

# ASSESSING SPAWNING HABITAT FOR LAKE STURGEON *ACIPENSER FULVESCENS* BELOW TVA DAMS ON THE UPPER TENNESSEE RIVER

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HYDRO  
RESEARCH  
FOUNDATION



# Outline

- Aquatic Habitat
- Sturgeon Biology
- Lake Sturgeon in Tennessee
- Research Objectives and Methods
- Management Applications



# Landscape vs Riverscape Ecology



National Land Cover Database: 30 x 30 m resolution  
land cover/vegetation satellite imagery

# Aquatic Habitat Assessments





# Human Alterations to Aquatic Habitat



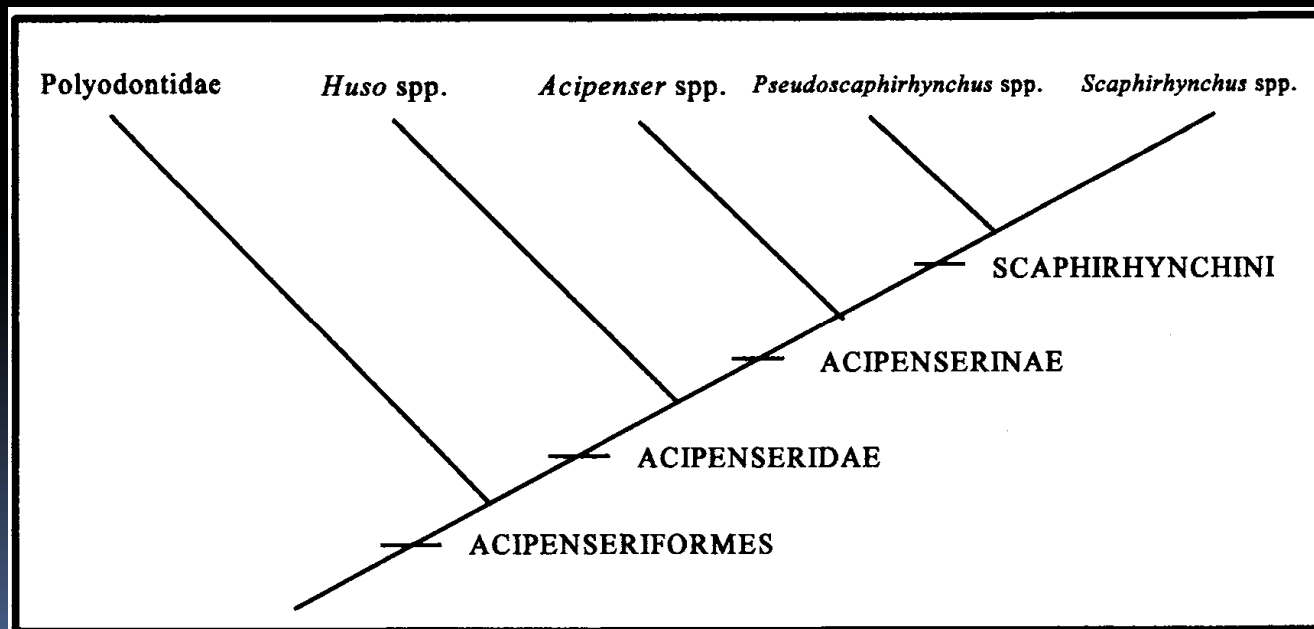
- Dam construction
  - ▣ Few rivers remain free-flowing, unregulated
- Dams serve useful purposes for humans
  - ▣ Flood control and mitigation
  - ▣ Water storage
  - ▣ Power generation
  - ▣ Recreation

# Human Alteration to Aquatic Habitat

- Impacts of dams on river systems:
  - Alter downstream flux of water and sediment
  - Change water temperatures
  - Create barriers to upstream-downstream movement of organisms and nutrients

