



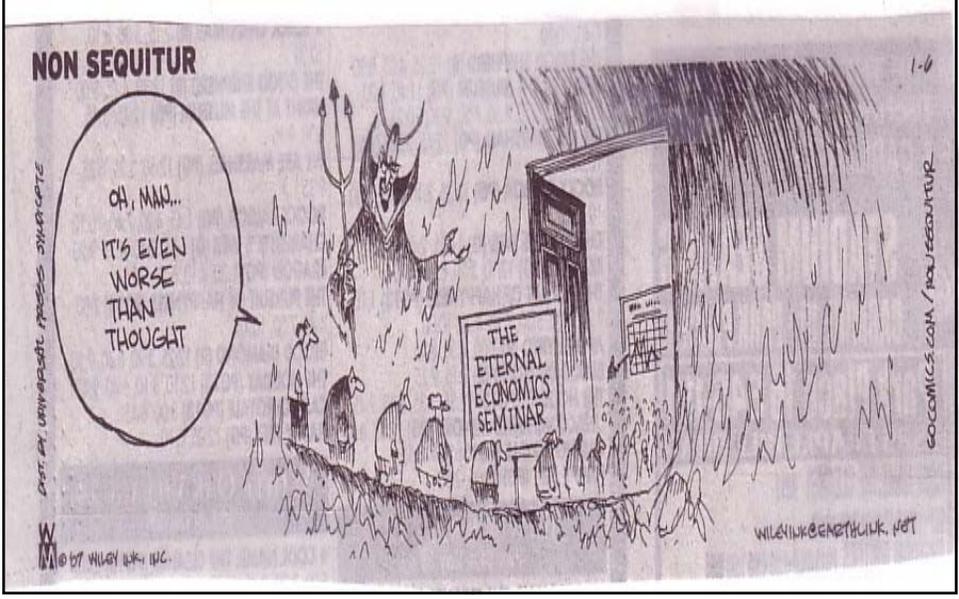
# The Ecological and Economic Values of Bottomland / Swamp Hardwoods in the South

Fred Cabbage and Erin Sills  
North Carolina State University

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



## Economics



NON SEQUITUR

OH, MAN...  
IT'S EVEN WORSE  
THAN I  
THOUGHT

THE  
ETERNAL  
ECONOMICS  
SEMINAR

WILSON BENTLEY

60COMICS.COM / NON SEQUITUR



## 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

Oswalt et al. 2014



## Key Bottomland Hardwood Valuation Questions

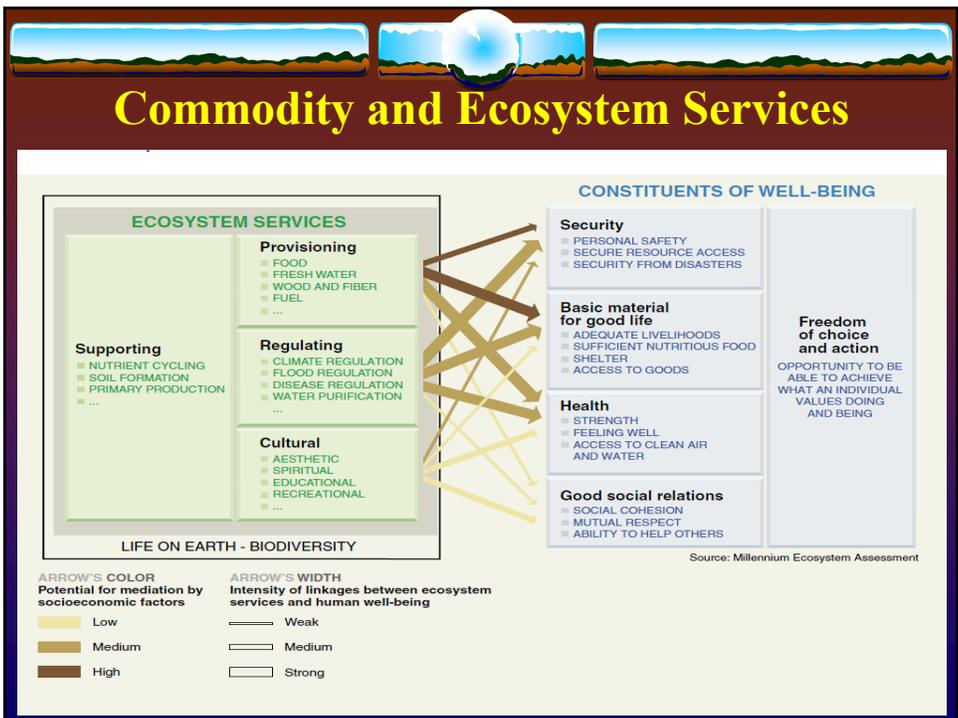
- Bottomland hardwood definition and area
  - Hydrology, soils, vegetation
  - Ecological, FIA, federal jurisdictional?
- Stocks and flows
  - Inventory, sinks, pools of goods or services
  - Annual or periodic flows
- Market and nonmarket values and prices
  - **Economic:** Timber, nontimber products
  - **Ecological:** Environmental services
    - with markets, or purely nonmarket

