
Quantifying Ecological Function in Restored Bottomland Hardwood Forests
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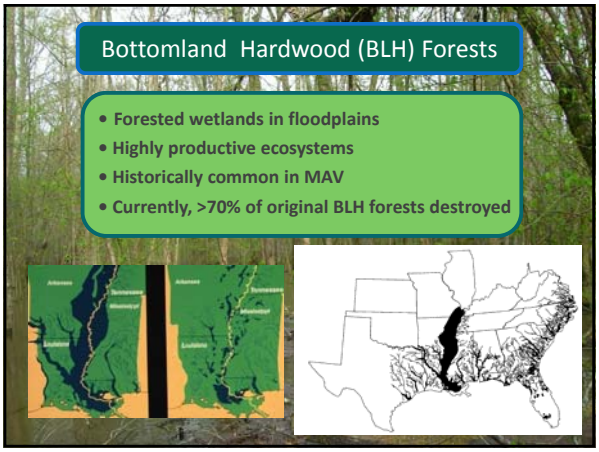
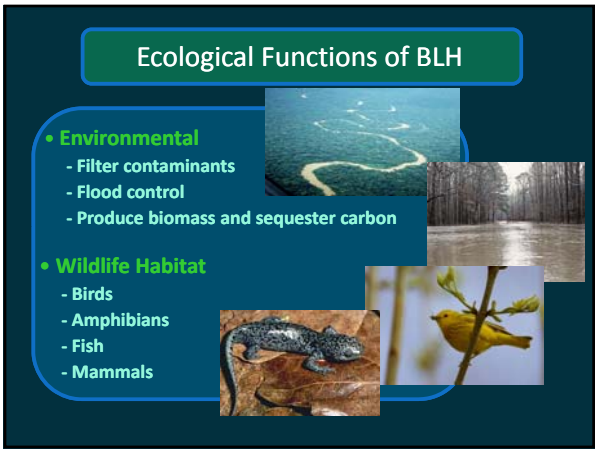

Bottomland Hardwood (BLH) Forests
• Forested wetlands in floodplains
• Highly productive ecosystems
• Historically common in MAV
• Currently, >70% of original BLH forests destroyed


Ecological Functions of BLH
• Environmental
- Filter contaminants
- Flood control
- Produce biomass and sequester carbon
• Wildlife Habitat
- Birds
- Amphibians
- Fish
- Mammals

Restoration

- Wetlands Reserve Program (WRP)
  - Established under 1990 farm bill by USDA NRCS
  - Voluntary program for landowners
  - Retires marginal agricultural land from production
  - Tree replanting
  - Currently 809,440 ha nationwide
  - $227,631,300 in 2007 alone

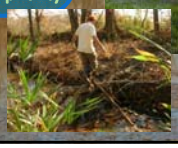
NRCS Natural Resources Conservation Service

- Tennessee
  - Began restoration under WRP in 1994
  - Currently 13,541 ha enrolled in TN
  - >90% HBL

Restored 2004

Monitoring

- Currently no monitoring protocol for WRP
- Important to ensure restoration goals are reached
- Primary goal of WRP: ecological function of HBL
  - Vegetation and birds are a priority



Bioassessments

Index of Biological Integrity (IBI)

- Ability of site to support balanced community similar to undisturbed sites
- Uses community metrics of several taxa to give summary score
- Example: bird, amphibian and vegetative communities

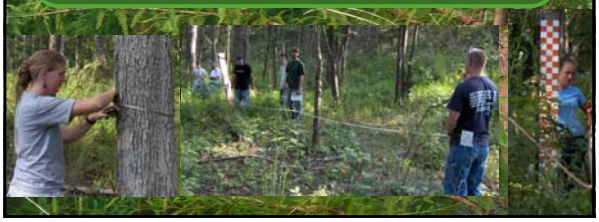
Disadvantage: Requires knowledge of taxa being measured

Habitat Models

Relate vegetative and abiotic characteristics to biological community metrics

Advantage:

Less expertise necessary, greater practical applicability



Goals

Compare abiotic and biotic characteristics of restored sites to reference sites

Develop models for future monitoring ecological restoration in HBL

Objectives

1) To quantify the state of ecological restoration on 17 restored hardwood bottomland sites by comparing biological characteristics with those of 4 reference sites.

