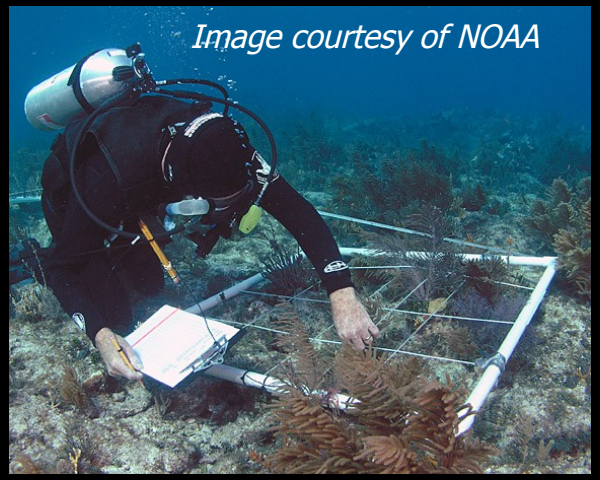
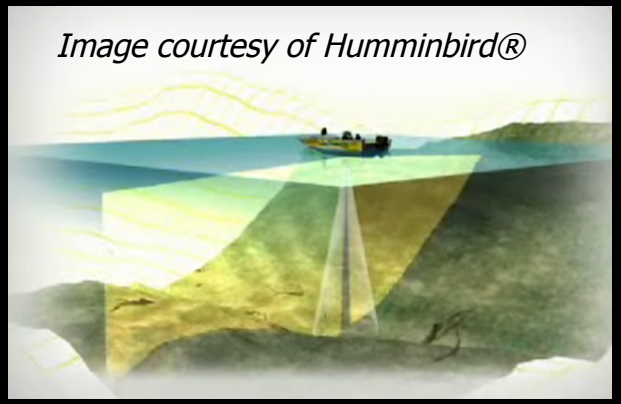
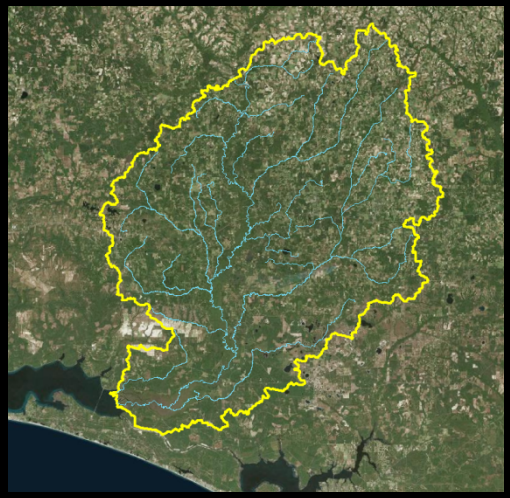
# Sound Sheds Light

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



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Auburn University
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U.S. Fish and Wildlife Service (ret)

# Purpose

1. Establish the role of low-cost side scan sonar in aquatic conservation

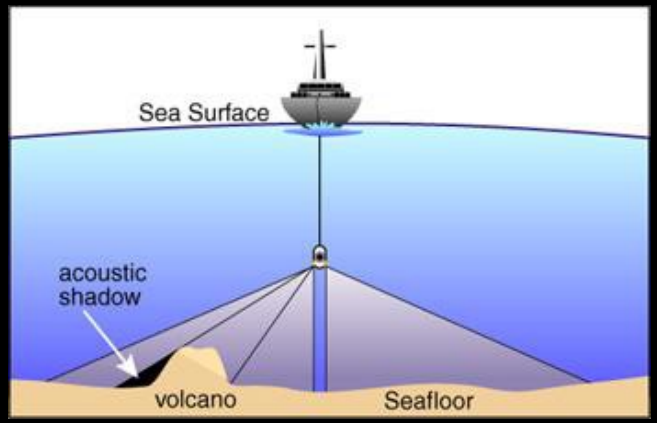
2. Highlight applications, and future developments for this technology

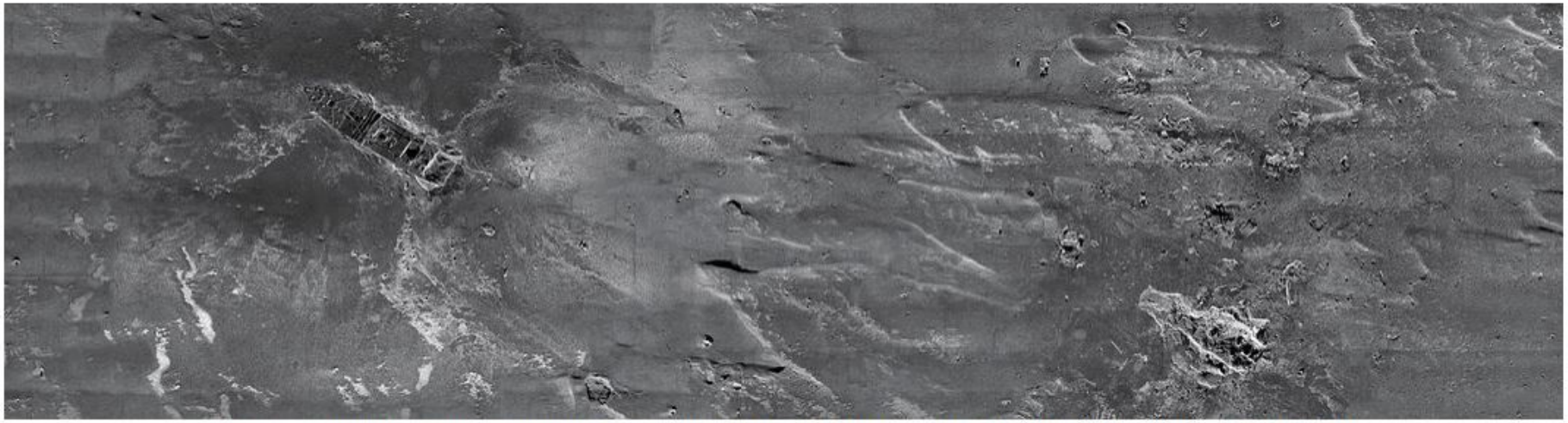
# What is side scan sonar?

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.

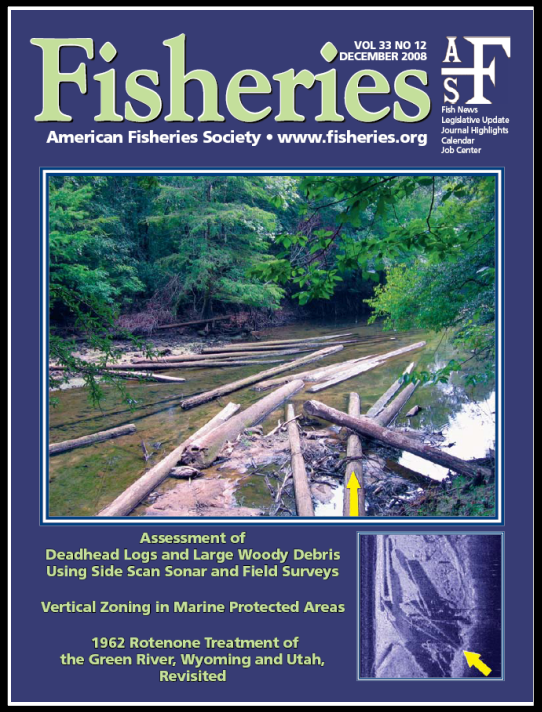
# Role of side scan sonar

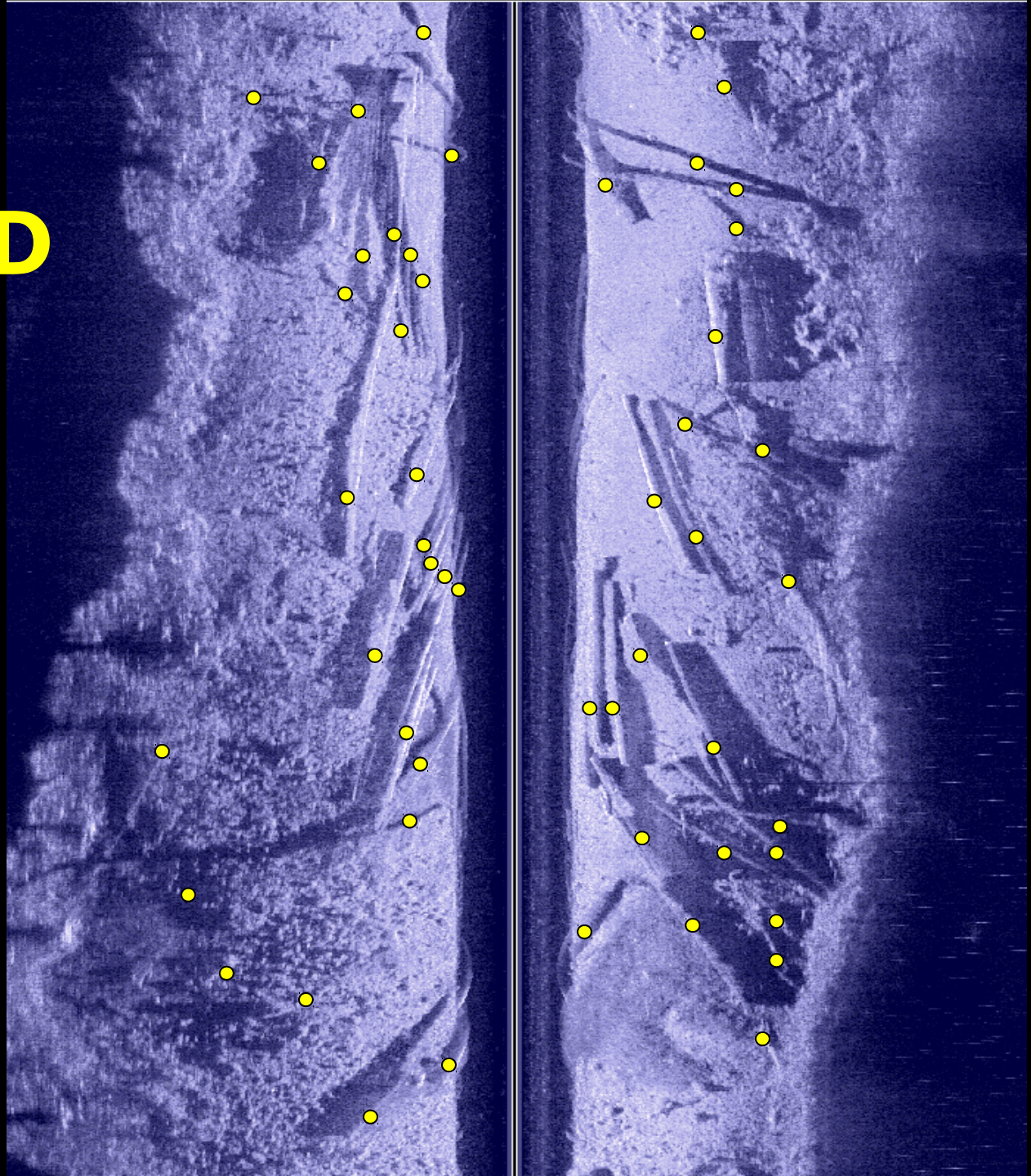
- **10 years ago (Spring 2005) Humminbird® released the 981c Side Imaging System**
- **First recreational-grade (i.e., low-cost) side scan sonar system; <$3,000; a sophisticated fish-finder**




