# Abstracts for Oral Presentation
# 2018 North American Sturgeon and Paddlefish Society Annual Meeting

## List of Abstracts

## Biology and Ecology



## Conservation Genetics

## Aquaculture and Conservation Propagation



## Habitat Restoration



## Management…….

## Biology and Ecology

### Evaluation of Methods for Estimating Age and Growth of Lake Sturgeon

Aaron O'Connell[1]

[1]Wisconsin Department of Natural Resources and University of Wisconsin-Stevens Point

2. Daniel Isermann, 3. Ryan Koenigs, 4 .Daniel Dembkowski, 5. Justin VanDeHey, 6. Ronald Bruch

2. U.S. Geological Survey, Wisconsin Fishery Cooperative Unit, 3. Wisconsin Department of Natural Resources, 4. & 5. University of Wisconsin-Stevens Point, 6. Wisconsin Department of Natural Resources (Retired)

Pectoral fin rays have been the preferred calcified structure used for estimating age of Lake Sturgeon (*Acipenser fulvescens*), as well as other sturgeon species. However, age estimates from pectoral fin rays underestimate the age of Lake Sturgeon ≥ age 14. Age interpretations from otoliths were reported as valid for Lake Sturgeon, but difficulties in otolith availability, collection, and processing have resulted in little to no comprehensive work with Lake Sturgeon otoliths. We are evaluating five different techniques for estimating age and growth rates of Lake Sturgeon including: use of sectioned pectoral fin rays, application of a correction factor assigned to ages estimated from pectoral fin rays, use of age-error matrices to correct ages estimated from pectoral fin rays, otolith frontal sections, and a Fabens–Wang mark-recapture growth model based on recaptures of tagged fish. Pectoral fin ray and otolith age estimates from known-age Lake Sturgeon (ages 4-15, n= 46) will be used to re-assess accuracy of age estimates for juvenile fish, while a broader suite of methods will be applied to age and growth data collected from older fish. Paired structures (pectoral fin rays and otoliths) have been collected from 851 Lake Sturgeon during the 2017 and 2018 Winnebago system winter spear harvests. Recent experimentation with otoliths using a thicker frontal section followed by sanding and polishing has yielded promising results in terms of accuracy of age estimates. However, preliminary results show a low percentage of otolith sections were deemed readable. Mark-recapture data from fish initially tagged during Wisconsin DNR annual spring spawning assessments were compiled using the Winnebago system Lake Sturgeon tagging database from 1975-2016 (n= >5,000 capture events). Von Bertalanffy growth parameters will be estimated and compared amongst all methods.

**Otolith Calcium Carbonate Diversity in Paddlefish and Four Species of Sturgeon and Applications for Ecological Microchemistry Studies**

**Brenda Pracheil**[1]

[1]Environmental Sciences Division, Oak Ridge National Laboratory

2. Bryan C. Chakoumakos, 3. Allison M. Fortner, 4. R. Seth Wood, 5. Alison R. Loeppky, 6. W. Gary Anderson, 7. Matt Newville, 8. Antonio Lanzirotti

2. Neutron Scattering Division, Oak Ridge National Laboratory, 3. Environmental Sciences Division, Oak Ridge National Laboratory, 4. Environmental Sciences Division, Oak Ridge National Laboratory AND Department of Earth and Planetary Sciences, University of Tennessee, 5. & 6. Department of Biological Sciences, University of Manitoba, 7. & 8. Center for Advanced Radiation Sources, University of Chicago,

Fish otoliths are among the most incredible structures in the natural world in that these calcium carbonate (CaCO3) ear bones can indicate not only age and past growth of fishes, but they can also provide a record of movement, water temperature, and habitat use through incorporation of trace elements and isotopes from ambient waters into the CaCO3 matrix. Otoliths can be comprised of any of the three most common forms of CaCO3—aragonite, vaterite, and calcite—but ecological interpretation of otolith trace element chemistry of non-aragonite otoliths is not straightforward. Sturgeon and paddlefish otoliths are almost exclusively vaterite and calcite thus presenting issues for ecological interpretation of otolith microchemistry. In this talk, we present quantitative CaCO3 abundance estimates from whole otolith neutron diffraction of lake, shovelnose, pallid, and Atlantic sturgeon, in addition to paddlefish. We also provide quantitative linkages between CaCO3 form (calcite and vaterite) using X-ray diffraction and elemental abundance using X-ray fluorescence on lake sturgeon otoliths to aid in interpretation of paddlefish and sturgeon otolith microchemistry data.

**Quantifying Spawning Runs of Atlantic Sturgeon in the Altamaha River System, Georgia**

**Cortney Bunch**[1]

[1]University of Georgia

2. Douglas Peterson

2. University of Georgia

The Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) is a large, benthic, anadromous fish found along the east coast of North America. Many populations were nearly extirpated by commercial harvest and the construction of dams on spawning rivers, resulting in a federal endangered species listing in 2012. The Altamaha River in Georgia likely hosts one of the most robust Atlantic Sturgeon populations within the South Atlantic. Previous studies of this population have documented consistent annual recruitment and age-1 juvenile cohorts of up to 6000 individuals. Unfortunately, estimates of the adult population are largely lacking because of the logistical constraints of sampling the large migratory adults. However, the recent availability of cost-effective side-scan sonar technology offers a new potential method for estimating adult spawners during their upstream migrations. The primary objectives of this study were to assess the Atlantic Sturgeon spawning run size in the Altamaha River and to determine adult contributions to stock-recruit dynamics. From September-November of 2017 we conducted continuous side-scan sonar surveys throughout the entire 432 river kilometers of potential spawning habitat within the upper Altamaha River system, including both the Oconee and Ocmulgee tributaries. In the first year of the study, we scanned a total of 1298 total river kilometers, and detected 85 apparent adult Atlantic sturgeon. We estimated a detection probability of 0.72 (SE 0.06) by conducting repeated side-scan sonar transects of selected survey reaches. Preliminary results of our N-mixture model analysis yielded a total run estimate of 207 adults for the 2017 spawning season. These results indicate that side-scan sonar is an effective tool for estimating abundances of adult Atlantic sturgeon during spawning migrations.

**Factors Affecting Lake Sturgeon Spawning Migration in the Black River, MI**

**Douglas Larson[1]**

[1]Michigan State University

2. Jonathan Hegna, 3. Ed Baker, 4. Kim Scribner

2. & 4. Michigan State University, 3. Michigan Department of Natural Resources,

Variation in timing of spawning migrations for lake sturgeon (*Acipenser fulvescens*) and duration of occupancy of spawning areas are often attributed to environmental cues (e.g., temperature, discharge, day length) or biotic factors (e.g., operational sex ratios). Using PIT antenna arrays, spawning migration data was collected from lake sturgeon adults during the 2016 through 2018 spawning seasons in the Black River, MI. Data on body size was obtained for a subset of adults upon capture on the spawning grounds. Timing of migration was most often observed between 20:00 and 10:00. Migration timing did not differ between sexes. Multiple intra-seasonal migration events were undertaken by individual males and females, contrary to previous reports. Based on Akaike's Information Criterion, models that included the largest lag change in water temperature over a 72-hour period prior to detection at the upstream spawning sites was the best predictor of daily number of migrating of lake sturgeon. Including the effect of discharge within a 24-hour lag improved model fit. Results show that lagged effects including increasing temperature and declining discharge strongly impact spawning behavior. Results of duration of migration, occupancy of spawning areas, and evaluation of the consequences of variation in migratory behavior to reproductive success will be discussed.

**Population Dynamics and Movement of Shovelnose Sturgeon in a Missouri River Impoundment**

**Hilary A Meyer[1]**

[1]South Dakota Game, Fish and Parks

2. Chelsey Pasbrig, 3. Mark Fincel
2. & 3. South Dakota Game, Fish and Parks

Aside from the free-flowing stretch of the Missouri River below Gavins Point Dam, little is known about Shovelnose Sturgeon (*Scaphirhynchus platorynchus*) in South Dakota. Shovelnose Sturgeon are found throughout the impounded portions of the Missouri River at low abundances. Little information exists regarding the ecology or population dynamics of this species in South Dakota. We examined growth and movement patterns of Shovelnose Sturgeon in Lake Sharpe, a small Missouri River impoundment in Central South Dakota. In spring of 2017 and 2018, we deployed trotlines baited with night crawlers on the riverine section of Lake Sharpe to target shovelnose sturgeon. All shovelnose sturgeon captured were weighed (g), measured (mm, FL), and tagged with an individually numbered floy tag. A small (10-15 mm) section of pectoral fin ray was collected in 2018 for age and growth analysis. In addition, 56 fish (26 in 2017 and 30 in 2018) were implanted with Vemco V13 acoustic telemetry tags. A total of 880 (459 in 2017 and 421 in 2018) sturgeon were captured and tagged. Initial results estimate a population of 5,301 adult shovelnose sturgeon in Lake Sharpe. Growth of adult shovelnose sturgeon appears to be slow (0-12mm/yr), similar to other populations throughout its native range. Shovelnose sturgeon in Lake Sharpe can move as much as 16 river km per day. In contrast, shovelnose sturgeon exhibit high site fidelity during winter months. Additional sampling and tracking will continue through the spring of 2020. We anticipate our study will answer questions regarding basic shovelnose sturgeon population demographics in Lake Sharpe, as this information has never been documented in the impounded sections of the Missouri River.

**Comparing Models and Abundance Estimates of Adult Atlantic Sturgeon in the York River, Virginia, from 2013 to 2017**

**Jason Kahn**[1]

[1]National Marine Fisheries Service

2 .Chris Hager, 3. Cater Watterson, 4. Noelle Mathies, 5. Kyle Hartman

2. & 4. Chesapeake Scientific, LLC., 3. US Navy, 5. West Virginia University

Atlantic sturgeon, *Acipenser oxyrinchus oxyrinchus*, were listed as five distinct population segments under the Endangered Species Act in 2012. At the time of listing, only two abundance estimates of any Atlantic sturgeon population were available; one from commercial fisheries landings in the Hudson River ending in 1995 and one from mark recapture research in the Altamaha River, Georgia in 2004 and 2005. In 2013, we verified spawning in the York River system and initiated a multiple year mark recapture study focusing on spawning run abundance. We used a modified Schnabel model and Huggins p and c robust model to produce estimates of annual spawning abundances from 2013 to 2017. The modified Schnabel estimates with 95% confidence intervals from 2013 to 2017 were 68 (17-133), 154 (97-211), 174 (128-220), 233 (68-398), and 197 (133-261), respectively. Because Atlantic sturgeon do not spawn every year, the general increasing trend in estimates does not suggest a recovering population, but rather variability in proportions of the adult population that return to spawn each year. The Chao M(h), Chao M(th), Darroch, Jackknife, and Null equations all produced similarly reliable estimates. For migratory species with skipped spawning, we recommend the modified Schnabel model or robust model using Jackknife, Null, and Darroch equations. The Jackknife equation was the most precise every year.

**Seasonal and Diel Vertical Movement of Paddlefish in the Upper Mississippi River Basin**

**John Hoxmeier[1]**

[1]Minnesota DNR

2. Joel Stiras

2. Minnesota DNR

Diel and seasonal movement of paddlefish has typically been measured in terms of horizontal movements in rivers and reservoirs. Depths at which paddlefish inhabited was often inferred from the location of the paddlefish and the maximum depth available. However, paddlefish are often found at the water surface and may not be following bottom contours of the river. We implanted ten paddlefish in the St. Croix River and Pool 3 of the Mississippi River with acoustic tags measuring depth and temperature. Data was collected from a passive array of acoustic receivers throughout the Mississippi, St. Croix, and Chippewa rivers. We analyzed over 235 thousand detections across the 3 river systems. Diel vertical movement was extensive from spring through fall. Diel vertical movement diminished during the winter, especially in areas of ice cover. Paddlefish occupied deeper water at the onset of winter and slowly moved up in the water column over winter. Reasons for overwinter patterns were unclear, but may be related to prey resources.

**Experimental Evidence for the Influences of Light, Prey Density, and Body Size on Larval Lake Sturgeon Survival**

**Joseph Riedy[1]**

[1]Michigan State University

2. Kim Scribner

2. Michigan State University

More larval lake sturgeon (*Acipenser fulvescens*) are consumed during nights with high lunar illumination due to the large diversity and abundance of visual predators in rivers and the nocturnal dispersal tendencies of larval fishes, including sturgeon. To evaluate alternative hypotheses underlying causes of positive associations between mortality levels and nightly light conditions, we empirically tested whether differences in predation levels were attributed to a change in prey selection in darker environments or whether there was an overall decrease in the number of organisms consumed by riverine predators. Three common prey taxa, including larval sturgeon, catostomids, and hetptageniid mayflies were released into flow-through raceways containing predatory rock bass and hornyhead chub. Trials were conducted in dimly lit conditions, mimicking a full moon, and dark conditions, mimicking a new moon. Both species consumed significantly fewer prey items, including sturgeon, in the darkest condition. Prey selection of rock bass varied with light conditions whereas hornyhead chub selected strongly for heptageniids under both conditions. This led us to investigate the effects of the combination of light with other variables including prey density and larval rearing temperature on sturgeon mortality. Lake sturgeon in larval drift that result from first spawning event of the season are often associated with darker conditions, higher densities of prey items, and colder rearing temperatures (resulting in larger body size), than those from later spawning events. Using similar methods as described above, a randomized block design was used to measure effects of varying light, rearing temperature, and prey density, as well as the combination of these factors. Indicating support for the match-mismatch hypothesis, preliminary results suggest smaller sturgeon are more likely to survive at lower densities while larger sturgeon are more likely to survive at higher densities, and sturgeon in darkest conditions have a higher probability of survival in higher densities.

**Synthesizing 15 years of Shovelnose Sturgeon Relative Weight Data in the Lower Missouri River**

**Juju Wellemeyer**

Missouri Department of Conservation

Standard weight equations, derived from lengths and weights from populations across the distributional range of a species, allow for comparisons of fish condition across localities and time using relative weights. Combined with multivariate statistics, it is possible to assess spatiotemporal trends within condition measures through the addition of covariates. The Pallid Sturgeon Population Assessment program has been recording data in the Missouri River since 2003, with a focus on sturgeon, using a variety of sampling gears including gill nets, trot lines, trawls, and trammel nets. Data from the lower Missouri River (811 river miles from Gavins Point dam to the confluence with the Mississippi River) were used to synthesize relative weight trends of Shovelnose Sturgeon (*Scaphirhynchus platorynchus*) across 15 years (2003- 2017). The objectives of evaluating Shovelnose Sturgeon condition were to 1) assess the changes in condition throughout the lower Missouri River and 2) evaluate covariate influences on fish condition. Multivariate ordinations indicated relative weight of Shovelnose Sturgeon varied across time, along the river, and was associated with different abiotic conditions. Synthesizing condition of these benthic fish can be useful for management of sturgeon species, especially when working in large river ecosystems, and it can also allow insight into the status of the fish community.

**Investigating Spawning Success of White Sturgeon in the Upper Columbia River Canada to Inform Adaptive Management Strategies**

**Katy Jay**

BC Hydro

2. James Crossman 3. Dean den Biesen 4. Marco Marello

2. & 3. BC Hydro, 4. Terraquatic Resource Management

White Sturgeon in the upper Columbia River, Canada, are listed as endangered and have been undergoing recruitment failure for many decades. Uncertainty exists regarding the early life stage (i.e., embryo, larvae, year-0) at which recruitment failure is occurring. We describe spawning success and associated environmental conditions for four spawning locations over three decades of monitoring. Embryos and yolk-sac larvae were captured using egg collection mats and d-ring drift nets in June through August from 1993 to 2017. Embryos and yolk-sac larvae were developmentally staged to estimate fertilization date and number of spawning days for each spawning location. Concurrently, water temperature, discharge, and preliminary substrate data was collected. Spawning typically occurred on the descending limb of the hydrograph once water temperatures reached 14°C. Number of spawning days remained relatively consistent across years within a spawning location but differed among locations ranging from several weeks to a few days. Proportion of developmental stages (e.g., cleavage, neurulation, yolk-sac larvae, feeding larvae) differed among spawning locations suggesting environmental conditions causing recruitment failure differs for each monitored location. Results improve knowledge of White Sturgeon reproductive ecology, inform adaptive management strategies (e.g., conservation aquaculture programs), and indicate further uncertainties to be addressed (e.g., substrate complexity) to facilitate recovery.

