PROJECT PROFILE

GLFT-GLSI Project 1766 - Developing virtual learning opportunities to train citizen scientists about lake sturgeon and coupled Great Lakes-tributary ecosystems

Synopsis

Project Title: Developing virtual learning opportunities to train citizen scientists about lake sturgeon and coupled Great Lakes-tributary ecosystems

Grantee Organization: Michigan State University

Project Team:

Kim Scribner, Dept. Fisheries and Wildlife, Michigan State University

Douglas Larson, Dept. Fisheries and Wildlife, Michigan State University

Meaghan Gass, Sea Grant Extension, Michigan State University Extension

Brandon Schroeder, Sea Grant Extension, Michigan State University Extension

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Grant Amount: $35,427

Time Frame: 4/18/2018 to 3/31/2021

Focus Area: Stewardship

Project Summary: Biodiversity and ecosystem resilience are important concepts to communicate to K-12 students and educators. We developed virtual community science curricula that was beta-tested with 19 classrooms in four Great Lakes states, focusing on lake sturgeon and coupled tributary-Great Lakes ecosystems. Participants learned about Great Lakes-tributary communities, inter-species interactions, and human disturbance that affect the sustainability of ecosystem processes and species viability. We produced underwater video recording fish passage into the Black River. We developed educational videos for students and a graphical interface allowing students to visualize results. Student and teacher evaluations provided feedback to course content to guide future curricula.

Project in Context

Goals of the Effort: The overall goal of this project was to develop and deploy an e-learning platform to provide educational and outreach community science to inform K-12 students, community members, and stakeholders about Great Lakes tributary communities, inter-species interactions, and human disturbance that affect the sustainability of ecosystem processes and species viability. The program allowed users to make observations, synthesize information, and draw conclusions in a web-hosted environment. Community science will help community

members learn more about scientific processes, become more engaged in local issues, and better understand the science behind natural resource policy decisions.

Specifically, the project objectives were:

1. To establish an interpretative "Community-Science" videography system using underwater cameras to record fish entering the Black River in NE Michigan and the time and date of passage up- and down-stream.
2. To develop a species identification key to train community scientists to identify fish species to improve the quality of data students provide to our research team.
3. To develop a web site to host the videos and background curricula materials on fish migration, reproductive ecology, predator-prey relationships, and effects of human disturbance, focusing on lake sturgeon mortality during early life stages.
4. To work with K-12 STEM educators to develop lesson plans to direct student learning.
5. To develop student and teacher evaluations to assess the efficacy of curricula developed in the context of learning outcome expectations.

Methods

Participant Selection and Recruitment

We targeted middle and high school students and educators focusing on STEM classrooms in both Michigan and across the Great Lakes basin. We shared this opportunity/program application via email through the Great Lakes Stewardship Initiative regional hubs and networks along with Center for Great Lakes Literacy partners. We also shared it with participating schools in the Sturgeon in the Classroom program. Educators also received a participant stipend in exchange for their time and input piloting the program. This additional funding was obtained from Michigan State University (MSU), Michigan Sea Grant and Center for Great Lakes Literacy.

In total, we received 54 applications from across the Great Lakes basin. Using a rubric to assess experience with Great Lakes content; scientific data & technology integration; plans integrate; and more, we selected 19 classrooms to participate in the pilot and beta-tasting representing elementary (1), middle (12), and high (13) classrooms (geographic distribution shown in Figure 1). Thus far, 14 educators and 483 students engaged in and piloted this Lake Sturgeon Community Science project.

Video Implementation and Design

In 2018, the Black River Streamside Rearing Facility (BRSRF) deployed two Defeway True 1080P Video Security System cameras under FO5 Bridge at the mouth of the Upper Black River in Cheboygan Co. Michigan (45°28’04” N, 84°18’11”W) prior to the adult lake sturgeon spawning migration. The cameras were mounted on the underside of the bridge with the

intention of videoing fish passing beneath. During July and August 2018, BRSRF crew evaluated overhead video collected during the 2018 spawning run in an effort to develop a lesson guide for teachers to conduct a citizen science program in their classroom. Unfortunately, most of the overhead video was difficult to effectively evaluate, particularly during the evening hours when the infrared setting on the camera would overpower the overhead lights, creating a blurry picture. Additionally, the video made it very difficult to identify adfluvial fishes smaller than a Lake Sturgeon. Because the overhead video was poor quality, BRSRF purchased and installed two Delta Vision HD cameras (Ocean Systems, Inc., Everett, WA; https://www.splashcam.com/product/delta-vision-industrial-hdtvi/). Delta Vision HD cameras are high quality, durable underwater cameras used by hydroelectric facilities and other fish passage projects.

On 14 April 2020, Delta Vision HD cameras were installed beneath the FO5 bridge near the mouth of the upper Black River. Three 2000 lumens (Husky Tools, model: K40170), portable LED work lights were installed on the underside of the bridge evenly spaced and set on a 12-hour timer (19:00 – 07:00) to provide light strong enough to illuminate the entire capture area below the bridge. Cameras recorded during the entire 24 period from 14 April 2020 to 31 May 2021. Video was stored on a 1TB 4 Channel DVR (DVR-4CH-1TB; Ocean Systems, Inc., Everett, WA) and snipped into one-hour segments using MovAVI Video Editor 15 (movavi, inc). For the pilot phase of this project, video was collected for the entire 24-hour period of 15 April 2020, 22 April 2020, 27 April 2020, 28 April 2020, 1 May 2020, 3 May 2020, 8 May 2020, 11 May 2020, 16 May 2020, 18 May 2020, and 20 May 2020.

MISG Video Methods

Video segments were uploaded in order to youtube.com, indexed by date and hour, and linked through a content hosting website created in the Google website suite. Students were randomly assigned videos in each of the participating classrooms using a random number generator created in Rstudio (4.10). A link to the content hosting site is provided in the Communication Section of this report.

