U.S. LUC Analyses in RPA National Assessments and Interfaces with the Forest and Agriculture Sector Optimization Model-Green House Gases (FASOMGHG)—Linkages Across the Land Base

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Forest and Ag GHG Modeling Forum—April 8, 2009

Collaborators

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Dhazn Gillig, TAMU
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Uwe Schneider, University of Hamburg
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Susan Stein, USDA Forest Service (S&PF)
Dave Wear, USDA Forest Service SRS

Sources of Support

USDA Forest Service
USEPA

Risk and Uncertainty, and Decision Making

- Xylitol and Willie the doxie
- Ken Skog's mention of discount rate (and the current economic challenge, subprime mortgages, toxic assets, stock market valuations, etc.)
- Projections can go down, stay the same, or go up
- IPCC Scenarios/Storylines—equal probabilities
- Fire on public lands—stochastic element in modeling
- Robert Beach's upcoming talk on insurance tomorrow
- Bruce McCarl's risk modeling
- Interconnections, intersectoral interactions, etc.
- Policy-informative vs. policy prescriptive

Outline of Talk

- **Background and History: Large-Scale Land Use Modeling in the US**
- **RPA Assessments and Total Land Base**
- **FASOM-GHG Modeling: Policy Context**
- **RPA and FASOM Ties**
- **Preliminary Results**
- **Summary, Wrap-Up, and Road Ahead**

Preventing GHG Emissions Through Avoided Land-Use Change

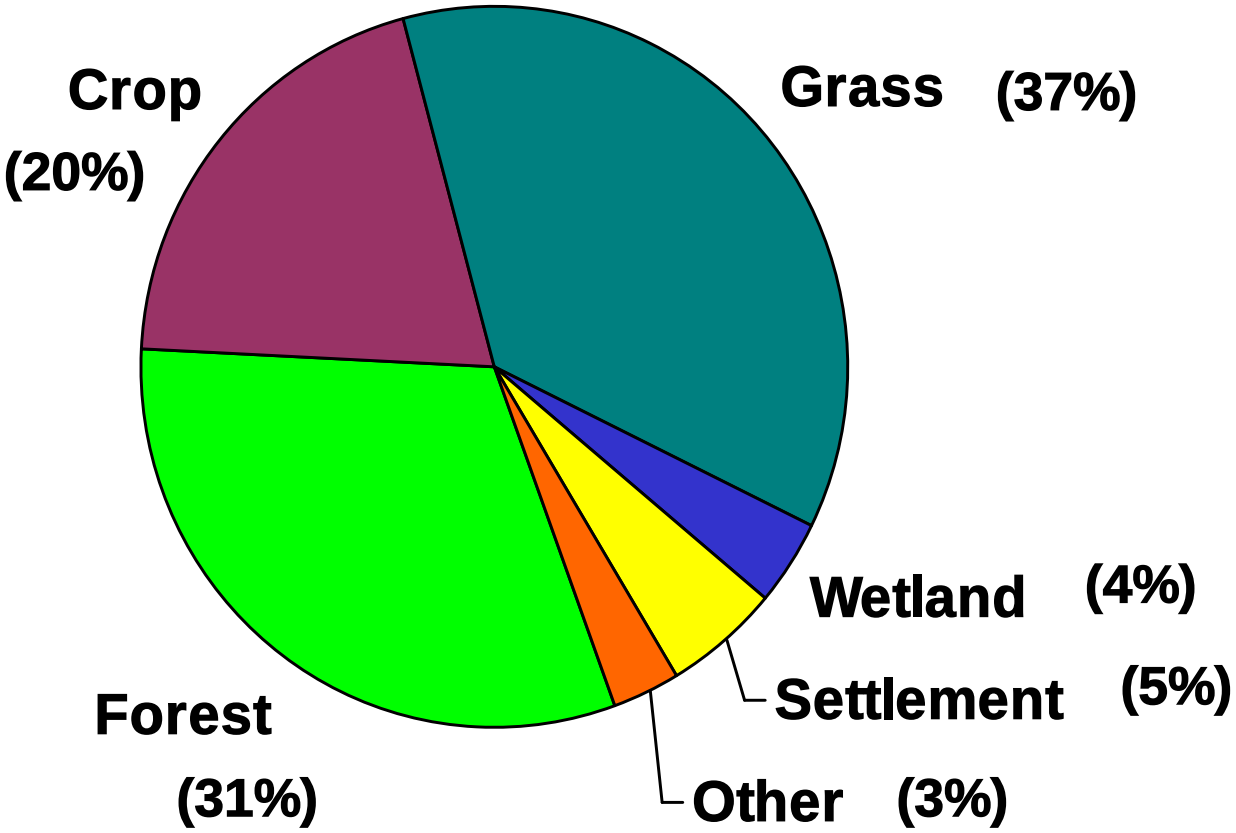
- April/May 2008: Society of American Foresters Task Force on Climate Change
- Globally, 1/3 of total carbon-related emissions between 1850 and 1998 due to forestland conversions
- Tools for Forest Retention or “Keeping Forests in Forests,” e.g., conservation easement
- Market-related effects for certain forest retention scenarios

Background: Previous Forum

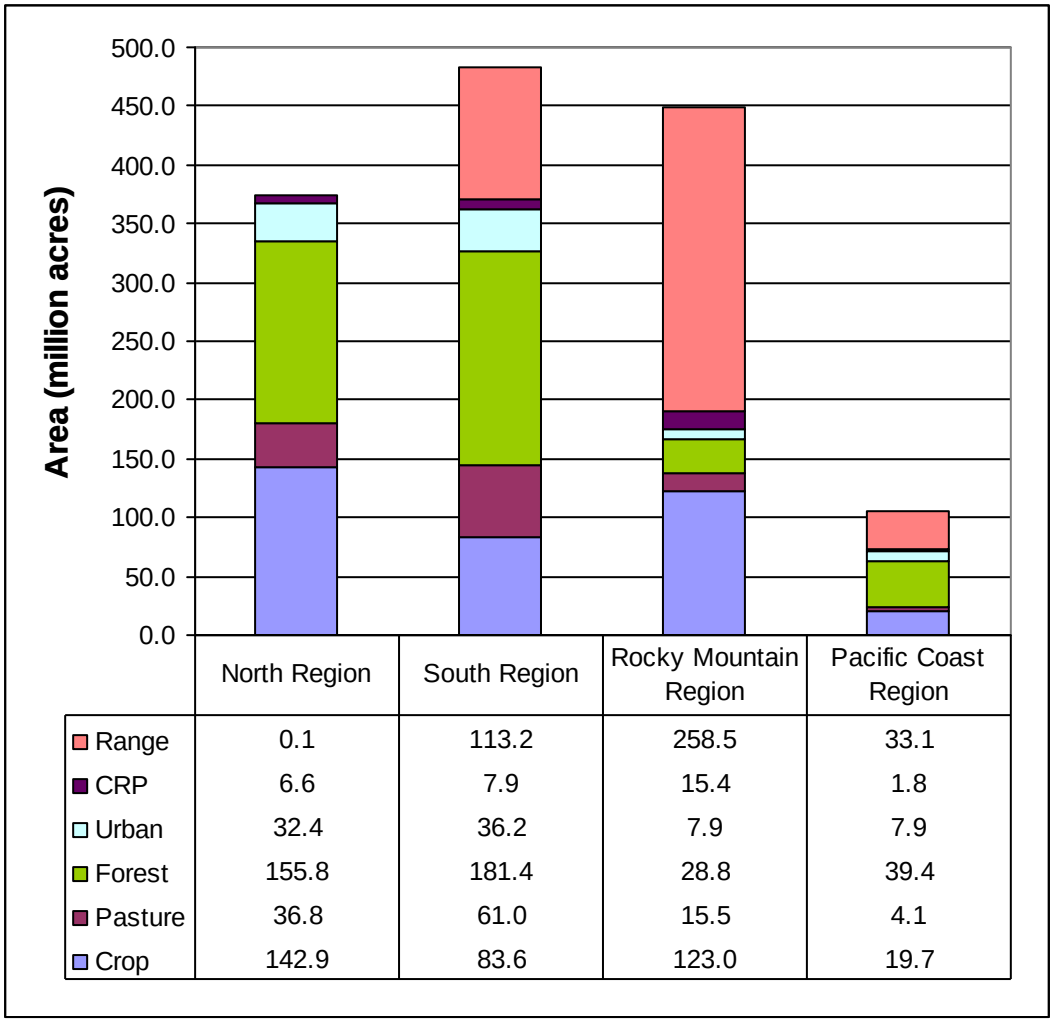
- Recent Trend: Two million acres of U.S. nonfederal rural land converted annually to developed uses
- Largest source is forest of land converted to developed uses
- Approximately one million acres per year of deforestation (roughly 8-10 times amount of that in Canada)
- Projections for >40 million acres of deforestation by 2060
- Tech. change affects demand for land, e.g., Green Revolution reducing pressure to convert forestland

US land uses, 2006

Source: **Inventory of US Greenhouse Gas Emissions and Sinks: 1990-2006, www.epa.gov/climatechange/emissions/index.html#inv**



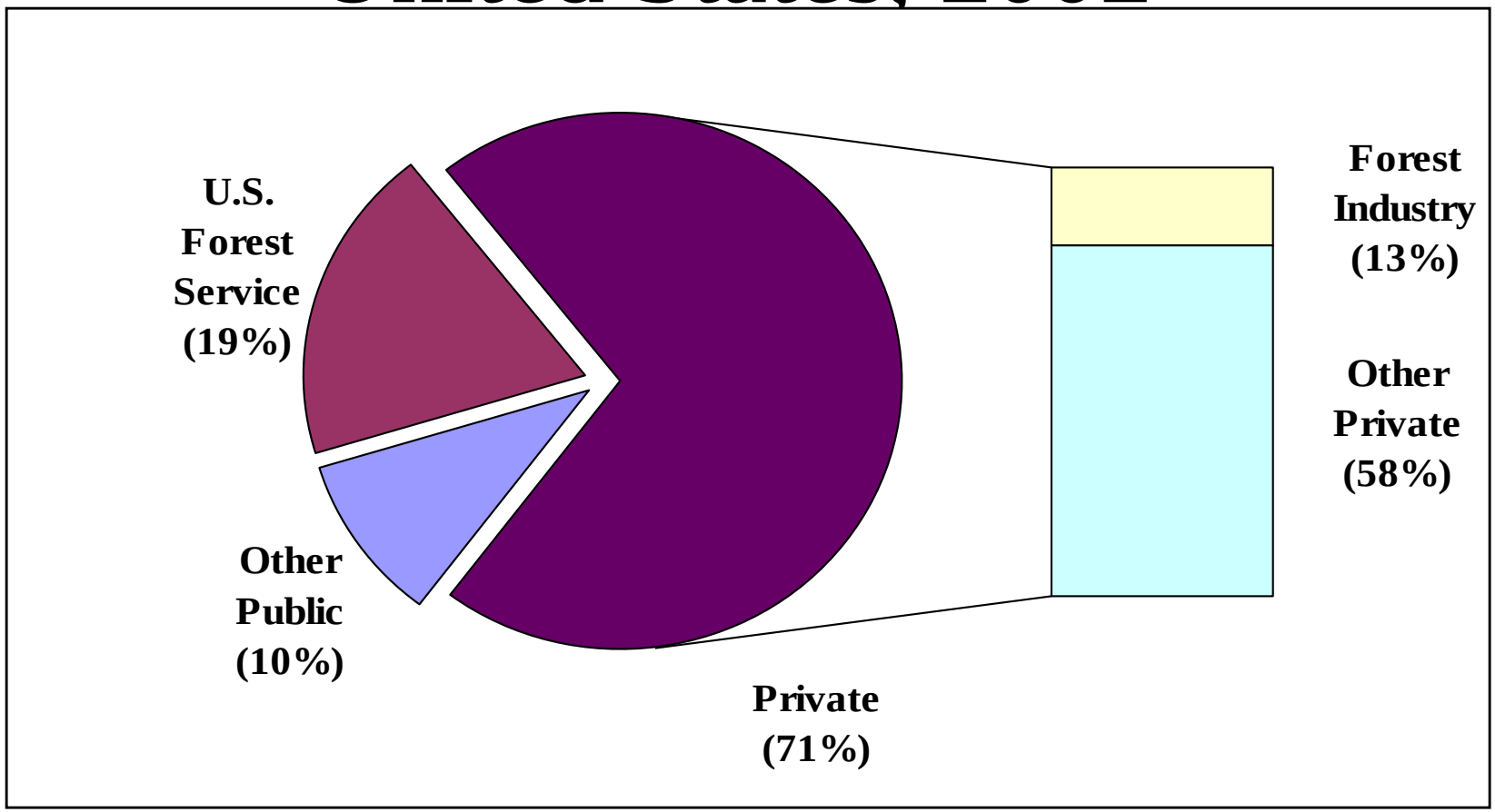
Allocation of nonfederal land by major use by region for the U.S., 2002



	North Region	South Region	Rocky Mountain Region	Pacific Coast Region
Range	0.1	113.2	258.5	33.1
CRP	6.6	7.9	15.4	1.8
Urban	32.4	36.2	7.9	7.9
Forest	155.8	181.4	28.8	39.4
Pasture	36.8	61.0	15.5	4.1
Crop	142.9	83.6	123.0	19.7

