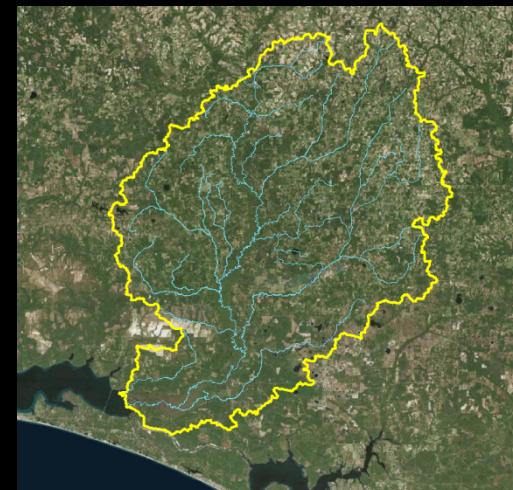
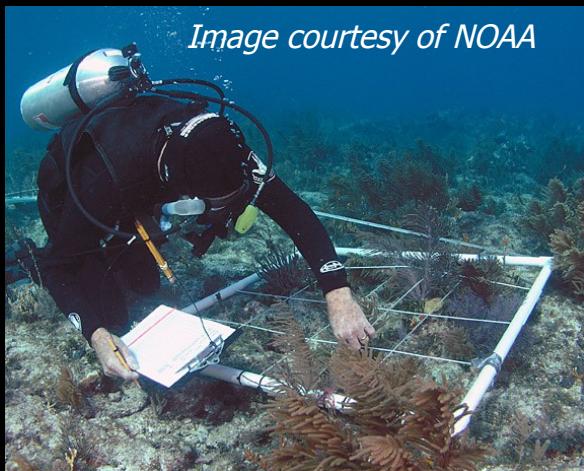


Sound Sheds Light

Advancing aquatic conservation by bridging the information gap with low-cost side scan sonar



Adam J. Kaeser

U.S. Fish and Wildlife Service

Reuben Smit

Auburn University

Frank Parauka

U.S. Fish and Wildlife Service (ret)



Purpose

1. Establish the role of low-cost side scan sonar in aquatic conservation
2. Highlight applications, and future developments for this technology

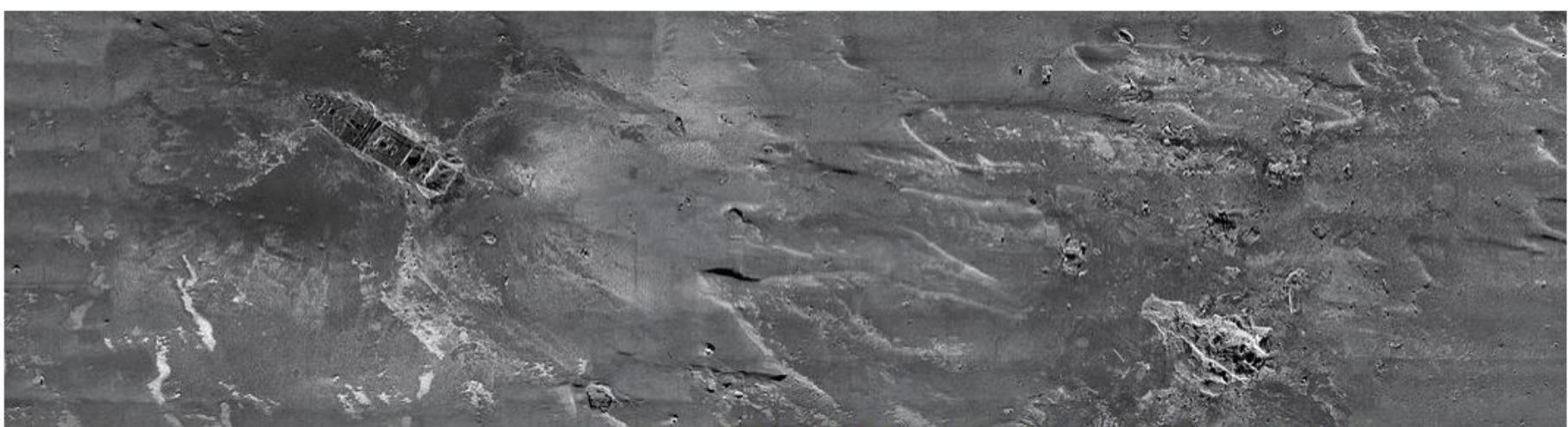
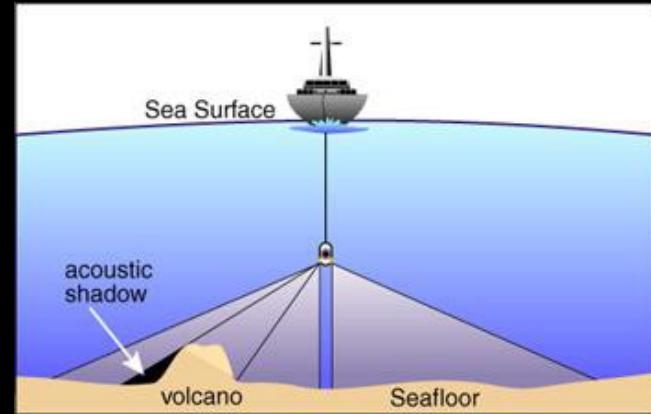
What is side scan sonar?

Device capable of producing picture-like images of underwater landscape using reflected sound



First invented in the 1960s

Used to located the Titanic (1985)



Sidescan sonar photomosaic of the *Titanic* wreck site. North and the bow section are to the left, south and the stern section to the right.

Photo © 2012 RMS Titanic, Inc.

Role of side scan sonar

- 10 years ago (Spring 2005) Humminbird® released the 981c Side Imaging System
- First recreational-grade (i.e., low-cost) side scan sonar system; <\$3,000; a sophisticated fish-finder

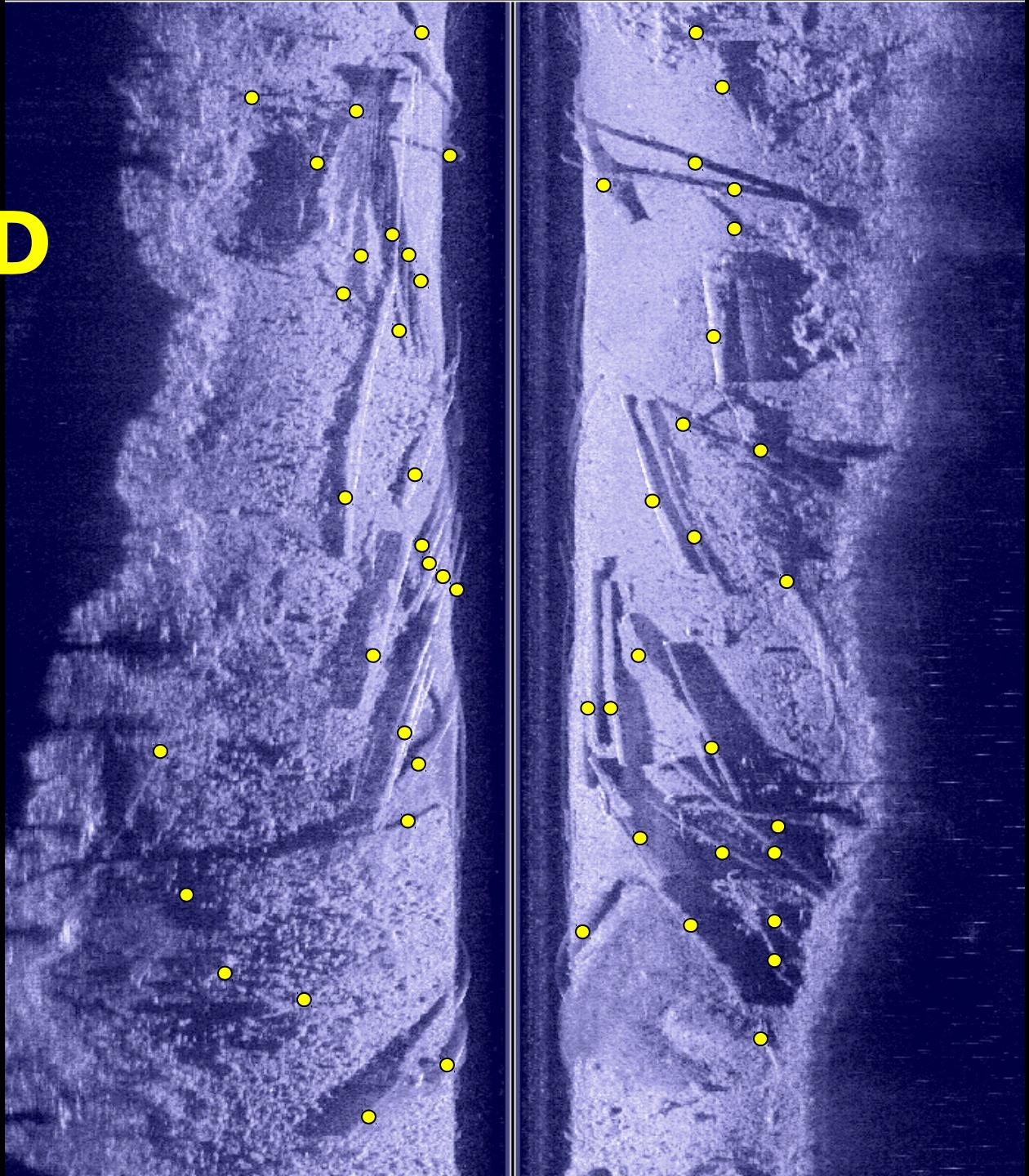
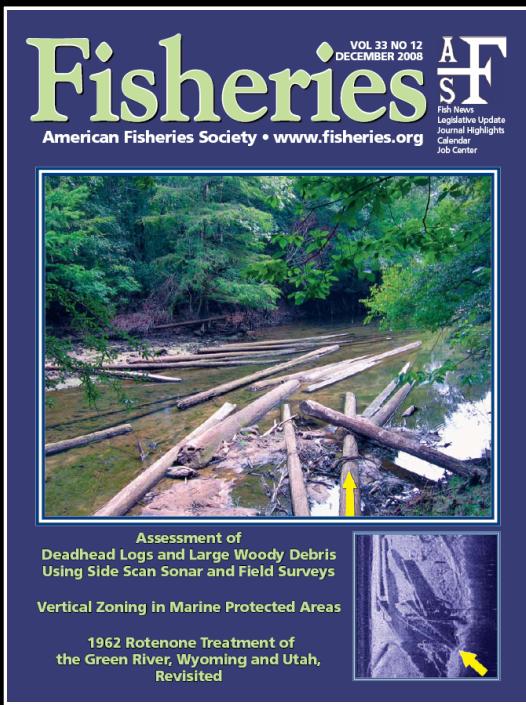


How I got started...