## Physical Characteristics and Simulated Transport of Pallid Sturgeon and Shovelnose Sturgeon Eggs

**Kimberly Chojnacki**[1]

[1]U.S. Geological Survey, Columbia Environmental Research Center

2. Susannah O. Erwin, 3. Amy E. George, 4. James Candrl, 5. Aaron J. DeLonay

2-5. U.S. Geological Survey, Columbia Environmental Research Center

Pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*S. platorynchus*) broadcast demersal eggs near the bed into fast-flowing, turbulent areas of large rivers. Eggs are thought to become adhesive in 2 to 13 minutes after fertilization; however, it is unknown whether eggs settle and adhere immediately after spawning or are transported downstream where substrate may differ from the release location. Our objectives were to 1) characterize the diameter, settling velocity, and specific gravity of pallid sturgeon and shovelnose sturgeon eggs, and 2) consider these physical properties in the context of the hydraulic conditions at documented spawning sites using principles of sediment transport and an existing numerical model. Diameter of 20-30 unfertilized eggs from 9 female captive pallid sturgeon and 14 female wild-caught shovelnose sturgeon was measured at 2 perpendicular axes. Settling velocity was measured by recording the time required to sink a known distance. Specific gravity was estimated using mean diameter and settling velocity in an empirical formula. We calculated the potential for settling or suspension of eggs, and estimated the vertical distribution of eggs in the water column based on mean flow conditions and physical properties of the eggs. We found that eggs of shovelnose sturgeon were slightly larger ($p=0.0254$), had faster settling velocity ($p<0.001$), and higher specific gravity ($p=0.0135$) than those of pallid sturgeon. Despite minor differences, simulations show that eggs of both species may be distributed throughout the water column, but present in higher concentrations near the bed in representative hydraulic conditions at documented spawning sites on the Lower Yellowstone and Lower Missouri Rivers. At both 25th and 75th percentile flow scenarios, eggs may be transported more than half a kilometer downstream prior to becoming adhesive, resulting in incubation sites that are well downstream from spawning sites.

**Seasonal Movements and Habitat Use of Juvenile Lake Sturgeon in Lake Champlain**

**Lisa K. Izzo[1]**

[1]Vermont Cooperative Fish & Wildlife Research Unit, University of Vermont

2. Donna L. Parrish, 3. Gayle B. Zydlewski, 4. J. Ellen Marsden, 5. Chet MacKenzie

2. U.S. Geological Survey, Vermont Cooperative Fish & Wildlife Research Unit, 3. Maine Sea Grant, University of Maine, 4. Rubenstein School of Environment and Natural Resources, University of Vermont, 5. Vermont Fish & Wildlife Department

Foraging and wintering habitats serve critical roles for survival and growth of juvenile fishes. Juvenile habitats can be especially important in a late-maturing species such as lake sturgeon (*Acipenser fulvescens*) where the juvenile phase can last more than a decade. However, little information is available regarding juvenile lake sturgeon use of and movements between summer foraging and wintering habitats, especially in large lakes. We aim to characterize the seasonal movements and habitat use of juveniles (< 900 mm) from a state-listed population of lake sturgeon in Vermont. Ten juvenile lake sturgeon (582 – 874 mm TL), captured in Lake Champlain from April – October 2017, were tagged with acoustic transmitters. Tagged sturgeon will be tracked through 2019 using an array of 32 stationary receivers. In 2017, juveniles were detected in shallow, flat areas on a river delta in the summer and fall (66% of detections in flat habitat, mean receiver depth = 7.8 m). Juveniles then moved into deeper, sloped areas from November - April (77% of detections in slope habitat, mean receiver depth = 28.8 m). Adult lake sturgeon are known to winter at a site located in < 10 m of water within 2 km of the mouth of the spawning river. However, six of the ten juveniles were detected wintering near receivers located 3.8 km south in > 30 m of water. From January - April five of the six juveniles made occasional movements to receivers (depths of 19.6 – 36.4 m) located another 3.4 km south. Juvenile sturgeon were not detected on these receivers at other times of year. These preliminary results suggest that juvenile and adult lake sturgeon use different wintering habitats in Lake Champlain. A greater understanding of juvenile movement patterns can be used to identify potential critical habitat for recovering lake sturgeon populations in large lakes.

## Lake Sturgeon Movement in a Southern Lotic Population with Comparisons to Other Populations Across its Range

**Michael Moore**[1]

[1]University of Missouri

2. Craig Paukert, 3. Travis Moore

2. USGS Cooperative Research Unit University of Missouri, 3. Missouri Department of Conservation

The native range of the Lake Sturgeon extends from the Hudson Bay to the Tennessee and Lower Mississippi River Basins and thus occurs over a sharp gradient of environmental conditions. However, biologists know little about Lake Sturgeon behavior at their southern range margin, particularly in lotic systems. We found that 83% of adult Lake Sturgeon movement studies focused on populations within the Great Lakes or Hudson Bay drainages and none focused on populations in the Missouri, Middle or Lower Mississippi, Ohio, or Tennessee River drainages. We use location data of 91 sub adult or adult Lake Sturgeon tagged with acoustic transmitters from March 2017 to July 2018 to characterize seasonal movement patterns in the Osage and Gasconade Rivers in central Missouri. We relocated fish using manual tracking and stationary receivers. In our study, Lake Sturgeon moved nearly twice as far in the spring than summer months and movement remained low during the fall and winter. Spring migrations were related to increases in temperature and flow in both rivers but occurred earlier in the unregulated Gasconade than in the Osage River. Use of Missouri River tributaries was high with some individuals migrating up multiple tributaries during the same spring. Movement declined as temperatures approached 28° C, a proposed threshold of thermal stress for Lake Sturgeon, and flows declined. Similar seasonal movement patterns have been observed in some Mississippi River drainage populations, although tributary use was infrequent. For the few Great Lakes or Hudson River drainage populations where year-round data is available, spring movements were sustained throughout the summer. Range-wide movement assessments will help managers to assess habitat bottlenecks and stock boundaries of Lake Sturgeon in the Missouri River Basin and other southern rivers.

**Recruitment and Overwinter Habitat Use of Juvenile Gulf Sturgeon in the Apalachicola River, FL**

**Nathaniel Hancock[1]**

[1]University of Georgia Warnell School of Forestry and Natural Resources

2. Andrew Marbury, 3. Adam Kaeser, 4. Douglas Peterson

2. & 4. University of Georgia Warnell School of Forestry and Natural Resources, 3. USFWS

The Gulf Sturgeon (*Acipenser oxyrinchus desotoi*) is currently listed as federally threatened because of chronic overfishing and habitat degradation that occurred throughout the 20th century. Although adult life history of Gulf Sturgeon has been well studied, little information is available regarding juvenile life stages. The objectives of this study were to estimate annual recruitment and to quantify overwinter survival and habitat use of age-1 Gulf Sturgeon in the Apalachicola River, Fl. From 2014 through 2017 we acoustically tagged at least 10 age-1 juveniles during the early spring and summer of each year. Using a passive acoustic receiver array deployed throughout the lower estuary and bay, we monitored seasonal movements and survival of the tagged fish to quantify annual survival and to identify high use habitats of the young fish. Acoustic detections obtained during the annual spring migration from the bay to the river, combined with annual recaptures of tagged juveniles, yielded an overwinter survival of 89 percent in 2014, 75 percent in 2015, and 75 percent in 2016. Annual mark-recapture estimates of juvenile cohorts indicated consistent but low recruitment of 46 (95 percent CL; 37-70), 54 (95 percent CL;34-119), 90 (95 percent CL; 73-118), 210 (95 percent CL;190-241), and 22(95 percent CL; 17-27) age-1 juveniles in each respective year. These findings suggest that population recovery is currently limited by slow recruitment to age-1, and not likely a result of poor survival of age-1 juveniles. Further studies are needed to quantify spawning success and to identify other variables affecting juvenile abundance during the first year of life.

**Pallid Sturgeon Migrations, Spawning, and Free Embryo Dispersal in the Yellowstone River and Missouri River, Montana and North Dakota**

**Patrick Braaten[1]**

[1]U. S. Geological Survey, Columbia Environmental Research Center

2. Mathew Rugg, 3. Aaron DeLonay, 4. Caroline Elliott, 5. Robert Jacobson, 6. David Fuller, 7. Tyler Haddix, 8. John Hunziker, 9. Ryan Wilson, 10. Edward Heist

2. Montana Fish, Wildlife and Parks, 3-5. USGS Columbia Environmental Research Center, 6-8. Montana Fish, Wildlife and Parks, 9. U. S. Fish and Wildlife Service, 10. Southern Illinois University

The Missouri and Yellowstone River systems of Montana and North Dakota contain a wild stock of 100-125 reproductively active pallid sturgeon (*Scaphirhynchus albus*), and evidence suggests that natural recruitment in this stock has been eliminated or severely curtailed since the mid-1950s. Throughout the last decade, focused investigations have examined pallid sturgeon reproductive ecology in this portion of the species range with the following objectives: 1) discern the spatial and temporal attributes of pre-spawn migrations, 2) verify spawning and identify locations and timing of spawning events, and 3) verify functionality of reproductive habitats to support oviposition, incubation, hatch, and emergence of free embryos. Pre-spawn migrations primarily occur within the Yellowstone River where hydrologic and thermal regimes are least-altered, but migrations may also occur in the hydrologically and thermally altered Missouri River under some environmental conditions. The spatial extent of pre-spawn migrations varies substantially (80-1,000 km), often involving a continuous series of up- and downstream movements within or between rivers. Male pallid sturgeon aggregate (e.g., 5-15 telemetered fish) at specific locations that function as spawning patches following female arrival. Spawning occurs annually in the Yellowstone River, verified based on the female entry into the male aggregation and changes in pre- and post-spawn reproductive indices. Conversely, only one known spawning event has been verified in the altered Missouri River. Spawning patches are functional as evidenced by the collection of dispersing free embryos in the drift genetically identified as pallid sturgeon. In several cases, dispersing free embryos have been genetically assigned to known parents within the spawning patches. While providing fundamental knowledge on pallid sturgeon reproductive ecology, results provide critical information necessary to guide restoration and management strategies throughout the Missouri River basin.

## Acoustic Telemetry and Benthic Habitat Mapping Informs the Spatial Ecology of Shortnose Sturgeon in the Hudson River, NY, USA

**Rich Pendleton[1]**

[1]New York State Department of Environmental Conservation/Cornell University

2. Christopher Standley, 3. Amanda Higgs, 4. Gregg Kenney, 5. Patrick Sullivan, 6. Suresh Sethi, 7. Bradley Harris

2. New York State Department of Transportation, 3. New York State Department of Environmental Conservation/Cornell University, 4. New York State Department of Environmental Conservation, 5. Cornell University, 6. US Geological Survey/Cornell University, 7. Alaska Pacific University

A history of overexploitation and industrialization of riverine habitats has impacted Shortnose Sturgeon *Acipenser brevirostrum*, leading this species to be one of the earliest listed under the U.S. Endangered Species Act. Presently, understanding spatial ecology of Shortnose Sturgeon is based on observations from a limited number Atlantic coastal rivers. To better understand Shortnose Sturgeon in the Hudson River in NY, USA, we used acoustic telemetry to characterize seasonal habitat use and to identify regions of the river with persistent sturgeon activity. One hundred and one adult fish were tagged and tracked from 2012-2016 and sturgeon persistence (a metric of fish observation standardized by search effort) was evaluated against benthic habitat variables using generalized additive regression models. Models indicated strong habitat associations in the Spring season defined by gravel dominated substrates and specific depth ranges, presumably associated with spawning activity. Sturgeon were more dispersed during Summer associating with muddy habitats, whereas, sturgeon congregated in specific regions of the river that provided energy refugia in the Fall/Winter. These data demonstrate river use and habitat associations vary seasonally and identify important areas for managing overlap between seasonal sturgeon habitat use and human activity on the river.

## Effects of Changes in Alternative Prey Densities on Predation of Drifting Lake Sturgeon Larvae

**Shaley Valentine**[1]

[1]Michigan State University

2. Justin Waraniak, 3. Kim Scribner

2. Michigan State University, North Dakota State University 3. Michigan State University

Predator–prey interactions including prey switching, predator swamping, and size-selectivity are important in maintaining multi-species systems. In fishes, early life stages are often recruitment bottlenecks due to high mortality partially caused by predation. High mortality is of particular concern for threatened species such as lake sturgeon (*Acipenser fulvescens*). Effects of different relative prey densities were examined using two predatory fishes [rock bass (*Ambloplites rupestris*) and hornyhead chub (*Nocomis biguttatus*)] and two density treatments of three prey [lake sturgeon, mayflies (Family: Heptageniidae), and suckers (Family: Catostomidae)]. Treatments consisted of prey introduced to predators in a series of pulses 30 min apart. In the initial low-density treatment, predators were offered prey at a pulse of prey at a 13:13:4 ratio of mayfly, suckers, and lake sturgeon, and a second pulse with a 1:1:1 prey ratio during the second pulse. In the equal-density treatment prey numbers were equivalent during both pulses. Larval sturgeon survival, predator preference, and size selection were measured for each trial. Lake sturgeon were the least preferred prey species while mayflies were positively selected. Hornyhead chub preference for lake sturgeon was higher in the equal-density treatment than in the low-density, indicating initial prey availability affected predator foraging behavior. High densities of preferred macroinvertebrate prey could protect threatened lake sturgeon larvae from predation.

## Preliminary results of Lake Sturgeon spawning migrations into tributaries to Eastern Lake Superior

**William Gardner[1]**

[1]Great Lakes Lab for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada

2. Thomas Pratt, 3. Lisa O'Connor, 4. Steve Chong, 5. Joshua Schloesser, 6. Henry Quinlan

2. & 3. Great Lakes Lab for Fisheries and Aquatic Sciences, Fisheries and Oceans Canada, 4. Upper Great Lakes Management Unit, Ontario Ministry of Natural Resources and Forestry, 5. & 6. Ashland Fish & Wildlife Conservation Office, United States Fish and Wildlife Service

A study on the movements of juvenile and sub-adult Lake Sturgeon (*Acipenser fulvescens*) in Eastern Lake Superior began in 2014 to investigate the basic biology and habitat interactions of this population. We tagged 107 Lake Sturgeon in Goulais and Batchewana Bays in Eastern Lake Superior from 2014-2016 using Vemco acoustic tags. We have deployed 90 Vemco Vr2W and Vr2TX acoustic receivers throughout eastern Lake Superior and in candidate rivers that, historically, have been identified as Lake Sturgeon spawning rivers. To date we have recorded movements of Lake Sturgeon into only 1 of the 5 historical spawning tributaries. This river, the Goulais River, flows west 84 km from an impassable waterfall to Goulais Bay, Lake Superior. It is a shallow river with no hydro development, several rapids, and an abundance of sandy shoals. There are both Spring and fall migrations of Lake Sturgeon into the Goulais River. Twenty Lake Sturgeon have entered the Goulais River over the past 3 springs and spent, on average, 35 days in the river. Less than half of those Lake Sturgeon have been recorded at a receiver 72 river km upstream. Two of the 20 Lake Sturgeon have returned to the Goulais River a second time, first in 2016 and again in 2018. Eleven tagged Lake Sturgeon have entered the Goulais River in the fall and on average, spent one week in the river. Three of these Lake Sturgeon returned to the Goulais River the following spring. Environmental and biological factors, such as temperature, water flow, and pre spawning activity in Lake Superior, as well as age of Lake Sturgeon, that may affect spawning movements will be discussed.

**Juvenile Green Sturgeon, *Acipenser medirostris*, Migration from the Upper Sacramento River to the legal Delta: 2016 -2017**

**William R. Poytress[1]**

[1]US Fish & Wildlife Service

2. Joshua J. Gruber, 3. Chad E. Praetorius

2. & 3. US Fish & Wildlife Service

Until recently, monitoring of the juvenile (>45 days post-hatch) life-history stage of Green Sturgeon, *Acipenser medirostris*, has resulted in minimal information regarding the habitat use and spatial distribution of this critical life stage in the Central Valley of California. Capture of juvenile Southern Distinct Population Segment of the North American Green Sturgeon in fresh water beyond the larval stage in the upper Sacramento River at Red Bluff Diversion Dam has occurred sporadically from multiple salmonid monitoring stations and, intermittently, from entrainment at the South Delta Federal and State Pumping Facilities. These data have resulted in anecdotal observations of a species that is then primarily detected as sub-adults and adults which, in recent years, much information on their habits and habitat use has become available. The lack of basic information on juvenile sturgeon has resulted in the inability of managers to take actions to conserve or protect juvenile Green Sturgeon in the freshwater portion of their life with respect to Central Valley Project and California State Water Projects' operations. Through the use of a benthic trawl and micro-acoustic technologies, the Red Bluff Fish and Wildlife Office has developed a reliable method to consistently catch age-0 juvenile Green Sturgeon rearing in the upper Sacramento River. A multi-year collaborative study to investigate potential drivers of juvenile migration from fresh water to brackish water in relation to environmental cues including temperature, flow, and turbidity is in progress. Information from the 2016 pilot tagging efforts (n=21) and 2017 tagging efforts (n=50) will be presented detailing catch results and migration patterns to the legal Delta observed thus far.

**The Use of Radio Frequency Identification to Characterize Factors Associated with Sperm Concentration in Male Lake Sturgeon**

**Zachary Witzel[1]**

[1]Biological Sciences Department, Western Illinois University, Macomb, IL, 61455

2. Douglas Larson, 3. Jake Kimmel, 4. Edward Baker, 5. Kim Scribner

2. & 3. Department of Fisheries and Wildlife, Michigan State University, 4. Michigan Department of Natural Resources, 5. Department of Ecology, Evolutionary and Behavioral Biology Program, Michigan State University

In many iteroparous species, sperm quality variability affects the outcome of male competitive fertilization success, though few studies examine how migratory behavior affects sperm quality. Using PIT antenna capture data collected at the mouth of the Upper Black River, MI and at the onset of the known spawning area, migratory data was collected from individual Lake sturgeon (*Acipenser fulvescens*) spawning adults in 2017 and 2018. Data on body size was obtained for a subset of adults upon capture on the spawning grounds. Based on Akaike's information criterion and averaged models ($\Delta AIC < 2$) of substantial support, sperm concentration was negatively associated with increased river residency time, greater number of intra-annual migrations, and increased upstream migration time. Sperm concentration was positively associated with larger fork length and longer inter-annual spawning interval. Results suggest varying migratory strategies are utilized by male Lake sturgeon, and that a "trade-off" may exist for each. Results of analysis using the Computer Assisted Sperm Analyzer (CASA), which evaluates sperm motility, velocity and mortality will also be discussed.