Data source: NRI

Timberland Ownership in the United States, 2002

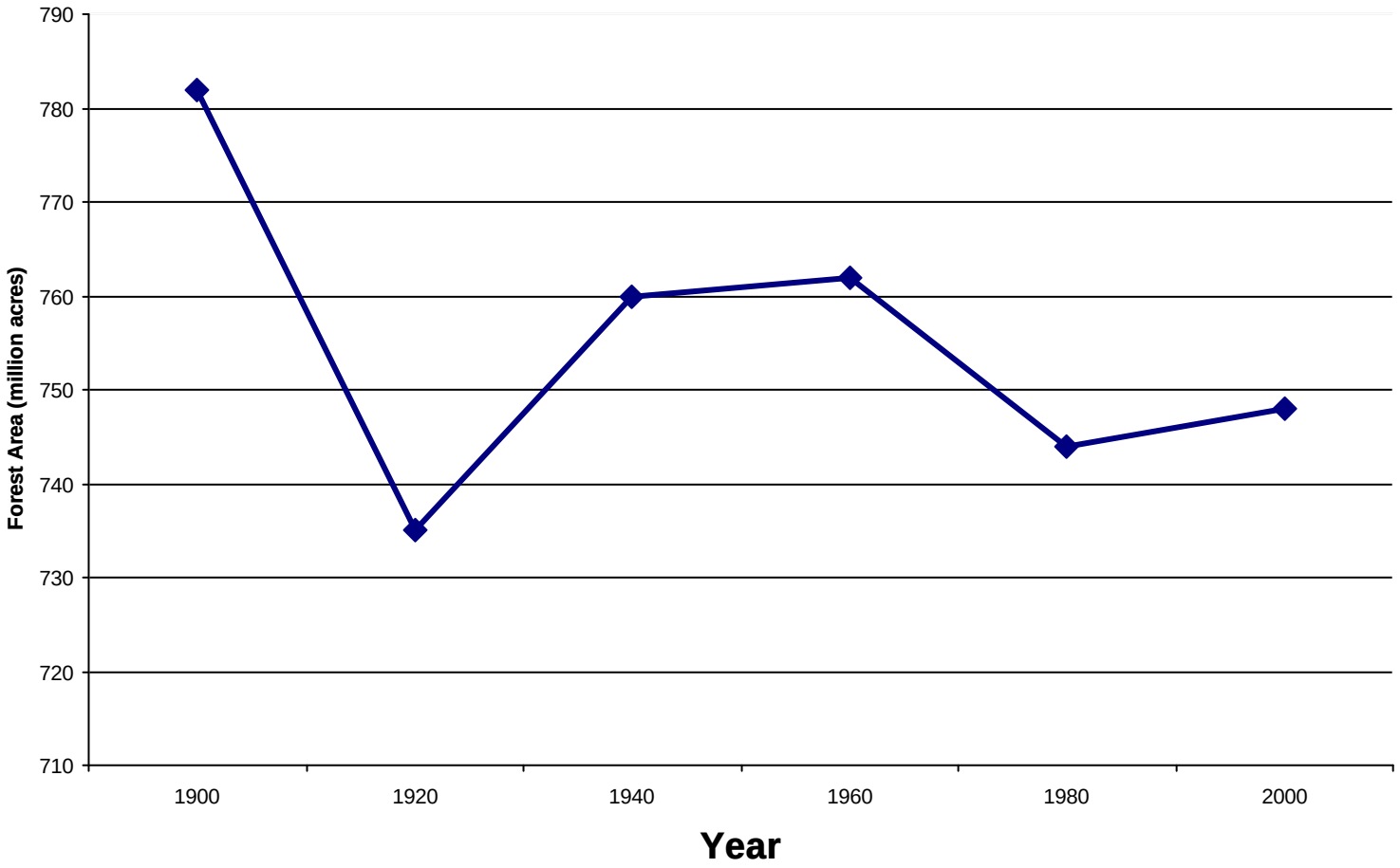


Source: Smith et al. (2004) GTR NC-241

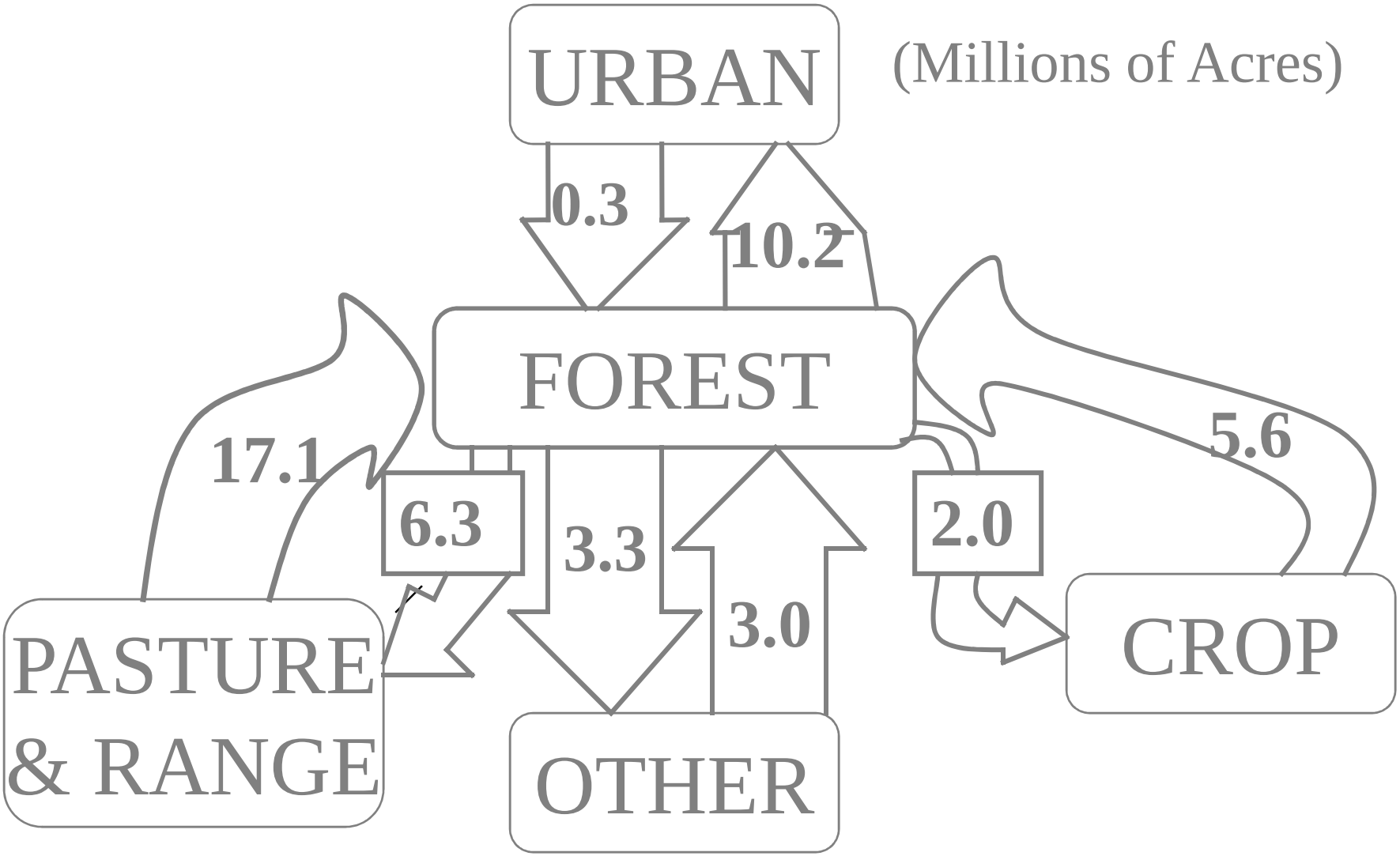
Parcelization—many private forested acres changing ownership

- **19 million acres of forest changed hands in 5 years (Mike Clutter, U of Georgia)**
- **Growth in area owned by Timberland Investment Management Organizations (TIMOs) and Real Estate Investment Trusts (REITs) since 1987 was 22% per year (Hancock Timber Resource Group)**
- **Number of family forest owners increased from 9.3 million in 1993 to 10.3 million in 2003**

Trends in U.S. Forest Area, 1900-2000 (source: RPA\FIA)



Sources and Sinks of U.S.Forestland, 1982-1997



Source: USDA NRCS, NRI

Uncertainty . . . Forest Policy on Feedstock Development

Where will extra land come from to grow biomass for energy, given <u>exponential growth</u> in withdrawals for land protection (not to mention urbanization and other development)?

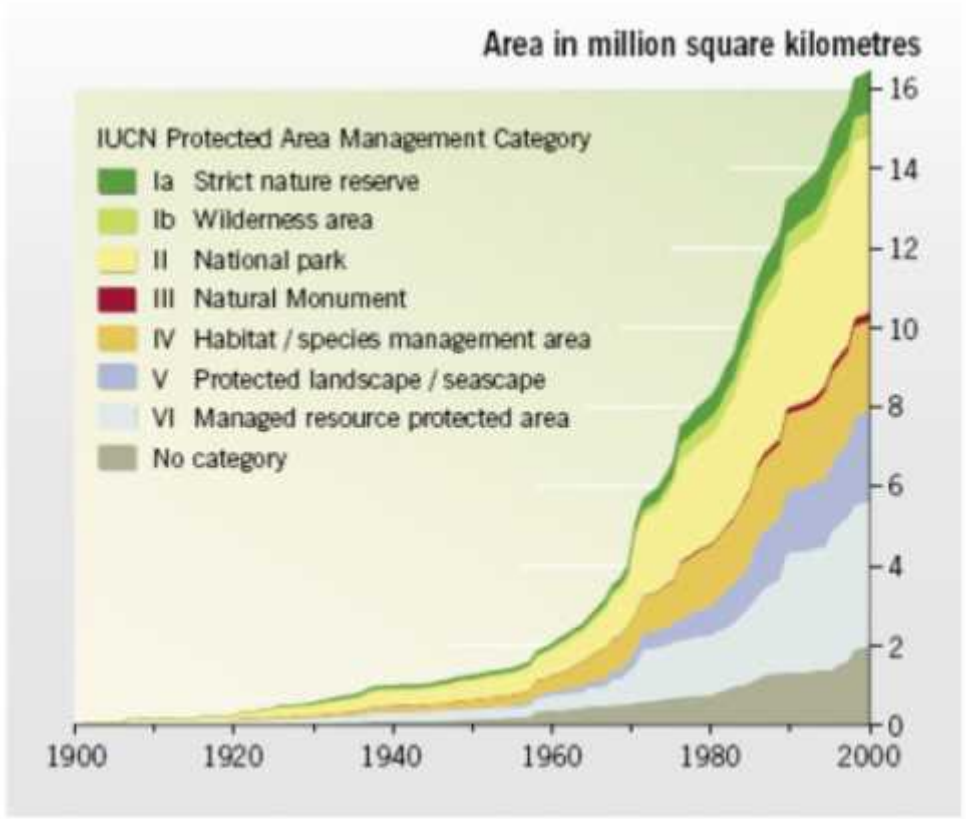


Figure 5.3 Trends in terrestrial surface under protection (CBD, 2006).

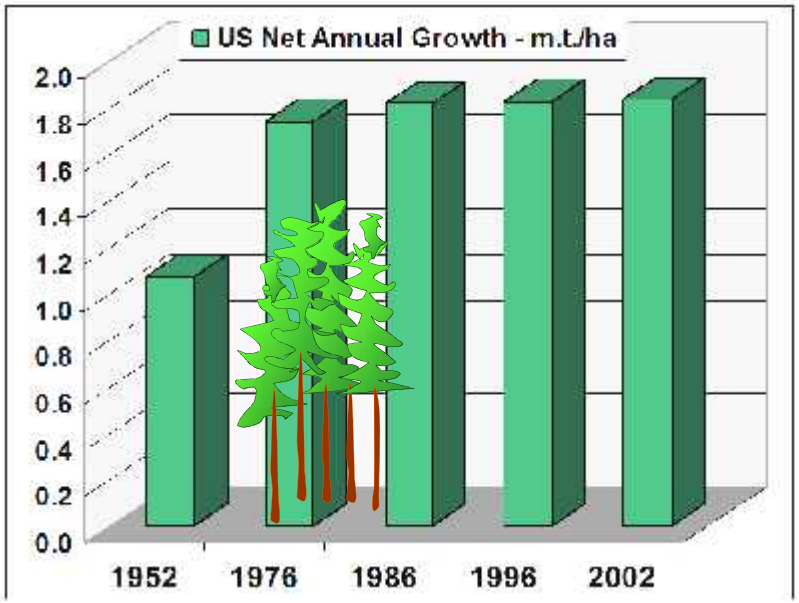
Source: Lysen, Erik, and Sander van Egmond (Eds.). 2008. Assessment of global biomass potentials and their links to food, water, biodiversity, energy demand and economy: Inventory and analysis of existing studies. Netherlands Environmental Assessment Agency MNP.

Biomass feedstock economics

A quantifiable source of uncertainty –

Future productivity of wood biomass . . .

