saw, data note book and cards, fin ray envelops, a soft measuring tape and a disposable camera. Abiotic data recorded for each lake sturgeon captured included: date, latitude/longitude, water depth and temperature, and bottom type. In addition, tag type, agency, and identification number of tag applied or observed (if fish was tagged) was recorded as well.

Results

Eleven commercial fishers (operating 18 boats) are providing information on incidentally captured lake sturgeon; nine of these fishers operate in Saginaw Bay. One new fisher began assisting with the project in 1999 (Table 1). Biological data were recorded from

45 lake sturgeon in 1999. The total number of lake sturgeon tagged increased slightly in 1999 compared to 1998 and was second to 1997 in total number of sturgeon tagged in one season. Since 1995, a total of 194 lake sturgeon have been tagged by commercial fishers.

Table 1. Number of lake sturgeon tagged by participating commercial fishers in Lake Huron trap net fishery since 1995. Dash indicates the fisher was not participating in the program.

Fisher	Year Enrolled	1995	1996	1997	1998	1999	Total
Barbeaux Fishery	1996	-	1	7	0	0	8
Bay Port Fish Company	1995	13	7	10	8	12	50
Beardsley Fish Company	1997	-	-	0	0	0	0
Cederville Fish Company	1997	-	-	1	7	9	17
Gauthier-Spaulding Fishery	1995	2	0	2	2	4	10
Kuhl Fishery	1999	-	-	-	-	1	1
Lentz Fishery	1995	3	8	8	9	10	38
M&W Fish Company*	1995	1	3	4	4	2	14
Serafin Fishery	1996	-	10	17	3	4	34
Beers Fishery	1995	2	0	1	0	0	3
Whytes Fishery	1995	2	7	3	4	3	19
Total		23	36	53	37	45	194

*Formally Sam's Fishery

Fork length of lake sturgeon captured in 1999 ranged from 41 cm to 185 cm with a mean fork length of 106 cm (Table 2). Age of these fish ranged from 3 to 30 years with a mean of 15 years. A summary of morphological data for lake sturgeon captured during the five years of this study are shown in Table 2. Figures 1 and 2 illustrate the length frequency and age frequency, respectively, of lake sturgeon collected during the course of this study.

Table 2. Summary of morphological data collected on lake sturgeon by commercial fishers in Michigan waters of Lake Huron. Dash indicates data was not collected.

	1995	1996	1997	1998	1999
Mean Fork Length (cm)	111	92	101	111	106
Median Fork Length (cm)	111	90	99	109	103
Fork Length Range (cm)	71 - 155	50 - 135	42 - 185	67 - 171	41 - 185
Mean Age (years)	-	-	17	14	15
Median Age (years)	-	-	13	12	13
Age Range (years)	-	-	4 - 72	4 - 59	3 - 30

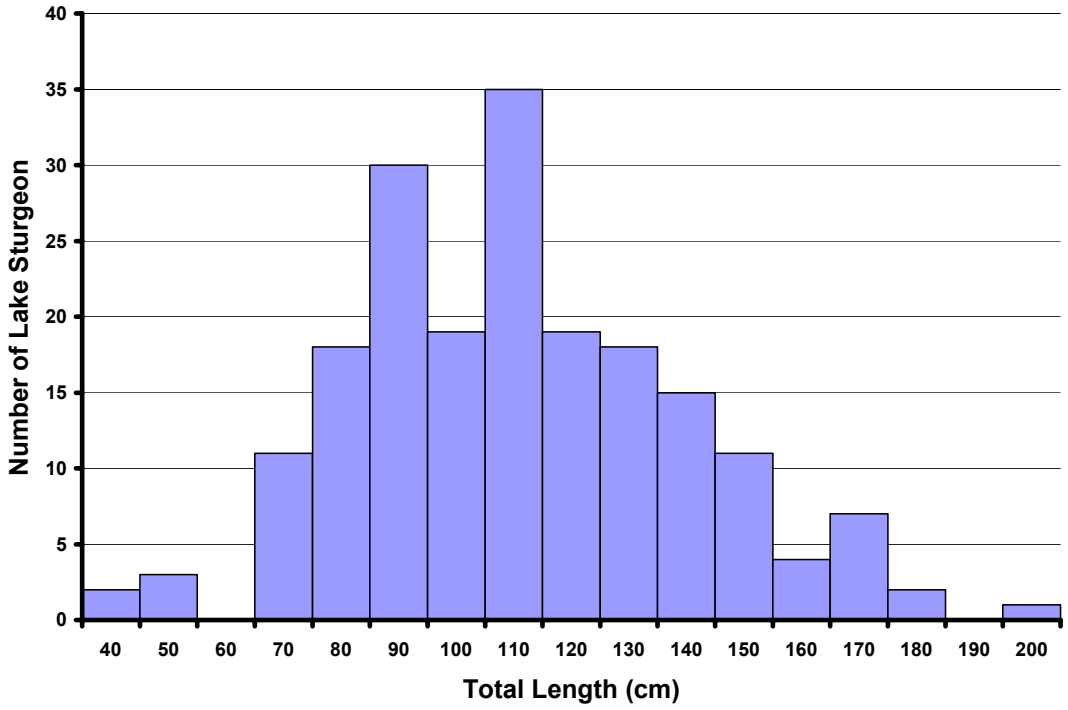

Figure 1. Length frequency of 194 Lake Huron lake sturgeon captured as by-catch in the trap net fishery, 1995-1999.

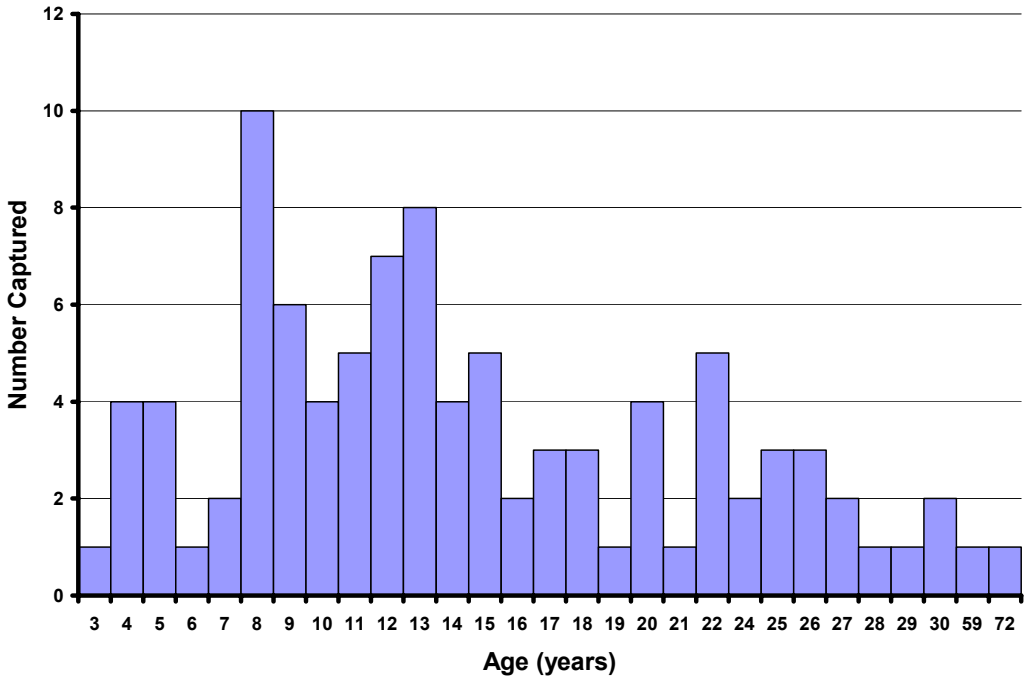

Figure 2. Age frequency of 95 Lake Huron lake sturgeon captured as by-catch in the trap net fishery, 1997-1999.

Overall, the age distribution of lake sturgeon caught in 1997, 1998 and 1999 is dominated by sturgeon older than 11 years with a total of 29 year-classes represented (Figure 2). Lake sturgeon younger than 8 years old represent 13% of the sturgeon sampled in the trap net fishery. This may be due to poor recruitment, gear selectivity, distribution of young sturgeon, or it may indicate that Saginaw Bay is merely a staging area for sub-adult lake sturgeon.

Seventeen previously tagged lake sturgeon have been recaptured in Saginaw Bay, the Main Basin and North Channel of Lake Huron (Table 3). All tagged lake sturgeon recaptured by Michigan state-licensed commercial fishers have been released unharmed. Coordination between OMNR-LHMU and the Alpena FRO on the lake sturgeon project in Lake Huron has provided documentation of interbasin movement of sturgeon between Saginaw Bay, the Main Basin and North Channel. Serafin Fishery has tagged five lake sturgeon that have been recaptured by other fishers (Figure 3). Three of these fish (4036, 4041 and 4043) have exhibited interbasin movement. Purdy Fisheries recaptured two of the fish (green and yellow) the third fish (blue) was found dead near Grand Bend, Ontario. The remaining two lake sturgeon (red and purple) were recaptured in Saginaw Bay. Purdy Fisheries have tagged two lake sturgeon in the southern Main Basin of Lake Huron that have been recaptured in Saginaw Bay (Figure 4). Fish number 485 (yellow) was tagged by Purdy Fisheries in southern Lake Huron and then recaptured by Cedarville Fishery in Saginaw Bay. Fish number 285 (red) was tagged by Purdy Fisheries on 22 October 1996. It was recaptured by Lentz Fishery on 6 June 1997. On 6 April 1999, it was again encountered in a commercial trap net north of Green Bay, Wisconsin, in Lake Michigan (grid 706, Robert Elliott, personal communication). This fish represents the first known documented case of significant upstream movement by a lake sturgeon. Several lake sturgeon that have been tagged in the Great Lakes have exhibited downstream movement (Ron Bruch, WI DNR; Lloyd Mohr, OMNR; Mike Thomas, MI DNR; Dave Davies, OH DOW, personal communications). Fish 161 exhibited movement between the North Channel and Northern Main Basin of Lake Huron (Table 3). In 1999, 7 lake sturgeon were recaptured by commercial fishers. This represents the greatest number of lake sturgeon recaptured by the Michigan state-licensed commercial fishers during a single season since the project began in 1995.

Table 3. Summary of lake sturgeon recapture information.

Tag Number	*Date Tagged*	*Date Recaptured*	*Tagging Grid*	*Recapture Grid*	*Tagging Fisher*	*Recapturing Fisher*
FWS00036	10/4/95	8/17/96	1509	1606	Bay Port	M&W
FWS00049	9/28/95	12/25/97	1608	1606	Bay Port	Sport Angler
161	6/4/96	10/15/97	212	306	Nyman	Barbeaux
285	10/22/96	6/6/97	2016	1408	Purdy	Lentz
485	7/17/99	11/9/99	2015	1509	Purdy	Cedarville
4033	10/29/96	5/22/97	1508	1508	Serafin	Serafin
4036	4/26/97	10/6/97	1508	2016	Serafin	Purdy
4041	7/2/97	10/6/97	1508	2016	Serafin	Purdy
4043	8/25/97	8/28/98	1508	1919	Serafin	OMNR
4047	10/6/97	6/3/99	1408	1507	Serafin	Lentz
4059	5/4/98	5/20/99	1508	1509	Whytes	Cedarville
4087	10/4/98	10/6/98	1508	2016	Bay Port	Purdy
4110	11/17/98	10/11/99	1507	1507	Lentz	Lentz
4114	9/20/98	4/26/99	1507	1508	Lentz	Bay Port
4125	6/23/97	9/29/97	1508	1509	Lentz	Bay Port
4159	10/12/98	4/20/99	1609	1508	Cedarville	Bay Port
4168	10/31/99	11/1/99	1509	1509	Cedarville	Cedarville

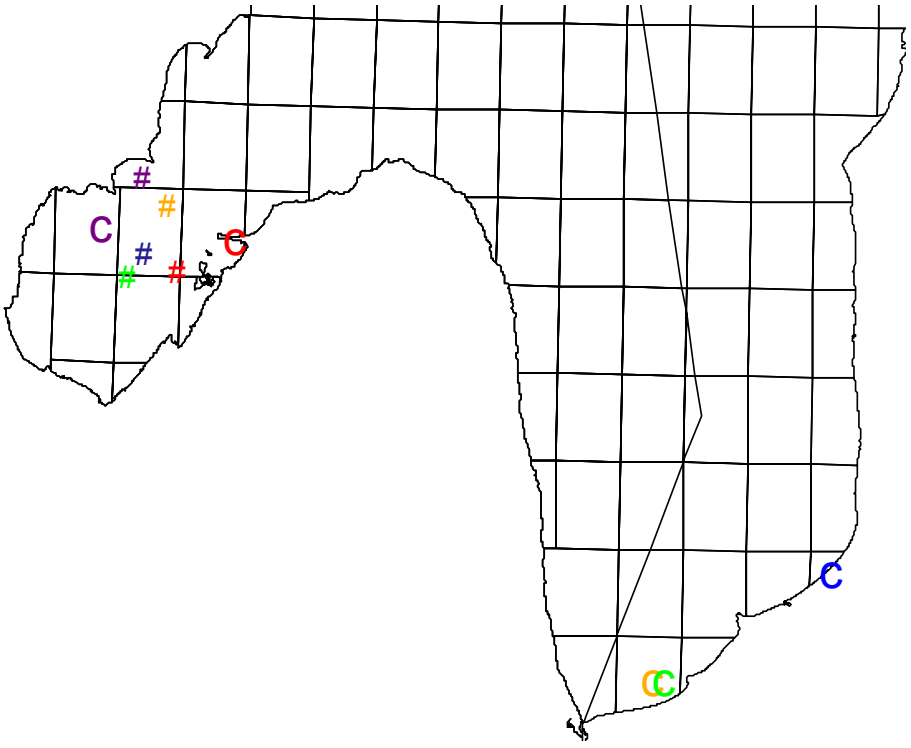

Figure 3. Lake sturgeon tagged by Serafin Fishery. Circles indicate tagging location, flags indicate recapture locations. Colors denote individual fish.

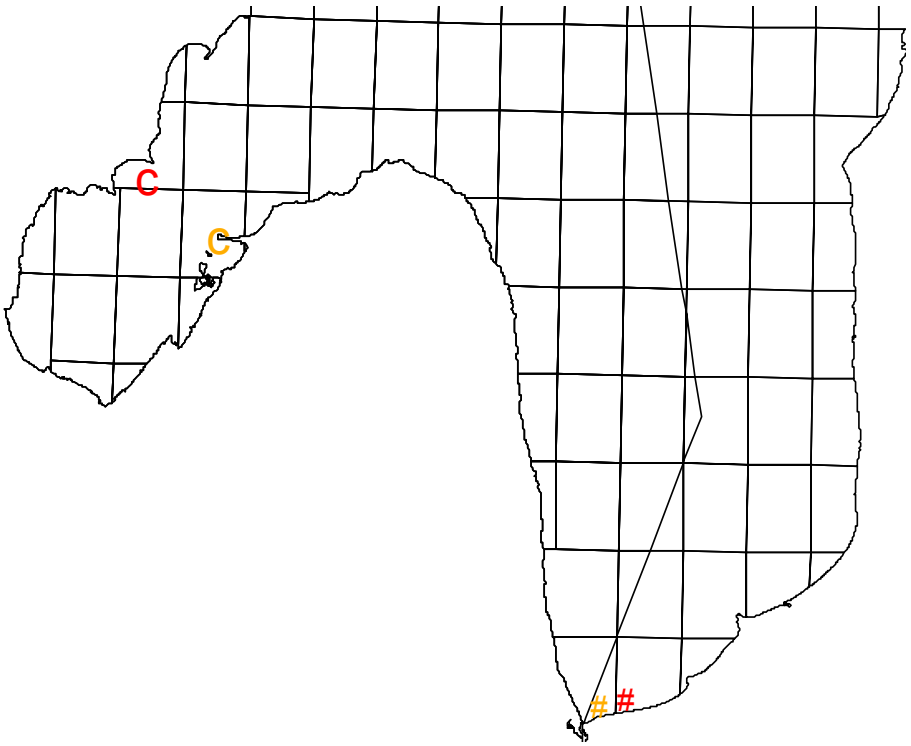

Figure 4. Lake sturgeon tagged by Purdy Fisheries. Circles indicate tagging location, flags indicate recapture locations. Colors denote individual fish.

