Evaluation of Lake Sturgeon Habitat In The Detroit River #GL98105

FINAL REPORT

Prepared For:

USEPA-GLNPO
West Jackson Boulevard
Chicago, IL 60604-3590

Prepared By:

Jerry R. McClain - Co-Project Manager
U.S. Fish & Wildlife Service
Alpena Fishery Resources Office
145 Water Street
Alpena, MI 49707
(517) 356-5102

and

Bruce A. Manny - Co-Project Manager
U.S. Geological Survey
Great Lakes Science Center
1451 Green Road
Ann Arbor, MI 48105
(734) 214-7255

December 21, 2000

Abstract

In 1999, we gathered preliminary information on the current status of reputed spawning sites of lake sturgeon *Acipenser fulvescens* in the Detroit River, determined if those sites still possesses the physical integrity needed to support spawning activity, and evaluated the extent that they are being utilized by sturgeon. To assess the population structure of lake sturgeon in the Detroit River, we caught, marked, and released sturgeon in the river using set-lines deployed on and near reputed spawning grounds. Examination of fin-ray data from these fish revealed that lake sturgeon captured in the Detroit River in 1999 were largely non-spawning, sub-adult and adult, 7-38 years old. Preliminary analysis of project water temperature data revealed that optimal water temperatures for spawning by lake sturgeon in the St. Clair River (13°C) occurred in the Detroit River before the field sampling was fully implemented. In 1999, water in the Detroit River warmed up to the preferred temperature for spawning by lake sturgeon about four weeks before water in the lower St. Clair River reached that temperature. Ideally, future research on lake sturgeon and their habitats in the Detroit River would be pursued in spring as the water warms up and before aquatic macrophytes begin to grow.

We examined 7 reputed sites and two other sites identified to us by fishermen using side scan sonar (SSS) and a remotely operated vehicle (ROV) equipped with an underwater video camera. We found that 2 of the reputed spawning sites (Grassy Island and Sugar Island-South) were theoretically suitable for spawning by lake sturgeon from a physical standpoint because they possess patches in excess of 9 square meters of clean rock-on-rock substrate with adequate (>5 cm) interstitial space, and adequate water current velocity (>0.5 m/sec), physical conditions measured by others elsewhere in the Great Lakes basin where sturgeon spawn and reproduce successfully. Four sites (Peche Island, Fighting Island, Banta Park, and Sugar Island-North) were less suitable due to a lack of hard substrate with adequate interstitial spaces, and two (Sturgeon Bar and Gibraltar Bay) were presently unsuitable for reproduction, due to inadequate water depth and flow velocity caused by low water levels.

Introduction

Over-exploitation and habitat loss, degradation and fragmentation have contributed to decline of lake sturgeon *Acipenser fulvescens* to levels requiring listing as Threatened by 19 of 20 states in its original range (Auer 1991). They are identified as a species of concern by the U.S. Fish and Wildlife Service and are recognized as a "globally rare" Great Lakes fish species by The Nature Conservancy (1994). 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 microhabitats 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.

In recent years, interest in the trends and status of lake sturgeon in the Great Lakes basin has been increasing for all natural resource agencies involved in fisheries management (Auer 1991; Krueger et al. 1995; McClain 1997a). Interagency collaboration for status and trends surveys in many Great Lakes waters between Lake Huron and the St. Lawrence River has been attempted through an ad hoc group of

resource managers since 1996 (McClain 1997b, Hill and McClain 1999). These efforts have been accomplished by expanding surveys and data collection in waters where assessment or commercial fisheries for other species routinely occurs. Unfortunately, no such effort has been directed at the Detroit River.

This study was undertaken in the Detroit River to examine 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.

Methods

Assessment fishing. 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 on a regular basis. A total of four lifts of setlines, two each in weeks 4 and 5, were made at the Peche Island site to provide coverage at all seven historical lake sturgeon spawning sites. 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 in 1997, it appears that depositional zones are effective assessment fishing sites prior to spawning (M. Thomas, Michigan DNR, personal communication). In an attempt to expand the search for additional spawning or feeding sites in the Detroit River, effort was applied throughout the field season on a roving basis to new locations. The additional effort was in conjunction with examination of historical sites and was assisted by anecdotal reports from local recreational fishers who encounter lake sturgeon in targeted fisheries or as by-catch in traditional sport fisheries.

An attempt was made to sample each of the six historical sites for the presence of lake sturgeon weekly from May 1 through June 30 to cover the anticipated spawning period. Sampling was confined to water depths of 3 meters or greater. The Sturgeon Bar site was eliminated as a sampling site when it was determined that habitat alteration and current low water levels in that region of the Detroit River no longer provides depth or flow considered minimal for lake sturgeon spawning. Therefore, only five of the six sites listed in Table 1 were routinely sampled.

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’

Fish collection and tagging. Setlines were fished three to four days per week from May through July 1998 and consisted of a minimum of one over-night set at each site per week (Table 2). Set-line configuration was similar to that used by Thomas and Haas (1999) in the St. Clair River and consists of 92 meter mother-lines (1 cm nylon line) with 25, size 4 (10/0), baited hooks suspended by 46 cm lengths of #36 tarred nylon twine (“snews”). The “snews” were attached to the mother-line with a net snap and swivel for easy attachment and removal. 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 for gobies by lake sturgeon in the St. Clair River. Each end of the setline was anchored with a 5.5 kg trap net anchor marked with a 119 cm circular float at the surface.

Table 2. Summary of lake sturgeon sampling schedule, by week, and gear used in the Detroit River, 1999.

WEEK	DATE	SET-LINES	GILL NETS	ELECTRO-FISHING	SEINE	BEAM TRAWL
1	April 26 –30	X				
2	May 3-7	X				
3	May 10 – 14	X				
4	May 17 – 21	X				
5	May 24 – 28	X				
6	May 31 – June 4	X				
7	June 7 – 11	X				
8	June 14 – 18		X			
9	June 21 – 25		X			
10	June 28 – July 2				X	X
11	July 5 – 9					
12	July 12 – 16	X	X			
13	July 19 – 23			X	X	
14	July 26 – 30					
15	August 2 – 6					
16	August 9 – 13					
17	August 16 – 20					
18	August 23 – 27		X			
19	August 30 – September 3					
20	September 6 – 10					
21	September 13 – 17					
22	September 20 – 24					
23	September 27 – October 1					
24	October 4 – 8					
25	October 11 – 15					
26	October 18 – 22	X				

A total of 24 overnight gill net sets were made between June 16 and August 23, 1999 (Table 2). Single, 33 m nets of 15 cm stretch mesh multi-filament nylon were fished June 16 – June 21. Eighteen (18) overnight sets with 66 m gangs consisting of 33 m panels of 5 cm and 6.4 cm monofilament gill nets were fished June 21 – August 23, 1999. Gill net effort was employed to target for juvenile and sub-adult lake sturgeon in waters consistent with habitat characteristics described by Kempinger (1996). On August 23, 20 cm stretch monofilament gill nets were fished to test the efficacy of this gear type for collection of adult fish in the Detroit River. Large mesh (>20 cm stretch mesh) gill nets have been shown to be very effective in similar habitats on the Manistee River system (D. Peterson, Central Michigan University, personal communication). All gill nets were set diagonal to the channel to minimize effects of current and drifting debris.