# How I got started…

# Deadhead Logs + LWD in HBSI Imagery



# Role of side scan sonar

## Major Breakthrough

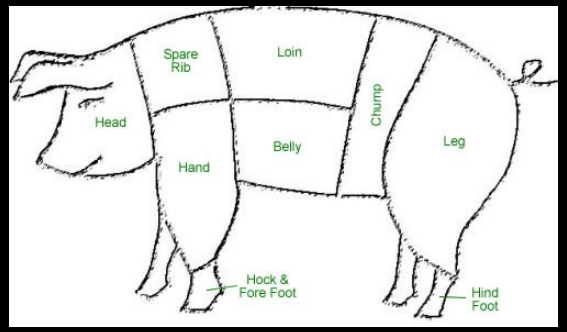
1. Low Cost

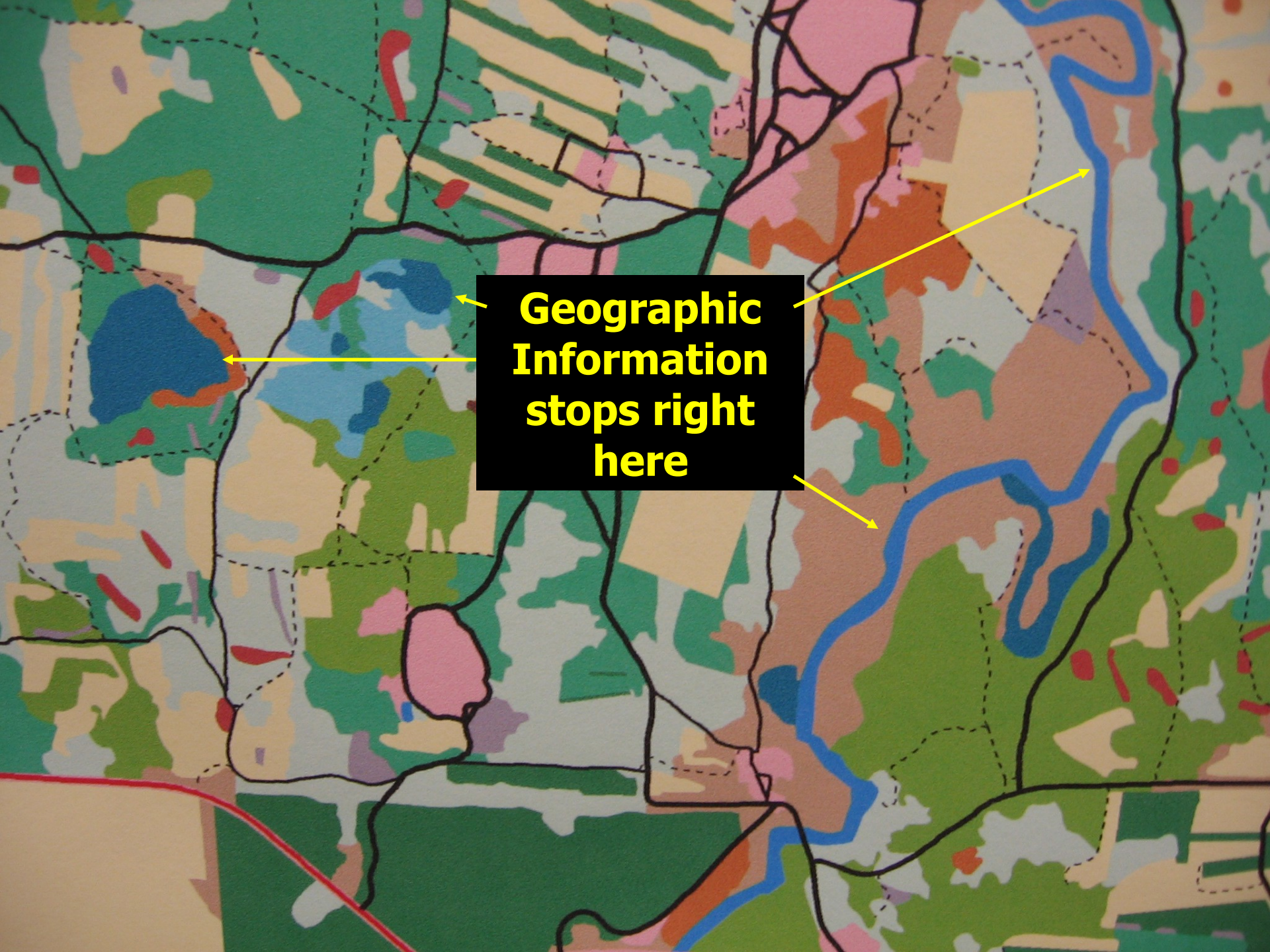
2. Easy to Use

3. High Resolution/Image Quality

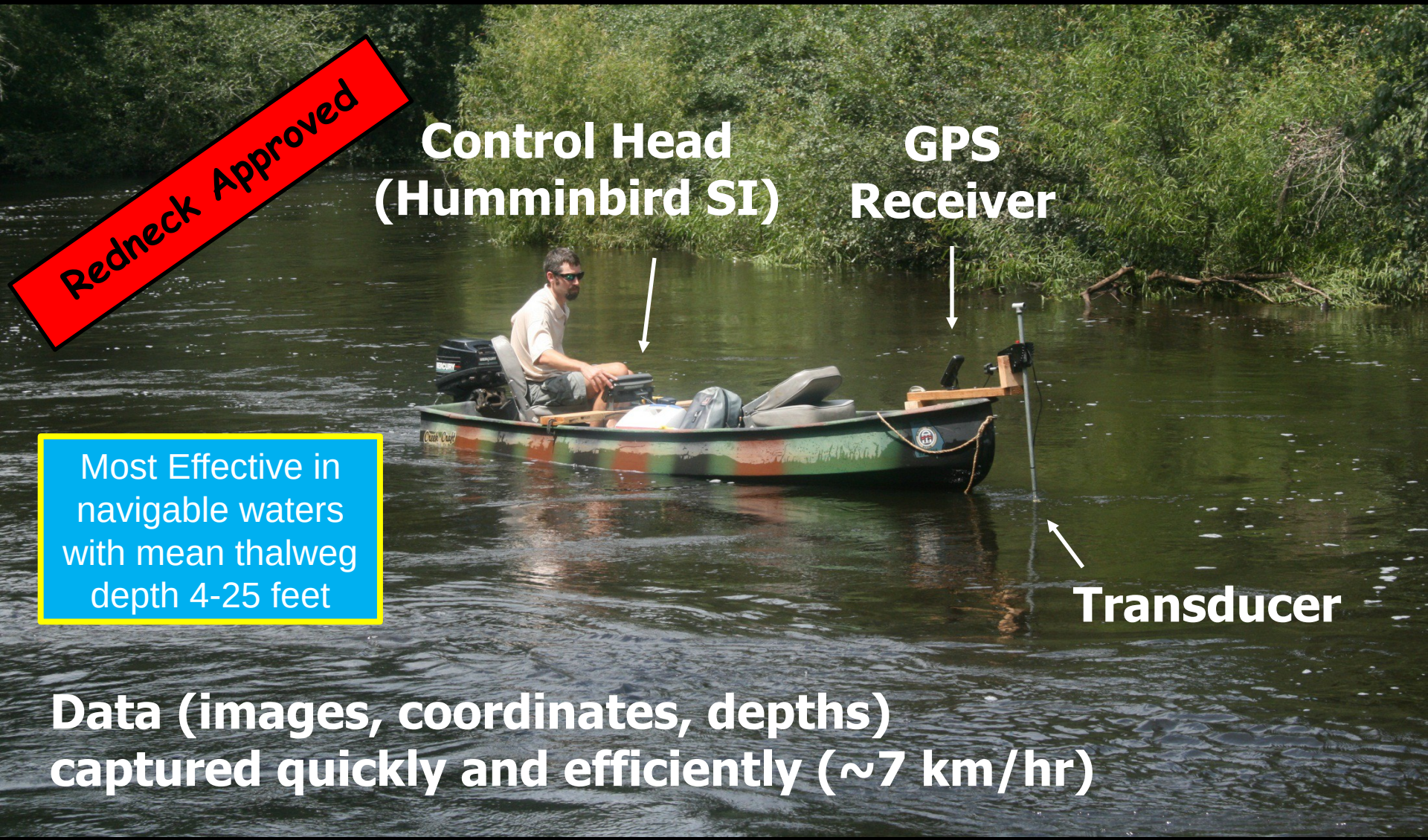
*Small, adjustable transducer*

4. Data Processing> Maps of Classified Features




Geographic Information stops right here

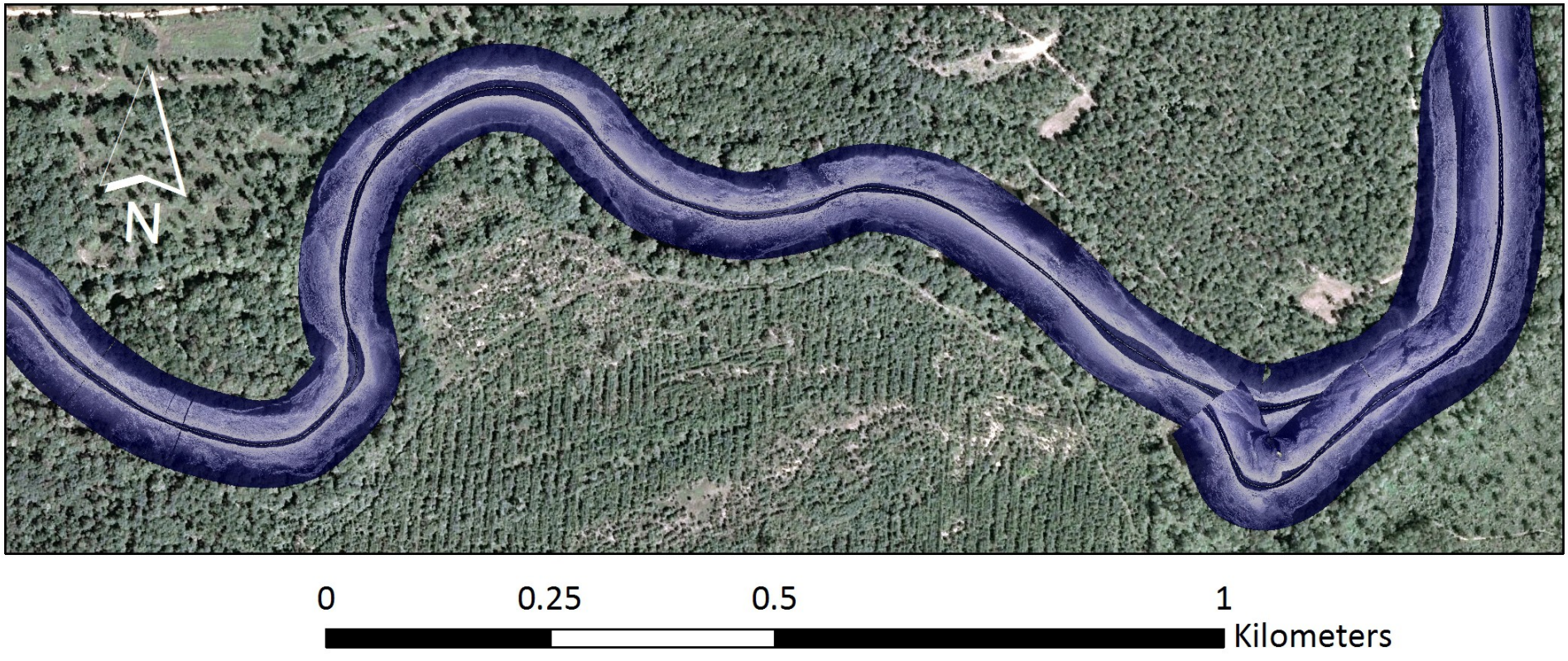
# Low-cost Sonar Habitat Mapping Survey




**Data (images, coordinates, depths) captured quickly and efficiently (~7 km/hr)**

# The Process

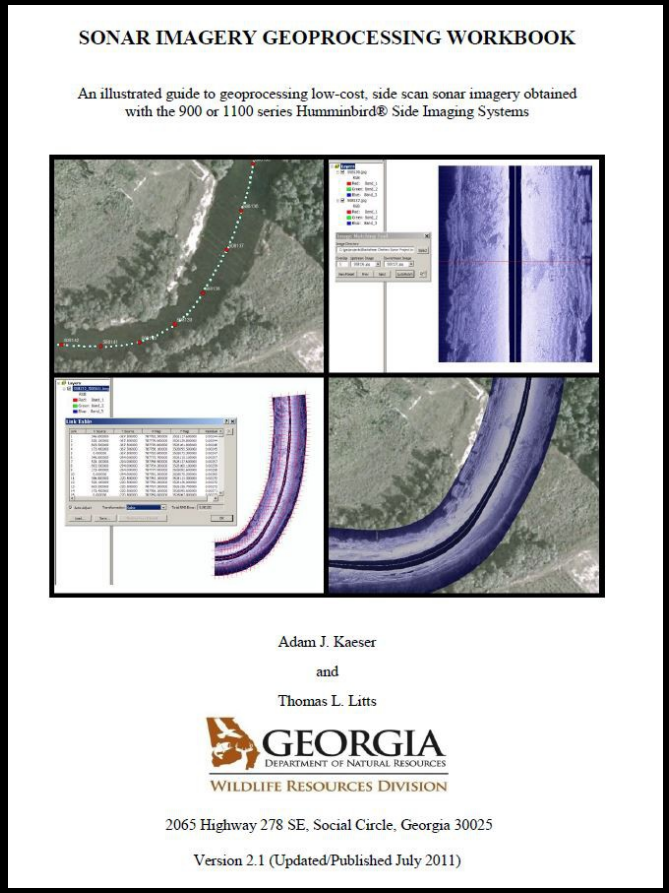
## Step B) Geoprocess sonar data (several approaches)



# 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

Adam J. Kaeser

and

Thomas L. Litts

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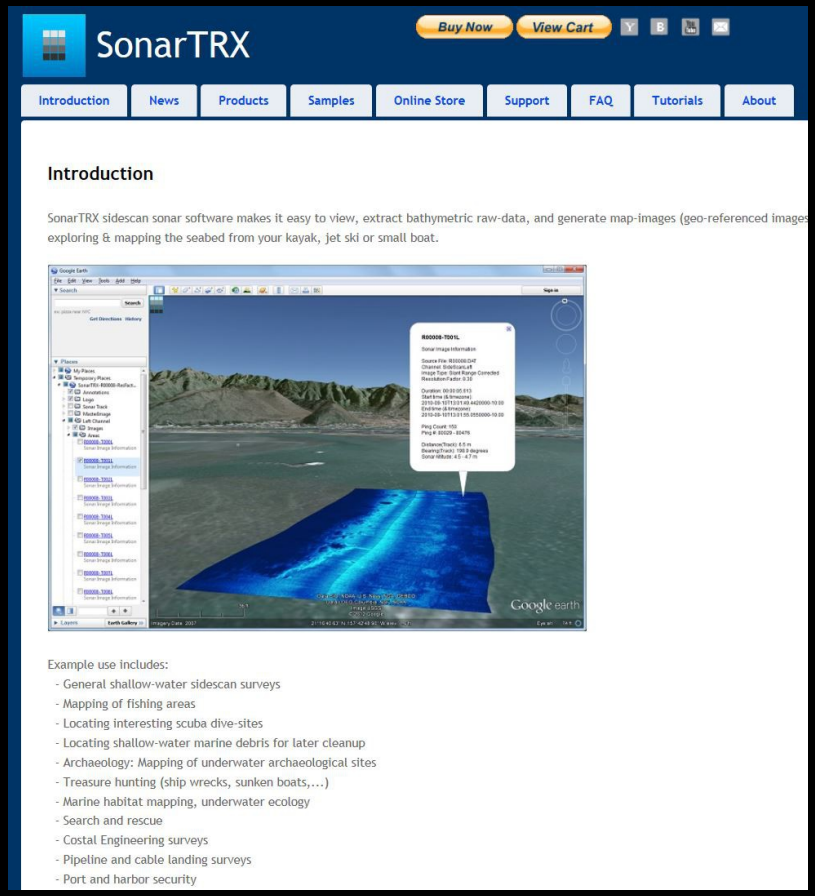
Version 2.1 (Updated/Published July 2011)



