The Ecological and Economic Values of Bottomland / Swamp Hardwoods in the South

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North Carolina State University

Presented at the Bottomland and Swamp Forests Symposium
Wilmington, NC
1 November 2017
Southern Forests, 2012

- 13 southern states ranging from Texas to Virginia
  - 535 million acres of land
  - 245 million acres of forest land
  - 210 acres of timberland that could provide commercial timber harvests

Forest Ownership
- 147 million acres (60%) private non corporate
- 65 million acres (27%) private corporate
- 33 million acres (13%) public owners

Key Bottomland Hardwood Valuation Questions

- Bottomland hardwood definition and area
  - Hydrology, soils, vegetation
  - Ecological, FIA, federal jurisdictional?

- Stocks and flows
  - Inventory, sinks, pools of goods or services
  - Annual or periodic flows

- Market and nonmarket values and prices
  - Economic: Timber, nontimber products
  - Ecological: Environmental services
  - with markets, or purely nonmarket

Oswalt et al. 2014
Goods and Services

Area, Stocks, and Flows

Types of Goods and Services
Definitions of Bottomland Hardwoods
Volumes or Inventories

Commodity and Ecosystem Services

LIFE ON EARTH - BIODIVERSITY

ARROWS COLOR
Potential for mediation by socioeconomic factors
- High
- Medium
- Low

ARROWS WIDTH
Intensity of linkages between ecosystem services and human well-being
- Weak
- Medium
- Strong

ECOSYSTEM SERVICES
- Provisioning
  - Food
  - Fresh Water
  - Wood and Fiber
  - Fuel
- Supporting
  - Nutrient Cycling
  - Soil Formation
- Regulating
  - Climate regulation
  - Pollination
  - Water Purification
- Cultural
  - Aesthetic
  - Educational
  - Recreational

CONSTITUENTS OF WELL-BEING

Security
- Personal Safety
- Secure Resource Access
- Security From Disasters

Basic material for good life
- Adequate Livelihood
- Access to Sufficient Nutritious Food
- Access to Goods

Health
- Strength
- Feeling Well
- Access to Clean Air and Water

Good social relations
- Social Cohesion
- Mutual Respect
- Ability to Help Others

Freedom of choice and action
Opportunity to be able to achieve what an individual values doing and being

Source: Millennium Ecosystem Assessment
Four Types of Goods and Services

- **Based on consumption & exclusion**
  - **I: Private goods** – individual, exclusive – markets work
    - food, timber, game, shelter, clothing
  - **II: Toll goods** – joint, some exclusion
    - parks, concerts – markets or government
  - **III. Common-pool goods (Open access)** non-excludable
    - air, water, fish, atmosphere, unregulated forest commons
  - **Collective goods (Public goods)** – jointly consumed
    - forest fire protection, biological diversity, soil conservation, scenic vistas, insect and diseases, spiritual values, carbon storage

Cubbage et al. 2017
**STOCK:** Southern Timberland Area (Million Acres / % of Total Area)

- Pine Plantation: 45 million acres (22%)
- Natural Pine: 32 million acres (16%)
- Oak-Pine: 18 million acres (9%)
- Upland Hardwood: 78 million acres (38%)
- Bottomland Hardwood: 31 million acres (15%)

204 million acres in South; 514 in USA  
Oswalt et al. 2014

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**FIA Southern Timberland Wetland Areas (Million Acres)**

<table>
<thead>
<tr>
<th>Southern Timberland Wetland Area</th>
<th>Total = 36,116,075 acres; 17.7%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pine Plantation</td>
<td>3.06</td>
</tr>
<tr>
<td>Natural Pine</td>
<td>1.842</td>
</tr>
<tr>
<td>Oak-Pine</td>
<td>1.393</td>
</tr>
<tr>
<td>Upland Hardwood</td>
<td>3.66</td>
</tr>
<tr>
<td>Bottomland Hardwood</td>
<td>13.697</td>
</tr>
<tr>
<td>Mesic-Seasonal</td>
<td>0.908</td>
</tr>
<tr>
<td>Mesic-Water</td>
<td>0.025</td>
</tr>
<tr>
<td>Hydric</td>
<td>0.134</td>
</tr>
<tr>
<td></td>
<td>0.918</td>
</tr>
<tr>
<td></td>
<td>1.027</td>
</tr>
<tr>
<td></td>
<td>0.526</td>
</tr>
</tbody>
</table>

Sheffield 2016
NLCD Land Use Map, 2015

Orange=urban; green=upland forest; purple=woody wetland (wet forest); cyan=emergent wetland; blue=water. The other classes (ag, grassland, shrubland, barren) are not colored.