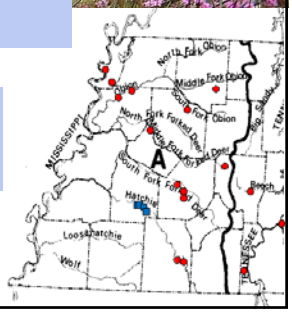
2) To use biological metrics of plant, amphibian and avian communities to develop IBI models that quantify ecological function in hardwood bottomlands.

3) To develop predictive habitat models that relate vegetation and abiotic characteristics of restoration sites to ecological complexity of the amphibian and avian communities.

Study Sites

- 17 Randomly selected restoration sites
  - 1st year of restoration (1987, 1995-2006)
  - Size (7.7 ha to 214.1 ha)
- 4 Reference sites located in Hatchie River watershed
  - Longest unchannelized tributary of Mississippi River

May – Jun 2007
Mar – Aug 2008



Restoration sites
Reference sites

Sampling Plot Placement

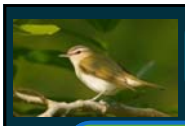
- Two plots at each site
  - minimum 250 m apart
  - Located in highest and lowest contours

--OR--

- One plot at center of site

sites too small for 250 m separation

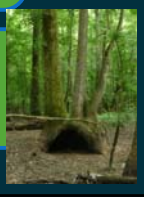
Methods



Biotic Variables

Sampled 3 assemblages:

- Amphibians
- Birds
- Vegetation

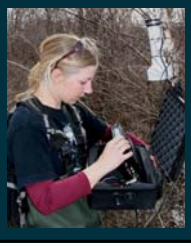


- Compare between restored and reference sites
- Quantify ecological complexity

Amphibian Composition

Sampled 2x per month
Mar – August 2008

1) Call surveys
   - Recording devices at one random plot per site
   - 5-min segments 0.5, 2.5, 4.5 hours after sunset
   - Call index (1 – 3) assigned to each species

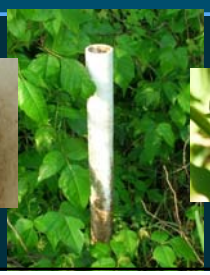


Amphibian Composition

Sampled 2x per month
Mar – August 2008

2) Treefrog Tubes

Two 6.4-cm diameter PVC tubes at each plot



Amphibian Composition

Sampled 2x per month
Mar – August 2008

3) Cover Boards

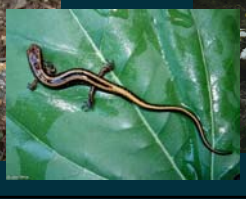
Two pairs of 0.56-m^2 plywood boards placed at each plot

Amphibian Composition

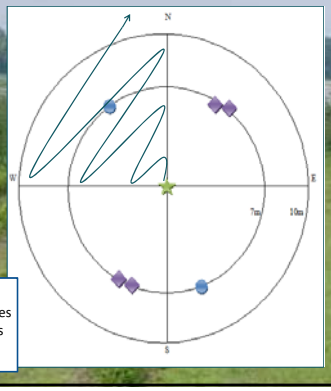
Sampled 2x per month
Mar – August 2008

4) Area Searches

- Two quadrants searched, twice per month
- Searched in zigzag pattern for 15 minutes or until 100 m was reached