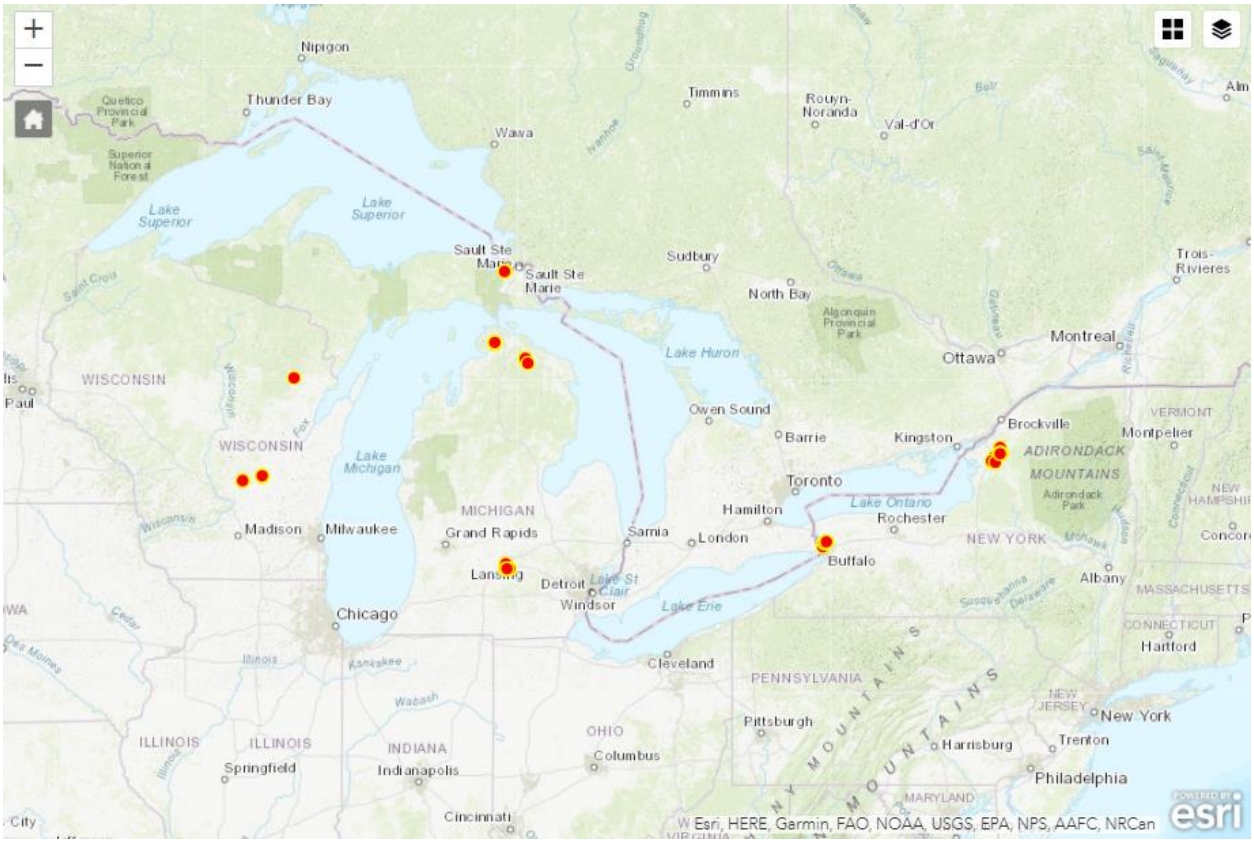
K-12 Classroom Engagement

We partnered with Michigan Sea Grant and MSU Extension to prepare materials for the Sturgeon Community Science Pilot. Brooke Groff, Pellston Area Schools, also assisted with reviewing student and teacher presentations, aligning lessons to Michigan's Next Generation Science Standards, and assisting with the development of the program's Google Classroom. With support from the Center for Great Lakes Literacy, we were able to provide a personal stipend to compensate Brooke for her time developing and launching this Sturgeon Community Science pilot.

Before engaging in the Sturgeon Community Science Pilot, educators participated in a synchronous virtual training via Zoom, where we overviewed the program deliverables,

expectations and answered questions. We recorded this session (https://youtu.be/oMy4wQ9cnT0) and shared it with educators following the meeting.

Figure 1. Map showing the locations of schools that participated in beta-testing of our Community Science Program during 2021.



To support student learning, we developed and shared resources using different Google Suite products (e.g. Google Classroom, Sheets, Sites, Slides, etc.) in order to make content and resources accessible by K-12 classrooms. Sturgeon Community Science Program pilot resources were designed to be shared with students either in-classroom by teachers or virtually via online learning management systems, like Google Classroom.

We developed videos sharing content related to Lake Sturgeon, Great Lakes Literacy and predator-prey relationships. In total, these videos were ~80 minutes in length. These videos were edited by Michigan Sea Grant partners and divided into shorter video segments. These videos are shared via YouTube and links can be found in this Communication Section of the report (Appendix 1). There was an optional module focused on human disturbances that was also available. Discussion questions were developed to accompany these videos (by both partners and pilot participants; Appendix 2).

Students were also required to complete a tutorial to aid in fish identification. Using video collected on the cameras during deployment in 2019 and 2020, project coordinators created an interactive fish identification tutorial showing multiple examples of fish students could expect to see on the camera data. The tutorial provided additional background native ranges and identifying characteristics. Students were also provided with a .pdf version of this key for reference to use during the identification quiz, and identification of fish during the lesson-based video. Links to the tutorial are provided in Appendix 1 and the Communication Section of this report.

Additional video clips were used to create a 15 question fish identification quiz, which students were required to complete prior to assignment of a video. The quiz, created in Google Forms, provided 12 multiple choice answers. These answers did not differ across questions/videos, so as not to create visual cues providing students the chance to "guess" the correct fish answer, while standardizing and streamlining results for the educator. Students were allowed multiple attempts to complete the quiz, though correct / incorrect results were not identified. A link to the Fish ID quiz is provided in the Communication Section of this report. This tutorial and quiz was estimated to take about 60 minutes.

To evaluate across grade level groupings (high school, middle school, combine high and middle school), students had to identify the classroom from which they were participating. Teachers assigned identification codes to each student which did not identify a student to the program evaluators, but allowed sorting of scores. To address issues with sample independence, only the final score from each student was evaluated. Test scores among grade level groupings were characterized by the educator, based on the student grade levels in each class. Grade level groupings were evaluated using a Kruskal-Wallis test, with post-hoc Dunn's Tests used to decipher pairwise differences between groups.

