Bottomland Hardwood Forests

- Periodically flooded stands of mature river-bottom trees
  – Baldassarre and Bolin

- Bottomland hardwood forests (BHF) are forested, alluvial wetlands occupying broad floodplain areas that flank large river systems
  – 2005 Louisiana conservation of habitats and species assessment

- BHF are found in low-lying areas often near rivers and streams which occasionally flood. In the Southeastern United States, mature BHF are dominated by deciduous trees such as oaks (*Quercus* sp.), gums (*Nyssa* sp.), and baldcypress (*Taxodium distichum*) which tolerate seasonal or semipermanent water.

Bottomland Hardwood Forest – History of Loss

- South Carolina drains the Cawcaw Swamp
  – 1754

- George Washington and the Dismal Swamp Land Company drain Dismal Swamp
  – 1763

- Swamp Lands Act (Federal acquisition of swamps for “reclamation”)
  – 1850

- Widespread use of drainage tiles for agriculture
  – 1880

- First National Drainage Congress
  – 1912

- Age of the Levees
  – 1920-Present
Mississippi River Alluvial Valley 1950s
Mississippi River Alluvial Valley 2001

Bottomland Hardwood Forests

MAV
10 million ha

Southeast
52 million ha

2 million ha
< 10 million ha
Today’s BHF

- National Wildlife Refuges / Forest Service / Park Service
- Remnant Patches
- WRP lands
- Hunting Clubs

Bottomland Hardwood Forest Conservation

- Recent impetuses
  - Louisiana black bear
  - Ivory-billed woodpecker
  - Declines in neotropical migrant populations
  - Carbon sequestration
  - Global climate change
  - Dead zone
  - NAWMP

Tree Species Composition

- Frequency = how often (within and among years)?
- Duration = how long remains flooded?
- Depth = how deep?
- Timing = what time of year?
Hydrology Indicates Composition

Naturally Flooded River Bottoms

Greentree Reservoirs

Natural Depressions / Cypress Swamps

Seasonal

Semipermanent

Q. nigra
Q. phellos
L. styraciflua
U. americana
C. aquatica
F. pennsylvanicum

Q. nigra
Q. phellos
N. sylvatica
L. styraciflua
U. americana
C. aquatica

Q. lyrata
N. sylvatica
T. disticum
Hydrology Influences Animal Community

Natural Flooding

- Infuses forest with nutrients and organic matter
- Flooding can slow decay of vegetative matter, allowing nutrients to build up
- Filtration
- Groundwater recharge and downstream flood amelioration
- Seed dispersal
  - Water
    - Baldcypress, Overcup oak

The Great Mississippi River Flood of 1927, photographed in Illinois on March 26.

Natural Flooding vs. Impoundments

The Flood-Pulse Concept

- Flooding is a critical component of the functioning floodplain system
- Nutrients added to floodplain
- Nutrients removed from floodplain
- Dynamic interaction between water and land

Effects of “Flood Control”

- Levees result in:
  - Drier floodplains
  - Higher nutrient pooling
  - Greater herbaceous biomass
  - Lower water tables
  - Lower redox potential
- Reduced disturbance in floodplains (heterogeneity)
Wildlife in Bottomland Forests

**Neotropical Migrants**
- Fish

**Herpetofauna**
- Mammals

Bears in Bottomland Forests

- **Needs**
  - Large cavities of denning sites (e.g., brush piles on hummocks)
  - Dense ground cover (understory)
  - Large habitat tracts and connectivity
  - Hard and soft mass
    - Acorns are very important in fall

- Bald cypress trees surrounded by water

- Sanctuaries' are extremely important
  - Pocosins

Bats in Bottomland Forests

- **Stand age**
- **>50 cm DBH**
Bats in Bottomlands

Fish in Bottomlands

- Spawning sites
- Nursery sites for juveniles
- Foraging sites
  - Acorns
  - Invertebrates
  - Crayfish
  - Soft mass
- Catfish, sunfish, paddlefish, etc.

BHF for Waterfowl
NAWMP Goals

1. Restore waterfowl breeding habitat…

2. To protect 686,000 additional acres of mallard and pintail migration and wintering habitat in the lower Mississippi River-Gulf Coast region and increase the carrying capacity for wintering birds on lands and waters already acquired for waterfowl.