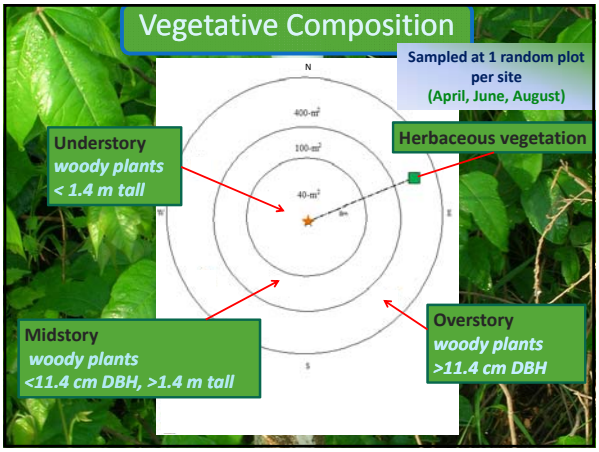


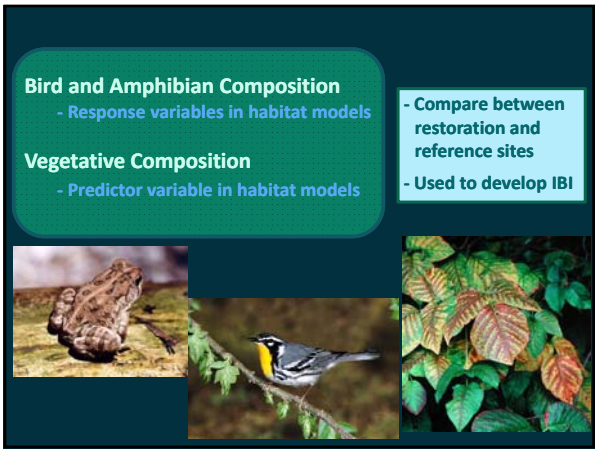
Amphibian Sampling Design

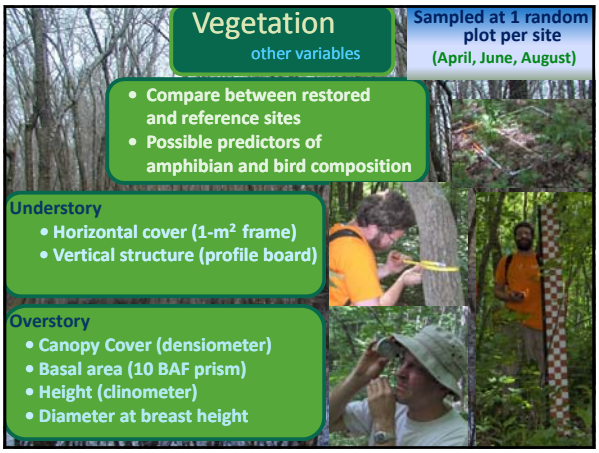


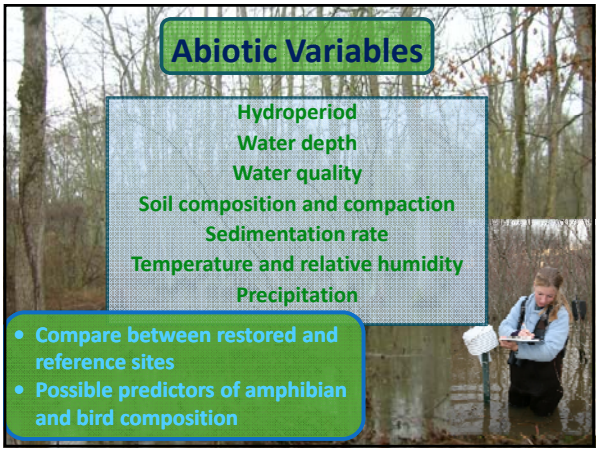
Recorders
Treefrog tubes
Cover boards
Area search

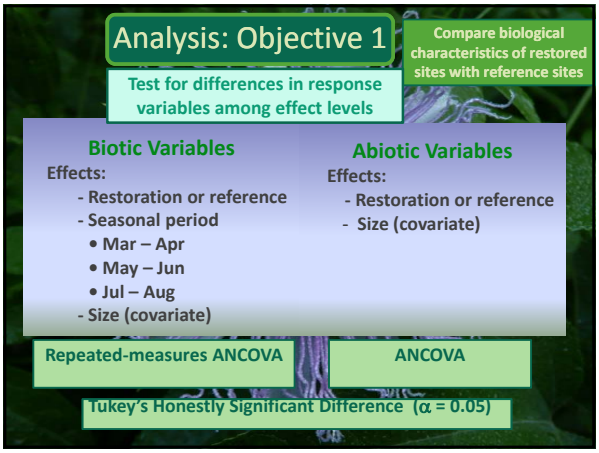

Bird Composition
Sampled 2x per month
Mar – Aug 2008
Point Counts
– Morning after amphibian recorders put out
– Ten minute count
– Each plot
– 4 Distance bands
• 0 – 10 m
• 10 – 25 m
• 25 – 50 m
• 50 – 100 m
– Recorded all individuals observed
• 0 – 3 min
• 3 – 7 min
• 7– 10 min