Net annual growth of timber on all US timberland has leveled out at ~1.8 m.t./ha
(Forest Service FIA Database)



Meanwhile, silviculture & commercial tree genetics promise future productivity of 25+ m.t./ha (in USA)

[More than 10X higher!
. . . But at higher cost]

ARBORGEN

Land-use Data

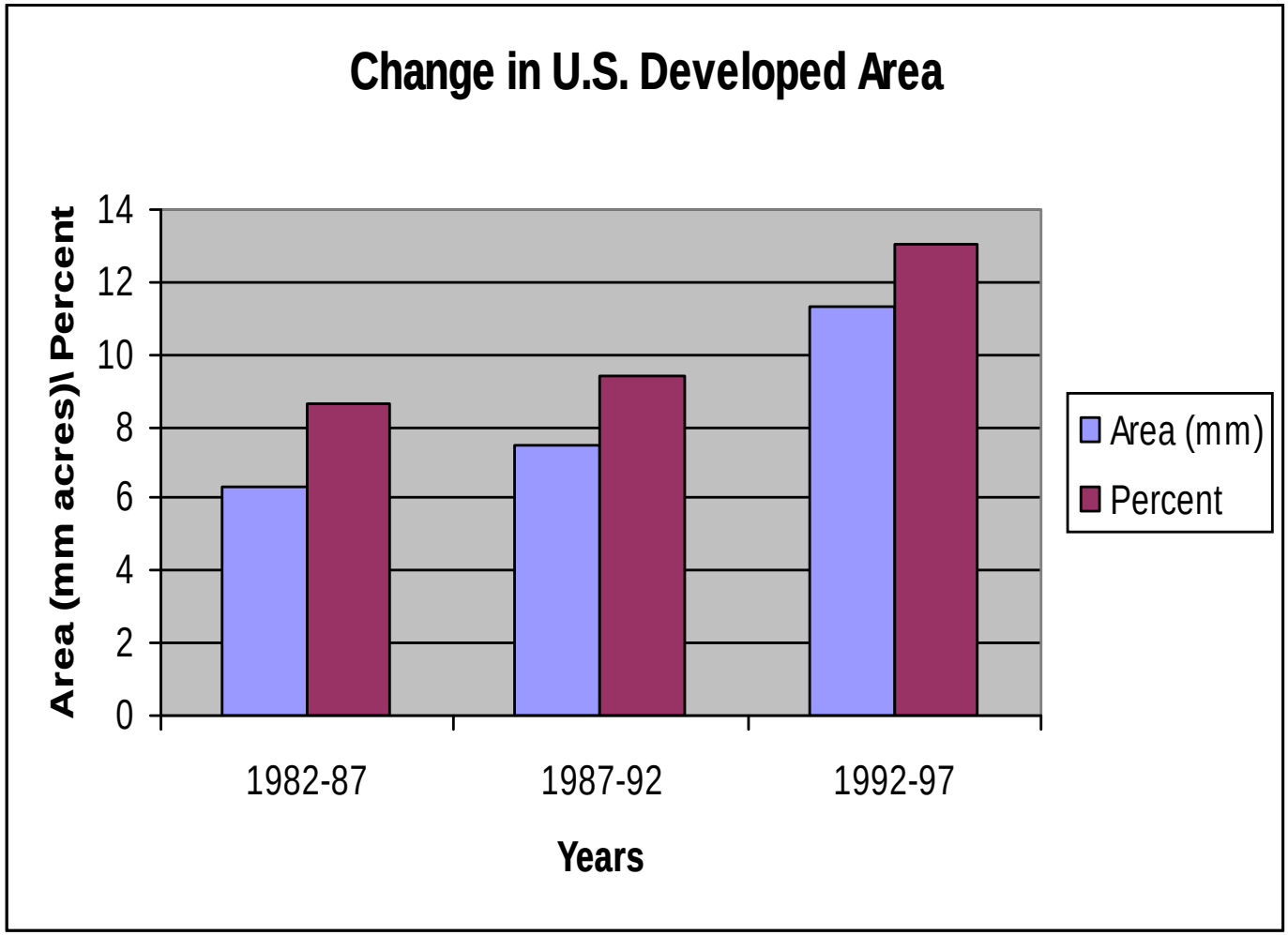
- FIA, NRI: latter has two-way flows vs. net changes
- Land productivity: ground surveys
- National consistent set of data
- Forestry: existing timber stocks, site productivity, forest types, age class (region, owner, forest type, existing or new, age class, site class, etc.)

Resources Planning Act Assessments

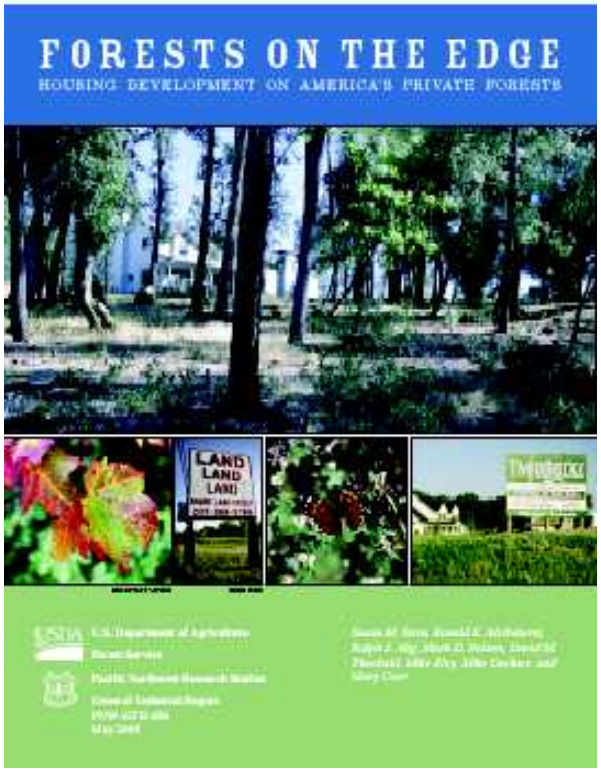
- 1979: expert opinion
- Early 1980s—Southern area model, tested in Special Study of "South's 4th Forest"
- Other regional, econometric models of land-use change
- National econometric model
- 2010 RPA Assessment, IPCC scenarios

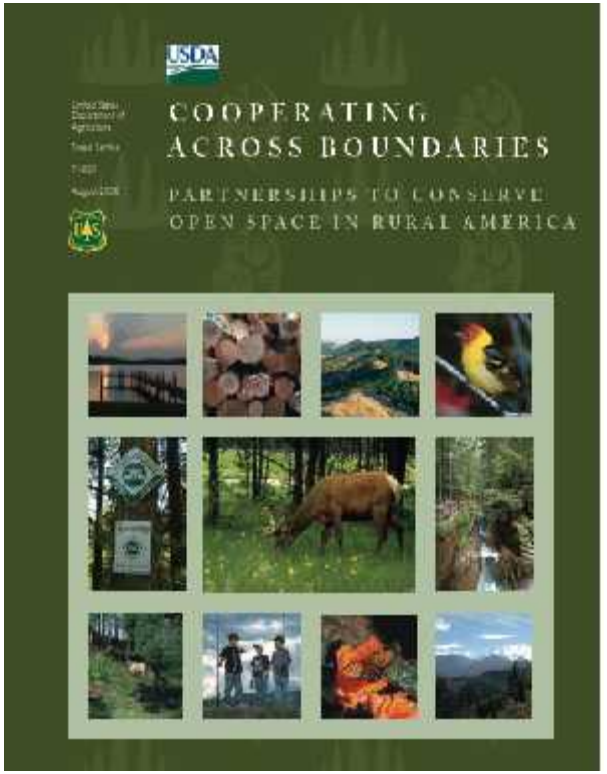
Forest-Ag Modeling

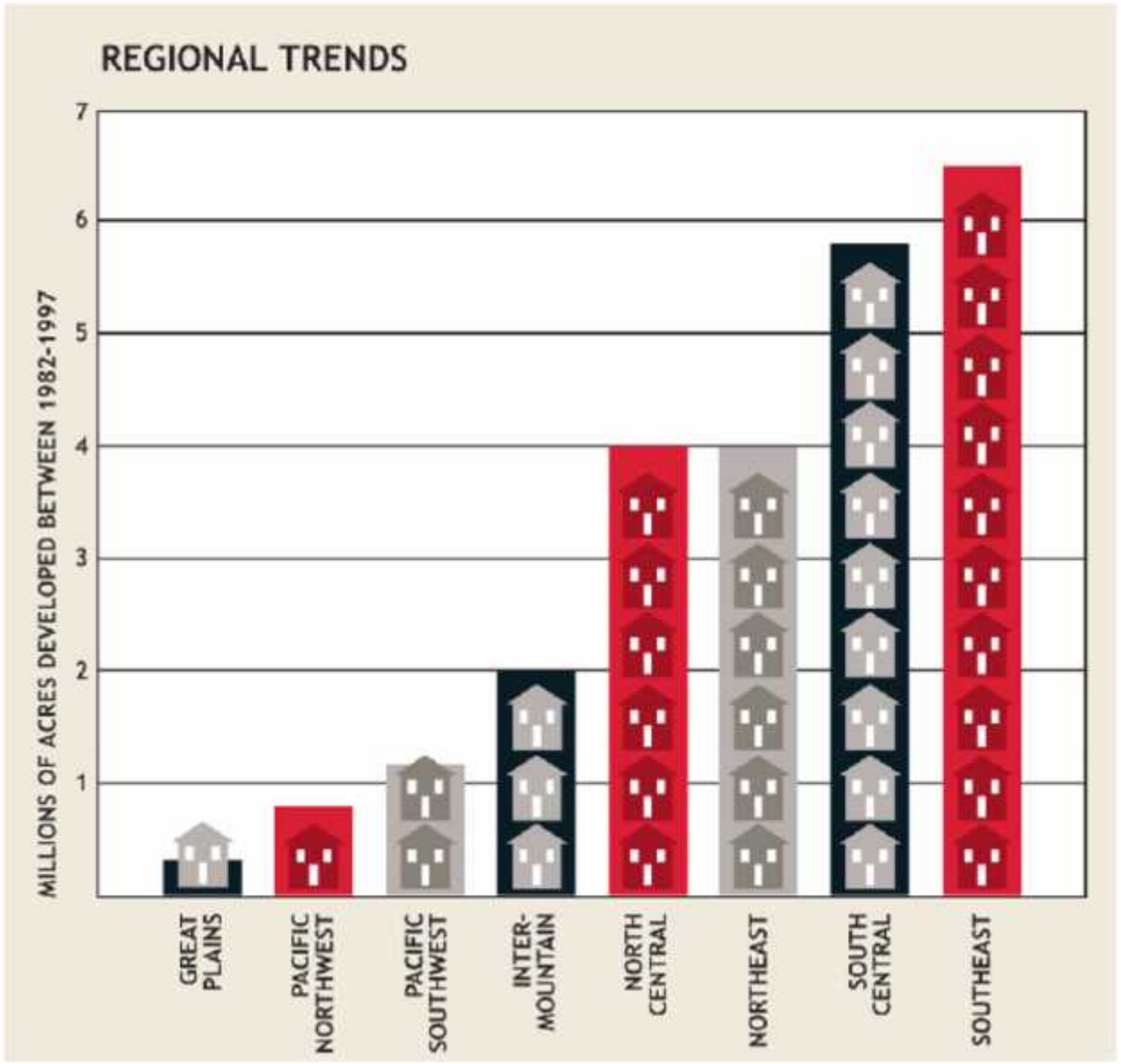
- Forest land viewed as reservoir of potential cropland (CARD)--1979
- USDA Basic Assumptions Working Group—ERS's NIRAP, FS's model of urban and developed land (Alig and Healy)
- SE CARD Model with Forest Sector
- RPA Total Land Base Model
- FASOM

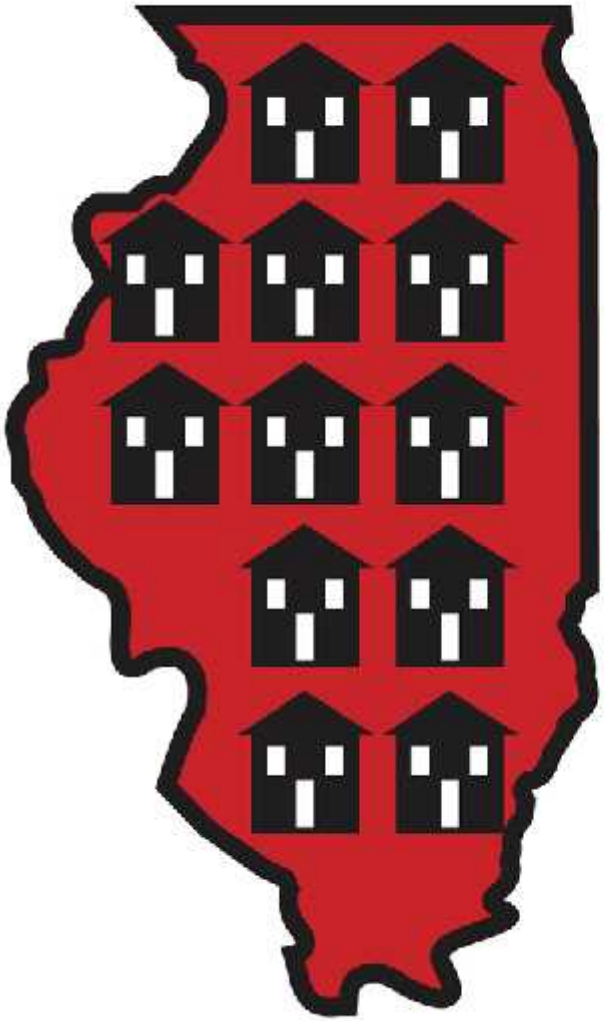

Change in U.S. Developed Area
Area (mm acres)\ Percent
14
12
10
8
6
4
2
0
1982-87
1987-92
1992-97
Years
Area (mm)
Percent

