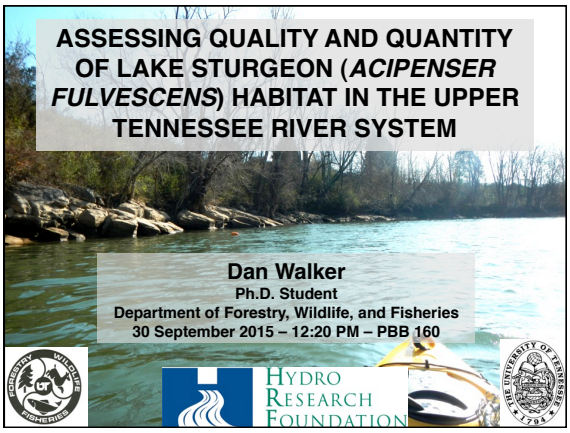

Outline

- Introduction & Research Justification
- Research Objectives
- Proposed Methods
- References

THE ALFORD LAB
THE UNIVERSITY OF TENNESSEE KNOXVILLE
ECOLOGY AND MANAGEMENT OF FRESHWATER FISHES

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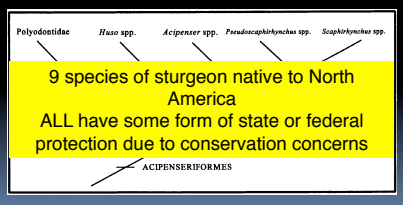
Acipenseriformes

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



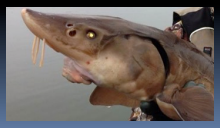
Birstein 1993; Choudhury and Dick 1998; Billard and Lecointre 2001

3

Sturgeon Characteristics

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

"Living fossils"



Scott and Crossman 1973; Birstein 1993

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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

SLSWG 2015

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Research Justification

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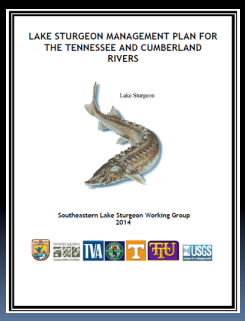
Research Justification

- **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**



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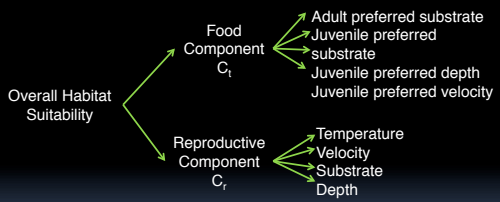
Lake Sturgeon HSM



Threader et al. 1998

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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

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Methods – Study 1

- **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**

LaHaye et al. 1992; Auer 1996; Threader et al. 1998; Bruch and Binkowski 2002; Kaeser and Litts 2010; Flowers and Hightower 2013; Kaeser et al. 2013; Thiem et al. 2013

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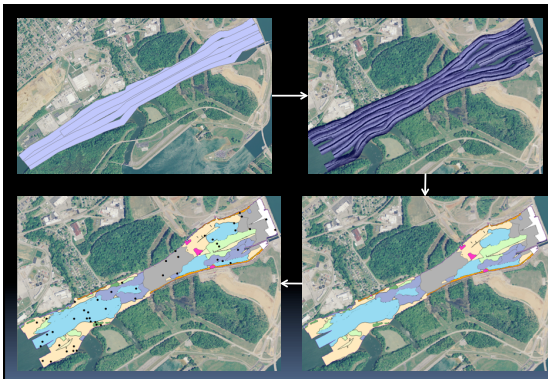
Lake Sturgeon spawning aggregation, Wolf River, Wisconsin, March 2015

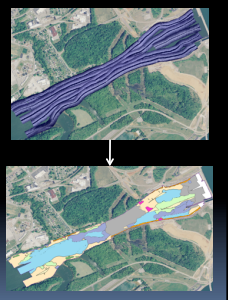
Side-scan sonar survey with Humminbird © fish-finder unit



Sonar image collection and processing steps

Analysis – Study 1

- 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
  - Areal measurements of substrate patches
  - Error matrices
- Optimization
  - Artificial spawning reefs



Threader et al. 1998; ESRI 2015

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Methods – Study 2

- Identify habitat variables best describing Lake Sturgeon summer refuge
  - Foraging habitat

1. Track Lake Sturgeon implanted with acoustic tags
2. Map reservoir(s) with Biosonics Echosounder ©
   - Substrate, bathymetry
3. Random stratified sampling – BAS, benthic macroinvertebrates & water chemistry

Sulak et al. 2009; Peck 2010; Fernandes et al. 2010; Munday et al. 2013; Robertson et al. 2013