## Conservation Genetics

### Genomics and Fine-Scale Population Structure in Lake Sturgeon

**Amy Welsh[1]**

[1]West Virginia University

2. Justine Whitaker, 3. Lucas Price, 4. James Boase

2. University of West Florida, 3. West Virginia University, 4. U.S. Fish and Wildlife Service

As with most species of conservation concern, genetic studies on lake sturgeon have previously focused on microsatellite loci. A suite of 12 microsatellite loci has been used to study lake sturgeon in the Great Lakes. These markers have been useful for detecting population structure in lake sturgeon at a broad scale. In this study, we used techniques that assess genetic variation throughout the genome and compared the results to previous data from microsatellite loci to determine whether fine-scale population structure exists among lake sturgeon in the Great Lakes. We focused on two sites: the St. Lawrence River and the St. Clair River systems. There are multiple spawning sites in both systems, indicating the potential for fine-scale population structure. Samples were analyzed using the 12 microsatellite loci and a technique called Genotyping-By-Sequencing (GBS). The microsatellite loci indicated weak population structure within each system. Discriminant analysis of principal components (DAPC) indicated the presence of three clusters in the St. Clair system and three clusters in the St. Lawrence system. Through GBS, we were able to identify ~10,000 SNPs (i.e., single nucleotide polymorphisms) throughout the lake sturgeon genome. Observed patterns were the same as those identified using microsatellite loci; however, there was greater resolution of the clusters, resulting in higher assignment accuracy. In the case of lake sturgeon, the use of SNPs will likely not change overall patterns observed with microsatellite data, but will likely result in higher resolution and power that will be useful for assignment testing and parentage analysis.

**A Novel Method for Rigorous Estimation of Spawner Number, Ns, Using Colony**

**Andrea Schreier[1]**

[1]University of California Davis

2. Phil Bates, 3. Ken Lepla, 4. Matthew Thorstensen

2. & 3. Idaho Power Company, 4. University of Manitoba

Because the mating behavior of most sturgeons is cryptic, genetic methods are required to determine parental contributions to wild year classes. In systems where parents can't be well sampled, pedigree reconstruction methods can be used to identify sibling relationships in a year class. From this, the number of spawners (Ns) contributing to the year class can be inferred. Colony has been used to estimate Ns in sturgeon studies but a rigorous method to evaluate statistical support of reconstructed families has been lacking. We describe a novel approach to identify inclusive and exclusive probability thresholds associated with known families to provide statistical support for Colony's sibship reconstructions. We developed an analytical pipeline to simulate full-sibling families using empirical genotype data to estimate inclusive and exclusive probability values consistent with true families in a focal population. The pipeline automates Colony runs and allows for rapid evaluation of probability thresholds in hundreds to thousands of replicate runs. We applied this method to estimate Ns in a new repatriation program operating in the Bliss to CJ Strike reach of the Middle Snake River in Idaho. Using simulated data generated from eggs and larvae captured for repatriation in 2015, we identified an inclusive probability threshold of 0.40 and two exclusive probability thresholds of 0.12 and 0.25 that provided a range of Ns estimates into with the true number of parents fell 96-100% of the time. Repatriation sampling in 2015 and 2016 in the Bliss to CJ Strike reach represented 36-98 and 24-82 parents, respectively. Repatriation Ns exceeded the number of broodstock used for conservation aquaculture in that reach as well as the reported number used in other white sturgeon broodstock-based programs. We hope our approach can be applied to better understand reproductive dynamics in wild sturgeon populations to guide management and conservation efforts.

**Molecular Data Quantify Factors Affecting Levels of Larval Lake Sturgeon (*Acipenser fulvescens*) Predation by Piscivorous Fishes in the Black River, MI**

**Kim Scribner[1]**

[1]Michigan State University

2. Justin Warraniak, 3. Edward Baker

2. Michigan State University, 3. Michigan Department of Natural Resources

Predation is a major factor affecting recruitment during early life stages of many fish species. Levels of predation of larval fish has been difficult to quantify using visual observations of morphological features. Development of genetic tools has made predation studies on larval fish more feasible. Potential fish predators of lake sturgeon (*Acipenser fulvescens*) larvae (N=1155) were collected in four 500-m transects dominated by sand (N=2) and gravel (N=2) substrates over 17 days during 2015 and 2016. Sampling of larvae dispersing from spawning areas was also conducted to estimate the nightly abundance of larval lake sturgeon and other potential prey (larvae of other fish species and macroinvertebrates) available to predators. Gastrointestinal (GI) tracts of predatory fish were dissected. DNA was extracted from the GI tract contents, and sturgeon-specific PCR primers that amplify part of the cytochrome oxidase subunit I region of mitochondrial DNA were used to detect the presence of lake sturgeon DNA. Binomial logistic regression was used to assess the relative contributions of biotic (e.g. predator species, biomass of larval sturgeon in the drift) and abiotic variables (e.g. habitat substrate type, lunar phase) to variation in incidences of larval lake sturgeon predation. Metabarcoding using massively parallel sequencing of the 18S gene allowed identification of entire stomach contents, allowing analyses of prey selectivity.

## Production and Verification of Mitotic Gynogens for Development of Genomic Resources in Pallid Sturgeon

**Richard Flamio Jr.**[1]

[1]Center for Fisheries, Aquaculture, and Aquatic Sciences, Southern Illinois University Carbondale

2. Kimberly A. Chojnacki, 3. Aaron J. DeLonay, 4. Marlene Dodson, 5. Rachel M. Gocker,

6. Jeffrey Powell, 7. Edward J. Heist

2-4. U.S. Geological Survey, Columbia Environmental Research Center, 5. & 7. Center for Fisheries, Aquaculture, and Aquatic Sciences, Southern Illinois University Carbondale, 6. U.S. Fish and Wildlife Service, Gavins Point National Fish Hatchery

Pallid sturgeon, *Scaphirhynchus albus*, is a federally endangered species in the Mississippi and Missouri River Basins. Hybridization with sympatric shovelnose sturgeon, *S. platorynchus*, may contribute to its imperiled status. Current methodology cannot genetically discriminate between either species and multigenerational backcrosses although this information is critical for management decisions. Genotypes from a large panel of unlinked single-nucleotide polymorphisms (SNPs) may provide greater resolution of the two species, however, paralogous sequence variants (PSVs) resulting from an ancient whole genome duplication event confound SNP development. We produced *S. albus* mitotic gynogens at the Gavins Point National Fish Hatchery in Yankton, South Dakota. Mitotic gynogens are doubled haploids with homozygous DNA present at each locus. Genomic sequencing of mitotic gynogens will facilitate construction of a reference genome sequence and allow differentiation between single-locus SNPs and intra-individual PSVs. Mitotic gynogens were produced by activating *S. albus* eggs with irradiated paddlefish sperm and exposing the activated eggs to thermal shock treatments. We confirmed the presence of sturgeon-only homozygous DNA in mitotic gynogens using 19 sturgeon microsatellite loci and four paddlefish microsatellite loci. We are currently confirming ploidy level using flow cytometry. Future work will involve isolating high-molecular-weight DNA from these doubled haploids to produce long sequence reads that can be used to develop SNP markers.

## Improvements of Genetic Analyses for Species Discrimination of Acipensiformes Unhatched Embryos

**Tom Kashiwagi[1]**

[1]Center for Fisheries, Aquaculture & Aquatic Sciences, Southern Illinois University Carbondale

2. Rachel Gocker, 3. Patrick Braaten, 4. Kimberly Chojnacki, 5. Aaron DeLonay, 6. Edward Heist

2. & 6. Center for Fisheries, Aquaculture & Aquatic Sciences, Southern Illinois University Carbondale, 3-5. U.S. Geological Survey, Columbia Environmental Research Center

The recovery plan for pallid sturgeon *(Scaphirhynchus albus*) lists identification and characterization of spawning habitat and documentation of spawning success "based on collections of eggs, larvae and young-of-year" as research "necessary for survival and recovery of pallid sturgeon." Pallid sturgeon eggs and embryos are morphologically indistinguishable from shovelnose sturgeon (*S. platorynchus*) and paddlefish (*Polyodon spathula*), which are far more numerous throughout the range of pallid sturgeon. Unfertilized eggs and early-stage embryos contain sufficient mitochondrial DNA to genetically discriminate *Scaphirhynchus* from *Polyodon*. Discriminating between closely-related pallid sturgeon and shovelnose sturgeon embryos requires markers coded by nuclear DNA, which is initially present in insufficient quantities but increases throughout embryo development. To determine the earliest embryonic stage at which pallid sturgeon could be genetically identified, we tested four commercially available DNA isolation kits using artificially spawned pallid sturgeon embryos of various developmental stages from stage 5 (approximately 3-6 hours post fertilization) to stage 33 (near hatch). Parentage analysis based on microsatellite genotypes of the embryos and known parents was used to confirm reliable genotyping. We found that one kit produced nuclear DNA of sufficient quantity and quality to genotype stage-14 embryos (approximately 18 to 36 hours post fertilization depending on temperature) while embryos at earlier developmental stages produced unreliable results. We are currently using these protocols to identify Acipenseriformes embryos collected from the upper Missouri River basin to support identification of habitat and conditions associated with successful pallid sturgeon spawning and embryo development in the wild.

## Aquaculture and Conservation Propagation

### Elemental Marking of Lake Sturgeon Fin Rays to Identify Hatchery Reared Individuals Post Release

**Alison Loeppky[1]**

[1]University of Manitoba

2. W. Gary Anderson

2. University of Manitoba

Stock enhancement programs involve introducing artificially reared fish into wild environments with the goal of increasing the abundance of a particular stock and is frequently used for Lake Sturgeon, *Acipenser fulvescens*. To measure the success of restocking efforts, hatchery produced individuals must be distinguishable from naturally spawned fish post release. Biological tags have been of interest due to their ability to successfully mark whole cohorts in a cost-effective manor. Stable isotope marking involves manipulating the natural isotopic ratio of specific elements to create unique elemental signatures in the hard structures of fish (e.g. fin rays, otoliths). We tested the validity of 24-hour immersion in 86Sr and 137Ba to mark the fin rays of juvenile Lake Sturgeon. At 100 days post fertilization, artificially fertilized Lake Sturgeon were immersed in either 100 µg.L-1 of 86Sr or 137Ba for 24-hours. Thirty days later, the same fish were immersed in the opposite isotope to implement a secondary mark. Fin rays were analyzed for isotopic ratios via LA ICP-MS and results indicated elemental marking at both time points was achieved with 100% success. The ability to implement combinations of isotopic signatures provides hatcheries with the opportunity to track the success of families or stocking groups. In addition, the fin rays of known hatchery released fish (age 1-5 years) were analyzed to identify whether naturally occurring differences in ambient water chemistry could create a distinct elemental signature distinguishable from naturally spawned individuals. Indeed, the concentration of manganese in hatchery-reared fish was significantly lower than wild conspecifics, allowing us to successfully classify hatchery versus wild caught individuals with 98% success negating the need to implement external tags.

## A Comparison of Methods for Determining Ploidy in White Sturgeon

**Aviva Fiske**[1]

[1]University of California, Davis

2. Joel VanEenennaam, 3. Anne Todgham, 4. Shawn Young, 5. Cara Holem-Bell
6. Alisha Goodbla, 7. Andrea Schreier

2. 3. 6. & 7. University of California, Davis, 4. & 5. Kootenai Tribe of Idaho

Release of sturgeon with abnormal ploidy into the wild may result in reduced fitness due to lowered fertility in the F2 and subsequent generations. Further, there is evidence that ploidy affects reproductive development and caviar yield. Therefore, the ability to accurately characterize the ploidy of white sturgeon (*Acipenser transmontanus*) is essential for commercial and conservation aquaculture. This study compares Coulter counter and blood smear data collected from 238 captive white sturgeon originating from two populations (the Kootenai River and the Sacramento River) to ascertain which method provides the most accurate and efficient characterization of ploidy. Flow cytometry is used to validate Coulter counter and blood smear techniques. Previous work suggests that blood smears can distinguish between 8N and 12N sturgeon, but further analysis is required to see if this method can be used to identify 10N fish and to provide robust evidence of its utility in 8N and 12N fish. We demonstrate that Coulter counter has 100% accuracy in ploidy assignment, while blood smears vary in their accuracy based on population, with a high degree of overlap between 8N and 10N individuals as well as some overlap between 10N and 12N individuals. The Idaho population showed overlap between 8N and 12N individuals while the California population did not, highlighting inter-population variability and demonstrating that this technique might be useful for identifying 8N and 12N individuals in some populations. Although blood smears are time-intensive and vary in their ploidy assignment accuracy, they are a low-cost technique and may have some utility for caviar farms aiming to identify 12N individuals in a small number of broodstock. By comparing the accuracy, efficiency and cost of these three methods, sturgeon farmers and conservation hatcheries will be able to choose the best method for their needs in determining the ploidy of their fish.

**Development of Predictive Egg Quality Indicators in Paddlefish: Egg Morphology, Tissue Culture, and Hormonal Indicators**

**Benjamin Thomas[1]**

[1]Missouri Department of Conservation & University of Central Missouri

2. Scott Lankford

2. Missouri Department of Conservation & University of Central Missouri

In the past, Blind Pony Fish Hatchery (BPH) has experienced inconsistent ovulation, fertility, and development rates in female paddlefish. Even if ovulation occurs, some paddlefish eggs stop developing prematurely; at times only half of the paddlefish spawned have resulted in usable fry. This inconsistency decreases the effective management of the put-grow-take paddlefish fishery, as well as drives up MDC's production costs. This project aims to develop a paddlefish broodstock ranking index for both egg quality and spawning readiness. The goal is to improve MDC's efficiency in selecting fish that will spawn in response to the hormonal injection and produce high-quality progeny that are more likely to survive the rearing process. Due to the limited knowledge available on paddlefish reproduction there are sparse techniques and spawning protocols available, and even fewer molecular assays. Because of this, the creation of a broodstock ranking index requires the development and optimization of the required scientific end points. The specific end points to be evaluated include spawning readiness indicators (i.e., egg polarity index [PI], and egg bioassay) and egg/progeny quality indicators (i.e., plasma estradiol, testosterone, and cortisol concentrations). The data presented were developed from tissues collected during the spawning of the 2015, 2016, 2017, and 2018 year classes and include the optimization data required to validate the following endpoints: PI, egg bioassay, and the hormone concentrations of estradiol, testosterone, and cortisol.

## Incidence of Spontaneous Auto-Polyploidy in Hatchery and Wild Lake Sturgeon Populations

**Doug Aloisi[1]**

[1]USFWS/Genoa NFH

2. Jennifer Bailey, 3. Megan Bradley, 4. Nathan Eckert

2-4. Lacrosse Fish Health Center, USFWS, Genoa NFH, USFWS

In a white sturgeon hatchery program on the Kootenai River, geneticists from the University of California Davis discovered spontaneous autopolyploidy was occurring, with a genome size 1.5 times that of their normal wild counterparts (Schreier et al. 2013; Gille et al. 2015). While normal white sturgeon are ancient octoploids (8N) with ~250 chromosomes, spontaneous autopolyploid white sturgeon are dodecaploid (12N) with ~360 chromosomes. Although 12N white sturgeon are fertile and produce 10N offspring when crossed with 8N white sturgeon, mating between 10N individuals with either 8N or 12N individuals would produce aneuploid offspring (odd number of chromosomes) that may exhibit reduced fertility. Lake sturgeon are also ancient octoploids, with ~240 chromosomes (8n) (Fopp-Bayat and Woznicki. 2006; Havelka et al., 2011). Therefore a spontaneous autopolyploidy (12N) lake sturgeon would also possess 360 chromosomes. This study researched the incidences of spontaneous autopolyploidy in two strains of cultured lake sturgeon spawned from wild brood pairs in the Wolf River, WI and the St. Lawrence River, NY, to deduce whether spontaneous autopolyploidy is occurring and estimate at what level that it may occur. Previous research (Schreier, et al, 2013) suggested that hormone manipulation may play a role through fertilizing eggs that have been collected hours past ovulation. Current spawning protocols for lake sturgeon on the St. Lawrence River strain call for hormone injection with carp pituitary and Lhrha to induce egg expression. Incidence of spontaneous autopolyploidy was examined from the St. Lawrence River strain of lake sturgeon that were induced and the non-hormone injected Wolf River strain. Pre-stocking samples were also taken from fall fingerlings to determine polyploidy incidence among random samples from 5 distinct strains.