www.fs.fed.us/openspace



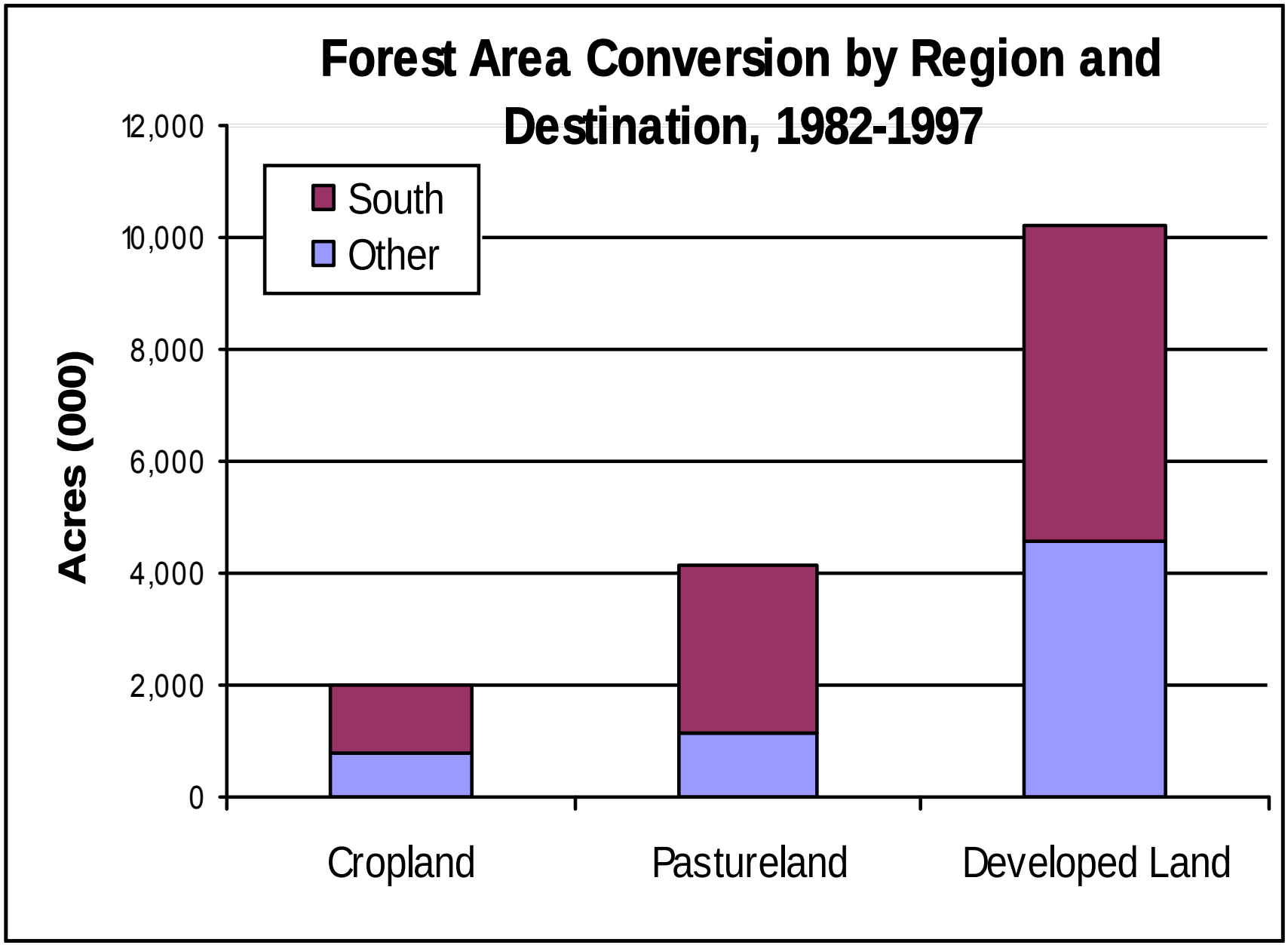



REGIONAL TRENDS
MILLIONS OF ACRES DEVELOPED BETWEEN 1982-1997
7
6
5
4
3
2
1
GREAT PLAINS
PACIFIC NORTHWEST
PACIFIC SOUTHWEST
INTER-MOUNTAIN
NORTH CENTRAL
NORTHEAST
SOUTH CENTRAL
SOUTHEAST

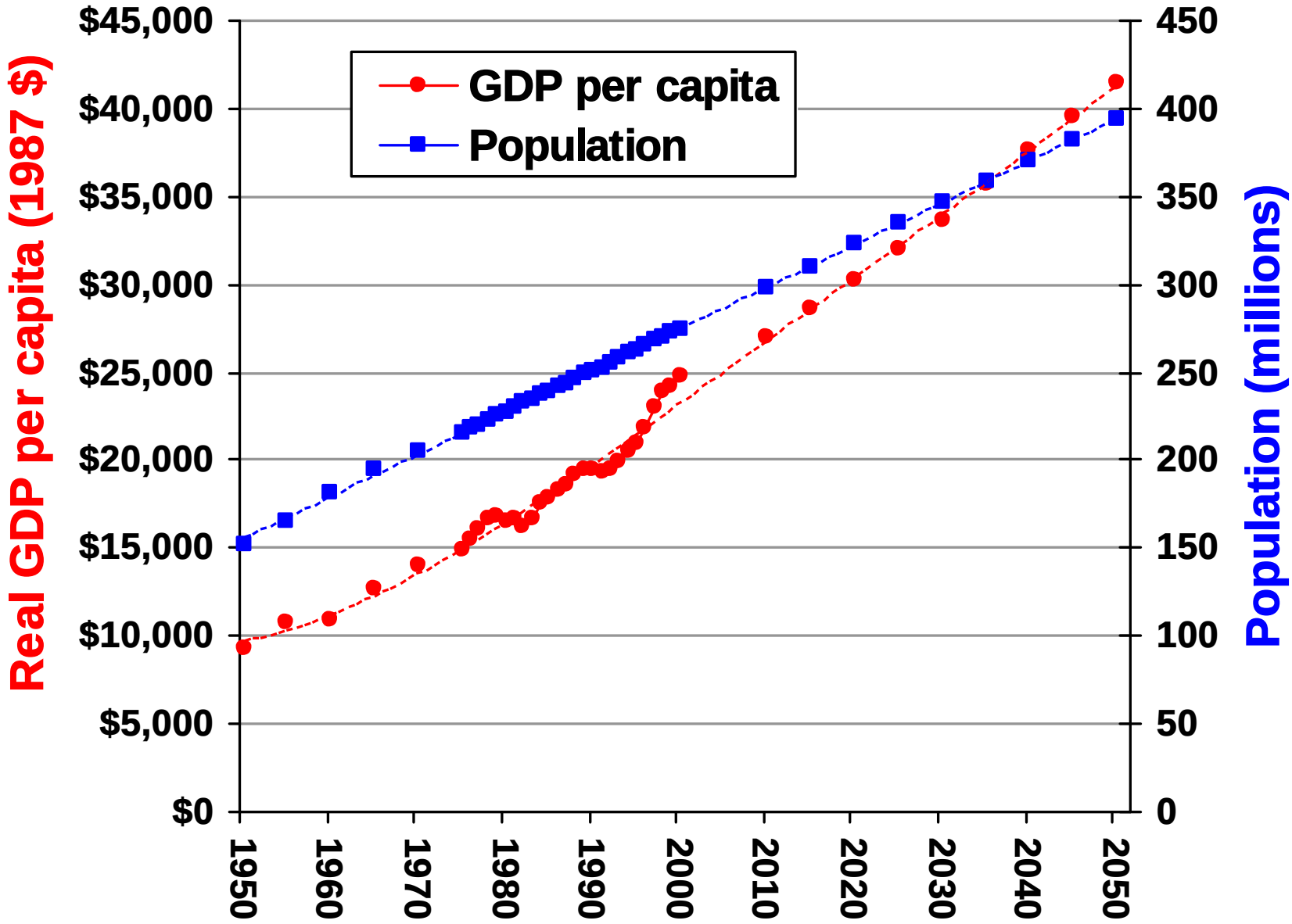


SHRINKING SPACES

From 1982 to 2001, 34 million acres of open space were converted to development. That's equivalent to the state of Illinois.


Forest Area Conversion by Region and Destination, 1982-1997
Acres (000)
12,000
10,000
8,000
6,000
4,000
2,000
0
South
Other
Cropland
Pastureland
Developed Land

U.S. Population and real GDP per capita



More Changes in Demand For Land-Looking Ahead

- World population to grow from 6 to 9 billion by 2050
- National population to grow by 120 million: ~40% increase
- Regional (West) population to grow by 5 million ~70% increase
- Higher average personal incomes
- Increased demand for land to produce biofuels

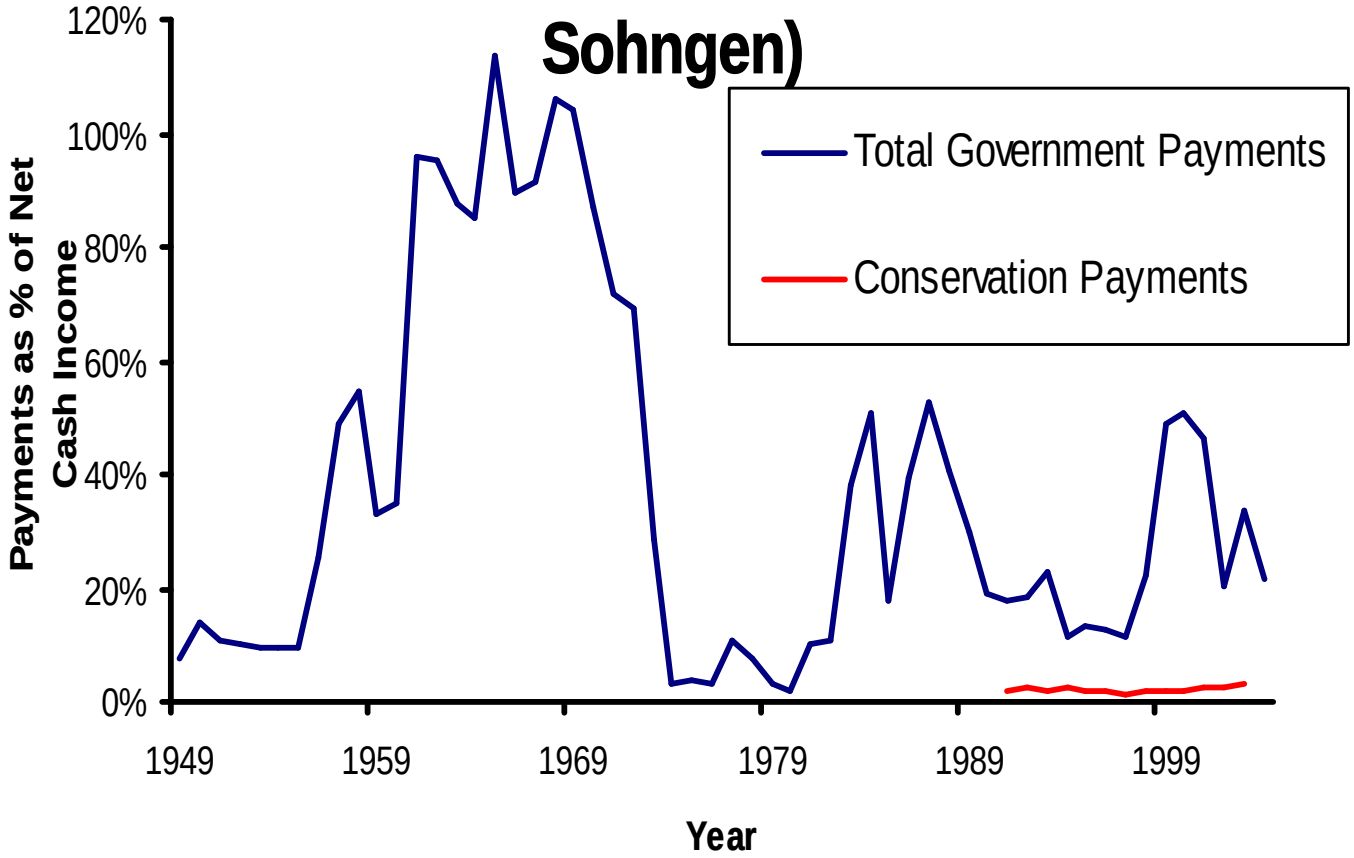
U.S. National Econometric Model of Land Use: RPA Applications

- Ruben Lubowski's PhD work at Harvard
- Collaboration with Andrew Plantinga, Oregon State University
- Application in the 2010 Resources Planning Act Assessment: Projections of areas for major land uses, such as for developed land, for nonfederal land, at county level

Forestry Intertwined with Cycles Involving Agriculture

- Soil Bank Program example
- World Demand for Agricultural Crops
- Conservation Reserve Program (nation's largest tree planting program)
- Freedom to Farm legislation/Record spending on farm programs

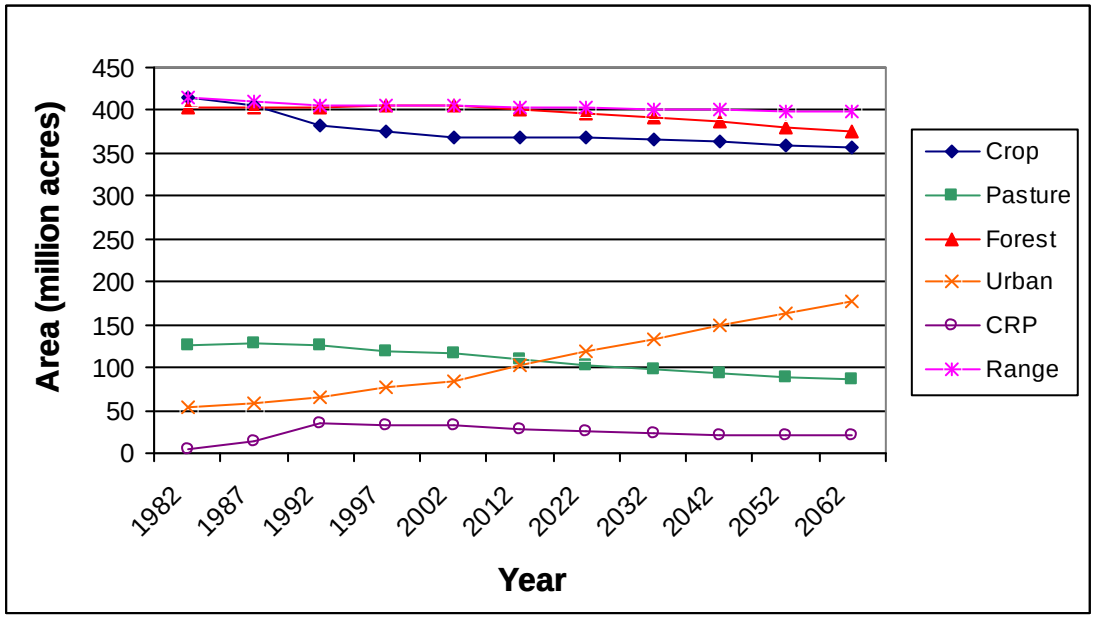
Farm Program Payments Can Reduce Forest Area (slide from Brent Sohngen)



