**Scope of Work**

**Wisconsin DNR Office of the Great Waters**

***Project Title:*** Mapping Lake Sturgeon Habitat in the Milwaukee River Using Side-Scan Sonar

***Project Applicant:*** Andrew Struck, Director, Ozaukee County Planning and Parks Department, 121 W. Main Street, P.O. Box 994, Port Washington, WI 53074, 262-238-8275, [astruck@co.ozaukee.wi.us](mailto:astruck@co.ozaukee.wi.us)

***WDNR Project Contact:*** Emily Punke, Office of Great Waters, 608-267-7439, [emily.punke@wisconsin.gov](mailto:emily.punke@wisconsin.gov)

***Project Location:*** The project will use side-scan sonar and a lake sturgeon habitat suitability index (Daugherty et al. 2008) verified by four field assessments using WDNR quantitative stream assessment protocols to evaluate 14.4 miles and 339 acres of in-stream habitat in the Milwaukee River in Ozaukee County from County Line Road to the first barrier (Bridge Street Dam in the Village of Grafton) located at river mile 31, and 3.5 miles and 36 acres of instream habitat on Cedar Creek from its confluence with the Milwaukee River to the Nail Factory Dam (see attached map).

***Problem Statement:***  Lake sturgeon (Acipenser fulvescens) are one of the Great Lakes basin’s oldest and largest indigenous species. Historically, this species had populations that numbered in the millions basin-wide, but were reduced to remnant populations by 1920 from overharvest, habitat loss and degradation. Furthermore, the construction of dams and other flood control measures along the Milwaukee River in the 1900s prevented natural sturgeon regeneration. Lake sturgeon are potamodromous, periodic spawners, migrating from lake feeding grounds upriver to spawn in the spring. Slow growth, late sexual maturation, and natal spawning requirements complicate rehabilitation efforts. Male lake sturgeon reach sexual readiness at 15-20 years of age and spawn every other year. Females sexually mature at about 20-25 years of age and spawn on average every four years.

Since 2006, Riveredge Nature Center, in partnership with the WDNR, has implemented the "Return the Sturgeon" reintroduction project in alignment with Wisconsin's statewide Lake Sturgeon Management Plan. This project includes the annual rearing and release of thousands of fingerling Lake Sturgeon into the Milwaukee River and Lake Michigan Basin. WDNR and Riveredge Nature Center have released approximately 11,000 juvenile sturgeon into the Milwaukee River since 2006 and adult Lake Sturgeon will begin to return to the Milwaukee River in subsequent years to naturally spawn as they reach sexual maturity. In conjunction with these efforts, the Ozaukee County Planning and Parks Department and its partners have removed or remediated several fish passage impediments, reconnecting 31 river miles between the Milwaukee River’s confluence with Lake Michigan to the Bridge Street Dam in the Village of Grafton. These remediations have included large-scale dam removals including the Lime Kiln Dam in Grafton and a nature-like fishway that bypasses the Mequon-Thiensville Dam (as well as the very recent on-going removal of the Estabrook Dam in Milwaukee County). However, it is unknown if remnant, accessible habitat will support a naturally reproducing population as no comprehensive lake sturgeon instream habitat suitability information exists for the Milwaukee River. Successful, proactive sturgeon management requires knowledge of existing (or lack of) high quality spawning and nursery habitat. A comprehensive habitat assessment in the Milwaukee River Watershed is the next logical step to ensure that the ongoing rehabilitation project will be successful.

Traditional, comprehensive instream habitat surveys of large areas can be time intensive and costly, employing discrete sampling techniques that require data extrapolation. Alternatively, side-scan sonar is a low cost, effective method to identify substrate and capture continuous habitat data, particularly for species highly dependent on substrate requirements such as lake sturgeon. Side-scan sonar can capture substrate information over large areas where traditional, comprehensive habitat survey methods are not feasible due to time, financial, or other constraints.