# Acipenseriformes

- **Sturgeons and Paddlefish**
- **Only found in the Northern Hemisphere**
- **Widely dispersed by Cretaceous >66 mya**



Birstein 1993; Choudhury and Dick 1998; Billard and Lecointre  
2001



# Sturgeon Characteristics

- **Cartilagenous skeleton**
- **Notochord retained through adulthood**
- **Heterocercal tail**
- **Bony scutes**
- **Freshwater spawners, require migration for spawning**

“Living fossils”

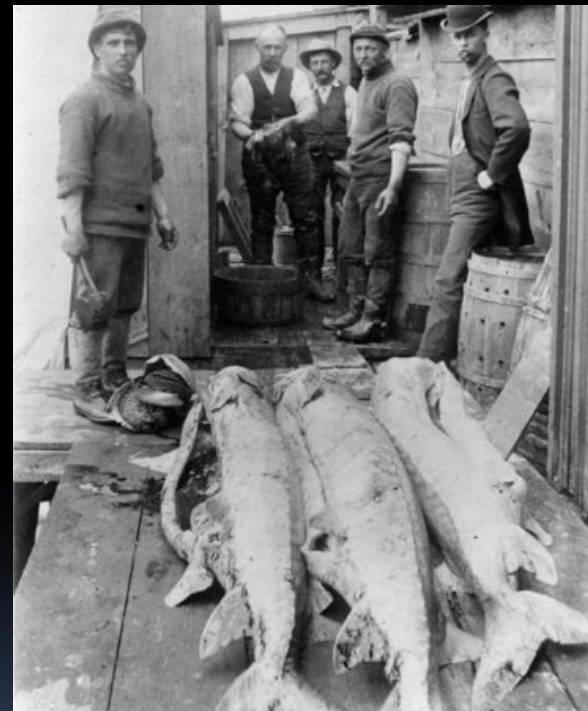


Scott and Crossman 1973;  
Birstein 1993



# Threats to Sturgeon

- **Over-fishing**
  - **Late 19<sup>th</sup> C.**
- **Industrial Fishing**
  - **Atlantic**
  - **Shortnose**
  - **White**
  - **Lake**



Birstein 1993; Saffron 2004; Secor et al. 2002; Smith 1985; Rich & Tursi 2012

# Threats to Sturgeon

- **Habitat Degradation**
  - **Loss of essential habitat**
    - **Migration, spawning**
    - **Feeding**
  - **Alabama**
  - **Green**
  - **Pallid**



Adams et al. 2007; Billard & Lecointre 2001; Mayden and Kuhajda 1996; Rider & Hartfield 2007

# Lake Sturgeon in Tennessee

- 1961 – last scientific reports of Lake Sturgeon from the Upper Tennessee River
- 1998 – formation of the Tennessee Lake Sturgeon Reintroduction Working Group
- 2000 – first release of Lake Sturgeon juveniles into French Broad River
- 2015 - >150,000 Lake Sturgeon juveniles have been released into the UTR, >300 recaptured