Intersections in the South

- Region has large amount of timber harvests
- Has many acres suitable for use in either agriculture or forestry
- Had relatively large increase in developed area in recent decades
- Implications for production possibilities

Historical and projected land-use trends on nonfederal land in the U.S., 1982 to 2062



Forest and Agricultural Sector Optimization Model (FASOM)-GHG

- Unique features:
  - Links forest and ag commodity markets,
  - Connects those markets to private land use decisions (for crops, pasture, forest)
- 5-year time step for optimization, typically 80-100 year time horizon
- CO_2, methane, and nitrous oxide emissions
- Underlying biophysical yields for ag, forest (including long-term forest growth process)
  - Can be adjusted to reflect projected impacts of climate change

FASOM-GHG GHG Accounting

- Comprehensive for forestry and agriculture, and carbon on developed land
- Forest pools: standing stock, understory, below ground (Linda Heath, Jim Smith, and Rich Birdsey)
- Carbon in wood products (Ken Skog)
- Soil carbon dynamics with land use change between forestry and agriculture

FASOM Application

- EPA's policy question (1995)—expand area of southern pine plantations, effects on carbon seq. and timber and ag markets
- Leakage—countervailing land transfers
- Unintended consequences

FASOM-GHG research examples

- What may be the socio-economic impacts of climate change on the U.S. forest sector and recreation?
  - National climate change assessment: Irland, Adams, Alig, et al. (2001) *Bioscience*
- What may be the impacts of climate change on U.S. forest and ag. sectors and carbon budgets?
  - Alig et al. (2002) *Forest Ecology and Management*
- What is the economic potential for forestry and agriculture to supply GHG mitigation? (EPA, 2005)
- What is the magnitude of leakage from forest carbon sequestration projects/programs?
  - Alig et al. (1997) *Environmental and Resource Economics*
- How competitive would biomass-fueled energy be?
  - McCarl, Adams, Alig, et al. (2000) *Annals of Operations Research*

Forestry/agriculture mitigation options

- Ag soil C-sequestration: crop tillage, crop mix, fertilization, grassland conversion
- Afforestation: from crop, pasture lands
- Forest management: harvest rotation, timber management intensity, forest set-asides
- Ag CH_4 and N_2O: enteric fermentation; livestock herd size, management; manure management; rice acreage; crop tillage, crop mix, crop inputs
- Crop fossil fuel: crop tillage, crop mix, crop inputs, irrigation/dry land mix
- Biofuel offsets: produce crop or woody feedstocks

PROJECTIONS USING FASOM-GHG MODEL

- FASOM-GHG MODEL: 2008 Version
- Model runs by GREG LATTA and BRUCE MCCARL
- 80-year model runs, focus on first 50 years of projections in talk
- Funding assistance by EPA

Exogenous amounts of Deforestation to Developed Use in the Base Case

- Average exogenous loss of forest area to developed uses is more than 7 million acres per decade over next 50 years
- Largest losses are in the South and NE

Scenarios: FOREST TO DEVELOPMENT

- 2X BASE amount
- No loss of timberland to developed uses

Carbon Price Scenarios

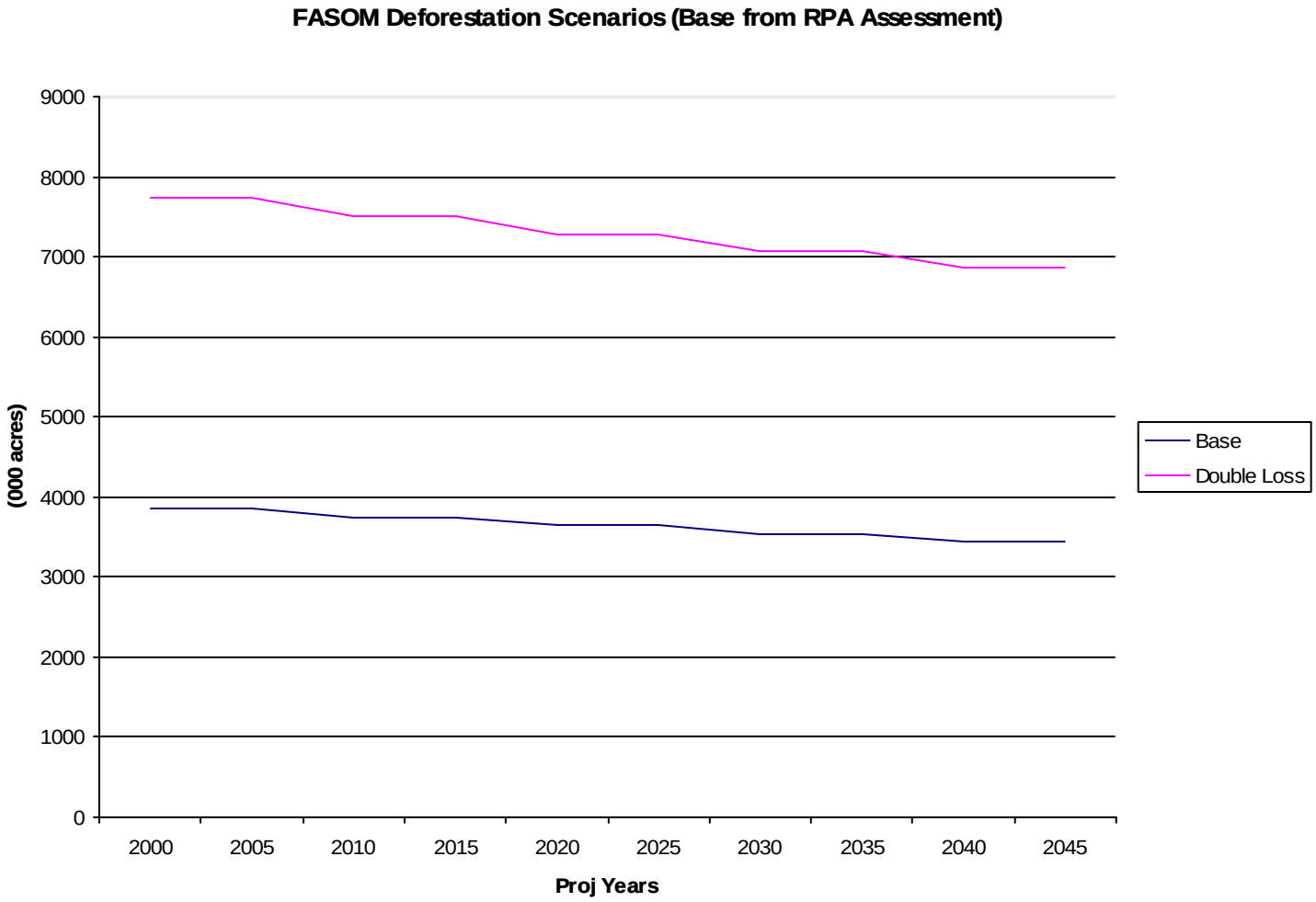
- $25 and $50 per tonne (CO2 equivalent)
- Constant prices used in this analysis
- Reflected in FASOM-GHG objective function

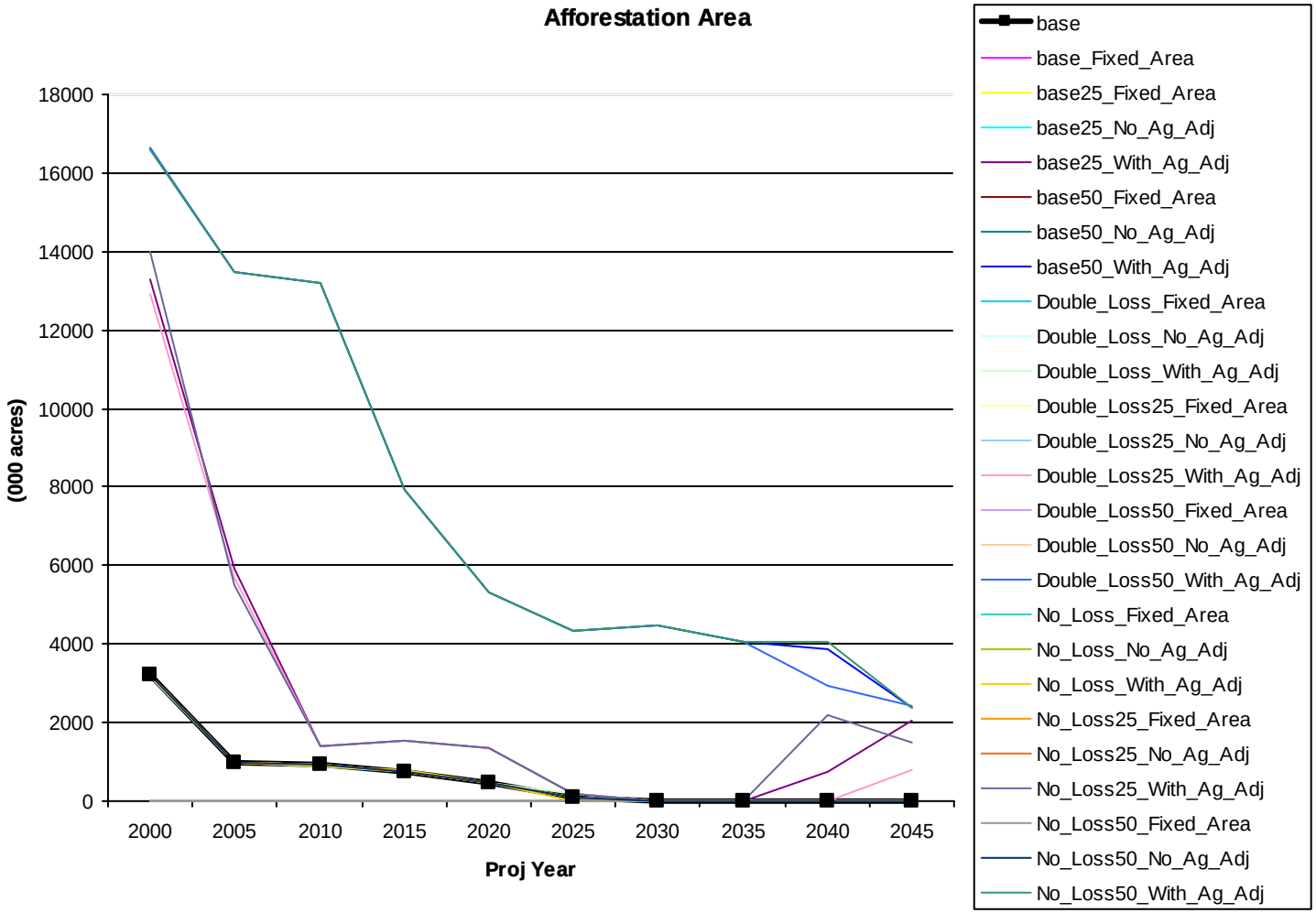
Scenarios About Responses by Agricultural Sector

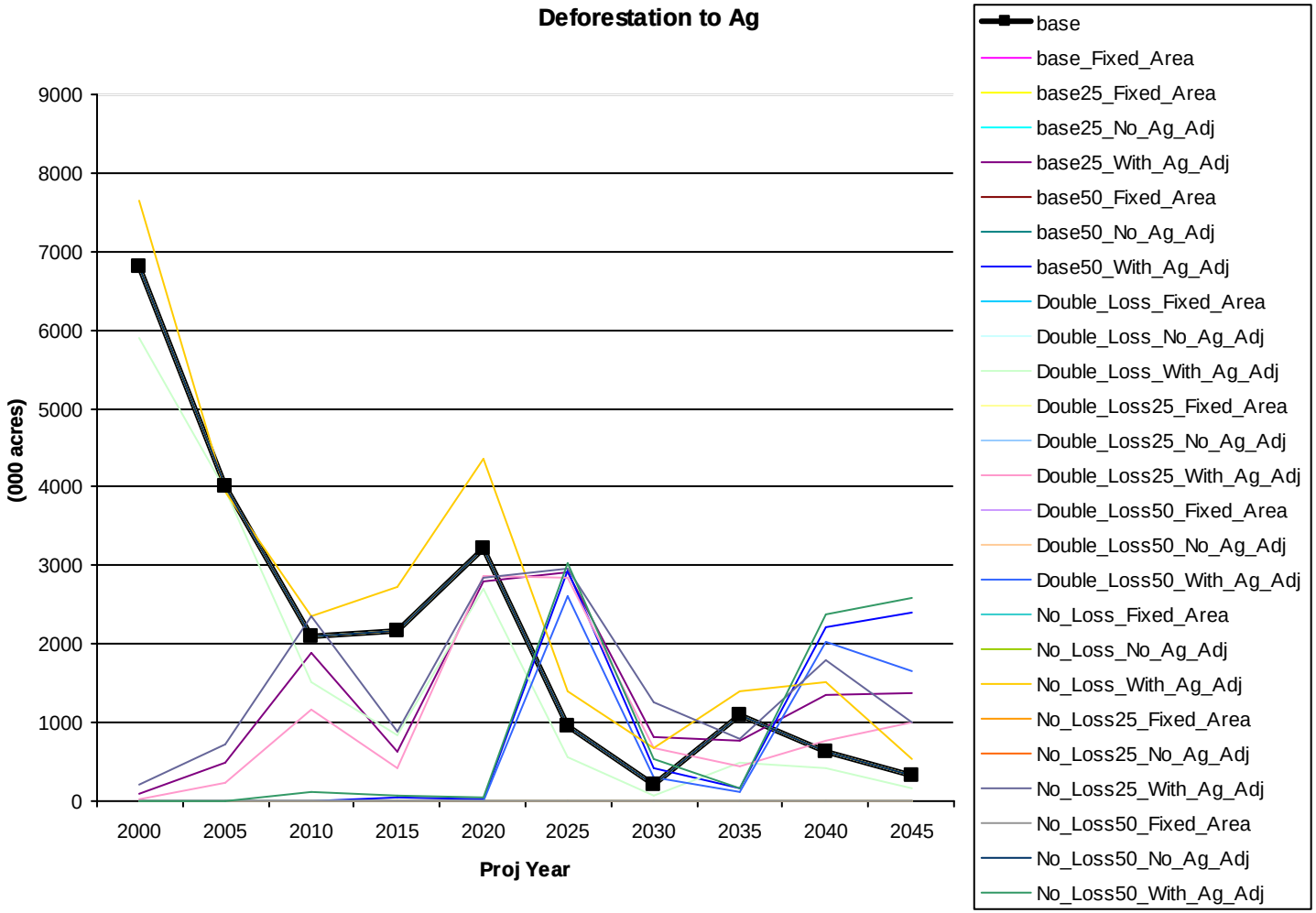
- Intersectoral land transfers (Fully endogenous)
- Intersectoral land transfers fixed at base run levels
- No transfers of land between forest and ag. sectors, such that timberland area is fixed except for transfers of timberland to developed uses