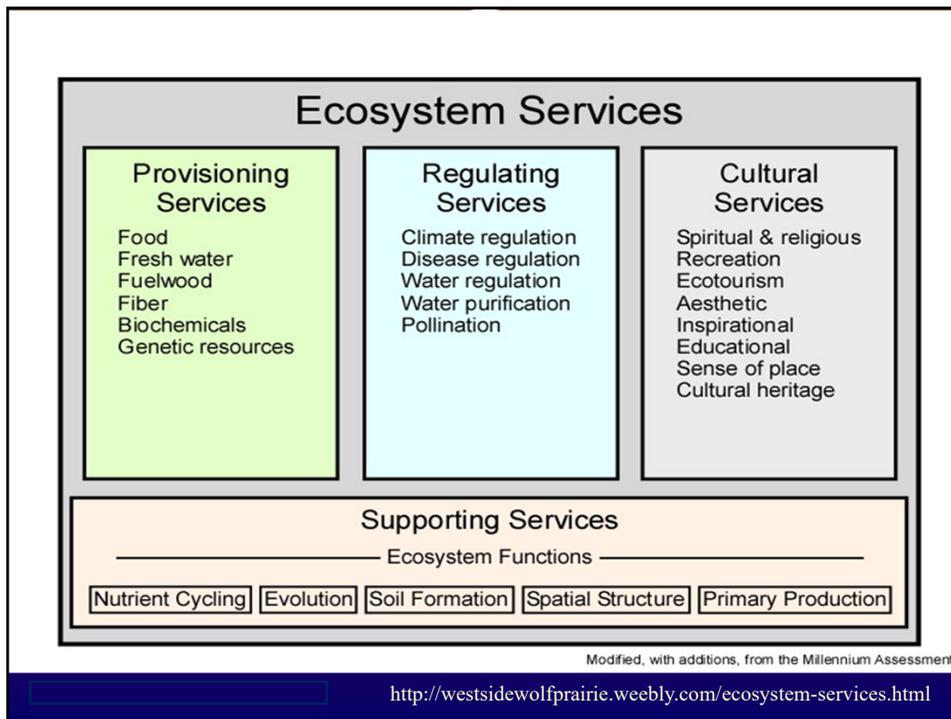


## Goods and Services

### Area, Stocks, and Flows