The project will use side-scan sonar and a lake sturgeon habitat suitability index (Daugherty et al. 2008) verified by four field assessments using WDNR quantitative stream assessment protocols to evaluate 14.4 miles and 339 acres of in-stream habitat in the Milwaukee River in Ozaukee County from County Line Road to the first barrier (Bridge Street Dam in the Village of Grafton) located at river mile 31, and 3.5 miles and 36 acres of instream habitat on Cedar Creek from its confluence with the Milwaukee River to the Nail Factory Dam. Sonar imagery will be translated to create detailed habitat maps that include substrate classification, bathymetric mapping, and associated lake sturgeon HSI scores. Knowledge of habitat quality will provide natural resource organizations with vital information needed to consider potential lake sturgeon restoration projects prior to the return of the 2006 sturgeon cohort. The natural resources community will be also be able to make more informed decisions on a variety of in-stream and riparian management issues using the comprehensive information produced by this project. This project will also serve to spread awareness of side-scan sonar a cost-effective and efficient technology to use in habitat substrate mapping projects. As a relatively new technology, the results of this project will be valuable to agencies and organizations in all types of aquatic ecosystems as they explore the uses if side-scan sonar. The region will benefit from having another organization with experience performing side-scan sonar surveys, as the Ozaukee County Planning and Parks Department will be able to advise and collaborate with future related habitat substrate mapping projects.

***Proposed Work:*** The overall goal is to contribute to the efforts to restore self-sustaining lake sturgeon populations to Lake Michigan and the Great Lakes Basin, and this project’s methodology is transferable across the region. Long-term collaborative efforts are essential for lake sturgeon rehabilitation; therefore, this study is predicated on both the historical and evolving research and technology in this field. To date, the Return the Sturgeon reintroduction project has focused on the successful rearing and stocking of fingerling sturgeon in Lake Michigan. To ensure success of the sturgeon reintroduction in the second half of the 25-year project, Ozaukee County will conduct targeted habitat assessments in the Milwaukee River and on Cedar Creek in Ozaukee County to identify spawning areas that will support the natural reproduction of the released sturgeon upon their return to the Milwaukee River, and identify potential areas for restoration and/or enhancements. This analysis will provide follow-up data to an initial WDNR 2006 "Lake Sturgeon Rehabilitation in the Milwaukee River" study, which included general Lake Sturgeon habitat assessments at four locations on the Milwaukee River in Milwaukee and Ozaukee Counties. This current effort will focus on identifying and assessing key habitat areas and areas that may have been improved through the removal of fish passage impediments since the 2006 study (e.g., former Lime Kiln Dam impoundment). The results will provide recommendations for future habitat improvement projects as necessary.

In 2000, the Great Lakes Fisheries Trust (GLFT) sponsored a workshop to identify the research and assessment needs to rehabilitate lake sturgeon in the Great Lakes. This and subsequent funding promoted new sturgeon research and rehabilitation projects across the Great Lakes region including the development of a lake sturgeon habitat suitability index (Daugherty et al. 2008). Concurrently, the application of side-scan sonar in lotic systems has recently been refined. Kaeser and Litts (2008) used side-scan sonar to rapidly estimate deadhead logs and to classify and map substrate in the Flint River (GA). Kaeser and Litts were able to classify sediment with an accuracy of 84%. Recent research includes an ongoing mapping of riverine sturgeon habitat in the AuSable River (Brian Schmidt, USFWS), and a habitat mapping project of the Milwaukee Harbor using side scan sonar techniques completed by UW-Milwaukee School of Freshwater Sciences student Brennan Dow.

Our project, in collaboration with FFLM, U.S. Geological Survey (USGS), GLFT, Wisconsin Department of Natural Resources (WDNR), U.S. Fish and Wildlife Service (USFWS), Southeastern Wisconsin Regional Planning Commission (SEWRPC), UWM School of Freshwater Sciences (UWM SFS), Riveredge Nature Center, and other partners, will combine use this technology to produce high resolution mapping of lake sturgeon habitat (e.g., substrate) in the Milwaukee River in Ozaukee County.

Specific **project goals** include:

• Conduct a review on efforts, research, and findings related to the status of lake sturgeon habitat in the Milwaukee River

• Collect side-scan sonar imagery of 14.5 river miles (339 acres) of the Milwaukee River and 3.5 miles (36 acres) of Cedar Creek

• Classify sonar imagery into substrate categories suitable for HSI use

• Validate sonar data classification through a combination of 4 field assessments using WDNR quantitative stream assessments, existing sediment deposition and composition data layers, and a series of randomized point verifications that will be used in an error matrix to determine sediment identification accuracy

• Utilize the lake sturgeon HSI to assess current habitat availability and quality

• Prioritize critical staging, spawning, and nursery habitat for further site assessment and/or rehabilitation/restoration

• Distribute project results to natural resource agencies and partners

• Educate public on current sturgeon issues through public engagement events and Department social media accounts

**Activities** include:

1. Completion of a Quality Assurance Project Plan as applicable and required for project activities associated with data collection.

