2015 Lake Huron Lake Sturgeon Working Group Report

Prepared by members:

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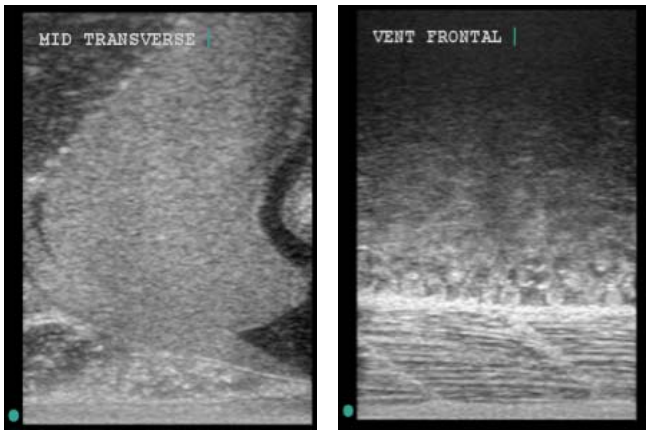
Location: Southern Lake Huron

Project Title: Using Ultrasound to Determine the Sex and Maturity of Lake Sturgeon in the Field

Project Description: Sex determination of fish species in the field is difficult to assess when sexual dimorphism and gametes are not apparent. For threatened and endangered fish species, unobtrusive techniques are needed when determining sex to minimize stress and the potential for mortality. The current study evaluated the use of a portable ultrasound unit to determine sex of lake sturgeon in the field. The sex and maturity of 41 female and 107 male lake sturgeon was determined by visually inspecting gametes through a small incision. Six images (ventral transverse, middle transverse, anterior transverse, ventral frontal, middle frontal, and anterior frontal) were collected from each fish using a SonoSite MicroMaxx ultrasound unit. The average time spent collecting images was 3 minutes, and ranged between 2-5 minutes once comfortable with operating procedures. Images were analyzed and sex and maturity was assigned and compared with the 148 sturgeon of known sex and maturity. Analysis indicates F4 (black egg), F5 (black egg-spawning) female, and M2 (fully developed) male gametes can be accurately identified during the spring spawning season. This work shows the utility of using an ultrasound unit in the field to determine sex of female and male lake sturgeon in later reproductive stages around the spawning season.

Chiotti, J.A., J. Boase, D. Hondorp, and A. Briggs. 2016. Assigning Sex and Maturity to Adult Lake Sturgeon using Ultrasonography and Common Morphological Measurements. NAJM 36:21-29.



Sex & Maturity	Number Field Verified	Number Correctly Assigned	
		Reader 1	Reader 2
Male - Fully Developed	107	95 (89%)	103 (96%)
Female - Yellow Egg	9	6 (67%)	3 (33%)
Female - Black Egg	32	32 (100%)	32 (100%)
OVERALL	**148**	**133 (90%)**	**138 (93%)**
MALES	**75 (70%)**	**95 (89%)**	**103 (96%)**
FEMALES	**2 (5%)**	**39 (95%)**	**36 (88%)**

Project Duration: 2012 – Spring 2015

Contact Information: Justin Chiotti, USFWS, Alpena FWCO (Waterford Substation)
Phone: 248-891-0087, justin_chiotti@fws.gov

Location: Southern Lake Huron

Project Title: Lake Sturgeon Population Assessment in Southern Lake Huron

Project Description: Southern Lake Huron (Upper St. Clair River) contains one of the largest populations of lake sturgeon in the Great Lakes. In 1995, the Ministry of Natural Resources and Forestry began a mark-recapture study to gain a better understanding of lake sturgeon population demographics at this location. Tagging operations ceased in 2008. Overall, 1,657 lake sturgeon were marked and it is estimated that the lake sturgeon population is near 30,000 individuals. In 2012, the U.S. Fish and Wildlife Service along with the Ministry of Natural Resources and Forestry and Purdy Fisheries resurrected lake sturgeon tagging operations at this location. Lake sturgeon will be tagged annually with the cooperation of Purdy Fisheries. Since 2012, 420 sturgeon have been tagged, with 241 tagged in 2015. The goal of this work is to obtain a more precise estimate of lake sturgeon abundance and monitor trends in abundance overtime.