Three sites that closely resembled the shallow, sandy, nursery habitat used by age-0 lake sturgeon in the Lake Winnebago system in Wisconsin (Kempinger 1998; 1996) were described to us by local sport fishers that had captured juvenile lake sturgeon at those sites in previous years. These sites, in conjunction with other potential juvenile microhabitats, were surveyed in June and July 1999 with a 5.5-m aluminum electrofishing boat (Kahn), a 3.6-m beam trawl deployed from an 8.5-m, outboard vessel, and/or a 23-m beach seine (1-m deep, 3-mm mesh, equipped with a center bag). A total of 238 minutes of daytime electrofishing was conducted July 19-21 with 340 V pulse DC at thirteen sites in the lower Detroit River. Sites electrofished included shallows near or adjacent to referenced spawning sites and in areas where young-of-the-year (YOY) lake sturgeon have been reported by residents. The beam trawl was deployed seven times in Gibraltar Bay at the southern end of Grosse Ile in beds of submersed aquatic macrophytes adjacent to a reputed spawning site, and where local fishers have reported catching sub-adult lake sturgeon as by-catch in recreational fisheries. Fish and aquatic macrophytes collected in each 5-10 minute trawl were sorted, identified to species, and recorded on a field data sheet. The beach seine was deployed 5-10 times in waist-deep waters largely or entirely free of submersed aquatic macrophytes along the sandy southern shore of Gilbraltar Bay and the eastern shore of Sugar Island on July 2 and July 19-21, 1999.

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 or sarcosy tissue preservative 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. Tags were affixed to the musculature at the base of the dorsal fin. By-catch of other fish was identified and recorded for each set.

Limnological data were collected at each location where fishery assessment gear was deployed, including air temperature (by stem thermometer), temperature and dissolved oxygen concentration of surface and bottom waters (by YSI dissolved oxygen meter), water depth and velocity (by Marsh McBirney Model 201 water current meter on metered line), and incident light (by Protomatic 4-phi light meter). Incident light measured 10 cm above the bottom of the water column was expressed as a percentage of that measured concurrently 10 cm below the water surface to assess relative light penetration.

Water depth was recorded at each end of the setline to help determine the bottom contour at the site. Temperatures, dissolved oxygen and coordinates were recorded at the mid-point between the two ends of the line and was used to define the parameters for the site. Depth was recorded with an Eagle Accura Sonar and latitude/longitude were recorded with a Trimble Model ProXR global positioning system (GPS) unit.

Habitat surveys. The location of seven reputed lake sturgeon spawning sites in the Detroit River was determined by reference to Goodyear et al. (1982). Two additional sites, Gibraltar Bay beneath a bridge from Elba Island to Meso Island which was reported to us by a local sport fisher, and Banta Park north of Stony Island where roving set-line fishing captured lake sturgeon, were investigated as potential spawning

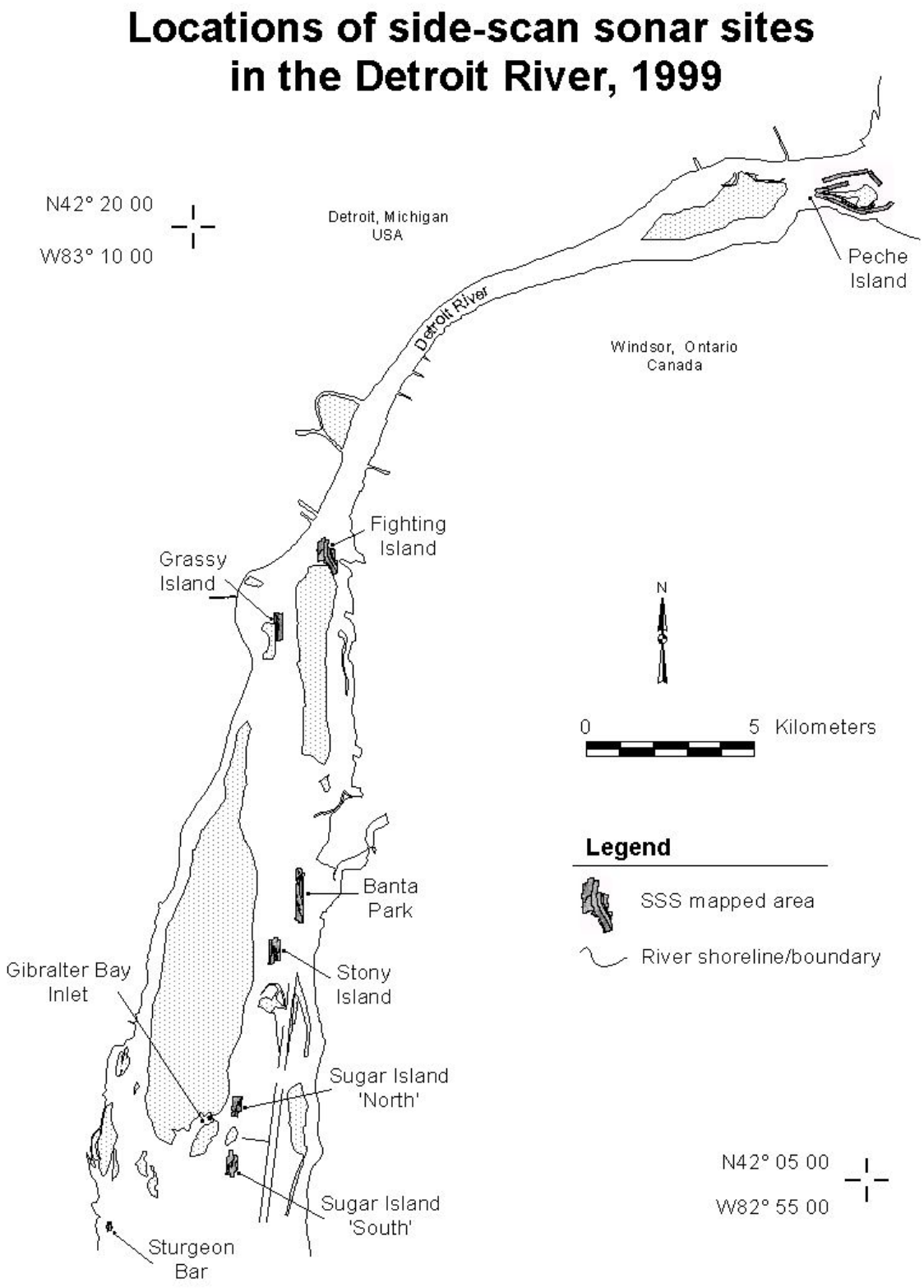

Figure 1. Location of seven historically referenced and 2 reported sites of potential lake sturgeon spawning investigated through fishery survey and side-scan sonar in the Detroit River, 1999.

sites. The locations of the 7 reputed and two 2 reported sites are shown on the map of the Detroit River (Figure 1). The site name "Banta Park" is derived from its location, one half mile directly west of a clearly visible white building in the Walter Banta Memorial Park on the Canadian shoreline.