2. Conduct a review on efforts, research and findings related to the status of Lake Sturgeon habitat in the Milwaukee River. This task will include communications with relevant agencies that may have been involved with local sturgeon rehabilitation efforts including the WDNR and USFWS. In addition, the Department will conduct a concise literature review including assessing the findings and recommendations in the WDNR 2006 Lake Sturgeon Rehabilitation in the Milwaukee River report. The Department will also provide a summary of fish passage removal or remediation projects on the mainstem Milwaukee River completed by the Department and/or other partners within Ozaukee County. This task will also include an analysis on recent water quality monitoring data collected in the Milwaukee River, and in particular, near the Lime Kiln Dam removal site.

3. Record side-scan sonar data using the Hummingbird Solix 15 from Milwaukee River mile 14.4 (County Line Road) to river mile 31 (Bridge Street Dam in the Village of Grafton) and from Cedar Creek mile 0 (confluence with Milwaukee River to mile 3.5 (Nail Factory dam). Side-sonar will be operated at a frequency range of 800 kHz to 1.2 MHz for optimal resolution when classifying sediment categories. Two longitudinal transects will be made to account for the reduced range of operating at higher frequencies. Surveys will be done in a jon boat or a specially outfitted kayak(s) depending on flow and depth conditions. Advisory roles have been established with Dr. Adam Kaeser (USFWS), Brian Schmidt (USFWS), Jayme Stone (USGS), Dr. John Janssen (UWM School of Freshwater Sciences), and Tom Slawski (SEWRPC) to ensure proper application of side-scan sonar technology. The aforementioned professionals have all conducted side-scan sonar habitat studies and have offered invaluable advice in the planning and implementation stages of the proposed project.

4. SonarTRX software will be used to extract and georeference raw sonar data using automatic GPS data collection included with the Hummingbird sonar unit. The sonar data will then be compatible for use in ArcMap 10.5. In ArcMap, the sonar data will be segmented into different categories based on substrate diameter and roughness.

5. Develop a sediment classification protocol and apply it to the habitat suitability index. Using the lake sturgeon habitat suitability index compiled in Daugherty et al. (2008), the identified substrate categories will be used to assign scores to the 18 river miles and 375 acres of the study area.

6. Assess classification accuracy using field assessments at four sites in Ozaukee County (e.g., County Line Road, HWY T, Lime Kiln Dam, and Falls Road) using the WDNR’s quantitative stream assessment protocols. The County Line Road and HWY T sites were previously assessed as part of the WDNR’s 2006 report using wadable stream monitoring protocols developed by Simonson, which quantifies in-stream and contributing riparian habitat. Department staff will re-assess these sites using the same methodology to: (1) ensure our methodology and results are generally consistent with prior work; (2) detect any significant habitat characteristic changes at the study site that may have occurred in the 12 years since the initial 2006 study; and (3) assess side scan sonar generated sediment classification accuracy. The Lime Kiln Dam was removed by the Ozaukee County Planning and Parks Department in 2010 as part of its Fish Passage Program. The dam created an approximately 14' deep scour hole and removal of the dam and resultant draining of the 5 acre impoundment revealed several locations of exposed, fractured bedrock, multiple pools, and cobble and boulders that is likely representative of excellent Lake Sturgeon spawning habitat. These habitat features continue for several hundred meters upstream under the Falls Road bridge and through the former Chair Factory Dam impoundment. Department staff will assess these sites using the same methodology described above. In addition, side scan sonar sediment classification accuracy will be assessed through randomly generated point checks, (prior studies using these techniques have achieved accuracy in the 77% to 84% range) and prior sediment studies completed by the Ozaukee County Planning and Parks Department (USEPA GLRI funding) to validate the results of the substrate classification.

7. Disseminate Results. Results of the project will be provided to WDNR, FFLM, USFWS, USGS, UWM SFS, SEWRPC, Riveredge Nature Center, and other partners through outreach events including professional meetings, seminars, conferences, public engagement events, and social media.