Data collected on lake sturgeon by our commercial fishing partners are biased because the fishers are not targeting sturgeon. The lake sturgeon are captured as by-catch while the fishers are targeting other fish species. There are, however, temporal differences in habitat overlap between lake sturgeon and the commercially targeted species. The greatest overlap occurs in the spring and fall period. Lake sturgeon are captured most frequently in May and October (Figure 5). This temporal information may prove useful in developing sampling protocol for assessment activities targeting lake sturgeon.

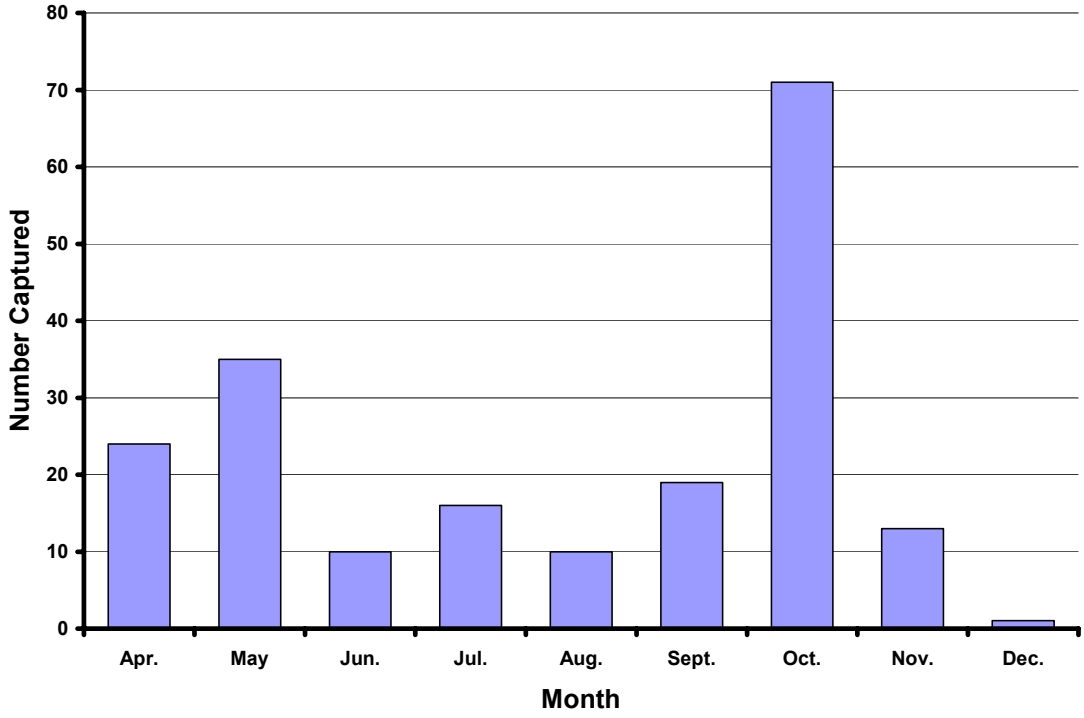

Figure 5. Number of lake sturgeon captured by Lake Huron commercial fishers, 1995-1999.

The cooperation and assistance provided by Lake Huron commercial fishers provides crucial information on the lake sturgeon populations in Saginaw Bay and the northern regions of Lake Huron. Lake sturgeon appear to be less abundant in U.S. waters of Lake Huron than in Canadian waters based on by-catch return data. This is not surprising given that historically important spawning streams in Michigan have been blocked by hydropower projects. Several large streams with available spawning habitat are still free flowing in Ontario, providing some degree of sustainability for lake sturgeon populations.

Increasing participation by commercial fishers should result in an escalation of lake sturgeon reports over the next few years. As the project continues and more lake sturgeon are tagged, additional information on seasonal movement should result from increased recaptures of previously tagged fish. In addition, collaboration between OMNR-LHMU and the Alpena FRO on the lake sturgeon project has begun to define movements of tagged sturgeon between the different basins of Lake Huron.

Alpena FRO staff hosted the 3rd Annual Appreciation Dinner to honor the commercial fishers assisting with the lake sturgeon project. The dinner was held on 14 December 1999 at the Bay Valley Resort in Bay City, Michigan. The dinner was followed by a short awards presentation. Tokens of appreciation were distributed to each of the participating fishers.

In addition to coordinating lake sturgeon data collection from the commercial fishers, other lake sturgeon activities were coordinated by the Alpena FRO in 1999. Alpena FRO updated the Great Lakes Lake Sturgeon web page (midwest.fws.gov/sturgeon). The page now contains information from 11 Fish and Wildlife Service offices, 3 state agencies (MI, OH, and WI), 3 Ontario Ministry of Natural Resources Lake Management Units (Superior, Huron, and Erie), and 4 universities (Central Michigan, University of Michigan, Michigan Technological, and Cornell). In addition to the agency/university contacts, the page contains the research priority needs of the Great Lakes Basin Ecosystem Team Lake Sturgeon Subcommittee, Great Lakes Lake Sturgeon Genetics Status Assessment and links to other sturgeon sites. The site has had approximately 7,500 hits/month since posting in April of 1998. The page received over 10,500 hits in August and November 1999.

Alpean FRO coordinated production of a Great Lakes lake sturgeon video with Earthwave Society representative Betty Wills and participating members of the CGLBLSG. "Sturgeon of the Great Lakes" is one of a five-volume video library "The Nine Sturgeons of North America". Filming began in Amherst, NY on 3 June, and covered Service lake sturgeon work on Lake Ontario and the Niagara River. Filming then shifted to Mt. Clemens, MI to cover Service, Michigan DNR, Ohio DOW, and Ontario MNR lake sturgeon activities on Lakes Huron, Erie and St. Clair Waterway. The video will highlight collaborative activities of the CGLBLSG and include on-camera interviews by agency partners funding the project. Many unique aspects of the CGLBLSG's work were captured on tape. Approximately, five hours of tape were recorded during the week long event. The video should be completed in early-June 2000. Once completed the video will be available free of charge to state and federal agencies, public schools and universities/colleges and sport groups.

2000

The cooperative lake sturgeon tagging and data collection activities made possible by the Lake Huron commercial fishers will continue in 2000. Consolidation of the tagging data into a common database will also occur in 2000. Need for consolidation of all agencies' tag information into a single database has been identified as a critical need for the group since 1995.

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1999

Since the 1950's, the U.S. Fish and Wildlife Service and Department of Fisheries and Oceans Canada have been contracted by the Great Lakes Fishery Commission to conduct operational activities of the Sea Lamprey Management Program (Program) throughout the Great Lakes basin. The Program continues to work with fisheries management agencies to achieve consensus on sea lamprey control and priority fisheries management projects in streams of the Great Lakes basin, apply the ecosystem approach, use adaptive management strategies, address risk management issues, and take action to minimize the risk to nontarget organisms. The Program has reduced populations of sea lampreys by 90% in the basin and is a key fishery management activity that contributes to the success of the Great Lakes fishery, an estimated benefit of about $4 billion/year to the region.

The Program uses several techniques to attack sea lampreys during different stages of the life cycle. Currently, the primary method to control sea lampreys utilizes the lampricide 3-trifluoromethyl-4-nitrophenol (TFM) that kills sea lamprey larvae in streams with little or no impact on other fishes. Other methods of control include barriers to block the upstream migration of spawning sea lampreys, sea lamprey traps to capture and remove adult lampreys, and the sterile-male-release-technique to reduce the success of sea lamprey spawning. Lampricide treatment and low head sea lamprey barrier dam construction in a stream occur only with the support and the approval of regulatory and management agencies.

During 1999, the Michigan Department of Natural Resources expressed concern for the impact of a lampricide treatment on a suspected population of lake sturgeons in the Sturgeon River, a tributary of the Cheboygan River to Lake Huron. Assessments by dip net during and immediately after treatment found no mortality of lake sturgeons. The assessments were completed to fulfill requirements specified in the 1999 certification of approval issued for lampricide treatments by the Michigan Department of Environmental Quality.

To learn more about the Sea Lamprey Management Program as it relates to lake sturgeon please visit the following web page; midwest.fws.gov/marquette/etc/sturgeon.html.

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1999

Summary: *A total of 172 lake sturgeon were collected from the St. Clair River and Lake St. Clair in 1999. Sturgeon were collected with bottom trawls and baited setlines. Pectoral fin ray sections were used to age 168 fish. Ages ranged from 1 to 62 years and included 45 year classes. Mean length at age suggests that these sturgeon grow faster as juveniles when compared with inland lake sturgeon in Michigan. A total of 167 sturgeon were tagged with serial numbered monel cattle ear tags and released in 1999, bringing the total number of sturgeon tagged and released since 1996 to 674 fish. Sparse tag recoveries have including seven recaptures with setlines, and eleven reported recoveries by sport or commercial fishermen. Documentation of habitat characteristics at a spawning site in the St. Clair River and a location of high trawl catches in Lake St. Clair continued in 1999.*

The Mt. Clemens Fisheries Research Station began an investigation into the distribution and abundance of lake sturgeon in the St. Clair River and Lake St. Clair in 1996. This project was formalized as a federal aid research project in 1997. The objectives of the study are (1) to determine spawning period, areal distribution of spawning activity, and characterize spawning habitat in the St. Clair River, (2) to determine early (juvenile) life history of lake sturgeon in the St. Clair River and Lake St. Clair and identify habitat requirements of young lake sturgeon, (3) to document lake sturgeon population parameters for Lake St. Clair and the St. Clair River, including estimated abundance, exploitation, age composition, growth rate, and age/sex composition of the spawning stock.

Capture of juvenile and adult lake sturgeon to collect biological data and mark with monel tags in the St. Clair River and Lake St. Clair - Sturgeon were collected and tagged with two gear types in 1999. A total of 107 sturgeon, including three recaptures were caught in 64 overnight sets using setlines in the North Channel of the St. Clair River between May 11 and June 4. Total length of sturgeon caught on setlines ranged from 546mm to 1,816mm. Age ranged from 3 to 62 years. A total of 107 fish were tagged with monel cattle ear tags and released. Additionally, six large sturgeon captured with setlines in the North Channel were implanted with sonic tags as part of a cooperative telemetry study with the University of Michigan.

A total of 209 trawl tows (113 with 10m headrope trawls and 91 with 4.8m headrope trawls) from June through October on Lake St. Clair captured 65 lake sturgeon. All sturgeon were collected in the 10m headrope bottom trawls. Total length of sturgeon

captured ranged from 351mm to 1,651mm. Age ranged from 1 to 42 years. A total of 65 fish were tagged with monel cattle ear tags and released into Lake St. Clair. Lower water levels in 1999 may have affected trawl efficiency. An area of the lake that produced high trawl catch rates for sturgeon from 1996-1998 became essentially unfishable with bottom trawls in 1999 due to heavy growth of *Chara*. Numerous lake sturgeon were still present in the area, as evidenced by telemetry, sidescan sonar, and observations of breaching sturgeon.

Since 1996, trawling at various locations across Lake St. Clair has produced a pattern of consistent sturgeon captures in an area of the lake located off the St. Clair River delta between the mouths of the Middle and South Channels (Figure 1). We refer to this area as the "sturgeon hole". Offshore trawls in other areas of the lake with water depths similar to that of the "sturgeon hole" have resulted in very sporadic sturgeon captures. No sturgeon have been captured at nearshore trawl locations (depths less than 8').
Overall, the age distribution of lake sturgeon captured from 1997 through 1999 appears well balanced with a total of 45 year-classes represented among the 579 lake sturgeon sampled for age (Figure 1). This sample reveals consistently good recruitment to this population from 1973 to 1993. It may not be coincidental that this period of recruitment followed the federal Clean Water Act of 1972. The strongest year-classes were produced in 1993, 1991, 1985, 1977. The 1995 to 1998 year classes are poorly represented in the sample. This may be due to gear selectivity, juvenile distribution, or poor recruitment in recent years. Since lake sturgeon are known to be capable of exceeding 50 years in age (Scott and Crossman 1973), year-classes prior to 1965 appear under-represented in the catch. This could be an indication that recruitment prior to 1965 was poor, and has improved dramatically since that time. Alternatively, those year-classes may have experienced high exploitation rates in the past, particularly during the 1970's and early 1980's, prior to the closure of sturgeon season during the spawning period in May and June for these waters in 1983.

Growth of lake sturgeon in the St. Clair ecosystem is good, with some fish attaining a total length of 1 m as early as age 8. A mean length of 1,270mm is attained by age 19. In contrast, inland lake sturgeon in Michigan grow slower, particularly from age 1 to age 15, and attain a mean length of 1270mm at age 22 (Baker 1980). Based on age and growth data collected during this study, the MDNR has implemented new regulations for sturgeon sport fishing on Lake St. Clair and the St. Clair River. The regulations included a "slot" size limit, with a minimum length limit of 1,067 mm (42 inches) and a maximum length limit of 1,270 mm (50 inches), a season bag limit of 1 fish, an open season from July 16 to September 30, and mandatory registration of harvested sturgeon at designated check stations. This "slot" limit will allow a limited harvest to continue, while protecting sexually mature female fish, and potentially allowing older fish to increase in abundance. No lake sturgeon were registered at the check stations during the 1999 harvest season.

Characterization of adult spawning habitat and juvenile habitat, based on catch distribution, using underwater video, sidescan sonar, doppler flow meter, temperature and oxygen profiles - In 1997 we identified a spawning location in the North Channel of the St. Clair River. This site was initially discovered through contacts with local riparians, fishermen, and conservation officers. Sturgeon spawned on the site, which is characterized

by water depths of 9m to 12m, flow rates of 1m/sec, and substrate composed of coal cinders ranging in size from <25mm to over 200mm in diameter, on June 13 and 14, 1997. Water temperature at the peak of spawning in 1997 was 13.2 ^{o}C. In 1998, water temperatures reached 13 ^{o}C, and sturgeon began spawning on the site on May 18. In 1999, water temperatures were 12 ^{o}C on May 20, when ripe sturgeon were first captured. The coal cinders are believed to have been deposited at the site during the late 1800's when coal burning vessels moored and emptied their cinders into the river. The cinder substrate is now zebra mussel encrusted and the 3 dimensional structure of the cinders combined with the zebra mussel layer provide a high level of interstitial space, offering excellent protection for deposited eggs. The cinder bed measures approximately 25m by 54m in size and roughly parallels the shoreline.

