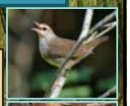
NEW BIOASSESSMENT MODELS FOR MONITORING ECOLOGICAL RESTORATION IN HARDWOOD BOTTOMLANDS



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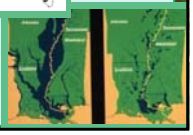
Bottomland Hardwood (BLH) Forests

- Habitat
  - birds
  - amphibians
  - mammals
  - fish
- Ecosystem services
  - Filter contaminants
  - Store sediments
  - Stabilize riverbanks
  - Flood control
  - Produce biomass, sequester carbon
- Most common wetland type in SE
- >70% of original BLH converted to Ag



Bottomland Restoration

Wetlands Reserve Program (WRP)

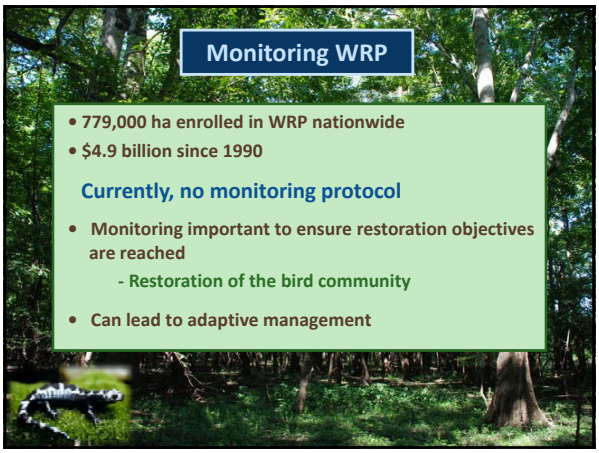
- Established 1990 under farm bill
- Retiring agricultural land in flood-prone areas
- SE: Restorations consist of replanting, minor hydrology

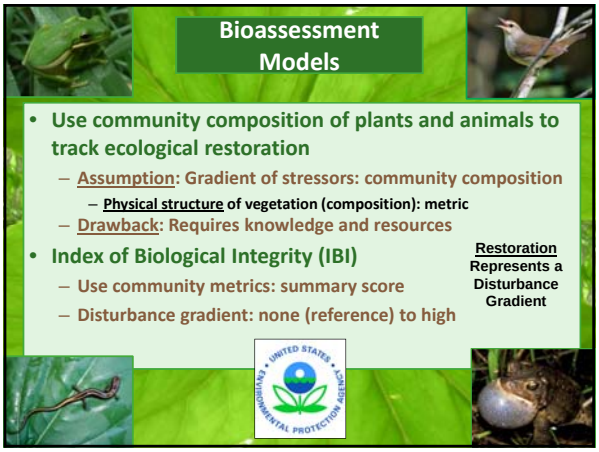
Most WRP sites in SE are Hardwood Bottomlands

Tennessee

- Began restoration under WRP in 1994
- 4,014 ha enrolled in TN
- 90% hardwood bottomlands
- Mostly in western 1/2 of state

2004


Monitoring WRP
• 779,000 ha enrolled in WRP nationwide
• $4.9 billion since 1990
Currently, no monitoring protocol
• Monitoring important to ensure restoration objectives are reached
- Restoration of the bird community
• Can lead to adaptive management

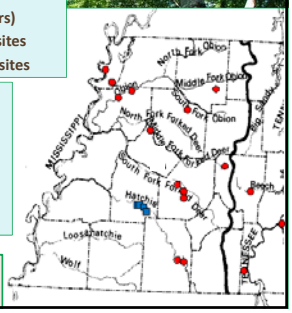

Bioassessment Models
• Use community composition of plants and animals to track ecological restoration
– Assumption: Gradient of stressors: community composition
– Physical structure of vegetation (composition): metric
– Drawback: Requires knowledge and resources
• Index of Biological Integrity (IBI)
– Use community metrics: summary score
– Disturbance gradient: none (reference) to high
Restoration Represents a Disturbance Gradient