Project Duration: Spring 2012 - Annually

Contact Information: James Boase, USFWS, Alpena FWCO (Waterford Substation)
Lloyd Mohr, Ministry of Natural Resources and Forestry
James Boase - Phone: 248-894-7594, james_boase@fws.gov
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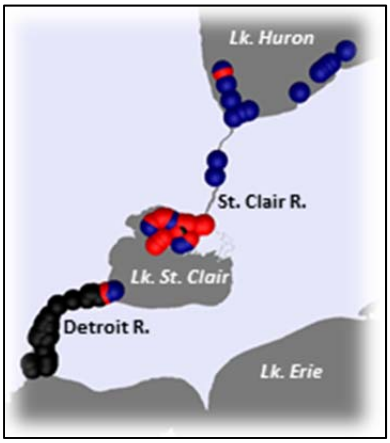
Location(s): Detroit-St. Clair River System; Lake Huron; Lake Erie

Project Title: Geographic organization and population structure of lake sturgeon in the Lake Huron-to-Lake Erie corridor as inferred from long-term, population-scale movement patterns.

Project Description: This study uses acoustic telemetry to describe the spatial structure of lake sturgeon populations that spawn in the St. Clair and Detroit rivers in order to provide managers with information on habitat use by different sturgeon populations as well as on population-scale movements and dispersal patterns at ecologically-relevant temporal scales. Since 2011, a total of 268 adult lake sturgeon have been captured in the Detroit and St. Clair rivers, implanted with high-power acoustic tags with a battery life of 10 years, and then released near the capture site. Strategically-located acoustic receivers in the Detroit-St. Clair river system, Lake Huron, and Lake Erie (map to the right), are allowing scientists to track sturgeon movements between feeding, overwintering, and spawning grounds over thousands of square miles. Study results will be used to test the hypothesis that a number of separate sturgeon populations occur in the Lake Huron-to-Lake Erie corridor rather than one large population.



Results to date have shown that lake sturgeon habitat use varies by release location. Lake sturgeon released into the Detroit River (black circles, left) tended to remain in the Detroit River or move up into Lake St. Clair, whereas lake sturgeon released into the lower St. Clair River (red circles) either remained in the St. Clair River or moved down into Lake St. Clair. Lake sturgeon released into the upper St. Clair river (blue circles) spread out to occupy Lake Huron, the St. Clair River, and Lake St. Clair. Significant mixing of release groups occurs in Lake St. Clair, whereas Lake Erie is rarely used by lake sturgeon, even those released into the Detroit River. The extent and timing of movements by different release groups suggest the potential for complex metapopulation dynamics, which could impact conservation strategies. Year-round tracking of lake sturgeon movements also has confirmed the existence of migratory and river-resident life histories. The high incidence of river residency in Detroit-St. Clair river lake sturgeon was a surprise.

Project Duration: 2012-2022

Contact Information: Darryl Hondorp, U.S. Geological Survey-Great Lakes Science Center (Ann Arbor, MI) Phone: 734-214-7241, dhondorp@usgs.gov

Location: Southern Lake Huron

Project Title: Characterization of the Migratory Phenotype in Lake Sturgeon

Project Description: The goal of this collaboration was to better understand the genomic basis for migratory phenotypes in lake sturgeon (*Acipenser fulvescens*) of the Great Lakes. Most lake sturgeon reside in the lakes, only entering the rivers to spawn. However, the coexistence of both river resident and out-migrating lake sturgeon in the St. Clair-Detroit River System (SCDRS) indicates the possibility of a molecular mechanism for differences in migration tendencies. An integrative approach employing morphometrics, genetic and epigenetic techniques was used to characterize the migratory phenotypes of the partially migrant population of lake sturgeon in the SCDRS. The objectives of the study were to: 1) determine whether the lake sturgeon of the St. Clair system differ morphometrically due to variation in migratory phenotypes, 2) determine if individuals with different migratory phenotypes are reproductively isolated, and 3) determine if migratory and river resident individuals are differentially methylated, indicating epigenetic differences between the two phenotypes. Based on telemetry data, fish were grouped according to migratory phenotype and then analyzed for differences in morphometrics, genetics, and epigenetics. The PCA, performed on 18 morphological features, did not support the hypothesis that there are morphological differences between lake sturgeon (n=71; 44 residents, 27 migrants). To identify a genetic component to the variation in migratory phenotypes, a subset of those samples (n=48; 25 residents, 23 migrants) was analyzed at 11 microsatellite loci. Bayesian analysis revealed that there is one population, indicating gene flow between the migratory phenotypes. The F_{ST} value calculated to determine genetic differentiation between migratory phenotypes was 0.0005 (p=0.3) which is interpreted as no genetic differentiation between the two groups. DNA extractions from blood samples were analyzed using the methylation sensitive amplified fragment length polymorphism (MS-AFLP) protocol to test for epigenetic differences. The AMOVA performed on all restriction sites (81) showed that the migratory phenotypes are differentially methylated ($p<0.05$). The AMOVA performed on individual restriction sites showed that 11 were differentially methylated. While there is no evidence for a genetic component to the migratory phenotypes of lake sturgeon in the SCDRS, DNA methylation may play a role in the observed plasticity of movement patterns.

