# Forest Carbon and Management Impacts on Optimal Rotation Ages for Loblolly Pine in the Southern U.S.

Don Hodges, Don Grebner, Robert Grala, and Prakash Nepal
University of Tennessee and Mississippi State University

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# Forestry's Role in Climate Policy

- Increasing interest in carbon sequestration through forestry in the U.S.
- U.S. forests offset 25% of $CO_2$ emissions during 1952-1995
- Afforestation considered as promising option to sequester additional carbon

# Outline

- Briefly describe major carbon sequestration programs in the United States.
- Identify general and technical issues associated with these programs.
- Evaluate trade-offs for loblolly pine management regimes producing traditional forest products, carbon, and/or bioenergy feedstock.

Photo: B. Lockhart

# Existing carbon registries and trading programs

- Chicago Climate Exchange (CCX)
- Regional Greenhouse Gas Initiative (RGGI)
- The California Climate Action Registry (CCAR)
- NGOs such as Climate Neutral Network, Clean Air-Cool Planet and Environmental Resources Trust, Ducks Unlimited, and EcoSecurities

# Chicago Climate Exchange

- Greenhouse gas (GHG) emission reduction and trading program for emission sources and offset projects in the United States, Canada, Mexico and Brazil.

- The most prominent emissions reduction and trading system in North America for all six greenhouse gases

**www.chicagoclimateexchange.com**

# Eligible Emission Offset Projects

- Landfill methane reduction in the U.S.;
- Agricultural methane reduction in the U.S.;
- Carbon sequestration in U.S. forestry projects;
- Carbon sequestration in U.S. agricultural soils;
- Fuel switching, landfill methane, renewable energy and forestry projects in Brazil.

# CCX Participants

- American Electric Power
- Green Mountain Power
- Manitoba Hydro
- TECO Energy, Inc.
- Ford Motor Company
- Rolls-Royce
- Motorola, Inc.
- IBM
- Aggregate Climate Credits Corporation
- International Paper
- Mead/Westvaco Corp.
- Temple-Inland, Inc.
- The City of Chicago
- University of Iowa
- University of Oklahoma
- Bayer Corporation
- Dow Corning
- Ducks Unlimited, Inc.

# Methods: CCX Forestry Protocols

- **Typical contract length: for 15 years**
- **Afforestation protocol**
  - Harvesting/thinning not allowed
  - 20% of earned credit placed in reserve pool

- **Managed forests protocol**
  - Need evidence of SFM
  - Harvests allowed except clear-cuts
  - Must establish a baseline of carbon stock
  - 20% of credit placed in reserve pool
  - Continuation from afforestation to managed forest contract possible

Source: ritchiewiki.com

# Methods: CCX Requirements

- **Long-lived wood products protocol**
  - Need evidence of SFM
  - Credits earned for carbon in use and landfills 100 years from the harvest
  - No reserve pool category

Source: climateforests.com

Source: martinfrost.ws

# Regional Greenhouse Gas Initiative (RGGI)

- **Cooperative effort between 10 northeastern U.S. states – CT, DE, MA, MD, NH, NJ, NY, RI, VT**
- **First mandatory, market-based $CO_2$ emissions reduction program in the U.S.**
- **Cap $CO_2$ emissions from Power generation sector**
- **Requires 10 % reduction in $CO_2$ by 2018**

**www.rggi.org**

# HOW RGGI WORKS

- **Multi-state $CO_2$ emissions budget that will decrease until 10 % less than initial value**
- **Individual $CO_2$ trading program in each state – via state-level regulations**
- **Electric power generators hold allowances equal to $CO_2$ emissions for 3 years**
- **Generators can buy, sell, or trade $CO_2$ emissions allowances**

**www.rggi.org**

# HOW RGGI WORKS

- **Proceeds from allowance auctions support 'low carbon intensity" energy solutions**
- **Offsets to help companies meet compliance regulations**

# RGGI OFFSET PROGRAMS

- **Landfill Methane Reduction**
- **Reduced Sulfur hexaflouride Emissions**
- **AFFORESTATION**
- **Reduced/Avoided $CO_2$ Emissions**
- **Reduced/Avoided Methane Emissions from agriculture**

**www.rggi.org**

# Ducks Unlimited, Inc. (DU)

Ducks Unlimited conserves, restores, and manages wetlands and associated habitats for North America's waterfowl.