SOUTHEASTERN  
LAKE STURGEON  
WORKING GROUP



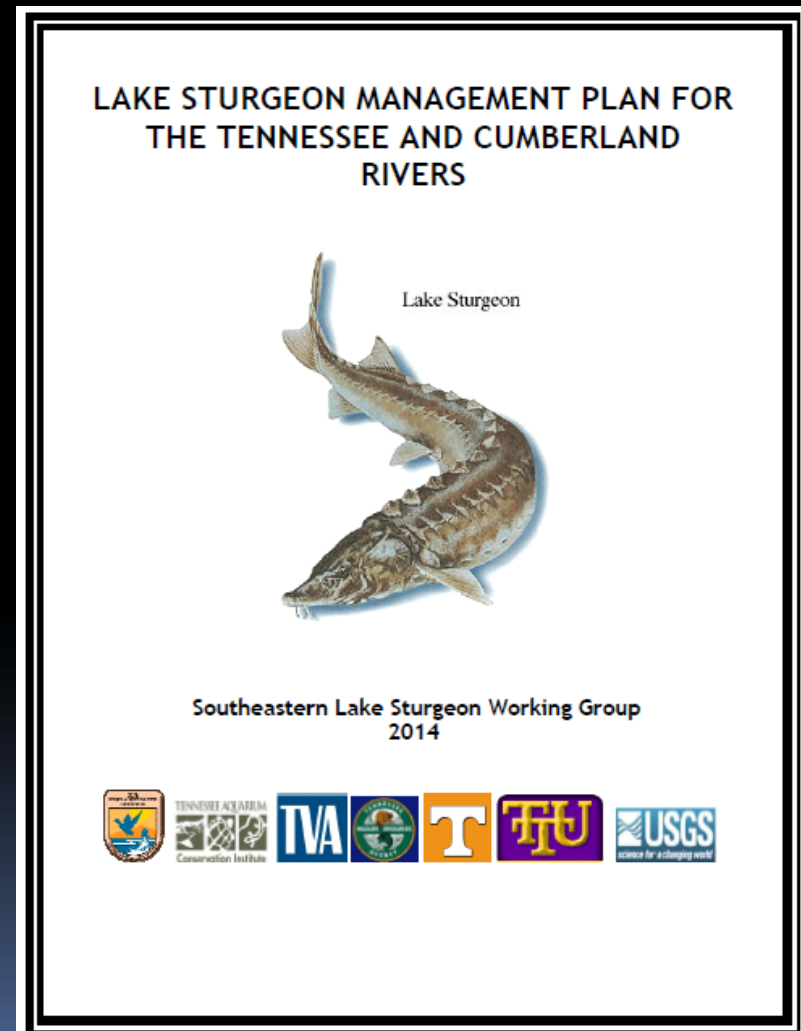


# Lake Sturgeon Reintroduction

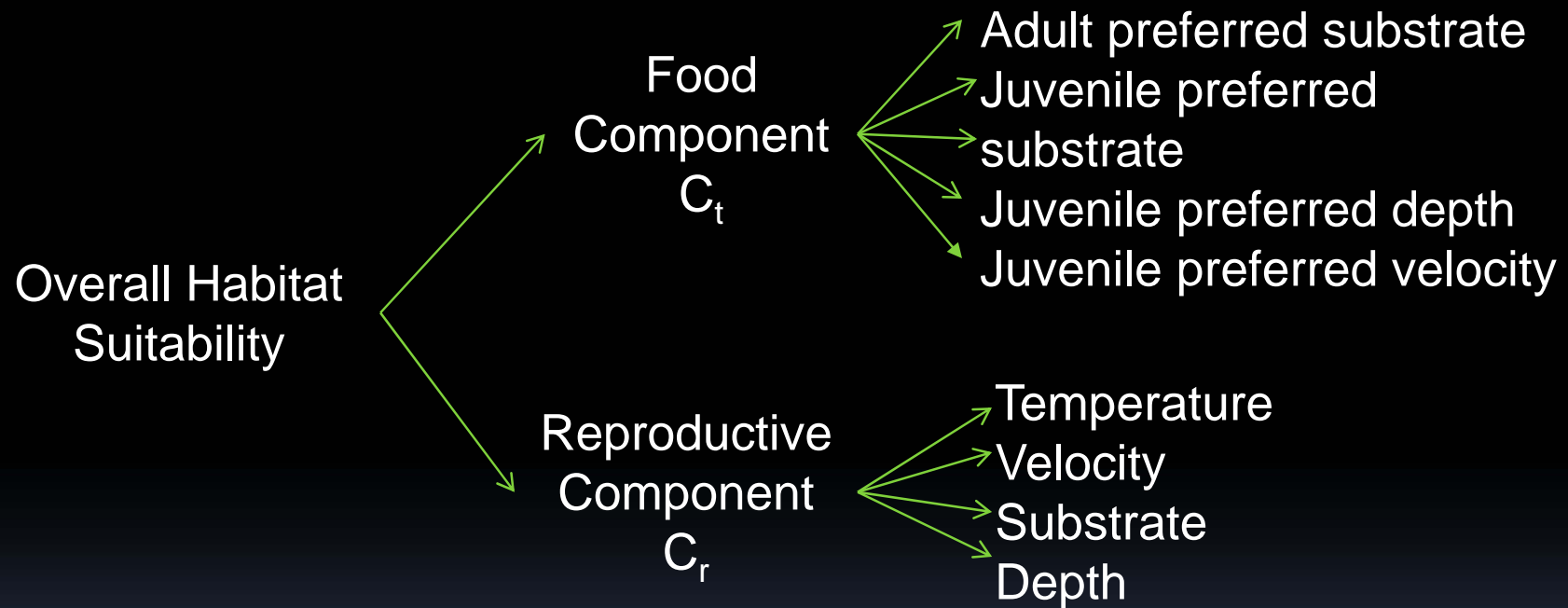


# Lake Sturgeon Reintroduction

- **SLSWG Management Plan**
  - Management goals and research needs
- **Assess the availability of physical habitat for Lake Sturgeon in the UTR**
- **Identify areas of critical habitat utilized by reintroduced Lake Sturgeon**