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Lake Sturgeon tracking, June-July 2014

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Analysis – Study 2

Statistical Methods

1. Classify habitat
   - Sturgeon present/absent
2. Parametric analysis
   - Logistic regression
3. Nonparametric analysis
   - Classification tree

Objective: Identify what variables distinguish Lake Sturgeon habitat

Habitat Variables

- Lake Sturgeon presence/absence

- Substrate occurrence/distribution
- Depth
- Temperature
- D.O.
- Conductivity
- Turbidity
- pH
- BMI species richness
- BMI species abundance
- BMI diversity (Shannon's H')
- BMI biomass

Breiman et al. 1984; White and Liu 1997; King and Zeng 2001 ; Lander 2013

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Picture Credits

- Todd Amacker, FWF, UTK
- Christina Saidak, FWF, UTK
- Mark Cantrell, USFWS
- Todd Stailey, TNACI

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Alford Lab – FWF – UTK

Questions?

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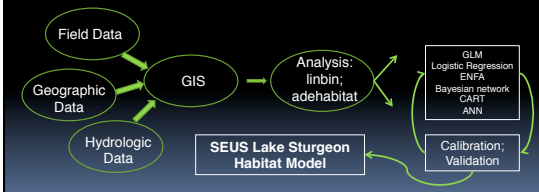
Supplemental slides

Research Outcomes

- **Quantitative comparison of suitability of UTR TVA hydroelectric dam tailwaters for Lake Sturgeon spawning**
- **A Southeast-specific Lake Sturgeon habitat model**



Guisan and Zimmermann 2000

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Spawning Habitat Classification

Substrate	Characterization	Spawning Habitat Score
Bedrock	> 75% exposed bedrock	3
Bedrock Fine	≤ 25% bedrock + fine matrix	2
Boulder	Discernible individual particles > 25 cm diameter	5
Cobble/Gravel	Particles 25 > x > 1 cm diameter	4
Riprap	Artificially placed bank stabilzing rock	5
Fine	Sand, silt, clay particles ≤2 mm	1
Unsure Fine	Unsure, particles ≤2 mm	
Unsure Coarse	Unsure, particles >2 mm	
Biological	Algae, aquatic macrophytes, zebra mussel reefs	0

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Methods – Study 3

- **Assess rates of bioaccumulation of anthropogenic contaminants in Lake Sturgeon**
  - **Heavy metals: negatively impact reproductive success, juvenile survival**

1. **Collect sediment and BMI samples from Lake Sturgeon core habitat areas**
2. **Collect Lake Sturgeon (and proxy species) tissue**
3. **Test samples for heavy metal loading, assess rates of bioaccumulation**

Toth et al. 1997; Hutchinson 1998; Alam et al. 2000; Kruse and Scarnecchia 2002; Vardy et al. 2011

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Methods – Study 3

Detection	Analyte
> 200 mg/kg	Aluminum, Calcium, Iron, Magnesium, Manganese, Potassium, TOC
Notable, >DL	Arsenic, Cadmium, Chromium, Copper, Lead, Mercury, Strontium, Zinc
Below Detection Limit	Antimony, Molybdenum, Selenium, Silver

Sediment heavy metal loading, Lake Sturgeon summer habitat (n = 5) – July 2014

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Methods – Study 3

- **Study 2 – delineate areas of summer foraging habitat**
- **Stratified random sampling design – sediment and bugs**
- **Yearly monitoring efforts – Lake Sturgeon and Blue Catfish (*Ictalurus furcatus*) tissues**

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Methods – Study 3

- Traditional methods to test heavy metal presence, loading in sediment, BMI, Blue Catfish
  - Cold vapor atomic flourescence spectrometry, Inductively coupled plasma – mass spectrometry
- Newer nonlethal contaminant testing methods
  - qPCR > biomarkers > metallothioneins
  - Combustion-AAS with ~1 mL blood samples

Liang et al. 1994; Montaser et al. 1997; Cizdziel et al. 2001; Leermakers et al. 2005; Reyes et al. 2009; Veldhoen et al. 2014

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Analysis – Study 3

Statistical Analyses

- Multiple regression
  - Factors determining Lake Sturgeon/proxy contaminant concentrations
- Cluster analysis/PCA
  - Patterns in contaminant distribution

Variables

- Lake Sturgeon contaminant concentrations

- Location of sample
- Heavy metal contaminant concentrations (ppm)
- Substrate particle occurrence – sediment
- Channel Catfish contaminant concentrations
- Channel Catfish length (TL and SL mm), weight (g), condition factor
- Lake Sturgeon length (TL and SL mm), weight (g), condition factor
- BMI contaminant concentration

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