Wickham 2016

Stocks and Flows:
Southern Timber Volumes and Harvests

- **Stock:** 359 billion cubic feet timber inventory, 2012
  - 136 billion cubic feet of softwoods
  - 222 billion cubic feet of hardwoods

- **Flow:** Annual timber harvests and removals, 2011
  - 8.0 billion cubic feet
  - 5.3 billion cu ft in softwoods
  - 2.7 billion cu ft in hardwoods

- Decrease from 9.8 billion cu ft in 2006

Oswalt et al. 2014
Southern Timberland Acres and Removals

Southern Timberland Acres by Type

Southern Removals by Species

Economic Values

Timber
Nontimber Forest Products
Payments for Ecosystem Services
Timber-mart South
Stumpage Price Trends

South-wide Sawtimber Stumpage Prices
quarterly averages, $ per ton

$$\begin{align*}
\text{2Q06} & \quad \text{2Q08} & \quad \text{2Q10} & \quad \text{2Q12} & \quad \text{2Q14} & \quad \text{2Q16} \\
\text{TimberMart-South} & \quad \text{Pine Sawtimber} & \quad \text{Chip-n-saw} & \quad \text{Hardwood Sawtimber}
\end{align*}$$

Forest2Market

- Bimonthly data
- Pine
  - Sawtimber
  - Chip n Saw
  - Pulpwood
- Hardwood
  - Sawtimber
  - Pulpwood
- 2005 to 2015
Montreal Process
Sustainable Forest Management
Key Economic Indicators

FIA Data
Southern Share of Forests ~ 40%
Bottomland Hardwoods – Share of South ~15%

And Computed Actual Prices and Payments
For Timber, Nontimber, and Environmental Services

Montreal Process Indicator 6.25:
Volume and Value of Wood Products

<table>
<thead>
<tr>
<th>Product</th>
<th>2006 ($billion)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufactured Forest Products Goods</td>
<td></td>
</tr>
<tr>
<td>Total USA Wood, paper, and furniture industries</td>
<td>309</td>
</tr>
<tr>
<td>USA Pulp and paper industries</td>
<td>165</td>
</tr>
<tr>
<td>USA Wood products</td>
<td>110</td>
</tr>
<tr>
<td>USA Wood furniture</td>
<td>34</td>
</tr>
<tr>
<td>Southern share of forest products industries value of shipments</td>
<td>160</td>
</tr>
</tbody>
</table>
## Southern Forest Products Industry Economic Contributions

### Forest, Timber Production, and Processing of Solid Wood, Wood Furniture, and Paper Products

<table>
<thead>
<tr>
<th>Statistic</th>
<th>Amount</th>
<th>Share of U.S. South Total for All Sectors</th>
</tr>
</thead>
<tbody>
<tr>
<td>Employment</td>
<td>470,000 persons</td>
<td>0.84%</td>
</tr>
<tr>
<td>Gross Industrial Output</td>
<td>$133 billion</td>
<td>1.62%</td>
</tr>
<tr>
<td>Wages and Salaries</td>
<td>$26 billion</td>
<td>0.96%</td>
</tr>
<tr>
<td>Total Value Added</td>
<td>$43 billion</td>
<td>0.98%</td>
</tr>
</tbody>
</table>

Dahal et al. 2015

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**Hardwood Lumber Mill, Smithfield NC**
## Southern Timber Stumpage Values, 2011

<table>
<thead>
<tr>
<th>Species Group</th>
<th>Harvest (billion cubic feet)</th>
<th>Harvest Value ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>8.0</td>
<td>4800</td>
</tr>
<tr>
<td>Softwoods</td>
<td>5.3</td>
<td>3180</td>
</tr>
<tr>
<td>Hardwoods</td>
<td>2.7</td>
<td>1620</td>
</tr>
<tr>
<td>Bottomlands @ 0.28% of Hardwoods</td>
<td>0.756</td>
<td>450</td>
</tr>
</tbody>
</table>

Values calculated at weighted average timber price of $0.60/cu. ft.; ½ sawtimber; ½ pulpwood by volume for both softwood and hardwood.
**Indicator 6.26 Value of Nonwood Forest Products Produced or Collected in U.S.**