To complete the Sturgeon Community Science activity, students were assigned videos by teachers (either as groups or individuals). Each student/student group watched underwater video footage from Black River (one hour in length, with the option to watch at a faster speed). They used Google Sheets to enter and share their findings. This activity was estimated to take between 60-90 minutes.

Using Google Sheets, individual data entry pages were created for each classroom with the videos randomly assigned available for data entry. Only the columns into which students could enter data were active so that students couldn't manipulate data. To prevent student and classroom overlap, a second data form was created and indexed by date to organize data from classrooms into a viewable form so students could see data from all classrooms in real time. Using the "import range" function, data from each classroom was centralized by date and across dates by hour. The data was protected so that students couldn't manipulate data, but they could evaluate trends in data as it was entered. Initially, the intention was to have students view videos in duplicate, but due to some classrooms dropping out, or students who did not participate, viewing data for each day was not possible. However, we were able to generate data across hours

for the entire viewing dataset. Data is graphically presented for each of 24 daily hours collated for the entire sampling period.

Evaluation

To assess program impacts, we utilized an outcomes-based, formative and summative evaluation model to assess gains in Great Lakes literacy, student achievement, and self-efficacy with respect to stewardship attitudes and behaviors. Educator and student participants were asked to complete an online post-program reflective evaluation including both qualitative and quantitative items. In addition to basic demographic information (participant name, school, state, and learners' grade levels), educator and youth participants were asked to reflect on their program experience, values, learning outcomes, and provide program improvement feedback.

Educator evaluations focused on educational values in this project ranging from student learning to how educators aligned with their school improvement or classroom instructional goals. We also asked educators for detailed program feedback in regards to what was most useful and valuable, as well as opportunities for improving this community science program in the future. Student evaluations assessed factors ranging from knowledge gains to changes in attitudes or values toward Great Lakes fisheries (anchoring on Lake Sturgeon), Great Lakes literacy and science learning, and civic community and conservation stewardship involvement.

Results

Fish Identification Quiz Results

Prior to identifying fish in videos collected in the Black River, students were required to complete a fish identification tutorial and identification quiz. In total, 436 students attempted the fish identification quiz at least one time. The mean ± SD score for all participants was 10.95 ±

3.90 correct answers out of 15 possible. The range of scores for each individual classroom are presented in Figure 1.

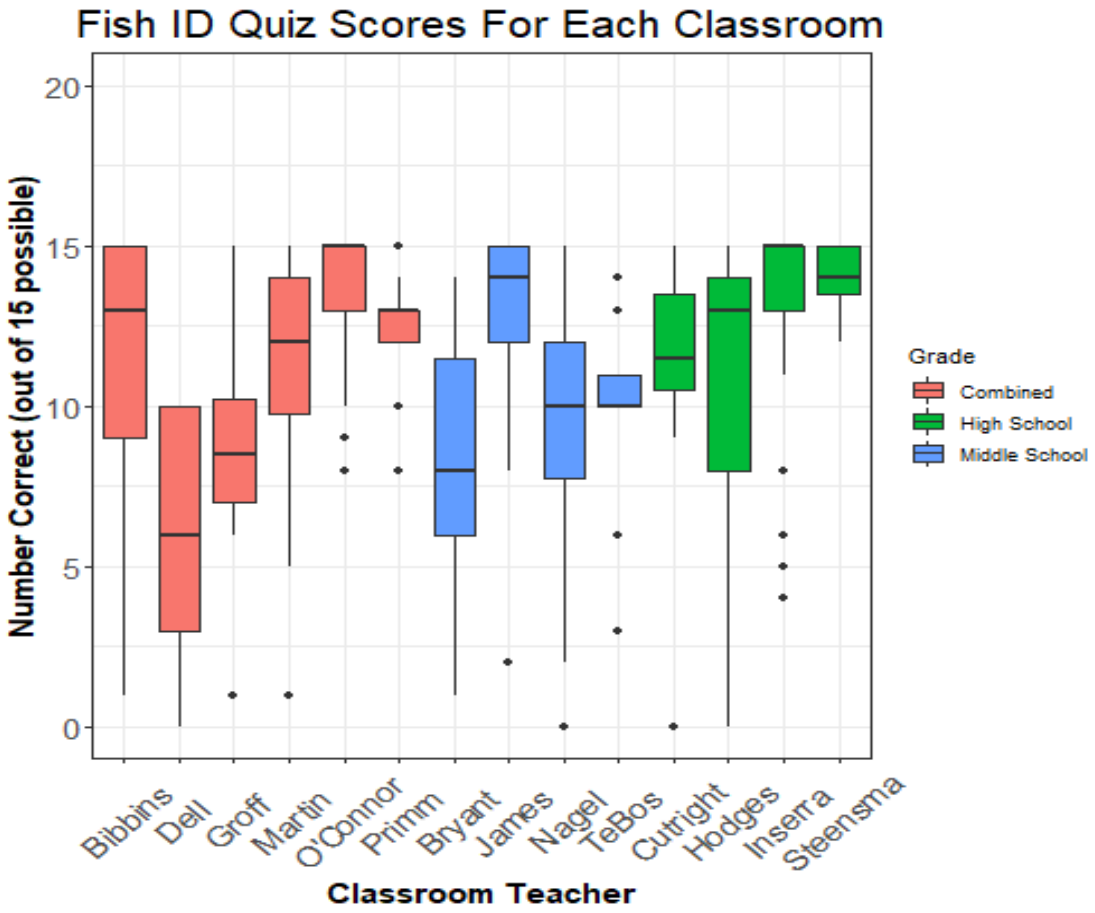


Figure 1. Distribution of student fish identification quiz scores across classrooms. Scores are also grouped by grade level of individual classrooms, where classrooms in red are students of both the high school and middle school level, classrooms in blue are middle school students and classrooms in red are high school students.