Efforts to map the spawning site with sidescan sonar in 1998 were partially successful. Unfortunately, plans to sidescan the cinder pit during the spawning period in 1999 were not completed due to equipment malfunction. The sidescan unit was repaired and will be used to map the spawning site during the year 2000 spawning period.

Our efforts to identify the habitat requirements of juvenile lake sturgeon have been impeded by our inability to consistently collect young lake sturgeon. Less than 1% of the sturgeon captured through 1999 were younger than age 3 (smaller than about 500 mm total length). Efforts to capture Age 0 lake sturgeon in littoral areas with a 4.8m headrope trawl have been unsuccessful. Similarly, efforts to locate Age 0 lake sturgeon by snorkeling in areas to shallow or vegetated to trawl have been fruitless. Age 0 lake sturgeon in the St. Clair system may inhabit deep channel areas of the St. Clair delta. Additional catch data from collections over the next few years may help identify a juvenile habitat based on the geographical distribution of juveniles in the catch.

Collection and analysis of tag recovery data - Tag recovery data remain sparse. To date, eighteen lake sturgeon tagged and released during this study have been recaptured. Seventeen were originally caught with setlines, tagged, and released in the North Channel of the St. Clair River. Seven have been recovered during the setline survey portion of this study in the North Channel. Seven recoveries were reported in 1998 and 1999 by sport anglers in the North Channel. Four recoveries have been reported from the Ontario commercial trap-net fishery in southern Lake Huron, approximately 70 kilometers from the tag site. All other recaptures have occurred within 10 km of the tag sites. Although trawling has accounted for 56% of the sturgeon captured during this study, only one recovery, 6% of the total recoveries, has been from a fish originally caught in a trawl on Lake St. Clair. This could be an indication that fish that reside year around in the St. Clair River or move north into southern Lake Huron experience a much higher level of fishing exploitation.

Table 1.–Mean length and weight for lake sturgeon collected from St. Clair River and Lake St. Clair in 1999.

	Set-line	Trawl
Total number caught	107	65
Mean length	1,211 mm	1,170 mm
Length range	546 mm – 1,816 mm	351 mm – 1,651 mm
Mean weight	13.4 kg	12.3 kg
Weight range	0.8 kg – 49.5 kg	0.2 kg – 29.8 kg

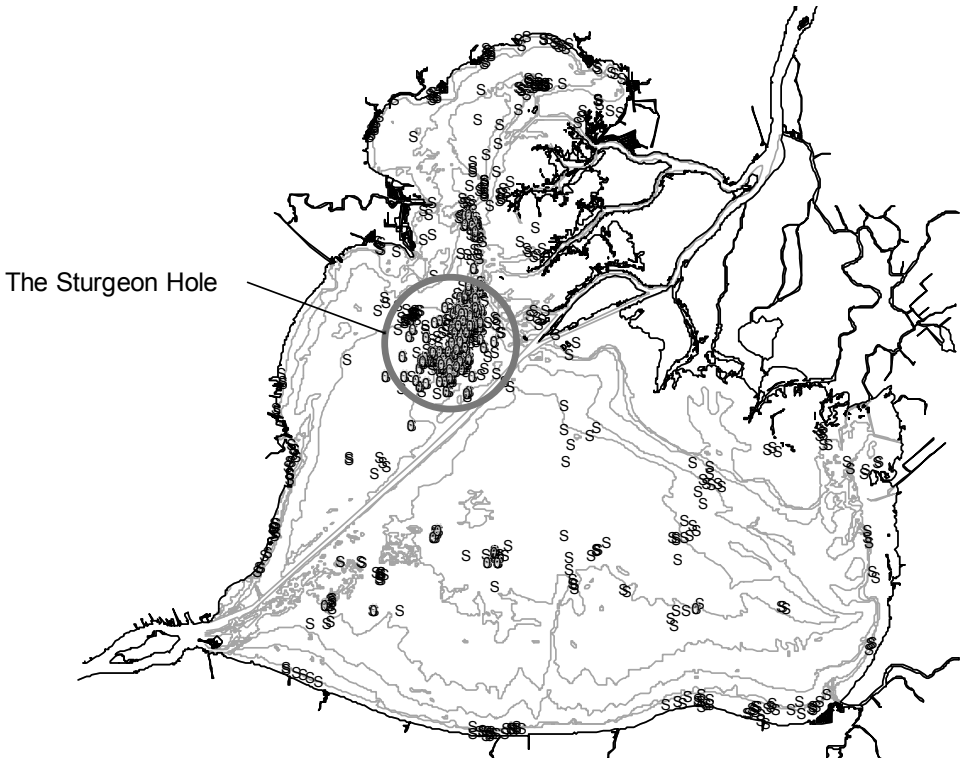

Figure 1. Trawl locations (empty circles represent trawls not capturing sturgeon, circles filled with cross represent trawls capturing 1 or more sturgeon) on Lake St. Clair from 1996 to 1999.

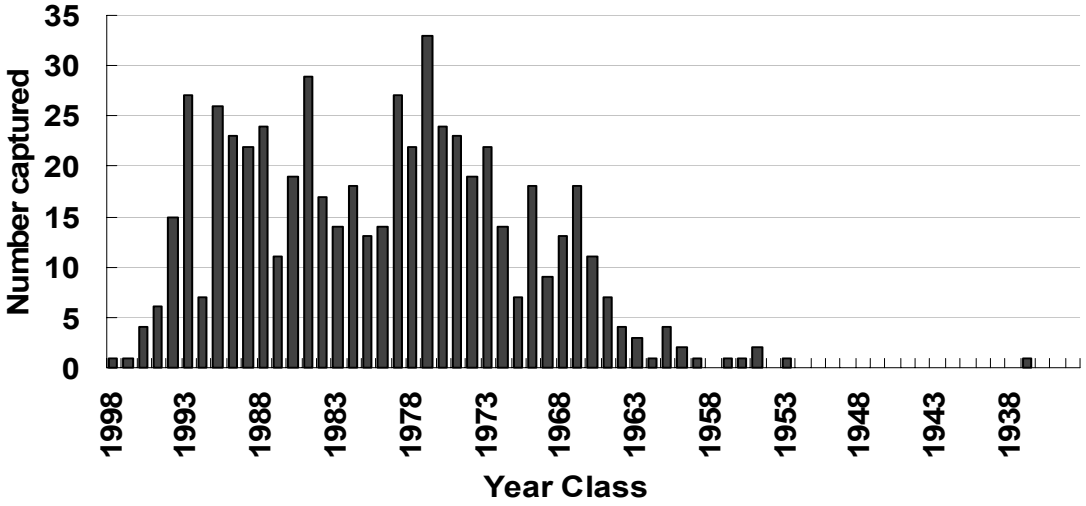

Figure 2. Year class frequency for lake sturgeon captured in the St. Clair River and Lake St. Clair from 1997 through 1999. Ages based on pectoral fin ray sections.

2000

2000 will be the fourth year of the current five year federal aid project. Our field sampling effort will be similar to 1999, with setline and trawl surveys continuing on the St. Clair River and Lake St. Clair. The adult telemetry project has been strengthened with the addition of EPA funding for a graduate student at UM. We also plan to focus more on characterizing the habitat in the "sturgeon hole" area of Lake St. Clair to help us understand why sturgeon are so commonly encountered in this region of the lake.

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1999

Within the St. Clair River system, a population of sturgeon exists which appears to spawn within the St. Clair River and juveniles continue to reside there for some period of time. Work in the early 1980s allowed us to collect small sturgeon throughout the year using set lines, and work during the spawning season 1996-1999 indicates that large adult sturgeon are common during the late May/early June spawning period. The nature of this stock is relatively unknown. In particular, we do not know the extent and locations of spawning habitats, the characteristics of selected spawning sites, the potential competitors and predators on eggs in these spawning sites, nor the residence or distribution of potential stocks. This lack of knowledge stimulated Michigan DNR, University of Michigan, U.S. Fish and Wildlife Service-Alpena Fishery Resources Office, and the U.S. Geological Survey-Great Lakes Science Center to initiate complimentary studies on the sturgeon population. Mark-and-recapture estimates have indicated a fairly large population of sturgeon spawn in this area, but whether these sturgeon represent fish resident in Lake St. Clair or in the wider Great Lakes system is unknown. The purpose of this telemetry study is to evaluate both spawning site selection and long-range movements of sturgeon that spawn in the St. Clair River system.

Lake sturgeon spawning appears to occur in the North Channel of the St. Clair River, in the main part of the channel at a depth of about 30-50 feet. Collections by setlines are fairly useful in evaluating sturgeon numbers and collecting fish for implantation. For this study, we used fish in excess of 55 inches in length, so that they would be fully mature and also tolerate the large transmitters. For the set lining data, the size structure indicates that most of the fish collected were smaller than this minimum size and that juvenile fish were relatively common in the St. Clair River.

A total of six fish were implanted during the 1997 season with both radio and ultrasonic transmitters. Four more fish were implanted with ultrasonic transmitters in the spring of 1998. The ultrasonic transmitters have batteries that are rated to last for 15 months, because of this we expected the transmitters that were implanted in the spring of 1997 to fail sometime during the 1999 season. Six new fish were implanted with ultrasonic transmitters in the spring of 1999. These fish were implanted to replace the fish from the first year. All fish used in this study were captured between late May and early June. Details on the dates of implantation and tracking are listed in Table 1.

The transmitters that were implanted in fish in 1997 did not fail during 1999 as expected. They have continued to provide us with information well past the 15 months that they were rated, although the strength of the signal is much weaker than when they were new. This year we were able to track movements of sturgeon back to their spawning location due to the extended life of the transmitters. In early May, we first located fish 5 in the lake close to our field station; two weeks later, the fish had moved into the St. Clair River (Figure 1). The fish remained in the river until after the spawning season was over and then moved back into the lake. Fish 4 was captured in the spring of 1997 in the North Channel (Figure 2). After it was implanted and released, it moved out into the lake then remained there the rest of the year. In 1998, the fish was first located in the river and has remained there since. In the early spring of 1999, the fish was captured by a local fisherman from the end of his dock on the North Channel. The man kept the fish alive in the water and notified Michigan DNR. Two biologists visited to gather biological information and to assess the overall health of the fish. The fish appeared to be in excellent health, and the location of the incision for the transmitter was almost non-detectable. The fish was released and is still located in the river. In 1999, fish 1 was relocated. This fish was implanted in the North Channel in 1997, then it was feared there was either a mechanical failure with the transmitter or it had moved out of the range of our sampling area. Fish 1 was found in August and September this year near the Detroit River.

In 1997 and 1998, after most fish had moved out of the North Channel, our search efforts were concentrated on the northern portions of Lake St. Clair. This year we wanted to focus more attention searching for fish in some of the more remote locations of the lake to see if we could locate individual fish using other areas. As a result, we did find sturgeon in remote locations, areas that in the past two years had only been checked infrequently (Figures 3 and 4).

During the 1999 season, contact was established with all 10 fish implanted in 1997 and 1998. We have also been able to follow four of the six fish that were implanted with transmitters this spring. We experienced various problems with three of the six fish that were implanted this spring. We lost contact with fish 12 a week after it was implanted. After fish 15 was implanted, it was tracked moving up the river over the next two weeks and was found in three separate locations. Two weeks after the last contact with fish 15 we tried unsuccessfully to find it and fish 12 by searching the entire river from Lake Huron to Lake St. Clair. We searched this stretch of river on two other occasions, and also checked some smaller branches that drain across the delta area with no success. The remaining four fish were followed throughout the summer, fall and early winter (Figure 5).

As of December 1999, we had a total of 445 fixed locations of fish (Figure 6). The majority of the sturgeon continue to congregate in an area off the St. Clair River Delta in water that is from 12 to 18 feet deep. At the onset of this project, we expected to see movement or longer term residence of sturgeon in habitats that are shallower and closer to shore. Areas such as these are very conducive to the production of benthic invertebrates, especially mayflies, a principal component of their diet. During the entire

three-year sampling period, no fish were detected in shallow water near shore. It is still unclear what features may attract adult lake sturgeon to this particular location. We evaluated temperature and dissolved oxygen as possible reasons why the fish may not be using other areas of the lake, because Anchor Bay and the southeastern end of the lake should represent areas with the greatest potential for stratification. We detected no significant difference in temperature or dissolved oxygen at these locations compared to the delta area.

Table 1. Biological and tracking information for 16 lake sturgeon captured from the St. Clair River, 1997-1999 (last tracking date 12/17/99).

Fish Number	Size (mm)	Sex	Age	Capture Date	Last Encountered
1	1524	F	-	05/30/97	09/30/99
2	1524	F	-	05/30/97	09/23/99
3	1575	F	36	06/02/97	12/13/99
4	1762	M	42	06/02/97	07/15/99
5	1397	F	26	06/05/97	12/17/99
6	1461	M	28	06/05/97	07/08/99
7	1455	M	29	05/19/98	12/17/99
8	1544	M	31	05/19/98	09/23/99
9	1448	-	25	05/19/98	12/13/99
10	1422	M	17	05/19/98	12/17/99
11	1537	M	25	05/26/99	08/09/99
12	1412	M	26	05/26/99	05/29/99
13	1582	M	38	05/26/99	08/24/99
14	1435	F	28	05/26/99	12/17/99
15	1816	F	62	06/03/99	06/11/99
16	1537	F	44	06/03/99	12/13/99

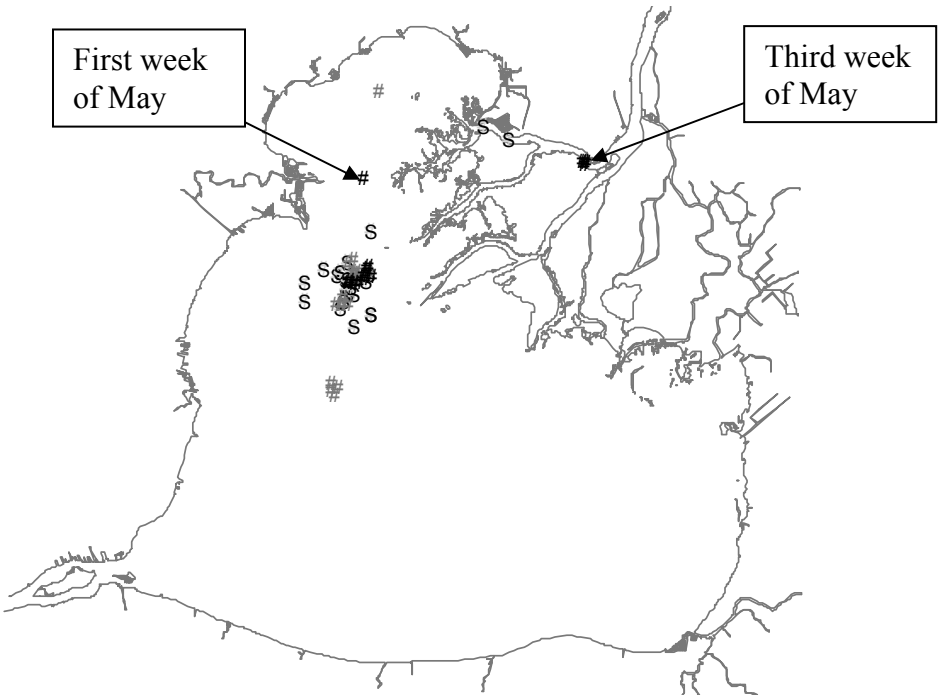

Figure 1. Movement of fish 5. Gray with border is 1997; dark gray is 1998; and black is 1999.