# Lake Sturgeon HSM

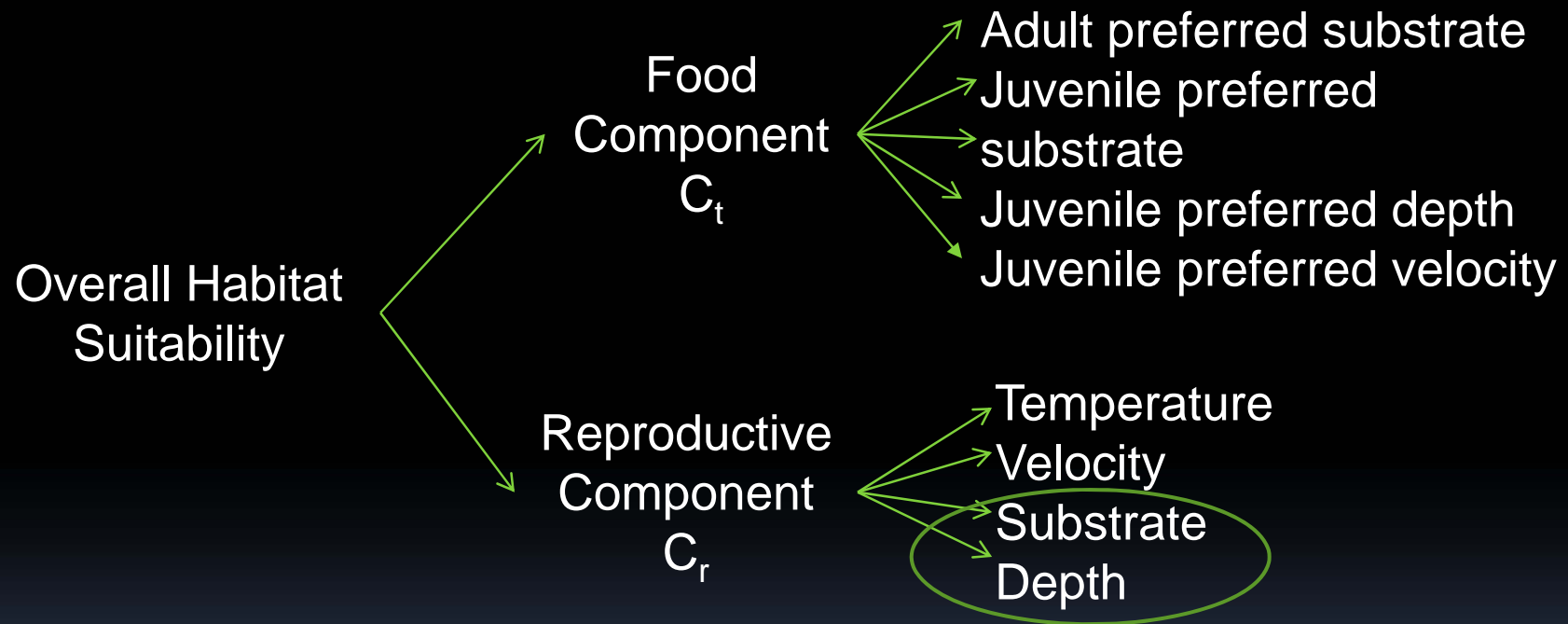




# Research Objectives

- 1. Assess the quantity of suitable spawning habitat for Lake Sturgeon below TVA hydroelectric dams on the UTR**
2. Identify habitat variables best describing Lake Sturgeon summer refuge
3. Assess rates of bioaccumulation of anthropogenic contaminants in Lake Sturgeon

# Lake Sturgeon HSM



# Methods

- **Assess the quantity of suitable spawning habitat for Lake Sturgeon below TVA hydroelectric dams on the UTR**