# How DU's Carbon Sequestration Program Works

- Agricultural landowners contact DU to place a carbon easement on their land.
- DU works with the landowner to estimate carbon quantity and eligibility on proposed rules.
- DU markets carbon to investors.
- If there is investor interest, DU offers a competitive price to landowner for acquisition or easement.
- A full biological site assessment is conducted.

# How DU's Carbon Sequestration Program Works

- An easement is negotiated, often with recreational activities such as hunting and fishing allowed.
- A restoration and management plan is developed. The carbon ownership rights for the property are conveyed to DU, including periodic access to monitor the easement and measure carbon.
- DU pays the landowner for the easement.
- DU conveys the carbon rights to an investor in a separate agreement.

# Proposed Federal Policy

## *Waxman-Markey & Kerry-Lieberman Bills*

- Allowable Domestic Offset Projects
  - Afforestation/Reforestation
  - Improved forest management
  - Harvested wood products carbon accounting
  - Avoided forest conversion
  - Reduced deforestation
- International REDD Offset Projects

# General Issues

- Uncertainty of markets
- Diversity of programs
- Use of easements versus contracts
- Use of genetically modified trees
- Biofuel markets

# Technical Issues

- Difference in contract lengths between programs
- Optimal rotation ages
- Lack of growth and yield information between trees species

# Assessing impacts on southern U.S. Forest Management

- Review of effects on rotation decisions with carbon sequestration and enhanced bioenergy markets
- Preliminary empirical investigation of loblolly pine (*Pinus taeda*) mgmt.
- Conclusions from empirical results

# Basic Faustmann formulation

$$PV_F = (p_w v(T) - g)e^{-rT}$$

where

$p_w =$ timber price

$v(T)$ = timber growth function

g = regeneration cost

r = discount rate

# Inclusion of carbon cost

$$PV_F = p_w v(T)e^{-rT} - p_c \alpha(1-\beta)v(T)e^{-rT}$$

where

$p_c$ = implicit social value of carbon
$\alpha$ = conversion factor (volume wood to c)
$\beta$ = fraction of harvested timber in long-term storage

**From: van Kooten et al. 1995**

# Present Value of Carbon Uptake

$$PV_c = \int_0^T (p_c \alpha v(t) e^{-rt}\, dt$$

where

$p_c$ = implicit social value of carbon

$\alpha$ = conversion factor (volume wood to c)

$v$(T) = timber growth function

**From: van Kooten et al. 1995**

# Present Value of Timber and Carbon

$$PV = \frac{PV_c + PV_F}{1 - e^{-rT}}$$

**From: van Kooten et al. 1995**

# Enhanced Bioenergy Demand

Modeled as increased prices for small-diameter stems (pulpwood and smaller)

# Establishment Costs

| Activity | USD per ha |
|---|---|
| Herbicides (broadcast) | $159.73 |
| Herbicides weed control (band) | $54.98 |
| Mechanical site preparation | $148.26 |
| Seedlings and labor | $197.34 |
| Land use tax | $17.30 |
| Annual management costs | $12.36 |