For comparative analysis, classrooms were organized by grade level to evaluate if fish identification differed across age groups. At least one group of students performed significantly differently than the other groups (Kruskall-Wallis, Chi-square = 39.077, df = 2, p-value <0.001). We observed no difference in test scores between high school and combined middle/high school students (Dunn's Test, Z = -1.513457, p = 0.390). Additionally, we noted that middle school classrooms (mean ± SD = 9.85 ± 3.68) scored significantly lower than combined middle/high school classrooms (mean ± SD = 11.5 ± 3.76) (Dunn's Test, Z = 4.62, p < 0.001) and high school classrooms (mean ± SD = 12.0 ± 4.03) (Dunn's Test, Z = 5.76, p < 0.001) (Figure 2).

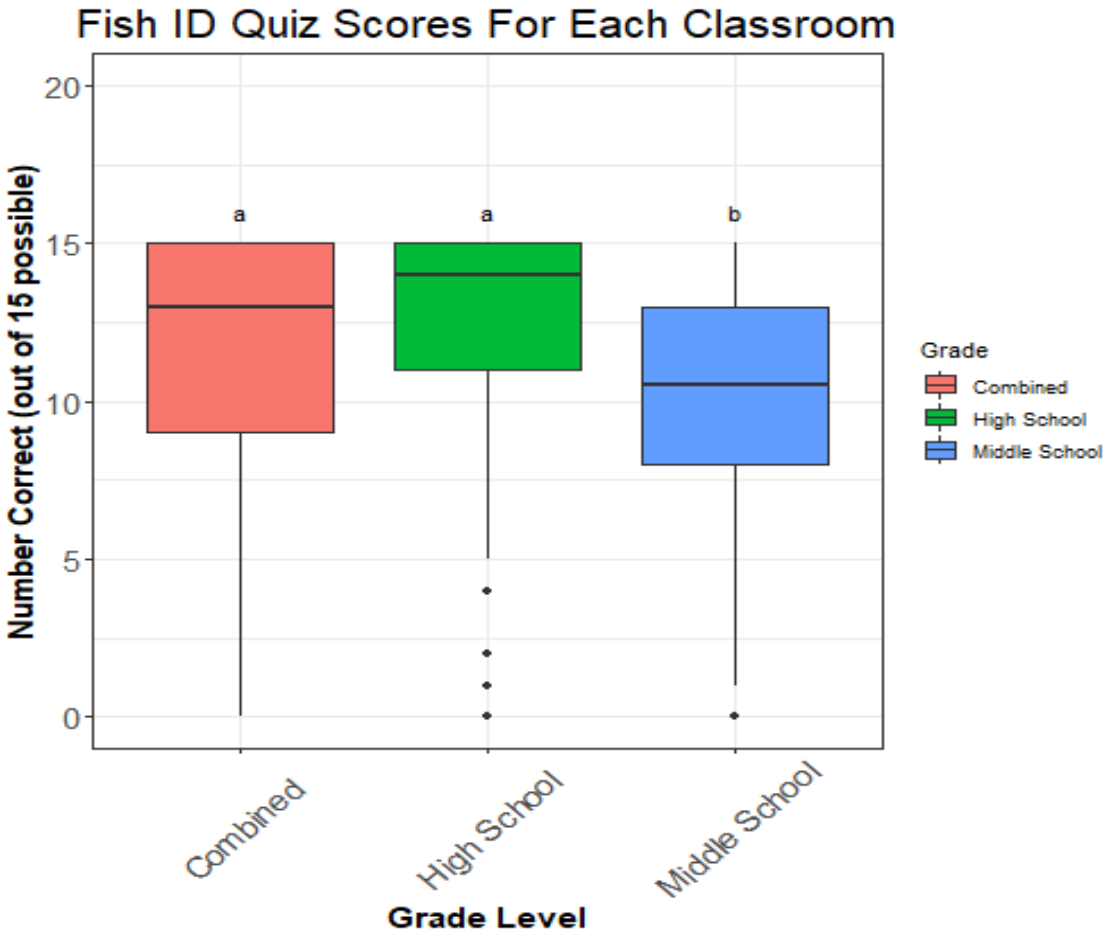


Figure 2. Distribution of student fish identification quiz scores grouped by grade level of individual classrooms, where classrooms in red are students of both the high school and middle school level, classrooms in blue are middle school students and classrooms in red are high school students. Letters indicate significant differences (Kruskall-Wallis, Chi-square = 39.077, df = 2, p-value <0.001).

Fish Video Identification

Video was collected for 24 continuous hours from 15 April 2020 to 20 May 2020. It was clear during the video editing phase that only one camera of the two installed collected video from which fish could be identified. Camera 2, which was installed on the East side of FO5 bridge in the upper Black River, Cheboygan Co. Michigan suffered at PTZ error which caused unfocused video. This video was not distributed to students.

We were limited by the number of students participating in the preliminary video identification and wanted to duplicate some videos in the event that classrooms did not fully participate. We selected videos from 12 days (15 April 2020, 22 April 2020, 27 April 2020, 28 April 2020, 30

April 2020, 1 May 2020, 3 May 2020, 8 May 2020, 11 May 2020, 16 May 2020, 18 May 2020, and 20 May 2020) spread throughout the 2020 lake sturgeon spawning migration. In total, 362 videos were assigned to students across 18 classrooms. Of the 362 assigned videos, 183 students completed identification of fish in a one-hour segment (50.55%).

In total students identified 464 individual fish passing the cameras. 60 of the identified fish were lake sturgeon, 109 were fish which produce co-distributed drifting larvae (white sucker, silver redhorse), and 295 identified were fish for which there is evidence of lake sturgeon larval predation (walleye, northern pike, largemouth bass, smallmouth bass, yellow perch, rock bass and darter species). 11 May 2020 and 16 May 2020 were the days in which the most fish were identified (Figure 3) with 70 fish and 69 fish identified, respectively. Conversely, only two fish were identified on 15 April 2020. Students could visualize movement of fish by individual date, or view data across all sampling dates by hour (Figure 4).