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

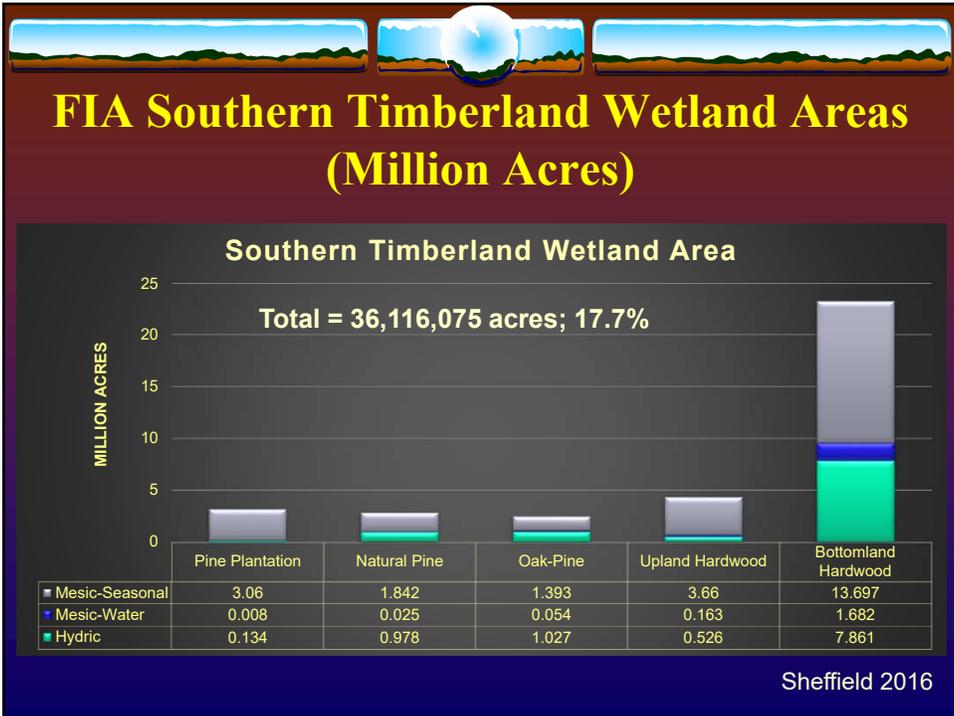
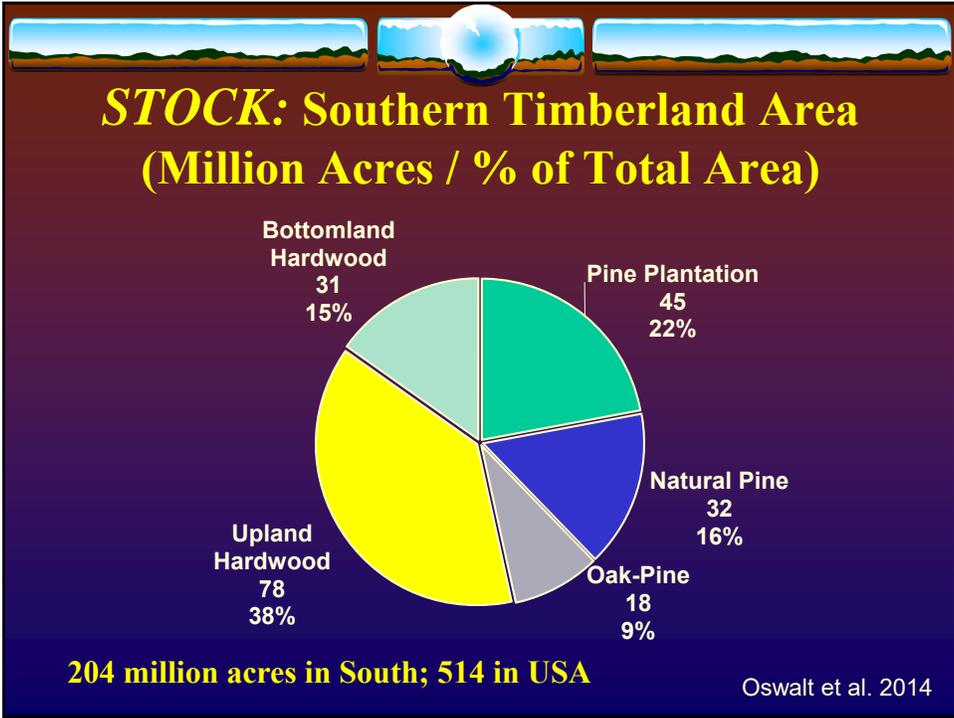