***Collaboration with Partners:*** As noted above, Department staff have contacted a variety of professionals and students who have successfully used side-scan sonar on a variety of habitat mapping projects. Advisory roles have been established with the USFWS, USGS, SEWRPC and UWM SFS. The Department has been in contact with UWM SFS graduate student, Brennan Dow, and his advisor Dr. John Janssen, who have recently completed a habitat inventory of the Milwaukee Harbor using side-scan sonar. Mr. Dow has provided important technical advice on how to process the sonar data and software recommendations for data processing. Mr. Dow’s habitat inventory data can be integrated into our project to provide insight into potential lake sturgeon staging habitat in the Milwaukee Harbor. His data will also be compatible with the resultant Habitat Suitability Index. Dr. Adam Kaeser is an aquatic ecologist with the U.S. Fish and Wildlife Service in Panama City, Florida. Dr. Kaeser has been performing side-scan sonar surveys in aquatic systems since 2006 (including work to rapidly estimate deadhead logs and classify and map substrate in the Flint River in Georgia and other regional aquatic systems) and has published multiple papers describing the process and results that can be achieved. Dr. Kaeser has also hosted six workshops focused on training other ecological professionals on the use of side-scan sonar. Department staff has been in close contact with Dr. Kaeser throughout the planning phase of this project and Dr. Kaeser has indicated his support of this project and has interest in collaborating with the Department in an advisory role for the project. Brain Schmidt, with the USFWS office in Alpena, Michigan is currently completing a habitat assessment for lake sturgeon in the Au Sable River in Michigan. Mr. Schmidt has provided the Department valuable information on the technical aspects of side-scan sonar equipment and their capability for lake sturgeon habitat studies. Department staff have also been in contact with members of the USGS from the La Crosse, Wisconsin office who have provided additional technical advice for using side-scan sonar, including Jayme Stone, a Cartographic Technician. Mr. Stone is currently using side-scan sonar to map river substrate. Department staff have been in contact with Mr. Stone throughout the planning phase of the project and he has given valuable insight into equipment recommendations and survey techniques and has indicated availability to assist the Department with any future issues or questions. The Department also routinely collaborates with Dr. Tom Slawski at SEWRPC. Dr. Slawski has recently completed side-scan sonar surveys of the Rock River in Southeastern Wisconsin and has offered his assistance in an advisory role to the project. The Department will also consult with local fisheries experts including Will Wawrzyn, WDNR Fisheries Biologist (ret.).

The Department has developed a network of local, state, regional, and nationally renowned fisheries and habitat restoration experts and will disseminate the outcomes of this project to this network and regional and local partners including WDNR (e.g., Lake Michigan Fisheries team, Water Resource Managers), USGS (Biologists, Mapping Specialists), USFWS (Fisheries Biologists and Managers), UWM SFS, FFLM, members of the Great Lakes Aquatic Connectivity Workgroup, Riveredge Nature Center, Milwaukee County, Milwaukee Riverkeeper, Milwaukee River Estuary Area of Concern Fish and Wildlife Technical Advisory Team (TAT), Southeastern Wisconsin Watersheds Trust (SWWT), SEWRPC, and the Milwaukee Metropolitan Sewerage District (MMSD).

***Timetable:***

|  |  |  |
| --- | --- | --- |
| **Project Category** | **Milestone Description** | **Target Dates** |
| **Project Coordination** | Project Award Date | 5/15/18 |
| Natural Resource Committee Funding Acceptance | 6/7/18 |
| County Board Funding Acceptance | 7/5/18 |
| Education and Outreach, Agency and Partner Coordination | Ongoing throughout grant |
| **Data Collection** | Conduct review of research, efforts, and findings of lake sturgeon habitat assessments in the Milwaukee River | 8/1/18-10/1/18 |
| Equipment setup, testing methods | 8/1/18-10/30/18 |
| Side scan data collection and field assessment/verification | 9/1/18-11/30/19 |
| Existing sediment data comparison for verification | 9/1/18-3/31/20 |
| **Data Processing** | Segmenting sonar data, classifying segments, applying HSI scoring | 9/1/18-6/30/20 |
| **Reporting** | Quarterly and Semi-Annual Reporting | Ongoing throughout grant |
| Final Reporting | 6/30/20 |

***Deliverables***: Specific deliverables and outcomes will include a final report containing:

1. Summary on status of efforts, research and findings related to the status of Lake Sturgeon habitat in the Milwaukee River Watershed.
2. GIS maps of the Milwaukee River and Cedar Creek within project boundaries that includes the following layers:
   1. Geolocated side-scan sonar data of the project area
   2. Bathymetric contour maps of the project area
   3. Sediment classifications of the project area
   4. Lake sturgeon Habitat Suitability Index scores for the project area
3. Analysis of the results of the lake sturgeon HSI that will identify critical areas of lake sturgeon habitat and provide suggestions for areas of restoration.
4. An accuracy analysis of the sediment classification. Using a combination of four quantitative habitat inventories and a series of randomly generated sediment point surveys, the accuracy of the project’s sediment classification will be assessed. Sediment predictions and confirmed sediment data will be entered into an error matrix to determine overall error percentage. The project aims to have an accuracy greater than 75%.
5. Summary of the lessons learned while using the side-scan sonar technology. This report will assist regional partners in expanding the use of side-scan sonar for habitat surveys.