BHF and Waterfowl

• Isolation (pairing)

• Breeding

• Foods

• Protection and shelter
BHF and Waterfowl - Foods

- Acorns
- Seeds
- Tubers
- Invertebrates
- Fish

Values of BHF

- Carbon sequestration
- Water quality
- Groundwater recharge
- Timber production
- Nutrient cycling
- Wildlife habitat

Recreation!
Management of BHF

- Beaver impoundments
- Selective timber harvest
  - Create openings
  - Leave brush piles
  - Uneven-age management
- Moist-soil clearings
- Water control
  - Greentree Reservoirs

Beaver Pond Management

- Advantages
  - Natural
  - Habitat complexity
  - Economical
- Disadvantages
  - Tree kill
  - Dynamic
  - Facilitate increase in beaver activity (snow ball)
Selective Harvest – Mast producers for waterfowl

Waterfowl food resources in bottomland hardwood forests of the Mississippi Alluvial Valley

waterfowl

Monsanto Research farms
Replenishment of winter food resources!

Provided by Jake Straub (MSU 2011)
Acorn Abundance and Canopy Composition

Chickasaw NWR, TN

\[ y = 0.6492e^{4x} \]

\[ 0 \quad 10 \quad 20 \quad 30 \quad 40 \quad 50 \]

\[ 0\% 
20\%
40\%
60\%
80\% \]

Red oak acorns (kg/ha)

% red oak canopy in forest

Provided by Jake Straub (MSU 2011)

Delta National Forest, MS

\[ y = 2.2931e^{0.4271x} \]

\[ 0 \quad 100 \quad 200 \quad 300 \quad 400 \quad 500 \]

\[ 0\% 
20\%
40\%
60\%
80\% \]

Red oak acorns (kg/ha)

% red oak canopy in forest

Provided by Jake Straub (MSU 2011)
Streamside Zones

- Reduces sediment loss
- Discourages travel in stream bed
- Reduces excessive input of debris
- Retains canopy to maintain suitable water temperature
- Provides habitat diversity
  - Edge
  - Herbaceous vegetation and scrub-shrub strata
- Travel corridors (habitat connectivity)

Greentree Reservoirs (GTRs)

- Stuttgart, AR
  - Grand Prairie
  - 1930’s
  - Noxubee 1960’s
- ~ 180 nationwide
  (most in the MAV)
GTR - Construction

- Hardwood bottomland forest enclosed partially or completely by levees containing water control structures
  - Flat topography for 1 - 18 in flooding
  - 40 yr-old mix of oaks, gums, and ashes
  - Impervious soils or clays
  - Minimum of 4 ha in traditional waterfowl flyways

GTR - Construction

- Levee construction
  - 1:3-6 slope ratio (wider is better)
  - 100 ft wide clearing for levee construction and borrow ditches
  - Plant with perennial grasses and cleared of woody vegetation annually

- Dependable water source
  - Reservoir
  - River diversion
  - Other

---

![Diagram of levee construction](image-url)
GTR - Management

- Seasonal flooding (October – March)
  - Latitudinal dependent
  - Leaf drop and bud swelling
  - Emulate natural flooding regimes if possible
- Do not overtop desirable seedlings with water
- Emergency spillway

GTR - Management

- Monitor beaver, muskrat, and nutria damage
  - Trees
  - Control structures
  - Levees
- Rotate flooding events on nearby GTRs
- Maintain or create dead snags

GTR Management - Positives

- Sustained, flooded wildlife habitat
- Flood water control
- Initial increases in waterfowl use, viable acorn production, and radial tree growth
- Recreation and aesthetics
- Simulates “natural” flood inundation in flood controlled areas
  - Can improve composition (from a waterfowl perspective)
  - Encourages some tree mortality
GTR Management - Negatives

- Decreased waterfowl use
- Decreased acorn production and viability (maybe)
- Decreased radial tree growth
- Change in overstory composition (maybe)
- Reduced regeneration of desirable trees
- Increased tree mortality (red oaks)

Traditional GTR Management

- Bottomland Hardwood Forests
- Greentree Reservoirs

Effects of GTR Management

- Low regeneration rates of seedlings
- Tree mortality
- Wind-throw
- Crown die-back
- Basal swelling
- Scarring by beaver
- Excessive sedimentation

*From Wigley and Filer (1989) – Survey of GTR managers
Effects of GTR Management

Cherrybark and Willow Oak → Overcup Oak

<table>
<thead>
<tr>
<th>Relative abundances</th>
<th>Hardwood Bottomlands</th>
<th>Greentree Reservoirs</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overcup Oak</td>
<td>27</td>
<td>58</td>
</tr>
<tr>
<td>Cherrybark Oak</td>
<td>49</td>
<td>40</td>
</tr>
<tr>
<td>Willow Oak</td>
<td>65</td>
<td>21</td>
</tr>
</tbody>
</table>