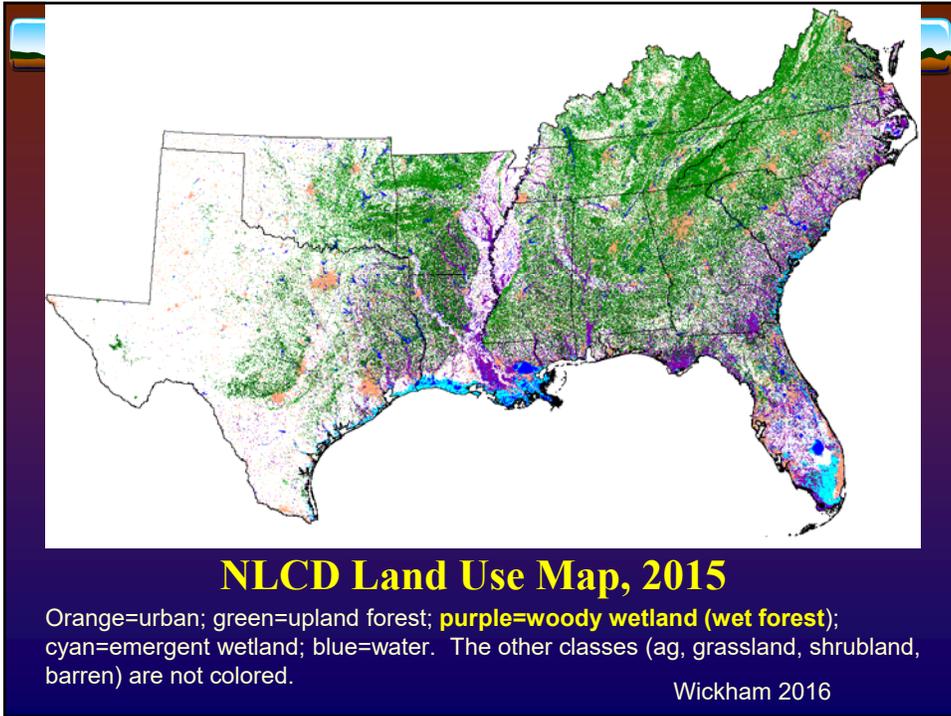


## Four Types of Goods and Services

- ❑ 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





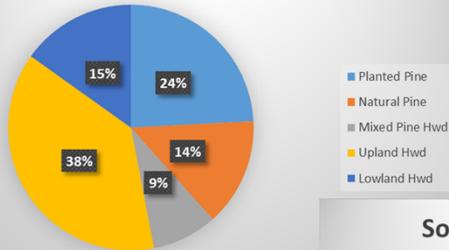
### Stocks and Flows: Southern Timber Volumes and Harvests