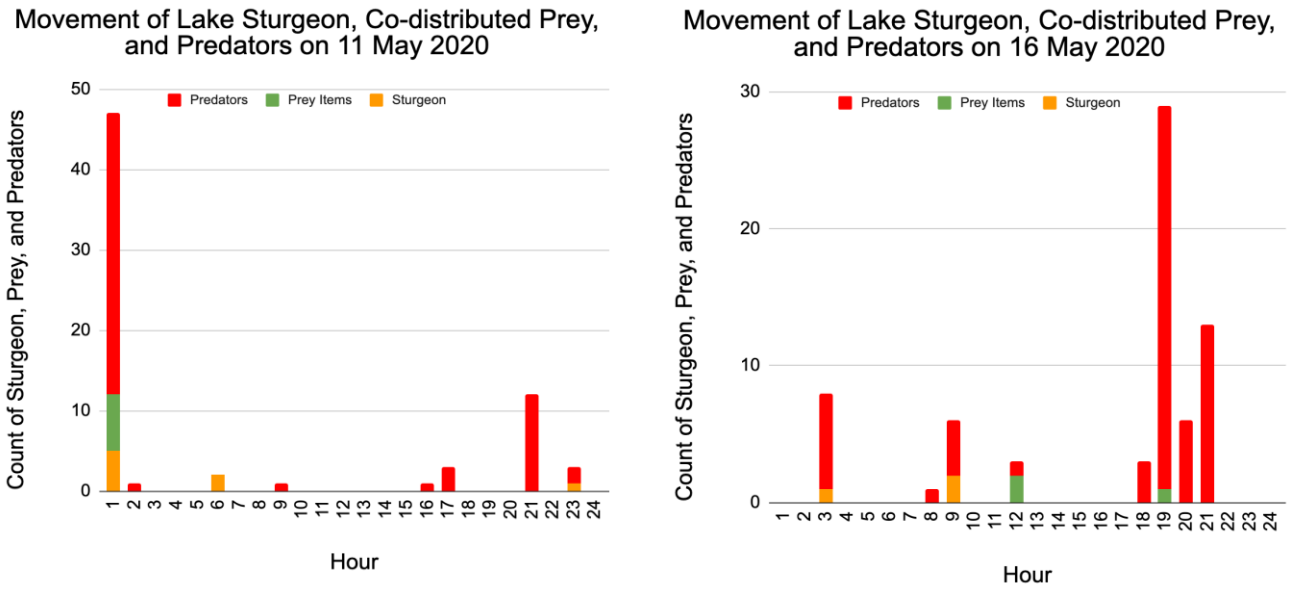


Figure 3. Movement of lake sturgeon, co-distributed prey items (white sucker, silver redhorse) and known larval lake sturgeon predators (walleye, northern pike, largemouth bass, smallmouth bass, yellow perch, rock bass and darter species) on 11 May 2020 and 16 May 2020.

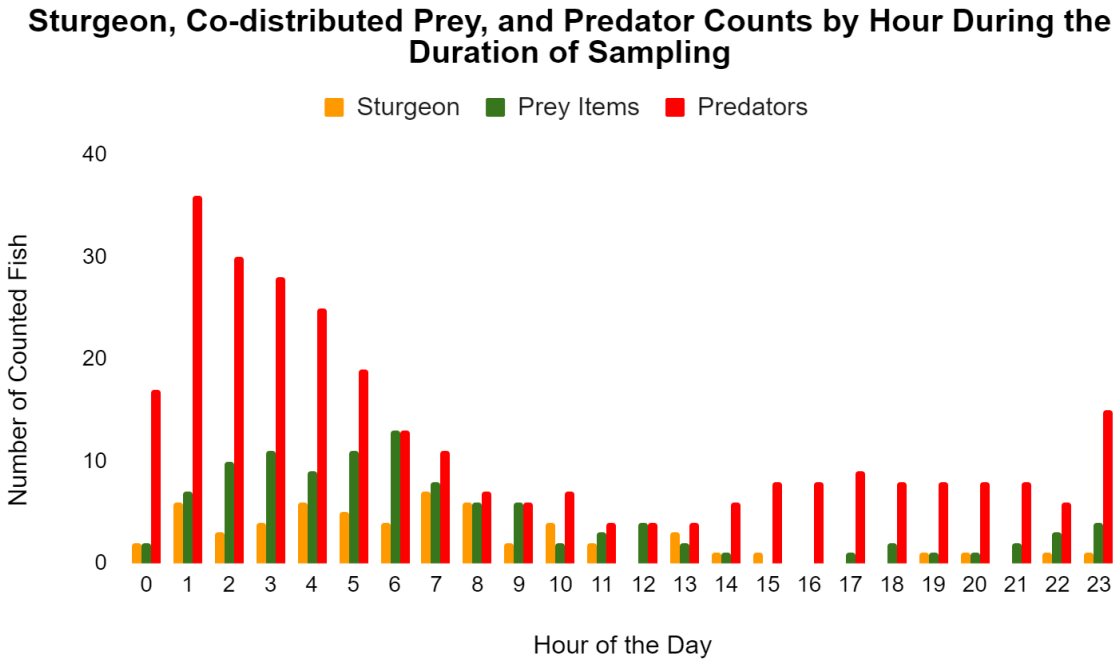


Figure 4. Movement of lake sturgeon, co-distributed prey items (white sucker, silver redhorse) and known larval lake sturgeon predators (walleye, northern pike, largemouth bass, smallmouth bass, yellow perch, rock bass and darter species) across all sampling days by hour.

FINAL NARRATIVE REPORT

Background/Overview

1. *Briefly summarize the project description as outlined in the original proposal.*

   Response - Our community science program has built capacity to acquire and synthesize lake sturgeon data and data on other physical and biological components of Great Lakes and tributaries focusing on aquatic community dynamics and connectivity (migration), sustainability, and stewardship. We developed and distributed virtual (web-based) data bases and curricula. We expanded our existing web-based K-12 STEM curricula to focus on seasonal migration of fishes into tributaries and both a source of predation and of additional prey resources, lake sturgeon reproductive ecology, and predator-prey dynamics. Background curricula emphasized how these processes affect biological diversity, the trophic structuring of stream aquatic communities, species viability, and the importance of sustainability of ecosystem services provided by streams and Great Lakes.

2. *Was the project completed as originally intended? If not, indicate how the final outcome(s) differed from what was anticipated. Does your experience suggest that original expectations were realistic? What factors hindered or helped progress?*

   Response - We believe that the final project was tremendously successful.