Objective
Develop bioassessment models (based on IBI procedures) for vegetation and avian communities to be used for monitoring the state of ecological restoration in hardwood bottomlands

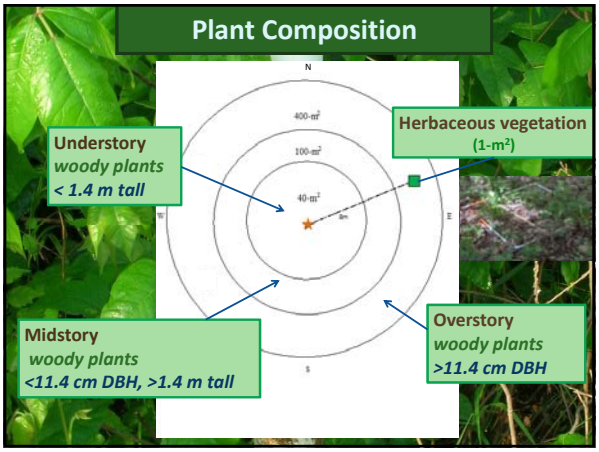
Study Sites

- **17 Randomly selected restoration sites**
  - Multi-stage sampling approach
  - – First level: 1st year of restoration (1987, 1995-2006: 2 – 13 yrs, 21 yrs)
  - – Second level: Size - large (>45 ha) 9 sites
    - small (<45 ha) 8 sites
- **4 Reference sites in the Hatchie River Bottomland (HNWR)**
  - – Longest unchannelized tributary of Mississippi River (Johnson 2007)
  - – Mean stand age: 49, 58, 41, and 55 years old

March – August 2008



Plant Composition



Vegetative Structure

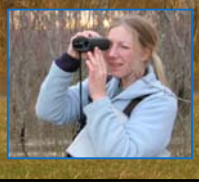
- Vertical structure (0-2 m above ground)
- Canopy closure
- Overstory height
  (nearest tree to plot center)
- Tree Basal Area
- Logs (>11.4 cm dia; 100-m radius plot)
- Snags (>11.4 cm dbh; 3.14 ha)

Bird Composition

Once every 2 wks
Mar – Aug 2008

Point Counts

- Ten minute count at each plot
- 50-m radius (0.79-ha plot)
  - Verified equal detection to 50 m among sampling sites



Community Metrics

- Species Richness
  - Total # of species per site
- Shannon-Wiener Species Diversity
- Abundance
  - Bird habitat-use guilds
    - 4 feeding guilds
    - 5 nesting guilds

Bird Habitat Use Guilds

DeGraaf and Chadwick 1984

Feeding Guilds
Air
Ground
Canopy

Nesting Guilds
Cavity
Shrub
Ground
Branch
Twig

Bioassessment Model Development

1) Identified community metrics which vary along a disturbance gradient: **time since restoration**
   - Model (Linear L-S Regression)

0 years → Site Age → Reference

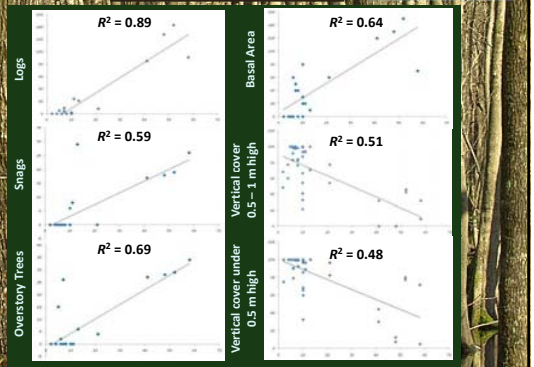
2) Select metrics: strength of relationship with site age
   - Decision rule: $R^2 \geq 50\%$ of maximum R^2 for a given community

3) Assigned scores to final metrics
   - Observed range of values across all sites for given metric
   - Divided range into quartiles

