LOWER BAD RIVER ACOUSTIC MAPPING PROJECT

Dan Yule and Gary Cholwek, U.S.G.S., Great Lakes Science Center, Lake Superior Biological Station, Ashland, WI.

Henry Quinlan, U.S.F.W.S. Ashland Fishery Resources Office, Ashland, WI. Tom Doolittle, Bad River Band of the Lake Superior Chippewa, Odanah, WI.

Project Goals:

- **Map and quantify habitat in the lower Bad River and nearby coastal waters of Lake Superior.**
- **Overlay existing juvenile sturgeon capture data.**

Juvenile lake sturgeon from lower Bad River.

Background:

Lake sturgeon (*Acipenser fulvescens*) is a species of concern in the Great Lakes region. Once abundant throughout the Great Lakes basin, lake sturgeon populations began to decline dramatically in the 1860's first from over harvest and later from man-induced environmental changes such as dams and pollution. The Bad River supports one of only two self-sustaining spawning populations remaining in the U.S. waters of Lake Superior (Elias 2001). Determining habitat requirements of all lake sturgeon life stages and quantifying available habitat will be important to restoration efforts.

Methods:

We surveyed the lower 9.6 km of the Bad River, Wisconsin, and a 3.2 by 2.0 km segment of Lake Superior near the Bad River mouth. Acoustic data were collected with a BioSonics DT-X echo sounder, equipped with an Ashtech differential GPS system. Acoustic data in the river and lake were collected using a 208 kHz 10º and 120 kHz 6º transducer, respectively. Acoustic signals were processed using BioSonics VBT – Seabed Classifier software using the echo ratio method (i.e., RoxAnn method). The VBT software measures the magnitudes of the first (E1) and false (E2) bottom echoes, corresponding to bottom hardness and roughness (Figure 1B). The general approach is to collect E1 and E2 values at sites with known substrates (i.e., ground truth sites) to develop a classification model to predict unknown sites based upon measured E1 and E2 pairs. Substrate types at ground truth sites in the river were confirmed using a petite ponar grab, while lake sites were confirmed by ponar sampling and underwater drop video camera (Figure 1A.). A statistical technique called recursive partitioning was used to develop classification models. Means of E1 and E2 values are calculated by substrate type, and splits are created that most significantly separate the means by examining the sums of squares, due to the mean differences. To minimize problems with high ping-to-ping variability, we averaged E1 and E2 values over five contiguous pings during the river survey (≈ 6 meters of boat travel) and twenty contiguous pings in the lake survey (≈ 40 meters). The survey and ground truth collections took three people four working days. Processing acoustic data took an additional work week.

Figure 1A.

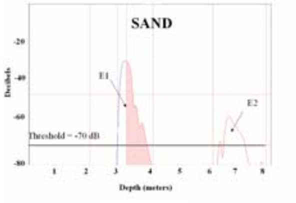


Figure 1B.

Example underwater photograph showing sand (Figure 1A.), and oscilloscope display showing E1 and E2 echo envelopes (Figure 1B.). Energy levels above a user-defined threshold were measured by VBT software .

Results:

Three substrate categories were identified in the Lower Bad River: clay (very densely packed with fine particles between 1/2048 mm to 1/256 mm diameter, Figure 2A.), a mixture of clay and sand (Figure 2B.) and sand (1/16 to 1/4 mm, Figure 2C.). The plot of E1 and E2 values at river ground truth sites (Figure 3A.) were split into four regions and the proportion of each substrate type in each region was calculated. This model was used to predict substrates (based on the highest probability) in the lower Bad River based on measured E1 and E2 values. A Lake Superior substrate classification model (Figure 3B.) was also developed from ground truth samples collected around the lake. Five substrate categories in Lake Superior were identified: clay (particles between 1/2048 and 1/256 mm diameter), sand with silt (1/256 to 1/8 mm), sand (1/16 to 1.5 mm), coarse sand/medium pebbles (0.5 to 10 mm) and cobble/boulder (64 to > 256 mm).

Figure 2A.

Figure 2B.

Figure 2C.

Figure 3A.

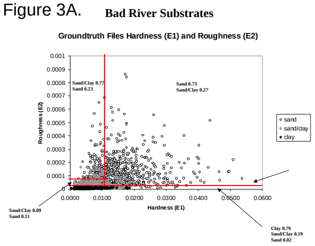
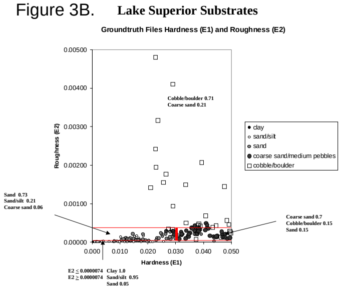


Figure 3B.

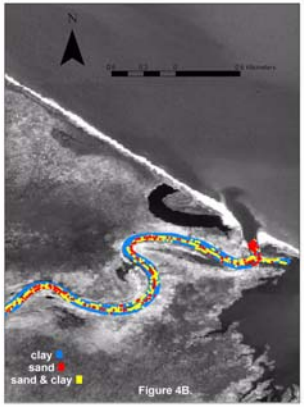


Lake Survey:

Sand with silt represented 73% of the samples (N = 703), followed by sand (23%), coarse sand/medium pebbles (2%), clay (2%) and cobble/boulder (< 0.1%).

River Survey:

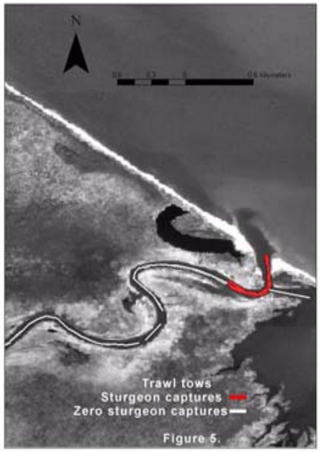
The upland portion of the lower Bad River has red clay banks extending from the bottom to just above the waterline. These clay banks are overburdened by sandy soils. The river inner bends are shallow with lower water velocities that allow settling sand to form bars extending out from the bank towards mid-channel. The outer bends have greater water velocities that increase scour, create greater depths and leave only the underlying dense red clay (Figure 4A. and 4B.). The most common substrate type was clay (70% of 13,715 total samples), then sand and clay (23%), and sand (7%).



Lake Sturgeon Trawl Survey :

In May 2001, USFWS trawled the lower Bad River for juvenile lake sturgeon using either a 3.0 m or 4.9 m footrope bottom trawl with a cod end mesh size of 6.4 mm bar. Trawls were towed at 3-3.5 mph in a downstream direction and deployed with the warp set at roughly 2.5 times the water depth. Average tow duration was 6.5 minutes. Start and end GPS coordinates were recorded for each tow.

Sturgeon were captured in 4 of 30 trawl tows with a catch rate of 2.2 per hour. Eight juvenile sturgeon ranging in length from 227-849 mm were captured. Seven of the 8 (88%) sturgeon were captured within 600 m of the river mouth (Figure 5.). Captured sturgeon were associated with relatively deep water (Figure 4A.) with bottom comprised largely of sand (Figure 4B.). Future fish surveys can be designed to proportionally sample all habitat types for improved description of juvenile lake sturgeon habitat preferences in the Bad River and other Lake Superior tributaries.



GIS Analysis:

The above GIS products are preliminary. Detailed bathymetric and substrate contour maps will be developed from the point data.

Literature Cited:

Elias, J. 2001. [Ed.] Bad River Band of Lake Superior Tribe of Chippewa Indians.Integrated Resources Management Plan.