Each of the nine sites was surveyed with up to 7 parallel, overlapping transects in July and August 1999 using side-scan sonar (SSS; EG&G International, Model 260 image-correcting microprocessor, Model 360 digital tape recorder, and Model 272-T 100 kHz towfish with time-varied gain) and a remotely operated vehicle (ROV; Benthos, Inc., MiniROVER MK II, equipped with a high-resolution, color, video camera) following procedures in Edsall et al. (1997).

No video coverage could be made at the Gibraltar Bay site because shallow water and abundant macrophyte growth prevented safe deployment of the camera. Strip-chart data from the SSS was used to illustrate the areal extent of different substrate zones. Further data about the substrate arrangement, water depth, water velocity, degree of silting, and amount of interstitial space in the substrate was derived from analysis of images recorded on three video tapes made of the bottom at all sites with the ROV, except the Sugar Island-South site. At that site, camera coverage did not coincide with sonar coverage and could not be used for the more detailed analysis. Video tape interpretation forms included the site, date, dive number, water depth, minutes of video coverage, start and stop video times, percentage of 6 bottom types, arrangement of 6 bottom types relative to each other, percentage of bottom covered by aquatic plants, aquatic plant species seen, exotic species seen, fish seen, light penetration, water velocity, degree of siltation, and date of video interpretation and interpreter (Appendix 1). Aquatic plants were identified by reference to Schloesser (1986). Results of the side scan and underwater video images were expressed as a table of general characteristics (size, area, and amount of video coverage) of the eight sites surveyed, maps of the river bottom substrates at each site, and descriptions of the river bottom at each site. Bottom substrates were judged by us to be "suitable" for spawning by lake sturgeon, on the subjective bases that they consisted of rock (large gravel, cobble, or boulders) resting on one or more layers of rock on the clay or sand river bottom, were clean and free of fine silts by water currents. All estimates of the depth of interstitial space at surveyed sites in this report are subjective estimates deduced from examination of video tape records of the river bottom.

Results

Assessment fishing. A total of 54 one-night sets was 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. The sixth site, Sturgeon Bar, was too shallow and did not contain physical habitat characteristics considered essential for spawning lake sturgeon, therefore no lake sturgeon sampling was conducted at that site. Two lake sturgeon were captured near Fighting Island (Table 3) 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 referenced 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 Banta Park 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 3). No age structures were taken from the two largest fish from this location but 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 was related to feeding activity rather than spawning.

Table 3. Data summary for lake sturgeon captured with setlines in the Detroit River, 1999.

Date	Site	Latitude	Longitude	Depth (m)	T.L. (cm)	F.L. (cm)	Girth (cm)	Weight (kg)	Age	Tag #
5/4/99	Fighting Is	42° 11.63	83° 06.56	13.5	149	141	68	31		4457
5/6/99	Banta Park	42° 09.19	83° 07.27	8.3	157	146	60	23		4472
5/12/99	Banta Park	42° 09.06	83° 07.48	7.1	153	143	59	22		4459
5/13/99	Banta Park	42° 09.03	83° 07.47	7.1	93	85	35	4	10	4602
5/18/99	Banta Park	42° 09.18	83° 07.36	9.0	99	91	40	7	8	4610
5/26/99	Fighting Is.	42° 14.63	83° 06.79	9.8	174	161	71	44	38	4469
5/27/99	Banta Park	42° 09.19	83° 07.31	9.1	124	113	47	15	15	4464
6/11/99	Banta Park	42° 09.12	83° 07.33	7.6	118	106	11		13	4613
10/21/99	Turkey Is.	42° 11.34	83° 06.53	9.5	96	88	32	5	7	4463
10/21/99	Banta Park	42° 08.96	83° 07.25	6.3	94	84	34	5	7	4466
10/22/99	Turkey Is.	42° 11.34	83° 06.53	9.5	116	107	40	7	10	4460

Three additional lake sturgeon were captured with 8 overnight setline sets at the Fighting Island, Banta Park and Turkey Island sites in October 1999 (Table 3). The fall sampling, although not a part of the spawning survey outlined in this study plan, 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 in the Detroit River.

Overall, a total of 11 lake sturgeon were captured with setlines fished in the lower Detroit River, May-October 1999. 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. Lake sturgeon have been reported as spawning from late April through mid-May throughout their range. Spawning has been reported at temperatures ranging from 8.3 –23.3° C with most reports in the 12.5 – 17.8° C range (Harkness & Dymond 1961; Kempinger 1988; Slade and Rose 1994). In 1997, water temperature at peak spawning in the St. Clair River was 13.2° C. This same population began spawning at 13° C in 1998 (Haas and Thomas 1999). If St. Clair River lake sturgeon spawning temperatures are indicative of the event in the Detroit River, it is likely that spawning would have occurred in late April or early May in 1999 (Figure 2). Only during week 1 of the study (April 26-30) was the mean water temperature below that reported as peak spawning