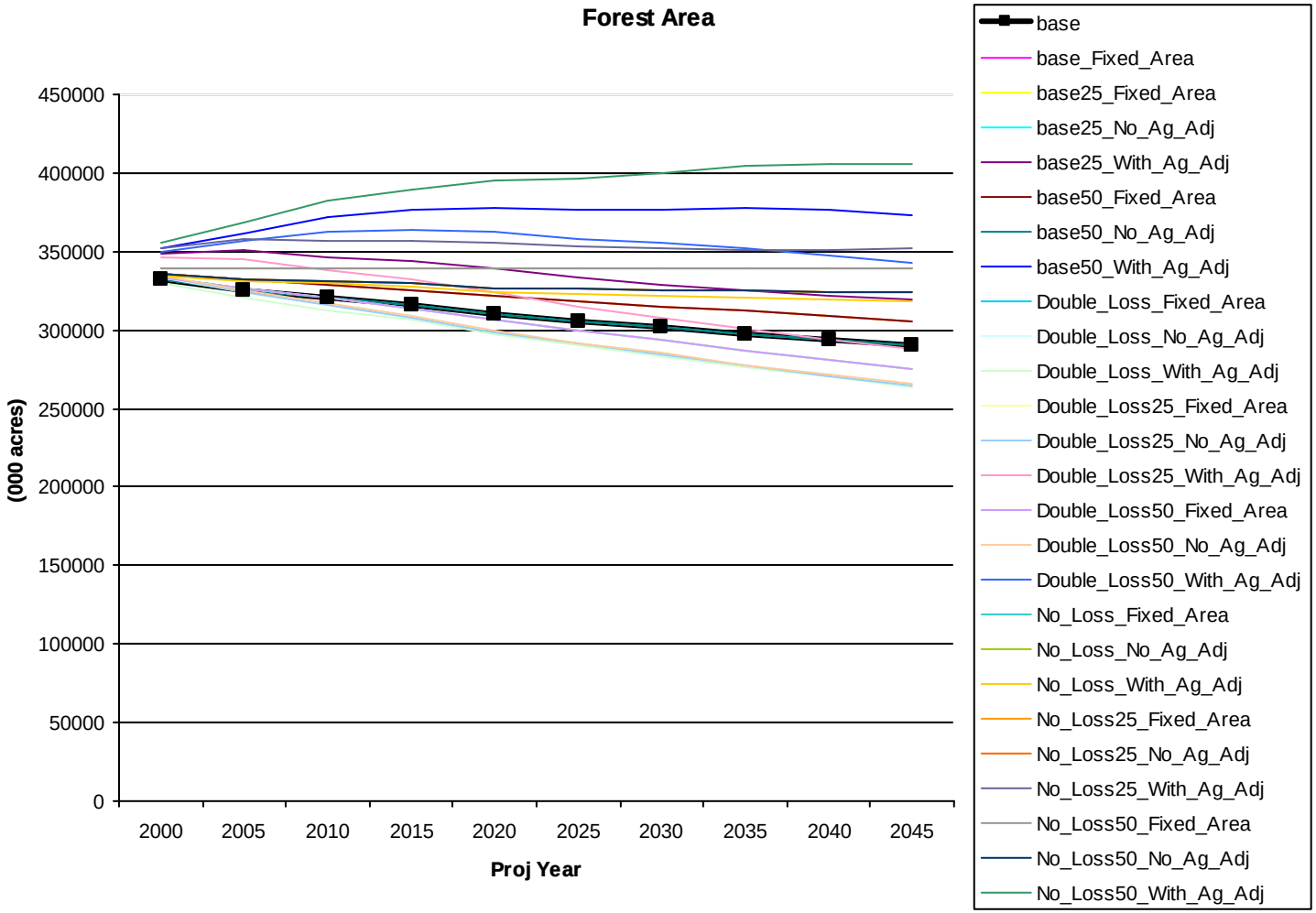
COMBINATIONS

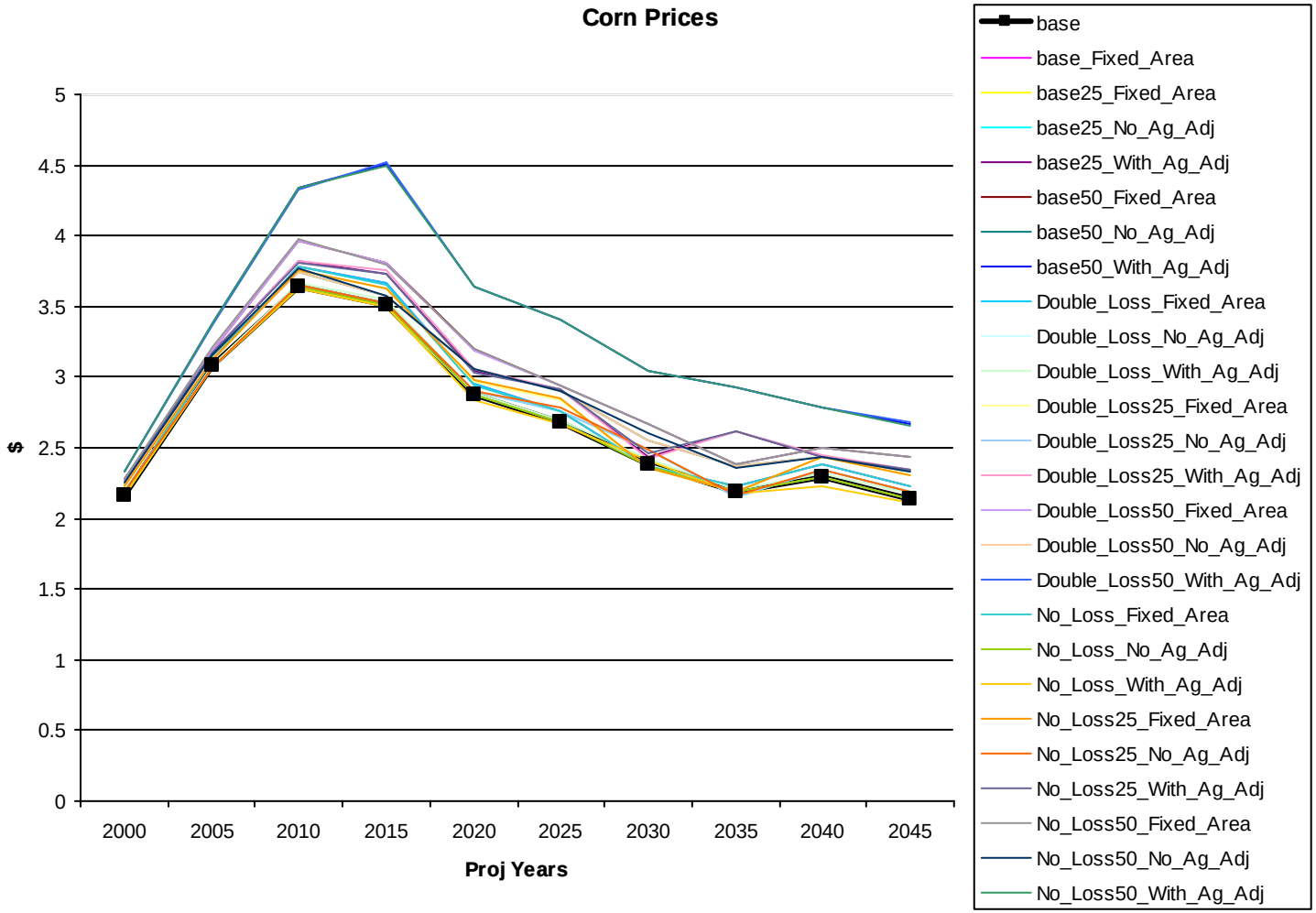
1. Timberland loss to development (Base, No Loss, Double Loss)
2. Carbon Price (0, $25, $50)
3. Intersectoral land transfers (Fully endogenous; Fixed at base run levels “limited ag adjustment;“ no transfers of "No land between forest and ag sectors"

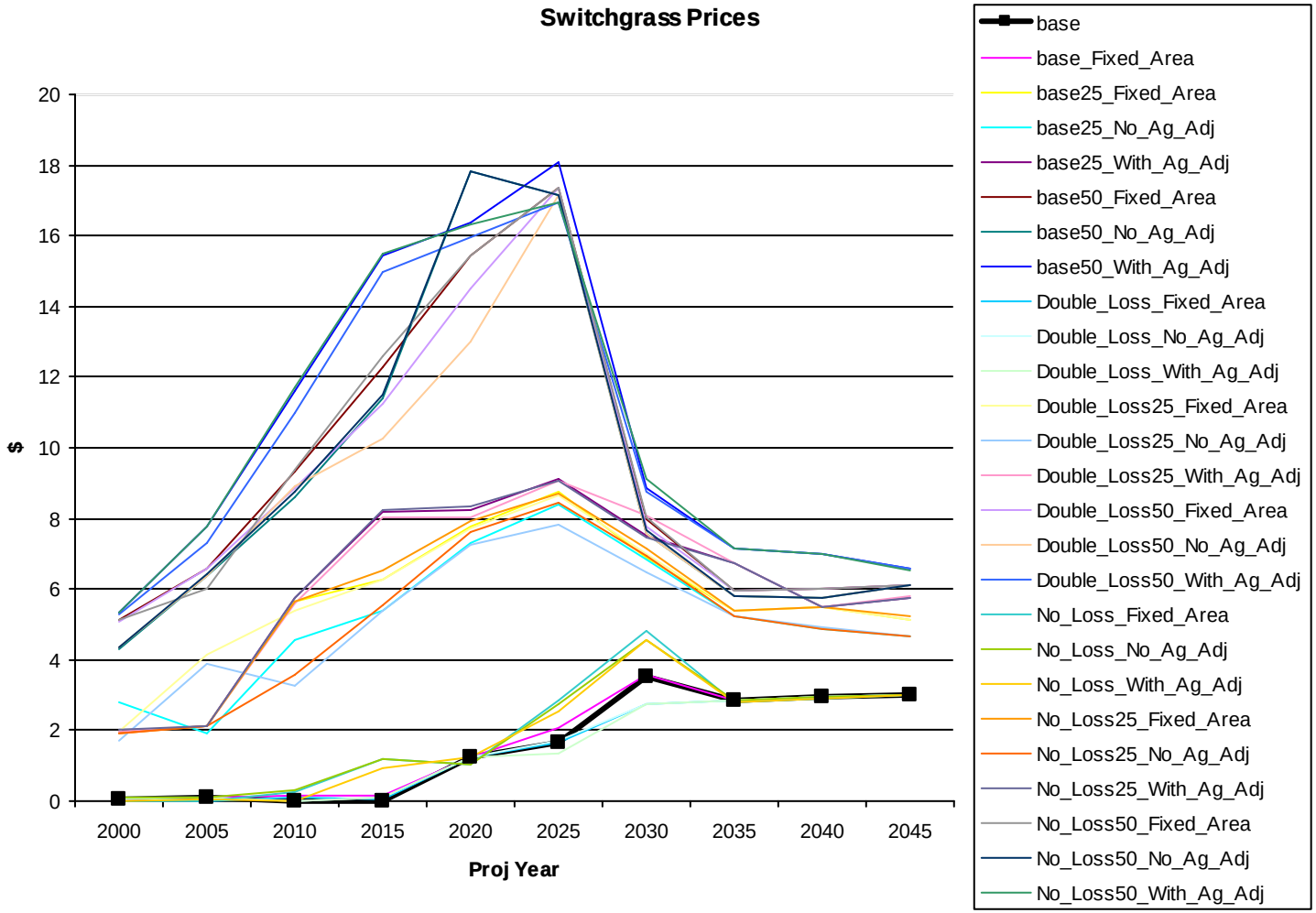

FASOM Deforestation Scenarios (Base from RPA Assessment)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
(000 acres)
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Years
Base
Double Loss