<table>
<thead>
<tr>
<th>Product</th>
<th>1998 ($million)</th>
<th>2007 ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Landscaping</td>
<td>89</td>
<td>28</td>
</tr>
<tr>
<td>Crafts/floral</td>
<td>119</td>
<td>138</td>
</tr>
<tr>
<td>Seeds/cones</td>
<td>6</td>
<td>3</td>
</tr>
<tr>
<td>Edible fruits, nuts, sap</td>
<td>56</td>
<td>42</td>
</tr>
<tr>
<td>Grass/forage</td>
<td>15</td>
<td>19</td>
</tr>
<tr>
<td>Herbs/medicinals</td>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td><strong>Subtotal</strong></td>
<td>285</td>
<td>232</td>
</tr>
<tr>
<td>Fuelwood</td>
<td>397</td>
<td>302</td>
</tr>
<tr>
<td>Posts and poles</td>
<td>89</td>
<td>24</td>
</tr>
<tr>
<td>Christmas trees</td>
<td>114</td>
<td>65</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>885</td>
<td>622</td>
</tr>
</tbody>
</table>

**Indicator 6.26 Revenue from Forest-Based Environmental Services in the U.S.**

<table>
<thead>
<tr>
<th>Product</th>
<th>2005 ($million)</th>
<th>2007 ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Government payments</td>
<td>378</td>
<td>366</td>
</tr>
<tr>
<td>Wetland mitigation banks</td>
<td>727</td>
<td>727</td>
</tr>
<tr>
<td>Hunting leases and entrance fees</td>
<td>405</td>
<td>410</td>
</tr>
<tr>
<td>Conservation easements</td>
<td>162</td>
<td>315</td>
</tr>
<tr>
<td>Conservation banks</td>
<td>34</td>
<td>34</td>
</tr>
<tr>
<td>Wildlife viewing</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td>Carbon offsets</td>
<td>0.6</td>
<td>1.7</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>1,737</td>
<td>1,887</td>
</tr>
</tbody>
</table>

National Report on Sustainable Forests 2010
### Comparative Estimated Southern Forest Values for Timber, Nontimber, and Environmental Payments

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Southern Share of Value ($million)</th>
<th>Bottomland Hardwood Share ($million)</th>
</tr>
</thead>
<tbody>
<tr>
<td>All Forest Products Shipments, 2006</td>
<td>160 000</td>
<td>15 280</td>
</tr>
<tr>
<td>Total For. Prod. Value Added, 2006</td>
<td>43 000</td>
<td>4 080</td>
</tr>
<tr>
<td>Annual Timber Harvest, 2011</td>
<td>4 800</td>
<td>450</td>
</tr>
<tr>
<td>Nonwood Forest Products, 2007</td>
<td>250</td>
<td>40</td>
</tr>
<tr>
<td>Environmental Service Payments, 2007</td>
<td>750</td>
<td>110</td>
</tr>
</tbody>
</table>

Southern timber land as 40% of U.S. timber land; Bottomland harvest and value added = 9.55% of south harvest total; Bottomland nontimber and environmental services at 15% of southern forests; thus southern bottomland hardwoods at 6% of all U.S. timberlands

### Market Values

- Prices reflect the value per unit of ‘private’ goods, which can be divided up and bought and sold by individuals
  - \( Q_{\text{output}} \times P \)
  - Observe \( P \) in records of market transactions

- Market prices summarized above
  - For commodities – timber and nontimber
  - And for “PES” – payments for ecosystem services, when government regulation creates markets
Financial Valuation

- Costs and prices measured as commercial market returns
  - Product prices
  - Stumpage, fishing, bird hunting, shellfishing
  - Price at road, delivered to a mill
  - Market prices, price reports, historical data

- Taxes and subsidies
  - Costs or income to the individual or organization
  - Deductions or additions to cash flows

Market (Provisioning and Cultural) Uses

- Wetland Examples
  - Timber – Sawtimber, pulpwood, pellets
  - Hunting & fishing & viewing – game, migratory birds, shellfish, birdwatching
  - Tourism and recreation – canoeing, eco/tourism, beach and shore protection
  - Educational uses – elementary to secondary schools, forestry, environmental, citizen science
  - Ecosystem services – when government regulation creates market, e.g., wetlands, endangered species
Hofmann Forest Wetland Bank

Westervelt Environmental Consulting: Credits & Payments for Ecosystem Services

Experienced Professionals

With more than 30 years of experience in the environmental industry, the wetland planners, ecologists, and biologists at Westervelt Environmental Consulting bring unique and innovative perspectives to biodiversity management and conservation. This team of professionals has a demonstrated commitment to identifying and implementing restoration opportunities in a wide range of environments, including wetlands, uplands, and riparian areas. Their expertise is drawn from a diverse range of projects and venues across the United States and internationally, ensuring a comprehensive and effective approach to conservation and restoration.