- **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

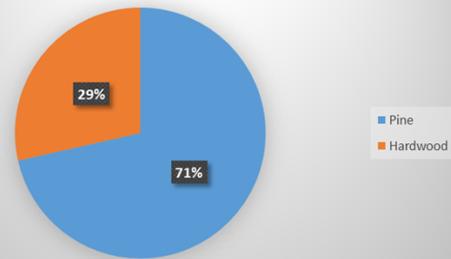
Oswalt et al. 2014

## Southern Timberland Acres and Removals

Southern Timberland Acres by Type

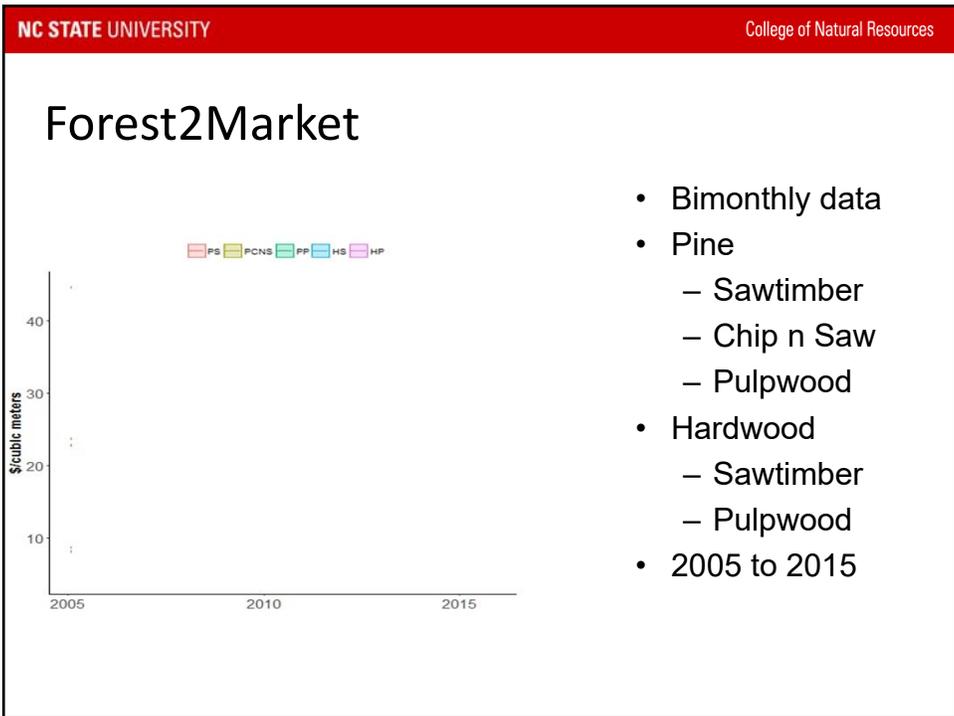


Southern Removals by Species



## Economic Values

Timber  
Nontimber Forest Products  
Payments for Ecosystem Services





**Montreal Process**  
**Sustainable Forest Management**  
**Key Economic Indicators**

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

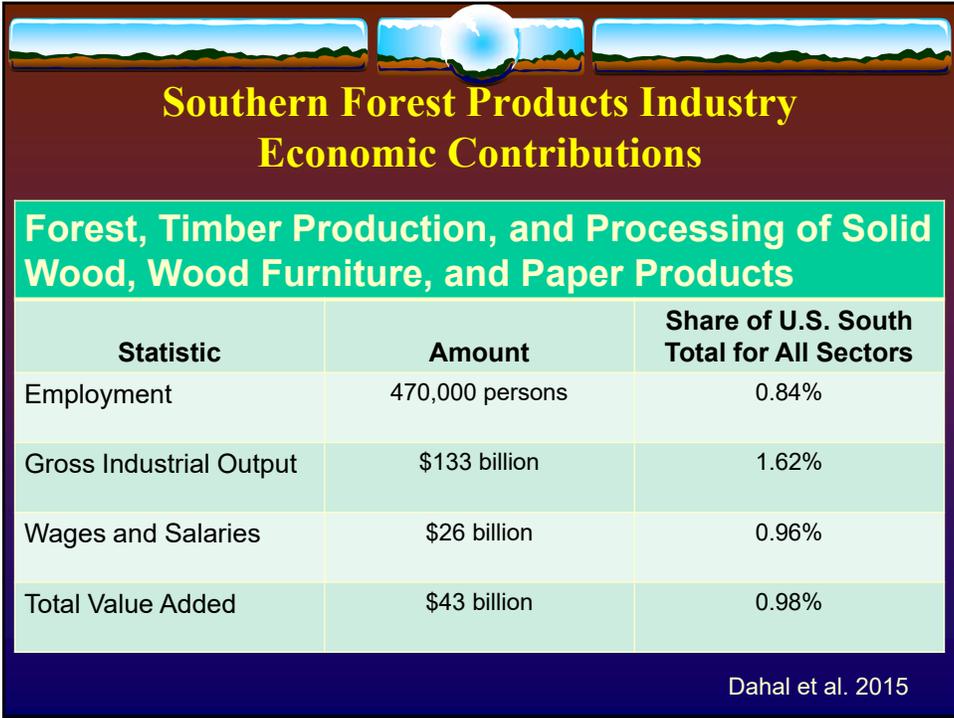
**And Computed Actual Prices and Payments**  
**For Timber, Nontimber, and Environmental Services**



**Montreal Process Indicator 6.25:**  
**Volume and Value of Wood Products**

Product	2006 (\$billion)
<b>Manufactured Forest Products Goods</b>	
Total USA Wood, paper, and furniture industries	309
USA Pulp and paper industries	165
USA Wood products	110
USA Wood furniture	34
Southern share of forest products industries value of shipments	160

National Report on Sustainable Forests 2010





**Southern Timber Stumpage Values, 2011**

Species Group	Harvest (billion cubic feet)	Harvest Value (\$million)
Total	8.0	4800
Softwoods	5.3	3180
Hardwoods	2.7	1620
Bottomlands @ 0.28% of Hardwoods	0.756	450

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.