SonarTRX

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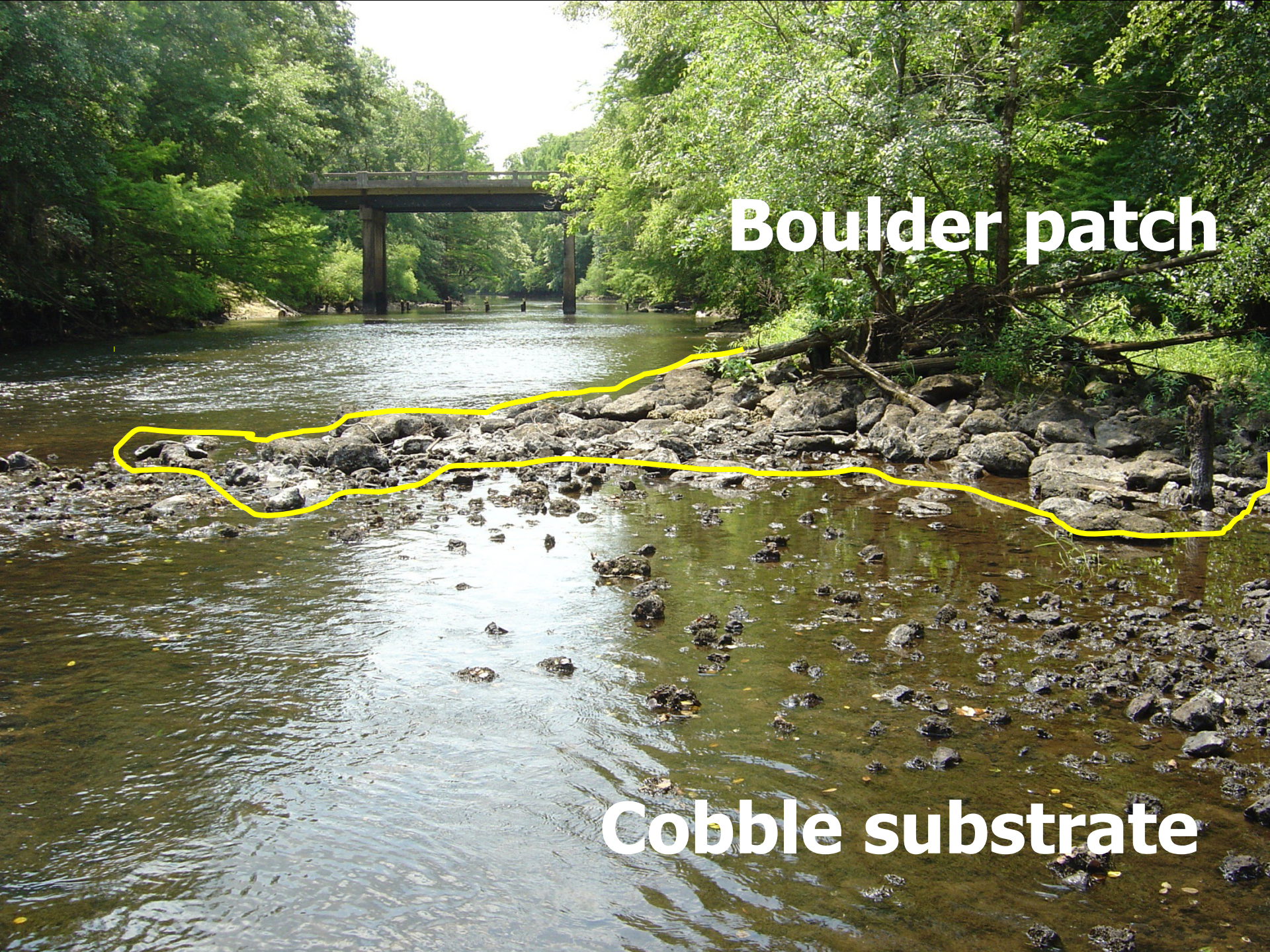
Introduction

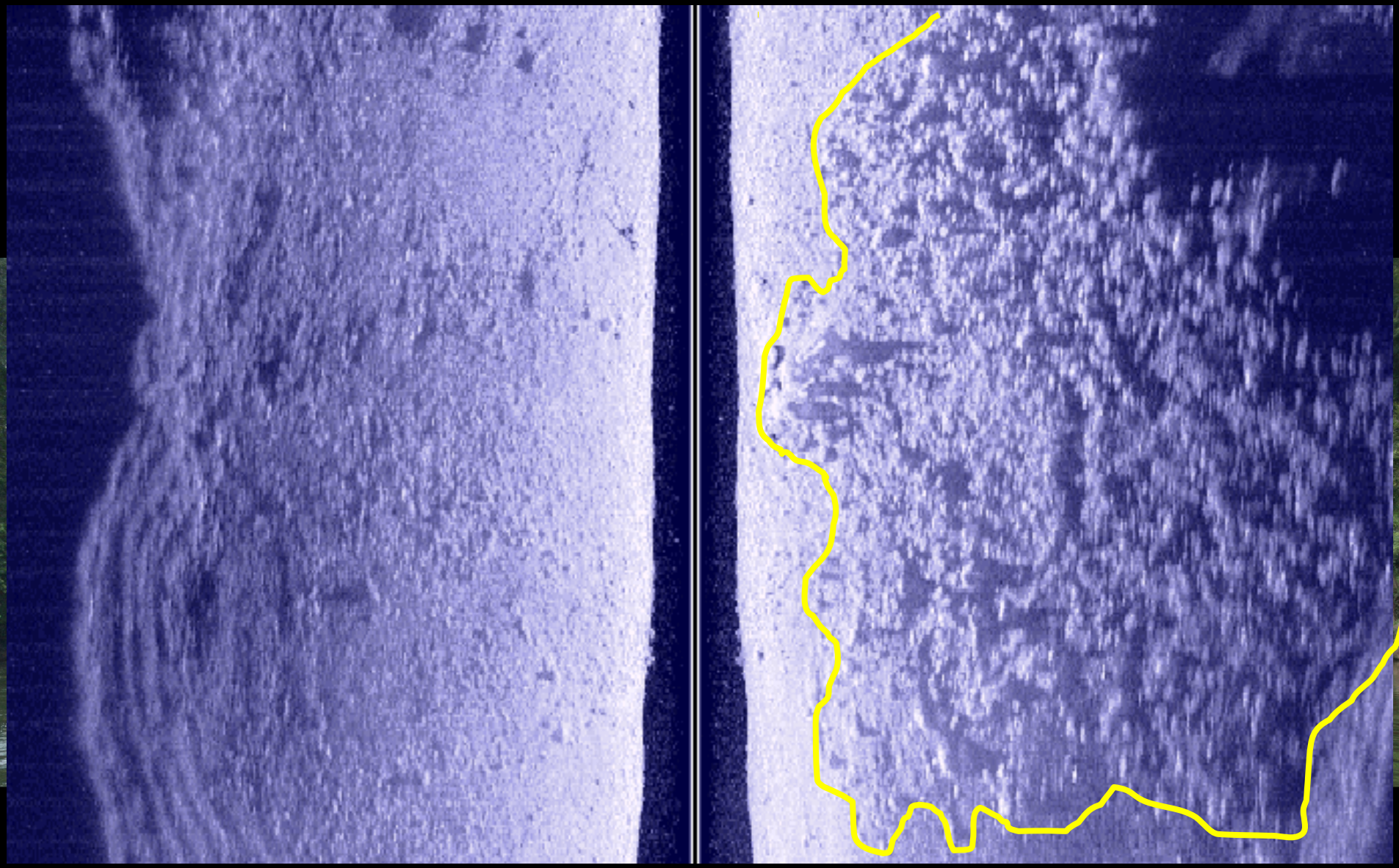
SonarTRX sidescan sonar software makes it easy to view, extract bathymetric raw-data, and generate map-images (geo-referenced images exploring & mapping the seabed from your kayak, jet ski or small boat.

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
- Costal Engineering surveys
- Pipeline and cable landing surveys
- Port and harbor security