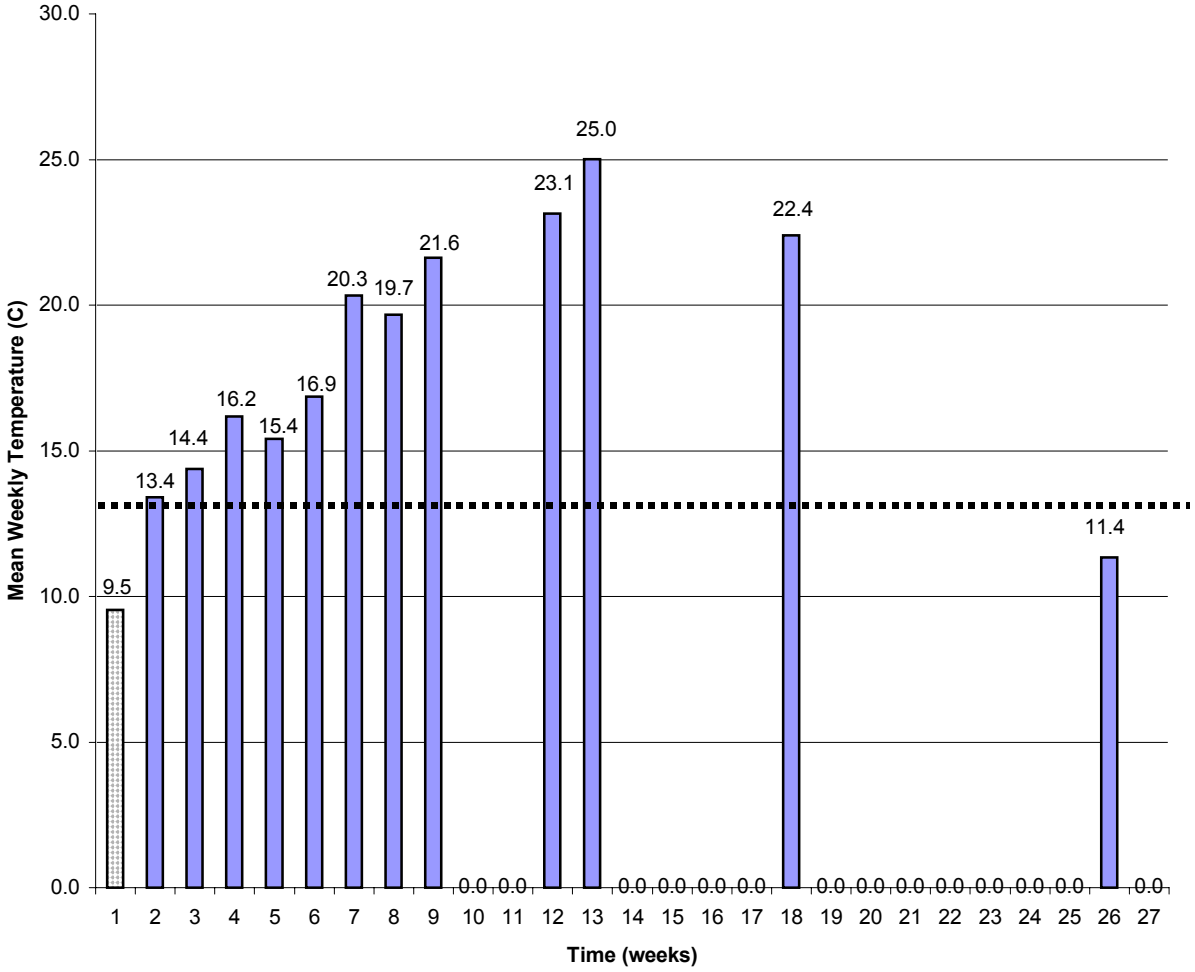

Figure 2. Mean weekly water temperature, calculated as mean temperature recorded for all sites sampled during the respective weeks in Detroit River, 1999. Broken line represents peak lake sturgeon spawning temperature in 1997 and 1998 as reported in the St. Clair River by Haas and Thomas (1999).

temperature in the St. Clair River. Divers monitoring lake sturgeon spawning at the St. Clair River site indicate that the actual spawning occurs over a one to two day period (Nichols, et al. 2000). Breaching, normally observed near spawning aggregations of lake sturgeon in other Great Lakes waters, was documented in a few cases in early May and may indicate that spawning was occurring near our sample sites, but not documented by the fish captured. It is probable that our sampling period started too late in 1999 to provide an accurate assessment of the pre-spawning and spawning populations in this region of the Detroit River.

No lake sturgeon were captured with gill nets, electrofishing or seine. Proliferation of aquatic macrophytes in the sample areas greatly diminished the effectiveness of all sampling gear after mid-June. Recreational and commercial boat traffic dislodged tremendous amounts of macrophytes that become suspended and drifted with the river currents. Gill nets, as well as set-lines, quickly became loaded with macrophytes that rendered them unfishable.

During the study, air temperatures exceeded water temperatures by 3°C on average and the temperature of surface water exceeded that of bottom water by an average of 0.4°C (Appendix 2). Air and water temperature increased in response to seasonal warming from lowest values in April (10 and 9°C, respectively) to highest values in July (30.0 and 26.0°C respectively). Water depths where we fished for sturgeon varied from 10 cm where we beach seined, to set lines in depths up to 6.6 m (Appendix 2). The water depth of our fishing efforts averaged 2.2 m. Incident light approached full sun (4000 ft-candles) just below the water surface and averaged 17% (range: 7-30%) of surface values 10 cm off the river bottom (Appendix 2). Light penetration at six stations where sturgeon were seen or caught was higher on average (20.5%; range: 14-25%) than the mean percentage of light penetration at all stations fished. Dissolved oxygen concentrations (mean 8.3 mg/L; range: 7.4-10.5 mg/L) were at or above saturation (100-120% saturated; using Dobson 1967) in a few sampling locations; below saturation (75-100% saturated) at all sampling stations in main channels of the river; and lowest in saturation (73%) at the station of lowest concentration in Gibraltar Bay on June 21, 1999 in mid-afternoon (Appendix 2). Water velocity near the river bottom exceeded 0.3 m/sec at seven sampling stations and averaged 0.21 m/sec, all stations combined (Appendix 2).

Area of the sites surveyed with sonar varied from 3-23 ha and covered a total area of 226 ha, all sites combined (Table 4). Video coverage of the bottom at the 9 sites surveyed with SSS varied from 7 to 61 minutes and 1-5 camera transects per site (Appendix 3). Water depth varied from 0.3-1.5 m at Sturgeon Bar to 5-10 m at Grassy Island in the Wyandotte National Wildlife Refuge. Bottom type at all sites was either clay or sand, overlain by varying amounts of shell, gravel, cobble, and boulders. "Suitable" rock on rock substrate in patches of 9 square meters or more, that we estimated to possess 5 cm or more of interstitial space was absent to scarce at five sites (Peche Island-Southwest, Peche Island-Northwest, Fighting Island, Banta Park, and Sugar Island-North), present but impaired by lack of water depth, abundant plant growth, or high siltation rates at two sites (Sturgeon Bar, and Gibraltar Bay); and present in adequate amounts and suitable conditions for successful spawning at two sites (Grassy Island and Sugar Island-South). Where rock on rock was present, the arrangement of bottoms types on the river bottom was most suitable (in decreasing order of estimated amount and interstitial depth) at Grassy Island (15-50%), Sturgeon Bar (35-40%), and Sugar Island-South (2-10%). Coverage of the river bottom by aquatic macrophytes was inversely proportional to water depth and varied from least at Peche Island (1%) to most at Sturgeon Bar (75-100%). Plant abundance obscured much of the river bottom also at Sugar Island-North (50%), close to the shoreline of Grassy Island (50%), and at Banta Park (10%). Water velocity was estimated to be high at four sites (Sugar Island-South, Sugar Island-North, Fighting Island, and Grassy Island), medium at one site (Peche Island-Southwest), and low at three sites (Banta Park, Sturgeon Bar, and Peche Island-Northeast). Siltation was estimated to be high and an impediment to spawning at three sites (Banta Park, Peche Island-Southwest, and Peche Island-Northeast). Vegetation identified during interpretation of video tapes of reputed and reported spawning sites of lake sturgeon was, in decreasing order of abundance, wild celery (*Vallisneria Americana*), narrow-leaf pond weed (*Potomogeton* spp.), clasping-leaf pondweed (*Potomogeton richardsonii*), naiad (*Najas flexilis*), and musk grass (*Chara* sp.). Because no preference for aquatic vegetation by lake sturgeon was found, aquatic plants we identified and recorded as present on the study sites were not weighed or investigated in detail. Overall, the condition of two sites was judged from examination of video coverage to be suitable for spawning by lake sturgeon in 1999: Sugar Island-South and Grassy Island.

Table 4. General characteristics (Name, Location, Area in hectares) of nine sites in the Detroit River surveyed in 1999 using side-scan sonar and an underwater camera. Sites listed in order from north to south.

Site Name	Site Location	Area (ha)
Peche Island	Head of river	75
Fighting Island	Northeast corner	36
Grassy Island	Northeast corner	16
Banta Park	Southwest of Turkey Island	33
Stony Island	North side/Ballards Reef	21
Sugar Island	North side	14
Sugar Island	Southeast side	19
Gibraltar Bay	Southern Grosse Ile	3
Sturgeon Bar	East side	9
Total:		226

Relative substrate classifications derived from the examination of SSS records of each of the nine sites varied from 1 to 4 zones (Appendix 4). Least varied was the substrate at Sturgeon Bar (one zone). Substrates at Peche Island and Grassy Island were the most varied (4 zones). Most of the river bottom in deep channels of fast moving water was featureless hard-pan clay devoid of plants. Plants were found growing on the bottom at Fighting Island to water depths of 5.8 m (Appendix 4).