**Effects of Poly Unsaturated Fatty Acid Enriched Artemia on Growth, Fatty Acid Ccompositions, Energy Density and Aerobic Scope of Age-0 Lake Sturgeon, *Acipenser fulvescens***

**Gwangseok Yoon[1]**

[1]University of Manitoba

2. Michael E. Yusishen, 3. Miyoung Suh, 4. W. Gary Anderson

2. Department of Biological Sciences, University of Manitoba, 3 & 4. Department of Food and Human Nutritional Science, University of Manitoba

Diet plays a significant role in phenotypic development during early life history in vertebrates, and dietary manipulation has been a common practice in aquaculture to promote growth performance and resistance to environmental stressors. Specifically, previous studies have shown that dietary intake of poly unsaturated fatty acid (PUFA) during larval development could improve growth performance in many teleosts as well as White Sturgeon, *Acipenser transmontanus*. In this study, we examined the effects of artemia enriched with PUFA on growth, fatty acid compositions, energy density and aerobic scope of age-0 Lake Sturgeon. A feeding trial was conducted for 3 weeks where larval lake sturgeon was fed either freshly hatched non-enriched artemia (control) or artemia enriched with Easy DHA Selco® for 24 hours (experimental) following the manufacturer's instructions. Fish fed with the enriched artemia showed significantly lower body mass and energy density without altering aerobic scope compared to control group ($p<0.01$). Longer term effects of dietary intake of PUFA on energy metabolism will be discussed in the context of conservation aquaculture of Lake Sturgeon, an endangered species across most of its natural range in North America.

## Reducing Hatchery Production of 12N White Sturgeon

**Joel Van Eenennaam[1]**

[1]University of California, Davis

2. Anne Todgham, 3. Fred Conte, and 4. Andrea Schreier

2-4. University of California, Davis

Triploid (12N) white sturgeon (*Acipenser transmontanus*) have been detected in progenies at both conservation and commercial aquaculture hatcheries, from wild-caught and domestic broodstock, respectively, and there is genetic evidence it has a maternal origin, from the retention of the seco0nd polar body in fertilized eggs. In general, the cause is hypothesized to be a combination of low0 quality eggs that are then exposed to in vivo aging and/or physical shock during de-adhesion procedures, while good quality eggs tolerate some aging and/or shock with low incidence of 12N's. Guidelines for the production of high quality eggs will be reviewed, including spawning at an optimal stage of maturity which requires an accurate measurement of the oocyte polarization index (PI), and not waiting too long after the last PI check to induce spawning. The reduction of in vivo egg aging can be accomplished by regular monitoring of females for first oviposition, and then collecting ovulated eggs at an optimal time. The optimal time will depend on the egg collection technique used, the size of the female, water temperature, and the rate of oviposition. During the de-adhesion procedure, a very gentle mixing will minimize any physical shock to the eggs, as we have determined that there is an increase in 12N production in eggs that have been silted too vigorously. If selected female broodstock are induced to spawn at an optimal PI, and the ovulated eggs are observed, collected, and fertilized in a timely manner, and handled gently, the incidence of 12N's in white sturgeon hatcheries can be reduced.

## Physiological Differences of Stress and Metabolic Responses in Diploid and Triploid White Sturgeon

**Michaiah Leal**[1]

[1]University of California, Davis

2. Joel P. Van Eenennaam, 3. Andrea D. Schreier, 4. Anne E. Todgham

2-4. University of California, Davis

In aquaculture, ploidy (number of chromosome sets) is often manipulated to achieve sterility to increase growth rates and reduce mating with wild stocks. Previous studies have demonstrated reduced performance in triploid salmonids when reared under suboptimal conditions, suggesting potential physiological costs associated with triploidy. Spontaneous autopolyploid white sturgeon (*Acipenser transmontanus*) have been discovered at both caviar farms and conservation hatcheries. Little attention has been paid to triploid sturgeon physiology, yet it is not clear if physiological performance is reduced in triploid sturgeon. Physiological performance, such as metabolic capacity and the ability to mount a stress response, can affect survival of sturgeon after release into the wild or in a production facility. The goal of our research is to investigate differences in the capacity of triploid white sturgeon to respond to chronic warming and acute stressors common in aquaculture. We examined the response to stressors through bioindicators of the generalized stress response, hematology, and aerobic performance. Our results suggest that key metabolic enzymes differ between ploidies, especially under warming conditions. Additionally, chronic exposure to elevated temperatures impacted the ability of white sturgeon to mount a typical stress response to an acute stressor. Differences in whole animal metabolism and aerobic scope will also be discussed.

**The Influence of Different Hatchery Rearing Techniques on the Development of Larval Lake Sturgeon**

**William Bugg[1]**

[1]University of Manitoba

2. Madison Earhart, 3. Jordan Kroeker, 4. Cobi Wiwchar, 5. Gary Anderson, 6. Ken Jeffries

2-6. University of Manitoba

In fish, changes in early rearing environment can have implications for an individual's long-term fitness and survival. In hatcheries, sturgeon embryos are typically reared in tumbling jars until hatch. This deviation from natural early rearing environments may have significant effects on the development of larval fish. The purpose of this experiment is to investigate the effects of tumbling jars on Lake Sturgeon *(Acipenser fulvescens*) development. Eggs and sperm collected from wild-caught spawning Lake Sturgeon were fertilized at the University of Manitoba. Full sibling eggs were placed half in tumbling jars with a flow rate of 0.13m/s while in the non-tumbled treatment embryos were allowed to adhease to a mesh substrate and provided with water flow of approximately 0.17m/s. Pre-hatch, embryo diameter and developmental stage was assessed daily. After hatching, larvae were evenly distributed equally between tanks and provided with bio-balls as substrate which were removed gradually as feeding behavior was observed. Occurrence of feed and release of anal plugs was observed at the same time between treatments. Post-hatch, individuals were sampled and measured for whole-body cortisol concentration, gene expression and growth weekly. Genes of interest include beta-actin, GAPDH, and StAR to evaluate changes in growth rate, metabolism, and steroidogenesis. Throughout embryogenesis (days 1-5 and day 8) non-tumbled embryos were larger in diameter than their tumbling jar counterparts ($P < 0.05$). Growth, in terms of body weight and length, was greater in non-tumbled fish throughout post hatch development, significantly so at 21 DPF ($P < 0.05$), 28 DPF ($P < 0.00001$), and 35 DPF ($P < 0.001$). Dry mass analysis of 28 DPF larvae show that while treatments have similar wet to dry mass ratios (10.8% non-tumbled vs 10.5% tumbled), non-tumbled larvae had 6.9% more dry mass. Data will be discussed in the context of larval Lake Sturgeon development.

# Global Sturgeon and Caviar Productions from the Beginning of Farming to 2017

**Paolo Bronzi**

## Habitat Restoration

### Pallid Sturgeon Spawning Habitat on the Lower Missouri and Yellowstone Rivers: What is it, Where is it, and How do we Know if it is Working?

**Caroline Elliott**[1]

[1]U.S. Geological Survey

2. Aaron J. DeLonay, 3. Patrick J. Braaten, 4. Robert B. Jacobson

2-4. U. S. Geological Survey

The pallid sturgeon (*Scaphirynchus albus*) inhabits sand-bedded rivers in the Mississippi River Basin and has experienced a decline generally associated with the fragmentation and alteration of river systems. From 2008 to 2018, we have conducted assessments of habitats supporting spawning, embryo incubation, and hatch on the Missouri and Yellowstone Rivers to quantify the physical characteristics of the spawning habitat: depth, velocity, and substrates. Reproductive pallid sturgeon were tracked to spawning locations by field crews using either acoustic or radio telemetry, and sturgeon were recaptured soon after the spawning event to validate that eggs had been released. Spawning habitat was characterized at the patch and reach scale using hydroacoustic tools including a multibeam echosounder, sidescan sonar, an acoustic Doppler current profiler, acoustic imaging sonars, and a variety of sediment sampling techniques. On the Lower Missouri River, spawning has occurred in discrete locations dispersed over hundreds of river miles in patches located on the outside of channelized bends in relatively deep and fast areas. Lower Missouri River spawning patches have mean depths of 5.1−7.7 m and mean depth-averaged velocities from 1.2−1.6 meters per second. Bank revetment, bedrock, and moving sand dunes have been mapped in these spawning patches. On the Yellowstone River, pallid sturgeon spawning has been documented in a 10-km long reach near Fairview, North Dakota just upstream from the confluence with the Upper Missouri River. Spawning patches used by pallid sturgeon within the larger reach have changed from year to year. Mean depths of Yellowstone River spawning patches range from 2.5-4.1 meters and mean depth-averaged velocities are 0.8-1.1 meters per second. Yellowstone River substrates in spawning areas include moving sand dunes, and small gravel patches. Assessments of spawning conditions in the less-altered Yellowstone River provide design criteria for restoration efforts in the highly-engineered Lower Missouri River.

## If You Build it Will They Stay? Maturation and Longevity of Artificial Fish Spawning Reefs in the St. Clair-Detroit River System

**Jason Fischer**[1]

[1]University of Toledo

2. Edward Roseman, 3. Christine Mayer, 4. Todd Wills

2. United States Geological Survey, Great Lakes Science Center, 3. University of Toledo, 4. Michigan Department of Natural Resources, Lake St. Clair Fisheries Research Station

Artificial rock reefs have been used to remediate spawning substrates for lithophilic spawning fishes (e.g., Lake Sturgeon, *Acipenser fulvescens*; Lake Whitefish, *Coregonus clupeaformis*; and Walleye, *Sander vitreus*) in the St. Clair-Detroit River System. Early projects used species specific metrics (e.g., proximity to historic spawning locations) to guide reef placement. However, long-term success of some of the initial reefs was compromised by accumulation of fine sediments. Therefore, to improve the likelihood of successful reef function, geomorphological criteria were incorporated into project development of reefs constructed after 2013 to identify sediment sources and depositional zones. To evaluate the effectiveness of the revised placement process, we quantified physical maturation of artificial reefs using annual side-scan sonar surveys beginning in 2014 and underwater video surveys beginning in 2015, both surveys continued to through 2017. Reef areas and bottom roughness were measured from sonar surveys and underwater video was used to quantify sediment composition. Roughness of reefs developed using geomorphological criteria remained greater than bottom roughness in areas adjacent to the reefs, however, roughness of the Hart's Light Reef was significantly lower at age three compared to age zero, indicating some sediment accumulation. Similarly, sediment composition and the prevalence of reef rock was similar across ages, expect for at Hart's Light Reef, where dreissenid mussel shells composed 32% of the substrate by age three. Overall, reefs constructed after 2013 remained exposed and continued to be used by spawning fishes, indicating geomorphological placement criteria can improve the longevity of reef remediation projects in large waterways.

## Pallid Sturgeon Seasonal habitat Selection in a Large Free-Flowing River, the Lower Mississippi River

**Patrick Kroboth**[1]

[1]Mississippi State University

2. Dylan A. Hann, 3. Michael E. Colvin, 4. Paul D. Hartfield, 5. Harold L. Schramm, Jr.

2. Previously at Mississippi State University; Currently: Arkansas Game and Fish Commission, 3. U.S. Fish and Wildlife Service, 4. U.S. Geological Survey Mississippi Cooperative Fish and Wildlife Research Unit (retired) 5. Arkansas Game and Fish Commission

The pallid sturgeon *Scaphirhynchus albus* is an endangered riverine sturgeon native to the Mississippi and Missouri rivers, and declining numbers have been attributed to multiple stressors, including habitat loss and alteration. The lower Mississippi River, although altered for navigation, provides a free-flowing system with a wide range of habitats and an only slightly altered hydrograph in comparison to upstream river segments; as such it provides a useful context to assess pallid sturgeon habitat selection. We applied a discrete choice model comparing changes in available habitats among hydrologic stages to observed habitat use of 102 telemetry tagged pallid sturgeon at two study reaches, testing habitat selection among stages and water temperatures. Analysis of telemetry data indicate habitat selection varied by river reach, water temperature, and stage but habitat selection appears to be strongly influenced by preference for sites with moderate depth (median 11.7 m; lower and upper quartiles 8.1 m and 16.3 m) and moderate current velocity (median 0.9 m/s; lower and upper quartiles 0.7 m/s and 1.2 m/s).

## Lake Sturgeon Response to a Decade of Spawning Habitat Restoration in the St. Clair-Detroit River System

**Robin L. DeBruyne[1]**

[1]University of Toledo, Lake Erie Center

2. James C. Boase, 3. Dustin Bowser, 4. Justin A. Chiotti, 5. Jaquelyn M. Craig, 6. Richard Drouin, 7. Jason L. Fischer, 8. Robert D. Hunter, 9. Stacey A. Ireland, 10. Gregory W. Kennedy, 11. Christine M. Mayer, 12. Edward F. Roseman, 13. Todd Wills

2. & 4. U.S. Fish and Wildlife Service, 3. & 5. U.S. Geological Survey, 6. Ontario Ministry of Natural Resources and Forestry, 7. University of Toledo, Lake Erie Center, 8. Michigan State University, 9. & 10. U.S. Geological Survey, 11. University of Toledo, Lake Erie Center, 12. U.S. Geological Survey, 13. Michigan Department of Natural Resources, Fisheries Division

Historically, lake sturgeon (*Acipenser fulvescens*) were abundant in the Laurentian Great Lakes connecting channel, the St. Clair - Detroit River System (SCDRS). However, by 1925 the removal of river bottom substrates greatly reduced spawning habitat and contributed to the decline of lake sturgeon populations in these rivers. To restore functional fish spawning habitat and remove beneficial use impairments, several reefs totaling >24 acres have been constructed throughout the SCDRS over the past 10 years. Here we examine the adaptive management process used, as well as the pre- and post-construction physical and biological monitoring efforts for egg deposition and larvae to determine if lake sturgeon, and other species, use the reef for spawning. Eggs were sampled using egg mats and larvae were sampled during nocturnal drift with benthic D-frame nets and depth-stratified conical nets deployed upstream and downstream of the reef. No eggs were collected at reference sample sites prior to construction; however, lake sturgeon eggs were collected on the reef material immediately after construction. Examination of larval drift collections downstream of the reefs show successful incubation and hatch of the eggs deposited on the reef, indicating that the reefs are providing functional spawning habitat for lake sturgeon. Thorough pre- and post-monitoring provides information critical to the adaptive management approach to restoration and to aid the recovery of lake sturgeon in the SCDRS.

# Management

## Genetic Origins and Movement of Lake Sturgeon in the St. Louis River and Western Lake Superior

**Kayden Estep**[1]

[1]University Wisconsin-Stevens Point

2. Justin VanDehey, 3. Joshua Rabbe, 4. Patrick Schmalz, 5. Deserae Hendrickson, 6. Dan Wilfond, 7. Andrew Carlson, 8. Paul Piszczeck, 9. Brian Borkholder

2. & 3. University of Wisconsin-Stevens Point, 4-7. Minnesota Department of Natural Resources, 8. Wisconsin Department of Natural Resources, 9. Fond Du Lac Natural Resources

Lake Sturgeon *Acipenser fulvescens* were extirpated from the St. Louis River (SLR) by the early 1900's. Improvements in water quality and habitat, and virtual elimination of exploitation led to efforts by resource management agencies to re-establish Lake Sturgeon in the SLR. Lake Sturgeon from the Wolf River (Lake Michigan) were stocked from 1983-1994. Lake Sturgeon from the Bad (1988) and Sturgeon rivers (1998-2000), Lake Superior sources, were also stocked into the SLR. Recently, natural reproduction has been documented, however questions still exist about the genetic origins and movements of spawning fish. Our objectives were to determine (1) the genetic origin of Lake Sturgeon collected in the SLR and (2) if Lake Sturgeon remain in the SLR throughout the year or emigrate into Lake Superior. During the spring of 2016, 2017, and 2018 ,712 adult Lake Sturgeon were collected in the SLR; 134 were implanted with acoustic transmitters. A majority of fish sampled in 2016 and 2017 (n = 322/383; 84%) genetically assigned to the Wolf River strain. By autumn of 2017, 50 tagged fish exited the SLR into Western Lake Superior while 55 fish remained in the SLR. Emigration to Lake Superior from the SLR peaked during late May and June in 2016 and 2017. Knowledge of genetic origins and movement will aid in management for this species of concern in Lake Superior and throughout the Great Lakes Basin.

## Three Obstacles to Recovering Pallid Sturgeon in the Missouri River

**Michael Mac**

USGS, retired

With the Congressional authorization of a stakeholder committee (Missouri River Recovery Implementation Committee, MRRIC) to advise the Corps of Engineers on the Missouri River Recovery Program, there is significantly more public involvement in the restoration of pallid sturgeon (*Scaphirhynchus albus*) than one would typically see for most endangered species. Recovering the pallid sturgeon was already a daunting task but, as previous MRRIC Chair, I feel the stakeholder involvement and increased visibility of the species will contribute additional obstacles to recover of which I have identified three.

1) Life History: A complex life history combined with highly altered habitat translates to a need for extensive investment in research to understand the reproductive biology of this species. Stakeholders can lose patience with science as they are looking for more immediate and well-defined actions. Adaptive management, critical to the learning process, is viewed by some as high risk while adding uncertainty to river management actions.