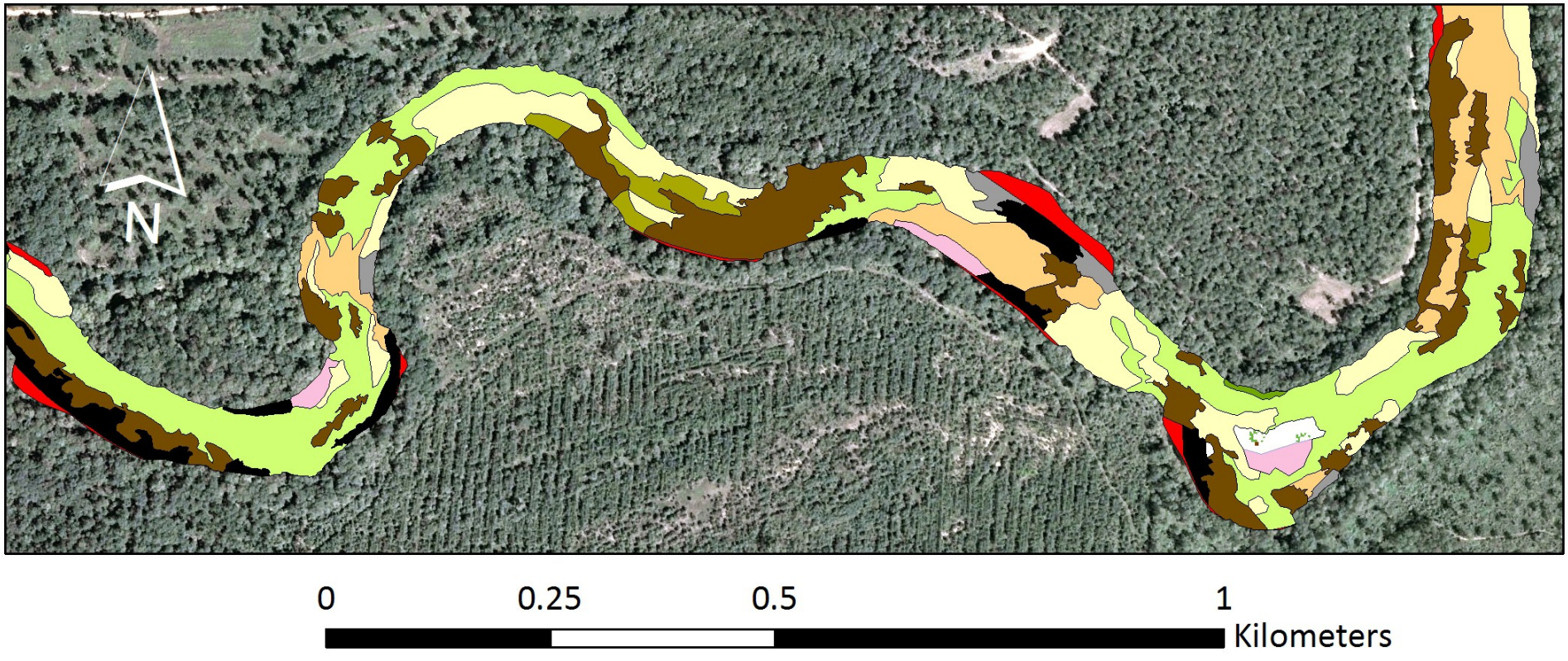

Boulder patch
Cobble substrate

# Substrates in HBSI imagery

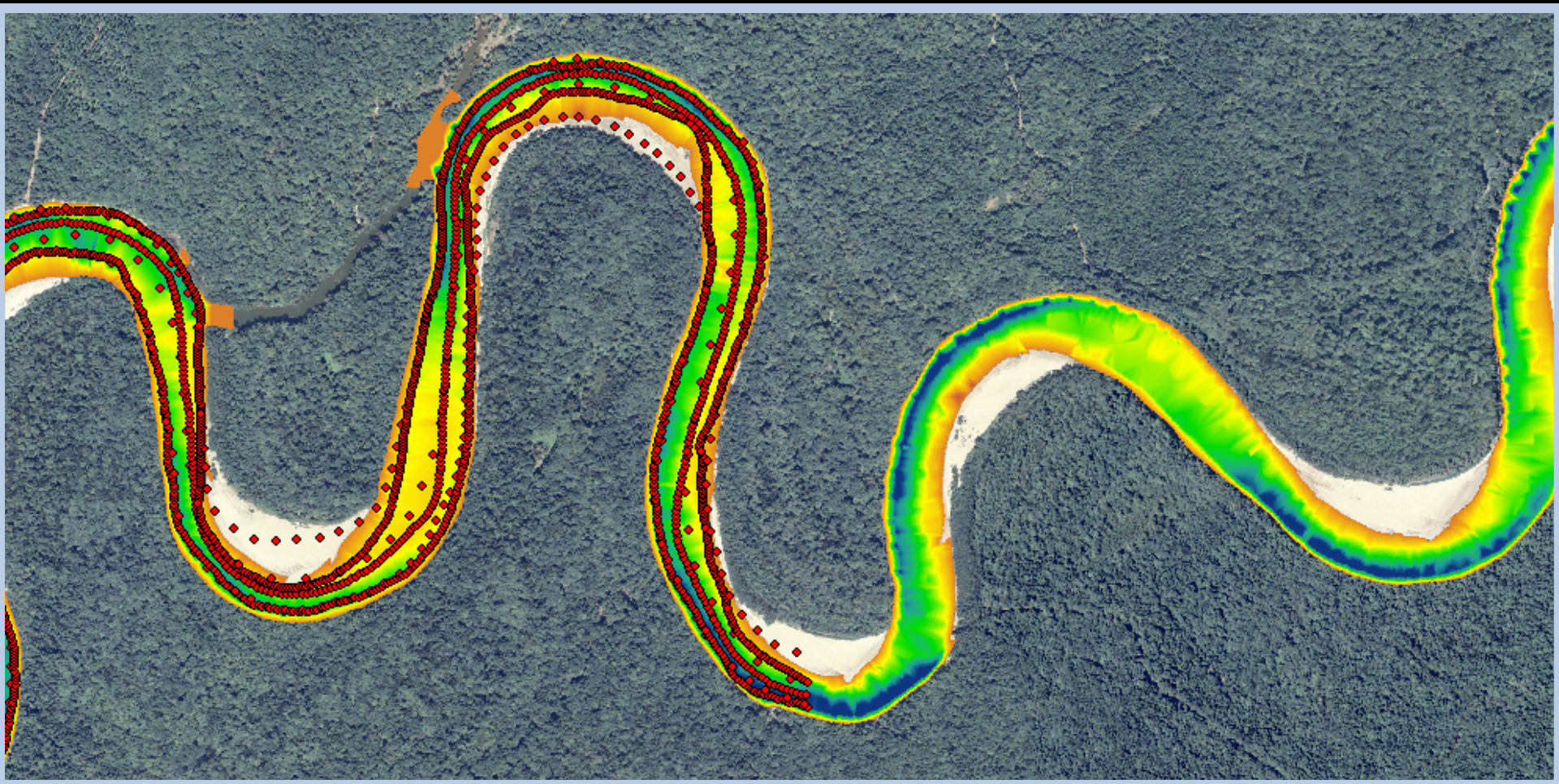


# The Process

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



# Depth data ➡ Bathymetric Model



# Role of side scan sonar

## Why do we need (sonar) Maps?

1. Because vast reaches of turbid, nonwadeble 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

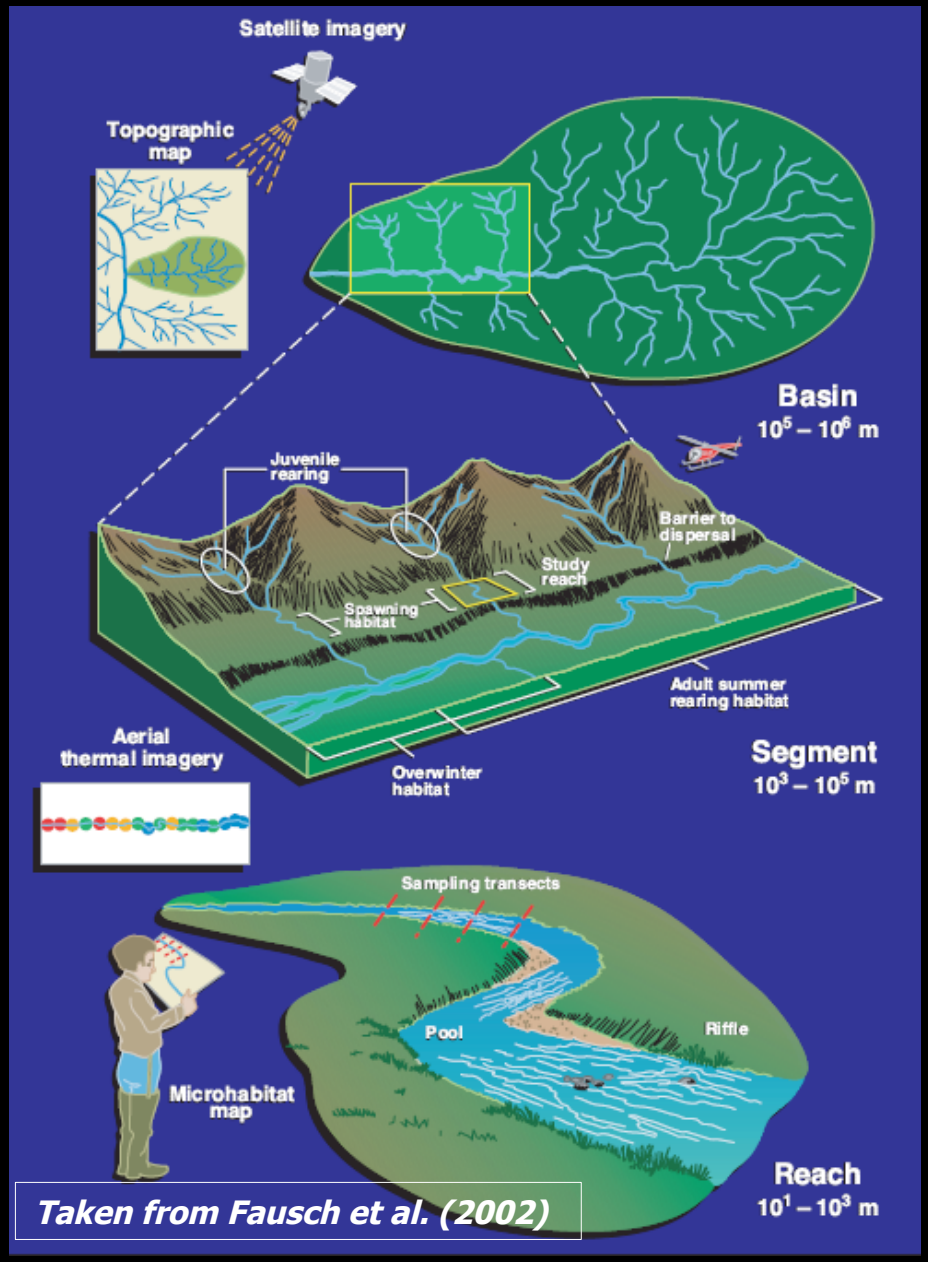
- ID and quantification of critical habitats
- Habitat condition assessments
- Development of SDMs linking populations to habitat
- Monitoring habitat change over time

*"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)

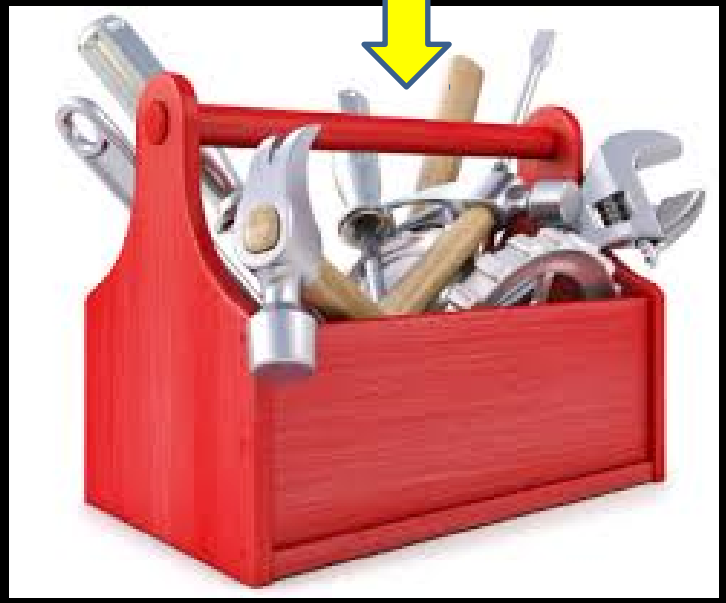



*Fausch, K. D., C. E. Torgersen, C. V. Baxter, and H. W. Li. 2002. Landscapes to Riverscapes: bridging the gap between research and conservation of stream fishes. BioScience 52: 483-498.*

# 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

# Shoal Habitat Affiliates

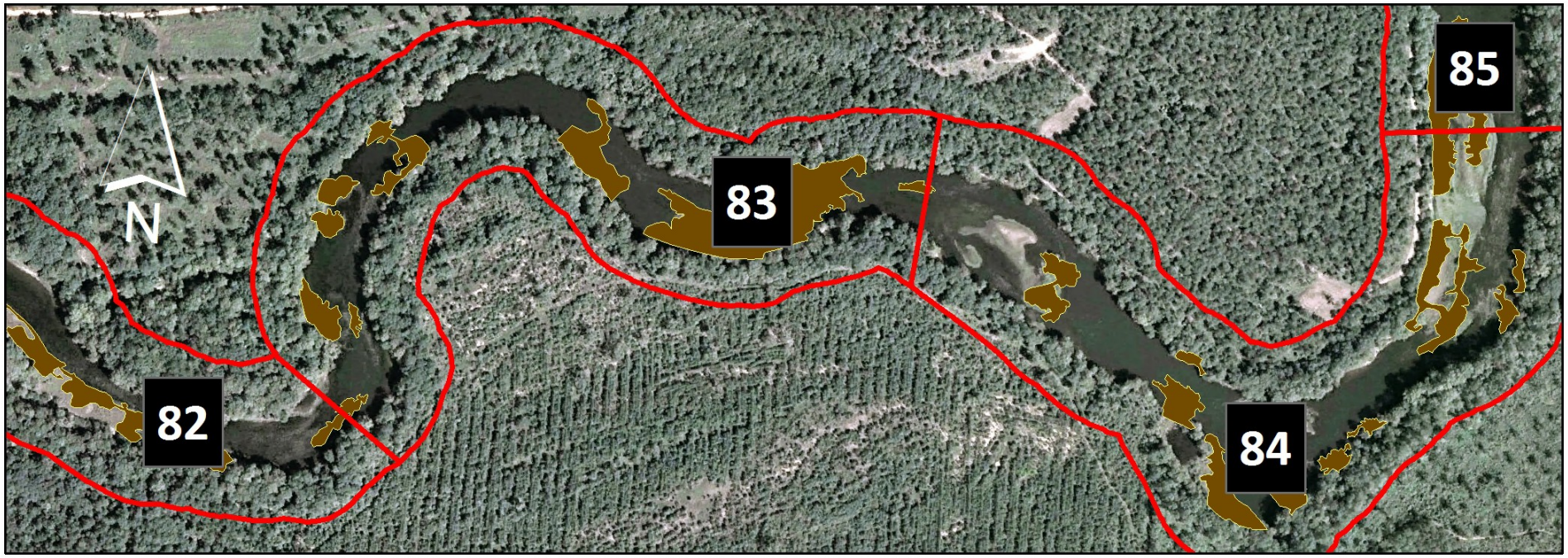
Gulf Sturgeon
*Acipenser oxyrinchus desotoi*