Discussion

Although assessment fishing was conducted at numerous locations in the lower Detroit River, including sites listed as historical spawning sites, only 8 fish were captured during what we would normally consider the "spawning season". Review of water temperature data indicates that temperatures considered optimal for spawning in the St. Clair River were reached and exceeded very early in the sampling season and it is very possible we missed any spawning activity that occurred in 1999. Proliferation of aquatic macrophytes diminished the effectiveness of the sampling gear as well. The fact that the 1999 project focused on attempts to document lake sturgeon spawning at historically referenced sites resulted in continual sampling in areas that may not hold fish for much of the open water season, if at all. Future efforts to locate spawning populations of lake sturgeon in the Detroit River should start as soon after ice out as possible to investigate the most probably spawning sites before water temperatures exceed 12 C. The results of this preliminary investigation represent only a quick "snapshot" of conditions in the Detroit River and should only be considered a beginning. The fact that no data existed prior to the initiation of this study provided very little in the way of guidance for locating appropriate sampling stations.

The small difference in the temperature of surface and bottom waters on each sampling date indicates that water throughout the water column at each of our sampling sites was well mixed. At all sampling stations, dissolved oxygen concentrations exceeded the minimum standard for protection of aquatic life, including "good fish populations" (Davis et al. 1979). Water velocity at all setline stations, including those where lake sturgeon were caught, were below 0.5 m/sec and may be marginal for lake sturgeon spawning. The low water velocities we measured were partly a consequence of low water levels that prevailed throughout 1999 in the Detroit River.

Coverage by sonar and camera were adequate at all sites but one (Sugar Island-South). At all other sites, sonar and camera coverage were adequate to characterize the extent and suitability of spawning substrate and the classes of substrate present.

Substrates that appeared to be most suitable for spawning by lake sturgeon at sites we surveyed included patches of at least 9 square meters, of at least two layers of clean, rock (gravel, cobble, or boulders) on rock, possessing at least 5 cm of interstitial space. Little of the Detroit River bottom included such substrate at the sites we surveyed in 1999. Only substrates at Grassy Island and Sugar Island-South sites possessed the physical integrity needed to support spawning activity by lake sturgeon. Determination of the extent and depth of such patchy substrate at these best sites was made more difficult by the rapid rate with which the underwater camera traversed the bottom there.

Continuing gaps in our knowledge of Detroit River lake sturgeon include; 1) numbers of fish present in the river when water temperatures reach the theoretical optimum, 2) where adult sturgeon spawn in the river, if it is occurring and, 3) whether sites other than those reported in the scientific literature or reported to us are used presently for spawning by lake sturgeon in the river. These and other information gaps need to be addressed to develop a successful restoration plan for lake sturgeon and their essential habitats in the Detroit River.

Acknowledgements

We wish to thank the many volunteers who assisted us with much of the field work, including members of the Downriver Walleye Federation. Special thanks to Mr. Jim Johnson and Mr. Rudy Gashin, residents of Grosse Ile who provided valuable insight on locations where sport fishers routinely catch lake sturgeon and allowed us to moor our boats at their residences periodically during the field season. Thanks to Mike Downs and Meade McCoy of our staffs who spent much of the summer, in all weather conditions, trying to locate lake sturgeon through the fishery assessment portion of this study.

Most importantly, funding support by the U.S. Environmental Protection Agency - Great Lakes National Program Office made the work possible and is greatly appreciated by the investigators.

Literature Cited

Auer, N.A. 1991. Conservation of the threatened lake sturgeon. Mich. Dept. Nat. Resour., Nongame Wildl. Fund and Living Resour. Small Grants Prog. Final Rep. 23p.

Davis, J.C., G.I. Bresnick, P.Doudoroff, T.R. Doyle, A.J. Mearns, J.B. Pearce, J.J. Peterka, J.H. Robinson, and D.L. Swanson. 1979. Dissolved Oxygen. Pp. 169-174 *In*: A review of the EPA Red Book: Quality criteria for water. R.V. Thurston, R.C. Russo, C.M. Fetterolf, Jr., T.A. Edsall, and Y.M. Barber, Jr. (Eds.) Water Quality Section, American Fisheries Society, Bethesda, MD.

Dobson, H.H. 1967. Principle ions and dissolved oxygen in Lake Ontario. Proc. 10th Conf. Great Lakes Res., International Assoc. Great Lakes Res., Ann Arbor, MI 1967. pp. 337-356.

Edsall, T.A. T.E. Behrendt, G. Cholwek, J.W. Frey, G.W. Kennedy, and S.B. Smith. 1997. Use of remote-sensing techniques to survey the physical habitat of large rivers. U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, MI. Contribution No. 983. 20 pp.

Goodyear, C.S., T.A. Edsall, D.M. Ormsby Dempsey, G.E. Moss, and P.E. Polanski. 1982. Atlas of the spawning and nursery areas of the Great Lakes fishes. Volume 8: Detroit River. U.S. Fish and Wildlife Service, Washington, D.C. FWS/OBS.82/52.

Haas, R. and M. Thomas. 1999. St. Clair waterway, p. 27-33. *In* Hill, T.D. and J.R. McClain [eds.] Activities of the Central Great Lakes Bi-National Lake Sturgeon Group in 1997 and 1998. Alpena Fishery Resources Office, Alpena, Michigan. 63 p.

Harkness, W.J.K. and J.R. Dymond. 1961. The lake sturgeon. Ontario Department of Lands and Forests, Toronto, Ontario.

Hill, T.D. and J.R. McClain [Eds.]. 1999. Activities of the Central Great Lakes Bi-National Lake Sturgeon Group in 1997-1998. Alpena Fishery Resources Office, Alpena, Michigan. 63 p.

Kempinger, J.J. 1988. Spawning and early life history of lake sturgeon in the Lake Winnebago system, Wisconsin. Am. Fish. Soc. Symposium 5:110-122.

_____. 1996. Habitat, growth, and food of young lake sturgeons in the Lake Winnebago system, Wisconsin. N. Am. J. Fish . Manag. 16: 102-114.

Krueger, K.M., K.S. Schrouder, J.P. Baker, M.P. Ebener, J.R. McClain. 1995. Status of cool-water fishes in 1992, p. 73-86. *In* M.P. Ebener[ed.] The state of Lake Huron in 1992. Great Lakes Fish. Comm. Spec. Pub. 95-2.

McClain, J.R. 1997(a). Preliminary evaluation of the current status of lake sturgeon (*Acipenser fulvescens*) in Michigan waters of Lake Huron – Progress Report for 1995 and 1996. Alpena Fishery Resources Office, Alpena, Michigan. 8 p.

_____. 1997(b) [Ed.]. Summary of 1996 activities of the Interbasin Lake Sturgeon Work Group in waters of Lake Huron, St. Clair and Erie. Alpena Fishery Resources Office, Alpena, Michigan. 10 p.

Nature Conservancy. 1994. The conservation of biological diversity in the Great Lakes Ecosystem: issues and opportunities. The Nature Conservancy, Chicago, Illinois.