2) Economics: Recent efforts to deliver an Environmental Impact Statement on the operations of the Missouri River system highlighted two primary economic drivers related to river flows: hydropower, and flood- risk reduction. While the natural hydrograph provides flows thought to be necessary for the different life stages of the pallid sturgeon, it is often at odds with the primary economic drivers.

3) Politics: Missouri River infrastructure supports agriculture, municipal water supply, and power generation, among other socioeconomic benefits. This translates into significant political interest in maintaining status quo on the river. Since establishment of MRRIC, some members have opted to seek congressional assistance resulting in political fixes on occasions of potential challenge to status quo. This practice could easily continue.

MRRIC's presence yielded benefits to the recovery process, however, for collaboration to be ultimately successful, all parties must have a need to negotiate.

## Lake Sturgeon Recovery in the Sturgeon Falls Section of the Menominee River

**Mike Donofrio**

Wisconsin DNR

Prior to the 19th and early 20th centuries, lake sturgeon from Lake Michigan could ascend the Menominee River to Sturgeon Falls, a natural barrier. Sturgeon Falls is 75 river miles upstream from the river mouth. Lake sturgeon (*Acipenser fulvescens*) were extirpated from the 21 mile Sturgeon Falls section of the Menominee River for several decades after construction of five lower river hydroelectric dams effectively blocked fish passage. This river section is bound on the downstream end by the Chalk Hills hydroelectric dam and upstream by the Sturgeon Falls dam. Sturgeon populations exist downstream of Chalk Hills dam through natural recruitment. From 1994 to 2017, Wisconsin DNR stocked 77,170 large fingerling and yearling fish to restore this species to the Sturgeon Falls river section. Those fish were progeny from feral sturgeon from the lower Menominee River and reared at a state hatchery. Twelve percent (9,558) of the stocked sturgeon were PIT tagged from 1999-2017. Electrofishing events from 2007-2018 captured 360 lake sturgeon and 255 were PIT tag recaptures. 19% of those recaptures had a total length exceeding 40 inches indicating good growth from the juvenile stock size. The recapture rate for stocked yearlings was 0.05 while the rate for large fingerlings was only 0.001. Two acoustic telemetry studies in 2010-11 and 2017-18 revealed that 109 stocked yearling sturgeon stocked with 3,657 non-transmitter fish remained in this river section during the first year post stocking. While downstream migration was documented throughout this river section, no stocked sturgeon were detected downstream of Chalk Hills dam. Wisconsin DNR suspended stocking in 2017 to further evaluate recovery including future documentation of natural recruitment in the upper Menominee River.

## Engaging Science to Manage a Very Rare Fish in a Very Large River – Pallid Sturgeon in the Missouri River

**Robert Jacobson**[1]

[1]USGS - CERC

2. Michael Colvin, 3. David Marmorek

2. Mississippi State University, 3. ESSA Technologies

The Missouri River Recovery Program (MRRP) seeks to revise river-management strategies to avoid jeopardizing the existence of three species: pallid sturgeon (*Scaphirhynchus albus*), interior least tern (*Sterna antillarum*), and piping plover (*Charadrius melodus*). Managing the river to maintain populations of the terns and plovers is relatively straightforward: reproductive success can be modeled with some certainty as a direct function of exposed sandbar area. In contrast, the pallid sturgeon inhabits the bottom of a deep, turbid river and many parts of its complex life history are not directly observable. Hence, pervasive uncertainties exist about factors limiting population growth and what management actions may reverse population declines. Uncertainties are being addressed by the MRRP through a multi-step process. The first step was an Effects Analysis (EA), which: documented what is known and unknown about the river and the species; documented quality and quantity of existing information; used an expert-driven process to develop conceptual ecological models and to prioritize management hypotheses; and developed quantitative models linking management actions (flows, channel reconfigurations, and stocking) to populations. The EA led to development of a science and adaptive-management plan with prioritized allocation of investment among 4 levels of effort ranging from fundamental research to full implementation. The plan includes learning from robust, hypothesis-driven effectiveness monitoring for all actions, with statistically sound experimental designs, multiple metrics, and explicit decision criteria to guide management. Finally, the science plan has been fully integrated with an adaptive-management structure that links science to decision makers. The reinvigorated investment in science stems from the understanding that costly river-management decisions are not socially or politically supportable without better understanding of fish responses. While some hypotheses can be evaluated without actually implementing management actions in the river, assessing the effectiveness of other forms of habitat restoration requires in-river implementation within a rigorous experimental design.

## Acipenserid herpesvirus 1 in Lake Sturgeon (*Acipenser fulvescens*) of Wisconsin

**Ryan Koenigs**[1]

[1]Wisconsin Department of Natural Resources

2. Danielle Goddard, 3. Ryen Kleiser, 4. Thomas Waltzek, 5. Logan Walker, 6. Susan Marcquenski

2. & 3. Wisconsin Department of Natural Resources, 4. & 5. University of Florida, 6. Wisconsin Department of Natural Resources (Retired)

Acipenserid herpesvirus 1 (AciHV1) was first isolated from moribund farmed juvenile white sturgeon (WS; *Acipenser transmontanus*) in California and later in Europe on an Italian farm rearing WS. In 2017, two apparently healthy adult lake sturgeon (LS; *Acipenser fulvescens*) were collected from the Wolf River in Wisconsin that presented with generalized cutaneous lesions similar to those observed in infected WS. Skin scrapes were sent for PCR analysis, and results were positive for the AciHV1 in both fish. This was the first confirmed observation of the AciHV1 virus in LS. Samples from an additional 10 fish were PCR tested from the Wolf River in 2018, with 9 of the 10 fish testing positive for AciHV1. These findings have prompted the Wisconsin Department of Natural Resources to conduct surveillance of other LS populations to determine the distribution of AciHV1. At this time, a single fish from the Menominee River has tested positive. LS from the Bad River within the Lake Superior drainage have also showed lesions similar to those observed within the Wolf River, but samples have not yet been collected to confirm AciHV1. Continued monitoring of LS populations in Wisconsin and throughout North America is warranted to evaluate the current distribution of the virus, and document potential spread. Additional research is also important to understand the transmission and life history of the virus and evaluate potential impacts on wild and hatchery reared fish.

## A Structured Decision Making Approach to Redesigning the Pallid Sturgeon Population Assessment Program

**Sara Reynolds**[1]

[1]Mississippi State University

2. Michael Colvin, 3. Robert Jacobson, 4. Tim Welker, 5. Landon Pierce, 6. Kirk Steffensen, 7. David Marmorek

2. Mississippi State University, 3. U.S. Geological Survey, 4. U.S. Army Corps of Engineers, 5. U.S. Fish and Wildlife Service, 6. Nebraska Game and Parks Commission, 7. ESSA Technologies Ltd.

Pallid Sturgeon (*Scaphirhynchus albus*), a species found in the Missouri and Lower Mississippi Rivers, was listed as "endangered" in 1990. The Pallid Sturgeon Population Assessment Program (PSPAP) was initiated in 2003 to monitor the trend of Pallid Sturgeon in the Missouri River using a standardized assessment to estimate relative abundance with catch. Recent modifications to the Missouri River Recovery Program (MRRP) specified objectives and metrics that included Pallid Sturgeon population abundance, and required improved understanding of links from actions to population responses. The need to redesign the PSPAP, a process affecting state and federal agencies collecting monitoring data, was triggered by the recognition that the current program could not provide sufficiently reliable Pallid Sturgeon abundance estimates. We used a structured decision making approach to elicit MRRP and stakeholder objectives, identifying 5 fundamental objectives for a population monitoring program. Simulation modeling was applied to candidate monitoring designs to evaluate their performance in achieving the objectives while accounting for uncertainty. Simulation outcomes were scaled and weighted to provide an overall utility for each monitoring design and then synthesized into a decision support-tool. We show how this tool can be used to incorporate learning, facilitate iterative monitoring program revisions, and address budgetary uncertainties.

**Paddlefish Exploitation and Movements within the Mississippi River Basin**

**Thomas Devine[1]**

[1]Southeast Missouri State University

2. Sara Tripp, 3.Nick Kramer

2. Missouri Department of Conservation, 3.Kansas Department of Wildlife, Parks, and Tourism

The American Paddlefish *Polyodon spathula* is an ancient species native to the Mississippi River and its larger tributaries. This species exhibits a unique combination of morphology and life history characteristics that leaves them vulnerable to negative impacts caused by river modification and the potential for overexploitation. This has led to population declines in portions of the historic range. Concern regarding unknown exploitation rates from sport and commercial fisheries has increased in recent decades and the Convention on International Trade of Endangered Species is now seeking information from state agencies regarding the sustainability of commercially harvested Paddlefish Populations. The Missouri Department of Conservation is addressing this through the implementation of a five year study on exploitation of Paddlefish in the Mississippi River. The first two years of this project found that minimal exploitation of Paddlefish along Missouri's eastern border with an exploitation estimate of 4.01% (SE=0.02). The third and fourth year of this study we focused on tagging more paddlefish with jaw bands and transmitters to further evaluate current exploitation rate and better understand paddlefish movement patterns in the Mississippi River and its tributaries. We found that paddlefish are moving great distances and crossed many regulatory boundaries. Despite low exploitation rate estimates, when information from this study is combined with previous work, a precautionary adjustment of regulations is advised to protect Paddlefish through maturation and ensure sustainability. In addition, Paddlefish regulations should be assessed across the entire Mississippi watershed, as regulations differ within and between regulatory and state boundaries. A combination of population monitoring (e.g. exploitation and population dynamics) and telemetry efforts have the potential to help inform future basin wide management approaches.

## Combining a Mark and Recapture Study with a Creel Survey to Estimate Abundance and Exploitation of Paddlefish in Webber's Falls Reservoir, Oklahoma

**Adam Geik**[1]

[1]Oklahoma Department of Wildlife Conservation

2. Jason Schooley

2. Oklahoma Department of Wildlife Conservation

The recreational paddlefish fishery at Fort Gibson Dam on Webber's Falls Reservoir is unique in Oklahoma. Upstream hydropower generation and liberal accessibility regulations allow recreational anglers to access paddlefish well into the summer, when other fisheries have ceased. Additionally, paddlefish have the potential to congregate at the tailwater from several different sources. Resident or downstream migrant paddlefish from the Neosho, Verdigris, Canadian, and Arkansas river systems could all feasibly converge at Fort Gibson Dam in substantial numbers when an attractant flow is present due to dam releases. Concerns of overfishing prompted an investigation into paddlefish population abundance, fishing pressure, and angler demographics. Three hundred paddlefish were captured with gill nets in Webber's Falls reservoir and tagged with jaw bands in December 2017 and January 2018. A creel survey will be conducted from May through August 2018 to collect data on paddlefish morphometry, angling pressure, angler demographics, and catch-and-release mortality. The number of tagged fish harvested in the creel will be used to estimate population abundance. Exploitation will be estimated using the abundance estimate and the harvest rates collected in the creel survey.

**Exploitation of Paddlefish in Missouri's Large Reservoirs**

**Dustin Broaddus[1]**

[1]Southeast Missouri State University

2. Sara Tripp

2. Missouri Department of Conservation

Creating reservoirs on large rivers drastically alters the habitat utilized by species occupying these modified aquatic environments. Large reservoirs transform habitat from predominately lotic to more lentic environments that potentially floods historic spawning grounds and blocks migratory pathways. As such, these anthropogenic modifications have been shown to influence species that have developed life history attributes (e.g., spring spawning migrations) associated with riverine environments. For example, Paddlefish populations throughout much of Missouri have been subject to the aforementioned human induced modifications and because of this, reservoirs are maintained through stocking. The sport of snagging is gaining popularity and thus there is an increased emphasis to evaluate the potential risk of overexploitation. Therefore, to estimate current exploitation rates, Paddlefish were sampled four years using hobbled gill nets, in three of Missouri's large reservoirs (Lake of the Ozark, Table Rock, and Harry S. Truman). Each Paddlefish was jaw tagged and 100 reproductive adults were implanted with ultrasonic transmitters in each reservoir. Exploitation was estimated as the percent of tagged fish harvested. To account for non-reporting we estimated tag reporting rates using two methods. Postcards were used as surrogates for tags to assess the willingness of snaggers to return a tag and we also used the number of transmitters that were neither reported harvested or detected within the telemetry array as a measure of non-reporting. Our results will provide insight into the exploitation of Paddlefish and aid in future management of these reservoir Paddlefish populations in Missouri.

## Trends from 22 Years of Lake Sturgeon Assessments in the St. Clair System

**Andrew Briggs**[1]

[1]Michigan Department of Natural Resources

2. Mike Thomas, 3. Brad Utrup, 4. Jan-Michael Hessenauer, 5. Todd Wills, 6. Justin Chiotti, 7. James Boase

2-5. Michigan Department of Natural Resources,
6. & 7. U.S. Fish and Wildlife Service

Michigan Department of Natural Resources staff at the Lake St. Clair Fisheries Research Station (LSCFRS) have been conducting Lake Sturgeon assessments in Lake St. Clair and the St. Clair River, home to one of the largest Lake Sturgeon populations in the Great Lakes, for 22 years. Setlines and trawls have been the primary survey techniques with all captured fish being tagged for population assessment. This large historical dataset on a relatively large population of Lake Sturgeon allows for unique opportunities to examine trends and answer questions that otherwise would not be feasible. Lake Sturgeon catch rates on setlines have remained relatively consistent throughout the survey years while trawl catch rates declined during the mid-2000s, presumably due to increased water clarity. Catches of juvenile Lake Sturgeon have increased in recent years on setlines and have declined in trawls. Since 2001 when the LSCFRS began double-tagging Lake Sturgeon with both passive integrated transponder (PIT) and monel tags, PIT tags have had an overall retention rate of 99% and monel tags an overall retention rate of 88%. Floy loop tags used by the U.S. Fish and Wildlife Service on Lake Sturgeon in the St. Clair-Detroit River System have had an overall retention rate of 64%. Additionally, the St. Clair River and Lake St. Clair have a harvest season for Lake Sturgeon and anglers have been required to register harvested Lake Sturgeon since 1999. Based on tag return rates and sturgeon harvest numbers, angling pressure for Lake Sturgeon has been increasing and harvest rate of sturgeon caught within the 42 – 50 inch slot limit during the harvest season is approximately 16%.

**Environmental Factors in Relation to Sampling Gear Effectiveness for *Scaphirhynchus* Species on the Lower Missouri River**

**Adam McDaniel**

Missouri Department of Conservation

Monitoring and sampling fishes in big river environments can present many challenges. Catch per unit effort is commonly used in fisheries to compare relative abundance of fishes from year to year. However, abiotic and biotic factors in big river environments can influence catchability and effectiveness of fish sampling gear types and thus resulting in variability in catch per unit effort that may or may not be associated with actual relative abundance in fish populations. This study examines some of these variables possibly associated with effectiveness of gear types such as experimental gill nets, trotlines and otter trawls used on the Pallid Sturgeon Population Assessment Program on the lower Missouri River. River discharge, water temperature and associated water velocities are sometimes problematic variables when sampling big river environments especially monitoring endangered or threatened species. This study examines catch per unit effort estimates for pallid sturgeon *Scaphirhyncus albus*, a federally endangered species, shovelnose sturgeon *Scaphirhynchus platorynchus* and total catch correlated with river discharges, water temperature and water velocities using gill nets, otter trawls and trotlines. Gill net catch per unit effort for pallid sturgeon, shovelnose sturgeon, and total fish combined all indicated a decreasing trend with increasing river discharges. Otter trawl catch rates for pallid sturgeon and total fish also followed a decreasing trend with increasing river discharge, however shovelnose sturgeon catch rates indicated an increasing trend with increasing discharge. Trotlines have proven to be an effective gear for sampling pallid sturgeon on the Missouri River and were initiated as a standard gear in 2010. However, trotlines are subject to interspecific competition at various water temperatures and water velocities. Environmental factors may not always affect catchability of fishes with some gear types, however, efforts should be made in understanding how conditions might influence results and perhaps limit variability in long term data sets.

**Tracking Fraser Giants Part Deux: What have we Discovered about Migration and Habitat Use Patterns for Adult White Sturgeon in the Lower Fraser River in the First 5 Years of Acoustic Telemetry Tracking**

**Erin Stoddard**

BC Ministry of Forest, Lands, Natural Resource Operations and Rural Development

Because the Fraser River is one of the few remaining watersheds supporting a significant White Sturgeon population and hasn't been impacted by cross channel dams or flow regulation, there is an opportunity to study habitat use and migration without human caused migration barriers. To respond to concerns with recruitment, in 2013, we began deploying 10 year battery life programmed Vemco V16 acoustic transmitters in adult White Sturgeon to assess habitat use and fidelity at critical spawning, overwintering and key feeding areas, to potentially assess spawn frequency and fidelity, and to evaluate adult migration patterns. So far, we've surgically implanted 140 transmitters in White Sturgeon from 151 cm to 283 cm in fork length from 20 km up to 184 km from the mouth of the river. Starting with only 14 receivers, we're now using downloads from a network of up to 38 semi-permanent and seasonal fixed station Vemco VR2W and VR2TX receivers, data collected from other Vemco receivers and locational detection data from a Vemco VR100, and have recorded nearly 2 million detections between the mouth of the Fraser and over 170 km upstream. Some very interesting, new and head scratching movement and habitat use patterns have emerged after the first 5 years. What have we learned so far, what are we planning to do and what do we expect to learn for the next 5 years?