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

National Report on Sustainable Forests 2010



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

Product	2005 (\$million)	2007 (\$million)
Government payments	378	366
Wetland mitigation banks	727	727
Hunting leases and entrance fees	405	410
Conservation easements	162	315
Conservation banks	34	34
Wildlife viewing	31	34
Carbon offsets	0.6	1.7
Total	1,737	1,887

National Report on Sustainable Forests 2010

## Comparative Estimated Southern Forest Values for Timber, Nontimber, and Environmental Payments

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

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
  - $Q_{\text{output}} * P$
  - 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



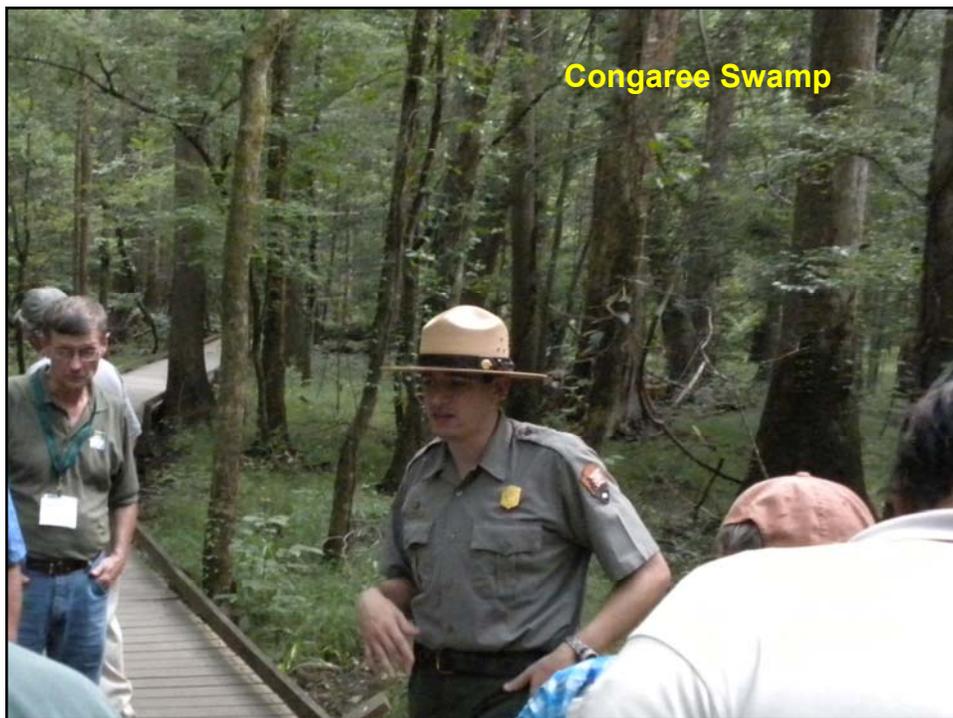
## **Financial Valuation**

- 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**

Environmental mitigation & conservation banking | Habitat planning | Westervelt Ecological Services - Google Chrome  
www.wesmitigation.com

**CREDITS**  
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**Experienced Professionals**  
With more than half a century of experience in the environmental industry, the senior planners, ecologists, landscape architects, economists, and engineers who guide the land acquisition process at Westervelt Ecological Services have successfully completed over 30 full restoration projects. Our team evaluates regional landscapes to identify potential restoration opportunities or valuable endangered species habitat.

**A Commitment To Projects**  
WES is one of six business units of The Westervelt Company. As stewards of more than 500,000 acres, we find our inspiration, our purpose, and our future in the land we manage. Each business is driven by a single long-term vision and a desire for sustainability. WES brings this vision and land ethic to all its banking projects to implement large-scale conservation - not just bigger, but better mitigation.