Project Duration: Spring 2012 – Fall 2015

Contact Information: Justine Whitaker, Wildlife and Fishery Resources Program, West Virginia University
Amy Welsh, Wildlife and Fishery Resources Program, West Virginia University

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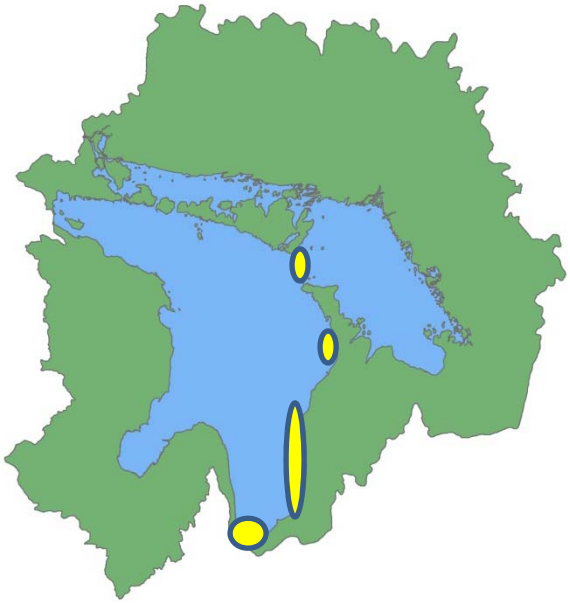
Location: Main Basin Lake Huron



Project Title: Great Lakes Acoustic Transmitter Observation System (GLATOS)

Project Description: Manually tracking tagged lake sturgeon in a system as large as Lake Huron is severely limited by financial constraints and staff resources. Using automated stationary acoustic receivers allows continuous tracking of sturgeon throughout the year with minimal staff involvement. Building upon the success of the receiver arrays set along the Huron-Erie corridor, six arrays were placed in the Ontario waters of the Main Basin targeted at tracking lake sturgeon tagged in the Detroit-St. Clair system and southern Main Basin of Lake Huron. In addition, a seventh array was deployed running along the boundary between Georgian Bay and the Main Basin. Since the project's inception, 97 unique acoustic tags have been recorded, 50 of which are attached to sturgeon. The remaining tags belong to walleye and lake trout. Preliminary movement analysis demonstrates that sturgeon tagged in the St. Clair River and southern Lake Huron rarely venture north of the southern Main Basin, although they have been recorded as far north as the Bruce Peninsula. Arrays in the northern portion of the lake have only been deployed for a single year so more data collection is required. Greater certainty regarding sturgeon movement in this area is pending collection and analysis of 2016 data.

Table: Original tagged location of fish identified by the Main Basin acoustic receiver arrays.

Tagged Location **Species**	**AuGres**	**Detroit**	**Drummond Island**	**False Detour**	**N Channel**	**Scammond Cove**	**St Clair**	**Tittabawassee**	**Unknown**	**Total**
Lake Sturgeon							50			50
Lake Trout			3	1		9				13
Sea Lamprey					1					1
Walleye	3	1						17		21
Unknown									12	12
Total	**3**	**1**	**3**	**1**	**1**	**9**	**50**	**17**	**12**	**97**

Project Duration: Spring 2013 – Fall 2016

Contact Information: Jeff Speers, MNRF, Upper Great Lakes Management Unit - Lake Huron
Phone: 519-371-5059, jeff.speers@ontario.ca

Location: Black Lake Sturgeon Research Program

Project Title: Lake Sturgeon Culture

Project Description: John Bauman published a five chapter master's thesis titled "Investigations of Aquaculture Methodologies to Enhance Success of Great Lakes Lake Sturgeon Streamside Facilities". Two chapters from this document have been published with an additional being submitted and in review. Published materials include rearing density recommendations, evaluation of feeding strategies, and a comparison of currently utilized chemical treatments; all available for development of site-specific rearing protocols. Remaining two chapters pertaining to effects of different egg chemical treatments and deadhesion methods are in revision. Additionally, during the summer 2015 two research projects were conducted to identify alternate hatchery food sources for rearing larval Lake Sturgeon. Currently, culture and delivery of live brine shrimp serves as the only reliable food source for Lake Sturgeon larvae (age 14 to 30 days).