Jan 2006- GADNR Deadhead Logging Program



Deadhead Logs + LWD in HBSI Imagery



Role of side scan sonar

Major Breakthrough

1. Low Cost



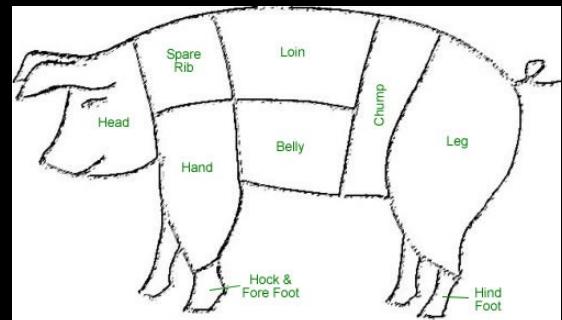
*Small,
adjustable
transducer*



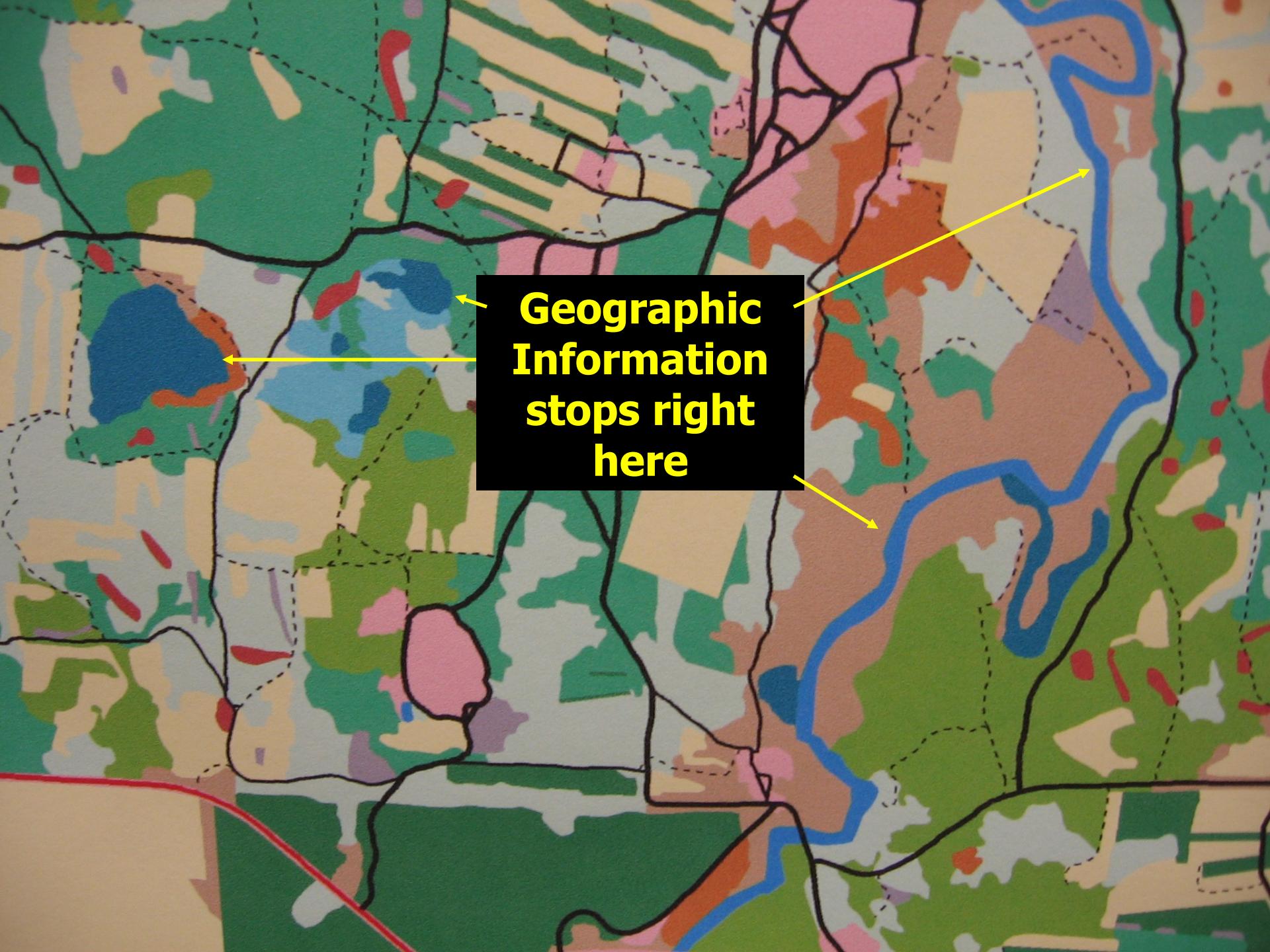
2. Easy to Use



3. High Resolution/Image Quality

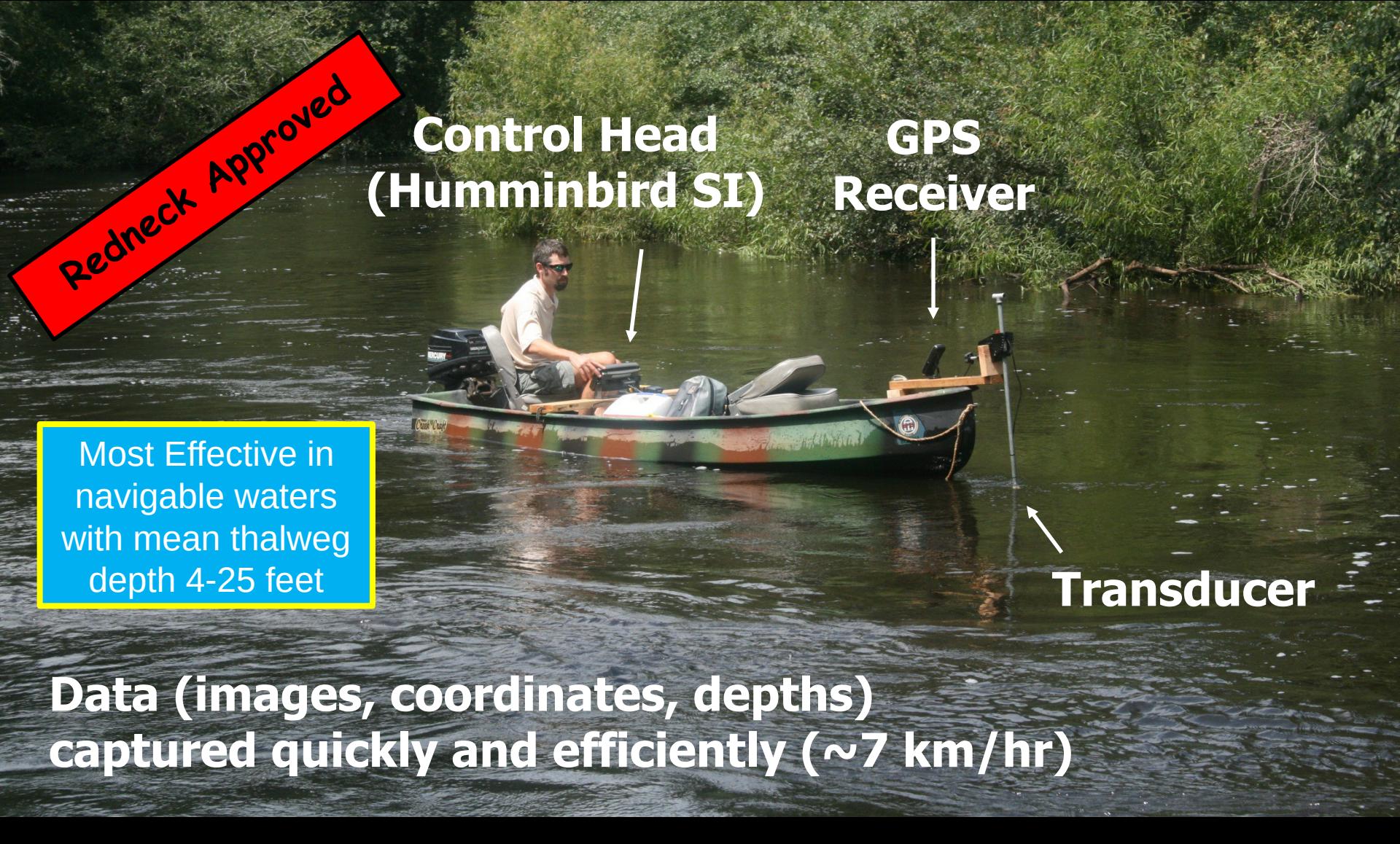


4. Data Processing> Maps of Classified Features



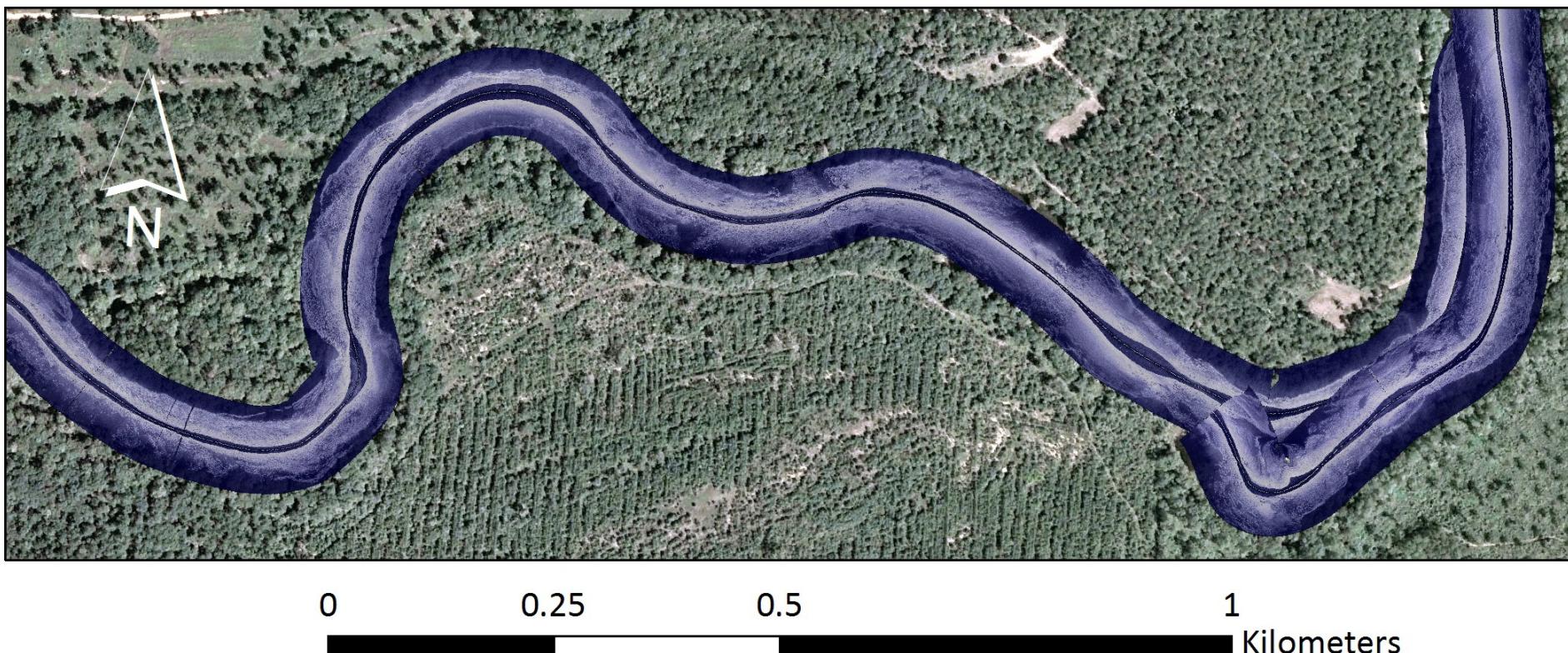
**Geographic
Information
stops right
here**

Low-cost Sonar Habitat Mapping Survey



The Process

Step B) Geoprocess sonar data (several approaches)



Geoprocessing Sonar Data

“Snapshot Approach” (T. Litts; GADNR)- GIS based, free

“Sonar Video Approach”- low-cost software= SonarTRX (\$180), Reefmaster

SONAR IMAGERY GEOPROCESSING WORKBOOK

An illustrated guide to geoprocessing low-cost, side scan sonar imagery obtained with the 900 or 1100 series Humminbird® Side Imaging Systems

The screenshot displays several windows from the Sonar Imagery Geoprocessing Workbook. At the top left is a map view with a red dashed line indicating a survey path. To its right is a software interface with a legend for 'Bathy' and 'Depth'. Below these are two large panels: one showing a vertical sonar profile and another showing a curved bathymetric map. At the bottom left is a table titled 'List Table' with columns for 'Index', 'Name', 'Depth', 'Length', 'Width', 'Avg Depth', and 'Avg Width'. The bottom right shows a detailed bathymetric map of a river bend.