Alabama Shad
*Alosa alabamae*

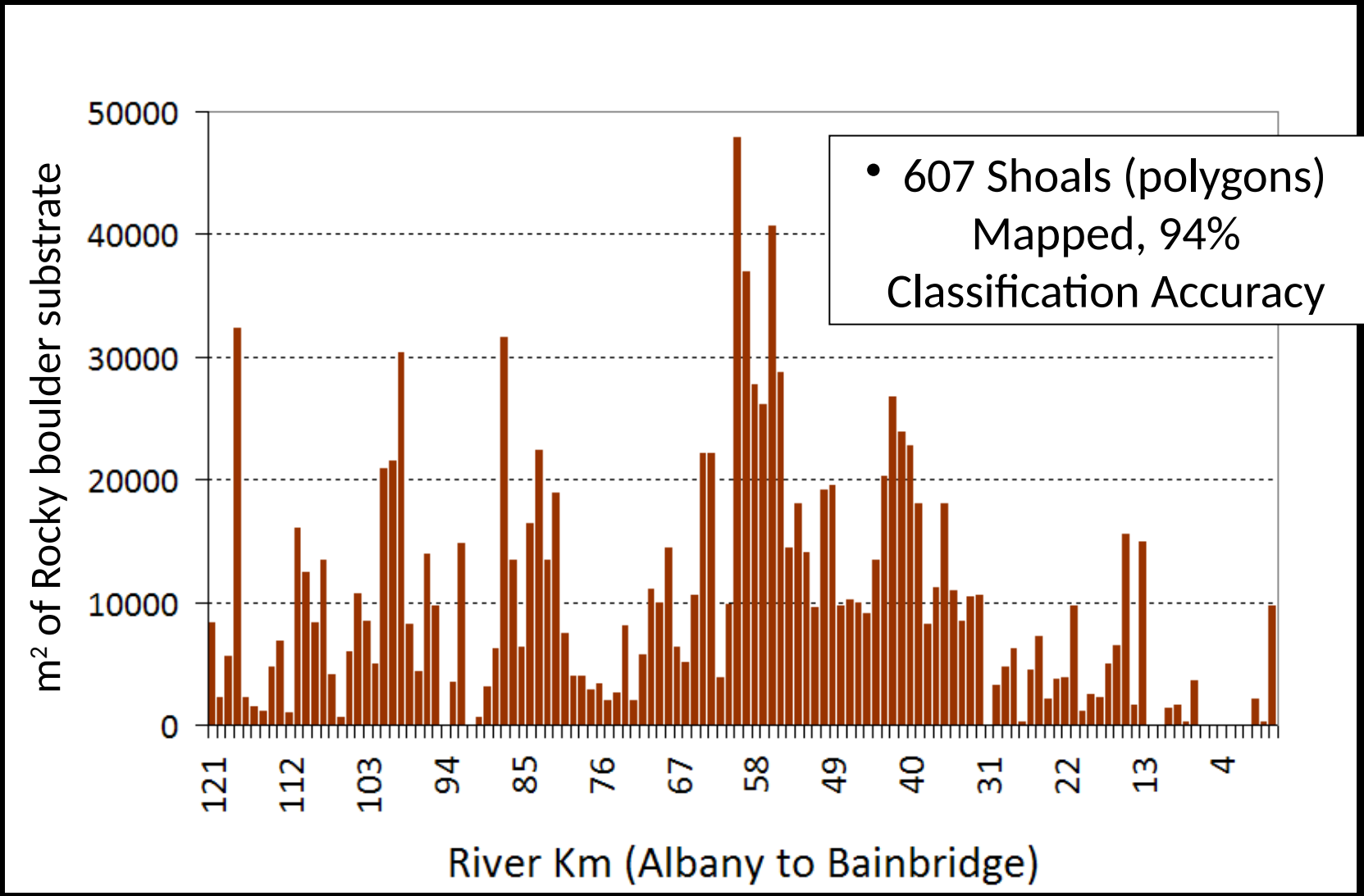
Shoal Bass
*Micropterus cataractae*

# Applications 1. Describe and Quantify Habitat

Extract data by river km segments to describe spatial trends



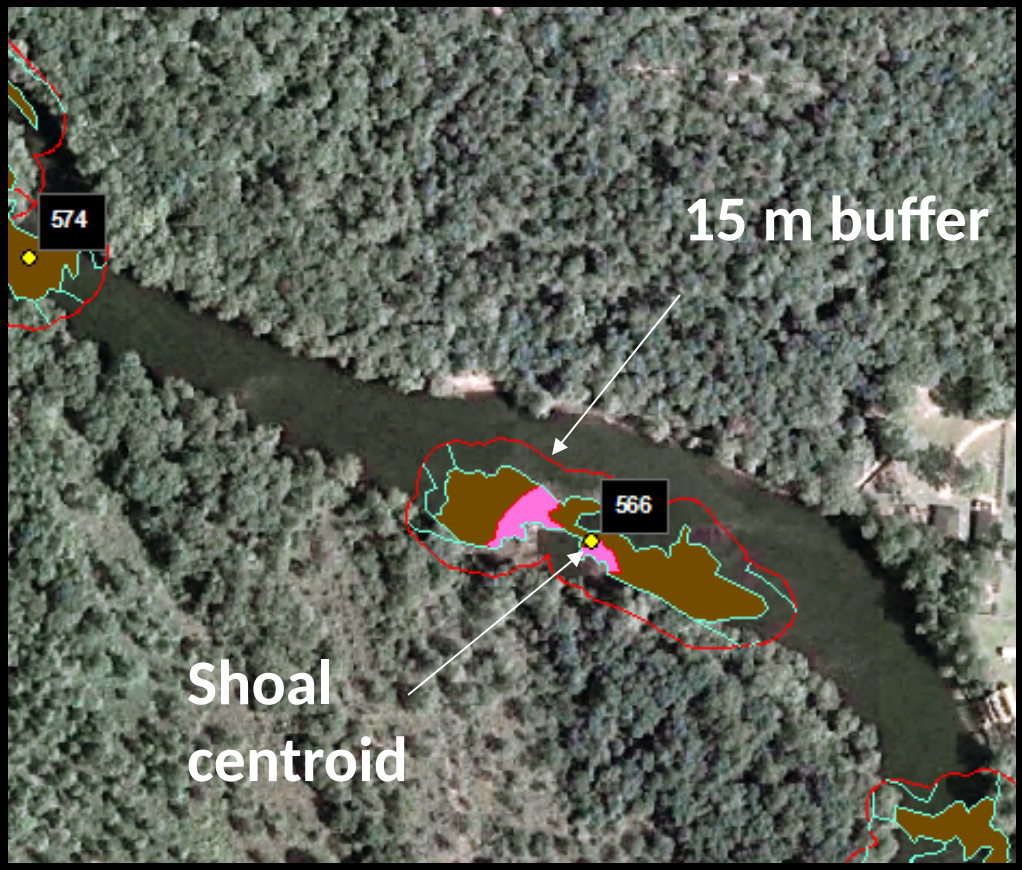
# Shoal Distribution and Abundance



# Digging Deeper- Habitat Analysis

## Patch Variables

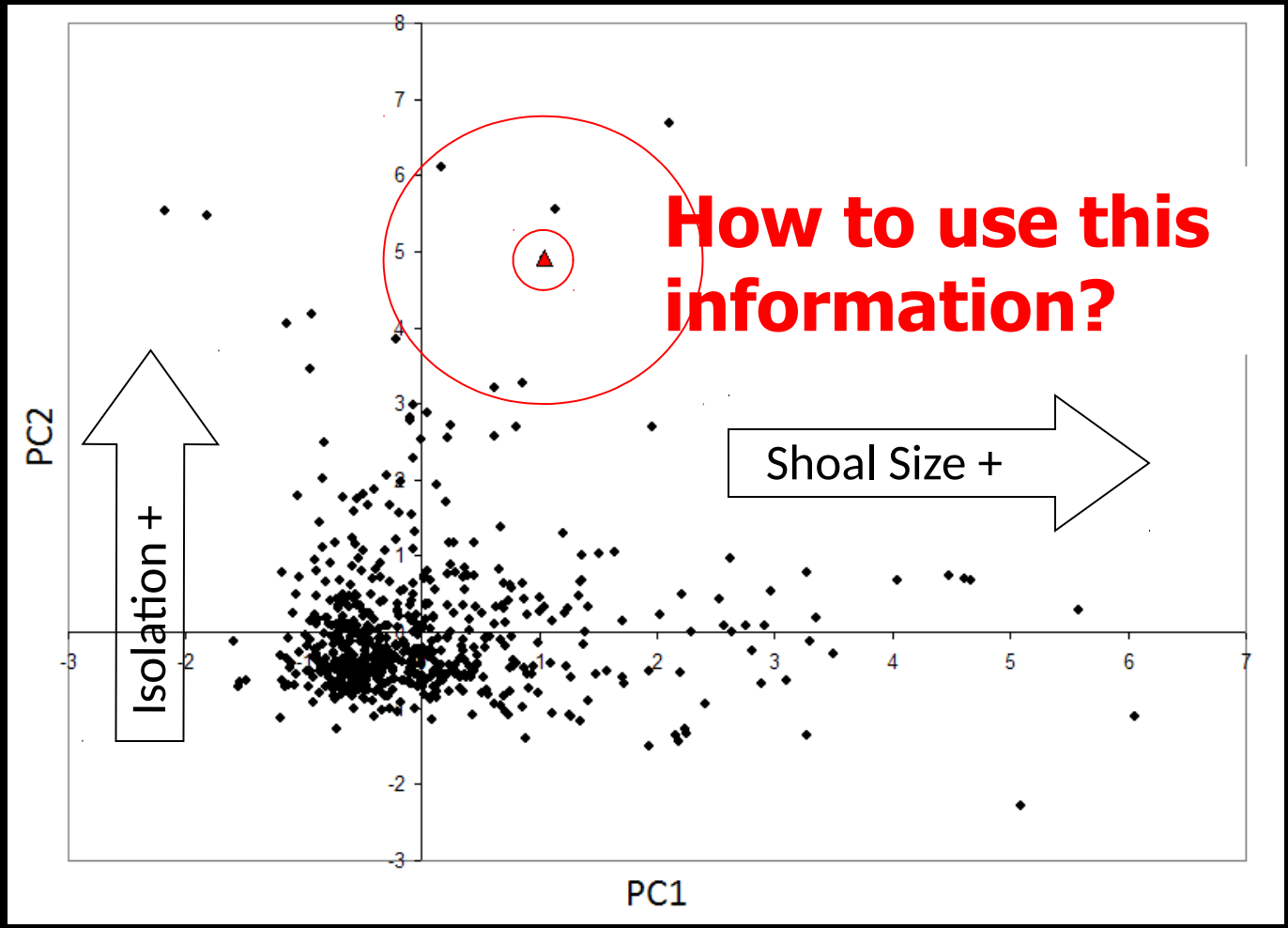
- Size (area)
- Shape (perimeter)
- Edge:Area ratio
- Edge within 15 m buffer
- % Exposed
- Distance to nearest shoal
- Size (area) of nearest shoal



# PCA - Patch Variables

**How do shoals differ from one another?**

**Does shoal 566 exhibit unique patch-level characteristics?**



# Applications 2. Animal-Habitat Investigations

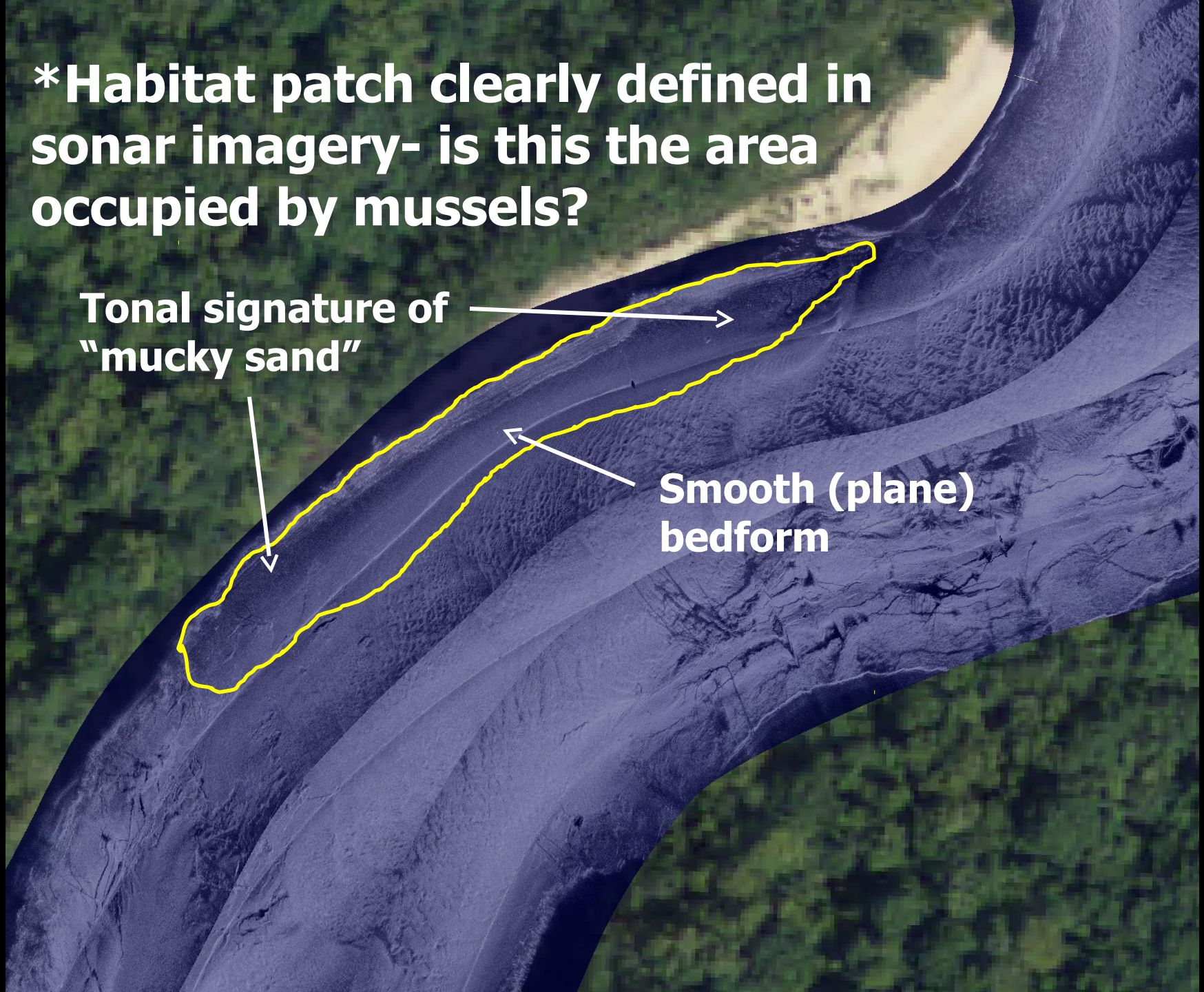
- **How much (mussel) habitat exists, where located?**
- **How many (mussels) exist, where located?**