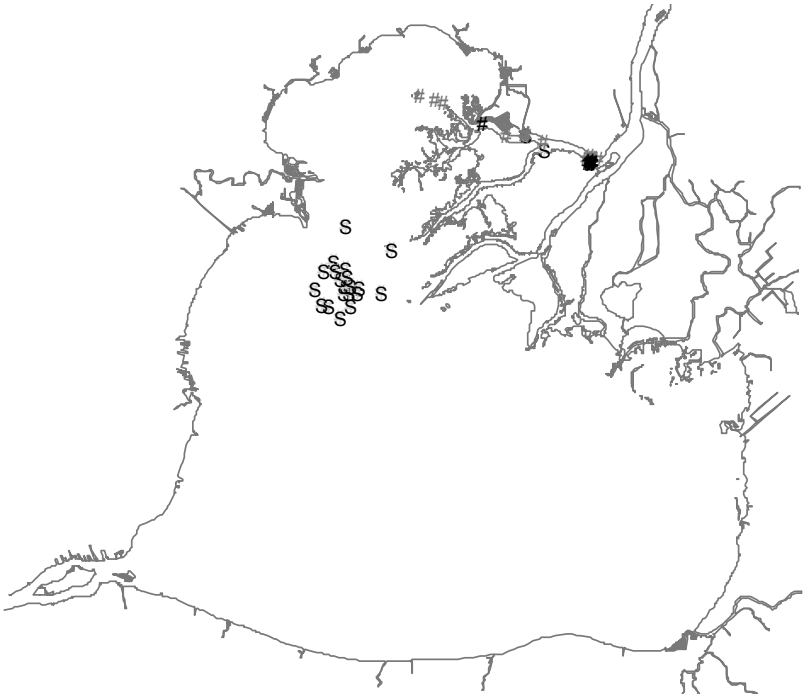

Figure 2. Movement of fish 4; notations as in Figure 1.

Figure 3. Movement of fish 3; notations as in Figure 1.

Figure 4. Movement of fish 8; notations as in Figure 1.

Figure 5. Locations of fish implanted in spring 1999.

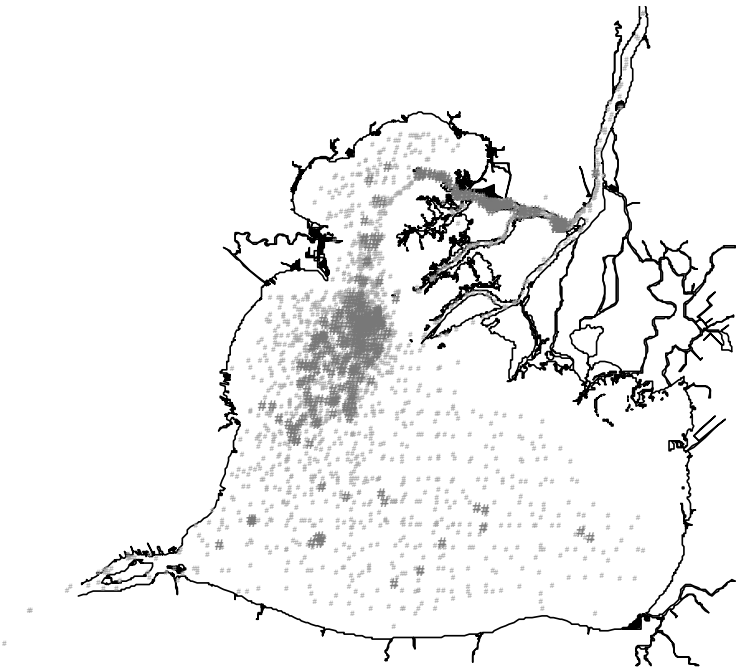

Figure 6. Locations for all fish through December 1999 (dark gray) and listening locations where fish were not located (light gray).

2000

We expect to track eight to ten fish through the summer and fall of 2000. We feel the information obtained from this study is excellent and should provide valuable additions to the information taken from mark-and-recapture work by Michigan DNR. In fact, because few fish have been recaptured at present, only the telemetry work is giving us any indication of stock dispersal at this time.

During this summer, we plan to address some potential reasons why sturgeon congregate in certain locations in Lake St. Clair. We plan to expand sampling of vegetation and benthic invertebrates, particularly in the area off the river delta and incorporate our results with those of previous studies. We also would like to estimate the type of forage lake sturgeon are consuming. To do this, we will attempt to use some method of gastric lavage. If this does not work, we will analyze stomach contents of fish that will be sacrificed for toxicology information. The number of fish to be sacrificed for toxicology has yet to be determined.

In the long term, we envision following up this study with a study of behavior of juvenile sturgeon in the St. Clair River system. During the past three springs, the large majority of fish taken by longlines were juveniles. These fish appeared to remain in the river system after the spawning season ended, and not move out into the lake as most adults did. The differential behavior of juvenile and adult fish is interesting, and it would be useful to know whether the juvenile stock in the St. Clair River system resides entirely there, or if some of those individuals also move out to Lake St. Clair or beyond.

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1999

The St. Clair River and Lake St. Clair ecosystem supports one of the only documented, significant population of free ranging, riverine-spawning lake sturgeon still extant in the Great Lakes. Historically, the St. Clair River contained a number of spawning sites (Goodyear et al. 1982) but only two are known to be active today: one in Port Huron, at the head of the river, and the second, in the North Channel, just before the river empties into Lake St. Clair. Relationships and connectivity, if any, between these two spawning stocks is still being determined. These two spawning grounds will be critical in the continuing recovery of lake sturgeon in this river system if they provide suitable habitat not only for spawning to occur, but also for the survival of larval sturgeon. There is no information presently available about the degree of spawning effort, or larval production

from either of these sites. Further concerns were recently raised since the exotic fish, the round goby (*Neogobius melanostomus*), has successfully colonized the St. Clair River (Baker 1980). This bottom-dwelling fish is a voracious feeder known to eat a wide variety of prey, including fish eggs and larvae (Charlebois et al. 1997). Densities of round gobies have increased exponentially throughout the St. Clair River system and in June 1997, Great Lakes Science Center divers videotaped numerous round gobies colonizing the sturgeon-spawning reef in the North Channel. Furthermore, sturgeon eggs were found in the stomachs of several of these gobies.

In 1998 and 1999, we surveyed the spawning reef in the North Channel in order to determine if it was an important recruitment site for lake sturgeon and to assess the potential problems that may be occurring due to round goby colonization. This spawning reef in the North Channel of the St. Clair River is small (1/8ha or 7500 sq. m), ranges from 6-13 m deep, and has an average water velocity of 1-3 m/sec. The reef is not a natural substrate, but instead is composed of coal clinkers, that were deposited over 100 years ago when this area served as a dock for salt freighters. These coal clinkers are irregular in shape, ranging from 0.5-12 cm in size and form deposits up to 2 m deep. No submersed vegetation is found on the site.

Lake sturgeon spawning behavior

The spawning period is of short duration and triggered by the onset of 13°C water temperatures. Adult sturgeon gather in a holding pattern about 1.3 km upstream of the reef in the North Channel. A few smaller sturgeon (~ 1m in length) are seen in and near the reef before temperatures reach 13°C, but no spawning occurs. Once temperatures reached 13°C, on May 17th in 1998, and May 25th in 1999, egg deposition began. Spawning occurred over the next 3 days in 1998 ending on May 20th and over 1.5 days in 1999, ending on May 27th. Adult sturgeon then left the reef and returned to the staging area. Based on SCUBA diver surveys and videotape analysis, only about 30-50 adult sturgeon were involved in the spawning runs in 1998 and somewhat fewer fish in 1999. Estimates of the number of adult fish present are conservatively low due to sampling constraints. First, dive time on the reef was limited to a maximum period of 4 hours/day. The fixed video camera provided more information as it was taping continuously, but its fixed position only provided view of sturgeon immediately in front of it. The divers never saw more than 3 groups of spawning adults at any time. Some of the fish were distinctively marked and remained on the reef for much of the spawning period. One had a severely deformed tail, and another appeared black in color. In both years, females were larger than the males, up to 8 ft in length, and fewer in number. We also assumed that spawning intensity was not different during the night. All of this observational data was used to estimate the number of adult sturgeon using the reef. Sex determination was based solely on behavior during the spawning runs as adult sturgeon are not sexually dimorphic (see Figure 3). In both years, a second spawning run occurred about 41 days after the first; on June 26th in 1998 and July 1st in 1999 when water temperatures were between 18-19° C. The number of adults in the second spawning run in 1998 was estimated at less than 20. No estimate was obtained for the number of adults involved in the second spawning run in 1999.

One concern we initially had was that the sturgeon would react negatively to the presence of the SCUBA divers. In fact, spawning sturgeon were greatly attracted to the divers and would rub up against them, allow themselves to be scratched and in general treated the divers as another large sturgeon.

Egg deposition rates

Estimates of the number of eggs deposited on the reef varied significantly between types of gear. Estimates based on the number of eggs in the polypropylene filter mats measured average egg deposition in 1998 at 2254 eggs/m^2 and fewer, 1638 eggs/m^2 in 1999. There was a significant difference in the number of eggs deposited between years and between mats within years. In 1998, egg deposition ranged between 1450/m² and 3659/m² (mean 2254; median 1659; standard deviation 1023; degrees of freedom 9). In 1999, egg deposition ranged between 651 and 3967 / m² (mean 1638; median 921; standard deviation 1410; degrees of freedom 9). The rate of egg deposition between years was compared using a two-tailed t-test. The t-statistic was 0.6506 indicating a significant difference in deposition rates between 1998 and 1999.

In 1998, estimates of egg deposition based on the quadrat samples averaged 185/m^2 (range 10-500/m^2; median 115; standard deviation 227.9; degrees of freedom 4). Number of eggs collected by each diver varied according to water flow and water clarity. This technique was not used in 1999.

In 1998, the plastic trays filled with rubble provided the lowest estimate of egg densities averaging 7.1/m^2 (range 0-30/m^2; median 2.95; standard deviation 9.9; degrees of freedom 24). This sampling gear was only used in 1998 as many of the trays silted in within a few days of being placed on the reef.

Egg viability and fate of fry

Sturgeon eggs are about 4 mm in diameter and are enclosed in an adhesive coating that anchors them loosely to the substrate. Around day 3 or 4 post-spawn, this sticky coat ruptures and the developing embryo drops down into the substrate. A cursory examination of the substrate cannot detect eggs or embryos once the sticky coat ruptures. Eggs hatched between 9-11 days after spawning in both 1998 and 1999. Sac fry were first observed on May 27th in 1998 and on June 4th in 1999. The hatch rate of the artificially spawned eggs that were loaded into trays and planted back on the reef was low, averaging 3%. Siltation was a severe problem with all the trays. The hatch rate of the naturally spawned eggs loaded into the metal cylinder and planted on the reef had an average that was higher than that of the eggs in the trays, but lower than that of the eggs sent to the hatchery. The average hatch in the cylinders was 19% (range 5-32%) based on 5 cylinders pulled between June 16th and June 22nd. Cylinders pulled after that date, when the larvae would have passed the yolk sac stage and been actively feeding contained no larvae but did contain a lot of fungused material.

The modified dig sampling technique did detect eggs, newly hatched larvae, and fully formed fry (Table 1), up to 20 cm down in the rubble. Fry were detected for a period of about 2 weeks after hatch, though in declining numbers (Table 1). By the 20th day after hatch, no sturgeon larvae of any size could be collected on the reef. On a few occasions,

divers noted that fry were present in the substrate, but avoided capture in the net by evasive swimming maneuvers (swimming over the net and back into the substrate). The sac fry (newly hatched) averaged 10 mm in total length in both years. Over the next 20 days or so, the fry completed development of eyes and mouth, lost the yolk sac, and grew to an average length of 17 mm. Fewer dig samples were collected in 1999, only 8 total; five on June 7th and 3 on June 22nd. Unlike the 1998 data, only one dig sample, taken on June 7th contained live fry (6 total). Three of the other four digs contained a total of 23 decaying fry. The fifth sample was empty. The modified dig sampler was the only technique that ever detected live sac fry or older larvae on the reef. The other techniques, such as fry traps, drift nets, etc., never collected larvae or fry in either 1998 or 1999.

Predation on sturgeon eggs and larvae by round gobies and native fish.

The predation on sturgeon eggs on this reef is limited to the period between the time of deposition and the time when the sticky coat ruptures and releases the embryo into the substrate, about 3-5 days. Round gobies have even less opportunity to feed on sturgeon eggs, as they leave the reef while the adult sturgeon are present. Adult sturgeon are known to prey on round gobies over other fishes (Thomas and Haas 1999). To date, no sturgeon sac fry or larvae have been found in any fish stomach.

A total of 106 round gobies (67-144 mm TL), 19 logperch (*Percina caprodes*, 67-114 mm TL), 2 yellow perch (*Perca flavescens*, 179, 247 mm TL), and 5 redhorse (*Moxostoma* spp.) were captured from May-July, 1998. Of the 106 gobies, 46 were female and were smaller than the males TL 85 $\pm$ 11.4 mm (S.D.) for the females compared to 103.7 $\pm$ 18.3mm. Every type of fish collected from May 17th – May 23, ate sturgeon eggs and redhorse eggs and fry. Table 2 shows the importance of various food items to round goby during the sampling season in 1998. Round gobies are opportunistic feeders on this reef, feeding mainly on invertebrates including zebra mussels, ephemeropterans, dipterans, crayfish, etc. Sturgeon eggs are eaten, but only for a short period of time. In 1999, we collected fewer fish: 52 gobies, 5 redhorse, 2 yellow perch, 1 walleye, and 1 common carp. Fish were collected from May 27th, at the start of spawning, to June 1st. Two separate sets of samples after those dates were lost underwater during diver gear failure.

Use of the reef by native and non-native fish

The reef fish community and physical structure changes during the season, as native and exotic fish spawn and feed on the site. At the start of the diving on the reef in 1998 (April 30th), the reef had a smooth slope flowing along a gradient from 6 m down to 12 m in depth. The substrate was moderately to heavily silted with visibility between 1.5-2 m. Water flow across the reef was constant at around 1.3 m/sec and visibility was poor, usually around 2 m. In late April, few fish were seen on the reef. Round gobies were the most commonly seen fish, at densities of 2-3 gobies /m² with an occasional carp (*Cyprinus carpio*) noted in the deeper areas.