Adam J. Kaeser
and
Thomas L. Litts

GEORGIA
DEPARTMENT OF NATURAL RESOURCES
WILDLIFE RESOURCES DIVISION

2065 Highway 278 SE, Social Circle, Georgia 30025

Version 2.1 (Updated/Published July 2011)

SonarTRX

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Introduction News Products Samples Online Store Support FAQ Tutorials About

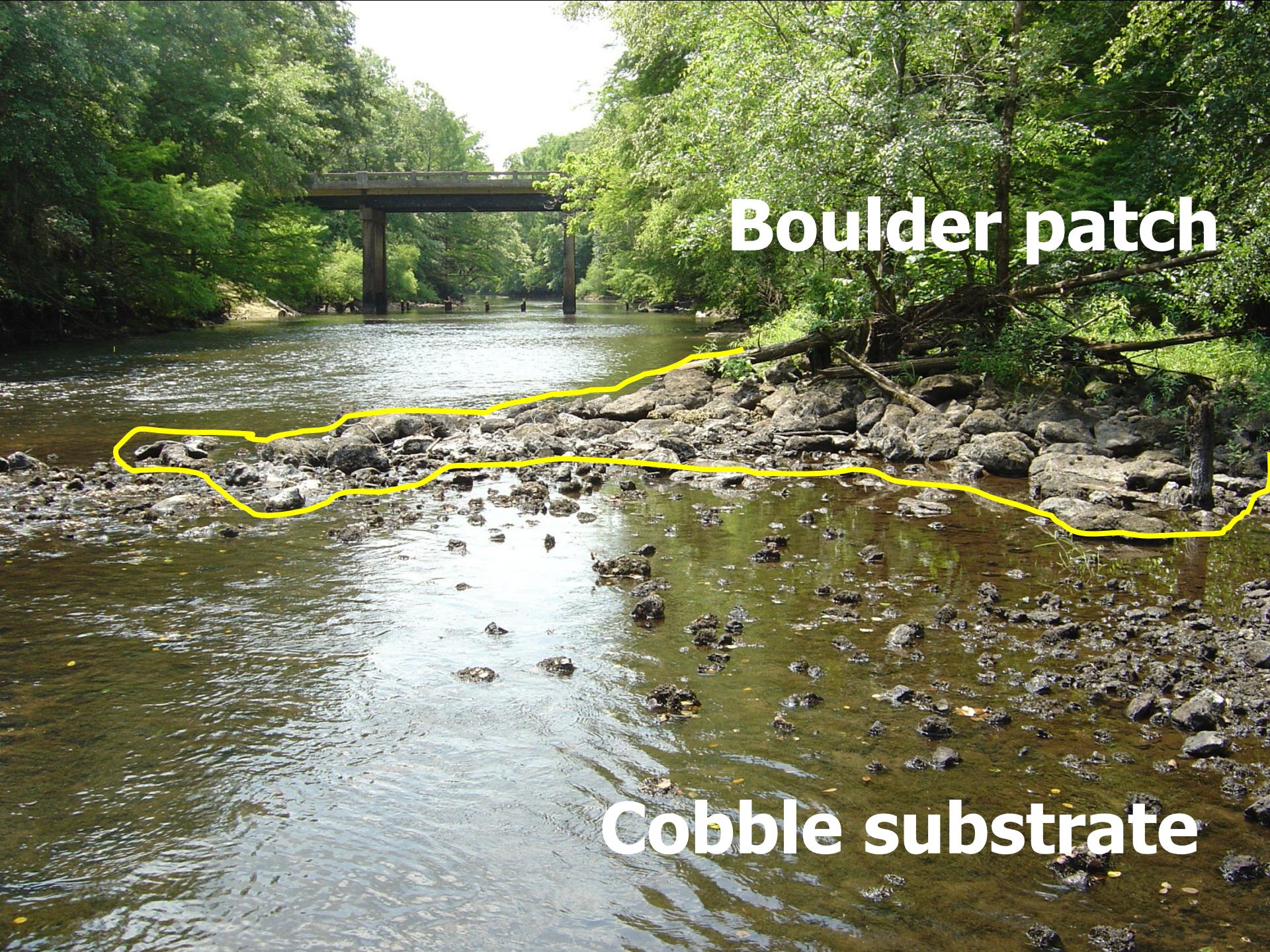
Introduction

SonarTRX sidescan sonar software makes it easy to view, extract bathymetric raw-data, and generate map-images (geo-referenced images) exploring & mapping the seabed from your kayak, jet ski or small boat.

The screenshot shows the SonarTRX software interface. On the left is a file browser window titled 'File Explorer' showing a folder structure. On the right is a main window displaying a 3D bathymetric model of a coastal area. A callout box over the model provides specific data: 'R80008-7001L', 'Sonar image information', 'Source File: R80008.DDF', 'Distance: 1000m', 'Image Type: Side Scan', 'Resolution: 0.05m', 'Duration: 00:00:00.515', 'Date: 2010-08-10T11:31:00Z', 'Depth Range: 0.00m - 10.00m', 'Timestamp: 2010-08-10T11:31:05.255000-10:00', 'Ping ID: 00000000000000000000000000000000', 'Ping #: 20220 - 04747', 'DatumWGS84: 4.5 m', 'Bottom Type: Regolith', 'Sonar Attitude: 4.0° - 4.7°m'. Below the main window is a 'Google earth' icon.

Example use includes:

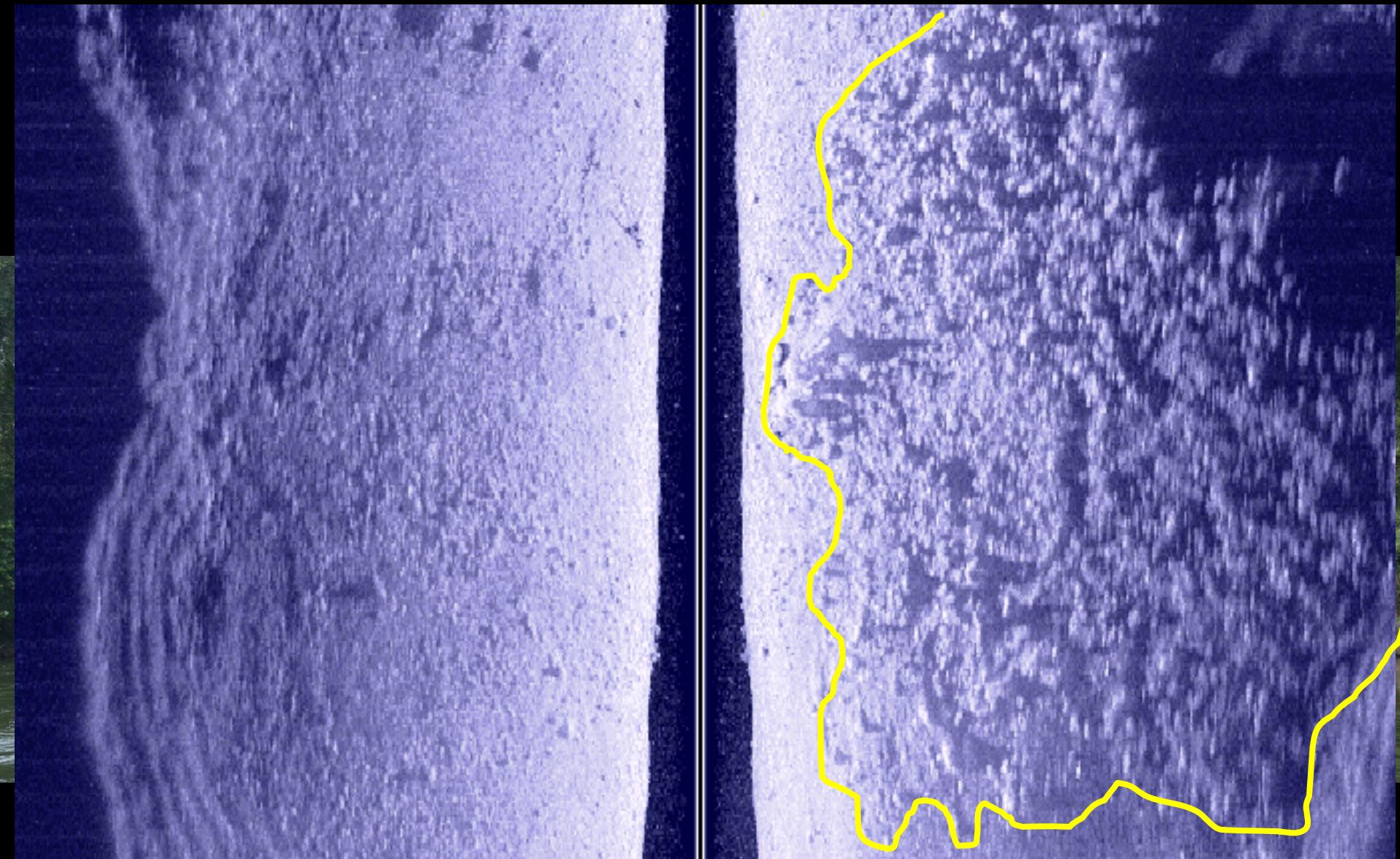
- General shallow-water sidescan surveys
- Mapping of fishing areas
- Locating interesting scuba dive-sites
- Locating shallow-water marine debris for later cleanup
- Archaeology: Mapping of underwater archaeological sites
- Treasure hunting (ship wrecks, sunken boats,...)
- Marine habitat mapping, underwater ecology
- Search and rescue
- Coastal Engineering surveys
- Pipeline and cable landing surveys
- Port and harbor security