A Commitment to Projects

Westervelt Environmental Consulting (WEC) is dedicated to delivering high-quality services that meet the needs of our clients. We are committed to delivering innovative and sustainable solutions that benefit both the environment and our clients. Our team of experienced professionals works closely with our clients to develop custom strategies that address their specific needs and achieve their goals.

History

Westervelt Environmental Services (WES) is one of the oldest and most respected environmental consulting firms in the country. Founded in 1975, WES has a long history of providing exceptional services to a wide range of clients across various industries. Our team of experts has the knowledge and experience to deliver results that exceed expectations.
Bird Watching

Citizen Science – Looking for Macroinvertebrates
Financial Valuation Challenges

- Commercial market returns
  - Not easy to find
  - Nor that accurate
  - Not stable over time
  - Especially at local region or small scale
- Taxes and subsidies
  - Not easy to determine either
  - Laws complex; many levels of taxes
- E.g. business plans (pro forma) - very complex

OK, So How About Other Values?

Provisioning
Regulating
Cultural
Supporting / Ecosystem Services

Need Indirect Estimates of Value:
Nonmarket Valuation
Nonmarket Values

- Prices are not available for most ‘public’ goods, which benefit the public as a whole
- Measured as imputed Willingness to Pay (WTP)
- $Q_{\text{output}} \times WTP \times Q_{\text{people}}$
- Requires
  - Estimate of $Q_{\text{output}}$ that can be attributed to forest
  - WTP comparable to $P$ (a ‘market price’)
  - Estimate of the number of people who benefit and who are in the accounting framework (e.g. citizens of the state)

Many Ecosystem Services* Are Public Goods

- *Regulatory, cultural, some provisioning
- Full value not reflected in private economic decisions
- No obvious value to use in cost-benefit analysis of alternative policies or management
- Not included in valuation of forests as capital assets - the “natural capital” component of comprehensive wealth
- Cannot be added into new indices of social welfare such as UN’s Inclusive Wealth Index and System of Environmental-Economic Accounting
Nonmarket Values – Wetland Examples
Supporting, Regulating, Cultural

- Watershed and soil protection – downstream uses
- Water filtering – surface water and aquifers
- Climate control – carbon storage and large sinks
- Nutrient cycling, soil formation, spatial structure
- Biodiversity – rare habitats, landscape, corridors
- Aesthetic, cultural, spiritual
- Nonuse
  - Existence - e.g. swamps
  - Bequest - e.g. better climate for heirs

Mill Pond, Trenton NC
Nonmarket Valuation: Estimating WTP

- Revealed preference (‘active’ use values)
  - Travel cost
  - Hedonics
  - Factor input to production function
  - Replacement cost

- Stated preferences (‘total economic’ value)
  - Contingent valuation method (CVM)
  - Attribute based methods – stated choice, conjoint

- Benefits transfer (unit value, function, structural)

Applications of Methods - Details

- WTP = maximum amount of income a person will pay in exchange for an improvement in circumstances, or the maximum amount to avoid a decline in circumstances

- Revealed preference methods work for ecosystem services that are really quasi-public goods - there is some dimension that can be related to private market activity - a weak complement (x) - and demand for x is choked off if cost of obtaining ecosystem service too high, and get zero utility if no x (weak complementarity)

- Replacement cost is a “cost” and may over- or under- estimate the benefit

- TEV includes passive use value, option value, existence value

- Benefits transfer makes sense especially when the service is consumed globally with no premium on a particular location, e.g. carbon
Nonmarket Valuation

Revealed Preference Methods

- Travel cost
  - Reveal price for natural areas with no/low price
  - Time and money spent to travel to site
  - Survey visitors
  - Estimate demand curve as a function of visits

- Hedonic pricing
  - Increased value/prices of property values
  - Statistical estimates of amenity or disamenity values
  - Or value of life in risky jobs

Nonmarket Valuation

Stated Preference Methods

- Contingent valuation method (CV or CVM)
  - Surveys of individuals for values
  - Monetary, ranks among questions, choices
  - Water, nature, biodiversity, forests

- Conjoint analysis (stated choice)
  - Selection among baskets of services
  - To obtain relative values

- Terms willingness to pay (WTP) for benefit
- Or willingness to accept (WTA) loss
Nonmarket Valuation Challenges