Nichols, S.J., J. French III, G. Kennedy, G. Black, J. Allen, E. Crawford, M. Blouin, J. Hickey, and S. Chernyak. 2000. Threats to the recovery of lake sturgeon (*Acipenser fulvescens*) in the lower St. Clair River, U.S. Geological Survey, Great Lakes Science Center, Ann Arbor, Mich. Unpubl. MS. 39pp.

Porter, B., T. Cavendar, P. Fuerst, and T. Nickell. 1995. The genetic status of lake sturgeon in Lake Erie and other populations in the Laurentian Great Lakes. Ohio Department of Natural Resources, Fish Division, Museum of Zoology, Columbus, OH 43224-1329, Contribution No. 1, 45pp.

Schloesser, D.W. 1986. A field guide to valuable underwater aquatic plants of the Great Lakes. Michigan State University, Cooperative Extension Service, East Lansing, MI. Extension Bulletin E-1902, 32 pp.

Slade, J.W. and J.D. Rose. 1994. Population characteristics of Bad River lake sturgeon. USFWS, Fishery Resources Office, Ashland, Wisconsin. 23 p.

Thomas, M.V. and R.C. Haas. 1999. Capture of lake sturgeon with setlines in the St. Clair River, Michigan. North American Journal of Fisheries Management 19:610-612.

Appendix 1. Example video tape interpretation form used in this research.

VIDEO TAPE INTERPRETATION FORM

Site: Date: Dive: Water Depth:

Start time: Stop Time: Minutes of video coverage:

Bottom Type (%): Clay Sand Gravel Cobble Boulder Shell

Arrangement
Of Bottom Types Clay Sand Gravel Cobble Boulder Shell

On: Clay _____
Sand _____
Gravel _____
Cobble _____
Boulder _____
Shell _____

Amount of bottom at site covered by rock on rock spawning substrate (%):

Position (Video time) of best spawning substrate observed:

Percent of bottom at site covered by plant growth (%):

Plant Species present (%)

Other biota seen: Exotic species: Fish:

Light penetration: High: Medium: Low:

Water velocity: High: Medium: Low:

Degree of siltation: High Medium Low

Condition of spawning substrate: Suitable Partly impaired Impaired

Notes:

Interpreter: Date interpreted:

Appendix 2. Abiotic data collected at set line (SL) and gill net (GN) fishing stations in the Detroit River, 1999. ND means not determined.

Station Location	Date/ Time	Temperature (°C) Air	Water Surface	Water Bottom	Water Depth (m)	Light (footcandles) Water Surface	Water Bottom	% Penetra.	Dissolved Oxygen (mg/L)	Water Velocity (m/sec)
SL1 Sugar Isl.	04/27/1999 9:15	10.0	9.0	8.9	5.3	1000	200	20	ND	ND
SL2 Stony Isl.	04/27/1999 10:08	10.0	9.2	9.3	3.4	2000	500	25	ND	ND
SL3 Grassy Isl.	04/27/1999 12:20	12.0	9.1	9.0	6.6	3000	400	13	ND	ND
SL4 Sturgeon Bar	04/27/1999 13:30	15.0	10.0	10.0	3.8	4000	700	18	ND	ND
SL3 Grassy Isl.	04/28/1999 9:13	9.6	9.1	9.0	2.9	1500	100	7	ND	0.4
SL2 Stony Isl.	04/28/1999 11:00	10.0	9.2	9.3	2.6	2000	450	22	ND	0.2
SL1 Sugar Isl.	04/28/1999 11:40	10.0	9.1	9.1	4.9	2500	500	20	ND	0.2
SL5 Sugar Isl.	04/28/1999 13:40	13.2	9.9	9.9	1.9	3500	450	13	ND	0.2
SL4 Sturgeon Bar	04/28/1999 14:15	14.0	10.9	10.9	2.9	3000	600	20	ND	0.1
SL4 Sturgeon Bar	04/29/1999 9:00	11.0	10.2	10.3	2.7	1500	400	27	ND	0.1
SL5 Sugar Isl.	04/29/1999 9:35	11.0	9.8	9.8	2.0	3000	650	22	ND	0.2
SL2 Stony Isl.	04/29/1999 10:15	13.0	10.0	10.0	2.3	2500	650	26	ND	0.2
SL1 Sugar Isl.	04/29/1999 10:48	13.0	9.7	9.6	2.7	3000	650	22	ND	0.2
SL6 Fighting Isl.-SE	05/04/1999 9:35	16.0	13.5	13.5	2.7	2500	600	24	ND	0.1
SL7 Fighting Isl.-N	05/04/1999 10:30	18.0	13.1	13.0	0.7	3000	600	20	ND	0.2

SL8	05/04/1999	18.0	13.6	13.5	2.0	3000	600	20	ND	0.2
Fighting Isl.-E	10:57									
SL9	05/04/1999	18.0	13.8	13.6	0.8	3500	650	18	ND	0.1
Powderhouse Isl.	13:06									
SL10	05/04/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Powderhouse Isl.-S	10:38									
SL11	05/04/1999	18.0	14.1	13.5	ND	3500	550	17	ND	0.2
Powderhouse Isl.-S	13:47									
SL12	05/04/1999	18.0	14.0	13.7	2.1	3500	500	14	ND	0.5
Banta Park	14:13									
SL13	05/05/1999	18.0	13.6	13.5	2.0	500	125	25	ND	0.1
Fighting Isl.-E	13:23									
SL14	05/05/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fighting Isl.-E	13:42									
SL15	05/05/1999	18.0	13.9	13.6	2.8	1000	200	20	ND	0.1
Fighting Isl.-E	13:55									
SL16	05/05/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fighting Isl.-E										
SL17	05/05/1999	18.0	14.0	13.8	1.8	1000	150	15	ND	0.2
Stony Isl.-N	14:23									
SL18	05/05/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Banta Park-N	14:37									
SL19	05/05/1999	18.0	13.9	13.8	1.7	5000	750	15	ND	0.1
Powderhouse Isl.-S	14:52									
SL20	05/05/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sugar Isl.-N										
SL14	05/06/1999	17.0	13.3	13.3	ND	ND	ND	ND	ND	ND
Fighting Isl.-E										
SL16	05/06/1999	17.0	13.5	13.4	ND	ND	ND	ND	ND	ND
Fighting Isl.-E	9:15									
SL 18	05/06/1999	17.0	13.4	13.3	ND	ND	ND	ND	ND	ND
Banta Park-N	9:40									
SL 20	05/06/1999	ND	13.7	13.7	ND	ND	ND	ND	ND	ND
Sugar Isl.-N	10:18									
SL 21	05/10/1999	18.0	14.4	14.2	2.9	3800	700	18	9.7	0.3
Fighting Isl.-E	13:23									