(a) The geographic extent of our proposed community science network was designed to be constituent groups in NE Michigan and Michigan GLFT-GLSI HUBs. The study site where data on lake sturgeon and other migratory stream fishes was obtained was on the upper Black River in the NE lower peninsula of Michigan. We expanded the geographic scope of the project to 19 classrooms from four Great Lakes states (Figure 1).

(b) The project design was to have an e-learning component, an 'on-site' component, and an 'in-classroom' component. Because of logistic difficulties with different camera's we were not able to get usable quality of camera video until 2020. The video was obtained during the Covid-19 pandemic. Classroom instruction was happening virtually so no 'in-classroom' visits by members of our team were possible. We had proposed to concentrate 'place-based' activities for school districts within areas serviced by the NW GLSI/Grand Traverse GLSI Hub and NEMIGLSI Hubs that are geographically in closest proximity ($\leq$2 hours) to the Black Lake study sites. Michigan State University did not permit non-Michigan State University personnel to access the research facilities. Accordingly, all our place-based learning activities were cancelled for the 2020 season.

We did provide place-based educational opportunities in 2019. Our team participated in the Sturgeon in the Classroom program in 2019. Classrooms brought fish to our research facility and released them into the Black River. Students toured our hatchery and field research facility and were given presentations about lake sturgeon and summaries of our long-term research program. We expanded our lake sturgeon production and stocking program to include four tributaries to the Saginaw River. Co-PI Meaghan Gass was instrumental in fostering community support for, and participation in release of fish. Place-based activities associated with fish release as part of the Sturgeon in the Classroom program continued in the 2020-2021 academic year. We provided fish to classrooms in fall 2020. Students returned to the Black River in spring 2021 to release fish.

Outcomes

3. *What activities were pursued in relationship to intended outcomes, and to what extent did you achieve the following intended outcomes listed in your proposal?*

Response – During this project, (1) we have established an interpretative "Community-science" videography system that used underwater cameras to record fish entering the Black River in NE Michigan and the time and date of passage up- and down-stream. (2) We have developed a species identification key that allows users to identify fish species to allow our team to critically evaluate the 'quality' of the data students were providing on the species seen in the video. (3) We have developed a web site to host videos and background materials on fish migration, reproductive ecology, and predator-prey relationships. We greatly expanded our capabilities by collaborating with Brandon Schroeder and Meaghan Gass of Michigan Sea Grant and Michigan State University E xtension, who assisted with content design and project implementation. Brooke Groff, Pellston Area Schools, also provided valuable input in coursework design.(4) We have worked with K-12 STEM educators to develop lesson plans to direct student learning. We worked with a teacher in the region of our Black River site to screen curricular materials

for content and level of competency. Ms. Groff worked with our time to revise power point presentations to be compatible with our targeted middle school and high school age groups.

4. *What audience(s) were you particularly hopeful of reaching? To what extent did you reach them? Did you receive any feedback?*

   Response – We targeted middle and high school students and educators focusing on STEM classrooms in both Michigan and across the Great Lakes basin. We shared this opportunity/program application via email through the Great Lakes Stewardship Initiative regional hubs and networks along with Center for Great Lakes Literacy partners. We also shared it with participating schools in the Sturgeon in the Classroom program. We received 54 applications from across the Great Lakes basin. Using a rubric to assess experience with Great Lakes content; scientific data & technology integration; plans integrate; and more, we selected 19 classrooms to participate in the pilot and beta-tasting representing elementary (1), middle (12), and high (13) classrooms. Thus far, 14 educators and 483 students engaged in and piloted this Lake Sturgeon Community Science project. Using different Google learning tools, we developed and shared resources related to the pilot along with evaluation tools for both students and educators.

5. *What relationships or opportunities were developed or strengthened through the work?*

   Response – Expanding our original team to bring in other people from Michigan Sea Grant and Michigan State University Extension was key to expand the technical capabilities to present curricular material more effectively, including using Google learning tools to share content. To encourage educator participation and support in beta-testing, we offered participant stipends to educators through additional funding obtained from Michigan State University, Michigan Sea Grant and Center for Great Lakes Literacy. In addition to the participant stipend, this partnership also helped recruit more teachers and students to our program across a greater geographic area than we had anticipated. We were able to engage with teachers and students in a greater breadth of ages and 'types' of classroom. By expanding the number and diversity of classrooms participating in the beta-testing, we were able to infuse 'replication' into an evaluation experimental design that we feel will be important to develop a peer-review publication that recounts our course development and quantifies evaluation responses.

6. *Was an evaluation included as part of this project? If so, what were the key findings? (Please attach a copy of the evaluation report).*

   Response – We assessed program progress and institutionalized gains in ecological knowledge. Specifically, we utilized an outcomes-based, formative and summative evaluation model to assess gains in Great Lakes literacy, student achievement, and self-efficacy with respect to stewardship attitudes and behaviors. Educator and student participants were asked to complete an online post-program reflective evaluation including both qualitative and quantitative items. In addition to basic demographic information (participant name, school, state, and learners' grade levels), educator and youth participants were asked to reflect on their program experience, values, learning outcomes, and provide program improvement feedback. Educator evaluations focused on educational values in this project ranging from

student learning to how educators aligned with their school improvement or classroom instructional goals. We additionally asked educators for detailed program feedback in regards to what was most useful and valuable, as well as opportunities for improving this community science program in the future. Student evaluations assessed factors ranging from knowledge gains to changes in attitudes or values toward Great Lakes fisheries (anchoring on Lake Sturgeon), Great Lakes literacy and science learning, and civic community and conservation stewardship involvement. Twelve educators (63% response rate) and 374 students (77% response rate) responded to the online program evaluation survey. Evaluation implementation, analysis, and summary were led by Michigan Sea Grant and Center for Great Lakes Literacy team members. Evaluation instruments and procedures were informed by evaluative work done by the Great Lakes Stewardship Initiative network. The evaluation forms and summarized report are provided as Appendices 3 and 4, respectively submitted to the GLFT final report web portal with this narrative. A summary of key findings and recommendations resulting from the program evaluation include:

- **Program Education Values:** Educators largely valued this project for its place-based, applied project learning opportunity; as well as the supporting educational materials, Great Lakes science (and scientist) connections, and well-organized/facilitated community science process.