**History**  
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**Bird  
Watching**



**Citizen Science –  
Looking  
for Macro-  
invertebrates**





## 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)
- ❑  $Q_{\text{output}} * WTP * Q_{\text{people}}$
- ❑ 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

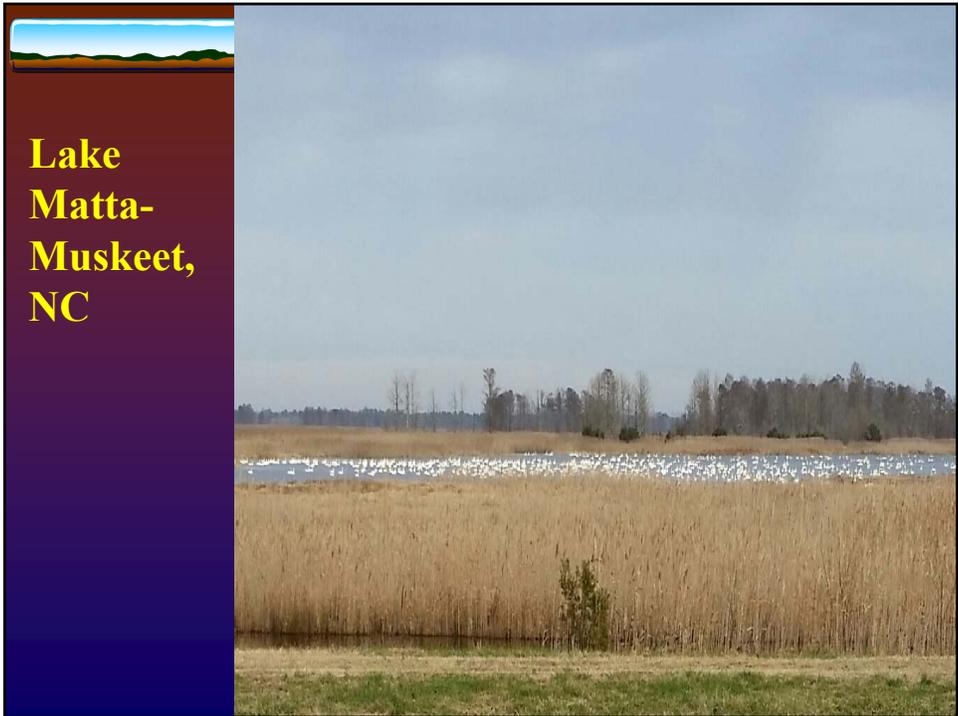
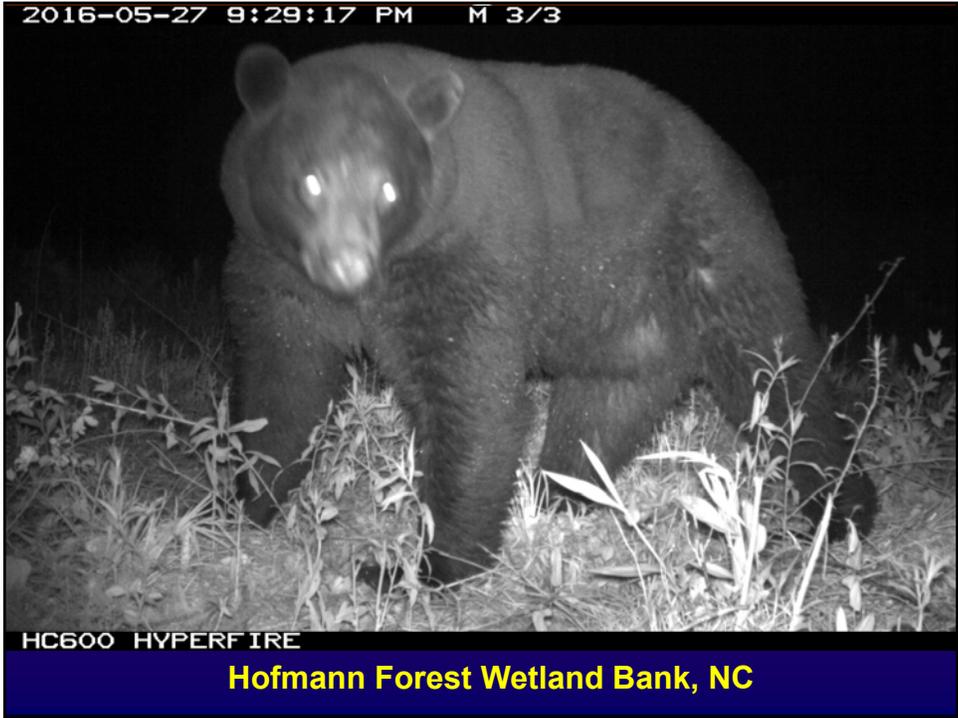
- ❑ *\*Regulatory, cultural, some provisioning*
- ❑ Full value not reflected in private economic decisions
- ❑ No obvious value to use in cost-benefit analysis of alternative policies or management
- ❑ Not included in valuation of forests as capital assets - the "natural capital" component of comprehensive 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