During the second week in May, redhorse suckers (*Moxostoma spp*.) arrived on the reef and began cleaning the gravel in preparation for spawning. At first, only 20-30 redhorse were present, and cleaned only a small portion of the cobble, but by the following week several hundred redhorse were digging nest depressions. By this time much of the reef

had been cleaned of silt and visibility dropped to <1 m. This digging behavior changes the entire surface topography of the reef. The reef surface changed from a smooth gradient to extremely rough, with large craters, plateaus and steep drops scattered throughout. Only the 11-13 m depth range was still smooth, although now mostly free from silt. As the surface gradient changed, water currents changed. There were now areas of lower current, swirling currents, eddies and channelized regions with extremely fast currents. The round gobies were pushed off most of the reef and were concentrated upstream and along the shallow edge (6 m) of the reef at densities of about 5-6 / m² and at the downstream end. The downstream, or back of the reef had an unusual current flow, an upwelling eddy that curled back upstream onto the back of the reef. This area was heavily colonized by round gobies, at densities of approximately 120 / m². They were feeding heavily on redhorse eggs and the benthic invertebrates that were drifting back as the redhorse dug up the reef substrate. The following week, as spawning waned, the numbers of adult redhorse dropped to an average of 75-80 fish on the entire reef.

On the 17th of May the lake sturgeon appeared and began spawning. The divers never observed more than 3-5 groups of spawning sturgeon at any one time, with a single group consisting of one large female and 2-3 attendant males. In 1998, several of the males on the reef were very distinctive in appearance. One was almost black in color and another had a malformed tail. These males remained on the reef throughout the spawning period. As the sturgeon were spawning, redhorse suckers moved down to the middle and the downstream end of the reef. However, redhorse were observed following the spawning sturgeon and feeding on sturgeon eggs, as they were deposited. After sturgeon spawning finished, the number of redhorse present on the reef dropped to 40- 50 fish.

Once the adult sturgeon left the reef round gobies returned, at densities up to 25 / m² and fed heavily on sturgeon eggs and redhorse eggs and fry. Logperch and yellow perch also appeared on the reef at this time. Logperch reached densities of 8-10 / m² from mid reef to the back of the reef in waters from 6-7 m deep. They were uncommon in waters deeper than 7m. Yellow perch schools of 15-20 fish up to 30 cm in length, were found in the same areas. Small mouth bass, 30-50 cm in length, appeared a few days later. Round goby densities dropped during this time to about 12-15/m². By mid June, just before the second sturgeon spawning run, there were just a few each of bass, log perch, redhorse, and yellow perch on the reef and round goby densities dropped to 1-2 / m².

In 1999, the patterns of fish use of the reef were the same as in 1998, but the timing and densities differed. In 1999, the arrival of the redhorse and arrival of the sturgeon occurred one-two weeks later than the previous year. Fish densities were drastically reduced particularly the redhorse. Only about 150 -200 redhorse were on the reef and they were concentrated and cleaned only the shallower areas (6-10 m areas). The deeper parts of the reef, 11-12 m, were minimally disturbed, and this part of the reef remained relatively flat and silty. The reef was not cleared of silt as completely as it had been in 1998.

Table 1. Number of lake sturgeon eggs and fry collected in the modified dig samples in 1998.

	# of samples	*Total # eggs*	*Avg. #/m²*	*Total # fry*	*Avg. #/m²*
June 2	5	17	3.4	17	3.4
June 4	4	6	1.5	3	<1
June 8	5	0	0	9	1.8
June 9	3	0	0	3	1
June 10	2	0	0	0	
June 17	3	0	0	1*	<1
June 25	3	165	55	0	
June 26	2	107	53	0	

* seen by the divers, but escaped the net.

Table 2. Index of relative importance (IRI) of prey in stomachs of round gobies from the lake sturgeon spawning reef in the St. Clair River, 1998. N is percent number, V is percent volume, F is percent frequency, n is number of goby stomachs sampled.

Date	*n*	*Prey*	*N*	*V*	*F*	*IRI*
May 23-28	16	Emeroptera	7.7	4.5	12.5	153.0
		Trichoptera	5.8	6.8	18.7	236.0
		Diptera	21.2	9.1	25.0	756.1
		Amphipoda	15.4	13.6	31.2	906.9
		Orconectes propinquus	1.9	22.7	6.2	154.1
		Dreissena polymorpha	1.9	2.3	6.2	26.2
		Gastropoda	0.0	0.0	0.0	0.0
		Other invertebrates	1.9	9.1	18.7	206.5
		Redhorse eggs	3.8	4.5	12.5	104.9
		Sturgeon eggs	38.5	31.8	31.2	2,196.2
June 1-10	24	Emeroptera	7.8	8.6	20.8	341.8
		Trichoptera	17.6	3.8	45.8	981.5
		Diptera	35.3	3.8	50.0	1,953.1
		Amphipoda	13.7	3.8	50.0	874.6
		Orconectes propinquus	2.9	44.5	3.0	593.3
		Dreissena polymorpha	12.7	22.9	33.3	1,189.7
		Gastropoda	6.9	8.6	29.2	449.0
		Other invertebrates	2.9	4.1	12.5	88.1
		Redhorse eggs	0.0	0.0	0.0	0.0
		Sturgeon eggs	0.0	0.0	0.0	0.0
June 16-17	40	Emeroptera	0.8	0.4	7.8	9.6
		Trichoptera	8.4	4.7	55.0	721.2
		Diptera	63.9	3.4	52.5	3,532.9
		Amphipoda	3.6	1.7	27.5	146.5
		Orconectes propinquus	2.5	24.3	27.5	739.2
		Dreissena polymorpha	15.0	61.7	65.0	4,986.7
		Gastropoda	2.5	3.0	25.0	139.4
		Other invertebrates	2.7	0.4	12.5	39.7
		Redhorse eggs	0.4	0.2	5.0	3.2
		Sturgeon eggs	0.0	0.0	0.0	0.0
June 26-July 2	40	Emeroptera	2.9	10.0	11.5	149.1
		Trichoptera	6.6	6.7	11.5	152.7
		Diptera	31.4	7.5	23.1	897.4
		Amphipoda	0.7	0.8	3.8	6.0
		Orconectes propinquus	1.5	9.2	3.8	40.9
		Dreissena polymorpha	2.2	9.2	7.7	87.4
		Gastropoda	0.0	0.0	0.0	0.0
		Other invertebrates	1.5	1.7	7.7	24.0
		Redhorse eggs	15.3	12.5	15.4	428.1
		Sturgeon eggs	38.0	42.5	19.2	1,547.0

DETROIT RIVER

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1999

Remnant, free-ranging, riverine spawning populations of Great Lakes lake sturgeon are now known to exist in only a few tributaries to southern Lake Superior, the St. Clair River and the St. Lawrence River. Recent incidental catch of young, genetically unique, juvenile lake sturgeon indicates that recruitment has occurred in western Lake Erie (Porter et al. 1997). The source of this recruitment is undetermined but is speculated to be associated with the lower Detroit River.

Seven historical lake sturgeon spawning sites were identified in the Detroit River by Goodyear et al. (1982), however, no assessment has been conducted to evaluate current use of these sites by lake sturgeon. Similarly, no studies have been initiated to determine the location or current condition of other potential spawning, nursery, and feeding micro-habitats that are consistent with those known to support self-sustaining stocks of lake sturgeon (Kempinger 1988; 1996). Identification and qualitative assessment of habitats utilized by the various life stages of any species is critical for successful recovery efforts, and for guidance of habitat protection, enhancement or restoration efforts. The U.S. Fish and Wildlife Service-Alpena Fishery Resources Office (FRO) in cooperation with U.S. Geological Survey-Biological Resources Division-Great Lakes Science Center (GLSC) initiated a project in the spring of 1999 to begin filling the data gaps on Detroit River lake sturgeon and their habitats. This study was undertaken to begin directing attention to the Detroit River through a cursory examination of historical lake sturgeon spawning sites to evaluate the current physical condition and determine whether lake sturgeon are currently using those or other sites in the river.

Six of the seven historical Detroit River lake sturgeon spawning sites identified by Goodyear et al. (1982) were investigated in this study (Table 1). The seventh site, near Peche Island at the head of the Detroit River, was geographically distant from the other six sites and was not logistically feasible to sample. The Sturgeon Bar site was eliminated because habitat alteration in that region of the Detroit River no longer provides depth or flow considered minimal for lake sturgeon spawning. In addition, areas adjacent to the six primary sample sites where river currents create a depositional zone were investigated concurrently for use as lake sturgeon feeding areas. Based on similar sampling efforts in the St. Clair River it appears that depositional zones are

effective assessment fishing sites prior to spawning (M. Thomas, Michigan DNR, personal communication).

Table 1. Six historical lake sturgeon spawning sites in the Detroit River, Michigan (from Goodyear et al. 1982)

SITE	*LATITUDE*	*LONGITUDE*
Fighting Island	42° 13.00'	83° 07.00'
Grassy Island	42° 13.50'	83° 08.00'
Stony Island	42° 08.33'	83° 07.83'
Sugar Island – North	42° 06.00'	83° 08.58'
Sugar Island – South	42° 05.08'	83° 08.67'
Sturgeon Bar	42° 04.08'	83° 11.25'

Setlines were fished three to four days per week from May through July 1999. Setline configuration was similar to that used by Thomas and Haas (1999) in the St. Clair River. Hooks were baited with a combination of round gobies (*Neogobius melanostomus*) and other fish species. Round gobies were used as extensively as allowed by availability due to an apparent feeding preference by lake sturgeon in the St. Clair River.

Data collected from all captured lake sturgeon included; total length (cm), fork length (cm), girth (cm), and weight (kg). The leading pectoral fin ray from the left side of the fish was removed for aging purposes and a 1 cm^2 section of the distal portion was removed and placed in a 15 ml vial containing 95% ethanol for later genetic analysis. Each lake sturgeon was externally marked with a self-piercing Monel livestock ear tag to assist in the determination of seasonal movement and distribution patterns. Abiotic data collected at each site included water depth, surface water temperature, bottom water temperature, dissolved oxygen (bottom), and latitude/longitude.

Results

A total of 54 one night sets were made at, or immediately adjacent to, 5 of the historical spawning sites listed in Table 1 between April 27 and July 15, 1999 with setlines. Two lake sturgeon were captured near Fighting Island (Table 2) but neither fish was near the coordinates referenced in Goodyear et al. (1982). Both fish were of sufficient size and age to be sexually mature but no signs of maturation were externally evident.

A total of 37 one night sets was made at depositional sites near the reference historical spawning sites, or during exploratory sampling within the Detroit River system between April 27 and July 15, 1999 with setlines. Six lake sturgeon were captured at the Ballard's Reef site and represents the greatest aggregation of lake sturgeon encountered during this initial sampling period. The six fish ranged in size from 93 – 157 cm (T.L.) and were captured primarily in May 1999 (Table 2). No age structures were taken from the two largest fish from this location but the fish were estimated to be of sufficient size and age to have been sexually mature. However, no external indication of sexual maturity was observed. It is assumed that this site and the occurrence of these fish were related to feeding activity rather than spawning.

Table 2. Data summary for lake sturgeon captured with set-lines in the Detroit River, 1999.

Date	Site	Depth (m)	T.L. (cm)	F.L. (cm)	Girth (cm)	Weight (kg)	Age	Tag #
5/4/99	Fighting Is	13.5	149	141	68	31		4457
5/6/99	Ballard's Reef	8.3	157	146	60	23		4472
5/12/99	Ballard's Reef	7.1	153	143	59	22		4459
5/13/99	Ballard's Reef	7.1	93	85	35	4	10	4602
5/18/99	Ballard's Reef	9.0	99	91	40	7	8	4610
5/26/99	Fighting Is.	9.8	174	161	71	44	38	4469
5/27/99	Ballard's Reef	9.1	124	113	47	15	15	4464
6/11/99	Ballard's Reef	7.6	118	106	11		13	4613
10/21/99	Turkey Is.	9.5	96	88	32	5	7	4463
10/21/99	Ballard's Reef	6.3	94	84	34	5	7	4466
10/22/99	Turkey Is.	9.5	116	107	40	7	10	4460

Three additional lake sturgeon were captured with 8 overnight setline sets at the Fighting Island, Ballard's Reef and Turkey Island sites in October 1999 (Table 2). The fall sampling, was completed to examine the relative abundance of lake sturgeon in the Detroit River in the fall. Other studies have indicated a fall migration of Great Lakes sturgeon into river systems for over-winter feeding and holding (R. Bruch, Wisconsin DNR, personal communication). Anecdotal reports of target fishing for lake sturgeon in this region of the Detroit River supports the hypothesis of such a movement. Reported numbers of sport caught lake sturgeon encountered in October and November indicates that aggregations of fish are common at that time of year.

Overall, a total of 11 lake sturgeon were captured with set-lines fished in the lower Detroit River, May-October 1999. All fish were tagged with Monel self-piercing livestock ear tags. Tags were affixed to the musculature at the base of the dorsal fin. As represented by the 8 fish aged, captured fish represented age classes 7-38. No external signs of sexual maturity were observed in any of the fish captured, therefore, no confirmation of spawning activity can be made at any of the historical sites cited.

2000

Staff from the Alpena FRO will work in cooperation with Central Michigan University to conduct a telemetry study on adult lake sturgeon in the Detroit River. The US EPA Great Lakes National Program Office and the Ohio Division of Wildlife are funding the study. It should allow the identification of lake sturgeon spawning locations in the Detroit River.

LAKE ERIE

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1999

The program of lake sturgeon reporting was continued in the Lake Erie basin in 1999. A total of 38 fish were reported to the Ohio DOW in 1999 as compared to 45 reported in 1998 and 64 reported in 1997. Again, as was the case in 1998, lake sturgeon reports came from a variety of sources, including commercial fishers, sport fishers, shoreline residents and others (Figure 1). The distribution of lake sturgeon sightings was lake-wide with the greatest occurrences, again, in the Lakeside-Marblehead and Cedar Point areas (Figure 2).

The length frequency distribution for lake sturgeon reported in 1999 is provided in Figure 3. Although no aging structures were collected from reporting sources, it is apparent that several age classes are represented in those fish reported in 1999.

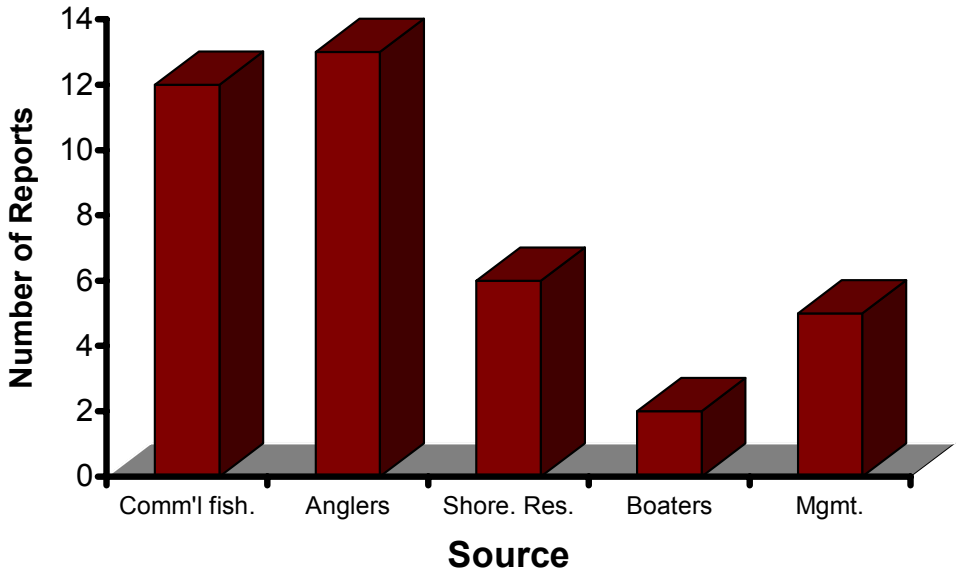

Figure 1. Numbers of Lake Erie lake sturgeon reported to Ohio DOW in 1999, by source.