## Human Dimensions of Oklahoma Paddlefish Management: A Decade of Angler Feedback and Observation

**Jason Schooley**[1]

[1]Oklahoma Department of Wildlife Conservation

2. Corey A. Jager, 3. Adam Geik, 4. Brandon Brown, 5. Dennis L. Scarnecchia

2-4. Oklahoma Department of Wildlife Conservation, 5. University of Idaho

Fish, habitat, and anglers comprise the key factors of a freshwater recreational fishery within the purview of natural resource managers. Stock and habitat assessment, maintenance, or enhancement are typical techniques in the manager's toolbox, whereas the human dimension often receives less inquiry. However, angler attitudes, motivations, and preferences play essential roles in successful recreational fishery management, where "success" is often gaged by satisfaction more so than stock assessment metrics. Oklahoma Department of Wildlife Conservation has employed human dimensions surveys as a key component of the Paddlefish management program since its inception in 2008. Results of angler mailing surveys, comparative access point creel surveys, impromptu angler surveys, economic analyses, and regulation choice models during 2008-2018 demonstrate how the fishery has evolved and responded to tightening regulations, natural fluctuations in stock recruitment, angling technology, and social attitudes towards Paddlefish. Meanwhile, survey results have provided management feedback in crafting restrictions on this sustainable harvest fishery and evaluating the impacts of such regulations.

## Factors Affecting Telemetry-Derived Survival Estimates of Highly Migratory Atlantic Coast Fish

**Jason Kahn**[1]

[1]National Marine Fisheries Service

2. Chris Hager, 3. Carter Watterson, 4. Noelle Mathies, 5. Kyle Hartman

2. & 4. Chesapeake Scientific, 3. U.S. Navy, 5. West Virginia University

Calculating fish survival is costly and requires sampling many individuals. Telemetry-based survival estimates are becoming more common because much of the data can be obtained remotely. Cormack Jolly Seber (CJS) analyses have shown Atlantic Sturgeon populations have ranges in annual apparent survival from 77.8% to as high as 94%. The York River adult population is small with about 35% of telemetered individuals being recaptured during this study. Those recaptures revealed 6 of 61 (9.8%) telemetered fish were likely still living despite the transmitter no longer being detected, violating the assumption of no lost marks. It appears two males and one female from the 55 remaining tags have either died or are non-recaptures with failed transmitters. Data analysis also revealed traditional monthly detection data for the CJS model violates the equal probability of detection assumption, with males being more likely to be detected each month. When data is compiled annually to have an equal probability of detection, the calculated mean apparent annual survival estimate was 97.8% (95% confidence interval, 86.5-99.7%) in the York River. Apparent annual survival estimates of males and females was 97.4% (85.8-99.6%) and 94.0% (80.7-99.2%), respectively. Duration of the study did not affect the mean survival estimates, but longer studies were more precise. Survival estimates are critical for the protection of at-risk species, but telemetry-derived estimates are likely biased by detection probability, the sex ratio transmittered, and/or an inability to account for tag loss or failure.

## Maumee River Lake Sturgeon Restoration Program

**Jennifer Johnson[1]**

[1]U.S. Fish and Wildlife Service

2. Doug Aloisi, 3. Kent Bekker, 2. James Boase, 4. Jon Bossenbroek, 2. Justin Chiotti, 2. Jessica Collier, 4. Todd Crail, 5. Chris Davis, 5. Richard Drouin, 6. James Francis, 7. Travis Hartman,

4. Christine Mayer, 7. John Navarro, 8. Trevor Pitcher, 9. Chris Vandergoot, 7. Eric Weimer, 10. Amy Welsh, 6. Todd Wills

2. U.S. Fish and Wildlife Service, 3. Toledo Zoo, 4. University of Toledo, 5. Ontario Ministry of Natural Resources and Forestry, 6. Michigan Department of Natural Resources, 7. Ohio Department of Natural Resources, 8. University of Windsor, 9. U.S. Geological Survey, 10. West Virginia University

Lake sturgeon (*Acipenser fulvescens*) recruitment in the Lake Erie basin is currently supported by two connecting channels, the St. Clair – Detroit River System and Niagara River. Historically, there were 16 other spawning populations in Lake Erie with an estimated adult population ranging between 300 thousand to 1.1 million. In an effort to delist this endangered species in the State of Ohio and throughout the Lake Erie basin, efforts are underway to rehabilitate lake sturgeon populations in suitable river systems. The Maumee River, located in western Lake Erie, historically supported large runs of lake sturgeon, but currently, sturgeon are considered functionally extirpated from the system. A habitat suitability model for spawning adult and age-0 lake sturgeon indicates sufficient habitat is present in the Maumee River. Therefore, the river is a strong candidate for a lake sturgeon reintroduction. As a result, a lake sturgeon restoration plan has been drafted for the system and approved by the Ohio Department of Natural Resources and Great Lakes Fishery Commission Lake Erie Committee. This year marks the first of a twenty year program to restore lake sturgeon in the Maumee River. Gametes were collected in southern Lake Huron in late spring of 2018. The sturgeon are being reared by the Toledo Zoo (stream-side reared) and Genoa National Fish Hatchery (traditionally reared) and the first cohort of juvenile sturgeon is expected to be released into the Maumee River this fall. Subsequent biological monitoring will then take place to assess post-stocking survival, movements, and stocking site fidelity between the two rearing strategies. The habitat suitability model and restoration plan provide the foundation for the Maumee River Lake Sturgeon Restoration Program, a multi-agency, international effort leading towards the restoration of the lake sturgeon population in Lake Erie.

**Estimating Precision and Accuracy of High Resolution Side-Scan Sonar Length Estimates of Overwintering Shortnose Sturgeon in the Hudson River**

**Amanda Higgs[1]**

[1]New York State Department of Environmental Conservation

2. Richard Pendleton, 3. Dewayne Fox, 4. John Madsen, 5. David Kazyak, 6. Patrick Sullivan, 7. Gregg Kenney

2. Department of Natural Resources, Cornell University, in cooperation with New York State Department of Environmental Conservation, 3. Department of Agriculture and Natural Resources, Delaware State University, 4. Department of Geological Sciences, University of Delaware, 5. U.S. Geological Survey, Leetown Science Center, 6. Department of Natural Resources, Cornell University, 7. Division of Marine Resources, New York State Department of Environmental

Shortnose Sturgeon (*Acipenser brevirostrum*) were initially listed as an endangered species in 1967 under the Endangered Species Preservation Act of 1966. As such, they were the first fish listed as endangered with enactment of the 1973 Endangered Species Act. In the 1990's, population estimates of Shortnose Sturgeon in the Hudson River, where presumably the largest abundance occurs along the entire Atlantic coast, indicated that the spawning population had increased substantially from that observed earlier in the 1970's. A new population estimate would identify if the increase has continued. Mark recapture population estimates are labor intensive and in a system like the Hudson would be prohibitively expensive. Recent studies using high-resolution side-scan sonar to locate and count fish suggest that this methodology can be successfully employed in population estimates. However, the minimal body size for a positive detection of an individual fish in a field setting using side-scan sonar is largely unknown. To better understand this limitation, 12 wooden Shortnose Sturgeon models of different sizes ranging from 0.5 to 1.5 m TL were mounted to cement blocks, lowered to the bottom of the Hudson River within the vicinity of a Shortnose Sturgeon overwintering area, and were imaged with a high-resolution Edgetech 4125P 600-1,600 kHz dual frequency side-scan sonar system. Adult Shortnose Sturgeon can be as small as 0.5 m and the detection/confirmation of sonar targets (fish) in the 0.5 to 1.5 m range provides critical information on the feasibility of using side-scan technology, integrated with other methods (e.g., acoustic telemetry), to assess Shortnose Sturgeon populations. In conjunction with the side-scan sonar data collection, gill netting was carried out to better understand the length frequency and assemblage of Shortnose Sturgeon in the area relative to the side-scan sonar imagery**.**

## Adaptive Management of Kootenai River White Sturgeon Recovery

**Shawn Young**

Kootenai Tribe of Idaho

The Kootenai River White Sturgeon (*Acipenser transmontanus*) was once abundant in the Kootenai/ay River Basin in Idaho and Montana, USA, and British Columbia, Canada. Historically, they provided important cultural fisheries throughout the basin. However, this population is now listed as endangered in both countries due to cumulative effects of habitat destruction and of Libby Dam hydro-power operations in Montana that have resulted in persistent recruitment failure since the 1970's. In 1990, the Kootenai Tribe of Idaho recognized the lack of natural recruitment and started an experimental aquaculture facility to determine the feasibility of using wild broodstock to artificially spawn and rear year classes to reverse population decline. The Kootenai Tribal Native Fish Conservation Aquaculture Program began rearing fish in 1992, and has been successfully releasing annual year classes since 1997. In tandem with conservation aquaculture, the Kootenai Tribe and fellow agencies are implementing large-scale river ecosystem habitat restoration to restore natural recruitment.

Since 1990, twenty-three year classes have been created at three different hatcheries using several different rearing and release strategies to promote post-release survival and growth. In addition, nutrient additions have been ongoing since 2002; habitat restoration in the current spawning areas has been ongoing since 2011; and alternative Libby Dam operations to promote spawning and early life stage survival have been attempted since 2012. To evaluate the effectiveness of these actions, post-release monitoring and evaluation studies have guided adaptive management of rearing and release strategies, and of habitat restoration. At present, approximately 12,000 hatchery juveniles and hatchery sub-adults survive; while the wild adult population has declined to around 1,000 spawning adults. A robust population structure consisting of the hatchery-reared juveniles and sub-adults is encouraging; however, natural recruitment failure still persists, with only a few wild juveniles captured annually. Also, post-release monitoring and evaluation results indicate differential growth and survival across the history of the program and across the recovery area. These data guide the adaptive management of the conservation aquaculture and the habitat restoration programs as the recovery effort continues. This presentation will provide a summary of research, monitoring, and evaluation results that guide the conservation aquaculture and habitat restoration programs, including current population demographics; and discuss how the programs may adapt as the recovery effort progresses.

## An Acoustic Telemetry Evaluation of Lake and River Mixing Rates for Juvenile Kootenay White Sturgeon

**Sarah Stephenson**

Ministry of Forests, Lands, Natural Resource Operations and Rural Development

The Kootenay (spelled Kootenai in the USA) White Sturgeon (*Acipenser transmontanus*) population is federally listed as endangered throughout its range in both the USA and Canada. Since 1990, hatchery produced juveniles have been released into the system and now make up the largest proportion of the White Sturgeon in the Kootenay Watershed. With most releases and sampling effort on the river portion of the range, recent efforts have focused on assessing the difference between the juveniles caught in the lake habitat versus the river habitat. This telemetry study was implemented in 2014 and included sonic tagging 50 juvenile sturgeon caught in the lake sampling. The age range was 3 to 23 years old (two age groups, 10 years and ≥ 10 years old). The mean annual survival rate for all years was 93%; 95% and 91% for the younger and older group, respectively. After three years of passive acoustic telemetry monitoring, data showed that the majority of time was spent in the lake and the mean time spent in the river was limited to 27.8 days (SE 3.8). On average, the older fish spent less time in the river than the younger fish, but there was no difference in the length of river used by either group. Overall, 30 juveniles were detected in the river, with the majority (87%; n=26) detected in the summer months. Only 34% of the tagged fish were detected ≥ 10 km upstream of the lake and all juveniles returned to the lake after river detections. This study supports the separation of lake versus river caught hatchery fish for understanding the abundance and growth estimates for the juveniles caught in the different habitats.

# 30 Years of Recovery actions of Adriatic sturgeon in Italy: Some Good Results

**Paolo Bronzi**

## Fish Passage

### An Evaluation of Optimal Surgical Incision Placement and Closure Methods for Intracoelomic Transmitter Implantation for Age-0 Lake Sturgeon

**Jonathan Hegna**[1]

[1]Michigan State University

2. Kim Scribner, 3. Edward Baker

2. Michigan State University, 3. Michigan Department of Natural Resources

This study evaluated the effectiveness of incision placement (midline vs. lateral), closure method (suture vs. Vetbond®), and tag burden on survival, surgical complications, growth, inflammation, incision healing, and apposition quality for age-0 lake sturgeon. The risk of death was 5.17 times higher for sturgeon that had midline incisions closed with Vetbond® (9.4% mortality rate) compared to all other treatments (0% mortality rate). The risk of viscera expulsion for midline incisions closed with Vetbond® was also 6.21 times higher (15.6% incidence rate) compared to the other treatments (0% incidence rate). Open incision width and length was minimal for all treatments, except for midline incisions closed with Vetbond®. The risk of PIT-tag loss was 6.21 times higher (15.6% incidence rate) and the risk of acoustic transmitter loss was marginally 3.06 times higher (6.25% incidence rate) for midline incisions closed with Vetbond® compared to all other treatments (0% incidence rate). Sturgeon with midline incisions closed with Vetbond® gained less weight compared to the other treatments, while sturgeon with lateral incisions closed with Vetbond® gained similar amounts of weight relative to both suture treatments and the control group. Inflammation was very low and slightly decreased over time for incisions closed with Vetbond®, while incisions closed with suture exhibited significant increases in inflammation levels over time. Time to complete healing was shortest for incisions closed with suture followed closely by lateral incisions closed with Vetbond®. However, for incisions closed with suture the healing process was 2-3 times more likely to relapse because of inflammation compared to lateral incisions closed with Vetbond®. Tag burden was not found to be a significant contributing factor in our analyses. The results suggest that Vetbond® can be safely used to close small lateral incisions just as effectively as sutures, with a much lower risk of severe inflammation.

## Examining Movement and Maximizing Capture of Lake Sturgeon in the Fish Elevator on the Menominee River

**Nicholas Porter**[1]

[1]University of Wisconsin-Stevens Point

2. Joshua Raabe, 3. Daniel Isermann, 4. Darren Kramer, 5. Michael Donofrio, 6. Shawn Crimmins, 7. Robert Elliott

2. & 6. University of Wisconsin-Stevens Point, 3. U.S. Geological Survey, Wisconsin Cooperative Fishery Research Unit, 4. Michigan Department of Natural Resources, 5. Wisconsin Department of Natural Resources

Dams impede Lake Sturgeon *Acipenser fulvescens* from accessing historic spawning habitats in many Lake Michigan tributaries. The Menominee Dam on the Menominee River, Michigan and Wisconsin, is only 3.9 km upriver from Green Bay so a fish elevator was constructed in 2014 to capture and transfer individuals upstream of the two lowest dams. This is the first elevator to specifically target Lake Sturgeon and limited knowledge exists on their behaviors near dams. Therefore, our objectives were to operate the elevator extensively to determine if different environmental conditions (e.g., season, photoperiod) or operating procedures (e.g., attraction flow, soak durations) influenced captures and to learn about behaviors near the dam using telemetry. A total of 756 elevator lifts (1792 hours soak time) across Spring 2017, Fall 2018, and Spring 2018 captured 246 Lake Sturgeon including 23 recaptures. Total length ranged from 495-1,765 mm with a mean of 1,324 mm. Preliminary analyses indicate higher attraction flow, longer soak times, diurnal operation, and water temperatures near 12.8 ºC may increase elevator captures of Lake Sturgeon. We implanted acoustic transmitters in 20 individuals transported upstream of Park Mill Dam and 90% moved upstream and remained for one spawning period. Additionally, 49 sturgeon released downstream of the Menominee elevator received both acoustic and radio telemetry transmitters; previously acoustic tagged individuals were also detected. Acoustic telemetry provided information on timing, general locations, and elevator capture rates of tagged individuals. Radio telemetry triangulations near the dam suggest Lake Sturgeon prefer to reside just off the main current of the outflow. Our goals are to provide guidelines for operating the elevator that will optimize sturgeon captures and offer information on sturgeon behaviors near dams that may benefit other managers considering passage.

## Regulated Rivers

### Evaluating Site Fidelity of Translocated Paddlefish *Polyodon spathula* in a Regulated System

**Chelsea Gilliland**[1]

[1]Mississippi State University

2. Michael E. Colvin, 3. Peter J. Allen, 4. J. Wesley Neal, 5. Steve Reagan

2–4. Mississippi State University, 5. U. S. Fish and Wildlife Service

Bluff Lake is an impoundment on Oktoc Creek in Sam D. Hamilton Noxubee National Wildlife Refuge, Brooksville, MS, and a 0.8 ha pool is located below the water control structure that regulates lake water levels. An abundant Paddlefish *Polyodon spathula* population occupies the pool year-round. Capture-recapture surveys over 3 years identified 117 individuals, with daily abundance estimates in the pool varying from 18 to 75 fish. Variability in estimated abundance suggested a mixed population structure, where some fish reside in the pool year-round and others display seasonal use. Telemetry study of 59 Paddlefish further supported our mixed population hypothesis, as some fish remained in the pool year-round, while others moved in and out, usually during spring months. Despite the presence of known-reproductively mature fish, spawning has not been detected in the pool; therefore, manual translocation of fish to the larger Noxubee River downstream may be an effective management action to provide access to a natural spawning environment. However, it is uncertain if translocated fish will remain in the Noxubee River, or if they will exhibit site fidelity and return to the pool by cuing on elevated flows from Bluff Lake. We translocated eight telemetered Paddlefish to the Noxubee River over three days in January 2018. One fish returned to the pool 53 days post-translocation. The other 7 remained in the Noxubee River and 5 were detected 90 rkm downstream 16 to 37 days post-translocation. Manual translocation into the Noxubee River was 87.5% effective at removing Paddlefish from the pool and is a potentially viable management strategy to increase population connectivity and promote access to in-river spawning habitat.