Publications

Bauman, J., E. A. Baker, T. Marsh and K. T. Scribner. 2015. Effects of rearing density on body size and survival of lake sturgeon (*Acipenser fulvescens*) free-embryos. North American Journal of Aquaculture. 77:444-448.

Bauman, John M., Edward A. Baker, Terry L. Marsh and Kim T. Scribner. Body size and survival of hatchery- and wild-produced larvae as a function of feeding frequency and alternate food type. North American Journal of Aquaculture. In press.

Bauman, John M., Edward A. Baker, Terry L. Marsh and Kim T. Scribner. Effects of different chemotherapeutant prophylactics on the survival of Lake Sturgeon (*Acipenser fulvescens*). North American Journal of Aquaculture. In revision.

Project Title: Effects of microbial populations on lake sturgeon egg survival and free embryo phenotype

Project Description: A major focus of lake sturgeon culture research has been associated with effects of microbial populations on egg survival and larval phenotype at hatch. Work is also being conducted on the effects of diet and chemical treatments of gut microbial populations. Work includes the following paper.

Publications

Fujimoto, M., B. Lovett, R. Angoshtari, P. Nirenburg, T.P. Loch, K.T. Scribner, T.L. Marsh. Antagonistic interactions and biofilm forming capabilities among bacterial strains isolated from the egg surfaces of Lake Sturgeon (*Acipenser fulvescens*). Microbial Ecology. In review.

Project Title: Genetic and environmental effects on larval phenotype and growth

Project Description: Work by PhD student Kari Dammerman has focused on the effects of stream temperature and flow regimes during incubation on larval phenotypes at hatch and larval growth. Papers include the following.

Publications

Dammerman, K.J., J.P. Steibel, and K.T. Scribner. 2015. Genetic and environmental components of phenotypic and behavioral trait variation during lake sturgeon (*Acipenser fulvescens*) early ontogeny. Environ. Biol. Fish. 98: 1659-1670.

Dammerman, K.J., J.P. Steibel, K.T. Scribner. Increasing thermal regimes reveal cryptic genetic variation during early ontogenetic stages of lake sturgeon (*Acipenser fulvescens*). Evolutionary Applications. In revision.

Project Title: Lake Sturgeon reproductive ecology

Project Description: A major focus of our research has been to estimate reproductive success of male and female lake sturgeon as a function of stream physical features, location and timing of spawning and demographic composition. The following papers are associated with this work.

Publications

Duong, Y., J. Crossman, P. Forsythe, E. Baker, and K.T. Scribner. Genetic evidence reveals no reproductive isolation in the long-lived lake sturgeon (*Acipenser fulvescens*) with repeatability in spawning time. Can. J. Fish. Aquat. Sci. in review.

Duong Thuy Yen, K. T. Scribner, James A. Crossman, Patrick S. Forsythe and E. A. Baker. Multi-year individual-based analyses reveal effects of environmental and demographic variables associated with mate number and reproductive success of male and female lake sturgeon. Molecular Ecology. In Revision.

Project Title: Estimates of stock recruitment for Great Lakes populations of Lake Sturgeon

Project Description: We have developed an estimation protocol to simultaneously estimate population contributions to Great Lakes mixtures and age-specific recruitment using genetic and length-at-age data, respectively. The research was recently published in the paper below.

Publications

Tsehaye, I., T.O. Brenden, J.R. Bence, W. Liu, K.T. Scribner, J. Kanefsky, K. Bott, and R.F. Elliott. 2015. Combining genetics with age/length data to estimate consistent changes in year-class strength of spawning populations contributing to admixtures, with application to Lake Michigan lake sturgeon. Fisheries Research. In press.

Contact Information: Kim Scribner, Michigan State University, Department of Fisheries and Wildlife
Phone: 517-353-3288, scribne3@msu.edu

Lake Huron

Table 1. Observations or general status of lake sturgeon populations in the Lake Huron Basin. Table includes water bodies that historically supported or recent evidence exists lake sturgeon may be present. Population status definitions are: **Extirpated** or **Extant**; **Re-I** (reintroduced) = fish stocked into a system with an extirpated population; **Supp** (supplementation) = fish stocked into a system with an extant population, or **Unk** = unknown. A "**Yes**" indicates regular observation or presumed annual occurrence. Occasional (**Occ**) observations are as noted. Successful reproduction was defined as recent capture of larval or juvenile sturgeon. Notes follow the table.