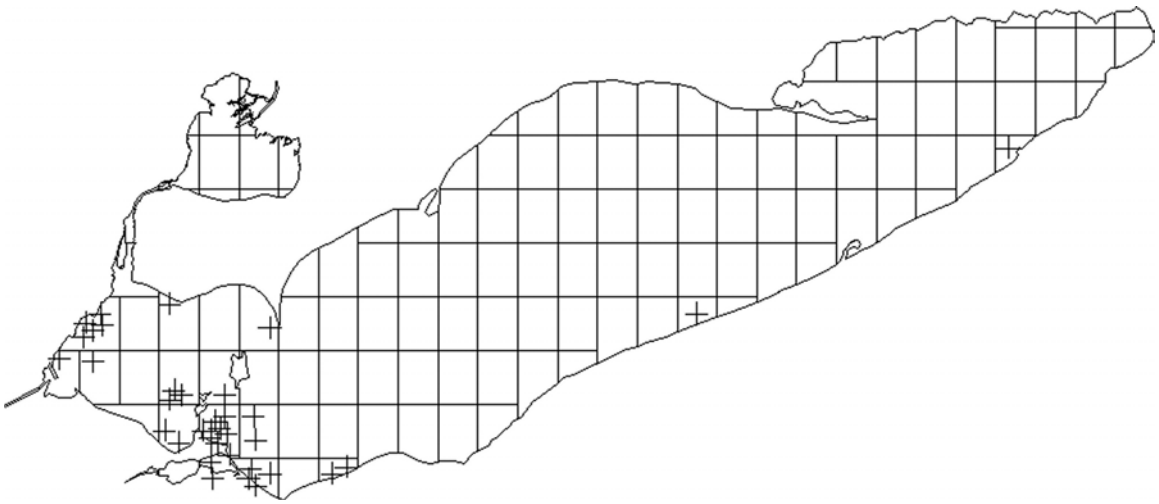

Figure 2. Sightings of lake sturgeon in Lake Erie, 1997, as reported to Ohio DOW from all sources. Relative size of circles denotes frequency of reports from individual sites.

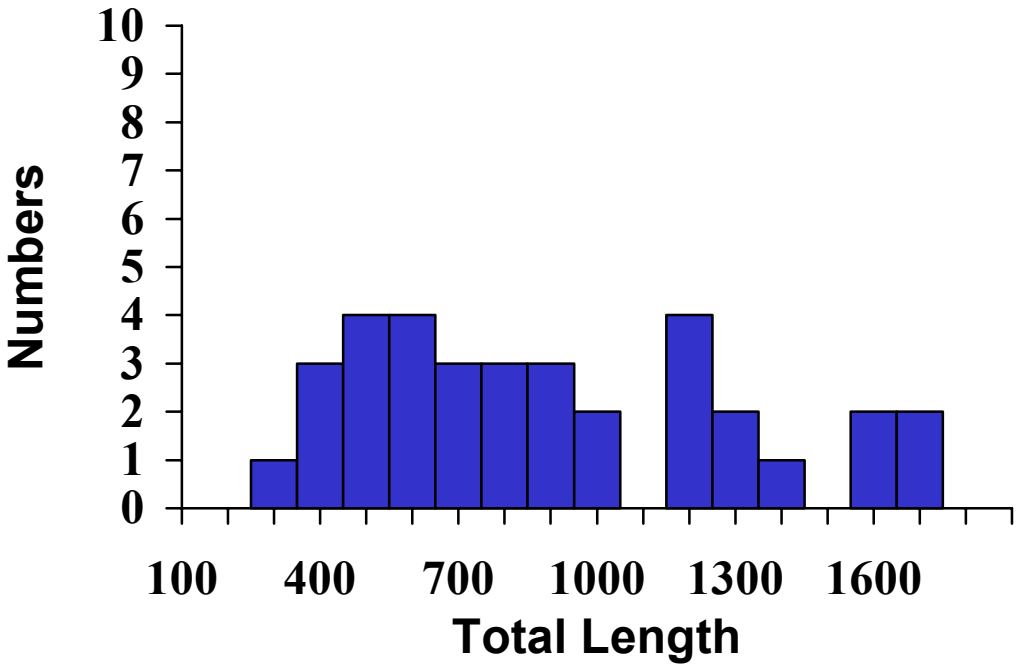

Figure 3. Length frequency distribution of lake sturgeon reported to Ohio DOW from all sources in Lake Erie, 1999.

NIAGARA RIVER / LAKE ONTARIO

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1999

Great Lakes Lake Sturgeon Genetics

A report entitled, Great Lakes Lake Sturgeon Genetics Status Assessment: An Analysis of Samples, Methods, and Standardization (Lowie 1999) was completed and distributed to agencies throughout the Great Lakes Basin. The objective of the report was to compile information on existing genetic samples and programs conducted by various natural resource agencies to determine compatibility and identify potential standardization methods. A genetics workshop, held in December 1999, complemented the report by providing a forum for biologists, managers, and geneticists to discuss the current state-of-knowledge, identify information needs, and standardize further collection and analysis of genetic samples. A brief overview from the open discussion session is provided below; however, these minutes have not been critically reviewed. The information is being provided for planning purposes only and should not be referenced. A proceedings document will be available in the near future, which will include final recommendations for future sample collection, distribution, and analysis.

Genetics Workshop Summary

Collection, fixing, and preservation methods
Samples should be collected primarily from spawning populations; however, samples from open water fish are valuable. Fin tissue is the most effective, yet least invasive, tissue type and should be provided in most circumstances. Use best professional judgement as to the quantity of tissue collected; however, more is better (up to 1 square inch from adults). Water rinse and wipe hands and utensils between samples to ensure they are not contaminated. The best fixing and preservation method was determined by geneticists to be air-drying. Drying is most easily achieved by placing the sample in a paper envelope. However, this is not best for archiving samples due to possible pest infestation. The second best method for preservation is putting the sample in 95% alcohol (not denatured alcohol), particularly if archiving the sample. It is best to change the alcohol after the initial fixation for long term storage. Completely submerge sample in at least two times as much alcohol as sample. If samples are frozen, keep them frozen until analysis is conducted.
Centralized depository for samples

It was discussed whether a depository should be established for samples or data. It was determined a database would be acceptable, which would be available to Great Lakes agencies. The database will be held within the USFWS Great Lakes Basin Ecosystem Team, Lake Sturgeon Committee's standardized database (to be held at the Alpena, MI FRO). This database will include information on standard biological data, tagging data, collector, location, etc.

Analysis methods
Microsatellite analysis is fastest for stock identification; however, experimentation with other methods will be left open for the future. A library of microsatellite markers is being established between some cooperative labs. More microsatellite markers might be needed; however, all existing markers should be examined more thoroughly to evaluate their usefulness. Existing and additional markers should be standardized and available to allow multiple labs to compare data. Contracts between agencies and genetic labs should be specific as to the use of samples and data.

The LGLFRO continues to lead the effort to obtain funding for genetics analysis. Proposals have been submitted to three sources, requesting funding over four years to collect additional samples from spawning populations, develop new markers, standardize the markers, perform stock structure analysis, and prepare a basin-wide management plan. To facilitate this study, it is recommended to continue collecting genetics samples and to hold them for later analysis. However, if there is an immediate need to have them analyzed, a contractual agreement should first be established.

PROJECTS

Lower Niagara River
Since the summer of 1998, we have been studying the population of lake sturgeon in the lower Niagara River. This lake sturgeon project is in cooperation with the State University of New York - College at Brockport. The data provided here is considered preliminary results, with complete analysis of the data being provided via a thesis publication (Hughes et al. manuscript in progress).

The overall goal of our study is to identify key spawning and feeding habitats in the river in order to better manage, protect, and enhance the lake sturgeon population. The research objectives of our study are to: (1) compare the daily, seasonal, and diel movement patterns of juvenile and adult lake sturgeon, (2) compare the utilization of macro- (e.g., river, main lake) and micro- (e.g., high flow, back eddy) habitats between juvenile and adult lake sturgeon, (3) determine the age and growth of adult and juvenile lake sturgeon, and (4) determine the genetic discreteness of Niagara River lake sturgeon.

To date, we have collected 32 lake sturgeon by SCUBA diving, gill nets and baited setlines. In 1999, we captured a total of 26 sturgeon with a CPUE of 0.27 fish per night for all methods (Table 1). We began our 1999 gillnetting efforts in late April by targeting adult fish (> 1200 mm) with 10" stretch mesh gillnets. We successfully captured five suspected adult fish (two known ripe males) before increased algal and

macrophyte drift decreased our sampling efficiency. We continued to sample through the summer; however, no additional adult sturgeon were captured. During the months of September and October, we had tremendous success using setlines baited with Chinook salmon egg skein, with a CPUE of 0.58 fish per night. We believe the sturgeon were keying in on the salmon eggs as large numbers of salmon were migrating up the river for their annual fall spawning run. Additionally in 1999, a considerable number of anglers reported catching lake sturgeon while salmon fishing.

Not knowing the age at maturity of the Niagara River population, we feel we have been catching primarily juvenile (<1000 mm TL) and sub-adult (1000-1200 mm TL) fish, with at least five fish, based on length, likely to be adults (>1200 mm TL) (Table 2). Two fish were known to be ripe adults since milt was observed during processing. We were unsuccessful, via internal examination through incision, in determining the sex and maturity of the other adult-sized fish.

Table 1. Comparison of lake sturgeon catch among different gear types in lower Niagara River, 1999.

	Gear Type				
	Exp. Gill Net	10" Gill Net	Setline	Diver	All
No. Fish Captured	3	7	10	6	26
CPUE (fish/night)	0.33	0.13	0.42	3.0	0.27
Mean Total Length (mm)	874	1254	990	766	996
Range (mm)	705 - 1141	886 –1566	851 - 1186	311 - 1021	311 – 1566
Mean Weight (kg)	5.4	17.6	6.4	3.1	8.5
Range (kg)	1.8 – 11.8	4.3 – 33.9	3.0 – 15.0	0.2 – 6.3	1.8 – 33.9

Pectoral fin rays were collected and analyzed to interpret the ages of all lake sturgeon captured. Ages of lake sturgeon captured ranged from 1 to 20 years old, with a majority (n =19) of fish between 4 to 6 years old (Figure 1, Table 2). Suspected adult fish were determined to be between the ages of 12 and 20 years old. Both of the ripe males were 12-year-old fish. In addition, two fish categorized as sub-adults (based on total length) were determined to be 12 years old and could potentially be adult fish (Table 2). The growth of these fish appear to be higher than populations from the Lake Huron Basin (Hill and McClain 1999). Specifically, lake sturgeon from the Niagara River tend to be longer and heavier than lake sturgeon of the same age from Lake Huron waters (Hill and McClain 1999). Age-length relationship is shown in Figure 2.

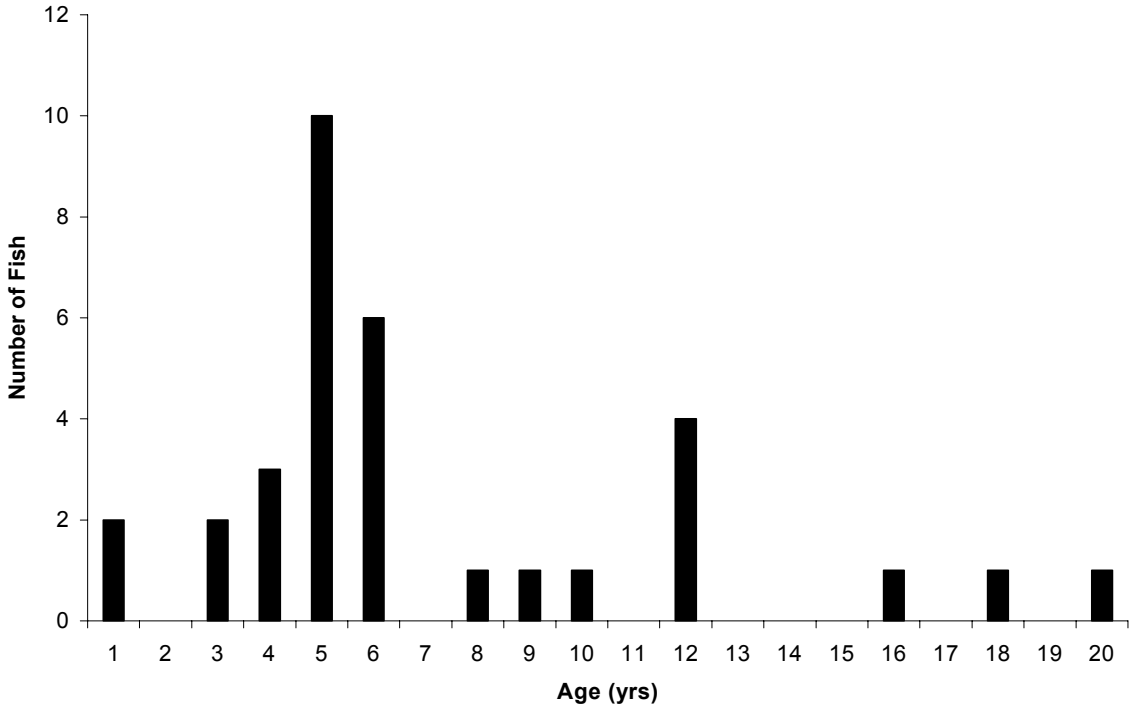

Figure 1. Age distribution of lake sturgeon caught in the lower Niagara River, 1998-99.

Table 2. Biological data for lake sturgeon captured in lower Niagara River, 1998-99.

Date Capture	Fork Length (mm)	Total Length (mm)	Girth (mm)	Weight (kg)	Age (yrs)	Suspected Maturity*
8/1/98	289	337	125	N/A	1	Juvenile
8/1/98	624	705	306	2	3	Juvenile
8/12/98	755	854	368	4	5	Juvenile
8/14/98	860	966	371	5.2	6	Juvenile
8/14/98	741	847	343	3.3	5	Juvenile
8/26/98	778	866	345	3.6	5	Juvenile
8/28/98	639	725	272	1.6	4	Juvenile
4/27/99	1197	1314	578	19.5	16	Adult
4/28/99	777	886	375	4.3	6	Juvenile
4/28/99	1396	1435	655	25.2	18	Adult
4/28/99	1450	1566	720	33.9	20	Adult
5/5/99	1121	1256	534	14.5	12	Ripe Adult (male)
5/18/99	1155	1240	260	15.5	12	Ripe Adult (male)
6/3/99	899	1021	414	6.3	8	Sub-adult
6/3/99	272	311	122	0.15	1	Juvenile
7/16/99	768	872	317	3	5	Juvenile
7/23/99	1020	1141	502	11.8	9	Sub-adult
7/23/99	788	890	359	4.2	6	Juvenile
7/23/99	746	837	319	3.2	5	Juvenile
7/23/99	690	787	310	2.7	5	Juvenile
7/23/99	668	750	297	2.2	5	Juvenile
7/30/99	658	705	265	1.8	3	Juvenile
8/4/99	695	775	295	2.6	5	Juvenile
8/6/99	976	1078	461	10	12	Sub-adult
8/6/99	968	1081	443	9.1	10	Sub-adult
8/19/99	755	851	355	3.7	6	Juvenile
9/29/99	818	940	410	4.8	5	Juvenile
9/29/99	854	963	328	4.2	6	Juvenile
9/29/99	898	992	403	5.7	5	Juvenile
9/29/99	1170	1186	540	15	12	Sub-adult
10/20/99	801	919	354	4.2	4	Juvenile
10/20/99	845	963	387	5	4	Juvenile
10/20/99	1009	1132	445	8.8	6	Sub-adult

*Maturity classification based on age and total length of fish.