Percentile	Score
0 – 25	1
26 – 50	2
51 – 75	3
76 – 100	4

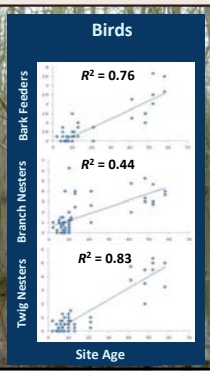
Results: Vegetation

$R^2 = 0.445$



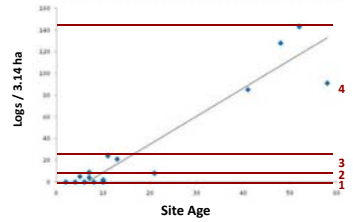
Results: Birds

$R^2 = 0.415$



Bioassessment Model: Vegetation

Metric	Field Measurement	IBI Restoration Score
Logs (3.14-ha plot)	0	1
	1 - 2	2
	3 - 21	3
	>21	4



Sum for final score

Model: Birds

Metric	Field Measurement	IBI Restoration Score
Branch nesters	0 - 0.3	1
(0.79-ha plot)	0.4 - 1.0	2
	1.1 - 2.6	3
	>2.6	4
Twig nesters	0 - 0.1	1
	0.2 - 0.5	2
	0.6 - 1.0	3
	>1.0	4
Bark feeders	0	1
	0.1 - 0.3	2
	>0.3	3

Application

- Use models alone or sum for overall score
- Establish sampling plot at site center
  - measure vegetation once (Apr – Aug)
  - sample birds ≥4 times (Mar – Aug)

State of Restoration	Vegetation Score	Bird Score	Summed Scores
Early	6 – 9	3 – 4	9 – 14
Mid	10 – 13	5 – 6	15 – 20
Late	14 – 17	7 – 8	21 – 26
Reference	18 – 21	9 – 11	27 – 32

Example: Vegetation Model

Metric	Field Measurement	Example	BI Restorati	Example
Logs (3.14-ha plot)	0		1	
	1 - 2	2 logs	2	← 2
	3 - 21		3	
	>21		4	+
Snags	0		1	
	1 - 2	1 snag	2	← 2
	>2		3	+
Overstory trees (0.04-ha plot)	0	Late restoration	1	
	1 -		2	← 2
	>5		3	
Basal area (ft^2 / acre)	0 - 1		1	+
	2 - 30	40 ba	2	
			3	← 3
			4	
			1	+
		82% cover	2	
			3	← 3
			4	
			1	+
		90% cover	2	← 2
			3	

State of Restoration	Vegetation Score	Bird Score
Early	6 – 9	3 – 4
Mid	10 – 13	5 – 6
Late	14 – 17	7 – 8
Reference	18 – 21	9 – 11

Conservation Implications

-Bioassessment models can be used as a tool to monitor hardwood bottomland restorations in TN

-Validated elsewhere

-LMAV

Confidence

-Successional gradient

-Models built using mature forested wetlands as reference and at sites without catastrophic disturbance

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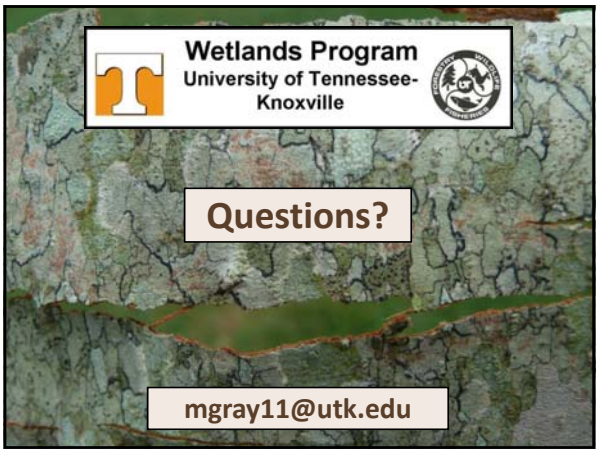
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