- Expensive and complex valuation
- Requires complex economic theory
- Producer and consumer surplus cannot be received
- Careful survey methods needed
- Research may lead to unique results
- Or site specific applications only
- Results change with time
- Double counting, joint production
- Values are less in less developed countries, with less income and WTP

Value Estimation Framework

- **Scoping:** Identify services and disservices that are most valuable and most rapidly changing
- **Markets:** Disaggregate forest area to capture differences in
  - Production functions (riparian forest, street trees, pine forest)
  - Demand for services (nearby/ downstream populations)
- **Quantification:** Estimate total annual flow of ecosystem (dis)services from forests in a state in physical terms appropriate for each flow (e.g., recreation user days, quantity of water)
- **Valuation:** Estimate marginal values ($) of changes in service flows resulting from marginal changes in forest area
Best Example: Jenkins et al. 2011: Valuing ecosystem services from wetlands restoration in the Mississippi Alluvial Valley

- Case: Effects of Wetlands Reserve Program
- Methods: Site and region level measurements + process models
- Greenhouse gas mitigation: $171-$222/ha/yr
- Nitrogen fixation: $1486/ha/yr
- Waterfowl recreation: $16/ha/yr
- Land value w/current markets: $70/ha/yr
- Land value w/potential markets: $1035/ha/yr

Ecological Economics 69(2010):1051-1061

Forest Ecosystem Valuation Project
Motivation: State Studies

- State forestry agencies have commissioned studies of the value of ecosystem services generated by forests in their states
- Benefit transfer, except for stated preference surveys of cultural values in GA and TX, and back-of-the-envelope disaggregation of total values of biodiversity and pollination
- Build on New Jersey studies by Costanza et al. (2006), Liu et al. (2010)

<table>
<thead>
<tr>
<th>State</th>
<th>Who</th>
<th>Scope</th>
<th>Total in billion/year</th>
</tr>
</thead>
<tbody>
<tr>
<td>Virginia</td>
<td>VDOF/VA Tech Yale/PEC</td>
<td>All forests All land</td>
<td>Billions $21.8</td>
</tr>
<tr>
<td>Florida</td>
<td>UFL/Florida Forest Service</td>
<td>NIPF lands in FSP</td>
<td>$2.06</td>
</tr>
<tr>
<td>Georgia</td>
<td>UGA/ GA Forestry Foundation</td>
<td>Private forests</td>
<td>$37.6</td>
</tr>
<tr>
<td>Texas</td>
<td>Texas A&amp;M Forest Service</td>
<td>All forests</td>
<td>$92.9</td>
</tr>
</tbody>
</table>
**Motivation: State Studies**

<table>
<thead>
<tr>
<th></th>
<th>Florida</th>
<th>Georgia</th>
<th>Texas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Timber</td>
<td>$225</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water</td>
<td>$8,160</td>
<td>urban and suburban forested wetland: $112,493</td>
<td>rural area: $2,667</td>
</tr>
<tr>
<td></td>
<td></td>
<td>rural forested wetland: $63,690</td>
<td>urban area: $16,333</td>
</tr>
<tr>
<td></td>
<td></td>
<td>riparian, non-wetland: $63,700</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>non-riparian, non-wetland urban: $100</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>non-riparian, non-wetland rural and suburban:</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>$0</td>
<td></td>
</tr>
<tr>
<td>Cultural services</td>
<td>$711 -  $63,695 depending on forest characteristics</td>
<td>rural area: $12,533</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(riparian, road-buffer, habitat value)</td>
<td>urban area: $27,067</td>
</tr>
</tbody>
</table>

**Ecosystem Service Accounting and Valuation: International**
Ecosystem Services in the US Forest Service

Conclusions – Market Prices Per Year

- Bottomland forests and swamps have large values
  - Market and nonmarket
  - Supporting, provisioning, regulating, cultural
- Southern wetland forest products at 0.0955 of total:
  - Value Added: $4.1 billion
  - Stumpage: $450 million
- Southern forest area share for NTFP / PES: 15%
  - Nontimber forest products: $40 million
  - Environmental payments: $110 million
Conclusions – Nonmarket Services

- Potentially huge values – Stocks and Flows
  - Watershed, filtering, soils, nutrients, carbon
  - Biodiversity, rare habitats, landscape corridors
  - Ecotourism, beach quality protection, aesthetic
- Moderate literature
  - Costanza et al., immense values
  - State and site specific – large as well
- Stated as higher than market values, but w/o cash payments to realize value and protect forests to date