Our sampling methods proved to be effective in catching lake sturgeon greater than 700 mm, with a mean total length of fish captured in 1999 of 996 mm (Table 1). We only captured two fish less than 700 mm (Figure 3). This reflects more the selectivity of our sampling gear and methodology rather than smaller size classes being absent from the population. Our gill nets (with few panels of 4-inch stretch mesh or less) and setlines targeted primarily larger fish. Divers indicate they have seen a fairly even distribution of size classes in the river.

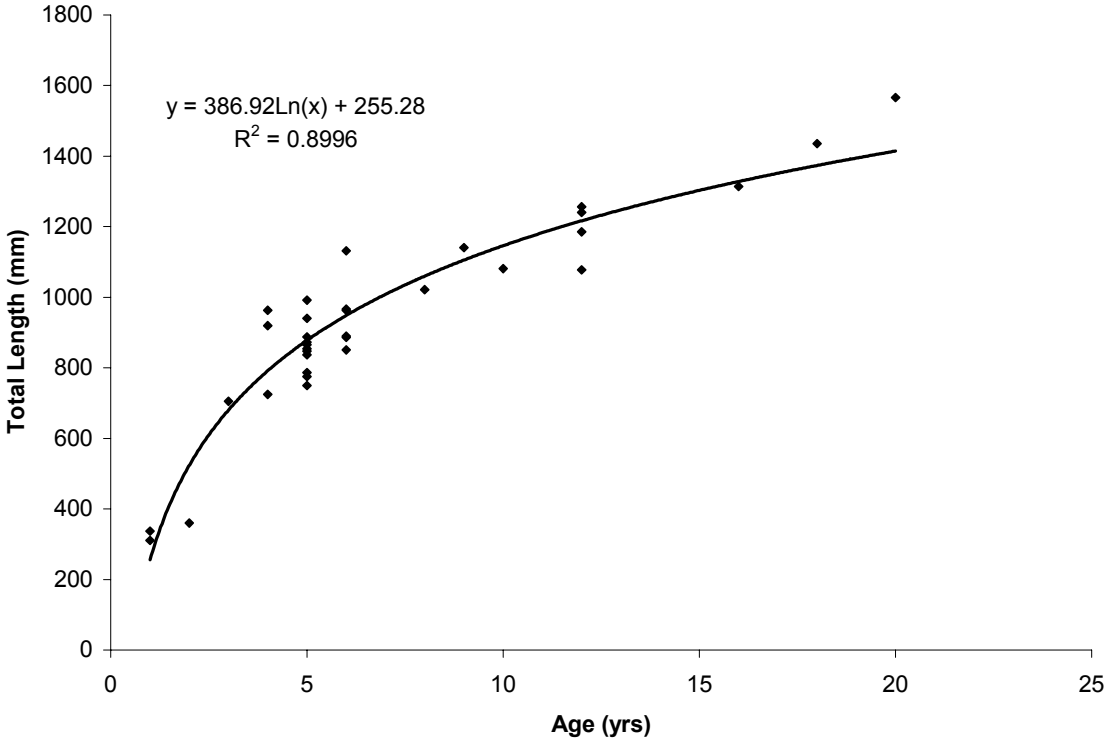

Figure 2. Relationship of age vs. length of lake sturgeon caught in the lower Niagara River, 1998-99.

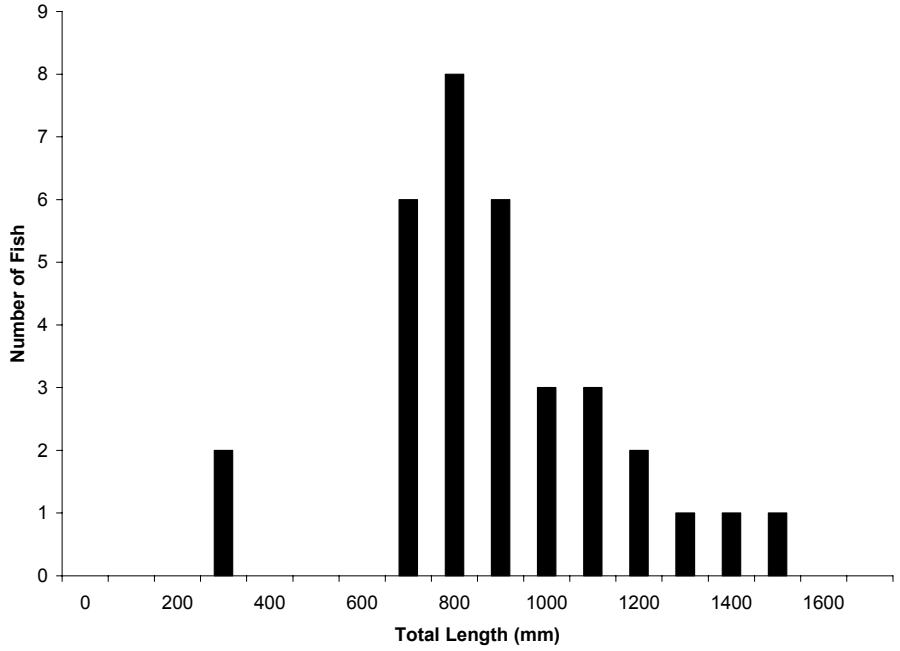

Figure 3. Length distribution of lake sturgeon caught in the lower Niagara River, 1998-99.

Ultrasonic Biotelemetry

Since August 1998, 19 fish have been fitted with ultrasonic transmitters to monitor their long-term movements in the lower Niagara River and its confluence with Lake Ontario (Table 3). Tags were attached externally to either the dorsal fin, when suitable tissue was available, or through the dorsal scutes. Several sonic tags have become 'idle' (e.g., lost tag) as indicated by prolonged stationary fixes, while other tags/fish have not been located since shortly after tagging (i.e. absent) (Table 3). Tag retention (track duration) averaged only 60 days among those tags that are currently 'idle.' Two adult fish (#293 and #257) have not been located since mid-June, the end of the suspected spawning period. Currently, we are actively tracking six fish, with five fish absent, and eight 'idle' tags (Table 3).

Table 3. Tagging data for ultrasonic tagged lake sturgeon captured in lower Niagara River, 1998-99. Tracking status as of 12/22/99.

Fish No.	Mount	No. Fixes	Date Capture	Date of Last Fix	Track Duration (d)	Tracking Status
266	scute	37	8/1/98	10/20/98	81	idle
347	dorsal	19	8/12/98	11/9/98	90	absent
338	dorsal	23	8/14/98	11/9/98	88	idle
356 ('98)	dorsal	33 *	8/14/98	4/26/99	259	recap
248	scute	31	8/26/98	12/11/98	108	idle
239	scute	26	8/28/98	10/9/98	43	idle
293	dorsal	7	4/27/99	6/16/99	51	absent
356 ('99)	scute	4	4/28/99	5/11/99	14	idle
257	dorsal	12	4/28/99	6/9/99	43	absent
455	dorsal	31	4/28/99	12/22/99	239	active
275	dorsal	22	5/5/99	12/22/99	231	active
96	dorsal	12	5/18/99	6/21/99	34	idle
2237	dorsal	17	6/3/99	11/8/99	158	active
374	scute	9	7/16/99	8/19/99	35	idle
87	dorsal	17	7/23/99	12/22/99	152	active
284	scute	3	7/23/99	7/27/99	5	absent
2228	scute	14	8/4/99	10/20/99	78	idle
2246	dorsal	5	8/6/99	9/28/99	54	absent
5-10	scute	9	8/19/99	12/22/99	126	active
446	dorsal	6	9/29/99	12/22/99	84	active

* #356 captured in 1998 contains fixes (4/12/99 and 4/26/99) prior to being recaptured and re-tagged in 1999.

In general, our tagged lake sturgeon inhabit both the Niagara River and Lake Ontario at its confluence with the river (Figure 4, Table 4). Fish in the lake (within our tracking 'circuit') are very seldom found outside the confluence of the river (Figure 4, Table 4). Juvenile lake sturgeon seemed to prefer nearshore, slow water currents (mean bottom velocity 0.19 m/s), primarily remaining where they were collected, in Peggy's Eddy and the Queenston Long Drift (Figure 4, Tables 4 & 5). Adults seemed to prefer the faster

currents (mean bottom velocity 0.37 m/s) of the river and its confluence with the lake (Figure 4, Tables 4 & 5). Juveniles (mean depth 10.4 m), sub-adults (mean depth 9.3 m), and adults (mean depth 10.6 m) occupied similar depths (Table 6). Overall, lake sturgeon occupied depths ranging from 2.3 to 25.3 m with a mean depth of 10.3 m (Figure 5, Table 6).

Table 4. Macro-habitat (river vs. lake) and within-habitat current preferences of different life stages of lake sturgeon in lower Niagara River, 1998-99.

				River		Lake	
Life Stage	No. Fixes	Percent River	Percent Lake	Percent Eddy	Percent Main	Percent Confluence	Percent Main
Juvenile (<1000 mm)	208	90	10	68	32	100	0
Sub-adult (1000-1200 mm)	45	56	44	60	40	100	0
Adult (>1200 mm)	84	64	36	11	89	93	7
All fish	337	79	21	56	44	97	3

Table 5. Average velocities of tagged lake sturgeon in lower Niagara River and its confluence with Lake Ontario, 1999.

Life Stage	No. Measurements	Average Surface Velocity (m/s)	Average Bottom Velocity (m/s)
Juveniles (<1000 mm)	7	0.18	0.19
Sub-adults (1000-1200 mm)	12	0.41	0.27
Adults (>1200 mm)	40	0.52	0.37

Adult lake sturgeon generally occupied two areas in the river during preferred spawning temperatures (13 to 18 ^{o}C literature range; May - June); the mouth of the river at Fort Niagara and the 'red cliffs' region from Stella Niagara upstream to Lewiston (Figures 4 & 6). On 5 June 1999 (water temperature 16 ^{o}C), three of five adult fish were located in close proximity to one another in the 'red cliffs' region (Figure 6, rkm 9). We have identified these areas as potential spawning sites in the lower river.

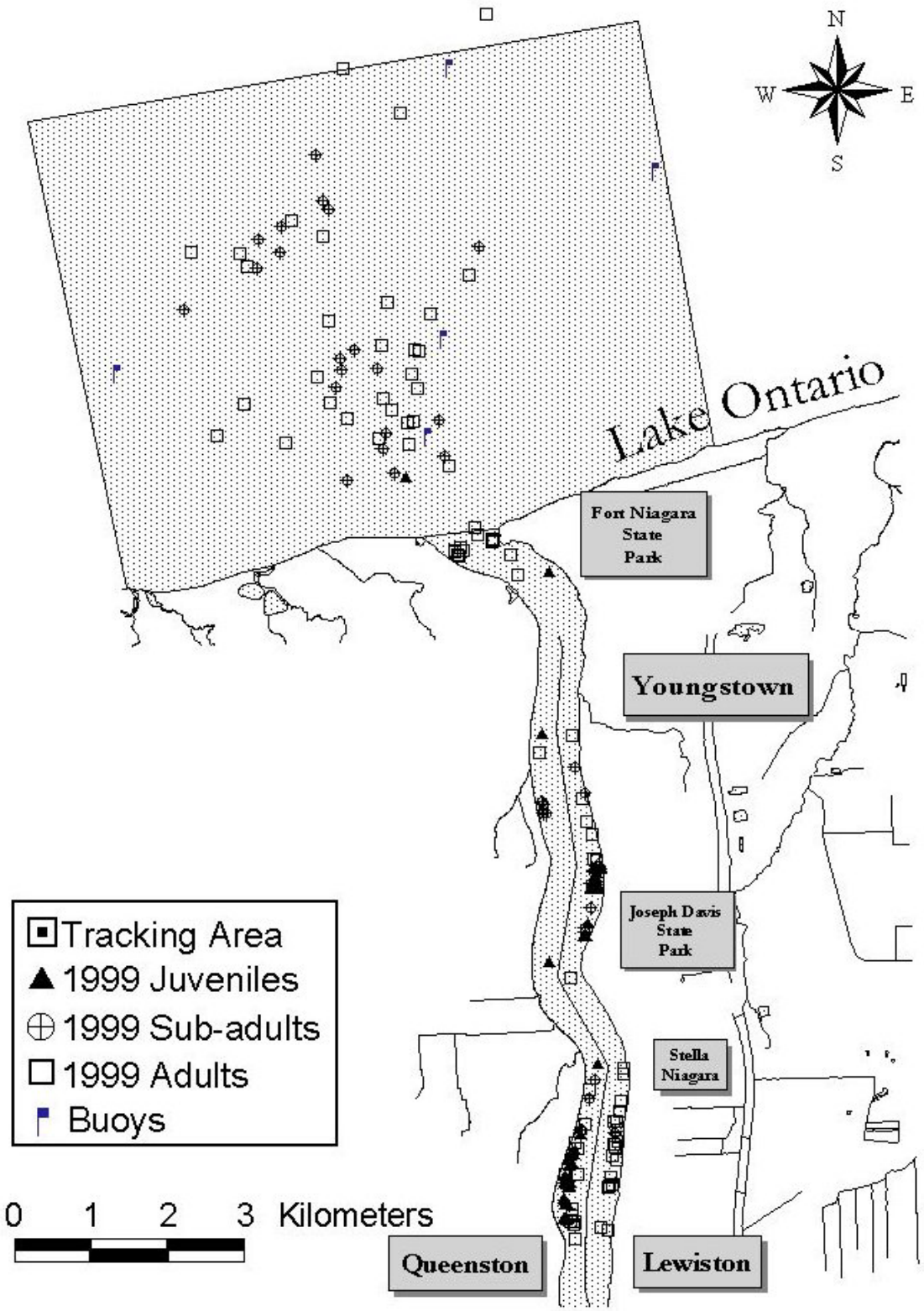

Figure 4. Location of lake sturgeon in Lake Ontario and the lower Niagara River, 1999.

Table 6. Depth preferences among different life stages of ultrasonic tagged lake sturgeon,
1998-99.