Boulder patch

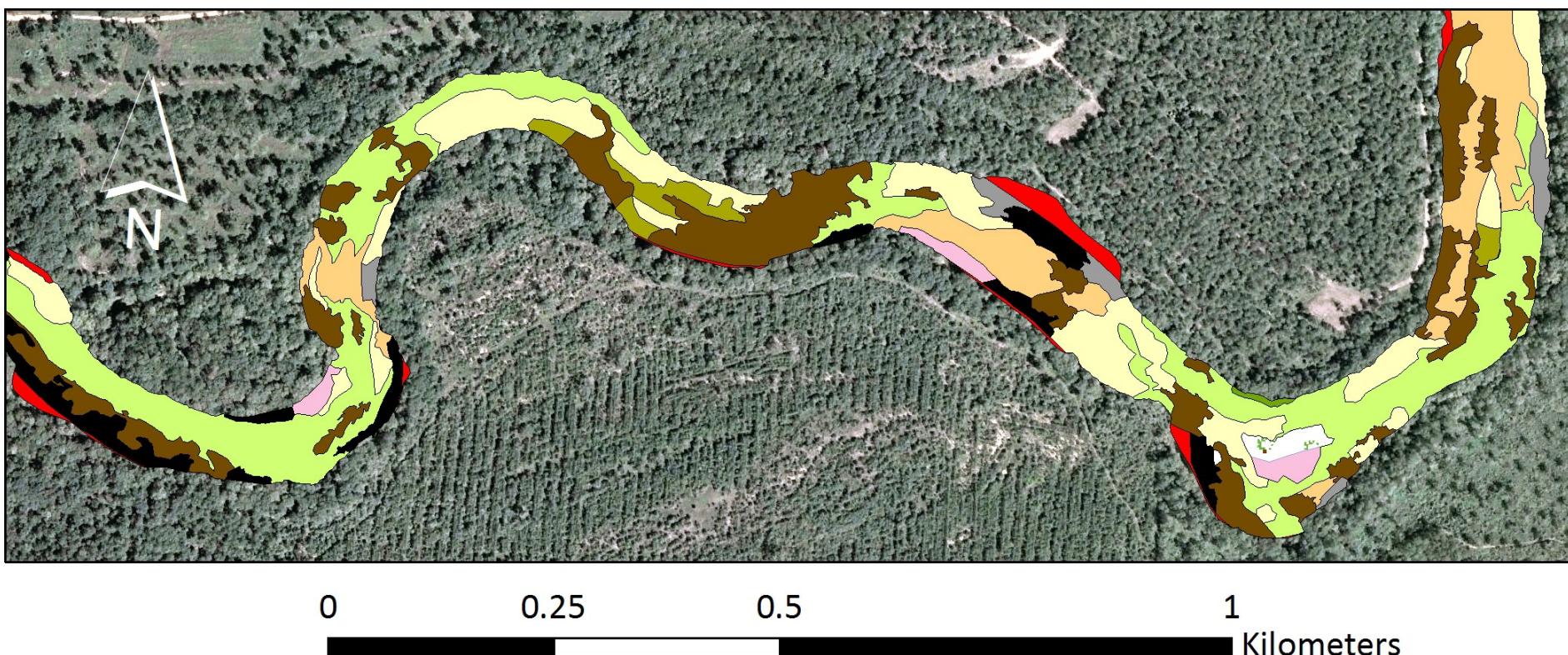
Cobble substrate

Substrates in HBSI imagery

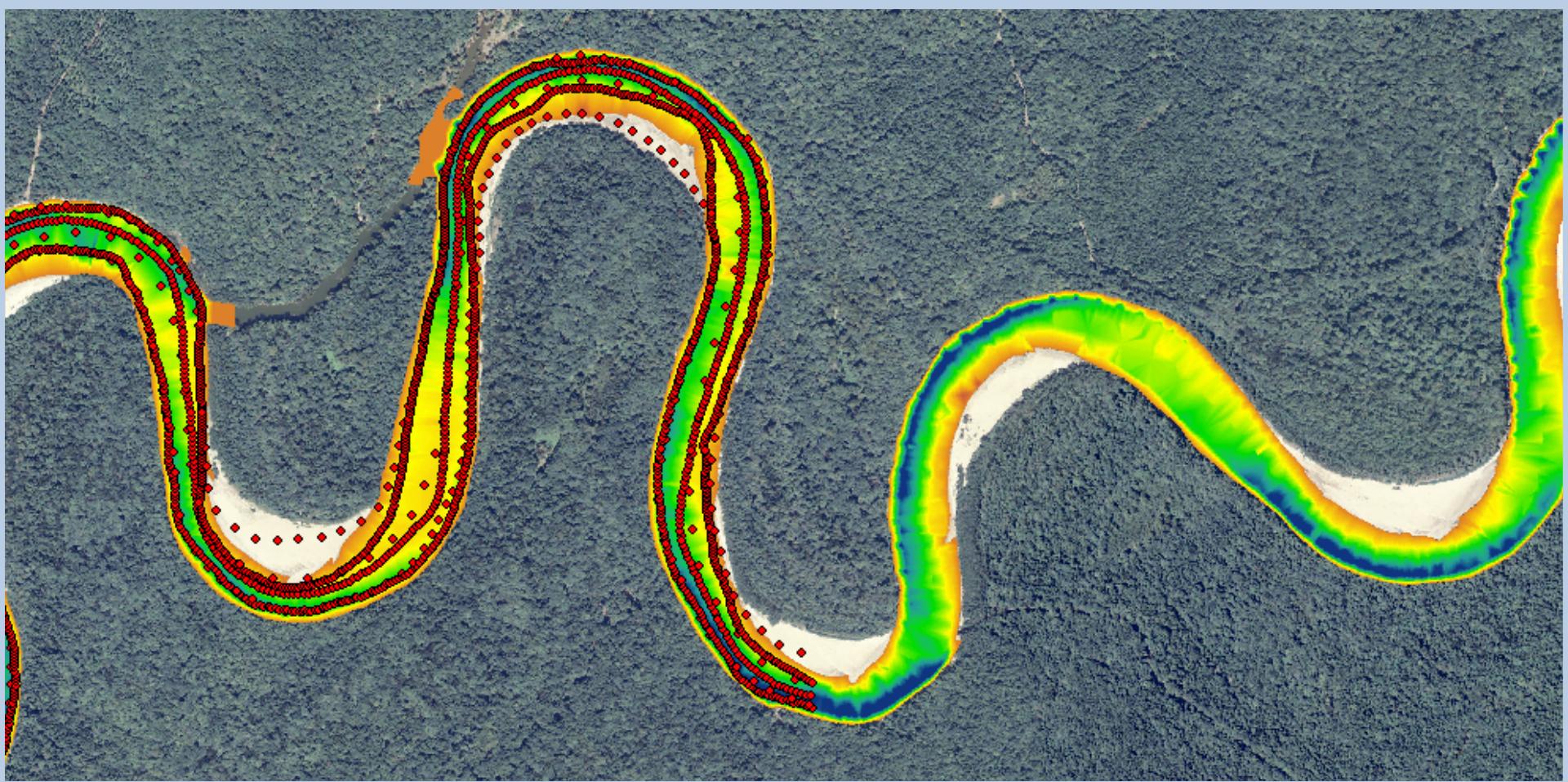


The Process

Step C) Prepare map revealing elements of riverscape mosaic (substrates, wood, submerged veg, bathymetry)



Depth data → Bathymetric Mode



Role of side scan sonar

Why do we need (sonar) Maps?

1. Because vast reaches of turbid, nonwadeable waterways are full of imperiled species
2. Because we cannot be fully effective at research and conservation without information provided at this scale



Strategic Habitat Conservation

Important to pursue these objectives at the spatial and temporal scale most relevant to the life history of the species

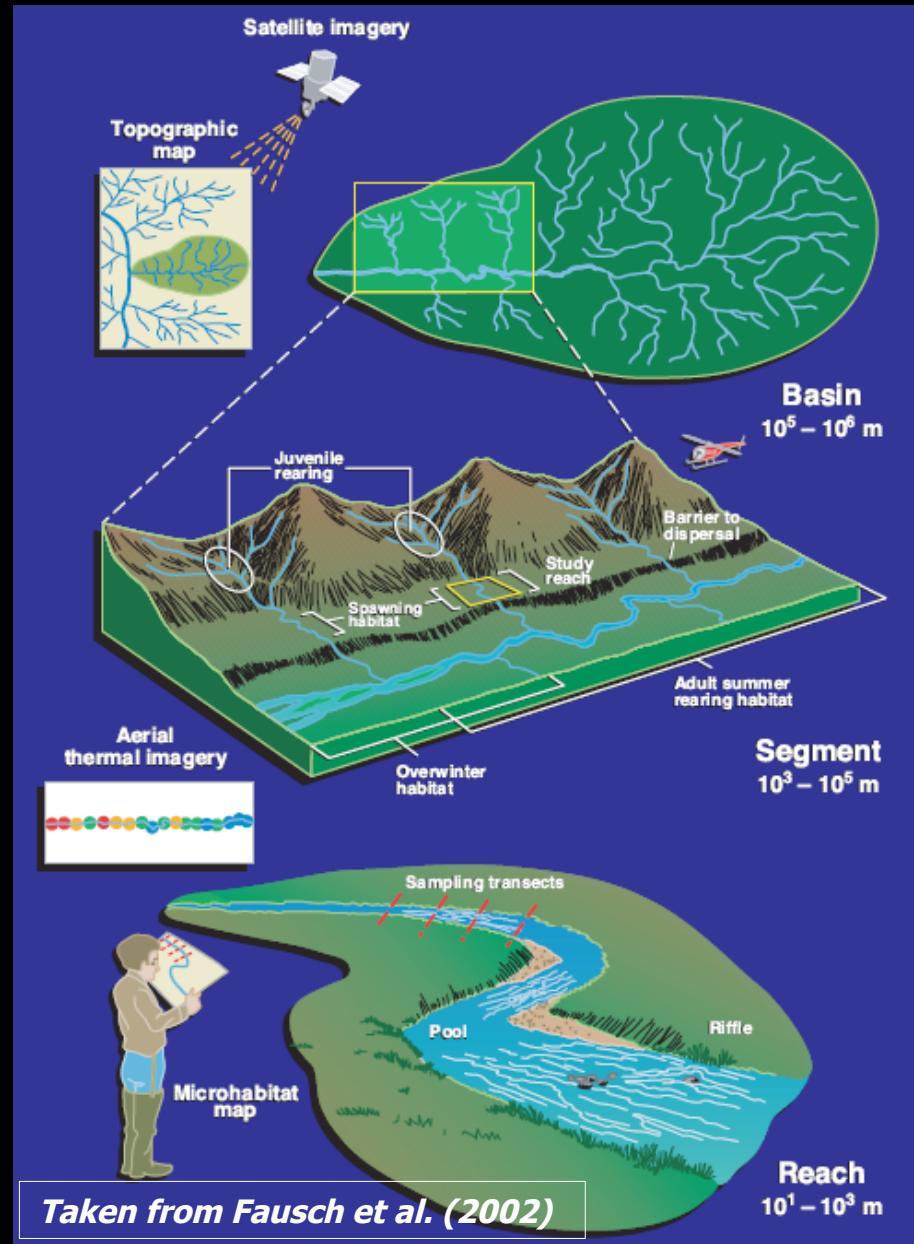
- ID and quantification of critical habitats
- Habitat condition assessments
- Development of SDMs linking populations to habitat
- Monitoring habitat change over time

"The development of maps predicting patterns in the ecosystem is the outstanding feature of conservation design"

Role of side scan sonar

The Mesoscale

- Fausch et al. (2002)- We need to bridge info gap at the intermediate spatial *and* temporal scale; where habitat features become most important to fish (other organisms)
- Also need a continuous view of the entire riverscape (aquatic landscape)

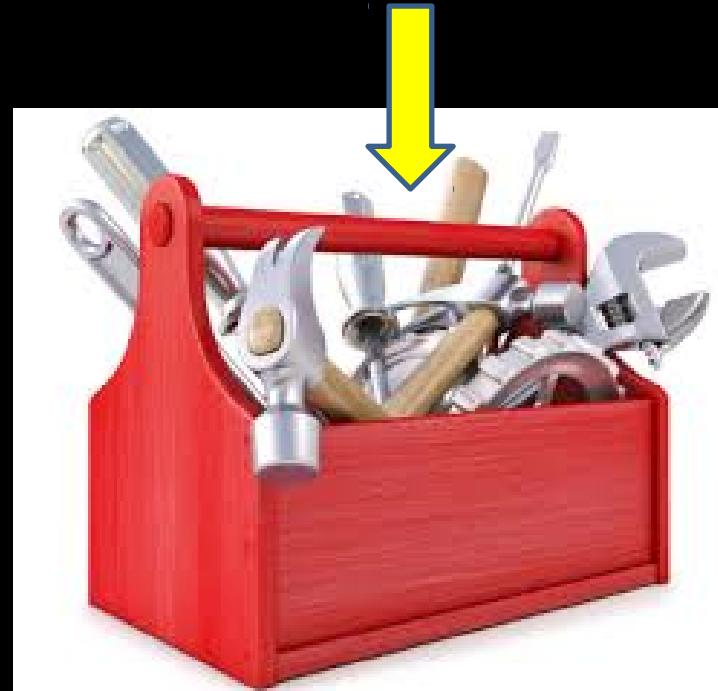


Fausch, K. D., C. E. Torgersen, C. V. Baxter, and H. W. Li. 2002. Landscapes to Riverscapes: bridging the gap between research and conservation of stream fishes. BioScience 52: 483-498.

Role of side scan sonar

Methodology Uniquely Suited

- Provides intermediate/mesoscale, patch resolution habitat data (10^1 - 10^3 m^2)
- Provides a continuous, complete perspective of riverscape mosaic
- Enables investigations at intermediate spatial *and* temporal scales (repeat surveys- change detection analyses)



Applications

- 1) Description/Quantification of aquatic habitat across large spatial scales**
- 2) Habitat-Organism research at scales relevant to the life history of organisms**
- 3) Quantifying change in physical habitat over time**
- 4) Detecting (some types of) fauna**