## Early Results of a Long-Term Lake Sturgeon Stocking and Juvenile Monitoring Program in northern Manitoba, Canada

**Cheryl Klassen**

Manitoba Hydro

The Keeyask Hydropower Limited Partnership (KHLP) is currently constructing a 695 megawatt hydroelectric generating station (GS) on the lower Nelson River in northern Manitoba, Canada. Prior to the start of construction in 2014, the KHLP was required to develop a mitigation and monitoring plan. Lake Sturgeon, *Acipenser fulvescens*, were identified as a key species for monitoring and a long-term stocking plan (25 years) was developed to mitigate the loss of spawning habitat. Since 2014, over 2,500 hatchery-reared yearlings have been stocked for the project, each marked with a passive integrated transponder (PIT) tag. Data from juvenile populations in the area have been collected intermittently since 2008 and annually since 2014. The plan is to conduct juvenile population monitoring annually until 2044 using the same capture methods in order to compare results between years. Questions being addressed at this time are: 1) does recruitment of wild sturgeon occur upstream and/or downstream of the GS during construction, 2) is there a change in condition factor and growth of juvenile sturgeon during construction, 3) what is the survival rate of stocked sturgeon and 4) what is the proportion of hatchery-reared to wild recruits within a birth year? Results since 2014 indicate that 1) reproduction in the wild is occurring upstream and downstream of the GS during construction, 2) there were some changes in growth rate and condition between fish caught prior to and during construction, although patterns have not been consistent, and 3) the stocking program is having a positive effect on juvenile numbers in the area, with hatchery fish accounting for over 60% of the 2014 and 2016 cohorts captured. Results from on-going monitoring will be used to assess future stocking practices.

## Juvenile Lake Sturgeon Recruitment Monitoring: Project Effects or Cryptic Population Regulation via Density Dependent Interactions?

**Craig McDougall**[1]

[1]North/South Consultants Inc.

2. Don MacDonell, 3. Laura Henderson, 4. Patrick Nelson

2–4. North/South Consultants

In 2006, dam safety concerns prompted the need to modernize Manitoba Hydro's Pointe du Bois Generating Station (GS) spillway, located at the upstream end of the Slave Falls Reservoir (SFR) on the Winnipeg River, Manitoba. Lake Sturgeon were identified as a valued ecosystem component and significant research was allocated into understanding the status of the population, with focus on spawning and recruitment. Prior to construction being undertaken, six years of data collection (2006 – 2012) served to establish the pre-project environmental baseline. Lake Sturgeon recruitment was observed to be occurring at a surprisingly high rate, despite intermittent cohort failures. The general consensus at the time construction of the new spillway began in fall 2012 was that the Lake Sturgeon population in the SFR was "healthy" and approaching carrying capacity. The new spillway was commissioned in 2014. In 2014 an average Lake Sturgeon cohort (relative to pre-project) was produced and in 2015 a strong cohort (the strongest since 2002) was produced. However, despite extensive egg deposition below both the powerhouse (not affected by the project) and the spillway, 2016 and 2017 appear to have both resulted in cohort failures. A high rate of loss might have occurred due to poor incubation, but a project specific linkage seems unlikely due to consistent flows in the weeks following egg deposition. A poor understanding of how Lake Sturgeon populations in large river systems self-regulate as they approach carrying capacity poses significant challenges in the context of monitoring the Pointe du Bois GS Spillway Replacement project. The likelihood of growth rate moderation and cohort-suppression being influential is discussed.

## Applying Back-Calculations of Age-0 *Scaphirhynchus* Drift to Identify Potential Spawning Locations

**Edward A. Bulliner**[1]

[1]U.S. Geological Survey Columbia Environmental Research Center

2. Kimberly M. Chojnacki, 3. Nathan J.C. Gosch, 4. Aaron J. DeLonay

2. & 4. U.S. Geological Survey Columbia Environmental Research Center,
3. U.S. Army Corps of Engineers

Unfavorable spawning habitat has been identified as a potential limiting factor for recovery of the endangered pallid sturgeon on the Missouri River and its tributaries. While some spawning habitats have been identified at time of spawning through tracking of reproductive adults, field-collected *Scaphirhynchus* larvae provide additional insight into spawning habitat. We use age estimates based on temperature-dependent length of larvae at time of capture and back-calculations of drift distance to identify potential successful spawning locations in the Missouri River and its tributaries. While rough estimates of drift distance can be made using mean-channel velocities, such estimates do not account for longitudinal variations in channel hydraulics and dispersion. Notably, traditional tools used to model longitudinal dispersion are generally used to calculate distance downstream traveled for passive particles going forwards in time, not to back-calculate the origin of a passive particle, the assumed mode of drift for early life-stage *Scaphirhynchus*, captured at a given time and place. We approximated dispersion processes by incorporating a 15-year archive of hydroacoustic velocity measurements from the Missouri River to create distributions of possible encountered velocities in various Missouri River channel locations and configurations, coupled with simpler velocity estimates in tributaries. To demonstrate the utility of this modeling, we use it to estimate potential spawning locations for age-0 sturgeon caught in channel margins near river mile 310 on the Missouri River, a bend colloquially referred to as 'old reliable' due to the consistency of age-0 *Scaphirhynchus* captures at this location. We compare wide distributions of possible spawning locations under a range of drift assumptions from our model for the youngest age-0 sturgeon relative to older age-0 sturgeon caught from the same location and interpret the results in the context of variable retention time for passively to actively drifting larval sturgeon.

**Movement and Habitat Use Patterns of Juvenile Lake Sturgeon in a Small Hydroelectric Reservoir System**

**Edward Baker[1]**

[1]Michigan Department of Natural Resources

2. Jonathan Hegna, 3. Kim Scribner

2. & 3. Michigan State University

Reconnecting lake sturgeon *(Acipenser fulvescens*) populations and rivers through the design and use of passage systems at hydroelectric dams is seen as a vital step toward recovery of the species. However, information on the movements and habitat use patterns of age-1 and age-2 lake sturgeon in small hydroelectric reservoirs is generally lacking. We used the juvenile salmonid acoustic telemetry system to actively track the movements of juvenile lake sturgeon throughout Kleber Reservoir in northern Michigan between the months of July and September in 2015 and 2016. Habitat mapping of the reservoir was accomplished with down-beam and side-scan sonar technology. Based on detections data from 47 different lake sturgeon we were able to examine coarse-scale spatial movement characteristics and habitat use patterns. The Getis-Ord spatial analysis showed that zones with high numbers of lake sturgeon detections were significantly clustered toward the head of the reservoir in the broadest and deepest part, located a short distance from the hydroelectric dam. Zones with low numbers of detections significantly clustered toward the shallower, channelized tail of the reservoir. The projected latent structure regression model examining the number of unique sturgeon detected showed that the amount of sand/silt habitat, amount of deep water habitat ($\geq$ 6.1 m), mean depth, and the amount of low hardness substrate in a zone were positively associated with levels of habitat use and explained 66.4% of the variance with three dimensions. Consequently, reservoir areas with ample deep water habitat, silt/sand substrate, and limited macrophyte vegetation will provide the most optimal habitat conditions to support lake sturgeon populations. Lake sturgeon avoided habitat with abundant macrophyte vegetation and used habitat in the vicinity of the hydroelectric dam, making them vulnerable to entrainment.

**Lake Sturgeon Harvest Vulnerability Based on Acoustic Telemetry in the St. Croix, Mississippi, and Chippewa Rivers**

**Joel Stiras[1]**

[1]Minnesota Department of Natural Resources

2. John Hoxmeier

2. Minnesota Department of Natural Resources

The St. Croix River (Minnesota/Wisconsin border water) and Chippewa River (Wisconsin) are direct tributaries to the Mississippi River (Minnesota/Wisconsin border water) with no barrier restricting Lake Sturgeon movement. However, harvest regulations vary across these systems. Current regulations for the lower St. Croix and Chippewa rivers allow harvest of one Lake Sturgeon (*Acipenser fulvescens*) per season (60 inch minimum length) from the first Saturday in September through September 30, while the Mississippi River is closed to Lake Sturgeon harvest. An acoustic telemetry project initiated in 2013 implanted 47 Lake Sturgeon from 2013 to 2017. Twenty Lake Sturgeon were implanted with transmitters in the lower St. Croix River, one in Pool 2 of the Mississippi River, and 26 in Pool 4 of the Mississippi River. Data from 44 Lake Sturgeon has shown that they move freely between the St. Croix, Mississippi, and Chippewa rivers. Analysis of 44 of these transmitter Lake Sturgeon revealed that 56.8% were vulnerable to harvest in the St. Croix or Chippewa rivers during the open harvest season. Of the Lake Sturgeon implanted with transmitters in the Mississippi River, nine out of 25 (36%) became vulnerable to harvest while at large, and 16 of 19 (84.2%) Lake Sturgeon implanted in the St. Croix River were vulnerable to harvest while at large. Because lake sturgeon tagged in the Mississippi River were sometimes vulnerable to harvest, and given that sturgeon harvest is low in the St. Croix and Chippewa rivers (mean less than three per year since 2009), managers may want to consider similar regulations across systems for simplification and increased angling opportunities.

## Monitoring to Detect Results During Construction and Operation of a New Hydro Generating Station: A Case Study in the Early Stages

**Stephanie Backhouse**

Manitoba Hydro

The Keeyask Generating Station (being developed by a partnership between Tataskweyak Cree Nation, War Lake First Nation, Fox Lake Cree Nation, York Factory First Nation and Manitoba Hydro) is under construction on the lower Nelson River in northern Manitoba, Canada. During the environmental assessment, it was determined that Lake Sturgeon (*Acipenser fulvescens*) populations in this area were vulnerable to the effects of hydroelectric development as a result of low population numbers and specific habitat requirements. Their cultural and spiritual importance to the partner First Nations and regulatory importance (Manitoba heritage species, assessed as endangered by COSEWIC and considered for protection under the Species at Risk Act) made them one of the species of greatest concern for the project, and the focus of considerable study and mitigation planning. Pre-project data (2001-2013) formed the basis for development of a mitigation and monitoring plan, to detect and offset the predicted impacts on spawning, juvenile rearing, loss of fish passage and potential for increased harvest. Mitigation measures (constructed spawning habitat and a comprehensive stocking program, along with contingency measures to create additional spawning habitat, replace juvenile rearing habitat and construct permanent fish passage if required) were included in the project, with the objective of increasing productivity of Lake Sturgeon in the region. A comprehensive and long-term monitoring plan, focusing on adult and juvenile Lake Sturgeon populations and movements, as well as stocking success, has been implemented to determine the actual impacts of construction and operation of the generating station, and the effectiveness of the implemented mitigation measures. Preliminary results are discussed here, and compared to project benchmarks, early warning triggers and conservation objectives defined pre-project, and approved by regulators.

# Abstracts for Poster Presentation
# 2018 North American Sturgeon and Paddlefish Society Annual Meeting

## List of Abstracts

## Biology and Ecology

### Sublethal Effects on Behavior of White Sturgeon Exposed to Copper

**Holly Puglis**[1]

[1]U.S. Geological Survey

2. Robin Calfee, 3. Edward Little

2. & 3. U.S. Geological Survey

White sturgeon (*Acipenser transmontanus*) in the Upper Columbia River (UCR) have experienced poor recruitment for decades. Previous studies have indicated that copper, commonly associated with slag contamination, was lethal to young white sturgeon at concentrations previously thought to be protective of aquatic life. In addition, adverse behavioral responses were evident with early onset during the first few days of exposures and became progressively more severe over exposure duration and increasing concentration of copper. Further studies were conducted with copper in order to accurately identify and interpret the behavioral changes seen in previous studies. Larval sturgeon were exposed to sublethal concentrations of copper for 14 days. Abnormal behavioral changes were observed within the first several days of exposure including loss of equilibrium and immobilization. Digital video tracking software was used to analyze the swimming behavior and analyses showed swimming velocity, distance moved, and time swimming decreased with increasing copper concentration. Our results indicate that copper may play a role in the recruitment failure observed in the UCR.

**Effect of Habitat Conditions on Dispersal Behavior of Early-Life Stage Pallid Sturgeon in an Artificial Channel**

**Kevin Buhl**[1]
[1]U.S. Geological Survey, CERC, Yankton FRS

2. Travis Schaeffer
2. Geological Survey, CERC, Yankton FRS

Upon hatching, Pallid Sturgeon (*Scaphirhynchus albus*) free embryos initiate a multiday period of drift until they transition to benthic-orientated larvae. Development and drift duration are temperature dependent, but little is known on how other habitat conditions affect drift and downstream dispersal. Laboratory studies were conducted to quantify dispersal behaviors of Pallid Sturgeon free embryos and larvae in artificial channels with different physical habitat conditions. Dispersal behavior experiments were conducted in two large oval flumes (average lap length of 850 cm) in 2015-2017. Both flumes produced nominal channel velocities of 0.15 meters per second and were nearly identical, except for differences in the test variables of substrate (sand or gravel) at 19 °C in 2015, channel complexity (natural pool or pool with a wing dike) at 19 °C in 2016, and water temperature (15 or 24 °C) with substrates and natural pool sections in 2017. Experiments were initiated with 10-20 newly-hatched free embryos and survival and dispersal behavior were monitored every three hours for 21 days. In tests conducted at 19 °C, we observed decreased drift velocities of fish starting at 9 days posthatch (dph) in both flumes with substrates and at 5 dph in both flumes with the pool sections. In 2017, reduced drift velocities of fish were observed at 4-5 dph in both warm-water experiments (flumes with substrates or pools) and at 9-10 dph in both cold-water experiments. In all experiments, we observed fish holding position along the bottom of the channel at the same or similar age as those exhibiting reduced drift velocities. Our findings indicate that in either cold or warm water, dispersal behavior was not differentially affected by the presence of substrate or pool habitat; whereas at 19 °C, dispersal may have been influenced by habitat type.

**Genetic and Environmental Components of Phenotypic and Behavioral Trait Variation during Lake Sturgeon (*Acipenser fulvescens*) Early Ontogeny**

**Kim T. Scribner[1]**

[1]Michigan State University

2. Kari Dammerman, 3. Juan Pedro Steibol

2. Dept. of Zoology, Michigan State University, 3. Dept. Animal Sciences, Michigan State University

Quantifying the relative contributions of genetic and environmental effects and their interaction on phenotypic variation is vital to understand how populations respond to their environment. Adults can plastically respond to environmental conditions by selecting breeding and egg incubation locations that affect offspring traits during embryonic and larval development. Environmental conditions during incubation can also affect traits during later ontogenetic stages (i.e. ontogenetic contingency). Using a population of lake sturgeon (*Acipenser fulvescens*) from Black Lake, Michigan, we conducted field and common garden studies and evaluated whether larval phenotypes and behavior at different ontogenetic stages would vary among families whose eggs were incubated under different thermal and flow regimes in the laboratory, and associated with different micro-habitat conditions in river substrates in the field. A significant family-by-treatment interaction was detected for traits (body length, body area, head area) measured at hatch associated with different flow (high, medium, low) and temperature (10oC, 18oC, variable, ambient) treatments. The greatest range in phenotypic variance was observed among individuals reared in the most environmentally deviant conditions (warm temperature and high flow treatments). Traits measured at hatch from eggs in the stream varied due to the influences of stream micro-habitat variables, while levels of additive genetic variance covaried with age. Results demonstrate that phenotypic variation across sequential ontogenetic stages is dependent on physical stream conditions and additive genetic effects, although the relative contributions of effects differ across ontogenetic stages. Increasingly deviant environmental regimes may reveal cryptic genetic variation, potentially leading to differential survival between genotypes, thereby altering the genetic architecture of populations.

**Rearing Environment Alters Behavior in Larval Lake Sturgeon**

**Lydia Wassink[1]**

[1]Michigan State University

2. Joseph Riedy, 3. Kim Scribner

2. & 3. Michigan State University

Lake sturgeon are a regionally threatened species known to be sensitive to environmental stressors during early life stages. Altered development of stress-related phenotypes influences antipredator behaviors, with consequences for survival. Wild-caught sturgeon larvae were compared to hatchery-reared sturgeon larvae in simultaneous behavioral trials, measuring baseline swimming activity, startle response, and reaction to alarm cue, conducted on day of capture and after three days in the hatchery. Overall, hatchery-reared larvae had significantly higher baseline activity compared to wild-caught larvae. However, after three days in the hatchery, hatchery-reared larvae and wild-caught larvae had similar activity levels. This study highlights the need for further research into how rearing environment influences behavioral development, and how increased activity levels affect sturgeon larvae in ecologically relevant contexts such as predator avoidance. Quantifying fitness outcomes of rearing environment and associated behaviors is important in informing management and conservation practices.