SL22	05/10/1999	18.5	14.4	14.1	2.1	3500	750	21	9.3	0.3
Banta Park-N	14:10									
SL23	05/10/1999	19.0	14.1	14.0	1.9	2500	450	18	ND	ND
Sugar Isl.-NE	15:15									
SL24	05/10/1999	19.0	13.8	13.7	2.0	3500	550	16	ND	0.2
Stony Isl.-N	15:45									
SL25	05/12/1999	14.5	15.0	15.0	2.6	4000	600	15	ND	0.2
Fighting Isl.-SE	10:15									
SL26	05/12/1999	15.0	14.8	14.8	2.2	4000	700	18	ND	0.1
Banta Park										
SL27	05/12/1999	14.5	14.6	14.5	2.0	3000	500	17	ND	0.1
Stony Isl.-N										
SL28	05/12/1999	14.5	14.6	14.0	0.8	1500	210	14	ND	0.3
Sugar Isl.-S										
SL29	05/13/1999	14.0	14.4	14.4	2.5	6000	400	7	ND	0.2
Fighting Isl.-SE										
SL30	05/13/1999	14.0	14.3	14.2	2.9	1000	200	20	ND	0.2
Banta Park										
SL31	05/13/1999	15.0	14.3	14.3	2.1	1100	250	23	ND	0.2
Banta Park-S										
SL32	05/18/1999	18.0	15.9	15.8	3.0	4000	600	15	9.0	ND
Grassy Isl.-N	9:35									
SL33	05/18/1999	18.0	16.2	16.1	ND	6000	1800	30	8.2	ND
Grassy Isl.-N	10:00									
SL34	05/18/1999	18.0	16.5	16.4	ND	750	100	13	8.1	ND
	10:35									
SL35	05/18/1999	18.0	16.4	16.3	ND	750	150	20	8.1	ND
Banta Park	10:55									
SL36	05/19/1999	14.0	14.2	14.2	2.4	1200	250	21	8.6	0.2
Peche Isl.-S	9:45									
SL37	05/19/1999	14.0	14.3	14.2	ND	3000	350	12	8.2	0.4
Stony Isl.-NE	10:12									
SL 38	05/19/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Sugar Isl.-N	13:40									
SL39	05/19/1999	ND	ND	ND	ND	4500	600	13	ND	0.1
Fighting Isl.-SE	14:45									

SL40	05/19/1999	ND	ND	ND	2.6	1000	200	20	ND	0.4
Banta Park										
SL41	05/20/1999	19.0	15.2	15.1	2.8	2500	320	13	ND	0.4
Livingston Ch. Bay	9:20									
SL42	05/20/1999	19.0	15.3	15.0	1.6	2400	420	18	ND	0.1
Stony Isl.-NE	9:55									
SL43	05/20/1999	19.0	15.5	15.5	ND	2000	500	25	ND	0.2
Turkey Isl.-SE	10:45									
SL44	05/20/1999	19.0	15.5	15.4	ND	3500	500	14	ND	0.1
Banta Park	11:15									
SL45	05/21/1999	19.0	16.0	16.0	2.3	2500	350	14	8.0	0.3
Fighting Isl.-S										
SL46	05/21/1999	19.0	16.0	15.9	2.3	2500	450	18	7.8	0.3
Banta Park	10:15									
SL47	05/21/1999	19.0	15.8	15.8	2.1	3000	400	13	7.9	0.2
Stony Isl.-N	10:32									
SL48	05/21/1999	ND	ND	ND	ND	3500	600	17	ND	ND
Sugar Isl.-E	11:06									
SL49	05/26/1999	13.0	12.2	12.1	ND	1000	250	25	7.9	ND
Fighting Isl.-NE	10:45									
SL50	05/26/1999	ND	12.7	12.7	ND	1000	200	20	7.5	ND
Banta Park	11:25									
SL51	05/26/1999	ND	12.8	12.7	ND	1000	250	25	7.5	ND
Stony Isl.-N	13:11									
SL52	05/27/1999	17.0	13.4	13.3	ND	3000	500	17	7.5	ND
Fighting Isl.-NE	10:00									
SL53	05/27/1999	ND	13.3	13.2	ND	3000.0	600.0	20	7.5	ND
Banta Park	10:50									
SL54	05/27/1999	ND	12.8	12.6	ND	4000	650	16	7.5	ND
Powderhouse/Fox Isl.	11:45									
SL55	05/28/1999	23.0	14.3	14.4	ND	ND	ND	ND	7.6	ND
Peach Isl.-E	10:00									
SL56	05/28/1999	ND	14.6	14.6	ND	ND	ND	ND	7.4	ND
Peach Isl.-W	10.22									
SL57	05/28/1999	ND	ND	ND	ND	4000	400	10	ND	ND
Banta Park	13:55									

SL58	05/28/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Horseshoe Isl.-N	14:30									
SL59	06/02/1999	20.0	16.2	16.1	ND	2500	450	18	7.7	ND
Fighting Isl.-N	10:40									
SL60	06/02/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fignting Isl.-NE	11:02									
SL61	06/02/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Fighting Isl.-NE shore	11:23									
SL62	06/02/1999	26.0	16.6	16.5	ND	4500	850	19	7.5	ND
Banta Park-S	13:20									
SL63	06/02/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Banta Park-N	13:53									
SL64	06/03/1999	20.0	16.4	16.3	ND	4000	600	15	9.5	ND
Fighting Isl.-NE	13:20									
SL65	06/03/1999	20.0	17.3	17.2	ND	4000	500	13	9.5	ND
Grassy Isl.-n	14:03									
SL66	06/03/1999	24.0	16.8	16.7	ND	4000	600	15	9.5	ND
Banta Park	14:45									
SL67	06/03/1999	24.0	18.0	17.9	ND	4000	600	15	10.5	ND
N of Fox Isl.	15:35									
SL68	06/04/1999	24.0	16.1	16.0	ND	3000	550	18	8.9	ND
Fighting Isl.-NE	11:30									
SL69	06/08/1999	ND	19.2	19.1	ND	3000	550	18	9.2	ND
Ballards Reef	11:15									
SL70	06/08/1999	ND	19.4	19.3	ND	4000	600	15	8.9	ND
Turkey Isl.-S	11:55									
SL71	06/08/1999	30.0	19.7	19.4	ND	4000	600	15	9.2	ND
Fighting Isl.-SE	13:45									
SL72	06/09/1999	ND	19.7	19.6	ND	4000	600	15	9.0	ND
Fighting Isl.-SE	11:10									
SL73	06/09/1999	ND	19.8	19.7	ND	4500	700	16	8.6	ND
Turkey Isl.-SW	13:00									
SL74	06/09/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ballards Reef	15:16									
SL75	06/10/1999	29.0	20.5	20.4	ND	3500	550	16	8.5	ND
Fighting Isl.-NE	11:05									