Applications 1. Describe and Quantify Habitat

Shoal Habitat Affiliates

Gulf Sturgeon

Acipenser oxyrinchus desotoi



Alabama Shad

Alosa alabamae



Shoal Bass

Micropterus cataractae

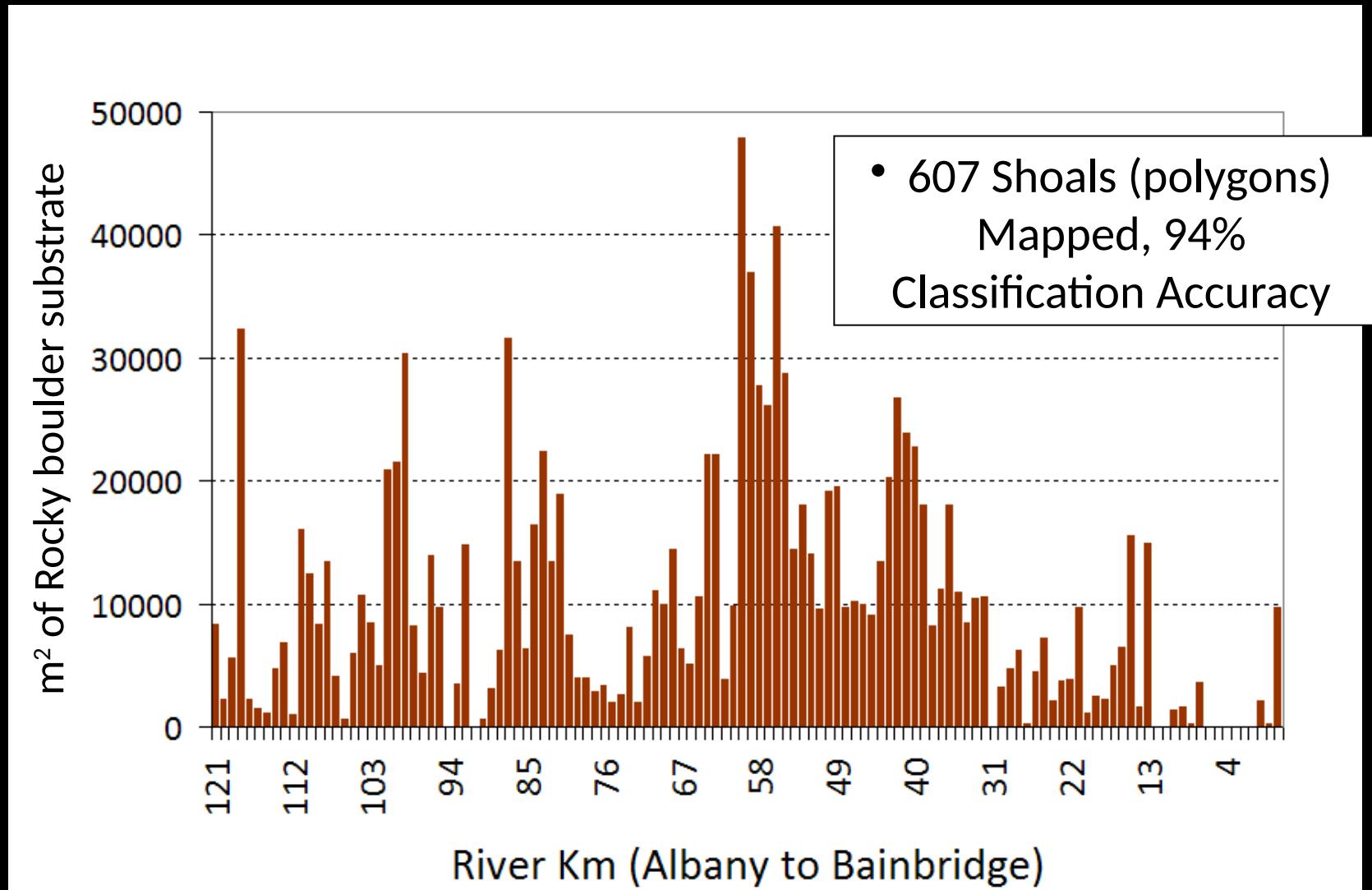


Applications 1. Describe and Quantify Habitat

Extract data by river km segments to describe spatial trends



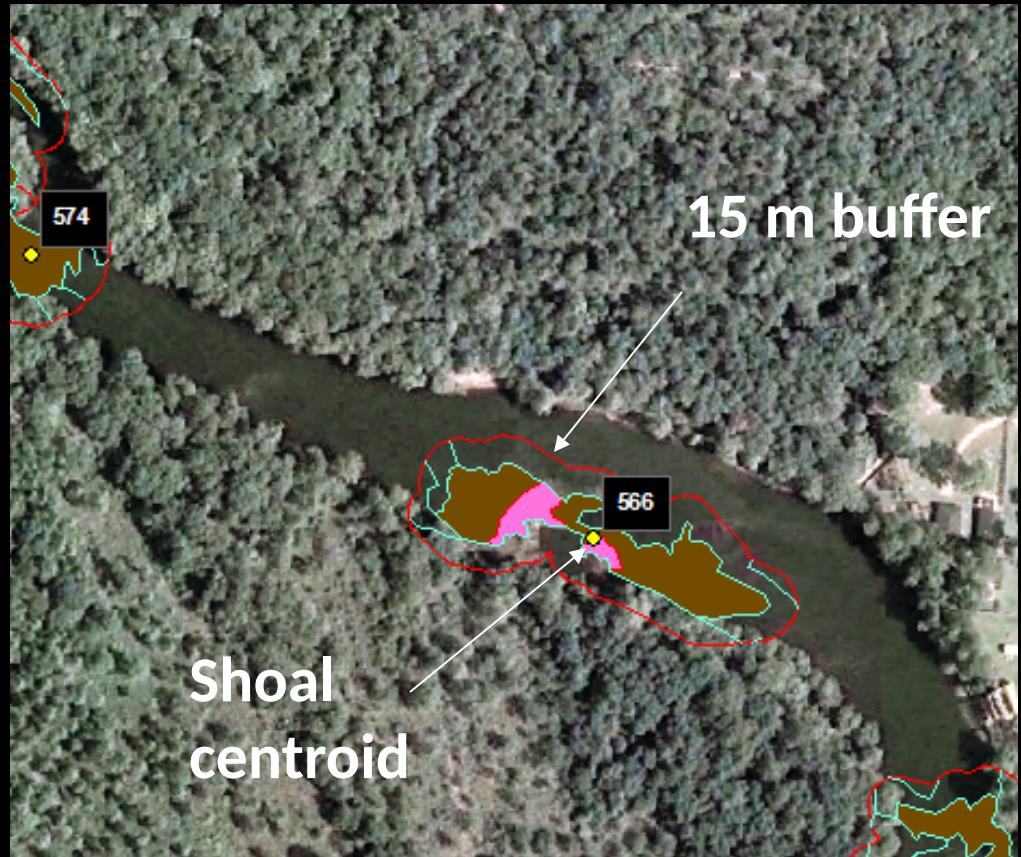
Shoal Distribution and Abundance



Digging Deeper- Habitat Analysis

Patch Variables

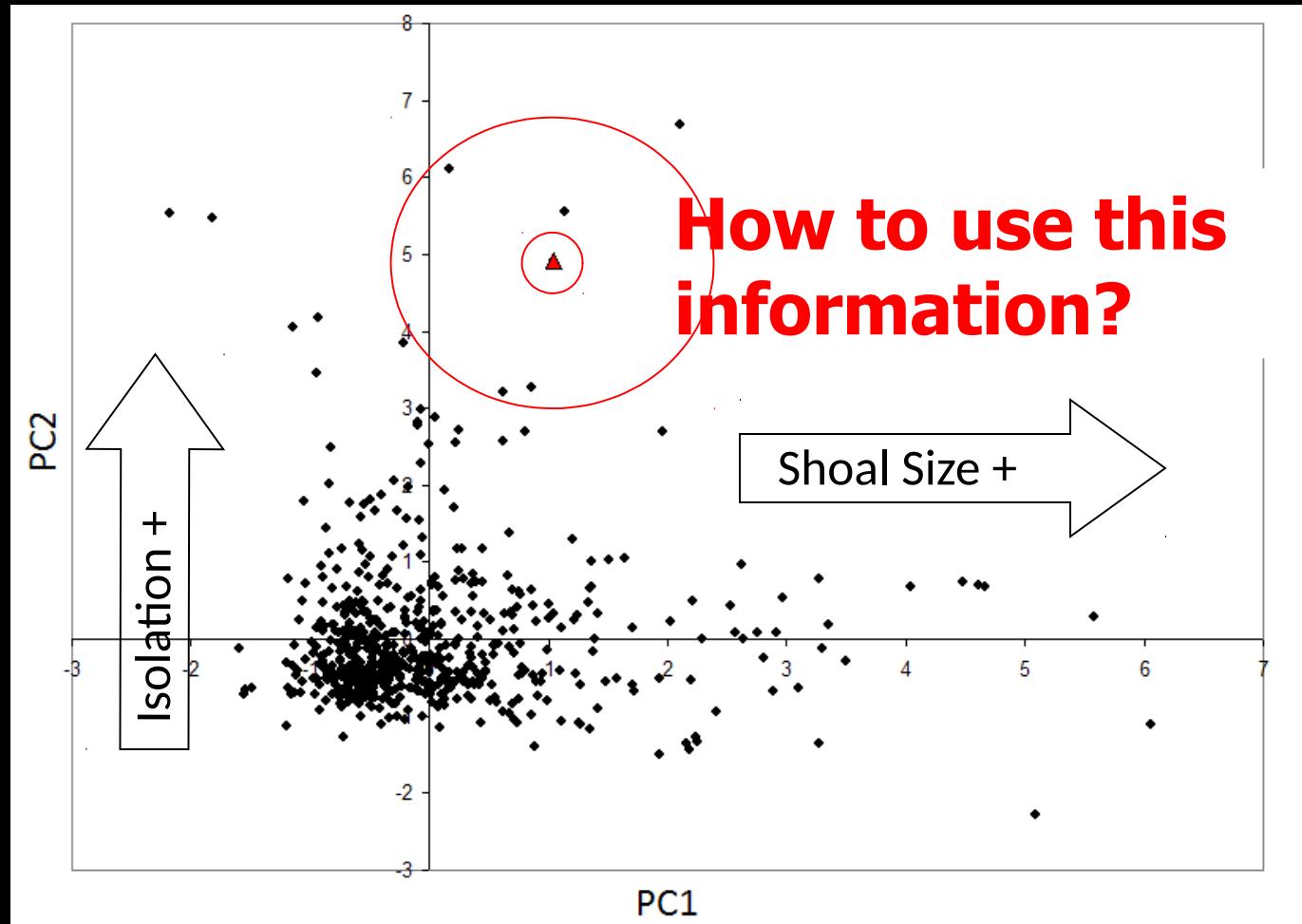
- Size (area)
- Shape (perimeter)
- Edge:Area ratio
- Edge within 15 m buffer
- % Exposed
- Distance to nearest shoal
- Size (area) of nearest shoal



PCA - Patch Variables

How do shoals differ from one another?

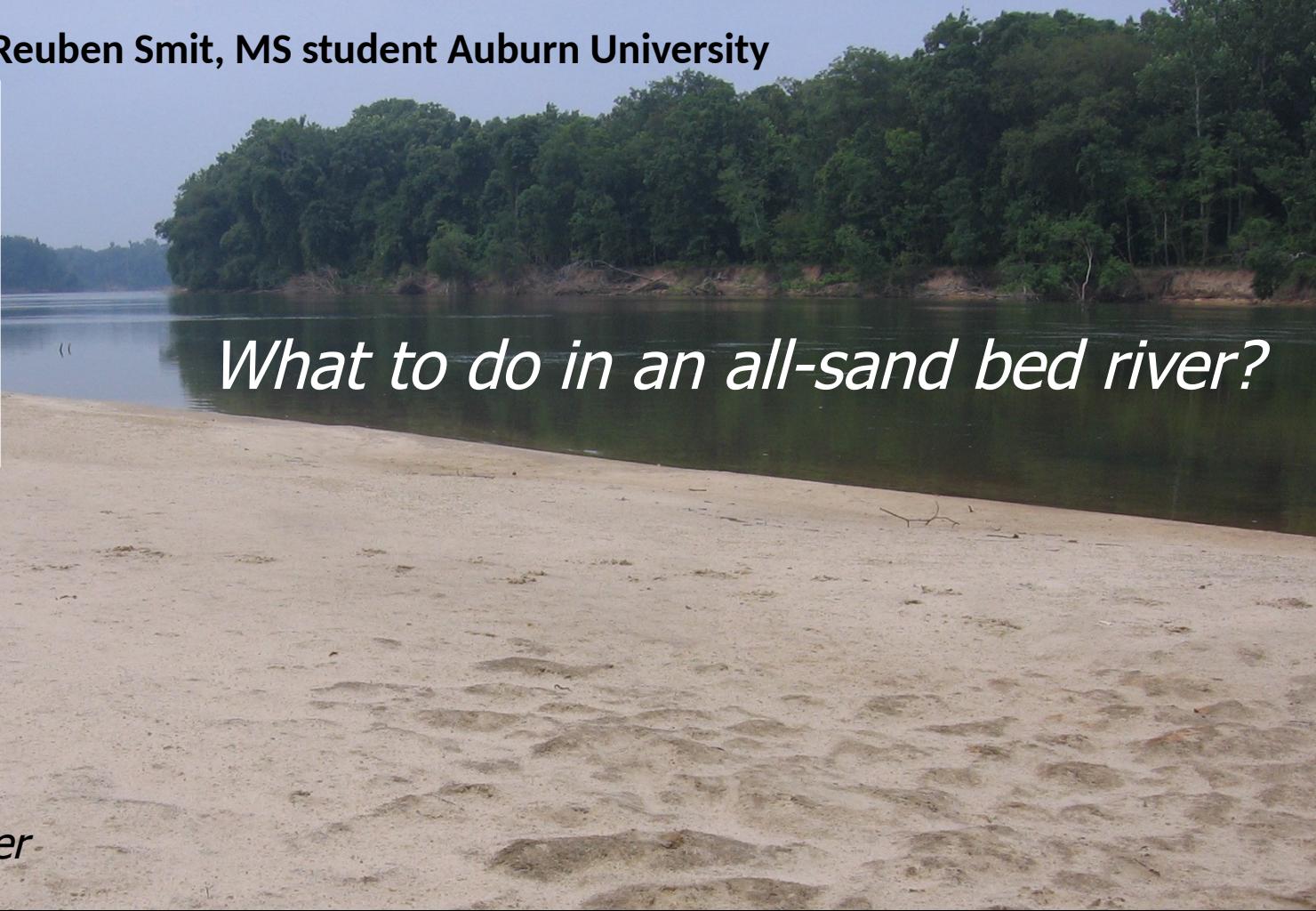
Does shoal 566 exhibit unique patch-level characteristics?



Applications 2. Animal-Habitat Investigations

- How much (mussel) habitat exists, where located?
- How many (mussels) exist, where located?

Project involved- Reuben Smit, MS student Auburn University



Apalachicola River

Traditionally- recognized mussel habitat



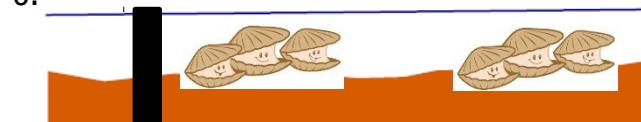
***Habitat patch clearly defined in sonar imagery- is this the area occupied by mussels?**

Tonal signature of
“mucky sand”

Smooth (plane)
bedform

*In Sand-bed Rivers

Increasing velocity



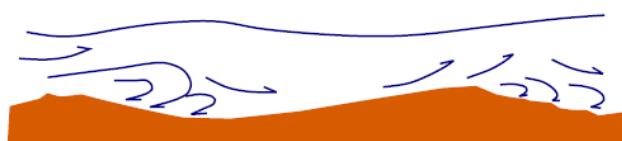
Plane bed

1.



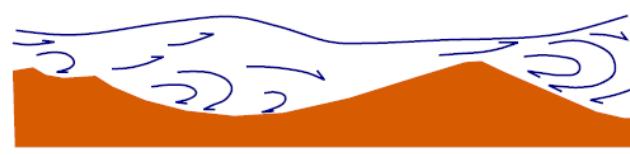
Typical ripple pattern

2.