- **Alignment with Classroom Learning Goals**: Educators described this project as very relevant and value-added to their learning goals, most readily identifying 'Place-based/Project-based' learning pedagogy and 'human interactions with the environment' and 'ecology and ecosystem studies' learning standards as core values in this project.

- **Student Knowledge and Learning:** As a result of this project, **s**tudents described a great deal of learning about Lake Sturgeon science, issues, and conservation opportunity. A majority (51%) of students entered into this project with very limited or no knowledge of Lake Sturgeon or fisheries biodiversity conservation efforts. For example, one student noted,*"I knew nothing about them. I didn't even know they existed."* Students most valued the opportunity to contribute to real science and stewardship of Lake Sturgeon in the Great Lakes; and demonstrated varying levels of growth in knowledge and attitudes toward conservation issues and Lake Sturgeon restoration efforts.

- **Students valued real, meaningful Science and Conservation:** Among their experience and learning, most meaningful to students in this experience was described as contributing to Lake Sturgeon or environmental conservation (29%) and/or contributing value to a real-world research effort collaborating with scientists (20%). This finding is best illustrated directly by student quotes:

  - *The thing that was most meaningful to me was becoming an actual kid scientist and helping improve the world.*

- *That with my help real world scientists might be able to save this species that may go extinct but maybe with a little of my help I can try to help prevent that. Also getting insight into science that happens in the real world.*
- *I got to genuinely be a part of something with real world effects and impacts.*
- *I really enjoyed that I was doing something that mattered, rather than collecting data for some experiment made up by a teacher, the data collected in this project was useful and important.*
- *It is nice knowing that I may have made a difference and it's nice that people are trying to preserve this long lasting species.*
- *The most meaningful part of this project to me was, knowing that what I am doing is going to be a small help in restoring the lake sturgeon population.*

- **Student Engagement:** Educators felt engagement of students varied, largely dependent on what specific videos they drew to review (e.g. fish in the video engaged students, videos without fish lost student attention). Educators requested more videos and opportunities for engaging students directly with Lake Sturgeon and/or the Lake Sturgeon Research and Rearing Facility. Opportunity to cross-connect with other Lake Sturgeon education efforts was highlighted as a student value. For example, students who were also raising sturgeon in their classroom, another related sturgeon education program, often identified this community science project as adding value (and helping them to better see the value) in their experience of raising and releasing their own fish. One additional project spin-off step toward creating a more immersive experience for future participants was to capture 360 degree photos/videos to explore opportunities to create a virtual tour of the station (proof of concept here: https://www.thinglink.com/video/1449910078894243843); as well as recording a 'thank you' video from researchers with Lake Sturgeon in the Black River for educators and students participating in this current pilot cohort.

- **Educational content and materials** were recommended by educators as higher level, most appropriate for high school/pre-college age learners. Educators overall felt these materials, as presented, were helpful in preparing themselves with background knowledge and learning that helped them to better facilitate the project with students. A recommendation for future cohorts would be to develop additional, more simplified companion materials/videos designed for use directly with students.

- **A Future for the Program?** Nearly all educators (91.7%) indicated they would participate in future. This speaks to value in current effort, and also that educators value and envision this project as a valuable opportunity and addition in their education efforts.

7. *Whether they were intended or unintended, what do you consider the most important benefits or outcomes of this stewardship project?*

   Response - Communicating science can be a two-way street. Our team's long term data, video presentations of background materials (Appendix 5), and structure decision making facilitated through questions for teacher-led discussion (Appendix 2) is a valuable contribution to student environmental literacy. However, in our case, the students were providing our research team with information on the number and species composition of predator and prey fish species entering our study river. These data allowed us to better characterize predator-prey dynamics that we believe had considerable impact on lake sturgeon juvenile survival and population abundance trends over time.

   A second benefit was we were able to expand our network of educators and collaborators in the GLFT-GLSI network and across the Great Lakes (Figure 1). We were able to increase the visibility of lake sturgeon as a species of conservation concern.

Related Efforts

8. *Was this project a stand-alone effort or was there a broader effort beyond the part funded by the GLFT? Have other funders been involved either during the time of your GLFT grant or subsequently?*

   Response – The project was 'stand-alone'. However, as mentioned previously, the geographic scope was expanded. In addition, project investigator Scribner and Michigan Sea Grant/Michigan State University Extension provided additional matching funds that was unanticipated to pay for the consulting teacher to develop curricula. Matching funds also paid each participating teacher in the form of a stipend for their role in beta-testing the e-learning course materials. Matching funds also paid for co-PI Larson's time to develop the fish video recordings, develop the fish key and training, and the graphical interface to allow students and teachers to see synthesized data.

   In addition, during the 2019 field season, our team held a teacher workshop that was part of the GLSI-NE Hub initiative based on the topic of lake sturgeon culture for the 'Sturgeon in the Classroom' program.

9. *Has there been any spinoff work or follow-up work related to this project?*

   Response – Project investigators are planning on writing a peer-review publication based on experiences of this project. Following further review of the results of student fish classifications and video summaries to ensure the accuracy of fish community summaries, we are collecting video in the Black River during the 2021 lake sturgeon field season. We plan to use these video materials along with additional 360 photos to develop more engaging content helping address educator feedback related to some of the program materials. We hope to launch this Sturgeon Community Science Program again in the 2021-2022 school, but we have not yet determined the recruitment process in the future in the absence of funding.

   One spinoff effort, resulting from the challenges of education during a pandemic, was to consider virtual tours using 360 degree photos/videos to create a virtual tour of the station (proof of concept here: https://www.thinglink.com/video/1449910078894243843).

Communication/Dissemination

10. List publications, presentations, websites, and other forms of formal dissemination of the project deliverables, tools, or results, including those that are planned or in process.

Response - A detailed accounting of all project materials and their internet locations is provided in Appendix 1. A partial list or products and resources produced by this project include:

Websites – See links provided in Appendix xx

www.glsturgeon.com – original Michigan State University lake sturgeon web site that has been expanded to include cross-references to all materials available through this project.