SL76	06/10/1999	ND	21.0	21.0	ND	3500	650	19	8.3	ND
Turkey Isl.-SE	11:45									
SL77	06/10/1999	ND	20.7	ND	ND	4000	500	13	ND	ND
Boblo Isl.	12:30									
SL78	06/11/1999	26.0	21.1	21.0	ND	2500	350	14	8.4	ND
Fighting Isl.-N	10:10									
SL79	06/11/1999	ND	21.3	21.2	ND	2000	400	20	7.5	ND
Ballards Reef	10:39									
GN1	06/16/1999	22.0	19.0	ND	2.8	ND	ND	ND	7.8	ND
Ballards Reef-E	13:10									
GN2	06/17/1999	ND	19.7	19.7	ND	ND	ND	ND	ND	ND
Ballards Reef-E	16:13									
GN3	06/17/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ballards Reef-SE	16:13									
GN4	06/21/1999	28.0	20.7	21.0	ND	ND	ND	ND	6.5	ND
Gibraltar Bay	14:10									
GN5	06/21/1999	24.0	21.2	21.1	ND	ND	ND	ND	ND	ND
Turkey Isl.-NE	15:36									
GN6	06/21/1999	24.0	21.1	21.0	ND	ND	ND	ND	ND	ND
Turkey Isl.-NE	15:58									
GN7	06/22/1999	25.0	21.2	21.1	1.6	ND	ND	ND	9.4	ND
Grassy Isl.-W	11:50									
GN8	06/22/1999	25.0	21.3	21.2	1.5	ND	ND	ND	8.4	ND
Mud Isl.-N	12:17									
GN9	06/24/1999	26.0	ND	ND	1.5	2500	400	16	ND	ND
Stony Isl.-N	11:58									
GN10	06/24/1999	ND	21.9	ND	ND	2500	400	16	ND	ND
Ballards Reef	12:25									
GN11	06/24/1999	ND	22.0	ND	ND	4500	650	14	ND	ND
Ballards Reef	12:45									
GN12	06/24/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Ballards Reef-N	13:05									
GN13	06/24/1999	ND	ND	ND	ND	ND	ND	ND	ND	ND
Stony Isl.-N	13:28									
Electrofishing	07/19/1999	30.0	26.0	ND	ND	1500	170	11	ND	0.1
Sugar Isl.-S										

Electrofishing Fighting Isl.-N	07/20/1999	25.0	24.3	24.1	ND	3000	400	13	ND	0.1
Electrofishing Grassy Isl.-S	07/20/1999 12:21	27.0	24.6	24.7	ND	1500	200	13	7.5	ND
Electrofishing Stony Isl.-N	07/20/1999 13:52	ND	24.8	24.8	ND	2000	250	13	ND	ND
Electrofishing/ Beach seine Sugar Isl.-W	07/21/1999	23.0	23.9	23.9	ND	2800	270	10	ND	ND
GN14 Lake Erie/DTR	08/22/1999 11:30	ND	ND	ND	ND	500	50	10	ND	ND
Average:		18.4	15.7	15.3	2.2	2851	475	17	8.3	0.2

Appendix 3. Summary of river bottom conditions and suitability for spawning by lake sturgeon at selected sites in the Detroit River, 1999, as interpreted by underwater video tapes.

Site	Video Coverage	Number of Camera Transects	Bottom Types (%)	Water Depth (m)	Arrangement of Bottom Types	Amount of Spawning Substrate(%)	Aquatic Plant Coverage (%)	Water Velocity	Degree of Siltation	Condition	Notes
Sugar Is. - SE	42	4	Sand(56) Gravel(30) Cobble(10) Boulder(2) Shell(2)	2.4 - 5.4	Gravel on sand Cobble on sand Boulder on sand	2.0 - 10.0	10.0-30.0	High	Low	Suitable	Couple of small piles of rock on rock Clay Shelf Plants: *Vallisneria* (95%) Narrow-leaf Potomogeton (3%) *Najas flexilis (2 %)*
Sugar Is. - N	7	1	Clay(30) Sand(25) Gravel(25) Cobble(15) Boulder(3) Shell(2)	2.7 - 5.8	Cobble on sand Boulder on sand Shell on sand Boulder on clay	3	50	High	Med	Partly Impaired	Clay Shelf Plants: *Vallisneria* (95%) Narrow-leaf Potomogeton (5 %)
Banta Pk	16	1	Clay(97) Cobble(2) Shell(1)	5.2 - 10.7	Cobble on clay Shell on clay	0	10	Low	High	Impaired/ Unsuitable	High turbidity & silt load Soft clay bottom Plants: *Vallisneria*
Fighting Is - NE	11	1	Clay(50) Gravel(40) Shell(10)	8.2 - 9.8	Gravel on clay Shells on clay	0	1	High	Low	Partly Impaired	Patches of gravel/shell Little rock on rock Many smallmouth bass Plants: *Vallisneria*
Sturgeon Bar	13	4	Clay(30) Gravel(30) Cobble(20) Boulder(20)	0.3 - 1.5	Gravel on sand Cobble on sand Boulders on sand Cobble on gravel Boulders on gravel Boulders on cobble	35.0 - 40.0	75.0 - 100.0	Low	Low to Med	Suitable to Partly Impaired	Clean (wave-washed) gravel, cobble, and boulders Plants: *Vallisneria (20%)* *Heteranthera (70%)* Filamentous algae (10%) Angular 1-2 inch diameter gravel and shells in patches on sand

Grassy Island	61	5	Clay(50) Gravel(25) Cobble(20) Boulder(3) Shell(2)	2.1 - 11.6	Gravel on clay/sand Cobble on clay Boulders on clay Gravel on gravel Boulders on sand Boulders on gravel	15.0 - 50.0	0.0 - 50.0	High	Low to Med	Suitable	Patches of gravel and rock on clean, sculpted clay bottom No plants in deeper channel Plants near shore: *Vallisneria, Heteranthera,* Narrow-leaf Potomogeton, & *P. richardsonii*
Peche Is. - SW	59	4	Clay(50) Sand(45) Gravel(5)	1.2 - 10.7	Sand on clay Gravel on clay Gravel on sand	0.0 - 3.0	0	Medium	Med to High	Impaired (silted in)	Pock-marked clay by shore Pea-gravel/shell on clay in channel
Peche Is. - NE	28	3	Clay(30) Sand(65) Gravel(3) Shell(2)	1.2 - 9.1	Gravel on clay/sand Cobble on clay/sand	0.0 - 2.0	5	Low to Med	High	Largely unsuitable	No loose gravel or cinders Little rock on rock/packed gravel One pile of rocks Plants on N. shore: Chara (95%) *P. richardsonii* (35%), *Vallisneria* (2%)

Appendix 4. Relative substrate classifications derived from examination of 1999 side scan sonar results from seven reputed and two reported lake sturgeon spawning sites in the Detroit River.

Site Name	Substrate Classifications
Peche Island	Heavily silted bar of sand and pock-marked clay Featureless open channel zone of sculpted clay Shallow silted zone colonized by aquatic macrophytes Shipping channel, deep, plant free, featureless clay bottom
Fighting Island	Shallow, silty zone colonized by aquatic macrophytes Hard-pan clay in deeper, high-velocity channel zone Slope between these two zones
Grassy Island	Open channel, patches of hard substrate Transitional slopes Shallow, silt/clay colonized by aquatic macrophytes Broken rip-rap at toe of island edge
Banta Park	Channel of hard-pan clay Eastern slope of soft silt and clay
Stony Island	Clumps of aquatic macrophytes on soft clay Clean hard-pan clay
Sugar Island-North	Western, shallow, clay colonized by macrophytes Eastern, deeper, hard-pan clay with embedded rocks, no macrophytes
Sugar Island-South	Need to redo camera work to overlap with side scan sonar coverage
Gibraltar Bay	Narrow channel of hard-pan clay Steep-sided slopes to channel Shallow, soft sediments zone colonized by macrophytes
Sturgeon Bar	Scattered boulders on sand and gravel in shallow water