  - **Dams = migration terminals**
  - **Suitable spawning substrate: coarse rocky, clean interstitial spaces**
- 1. Side scan sonar mapping with Humminbird© consumer grade boat-mounted sonar**
- 2. Image classification**





**Lake Sturgeon spawning aggregation, Wolf River, Wisconsin, March 2015**

# Side Scan Sonar Procedure



Dr. Adam Kaeser – U.S. Fish and Wildlife Service  
Thomas Litts – GA Dept. of Natural Resources

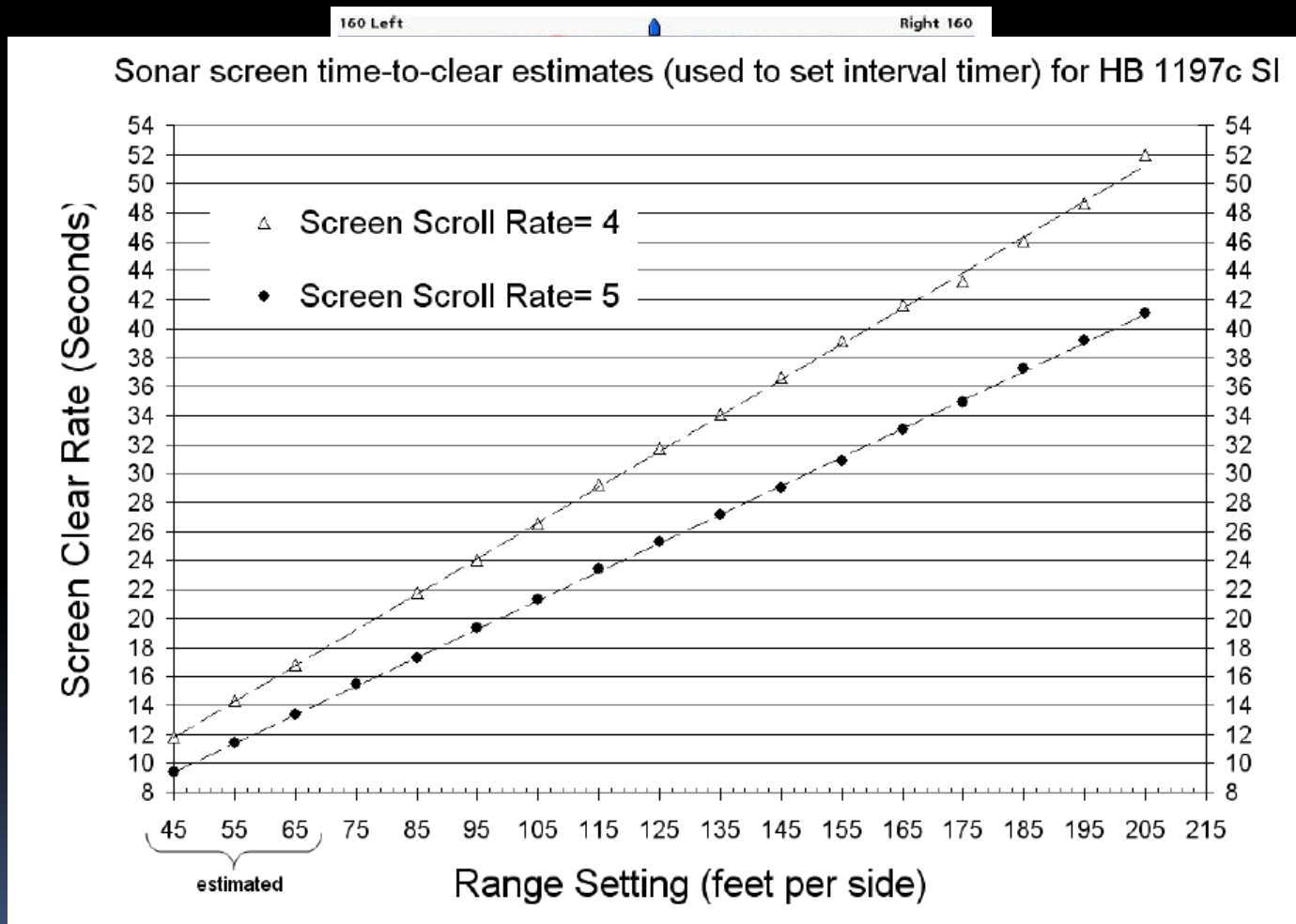
<http://www.fws.gov/panamacity/sonartools.html>