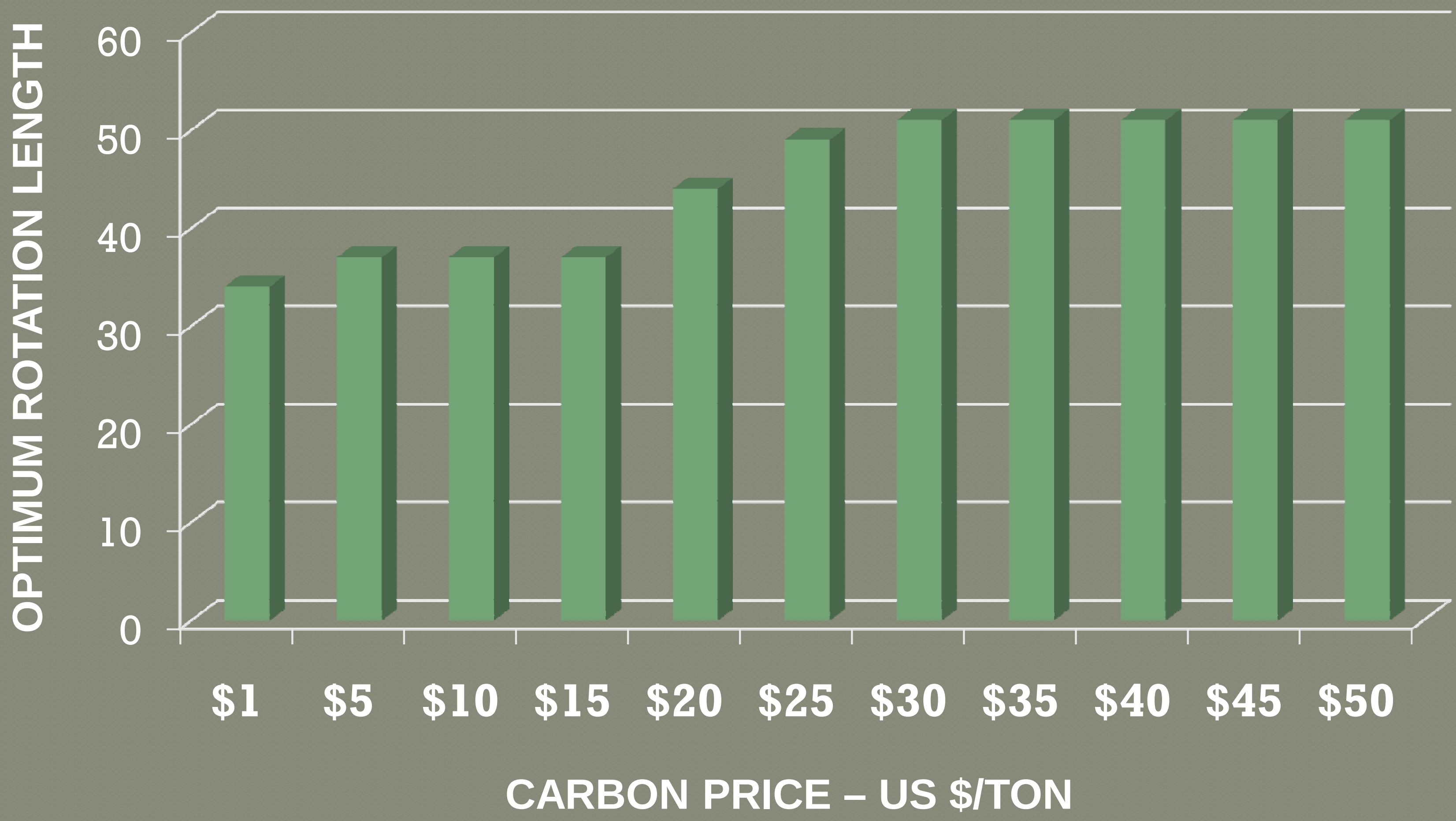
# Prices

| Activity | USD per metric ton |
| --- | --- |
| Pine Sawtimber | $32.94 |
| Pine Chip-N-Saw | $16.58 |
| Pine Pulpwood | $9.20 |
| Carbon | $4.41 |

# Timber Only Results

| | |
|---|---|
| Optimal Net Present Value: | $ 837.05/ha |
| | 35 years |
| Optimal Land Expectation Value: | $967.20/ha |
| | 34 years |

# Timber and Carbon Results



# Conclusions

- Timber and carbon is not necessarily incompatible. In fact, joint production often is a better option.
- As expected, carbon sequestration increased rotation length relative to timber only for all discount rates evaluated.
- The "pickling" factor reduces the optimal rotation length but not as dramatically as in some other studies such as Bjørnstad and Skonhoft (2002).
- Increased prices for woody biomass do not affect decisions substantially - < 2 years

# Conclusions

- Limitations
  - Prices and costs were assumed to be constant
  - Carbon in other pools (soil, forest floor) were not considered
  - Only selected management regimes were considered. Does not incorporate the effect of various silvicultural improvements
  - No participation costs related to enrollment in carbon offset programs were considered. Startup costs such as cost of inventory and management plans were not included in the analysis.