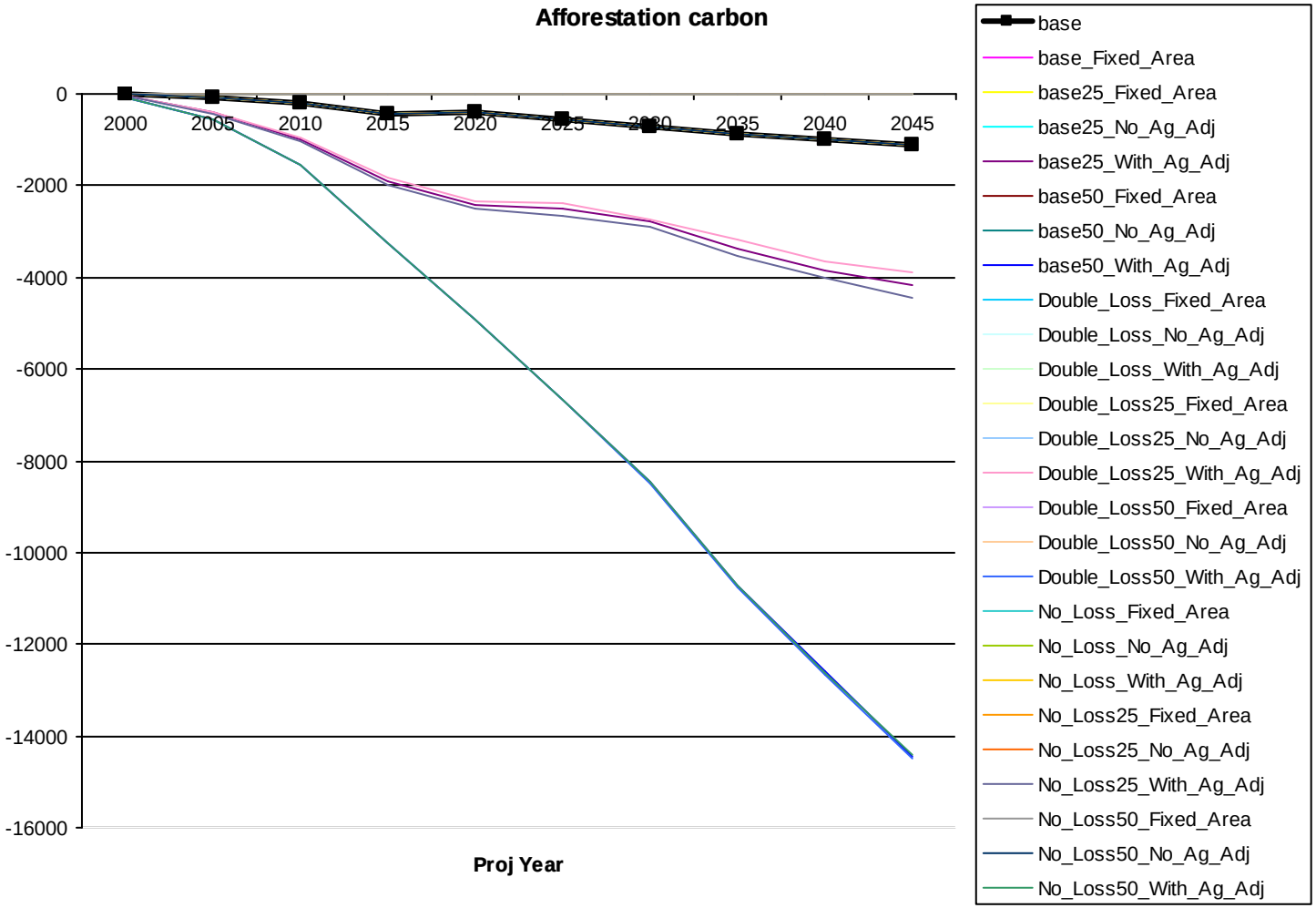

Afforestation Area
(000 acres)
18000
16000
14000
12000
10000
8000
6000
4000
2000
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj


Deforestation to Ag
(000 acres)
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj


Forest Area
(000 acres)
450000
400000
350000
300000
250000
200000
150000
100000
50000
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj


Corn Prices
5
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
$
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Years
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj


Switchgrass Prices
$
20
18
16
14
12
10
8
6
4
2
0
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj


Afforestation carbon
0
-2000
-4000
-6000
-8000
-10000
-12000
-14000
-16000
2000
2005
2010
2015
2020
2025
2030
2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
No_Loss25_No_Ag_Adj
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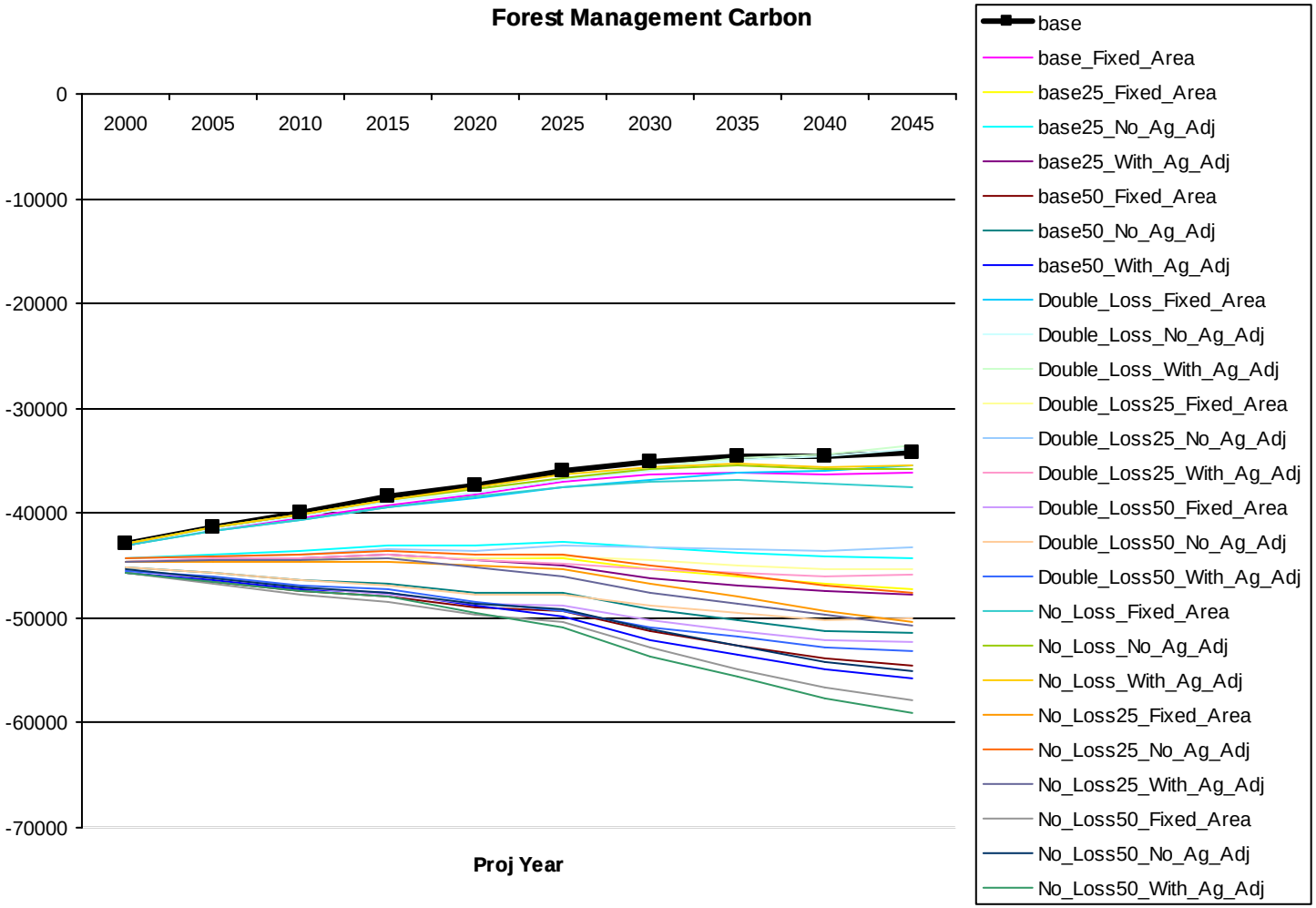
No_Loss50_With_Ag_Adj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2000
2005
2010
2015
2020
2025
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2035
2040
2045
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
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Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
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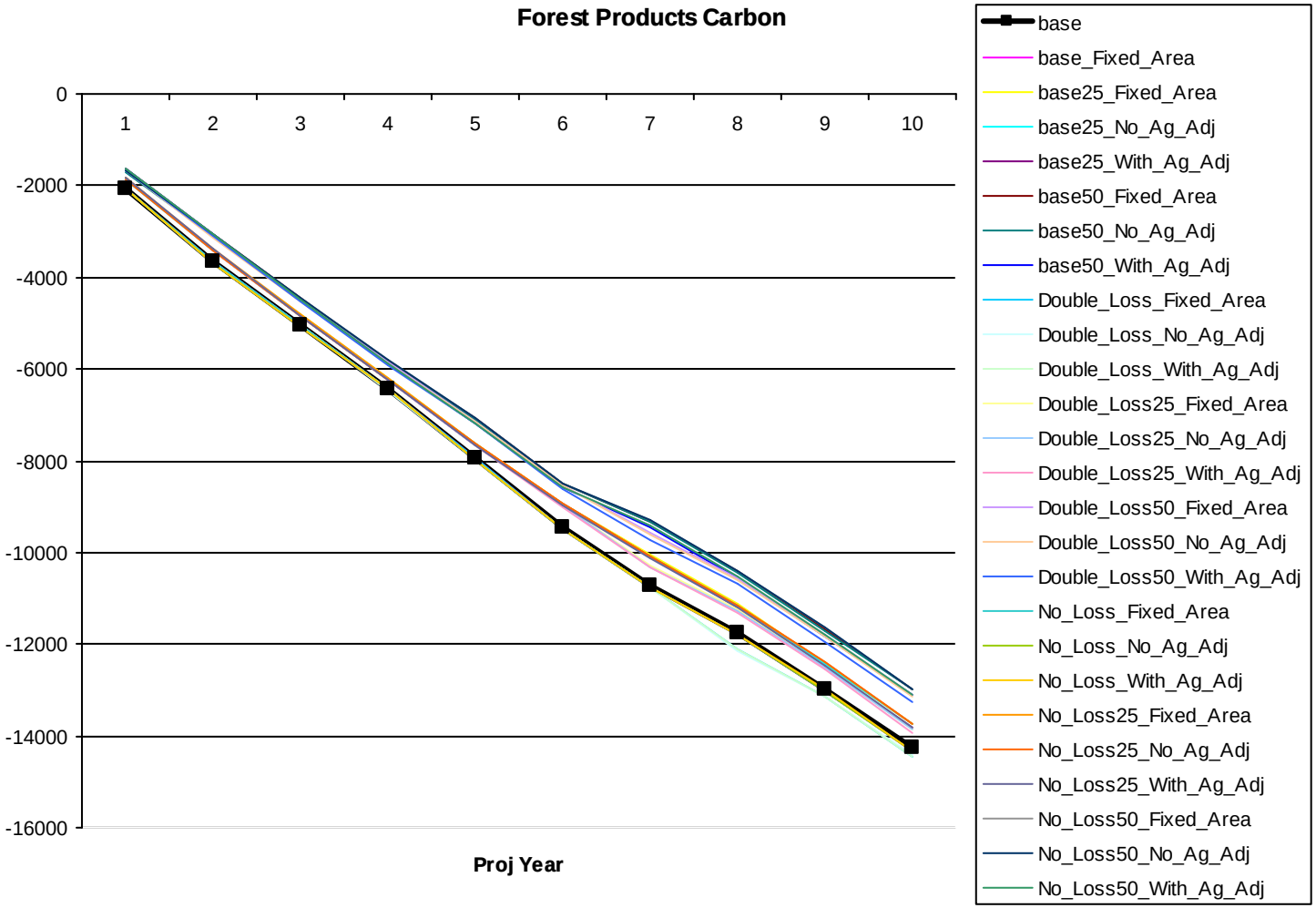
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1
2
3
4
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6
7
8
9
10
Proj Year
base
base_Fixed_Area
base25_Fixed_Area
base25_No_Ag_Adj
base25_With_Ag_Adj
base50_Fixed_Area
base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
Double_Loss_With_Ag_Adj
Double_Loss25_Fixed_Area
Double_Loss25_No_Ag_Adj
Double_Loss25_With_Ag_Adj
Double_Loss50_Fixed_Area
Double_Loss50_No_Ag_Adj
Double_Loss50_With_Ag_Adj
No_Loss_Fixed_Area
No_Loss_No_Ag_Adj
No_Loss_With_Ag_Adj
No_Loss25_Fixed_Area
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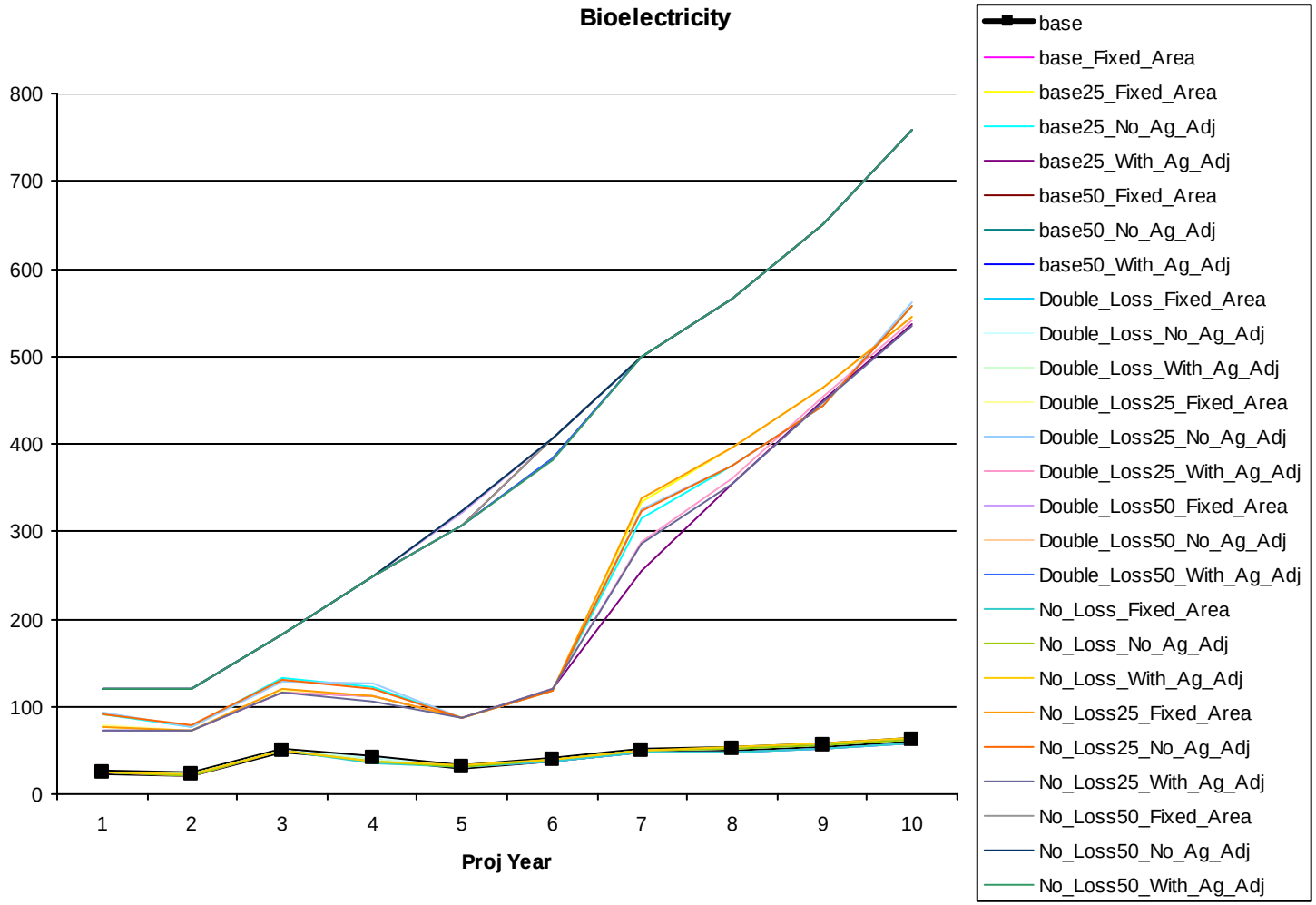
No_Loss50_With_Ag_Adj