**Project involved- Reuben Smit, MS student Auburn University**

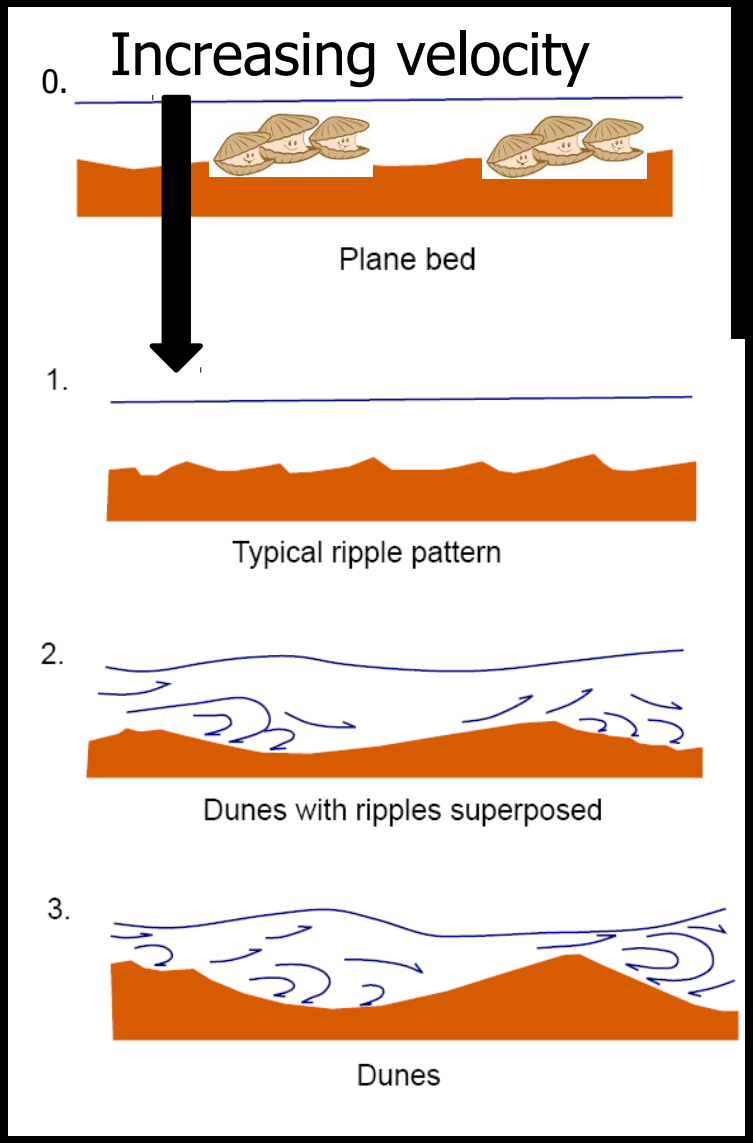
*What to do in an all-sand bed river?*

*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

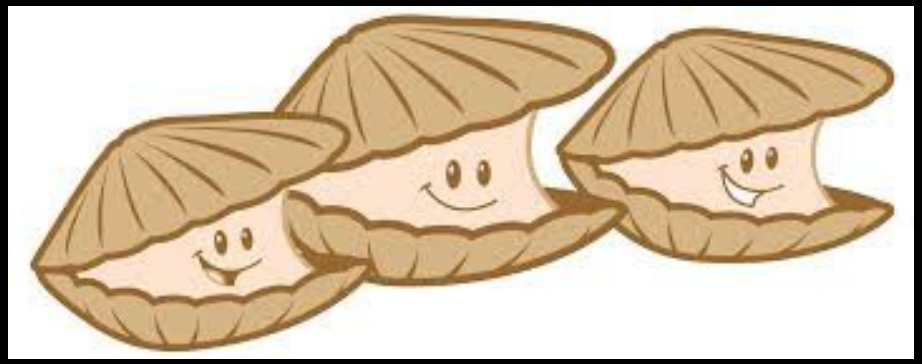



# Bedforms =

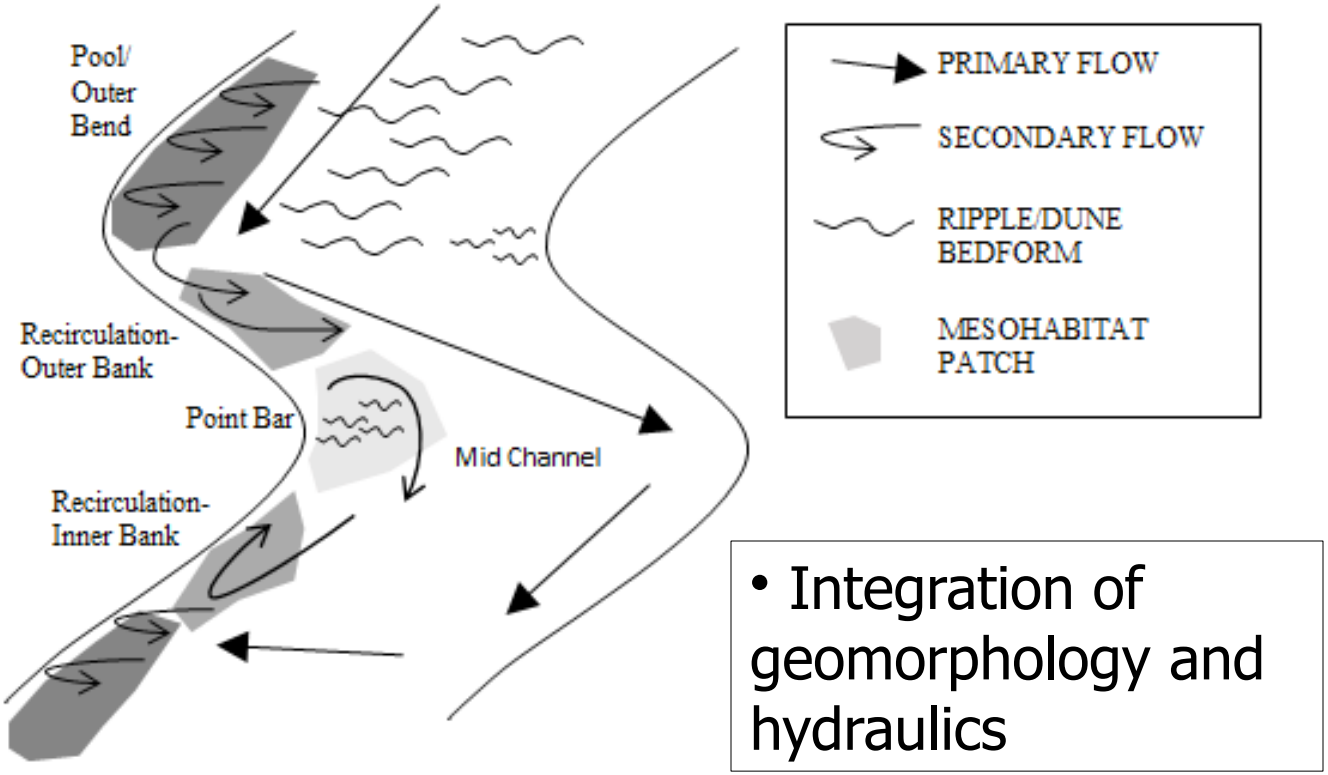
**shear stress X substrate**

**at sediment/water interface**

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



# Meso-scale Habitat Classification Scheme

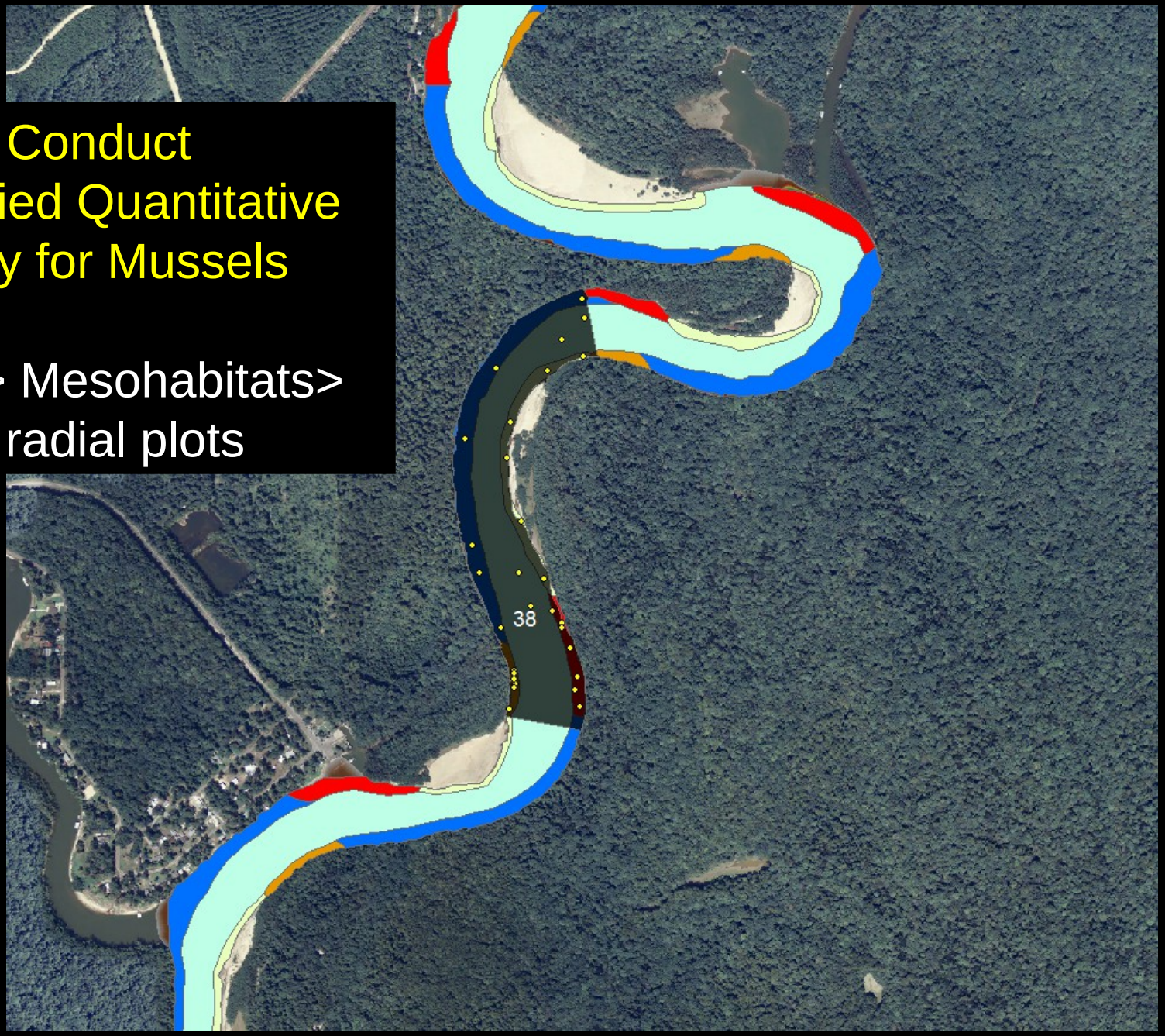



- Integration of geomorphology and hydraulics

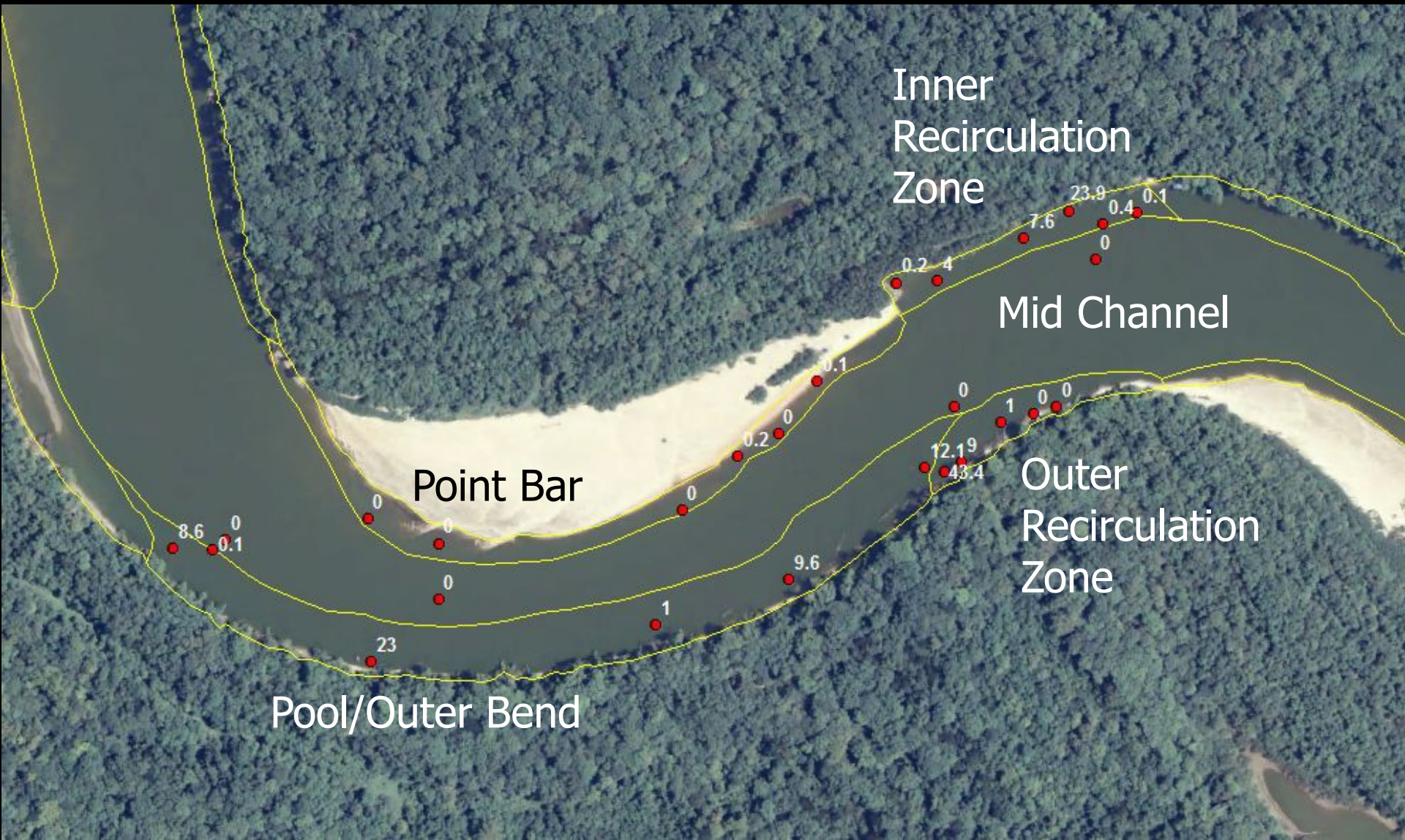
Figure 3. Conceptual illustration of the primary and secondary flow environments around a meander bend and associated habitat units used for this classification. Adapted from Garcia et al 2012.