Life Stage	No. Measurements	Average Depth (m)	Minimum Depth (m)	Maximum Depth (m)
Juveniles (<1000 mm)	179	10.4	2.3	25.3
Sub-adults (1000-1200 mm)	36	9.3	5.0	22.1
Adults (>1200 mm)	81	10.6	5.8	23.8
All fish	296	10.3	2.3	25.3

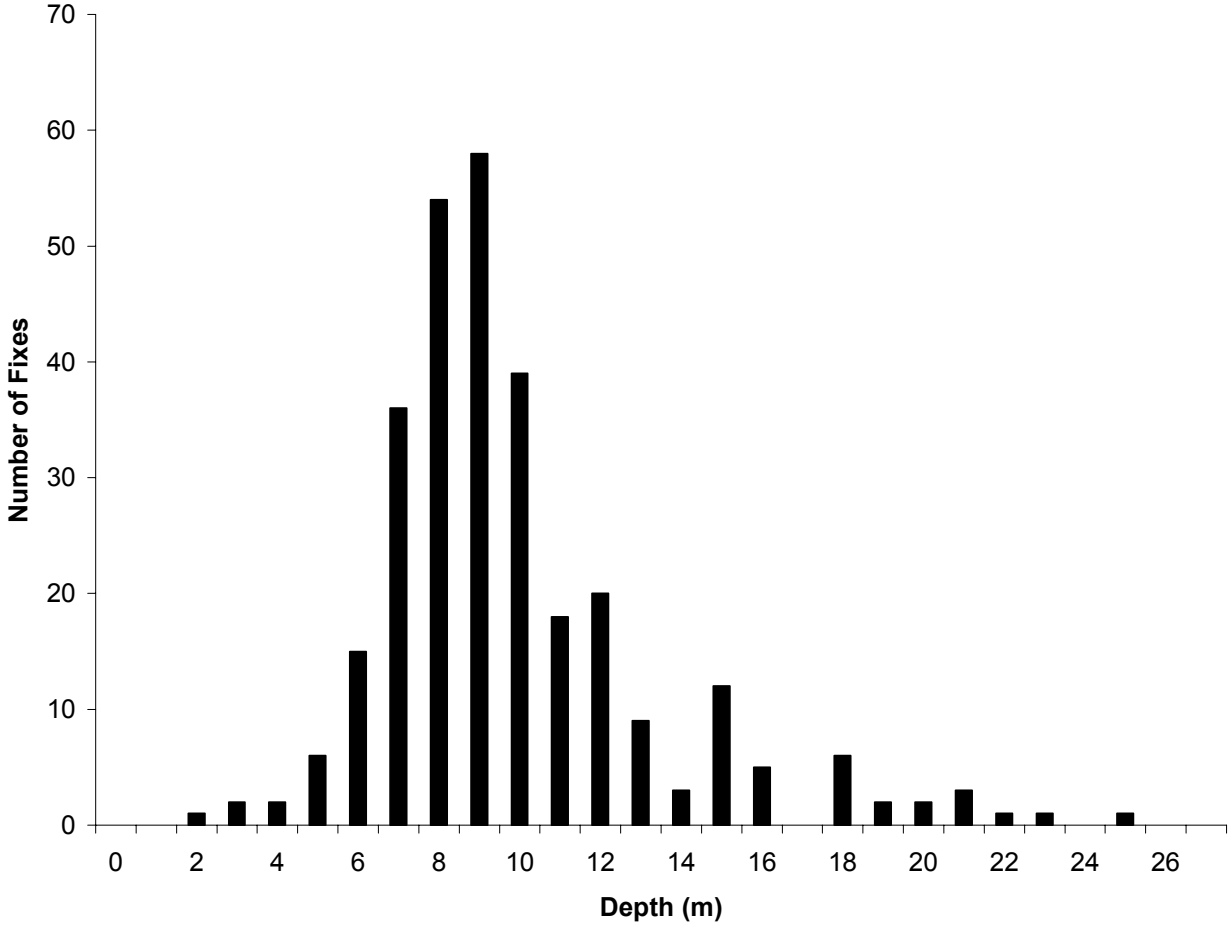

Figure 5. Depth distribution of lake sturgeon caught in the lower Niagara River, 1998-99.

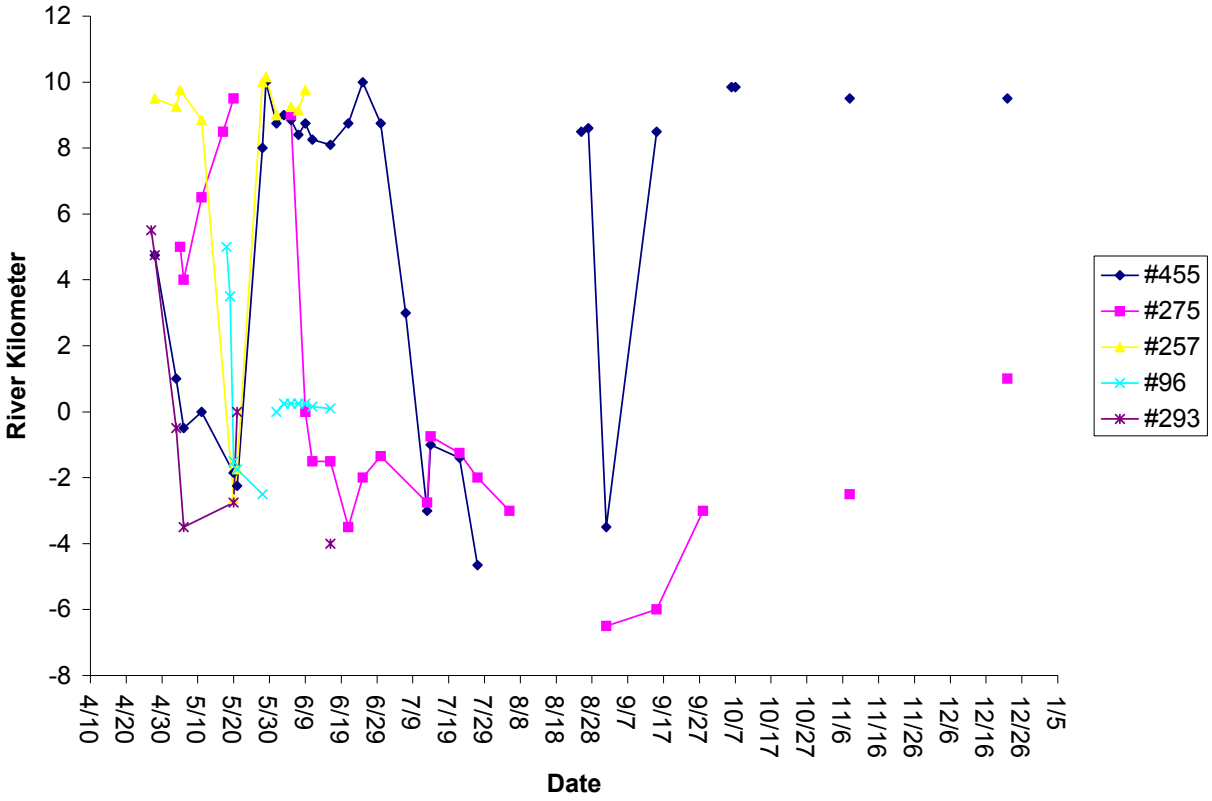

Figure 6. Seasonal movement of five adult lake sturgeon in the lower Niagara River and Lake Ontario. River kilometer zero represents the mouth of the river. Positive river kilometers represent river locations and negative numbers represent lake locations. Disconnected lines indicate when a fish was 'absent' from the tracking area or when the interval between tracking events was greater than 14 days (e.g. we did not rack between 8 November and 22 December).

The substrate composition in 'high use' areas was surveyed using a Ponar dredge. In the eddy environments substrate was made up of silt, sand, and gravel. As flow increased, on the outside of eddies and in the main current, successive dredges collected very little substrate particles. In these areas, the substrate was characterized as hard bottom. The benthic fauna in the eddies consisted primarily of Oligochaetes, Chironomids, Mollusks (Dresseina sp., snails, fingernail clams), and Amphipods. No diet studies have been performed.

Twenty-four hour tracking events occurred on August 31, September 2, and September 3, 1998 to investigate the diel movement of tagged lake sturgeon. Prior to our study, we hypothesized that (1) lake sturgeon may be utilizing deeper waters (> 15 m) during the day then moving into shallow waters (< 10 m) to feed at night; and, (2) some fish may occupy the lake during the day and move into the river at night, particularly at or near its mouth. These suspicions were not confirmed by our sample of ultrasonic tagged fish. In general, fish did not exhibit large-scale movement patterns between day and nighttime hours. However, fish did appear to be more active at night, as indicated by increased localized movements. Unfortunately, we were unable to conduct more 24-hour tracking

with greater sample sizes of fish, so we cannot draw any significant conclusions from the diel movement data.

Genesee River

In a cooperative effort with New York State Department of Environmental Conservation (NYSDEC) Region 8, Avon and Endangered Species, and U.S. Geological Survey, Tunison Laboratory of Aquatic Science, we are determining the habitat suitability for, and the present utilization of lake sturgeon in the Genesee River below Rochester. Our office deployed 10-inch stretch gillnets in the river to catch adult lake sturgeon potentially migrating during the suspected spawning period. In addition, during the summer months (July and August), experimental gillnets were fished to capture young lake sturgeon. No lake sturgeon were caught after 27 gillnet nights of effort (Table 7). According to the HSI for lake sturgeon (Threader et. al. 1998), suitable spawning habitat (0.5-2.5 m depth, 50-240 cm/s velocity, 10-18^{o} C, and boulder/cobble substrate) was found below the lower falls. Sub-optimum juvenile habitat was found in the downstream areas of the river. The Rochester Embayment is listed as an Area of Concern, therefore the effects of chemical contamination on the suitability for lake sturgeon cannot be ignored. However, no water chemical analysis was done in 1999.

Table 7. Lake sturgeon sampling effort in lower Genesee River, 1999.

Method	Total Nights	Total Hours
10" Gillnet	13	287.3
Exp. Gillnet	14	309
All	27	596.3

Oswegatchie River

The Oswegatchie River lake sturgeon project is in cooperation with the New York State Department of Environmental Conservation (NYSDEC) and the State University of New York - College of Environmental Science and Forestry. To determine the success of the restoration effort several objectives were set forth. These included determining the distribution, movement, and habitat utilization of stocked juvenile lake sturgeon in the Oswegatchie River, tributary to the St. Lawrence River at Ogdensburg, NY (Lowie et al. 1999).

Sampling continued to determine downstream distribution of stocked juvenile lake sturgeon at selected sites. Gillnetting was conducted on 15 nights consisting of 50 individual gillnet sets (4 sampling periods, May - Oct.). This yielded 264 lake sturgeon comprised of 5 year classes (24 specimens age not determined). A total of 23 lake sturgeon were captured from the 1999 stocking year class, 45 from the 1998 stocking year class, 127 from the 1997 year class, 44 from the 1996 year class, and 1 lake sturgeon from the 1995 stocking year class. The 23 lake sturgeon from the 1999 stocking year class were captured during the October sampling period and were released from the hatchery less than one month prior. Table 8 shows mean total length for each stocked year class collected in 1998 and 1999.

Movements of 1998 radio tagged lake sturgeon were monitored in 1999, and fish continue to show a pattern of downstream movement. The tagged naturalized lake sturgeon eventually displayed the same pattern as the newly stocked hatchery sturgeon but moved downstream at a much slower rate. As shown in the 1998 data (Lowie et al. 1999), newly stocked lake sturgeon remain in the upper reaches of the sampled area. As lake sturgeon remain in the system, they tend to move to the middle and then downstream reaches of the river. Compared to 1998, a shift in dominant year class composition was obsserved at the four standardized sampling sites. This supports the telemetry data showing the same overall downstream movement of stocked juvenile lake sturgeon.

Table 8. Mean total length of stocked lake sturgeon caught in the Oswegatchie River, 1998 and 1999.

Stocked Year Class	1998 Mean Total Length (mm)	1999 Mean Total Length (mm)
1995	560.9	535
1996	456.5	483.4
1997	271.5	372.1
1998		306.5
1999		252.2

LAKE STURGEON SIGHTING PROGRAM and PUBLIC EDUCATION

Anecdotal information of lake sturgeon sightings has been reported by recreationalists and commercial fishermen since 1994. In 1998, we significantly increased our public outreach efforts. Lake sturgeon 'Sighting Alert' cards were distributed to marinas, bait shops and boat launches; posters were displayed in dive shops; LGLFRO web pages were created; and a 'Sighting Alert' notice was posted in the NY State Fishing Regulations Guide. In each sighting report, participants recorded general information regarding the sturgeon siting (date, time, location, number and size of fish) as well as habitat variables (depth, water temperature, substrate composition, and vegetative abundance). As a result of our increased educational effort, 86 reports of 120 lake sturgeon (in 7 waterbodies) were filed by our office in 1998. In 1999, 77 reports of 119 lake sturgeon (in 16 waterbodies) were recorded. The increase in the number of waterbodies where lake sturgeon were sighted in 1999 is likely due to NYSDEC stocking efforts and increased public awareness. All new waterbodies reported in 1999 have received stocked lake sturgeon either directly into or in adjacent waters over the past three years.

The majority of reports/sightings have been received from the Niagara River. More detailed analysis of this information has provided and continues to provide questions/hypotheses for us to investigate, but also additional opportunities to better assess the populations of the upper and lower river. In 1999, the most substantial observation was the amount of lake sturgeon caught by anglers in the lower river in the fall. In each of 1998 and 1999, over 20 lake sturgeon, primarily 36 inches or less, were caught in a 1.5 to 2 month period.

Also in 1999, we conducted a second mass dive event in the upper Niagara River, the first being held in 1998. Eight boats and a total of 26 divers participated in each dive. The purpose of the "mass dives" was to better identify lake sturgeon distribution and abundance in the river. The "mass dives" provided excellent educational opportunities for the diving community to interact with LGLFRO biologists and learn more about the lake sturgeon. They also allowed LGLFRO biologists to further explore the potential for diver sightings to be used as a method of lake sturgeon population and habitat assessment.

As a member of the Central Great Lakes Bi-National Lake Sturgeon Group, our office participated in filming our lake sturgeon research project for production of a Great Lakes' sturgeon educational video. Specifically, footage was taken of the diving activity, with divers capturing lake sturgeon underwater; gillnetting; and, sonic tracking. Also, footage was taken of the Niagara Falls area and a personal interview with Chris Lowie.

2000

We will further analyze the movement data of our tagged lake sturgeon, looking specifically at any differences that may exist between the different size/maturity classes among several variables (e.g., total distance moved, average distance moved between fixes, and upstream vs. downstream movement between fixes)**.** During the 2000 field season, we plan to focus on monitoring adult individuals by deploying 6 more ultrasonic tags on fish caught in March-May. Daily tracking will occur on all tagged adults found in the study area to identify potential spawning areas. Egg mats will be placed in these suspected areas to confirm spawning. Other tagged lake sturgeon will continue to be monitored for movements and habitat utilization. Additional individuals will continue to be collected to support ongoing collaborative work comparing the age, growth, status, and genetics of Great Lakes lake sturgeon populations. Select anglers will be provided with tool boxes to assist us in collecting biological data from by-caught lake sturgeon. Habitat parameters will also continue to be collected throughout the study. We hope to enhance the diving component of the Niagara River research project.

We will survey for adult, migrating lake sturgeon in the Genesee River as well as collect a second year of habitat data. If no lake sturgeon are found and habitat data appears positive, we likely will implement a cooperative research initiative to stock Niagara River lake sturgeon into the Genesee, and monitor their distribution, survival, growth, and habitat utilization.