Basin / Site Number	Site Name	Population Status	Size of Annual Spawning Run	Observations:				Juvenile Index (year)	Repr. Success?
				Adults	Spawning	Larva	Juveniles		
Lake Huron									
1	Carp River, MI	Extant	Unk	Yes	Occ	Unk	Unk		Unk
2	St. Marys River, MI ON	Extant	Unk	Yes	Unk	Unk	Yes		Yes
3	Root River, ON	Extirpated							
4	Garden River, ON	Extant	Unk	Yes	Yes	Yes	Unk		Yes
5	Echo River, ON	Extant	Unk	Yes	Unk	Unk	Occ	1.0 (2012)	Unk
6	Thessalon River, ON	Extant	Unk	Yes	Unk	Unk	Unk	0.0 (2012)	Unk
7a	Mississagi River, ON	Extant	150	Yes	Yes	Yes	Yes		Yes
7b	Mississagi River (upriver), ON	Extant	Unk	Yes	Yes	Unk	Yes		Unk
8	Blind River, ON	Extirpated					Occ	2.2 (2012)	Unk
9	Serpent River, ON	Extirpated					Occ	5.8 (2012)	Unk
10	Spanish River, ON	Extant	Unk	Yes	Yes	Unk	Yes	5.3 (2012)	Yes
11	French River, ON	Extant	Unk	Yes	Unk	Unk	Occ		Unk
12	Key River, ON	Unk	Unk	Unk	Unk	Unk	Unk	0.0 (2012)	Unk
13	Magnetawan River, ON	Extant	Unk	Occ	Unk	Unk	Unk	0.0 (2012)	Unk
14	Naiscoot River, ON	Extant	Unk	Occ	Unk	Unk	Unk		Unk
15	Seguin River, ON	Extant	Unk	Occ	Unk	Unk	Unk		Unk
16	Moon River, ON	Extant	Unk	Yes	Yes	Yes	Yes		Yes
17	Go Home River, ON	Extirpated							
18	Severn River, ON	Extant	Unk	Occ	Unk	Unk	Unk		Unk
19	Sturgeon River, ON	Extirpated							
20	Nottawasaga River, ON	Extant	≅ 200	Yes	Yes	Unk	Yes		Yes
21	Manitou River, ON	Unk	Unk	Yes	Yes	Unk	Unk		Unk
22	Sauble River, ON	Unk	Unk	Occ	Unk	Unk	Unk	0.0 (2012)	Unk
23	Saugeen River, ON	Unk	Unk	Occ	Unk	Unk	Unk	0.0 (2012)	Unk
24	AuSable River, ON	Extirpated						0.0 (2012)	
25	Blue Point, ON	Unk	Unk	Yes	Unk	Unk	Occ		Unk

26	Musquash River, ON	Unk	Unk	Occ	Yes	Unk	Occ		Unk
27	Saginaw River, MI	Extant	Unk	Occ	Unk	Unk	Unk		Unk
28	Saginaw Bay, MI	Extant	Unk	Yes	Unk	Unk	Unk		Unk
29	AuSable River, MI	Extant	Unk	Occ	Unk	Unk	Unk		Unk
30	Thunder Bay River, MI	Extirpated							
31	Cheboygan River, MI	Extant	Unk	Occ	Unk	Unk	Unk		Unk
32	Black Lake, MI	Supp	≅ 200	Yes	Yes	Yes	Yes		Yes
33	Burt/Mullett Lake (including lower Black River downstream Alverno Dam) MI	Supp	Unk	Yes	Occ	Yes	Yes	2009-2011	Unk
34	Rifle River, MI	Extant	Unk	Unk	Yes	Unk	Yes	0.0 (2013)	Unk
35	Au Gres River, MI	Unk	Unk	Unk	Unk	Unk	Unk		
36	Otsego Lake	Re-I	Unk	Yes	No	No	Yes		No
37	Kawkawlin River, MI	Unk	Unk	Unk	Unk	Unk	Unk		
38	Munuscong River, MI	Unk	Unk	Unk	Unk	Unk	Unk		
39	Ocqueoc River, MI	Unk	Unk	Unk	Unk	Unk	Unk		
40	Pigeon River, MI	Unk	Unk	Unk	Unk	Unk	Unk		
41	Tittabawassee River, MI	Extant	Unk	Occ	Unk	Unk	Unk		