## 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
- 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

	Florida	Georgia	Texas
	<i>NIPF in FSP</i>	<i>Privately-owned</i>	<i>All forestland</i>
Timber	√		
Water	√	√	√
Carbon Stocks	√	√	√
Biodiversity (Habitat & Wildlife)	√	√	√
Pollination		√	
Cultural services		√	√



## Public and Political Recognition

- 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

State	Who	Scope	Total in billion/year
Virginia	VDOF/ VA Tech Yale/ PEC	All forests All land	Billions \$21.8
Florida	UFL/ Florida Forest Service	NIPF lands in FSP	\$2.06
Georgia	UGA/ GA Forestry Foundation	Private forests	\$37.6
Texas	Texas A&M Forest Service	All forests	\$92.9

- Build on New Jersey studies by Costanza et al. (2006), Liu et al. (2010)

## Motivation: State Studies

	Average Total Present Value (2010 USD) per hectare		
	Florida	Georgia	Texas
Timber	\$825		
Water	\$8,160	urban and suburban forested wetland: \$ 112,433 rural forested wetland: \$ 63600 riparian, non-wetland: \$23700 non-riparian, non-wetland urban: \$100 non-riparian, non-wetland rural and suburban: \$0	rural areas: \$2,667 urban areas: \$16,333
Cultural services		\$711 - \$63,695 depending on forest characteristics (riparian, road-buffer, habitat value)	rural areas: \$12,533 urban areas: \$27,067

## Ecosystem Service Accounting and Valuation: International

**System of Environmental-Economic Accounting 2012**  
Central Framework

Logos: United Nations, European Commission, Organisation for Economic Co-operation and Development, World Bank

**System of Environmental-Economic Accounting 2012**  
Experimental Ecosystem Accounting

White cover publication, pre-edited text subject to official editing

European Commission, Organisation for Economic Co-operation and Development, United Nations, World Bank

## Ecosystem Services in the US Forest Service

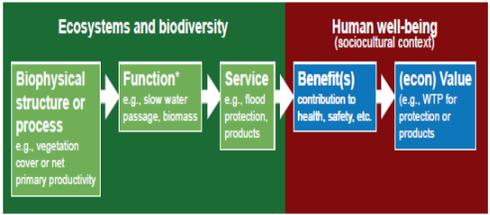


United States Department of Agriculture

### Integrating Ecosystem Services Into National Forest Service Policy and Operations



Forest Service    Pacific Northwest Research Station    General Technical Report GTR-493    January 2017



```

graph LR
    subgraph Ecosystems_and_biodiversity [Ecosystems and biodiversity]
        A[Biophysical structure or process  
e.g., vegetation cover or net primary productivity] --> B[Function*  
e.g., slow water passage, biomass]
        B --> C[Service  
e.g., flood protection, products]
    end
    subgraph Human_well-being [Human well-being  
(sociocultural context)]
        D[Benefit(s)  
contribution to health, safety, etc.] --> E["(econ) Value  
e.g., WTP for protection or products"]
    end
    C --> D
    
```

\* Subset of biophysical structure or process providing the service.

Figure 6—The U.S. Forest Service can join efforts to translate existing data about natural processes to human benefits via an ecosystem services approach. WTP = willingness to pay. (Adapted from Haimes-Young and Potchin 2010.)

## 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