*From Young (1995) – GTRs 1-2 and 1 UBHF site @ Noxubee NWR

Effects of GTR Management
Continuous vs. Periodic flooding

<table>
<thead>
<tr>
<th>Continuous</th>
<th>Periodic</th>
</tr>
</thead>
<tbody>
<tr>
<td>Taller seedlings</td>
<td>Higher survival</td>
</tr>
<tr>
<td>No density difference</td>
<td></td>
</tr>
</tbody>
</table>

*Recommendation – Flood GTRs periodically during winter

*From Gray 1996 – GTRs 1-2 @ Noxubee NWR

Effects of GTR Management
Unimpounded BHF vs. GTRs

<table>
<thead>
<tr>
<th>Similarities</th>
<th>Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>Canopy density</td>
<td>Species composition</td>
</tr>
<tr>
<td>Mid-story/canopy abundance</td>
<td></td>
</tr>
<tr>
<td>Stress</td>
<td></td>
</tr>
<tr>
<td>Gap frequencies</td>
<td></td>
</tr>
<tr>
<td>Diversity</td>
<td></td>
</tr>
</tbody>
</table>

*From Ervin et al. 2006 – GTRs 1-4 and 4 UBHF @ Noxubee NWR
Effects of GTR Management

- Changes in species composition
- Willow → Overcup oak
- Reduced survival of planted seedlings
- Acorn production not reduced (short-term)

*From Guttery 2006 – GTRs @ Monsanto Farms

Effects of GTR Management

Fig. 5 Decomposition of overcup oak and red maple on naturally flooded sites in southeast Missouri.

Adaptive Management of GTRs and Bottomlands

<table>
<thead>
<tr>
<th>Impact</th>
<th>Cause of impact</th>
<th>Mechanisms to sustain impact</th>
<th>Management position</th>
</tr>
</thead>
<tbody>
<tr>
<td>Loss of productivity</td>
<td>Reduced light, reduced vigor, reduced productivity</td>
<td>Structural treatment, reduced demand, increased demand, increased productivity</td>
<td>This needs to be managed and restored</td>
</tr>
<tr>
<td>Change in water table</td>
<td>Reduced light, reduced productivity, reduced demand, increased demand</td>
<td>Structural treatment, reduced demand, increased demand, increased productivity</td>
<td>This needs to be managed and restored</td>
</tr>
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<td>Nutrient loss</td>
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<td>This needs to be managed and restored</td>
</tr>
</tbody>
</table>
Implications on Timber Value in GTRs

- Cherrybark Oak (Sawtimber) $300 / mbf
- Overcup Oak (Sawtimber) $138 / mbf
- Bald Cypress (Sawtimber) $138 / mbf

*Values - MSU Timber Price Report, Fall 2002

Concerns for Waterfowl Management in GTRs

- Reduced waterfowl use
- Lack of regeneration of understory trees
- Reduced hunting success
- Reduced public and waterfowl “satisfaction”

GTR Management

- Create Gaps…
  - Growing season flooding
  - Soil saturation and wind throw
  - Selective timber harvest
  - Regeneration cuts
GTR Management for Waterfowl

- Selective regeneration cuts
  - Hack and squirt seedling competition
  - Manually thin undesirables
  - Plant desirable seedlings

- Clear understories of large oaks (> 60 ft)

- Hack and squirt undesirables and leave as snags

GTR Management for Waterfowl

- Rotationally maintain timber harvest openings for waterfowl
  - Mowed or disked woodland regeneration
  - Moist-soil plots
  - Semipermanent wetland depressions
  - Waterfowl food plots (crops)

<table>
<thead>
<tr>
<th>Habitat</th>
<th>Food useNewUrlParserable (kcal/ha)</th>
<th>Time mouse/acladable energy (MJ/ha)</th>
<th>E/R (Mcal/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bottomland/woodlots</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>30% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
<td>40% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
<td>50% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
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<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
<td>70% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
<td>80% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
</tr>
<tr>
<td>90% oak suckers</td>
<td>105*</td>
<td>2.45*</td>
<td>155</td>
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<tr>
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<td>105*</td>
<td>2.45*</td>
<td>155</td>
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</tbody>
</table>
GTR Management for Waterfowl

• Initial investment saves on maintenance
• Maintain refuge areas
• Micro-complex
  – Use natural topography

GTR Management

• “…GTR management is an expensive, labor intensive, and long-term commitment.”
  – Funding
  – Willing and cooperative staff
  – Ever-evolving

• Conclusion: “Naturally flooding BHF should not be impounded except under unusual circumstances (e.g., T & E species at risk).”
  *From King and Allen (1996) - published in Wetlands

Summary

• BHF have declined substantially
• Private entities and conservation initiatives have slowed the trend (e.g., WRP, Environmental Edge, etc.), but species compositions are altered
• BHF may not ever be truly replaced
  – Altered flooding regimes
  – Timber demand
  – Cellulosic ethanol
  – People
  – Pests and pathogens
• Patience and active/intensive management required to simulate historic BHF with GTRs
• Nesting
  - Tree cavities or nest boxes
  - 5 ft – 65 ft above ground
  - 5 suitable cavities per acre
  - >50 total cavities per acre
  - No “wood duck box clusters”
Wood Duck Management
Nesting

82% of nests in uplands = 3 km from water!