Dunes with ripples superposed

3.



Dunes

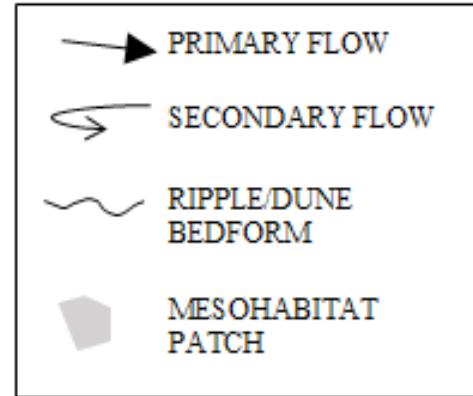
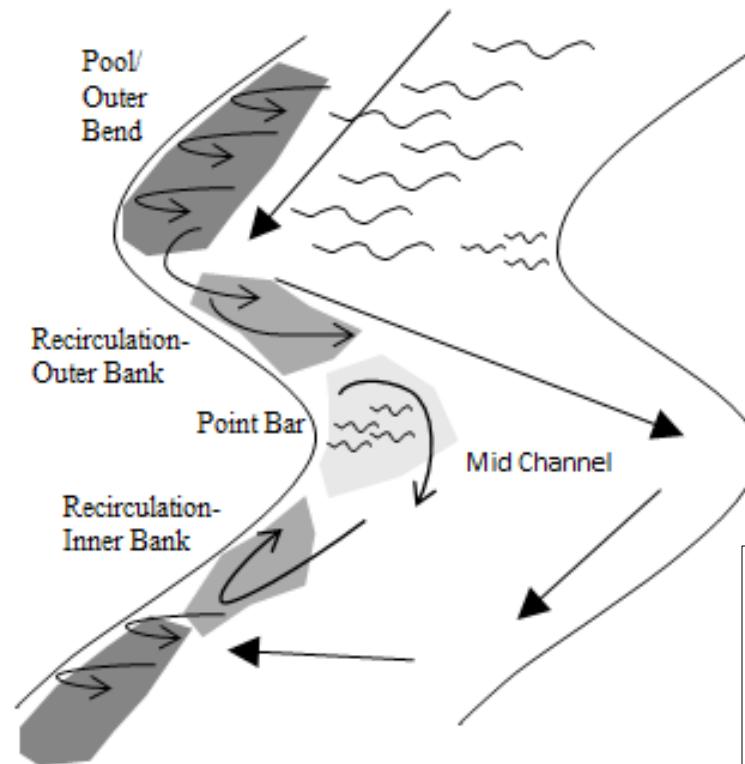
Bedforms =

**shear stress X substrate
at sediment/water interface**

***Mussels are happy in stable benthic environments**



Meso-scale Habitat Classification Scheme



- Integration of geomorphology and hydraulics

Figure 3. Conceptual illustration of the primary and secondary flow environments around a meander bend and associated habitat units used for this classification. Adapted from Garcia et al 2012.

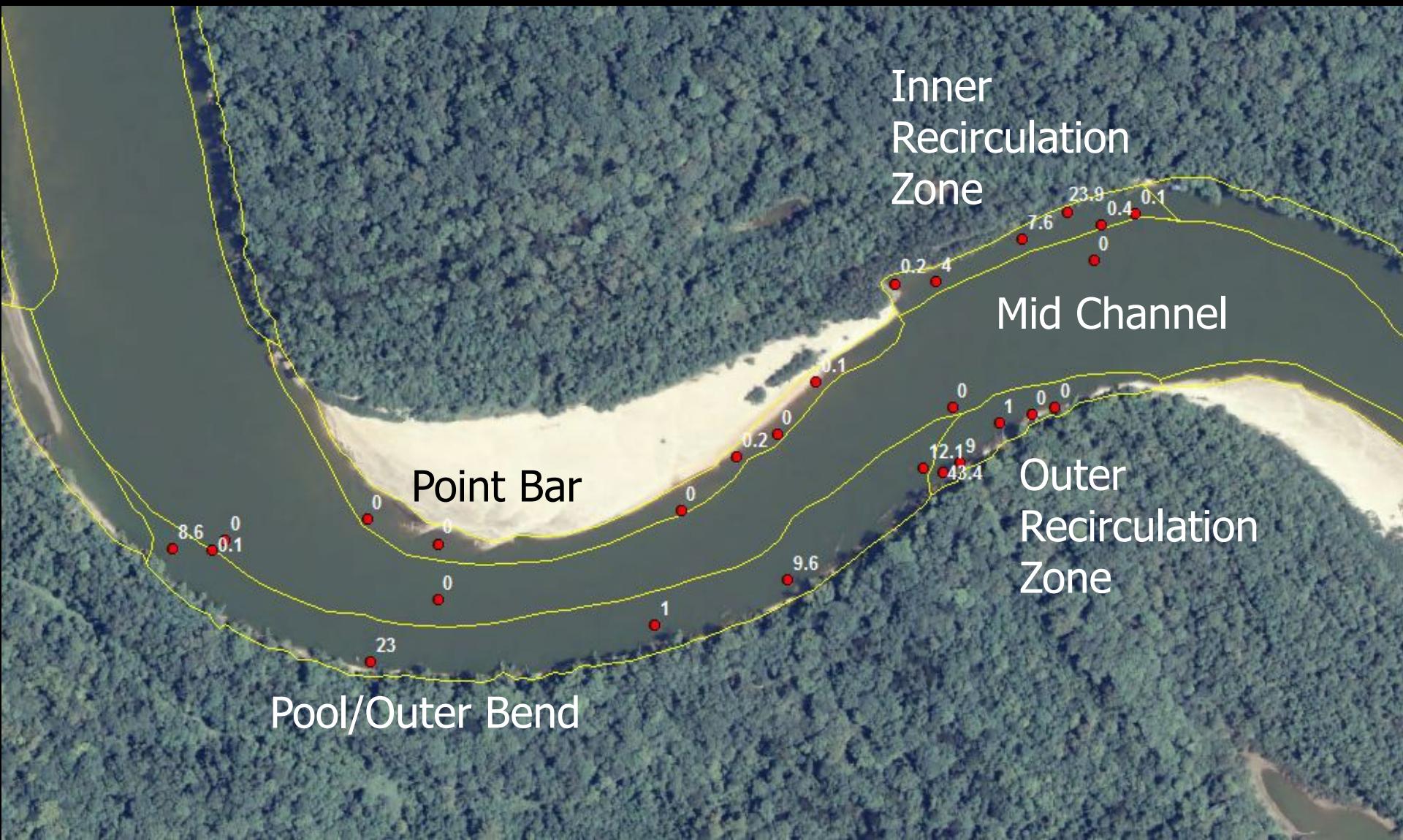


Map> Conduct
Stratified Quantitative
Survey for Mussels

Sites> Mesohabitats>
10m² radial plots

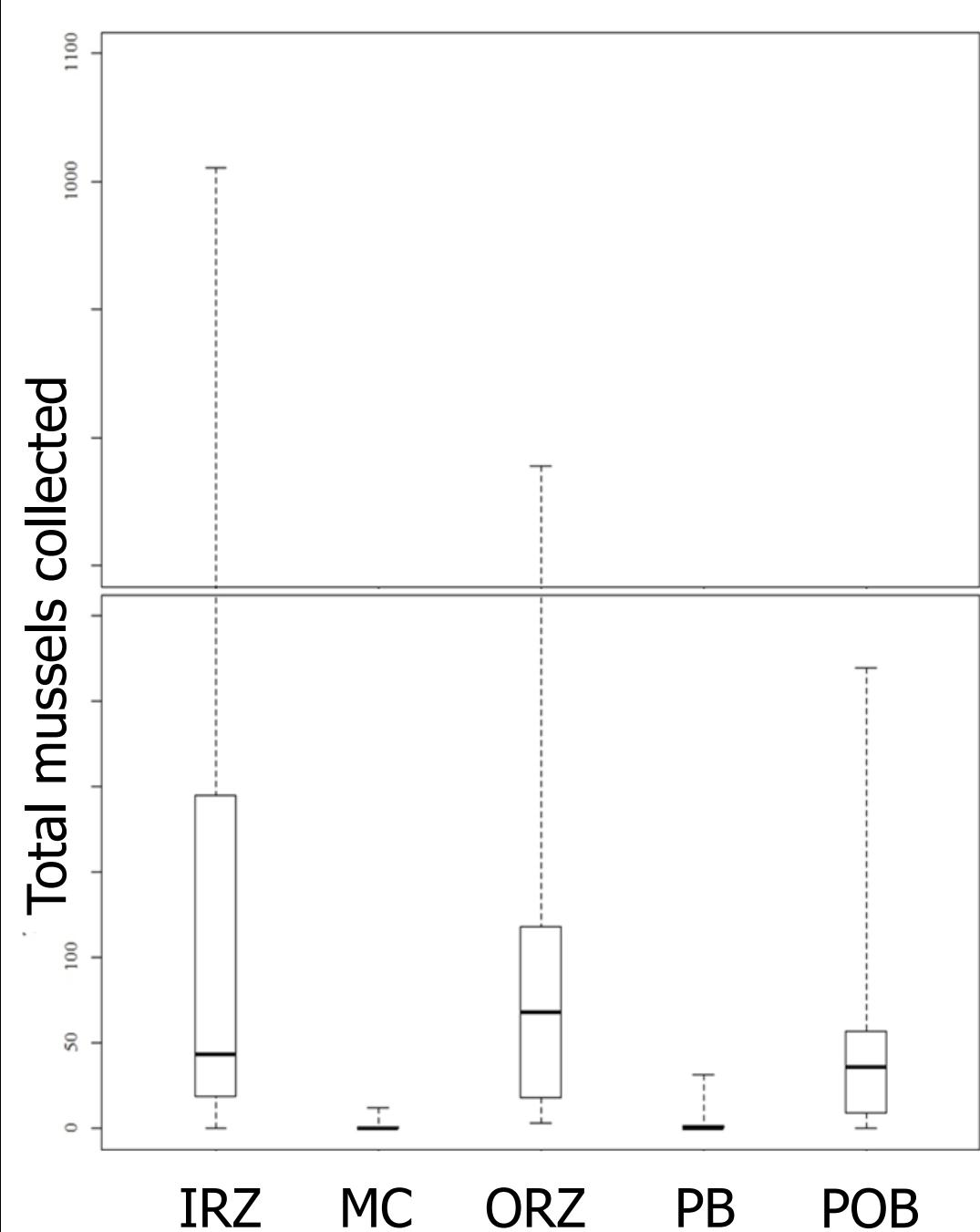


Density of *A. neislerii* (m^2)



Key Finding

Using only SSS
and bedform
patterns, we
clearly
differentiated
suitable from
non-suitable
mussel habitat
across a 50 km
riverscape



Applications 2. Develop Predictive SDMs for *A. neislerii*

1) Presence/Absence

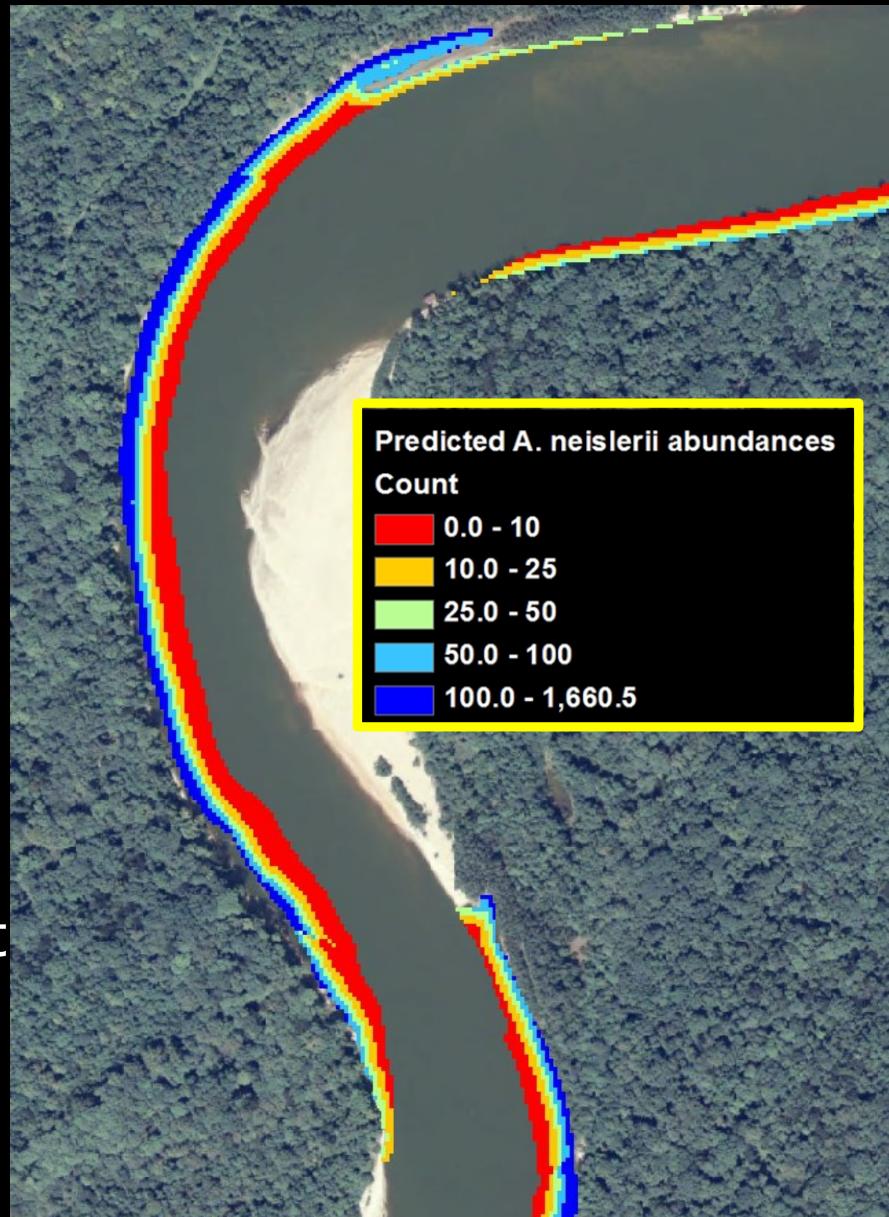
Multiple logistic regression

2) Abundance

GLM w/neg binomial dist

Habitat Variables

- Mesohabitat Class
- Distance to low flow bank
- Distance to unstable habitat
- River Kilometer