**Toward Development of a Better Understanding of the Inter-relationships Among Pallid and Shovelnose Sturgeons, Chubs, and Invertebrates Using a Lower Missouri River Fish Community Model**

**Mark Wildhaber[1]**

[1]U.S. Geological Survey

2. Janice Albers, 3. Nicholas Green

2. & 3. U.S. Geological Survey

We applied a community model for a subset of the Lower Missouri River benthic fish assemblage to try and understand inter-relationships among community members and to explore factors that influence abundance in the contemporary Missouri River. The model was constructed to incorporate population submodels for Pallid Sturgeon (*Scaphirhynchus albus*), Shovelnose Sturgeon *(S. platorynchus*), and their hybrids, three *Macrhybopsis* chub species, midges (Chironomidae), and their interactions. The critically endangered Pallid Sturgeon is piscivorous as an adult and declining. Native *Macrhybopsis* chubs have been identified in several studies as important prey of the Pallid Sturgeon. The sympatric Shovelnose Sturgeon is a likely competitor for the Pallid Sturgeon during young-of-year and juvenile life stages when both species feed on benthic invertebrates, especially midges. Each species submodel incorporated hierarchical partitioned variance. Each sturgeon submodel also incorporated a bioenergetics component. Interactions between species were modeled as a combination of predator-prey and competition dynamics. Outputs that incorporated model uncertainties through implementation of hierarchical partitioning of variance were designed to provide estimates of the range of possible population responses the fish community may have to management actions (for example, stocking, habitat restoration, or flow management). We report some initial population patterns forecasted by the model and the potential effects that different management scenarios may have on those patterns.

**Development of Pallid Sturgeon and Shovelnose Sturgeon Free Embryos Reared in the Laboratory**

**Marlene J. Dodson[1]**

[1]U.S. Geological Survey, Columbia Environmental Research Center

2. Kimberly A. Chojnacki, 3. Amy E. George, and 4. Aaron J. DeLonay

2-4. U.S. Geological Survey, Columbia Environmental Research Center

Sturgeon transition through a complex series of brief life stages during their first year, including a free-embryo period extending from hatch to the initiation of exogenous feeding. This period is represented by rapid developmental changes that occur in a distinctive pattern. Characteristics for ten developmental stages of *Acipenser* free embryos were described in Dettlaff et al. (1993); however, a detailed description of early developmental stages for *Scaphirhynchus* is lacking. We completed a developmental series to characterize the ontogenetic development of *Scaphirhynchus* free embryos from hatch through melanin plug expulsion. Pallid sturgeon (*Scaphirhynchus albus*) and shovelnose sturgeon (*S. platorynchus*) from multiple breeding crosses were reared separately in the laboratory at a mean temperature of 17.8° C (range 17.3 - 18.4° C). Free embryos from each cross were preserved at two to four hour intervals, and microscopically examined, and total length was measured (n=5,959). While there were minor developmental differences between *Acipenser* and *Scaphirhynchus*, development of both *Scaphirhynchus* species was similar. The rate of development also was similar between *Scaphirhynchus* species, requiring a mean of 323.5 cumulative thermal units (CTU) from fertilization to melanin plug expulsion for pallid sturgeon and 318.3 CTU for shovelnose sturgeon. Free embryos of both *Scaphirhynchus* species showed considerable overlap in lengths among developmental stages indicating that length of free embryos alone is insufficient to estimate the age of specimens. A detailed description of pallid sturgeon and shovelnose sturgeon free-embryo development provides a necessary template to estimate the age of field collected specimens accurately, and better inform free-embryo transport models.

**An Esri Story-map of the 2016 Juvenile Green Sturgeon Overwintering Outmigration in the Sacramento River, California**

**Samantha Adams**[1]

[1]U.S. Fish and Wildlife Service Red Bluff

The upper Sacramento River in California contains spawning and rearing habitat for the Southern Distinct Population Segment (DPS) of North American Green Sturgeon *Acipenser medirostris*. In 2006, National Marine Fisheries Service published notification of the listing of the Southern DPS of North American Green Sturgeon as Threatened (71 FR 17757). The U.S. Fish and Wildlife Service's Mainstem Juvenile Monitoring Program in Red Bluff, California has been investigating the outmigration of juvenile green sturgeon from the upper Sacramento River to the San Joaquin/Sacramento delta. In 2016, 19 individual juvenile green sturgeons were tagged with three types of Juvenile Salmon Acoustic Telemetry System (JSATS) micro-acoustic tags. Their outmigration towards the delta was monitored by the use of the JSATS receiver array maintained through a collaborative effort by U.S. Fish and Wildlife Service, U.S. Army Corps of Engineers and the National Oceanic and Atmospheric Administration. The data collected during the 2016 outmigration investigation has been summarized in an Esri story-map. This is an interactive format which allows users to combine accurate maps along with multi-media and graphical data to present information that can be readily accessible to the scientific community and general public. This story-map contains information of where these individuals were captured, tagged and released. As well as, individual movement within the JSATS receiver array during outmigration to the San Joaquin/Sacramento delta. This story-map was developed to showcase our program's juvenile green sturgeon results with the use of leading edge technological applications provided by Esri.

## Conservation Genetics

### A Genetic Assessment of Missouri's Lake Sturgeon after 30 Years of Restoration Releases

**Leah Berkman**[1]

[1]Missouri Department of Conservation

2. Michelle Anderson, 3. Dave Herzog, 4. Travis Moore, 5. Lori Eggert, 6. Jeff Koppelman

2-4. & 6. Missouri Department of Conservation; 5. University of Missouri

The Lake Sturgeon (*Acipenser fulvescens*) is native to three major watersheds in the US: the Great Lakes, Hudson Bay, and Mississippi River drainages but they have declined across much of their range due to overfishing, pollution, and major river alterations. Following their near extirpation in Missouri, the Missouri Department of Conservation initiated a reintroduction program to restore the lake sturgeon in Missouri's waterways. From 1984 to 2015, offspring originating from Lake Winnebago (1984-2003) and the Wisconsin River Basin (2004-2015) were reared in captivity and released into portions of the Mississippi and Missouri Rivers. After 32 years of restorative releases, we screened Missouri Lake Sturgeon samples using microsatellite loci and mitochondrial DNA control region sequences. We examined overall genetic diversity and genetic structure of Lake Sturgeon captured in the Mississippi and Missouri Rivers for differences among rivers and among groups within rivers and among cohorts. We found high levels of genetic diversity within both rivers with very little genetic differentiation among them. Higher relatedness within sample groups and heterozygote excess indicated the population is not yet mating at random and that closely related fish may be aggregated at stocking sites. We recommend continued research and monitoring of reproductive habits, preservation of multiple spawning sites to continue the long path toward a self-sustaining lake sturgeon population in Missouri's waters.

## Management

### Estimating Abundance and Capture Probabilities of a Rare, Endangered Species---Pallid Sturgeon---in the Lower Missouri River

**Sara Reynolds**[1]

[1]Mississippi State University

2. Michael Colvin, 3. Marcus Miller, 4. Tim Welker, 5. Todd Gemeinhardt, 6. Kirk Steffensen, 7. Landon Pierce, 8. Robert Jacobson

2. Mississippi State University, 3-5. U.S. Army Corps of Engineers, 6. Nebraska Game and Parks Commission, 7. U.S. Fish and Wildlife Service, 8. U.S. Geological Survey

Estimating population-level abundance of endangered species like Pallid Sturgeon (*Scaphirhynchus albus*) is challenging because they are rare, difficult to capture, and inhabit a large turbid river. Catch-effort monitoring designs are insufficient in evaluating the current Missouri River Recovery Program's monitoring objectives linked to abundance because they only provide relative population indices. Therefore, we designed an intensive capture-recapture study of Pallid Sturgeon in 2 Lower Missouri River segments in 2018. Multiple deployments of gill nets and trotlines were used within a river bend to capture sturgeon species (*Scaphirhynchus* spp.) over 3 capture occasions (days). Captured sturgeon were individually marked and released. We used various closed population capture-recapture estimators to estimate bend-level sturgeon abundance and gear-specific capture probabilities. Pallid Sturgeon captures were rare with few recaptures; however, Shovelnose Sturgeon (*Scaphirhynchus platorynchus*) captures were high and provided sufficient recaptures to estimate capture probabilities. Capture probabilities varied among gear combinations, providing a preliminary estimate for Pallid Sturgeon segment-level density of 1.7 Pallid Sturgeon per rkm. These preliminary efforts for a large-scale population assessment program indicate that population-level abundance estimates are achievable for Pallid Sturgeon but require more effort than a catch-effort based monitoring program and an assumption that Pallid and Shovelnose Sturgeon capture probabilities are similar.

## White Sturgeon and Canada's Species at Risk Act

**Erin Gertzen[1]**

[1]Fisheries and Oceans Canada

In Canada, White Sturgeon (*Acipenser transmontanus*) occurs only in the Fraser and Columbia river systems in British Columbia (B.C.). White Sturgeon populations face several threats, including: loss of habitat, fishing effects, reduced or altered food supply, altered hydrograph, pollution, effects of small population size, hatchery and aquaculture effects, and change in ecological community. In 2006, four populations of White Sturgeon were listed under Canada's federal Species at Risk Act (SARA): Upper Columbia River, Upper Kootenay River, Upper Fraser River, and Nechako River. At the time, Lower and Middle Fraser River populations were not listed.

In 2012, the Committee on the Status of Endangered Wildlife in Canada (COSEWIC), an arms-length body that assesses the status of species, re-grouped the six White Sturgeon populations into four designatable units (DUs): Upper Columbia River, Upper Kootenay River, Upper Fraser River (combination of the Middle Fraser River, Upper Fraser River and Nechako River populations) and Lower Fraser River. Lower Fraser River was assessed as threatened and the other three DUs were assessed as endangered. As a result of the COSEWIC assessment, the government must decide whether or not to provide legal protection to re-grouped Fraser River DUs, informed by a science-based recovery potential assessment, management scenarios, socio-economic analysis, information on the cultural significance of White Sturgeon and fisheries that may intercept White Sturgeon to First Nations, and consultations.

SARA provides legal protection for listed wildlife species at risk. It prohibits harm against individuals, residences and critical habitat of listed species and it sets out requirements for recovery planning, including the development of a recovery strategy, action plan and reporting on implementation of recovery measures. Recovery of White Sturgeon in B.C. has progressed collaboratively with national and basin recovery teams consisting of members from federal and provincial governments, First Nations, industry, non-governmental organizations and international partners.

## Fish Passage

### Paddlefish Movement, Habitat Use and Selectivity through the Use of Acoustic Telemetry in the Upper Mississippi River

**Dominique Turney[1]**

[1]Western Illinois University

2. James Lamer, 3. Kevin Irons, 4. Kyle Mosel

2. Western Illinois University 3. Illinois Department of Natural Resources, 4. U.S. Fish and Wildlife Service

The construction of dams on the Upper Mississippi River has disrupted movement of the highly migratory paddlefish. Even though important work using radio-telemetry has provided information on paddlefish dam passage and lateral habitat use, these studies are often limited spatially and were undertaken prior to the establishment of the extensive acoustic receiver array upstream and downstream of each dam on the Mississippi River. Lock and Dam 14 and 15 are infrequently at open river conditions and most fish passage occurs in the lock chamber. To better understand native fish passage in this poorly understood region, we acoustically tagged 120 paddlefish and tracked their movements manually and with stationary receivers upstream and at the approach to each dam. We will quantify frequency of passage, habitat use and selectivity in the Upper Mississippi River. A clear understanding of paddlefish movement and habitat use in the UMR will allow researchers and biologists to better understand dam passage of other fishes and evaluate the impacts of potential invasive species deterrents at these locations.

## Regulated Rivers

### Documentation of Successful Lake Sturgeon Spawning Near the St. Marys Rapids in the St. Marys River, Michigan

**Jason Gostiaux[1]**

[1]U.S. Geological Survey, Great Lakes Science Center

2. Edward F. Roseman, 3. Robin L. DeBruyne, 4. Jason L. Fischer, 5. Faith K. Vandrunen, 6. Ethan Binkowski, 7. Christopher Olds, 8. Kaley Genther, 9. Steve Nimcheski, 10. Ashley Moerke, 11. Kevin Kapuscinski

2., 5. & 6. U.S. Geological Survey, Great Lakes Science Center, 3. & 4. University of Toledo, Lake Erie Center, 7-9. U.S. Fish and Wildlife Service, 10. & 11. Lake Superior State University,

The St. Marys River is the Great Lakes connecting channel connecting Lake Superior to Lake Huron and is the international border between Michigan, United States, and Ontario, Canada. This large river naturally encompasses a variety of habitats including lakes, wetlands, islands, tributaries, side channels, and main channels. The river flow is regulated through the navigational locks and a series of 16 compensating gates immediately upstream of the area known as the St. Marys Rapids. To survey fish use upstream and downstream of the St. Marys Rapids/locks/compensating gates area and near the Little Rapids area, we used egg mats and D-frame, bongo, and Miller sampler nets to collect drifting larvae near the bottom and surface during day and night sampling. Viable lake sturgeon eggs were collected in the outfall from a hydro-electric power facility adjacent to the St. Marys Rapids in late June 2018 and larvae were collected for several weeks during July. Eggs were reared in the laboratory until hatching for verification of identity. No eggs or larvae were collected directly downstream of the St. Marys Rapids or near the Little Rapids area. Even though lake sturgeon larvae have been documented in the Garden River, a Canadian tributary of the St. Marys River, this is the first contemporary documentation of successful lake sturgeon spawning and larval drift within the St. Marys River proper.

**Movement of Hatchery-Reared, Age-0 Paddlefish in Lake Sharpe, South Dakota**

**Dylan R Turner[1]**

[1]U.S. Fish and Wildlife Service

2. Hilary A Meyer, 3. Landon L Pierce, 4. Daniel A James

2. South Dakota Game, Fish and Parks, 3. & 4. U.S. Fish and Wildlife Service

Paddlefish *Polyodon spathula* are a large river species native to several major rivers and tributaries throughout the USA. Abundance of Paddlefish has declined due to habitat modifications (i.e., channelization, dams, and water quality) and unsustainable commercial harvest. Some meta-populations within the Missouri River have been sustained with hatchery stocking, but in Lake Sharpe, SD, Paddlefish are nearly extirpated. Since 2015, the South Dakota Department of Game, Fish and Parks (SDGFP) and U.S. Fish and Wildlife Service (USFWS) have stocked, >170,000 Paddlefish in Lake Sharpe to restore the fishery. However, little is known about initial age-0 movement after being stocked. Thus, our objective was to examine movement patterns of age-0 Paddlefish within Lake Sharpe. We surgically implanted acoustic telemetry tags (Vemco V8-4x) into 50 individuals to track movement using a Vemco receiver array (n = 23 passive receivers) within Lake Sharpe. Paddlefish moved an average of 60 ± 9.2 rkm (total movement, regardless of direction) and an average of 25 ±4.8 rkm (downstream movement) during the first 3 months after stocking. The majority of Paddlefish generally moved away from their stocking location and used a large portion of the reservoir within a short time frame post-stocking. This information will better inform SDGFP and USFWS if stocking locations influence movement of juvenile paddlefish within Lake Sharpe, SD.

## Bottlenecks to Recovery

### Retention of Age-0 Sturgeon in Natural Side Channels of the Lower Missouri River

**Kyle Winders**[1]

[1]Missouri Department of Conservation

2. Thomas Boersig, 3. Jacob McQuaid, 4. Catlin Ames

2. & 3. Missouri Department of Conservation, 4. University of Maine

The Missouri River has been drastically modified by impoundments, disconnection of adjacent floodplains, and simplification of physical aquatic habitat to facilitate commercial navigation and flood control. Several fish species, including the federally endangered pallid sturgeon, have declined dramatically after a century of river modification. Recovering these ecologically important species requires understanding the mismatch between species' life history and available physical habitat within the modified riverscape. It is hypothesized that increasing channel complexity in the lower Missouri River will improve age-0 pallid sturgeon survival by allowing free drifting embryos to be intercepted and retained in supporting habitat. In this study, our objective was to improve our understanding of retention rates of age-0 *Scaphirhynchus* sp. sturgeon by evaluating four natural side channels that represent the best-available rearing habitat in the lower Missouri River. Trawl sampling occurred weekly at Cranberry, Jameson, Pelican Island, and Little's Island side channels during May through October of 2014 and 2015. Ages and hatch dates of larval sturgeon were estimated by using lengths on date of capture and thermal growth units. A total of 416 age-0 sturgeon were collected and used for regression analysis of age frequencies beginning at 14 days-post-hatch because this appeared to be when fish were fully recruited to sampling. Estimated weekly retention rates of age-0 sturgeon ranged from 0.59 – 0.85 in 2014 and 0.61 – 0.73 in 2015 with an overall average of 0.71 (0.11, 2SE). This converts to a daily retention rate of 0.95 (0.021). These may be overestimates of retention as we were unable to identify immigration. However, regardless of the origin of age-0 sturgeon, these estimates provide a measure of expected declines in age frequencies in adequate rearing habitats and when coupled with relative abundance estimates could provide quantitative success criteria for future reconfiguration projects.