Map> Conduct Stratified Quantitative Survey for Mussels

Sites> Mesohabitats> 10m2 radial plots

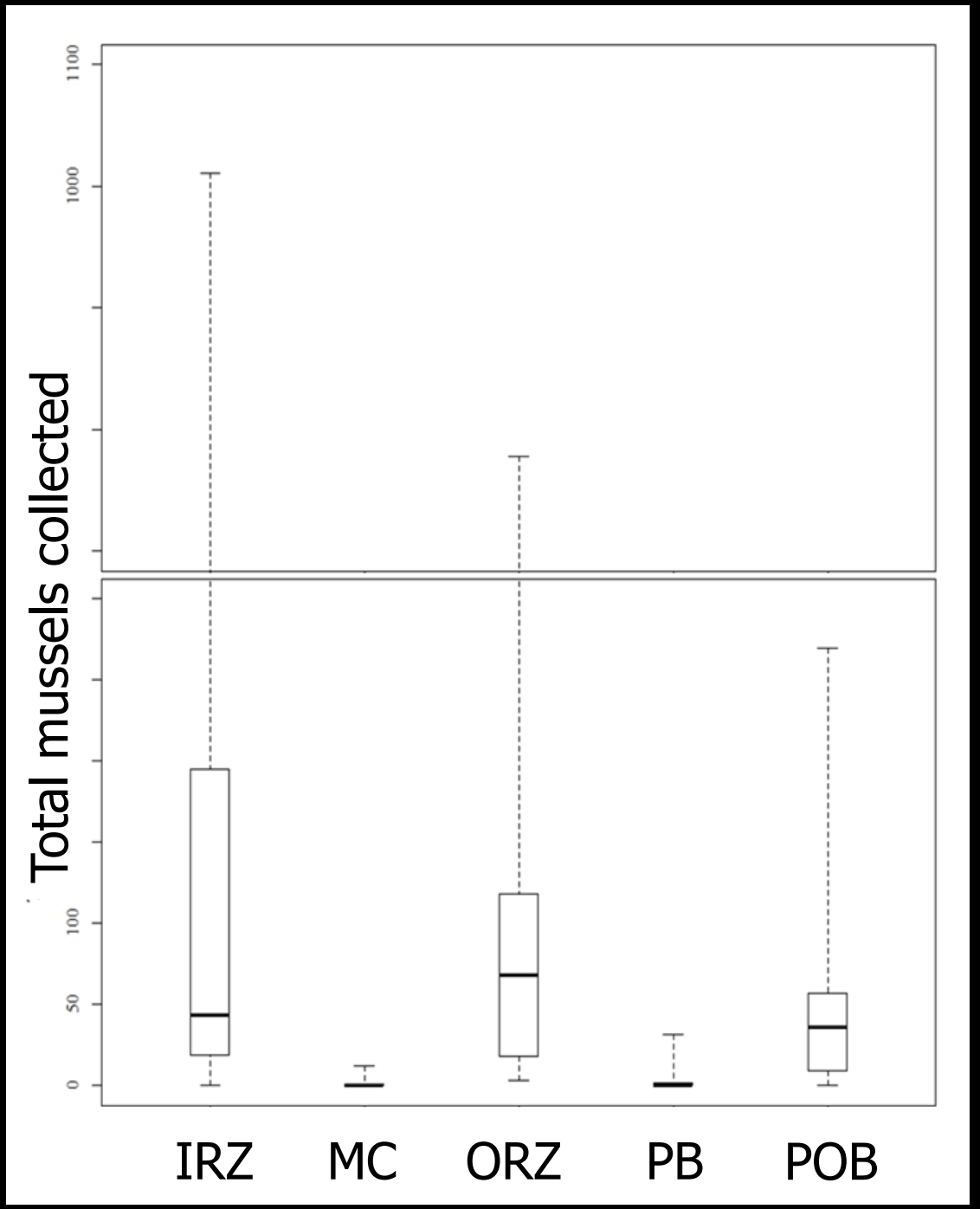


# Density of *A. neislerii* ($m^2$)



# 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

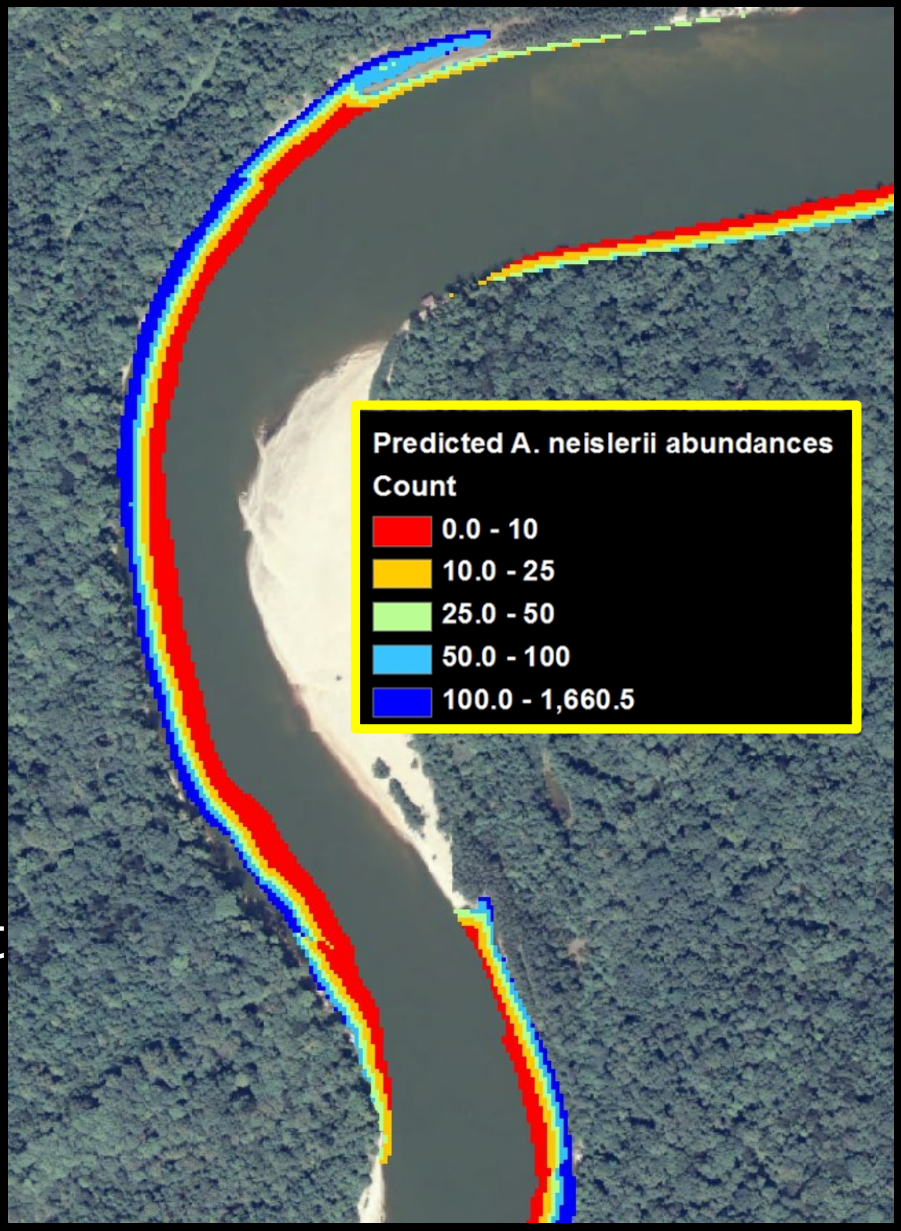
Multiple logistic regression

2) Abundance

GLM w/neg binomial dist

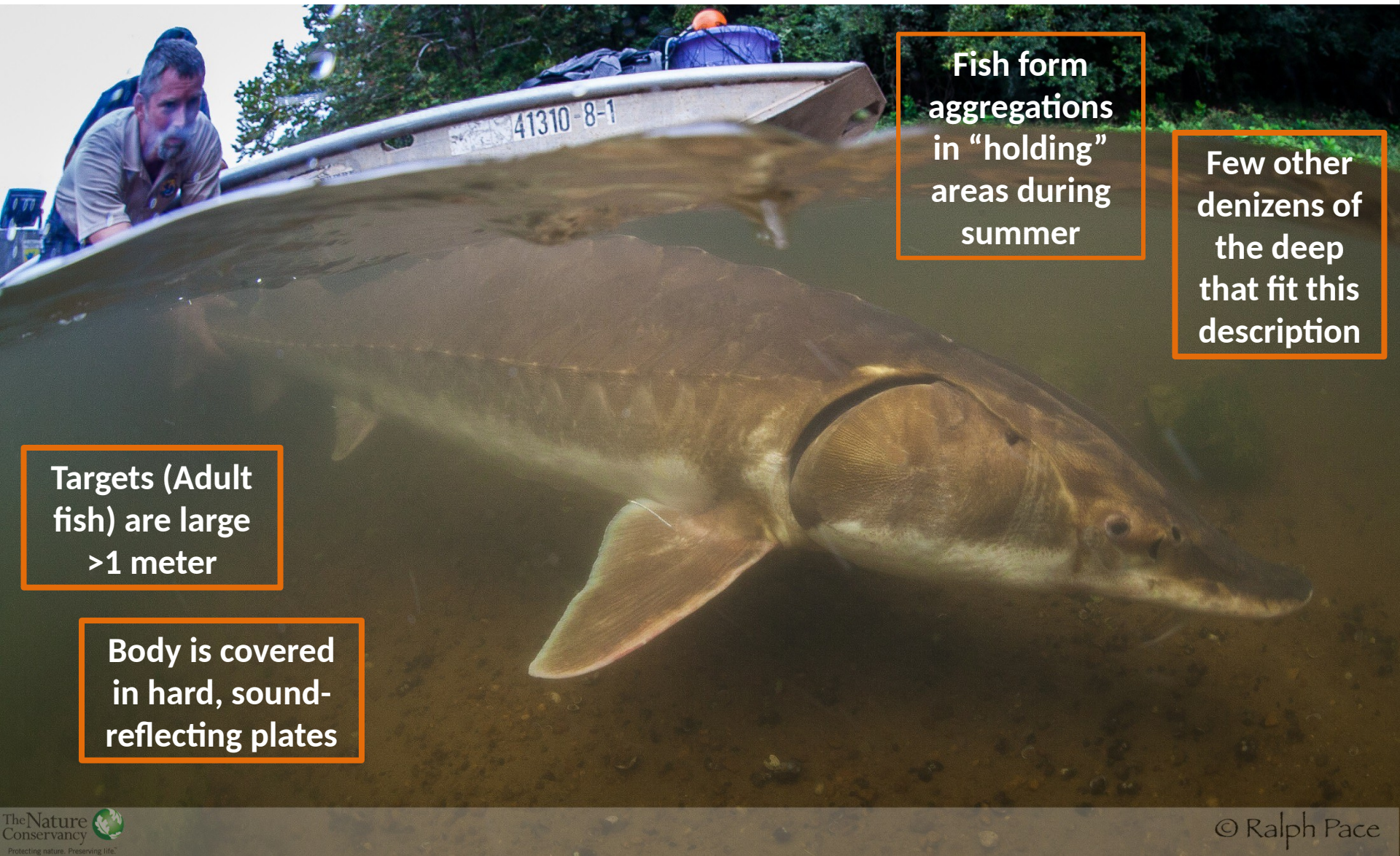
Habitat Variables

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

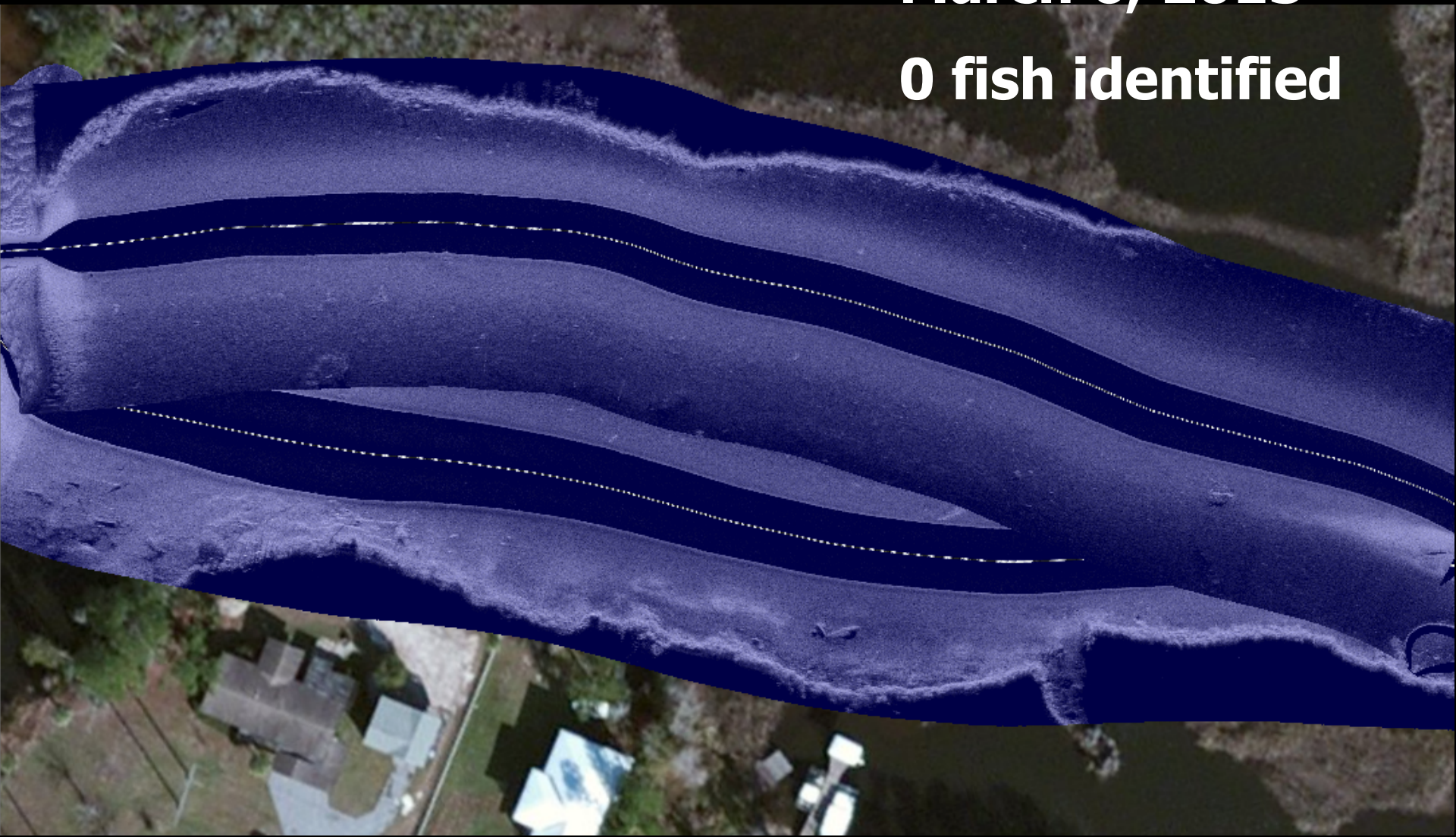


# Applications 4. Detecting some types of fuana

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



# Detecting Sturgeon in a Holding Area



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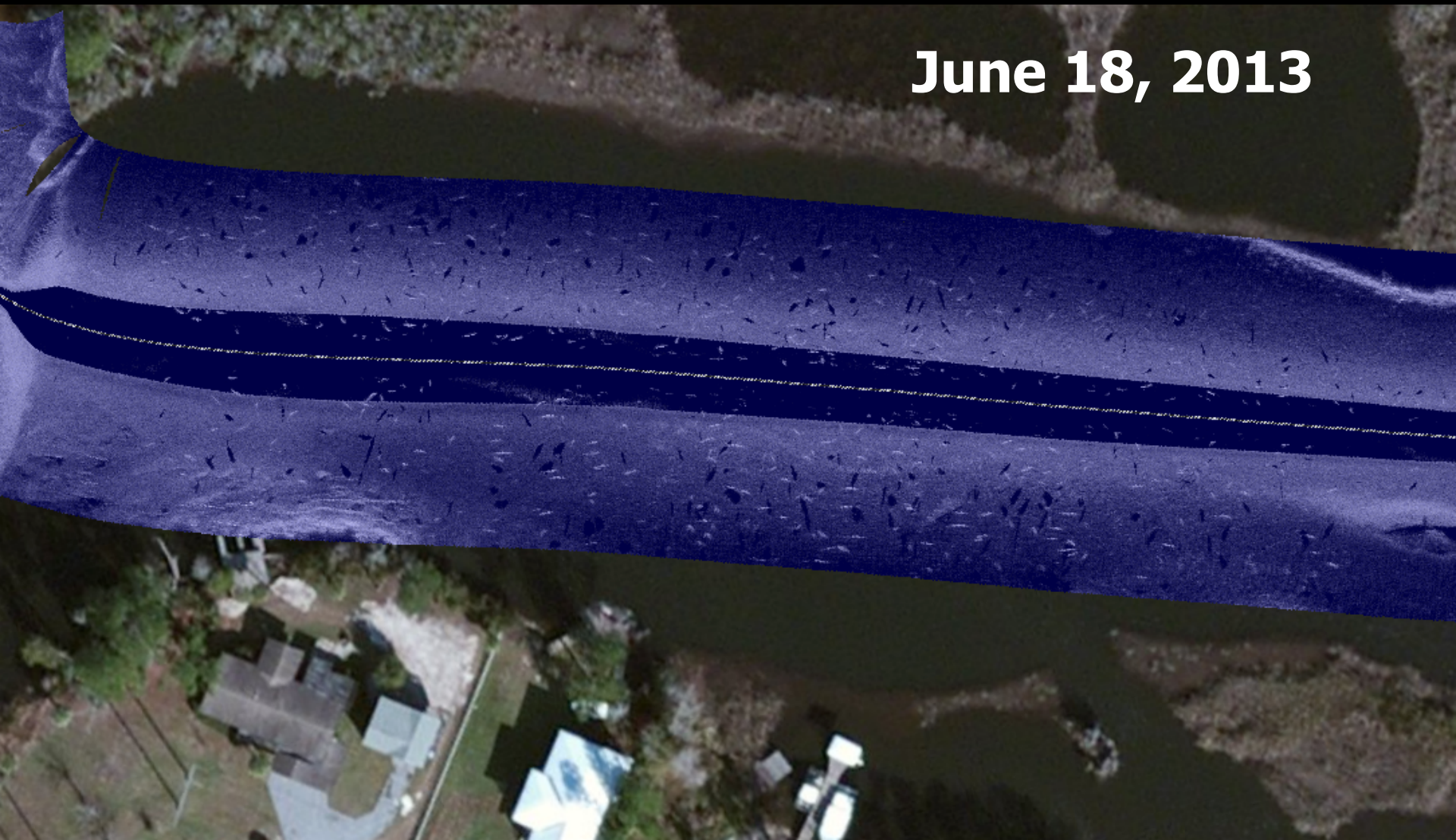