# Side Scan Sonar Procedure

1. Collect consecutive, overlapping sonar images
2. Clean imagery
3. Georeference imagery, create control point network
4. Generate spatially-explicit mosaic of imagery



# Side Scan Sonar Procedure



<b>5.6</b>	<b>12.8</b>	N 31.55052° W 084.14604°	1:47:27 PM 12/06/10	<b>54.7</b>
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# Side Scan Sonar Procedure

Table

trpkts\_edit


FID	Shape *	No	Latitude	Longitude	Depth
901	Point	977	35.841591	-84.013023	13.26
902	Point	978	35.841598	-84.012987	13.03
903	Point	979	35.841605	-84.012951	13.28
904	Point	980	35.841613	-84.012915	13.43
905	Point	981	35.841613	-84.01287	13.45
906	Point	982	35.841613	-84.012826	13.14
907	Point	983	35.841613	-84.012781	13.05
908	Point	984	35.841613	-84.012727	12.63
909	Point	985	35.841613	-84.012673	12.27
910	Point	986	35.841627	-84.012637	11.91

1 | (288 out of 1193 Selected)

wpts\_raw\_proj | trpkts\_edit

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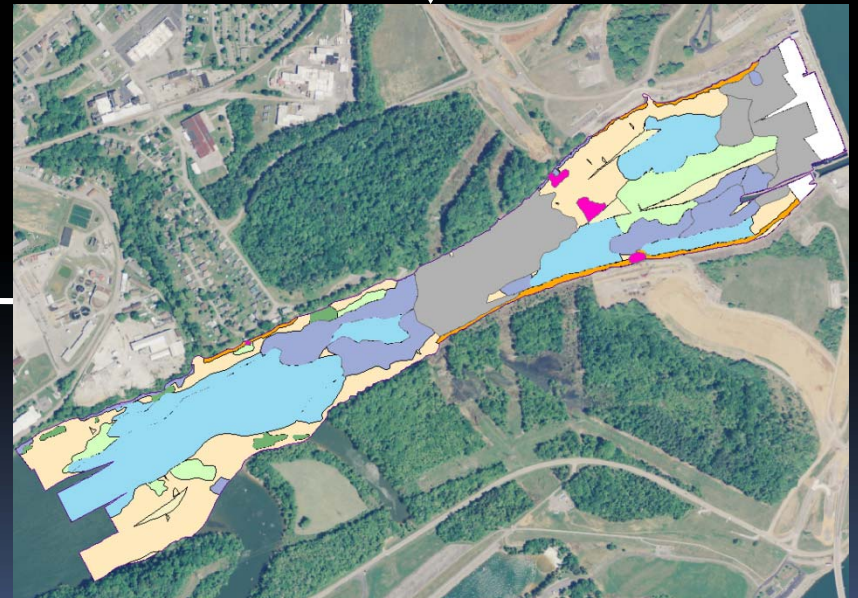
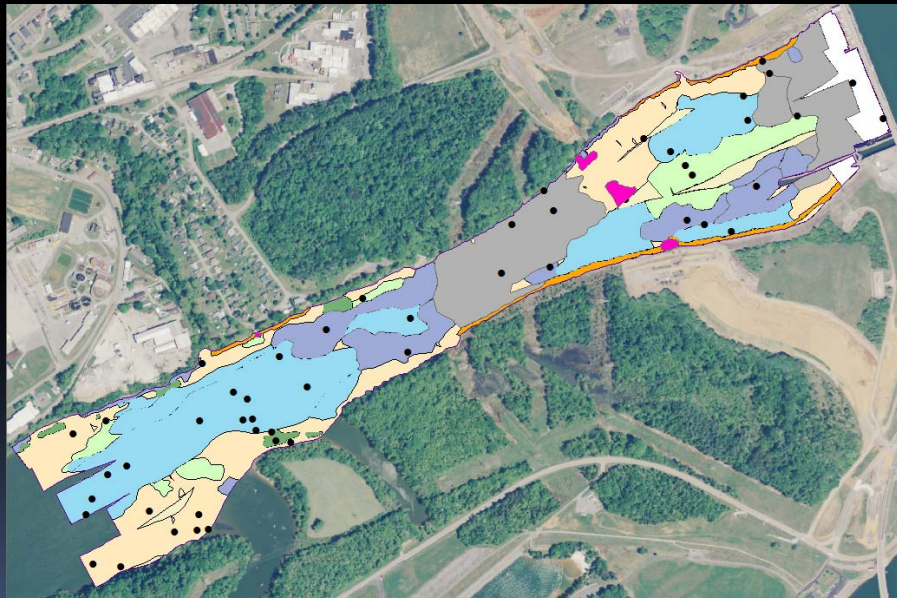
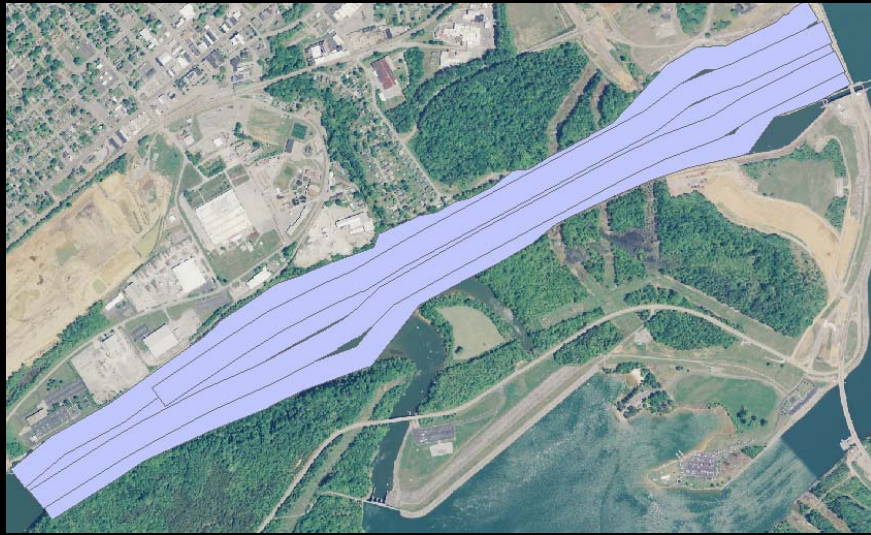
- Layers
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    - trpkts\_edit
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    - trpkts\_seg2
    - trpkts\_seg3
    - trpkts\_seg4
    - wpts\_seg1
    - wpts\_seg2
    - wpts\_seg3
    - wpts\_seg4