Applications 4. Detecting some types of fauna

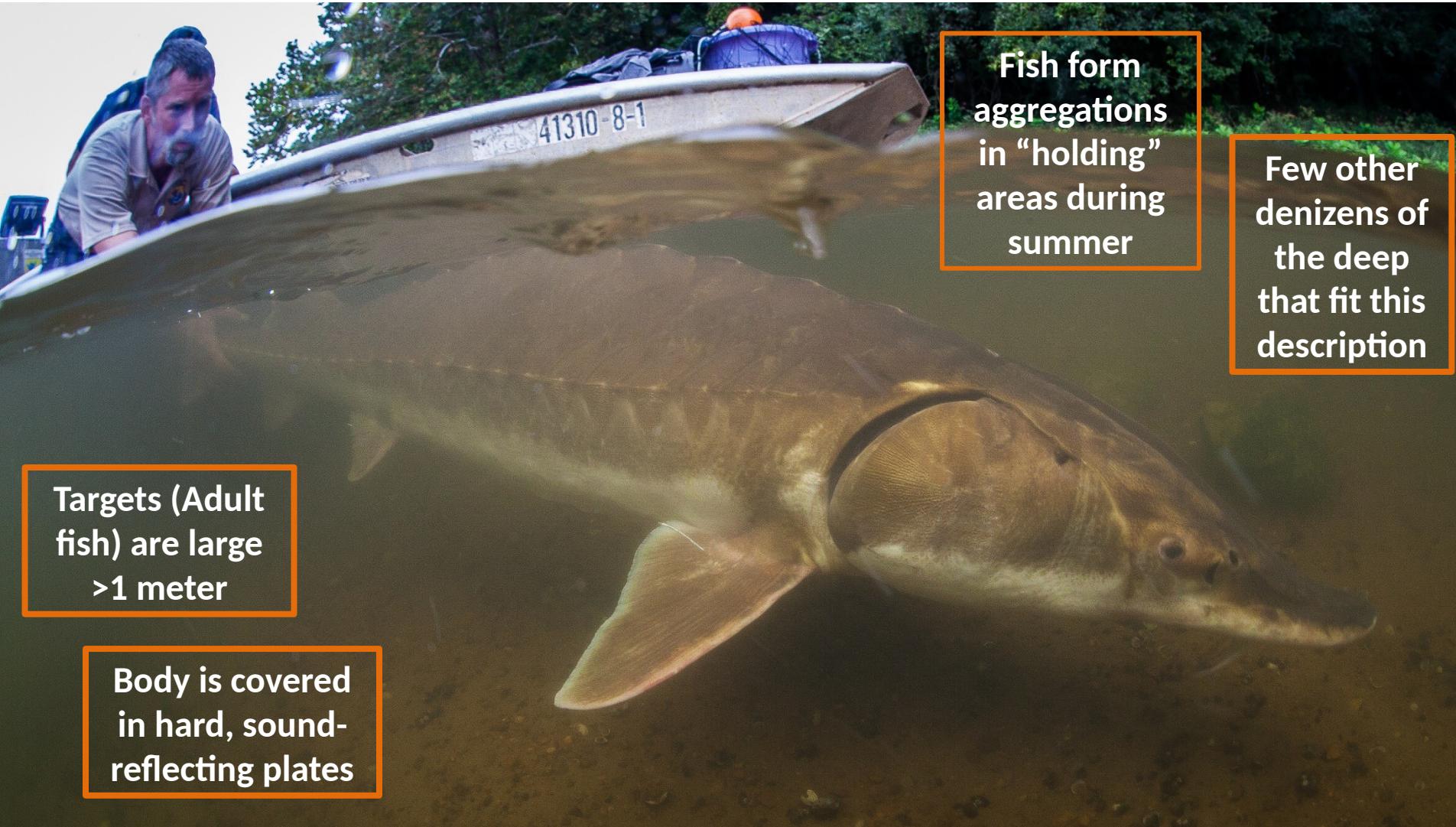
Project involves-

Frank Parauka, USFWS (retired)



Gulf Sturgeon

Developing and Validating a sonar-based, index approach to monitoring Gulf sturgeon



Targets (Adult fish) are large
>1 meter

Body is covered in hard, sound-reflecting plates

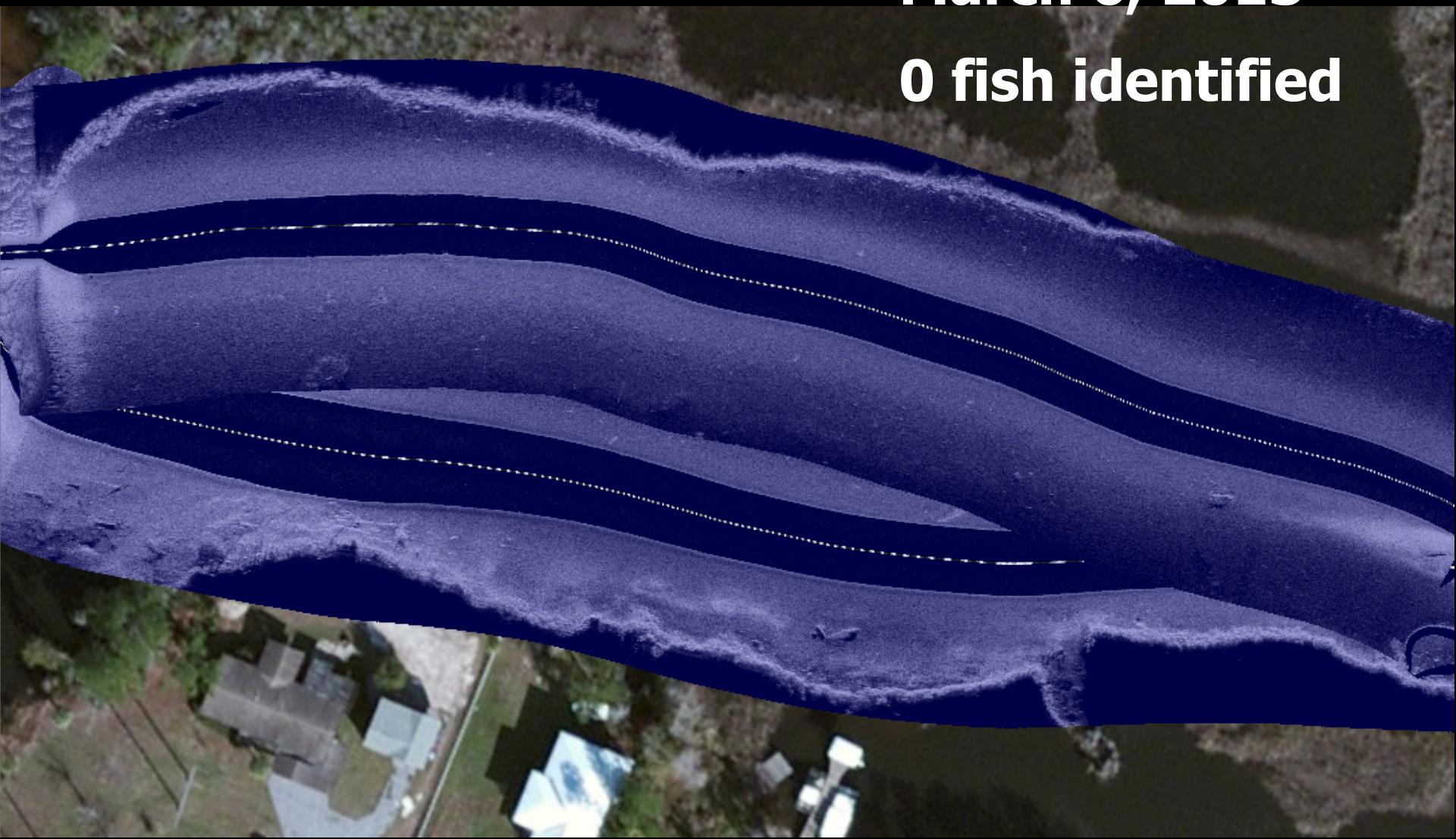
Fish form aggregations in “holding” areas during summer