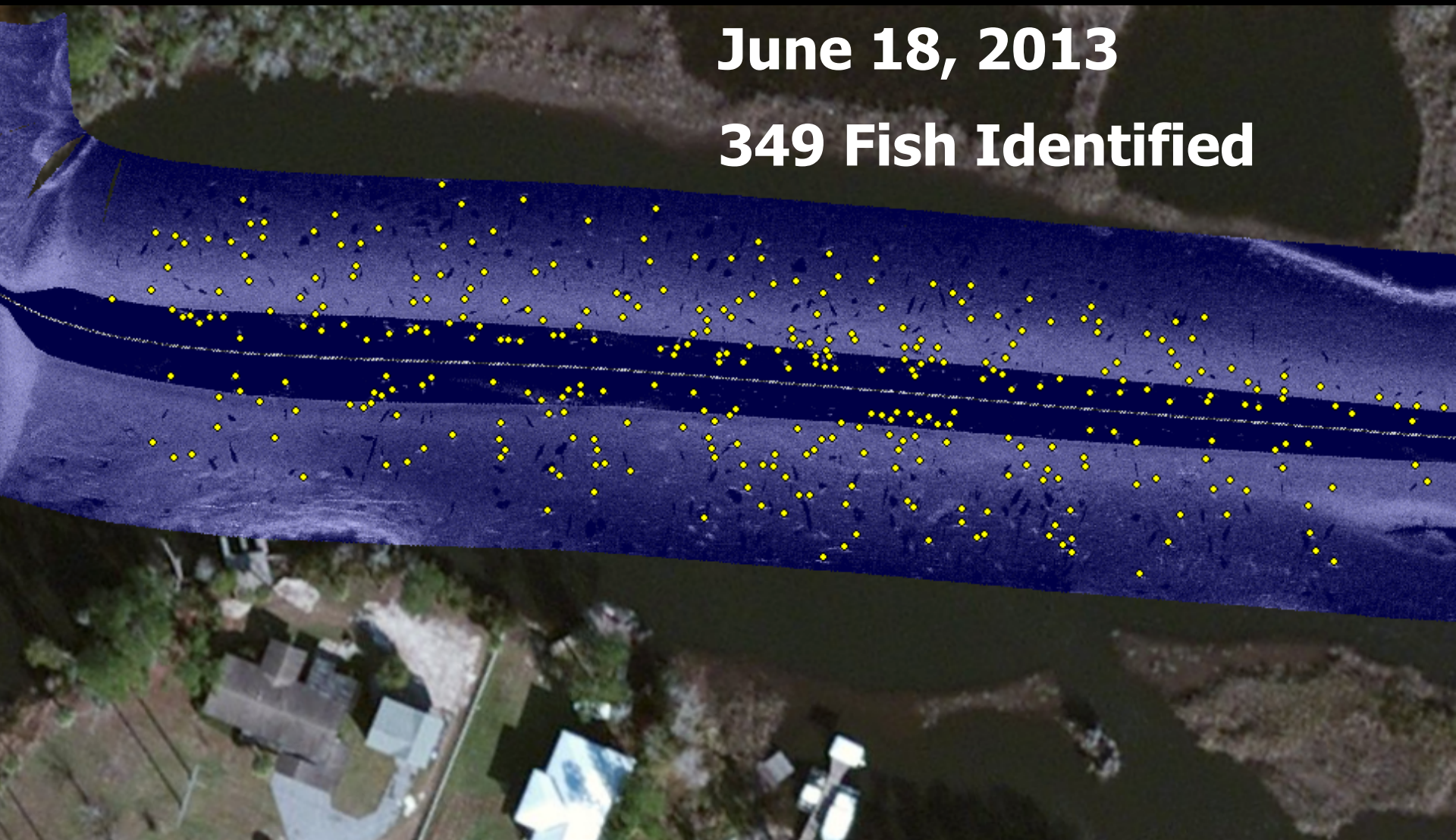
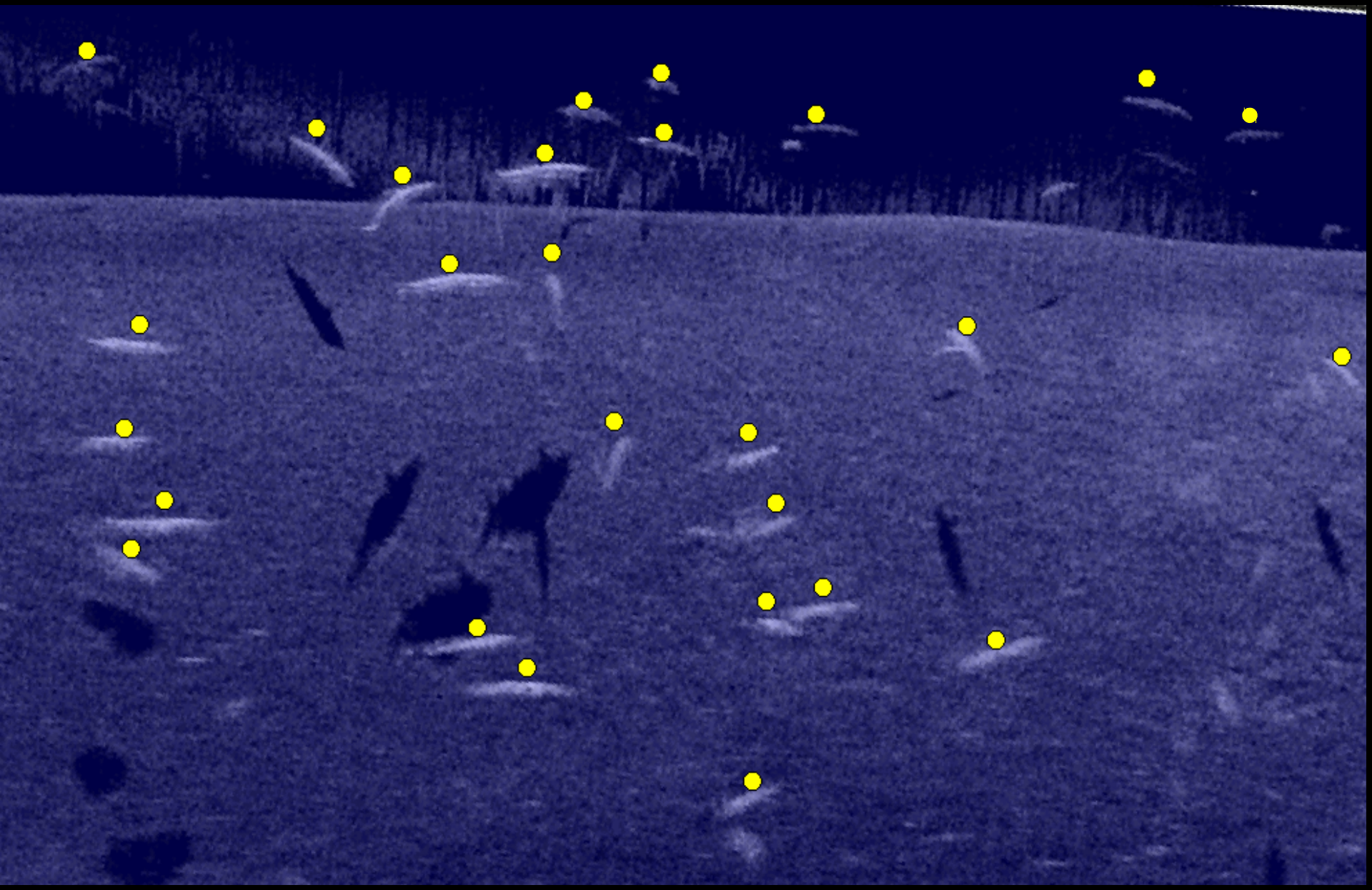


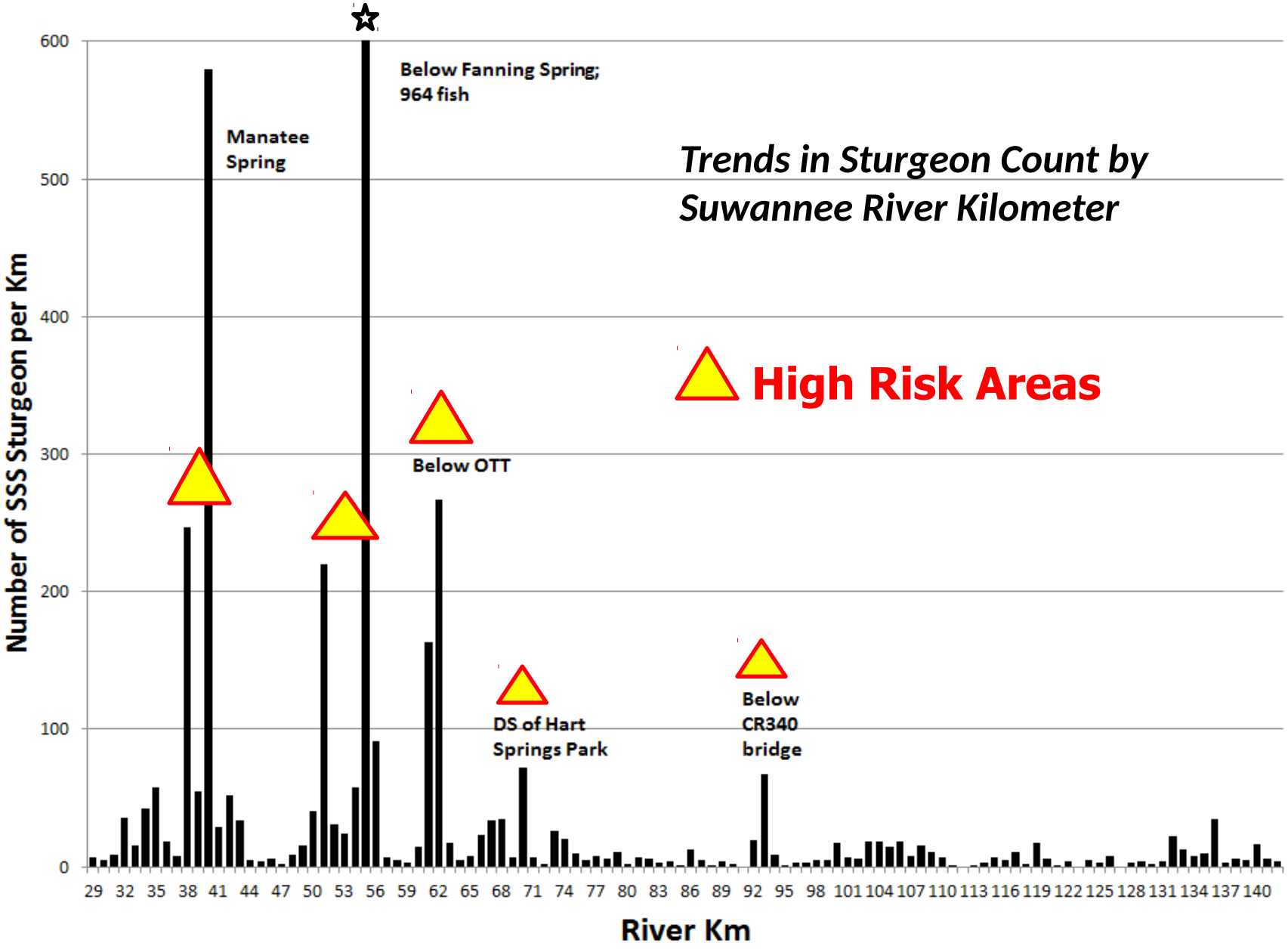
# Fish can be counted and associated directly with habitat



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



# Enhancing Public Safety using SSS data

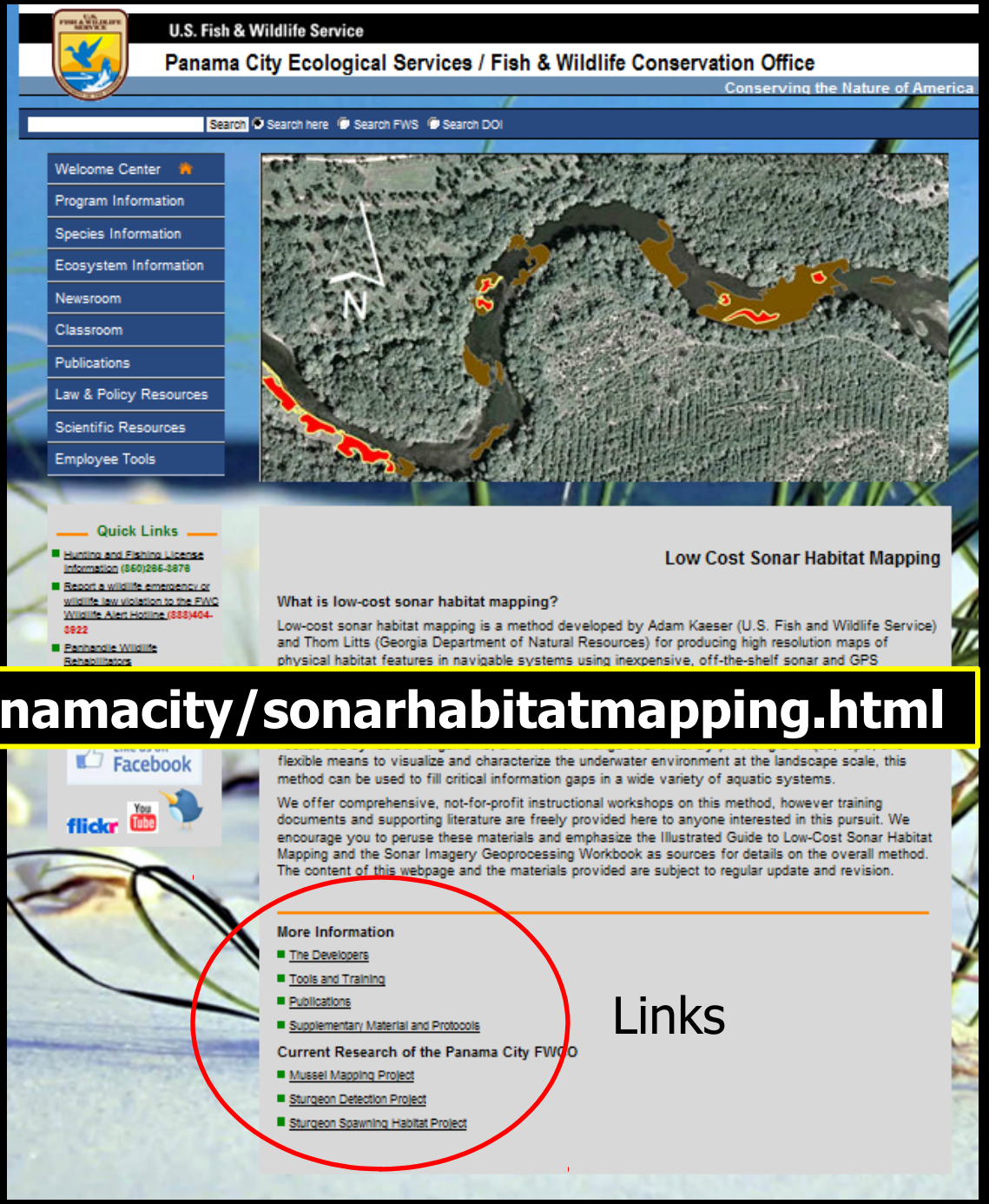


# For More Information

- Google Search- "sonar habitat mapping"

**http://www.fws.gov/panamacity/sonarhabitatmapping.html**

- Research Gate for research manuscripts



# Training Workshops


***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


GEORGIA
DEPARTMENT OF NATURAL RESOURCES
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Fisheries Information & Technology Section

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