Wood Duck Management
Nesting

• Brood Rearing
  - 50 – 70% cover
  - 50 – 30% open water
  - **Scrub-shrub**
  - Beaver ponds, cypress-tupelo swamps, streams
  - Invertebrates important
  - Isolated wetlands, away from other broods and aggregations of nest boxes
  - Post-hatching movement to other wetlands/permanent waters (complexes important)
Wood Duck Management

Nesting and Brood Rearing – avoid clustering

Wood Duck Management

• Molting
  – Permanent water
  – Emergent marshes (aquatic plants seeds / inverts)
  – Large wetlands or complexes with many wetlands in close-proximity
    (e.g., aquaculture ponds, forested backwaters and oxbows)

Wood Duck Management

Molting

Barras et al. 2001 (SEAFWA)
Wood Duck Management

• Winter
  – Bottomland hardwood wetlands
  – River backwaters
  – Downed woody debris and timber
  • Loafing
  • Pair bonding
  • Thermoregulation
  – Scrub shrub (buttonbush)
  – Small creeks and streams
  – Acorns are the primary winter foods
    • bald cypress, hickory, sweet gum, buttonbush, arrow-arum, bur-reed, and
    wild rice are also common winter foods

Wood Duck Management

Winter

<table>
<thead>
<tr>
<th>Date</th>
<th>Weather</th>
<th>Temperature</th>
<th>Wind</th>
<th>Acorns</th>
<th>Sunlight</th>
</tr>
</thead>
<tbody>
<tr>
<td>10/17/2011</td>
<td>Sunny</td>
<td>50°F</td>
<td>Slight</td>
<td>35%</td>
<td>Moderate</td>
</tr>
</tbody>
</table>

Northern Prairie Wildlife Research Center

Wood Duck Management

Table 2. Numbers of male, female, and unmarked wood ducks (by age) during 3 wintering periods between 24 February 1985 and 3 March 1985, Mississippi State University.

<table>
<thead>
<tr>
<th>Period</th>
<th>Male</th>
<th>Female</th>
<th>Unmarked</th>
</tr>
</thead>
<tbody>
<tr>
<td>1985-1986</td>
<td>34</td>
<td>26</td>
<td>48</td>
</tr>
<tr>
<td>1986-1987</td>
<td>40</td>
<td>32</td>
<td>52</td>
</tr>
<tr>
<td>1987-1988</td>
<td>38</td>
<td>30</td>
<td>50</td>
</tr>
</tbody>
</table>

Wood Duck Management

Winter

Table 6. Frequency (f) and % of female wood ducks lost during the January 1991 to a control treatments, Mississippi State University, winter 1991-92.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>N</th>
<th>f</th>
<th>%</th>
</tr>
</thead>
</table>
| Control   | 10 | 2 | 20%
| 50%       | 5 | 1 | 20%
| 80%       | 0 | 0 | 0%

Wood Duck Management

Winter

Table 6 shows the frequency of female wood ducks lost during the January 1991 to a control treatments, Mississippi State University, winter 1991-92.
Wood Duck Management

Winter

Table 1. Seasonal analysis of nest, brood, water, and habitat use data and Wood Duck foraging, water, and habitat use data. (JWM) 1997 (Demarest et al.)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Winter</th>
<th>Spring</th>
<th>Summer</th>
<th>Fall</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nest success</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Brood success</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
<tr>
<td>Water use</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
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<tr>
<td>Habitat use</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Hartke and Hepp 2004 (JWM)

Year-Round

Table 2. Analysis of nest, brood, water, and habitat use data and Wood Duck foraging, water, and habitat use data. (JWM) 1997 (Demarest et al.)

| Table 2. Seasonal analysis of nest, brood, water, and habitat use data and Wood Duck foraging, water, and habitat use data. (JWM) 1997 (Demarest et al.)
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<td>0.00</td>
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<td>0.00</td>
<td>0.00</td>
</tr>
</tbody>
</table>

Year-Round - Summary

- Wetland complexes
- Maintain snags and dead trees
- Maintain older, mature trees
- Adjacent upland forests are important!
- Boxes are important, but can be an ecological trap
- Management is necessary because historical floodplain forest conditions will likely never return