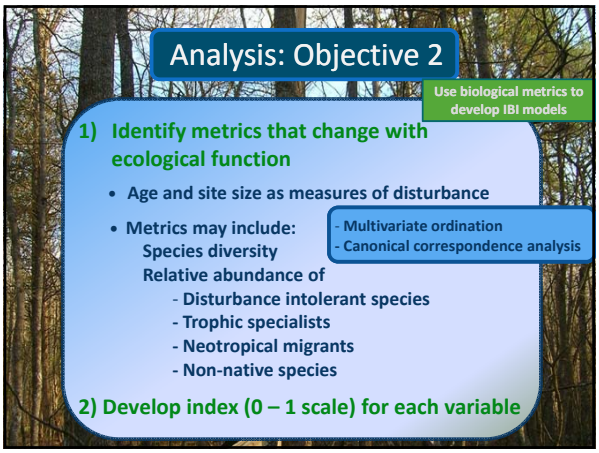

Vegetative Composition
Sampled at 1 random plot per site
(April, June, August)
Understory
woody plants
< 1.4 m tall
Herbaceous vegetation
Midstory
woody plants
<11.4 cm DBH, >1.4 m tall
Overstory
woody plants
>11.4 cm DBH

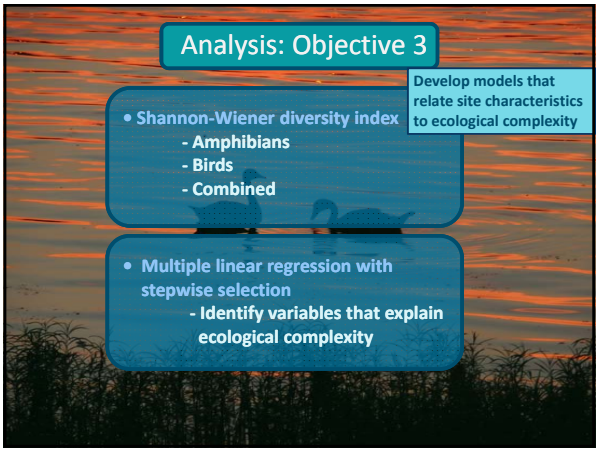

Bird and Amphibian Composition
- Response variables in habitat models
Vegetative Composition
- Predictor variable in habitat models
- Compare between restoration and reference sites
- Used to develop IBI


Vegetation
other variables
Sampled at 1 random plot per site
(April, June, August)
• Compare between restored and reference sites
• Possible predictors of amphibian and bird composition
Understory
• Horizontal cover (1-m² frame)
• Vertical structure (profile board)
Overstory
• Canopy Cover (densiometer)
• Basal area (10 BAF prism)
• Height (clinometer)
• Diameter at breast height


Abiotic Variables
Hydroperiod
Water depth
Water quality
Soil composition and compaction
Sedimentation rate
Temperature and relative humidity
Precipitation
• Compare between restored and reference sites
• Possible predictors of amphibian and bird composition


Analysis: Objective 1
Compare biological characteristics of restored sites with reference sites
Test for differences in response variables among effect levels
Biotic Variables
Effects:
- Restoration or reference
- Seasonal period
• Mar – Apr
• May – Jun
• Jul – Aug
- Size (covariate)
Abiotic Variables
Effects:
- Restoration or reference
- Size (covariate)
Repeated-measures ANCOVA
ANCOVA
Tukey's Honestly Significant Difference (α = 0.05)


Analysis: Objective 2
Use biological metrics to develop IBI models
1) Identify metrics that change with ecological function
• Age and site size as measures of disturbance
• Metrics may include:
Species diversity
Relative abundance of
- Disturbance intolerant species
- Trophic specialists
- Neotropical migrants
- Non-native species
- Multivariate ordination
- Canonical correspondence analysis
2) Develop index (0 – 1 scale) for each variable


Analysis: Objective 3
Develop models that relate site characteristics to ecological complexity
• Shannon-Wiener diversity index
- Amphibians
- Birds
- Combined
• Multiple linear regression with stepwise selection
- Identify variables that explain ecological complexity


Acknowledgements
Dr. Matthew J. Gray
Dr. David A. Buehler
Dr. James Fordyce
Dr. Thomas H. Roberts
Luke Owens
Mike Zeman (NRCS)
Bobby Mimms (NRCS)
Monica Clutch (TNC)
Mike Chouinard (Hatchie NWR)
Jason Maxedon (TWRA)
Mike Pitts (TN State Parks)
Dr. Robert Hayes (WTREC)
Funding:
NRCS Agricultural Wildlife Conservation Center
The Nature Conservancy


Photo Credits
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Jacob S. Spendelow


Questions?