ArcToolbox

- ArcToolbox
  - 3D Analyst Tools
  - Analysis Tools
  - Cartography Tools
  - Conversion Tools
  - Data Interoperability 1
  - Data Management To
  - Data Comparison
  - Database
  - Distributed Geoda
  - Domains
  - Feature Class
  - Features
  - Fields
  - File Geodatabase
  - General
  - Generalization
  - Graph
  - Indexes
  - Joins
  - Layers and Table \
  - Package
  - Projections and Tr
  - Feature
    - Batch Proje
    - Project
  - Raster
    - Flip
    - Mirror

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Sonar image collection and processing steps





**Side-scan sonar survey with Humminbird © fish-finder unit**

# Analysis

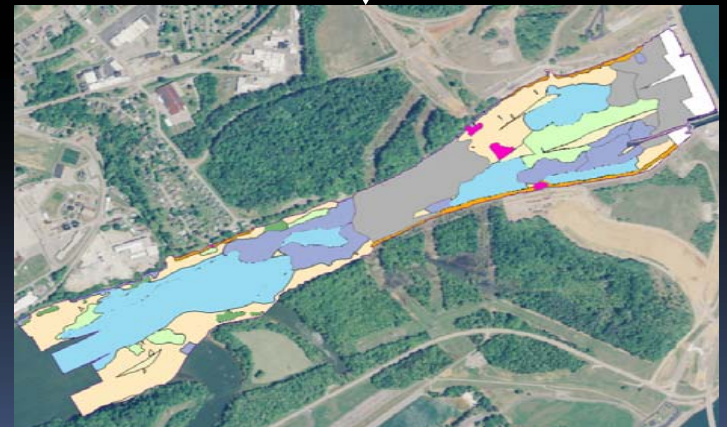
- Lake Sturgeon are lithophilic spawners
- Best spawning substrate =
  - Coarse, clean, rocky substrate
- Generate areal estimates of total available spawning substrate below 4 TVA dams
- Assess accuracy of image classification methods





# Analysis

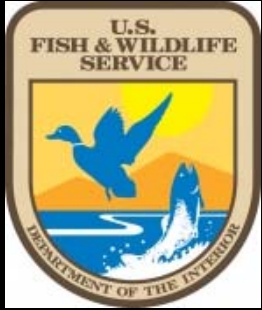
- **Supervised image classification – ArcGIS 10.3**
  - Maximum likelihood
  - Use real imagery of substrate to delineate training set
- **Compare results of supervised classification to heads-up digitizing, interpolation**
  - Areal measurements of substrate patches
  - Error matrices



# Management Applications

- Evaluate extent of suitable spawning habitat below 4 upstream TVA dams on the Tennessee River
  - Compare results: sonar image interpretations v. interpolation of habitat types from video imagery v. 'heads-up' digitizing
- Identify optimal locations to construct artificial spawning reefs under various budgets

# Acknowledgements



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Southeastern Lake Sturgeon Working Group



Wisconsin Department of Natural Resources

Dr. Adam Kaeser and Thom Litts



Alford Lab – FWF – UTK



SOUTHEASTERN  
LAKE STURGEON  
WORKING GROUP



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# Questions?

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