Few other denizens of the deep that fit this description

Detecting Sturgeon in a Holding Area

March 6, 2013

0 fish identified



Detecting Sturgeon in a Holding Area

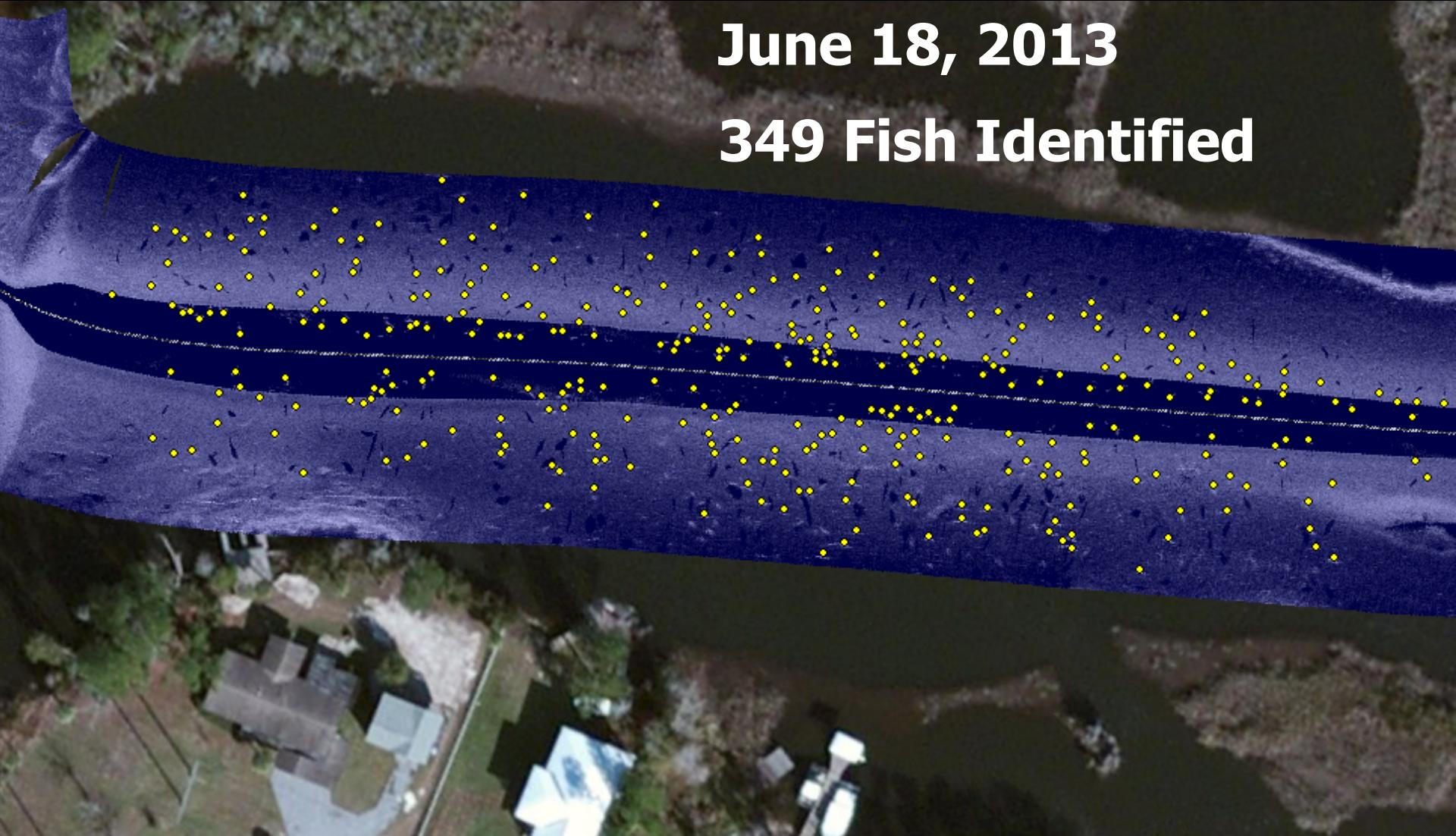
June 18, 2013



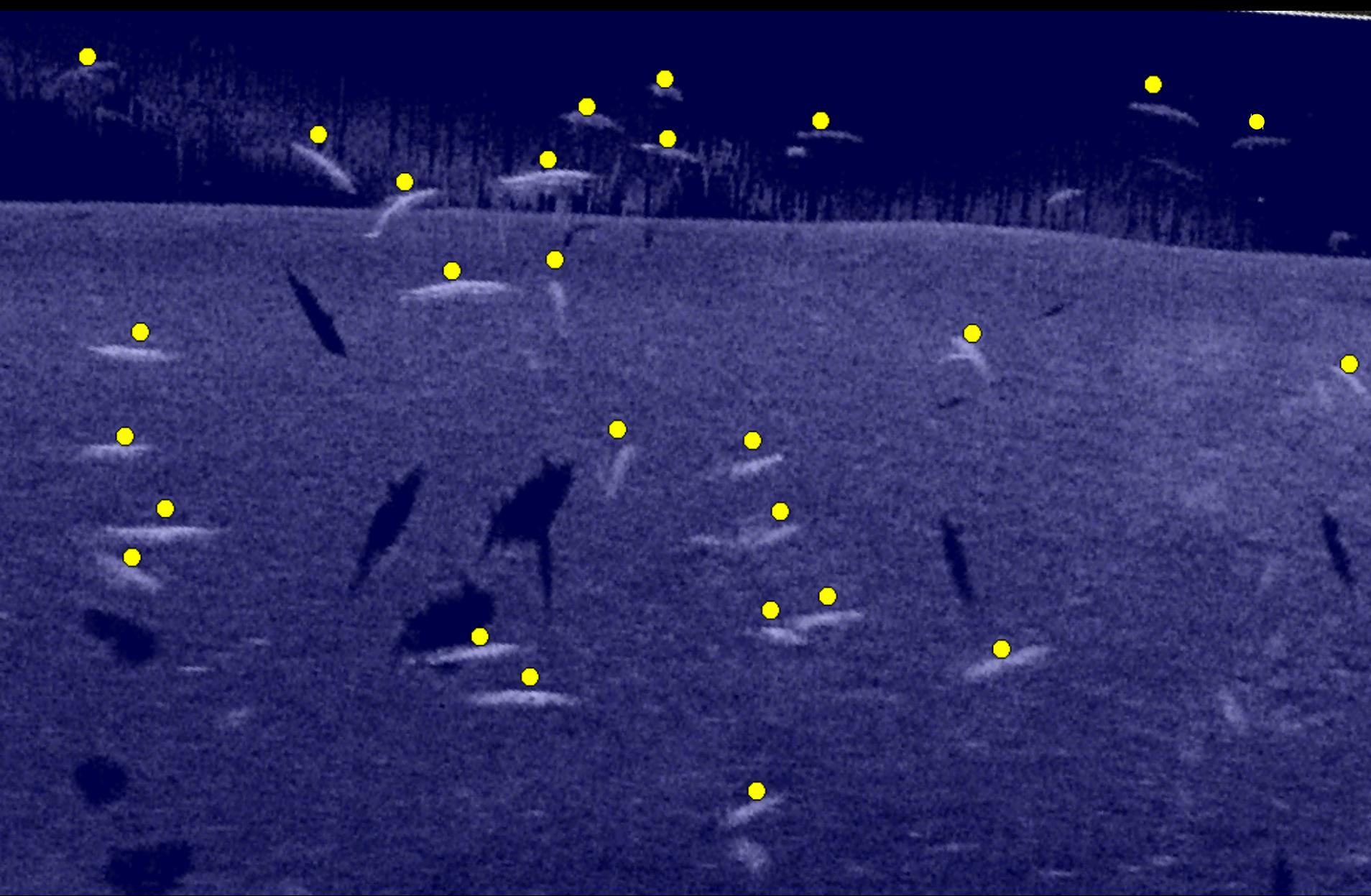
Fish can be counted and associated directly with habitat

June 18, 2013

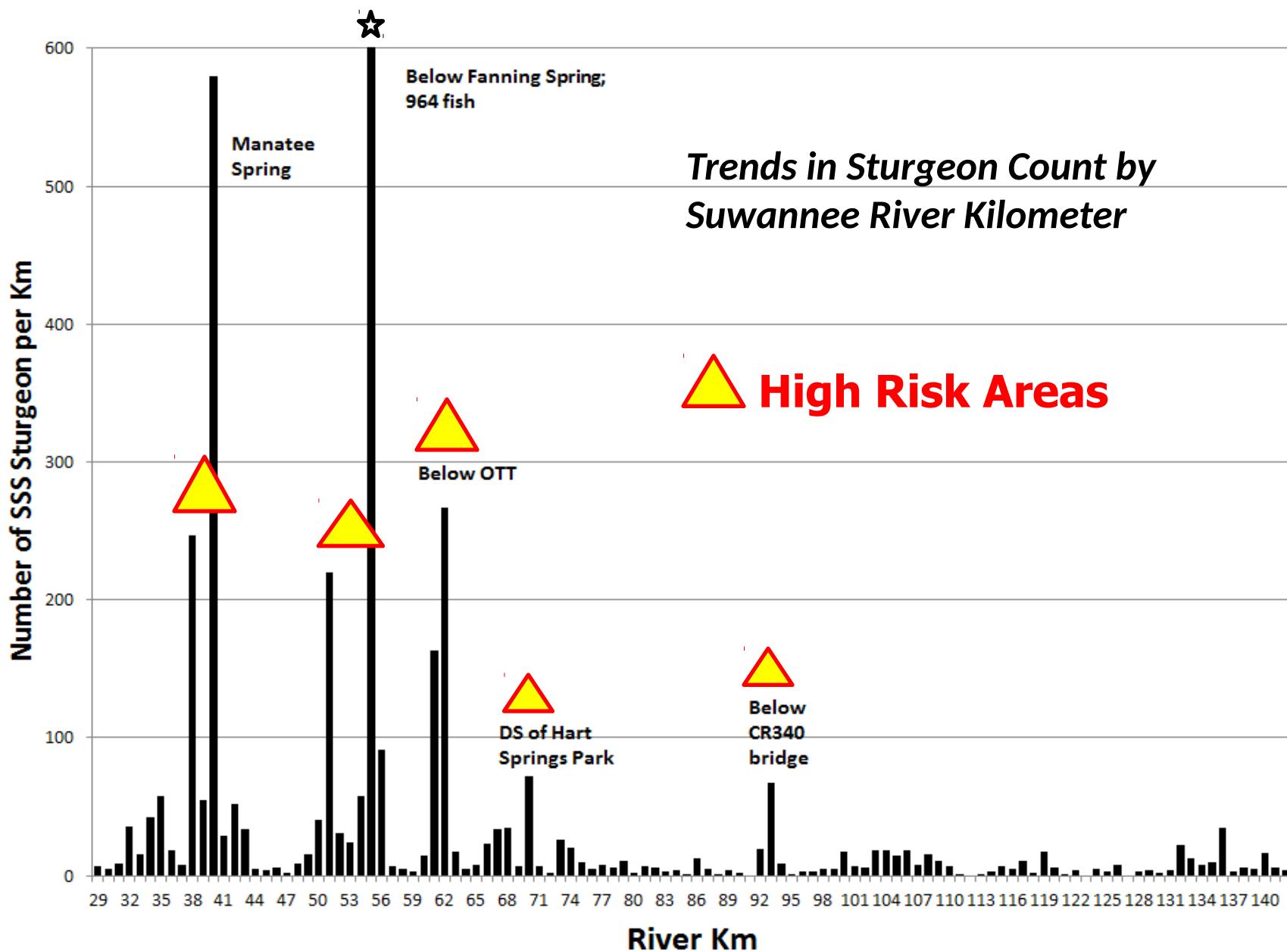
349 Fish Identified



>90 cm FL fish identified at 1:150 – 1:250 map scale



Enhancing Public Safety using SSS data



For More Information

- Google Search-
“sonar habitat mapping”

<http://www.fws.gov/panamacity/sonarhabitatmapping.html>

 U.S. Fish & Wildlife Service
Panama City Ecological Services / Fish & Wildlife Conservation Office
Conserving the Nature of America

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[Endangered Wildlife Rehabilitation](#)


Low Cost Sonar Habitat Mapping

What is low-cost sonar habitat mapping?
Low-cost sonar habitat mapping is a method developed by Adam Kaeber (U.S. Fish and Wildlife Service) and Thom Litts (Georgia Department of Natural Resources) for producing high resolution maps of physical habitat features in navigable systems using inexpensive, off-the-shelf sonar and GPS.


flexible means to visualize and characterize the underwater environment at the landscape scale, this method can be used to fill critical information gaps in a wide variety of aquatic systems.
We offer comprehensive, not-for-profit instructional workshops on this method, however training documents and supporting literature are freely provided here to anyone interested in this pursuit. We encourage you to peruse these materials and emphasize the Illustrated Guide to Low-Cost Sonar Habitat Mapping and the Sonar Imagery Geoprocessing Workbook as sources for details on the overall method. The content of this webpage and the materials provided are subject to regular update and revision.

More Information

- [The Developers](#)
- [Tools and Training](#)
- [Publications](#)
- [Supplementary Material and Protocols](#)

Current Research of the Panama City FWCO

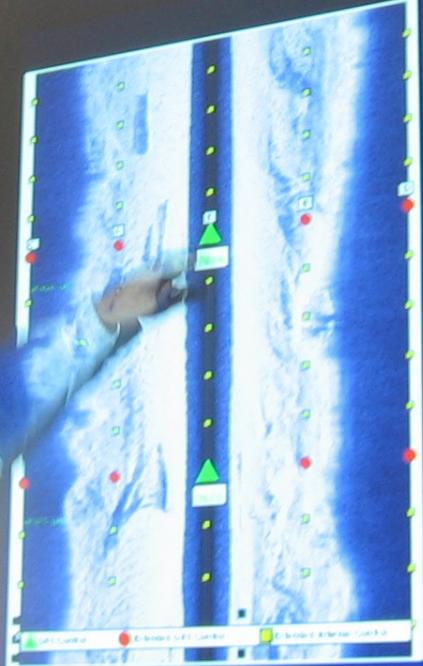
- [Mussel Mapping Project](#)
- [Sturgeon Detection Project](#)
- [Sturgeon Spawning Habitat Project](#)

Links

Training Workshops



Step C. Geoprocessing
Establish Image Control Point Network



The projection screen shows a map of a river or waterway. A boat's path is depicted as a dark blue line. Numerous green dots are placed along this path, representing GPS points. Red dots are also present, likely representing measured control points. The text on the right describes the process of establishing an image control point network based on these markers.

- 1) Image control is first placed at known location on the ground (image center/end)
- 2) Image control is extended horizontally across the image at GPS points and at 20% intervals along the boat's path.
- 3) Control placed at the image edges and half way between the measured control and image edge

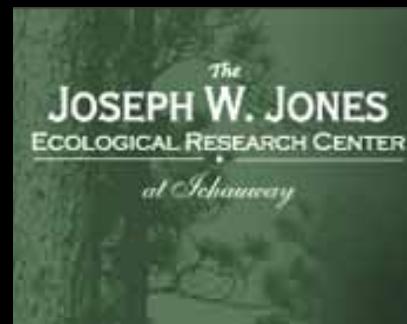
Next offered – Arkansas AFS Annual Meeting, January 24, 2017

Future Developments

- **Automated/semi-automated procedures for image segmentation and classification (Dan Buscombe, USGS)**
- **Integrated SSS and multi-beam bathymetric system at low cost> Lowrance Structure Scan 3D (\$1000)**



Acknowledgments



SDAFS Reservoir Committee