The project may be used by the WDNR and Riveredge Nature Center to inform decisions involving the Milwaukee River lake sturgeon reintroduction project and to determine funding priorities for future restoration projects. Project outcomes will inform the Milwaukee River AOC Fish and Wildlife Technical Advisory Team (TAT) as they develop recommendations for Remedial Action Plan updates. FFLM may use the results of the project to direct future funding and research within the Lake Michigan Basin. USFWS, USGS, WDNR, SEWRPC, UWM SFS, and other organizations will find the applications of this project beneficial as they consider use of cost-effective side-scan sonar surveys. The resultant substrate and bathymetric mapping of the Milwaukee River will have multiple, long term applicability to other studies and uses (e.g. aquatic habitat, sediment evaluation, etc.) across the Great Lakes natural resources community.

***Project Budget:***

The following table lists direct WDNR OGW charges for the project period.

|  |  |  |  |
| --- | --- | --- | --- |
|  | **Year 1 [8/1/18-6/30/19]** | **Year 2 [7/1/19-6/30/20]** | **Total** |
| Personnel/Salaries | $11,811.50 | $11,811.50 | $23,623.00 |
| Fringe Benefits | $3,188.50 | $3,188.50 | $6,377.00 |
| Travel |  |  |  |
| Equipment |  |  |  |
| Supplies |  |  |  |
| Contractual: |  |  |  |
|  |  |  |  |
| Other Costs |  |  |  |
| Total Direct Charges | $15,000.00 | $15,000.00 | $30,000.00 |
| Indirect Charges |  |  |  |
| **Total Cost** |  |  |  |
|  | $15,000.00 | $15,000.00 | $30,000.00 |

***Budget Detail:***

The overall project budget includes the $30,000 WDNR OGW request, $60,000 in secured FFLM funds, $10,000 in secured WDNR River Protection Planning funds, and $5,000 in secured National Fish and Wildlife Foundation Bring Back the Natives funds for a total project budget of $105,000.

|  |  |  |  |
| --- | --- | --- | --- |
| **Budget Object Class** | **Total Project Budget** | **WDNR OGW** | **Match** |
| Personnel/Salaries | $76,335.00 | $23,623.00 | $52,712.00 |
| Fringe Benefits | $20,665.00 | $6,377.00 | $14,288.00 |
| Travel | $1,500.00 | $0.00 | $1,500.00 |
| Equipment | $0.00 | $0.00 | $0.00 |
| Supplies | $6,500.00 | $0.00 | $6,500.00 |
| Contractual | $0.00 | $0.00 | $0.00 |
| **Totals** | **$105,000.00** | **$30,000.00** | **$75,000.00** |

**Personnel/Salaries** (WDNR OGW: $23,623; Match Funding: $52,712; Total: $76,335)

Personnel/Salaries are included for the following Department staff for grant years 1 and 2: Director, Administrative Manager, Program Manager, Planning and GIS Specialist, Ecological Program Assistant II (2), Planning and Parks Intern I, Planning and Parks Intern II, and Civil Engineer –Environmental (PE).

**Fringe Benefits** (WDNR OGW: $6,377; Match Funding: $14,288; Total: $20,655)

Fringe Benefits for the personnel as described above include costs for FICA, medical and dental insurance, retirement and disability.

**Travel** (WDNR OGW: $0; Match Funding: $1,500)

Travel expenses include gas mileage for project meetings, site visits, and education and outreach.

**Equipment** (WDNR OGW: $0; Match Funding: $0)

No formal budget is allocated towards equipment; however, Ozaukee County will use existing equipment including a jon boat, motor and trailer and kayaks.

**Supplies** (WDNR OGW: $0; Match Funding: $6,500)

Supplies include side scan sonar hardware and software, miscellaneous field supplies, watercraft conversion materials, safety equipment, GIS software, etc.

**Other Costs** (WDNR OGW: $0; Match Funding: $0)

**Total Direct Charges** (WDNR OGW: $30,000; Match Funding: $0)

**Indirect Charges** (WDNR OGW: $0; Match Funding: $0)