Main Community Science Web Site:
https://sites.google.com/msu.edu/sturgeoncommunityscience

Community Science Lessons Page:
https://sites.google.com/msu.edu/sturgeoncommunityscience/home/community-science-lesson

Black River Fish Videos:
https://sites.google.com/msu.edu/sturgeoncommunityscience/home/community-science-lesson/videos

Master Data (view only):
https://docs.google.com/spreadsheets/d/1pb4scM6r8yMq0I9wndLv9m7t1z2S3vcerWQViHFuO-Q/edit#gid=187306317

Classroom reporting (view only):
https://sites.google.com/msu.edu/sturgeoncommunityscience/home/community-science-lesson/turn-in-data

Upper Black River Fish ID Guide

https://drive.google.com/drive/folders/0BzlOsvAlZ7FAfjhrNTNOX1QwMldsclY4MHlnNjlwUWNVM1RhRmZOaUtqUTM1TlZ0RlV0UmM

Educator Evaluation site:
https://docs.google.com/forms/d/1EvxTYeWxtuWXJeTTBlIIYMCwe2392JW0MBJ1UYYtkiw/edit

Student Evaluation site:
https://docs.google.com/forms/d/101Mk420qx71SdgQhjSZxvP0ZEmq7HSWz18W2so1hE2s/edit

Video Recordings and background lecture materials for classroom instruction. Videos were recorded in short segments and uploaded to youtu.be. Our team worked with teachers to organize questions and answers for teacher-led discussion after each lesson (see Appendix x).

Video recordings of introduction and curricula material for students and teachers

Lesson 1 Teacher Check in

https://survey123.arcgis.com/share/137ccef121f249c88749824fa01b5fc7

Lesson 2 Introduction to the Program (4 min)

https://youtu.be/vud1OV03AXA

Lesson 3 All About Sturgeon (9 min)

https://youtu.be/TEi3xUOO0GM

Lesson 4 Why do we want to restore sturgeon? (4 min)

https://youtu.be/DO9-QJ08k8o

Lesson 5 Great Lakes Literacy 101 (1 min)

https://www.youtube.com/watch?v=cAXCVgZgS_U&feature=emb_logo

Lesson 6 Biodiversity of the Great Lakes (13 min)

https://youtu.be/AJDmBUde4_o

Lesson 7 Biodiversity of Sturgeon (16 min)

https://youtu.be/NHjvFDg8U1o

Lesson 8 Who eats who (part 1) (15 min)

https://youtu.be/pxuCNhXQd4I

Lesson 9 Who eats who (part 2) (9 min)

https://youtu.be/kABY7GCbu00

High school student Liz Thomson engagement in early phases of underwater video work can be viewed here
https://www.canr.msu.edu/news/student_builds_msu_network_through_underwater_robotics_msg18_schroeder18.

Presentations

Scribner, K.T., D. Larson, M. Gass, B. Schroeder, and E. Baker. Virtual learning to train community scientists about lake sturgeon and coupled Great Lakes-tributary ecosystems. IAGLR Annual virtual meeting, May 17-20, 2021.

Publications

Our team is preparing a peer-review publication for a science education journal to discuss our project.

Scribner, K.T., D. Larson, M. Gass, B. Schroeder, and E. Baker. Virtual learning to train community scientists about lake sturgeon and coupled Great Lakes-tributary ecosystems. Journal to be determined. In preparation.

11. *Please characterize your efforts to distribute and encourage use of products, processes, programs, etc. developed through this grant.*

    Response – Following completion of this report we will distribute the report and all curricula materials through the Great Lakes Stewardship Initiative regional hubs and networks along with Center for Great Lakes Literacy partners. We will work with Michigan State University Extension and Michigan Sea Grant to distribute materials nationally.

Reflections

12. *Please describe any unanticipated benefits, challenges, surprises, and/or important lessons learned over the course of the project.*

    Response – The Covid-19 pandemic was a significant impediment to the implementation of the project, in terms of (a) deployment of the camera equipment, (b) hiring staff to edit video, (c) working with teachers to understand and use the curricula when most teachers were teaching remotely.

13. *What recommendations (if any) would you make to other project directors working on similar efforts or to the GLFT?*

    Response - We had envisioned that part of the enthusiasm exhibited by teachers and students in the 'community science' process was the sense of accomplishment of having contributed to collection of data that could be used to develop management prescriptions for the management of a charismatic and threatened species. Students and teachers were provided with a graphic interface to visualize real-time results of their classroom video species counts and counts across all classrooms by species and over time. While we have reviewed the results of student video fish identification tests, we still lack information on how useful the student data will be to allow us to alter information on fish community composition in the Black River. We have begun to synthesize evaluation results and the quality of data to assess how to use student-synthesized data in our research.

Attachments

14. *Please attach any reports or materials developed through the grant. – see attachments provided throught the GLFT grant submission portal.*

Response – Additional detail and background materials associated with this document cab be found in supplemental materials submitted with the final report through the GLFT grant report portal.

Appendix 1 – List of internet locations of educational materials associated with the Community Science program. Summary of Google Classroom technology used to (a) interact with teachers, (b) teachers to interact with our materials

Appendix 5 – Power point presentations we used for videos including presentation to the teacher orientation. Questions we provided for teachers to use in teacher-led classroom discussion after the video data had been recorded and students saw all recorded videos.

Appendix 3 and 4 – Final student and teacher evaluation forms and results.

https://drive.google.com/file/d/1jEj_rWU8yAX4ilYMPwHy1xOJOVr5c2lW/view?usp=sharing

Note the Direct link to the google form for student evaluation here:
https://docs.google.com/forms/d/e/1FAIpQLSeOJxjg5rXdS8oBsB66UQNVxyqx7kN6-9mBOHIkkH-QVHtJXg/viewform?vc=0&c=0&w=1&flr=0

Note the direct link to the google form for educator evaluation here:
https://docs.google.com/forms/d/e/1FAIpQLSevUBlCOUBnHYrEl6i0igXzrA1ArFNEP-UvdeyqV42vukHy0A/viewform?vc=0&c=0&w=1&flr=0