Bioelectricity
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700
600
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300
200
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0
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2
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10
Proj Year
base
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base25_No_Ag_Adj
base25_With_Ag_Adj
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base50_No_Ag_Adj
base50_With_Ag_Adj
Double_Loss_Fixed_Area
Double_Loss_No_Ag_Adj
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No_Loss25_With_Ag_Adj
No_Loss50_Fixed_Area
No_Loss50_No_Ag_Adj
No_Loss50_With_Ag_Adj

Summary

- RPA Assessments foundation of forest sector modeling supporting FASOM-GHG development
- Carbon Price Has Relatively Large Influence on FOR-AG interactions in FASOM-GHG for Prices Examined--$25 and $50
- With large land base, U.S. deforestation can be largely accommodated in terms of aggregate effects
- Land transfers between forestry and agriculture are important in climate change mitigation options involving forestry, including when carbon prices are in effect

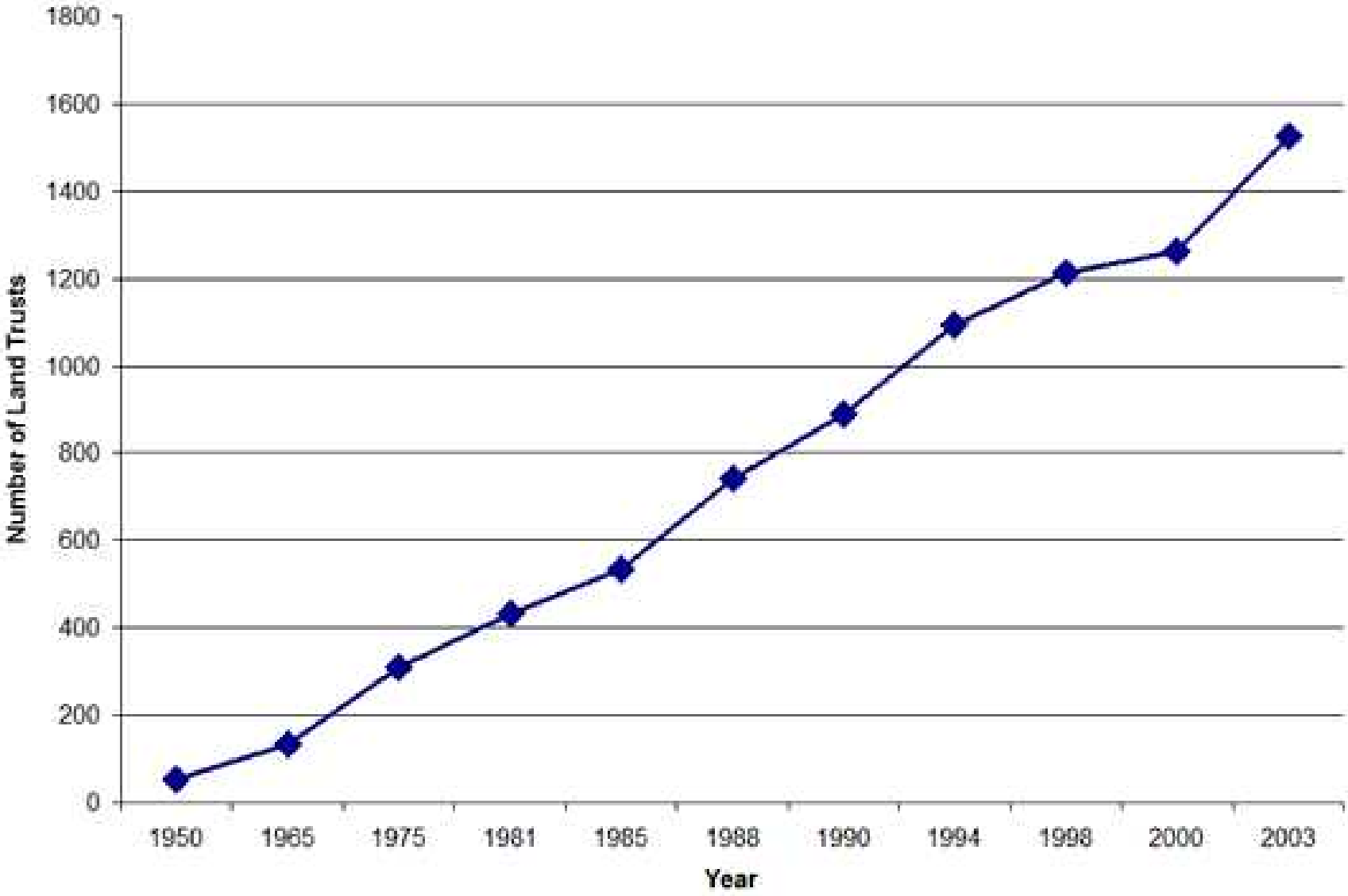
Summary (con’t)

- Timing of ag crop peak prices influenced by Renewable Fuels Standard, with corn price peaking around 2015-2020, and more reliance on switchgrass in subsequent decades and switchgrass prices peaking about 10 years later
- Amount of afforestation is frontloaded in projections, as is deforestation to ag
- Amount of bioelectricity from cellulosic sources is notably higher with $50 carbon price

Demand for land: examples

- World demand for agricultural commodities
- Green revolution in agriculture and land sparing effects for forestry
- Growing population
- Technological improvements, productivity increases
- Fewer people per household
- Spatial effects of policies: Maryland's no net loss or Oregon's land use law

NUMBER OF LAND TRUSTS IN THE UNITED STATES, 1950 to 2003



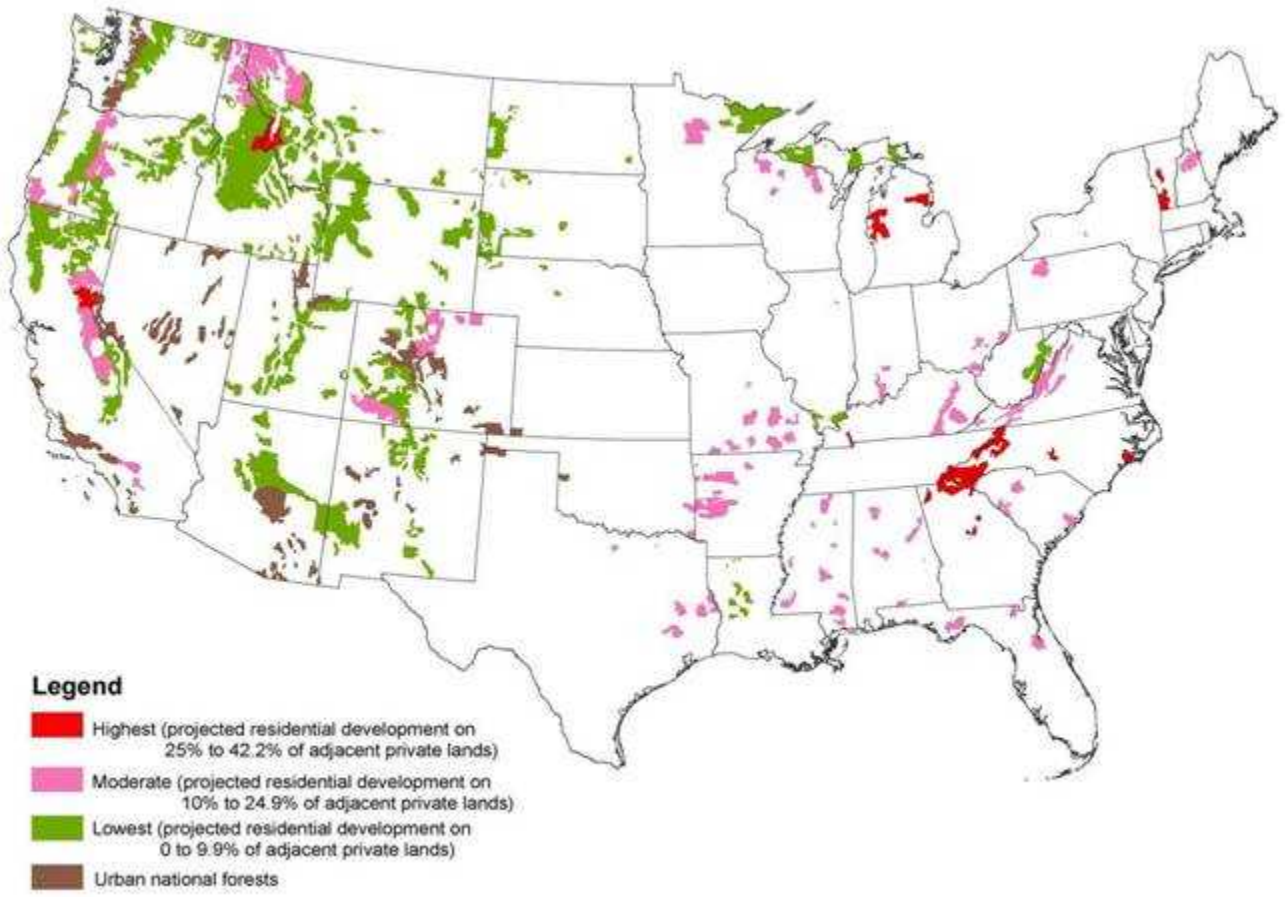
Source: Land Trust Alliance

Wildland-urban interface (WUI)

Across the U.S., the 1990s was a period of rapid housing growth, with a net gain of 13.5 million housing units, a rate of 13% growth.

- The WUI was a preferred setting for new housing. Nationwide, more than 60% of housing units built in the 1990s were constructed in or near wildland vegetation.

Housing to increase on over 21 million acres of rural lands within 10 miles of national forests and grasslands (National Forests on the Edge)



Climate Change Can Affect Land Conservation

- Effects on forest ecosystems and wildlife, outdoor recreation, water, and other resources
- GHG storage in forests and products as part of mitigation
- Increased demand for land for biofuels and use of cellulosic ethanol

Land-Use Changes

- Mostly on private lands; private landowner behavior—e.g., conservation easements and opportunity costs

- Economic considerations: “keeping forests in forests” and economic hierarchy of land use

- Fixed land base, increasing demands for land—squeezing the balloon

The Changing Character of Rural Areas: Driving to Shepherdstown

- U.S. urban and developed area increased by 25% (21.6 million acres) between 1992 to 2003
- Rural and exurban development is expanding more rapidly than urban/suburban
- The Wildland-Urban Interface (WUI) was a preferred setting for new housing. Nationwide, more than 60% of housing units built in the 1990s were constructed in or near wildland vegetation.
- Population growth of counties with national forest land is among the highest in the country
- Parcelization—many forested acres changing ownership; TIMO's, REIT's, conservation groups, and others are involved

Source: Theobald 2005, based on NRCS NRI data

Data Needs

- Nationally consistent database of recent land-use changes for entire land base
- Forest ownership changes, owner characteristics, etc.
- Adaptation, passive afforestation, and interactions of adaptation and mitigation (Bruce’s bulldozer(s) and ambulance)

Public Timberland Modeling

- Carbon seq. potential for: a) current harvest trend; b) return to early 1980s; and c) no timber harvest.
- Depro et al. (2008); *Forest Ecology and Management*
- Age class distribution by region and concentration of timber stocks in the West

Future Public Forestland Modeling

- Endogenous in FASOM-GHG; application example—reduction of hazardous forest fuels and biomass utilization
- Public-private interactions: example complementary age class distributions

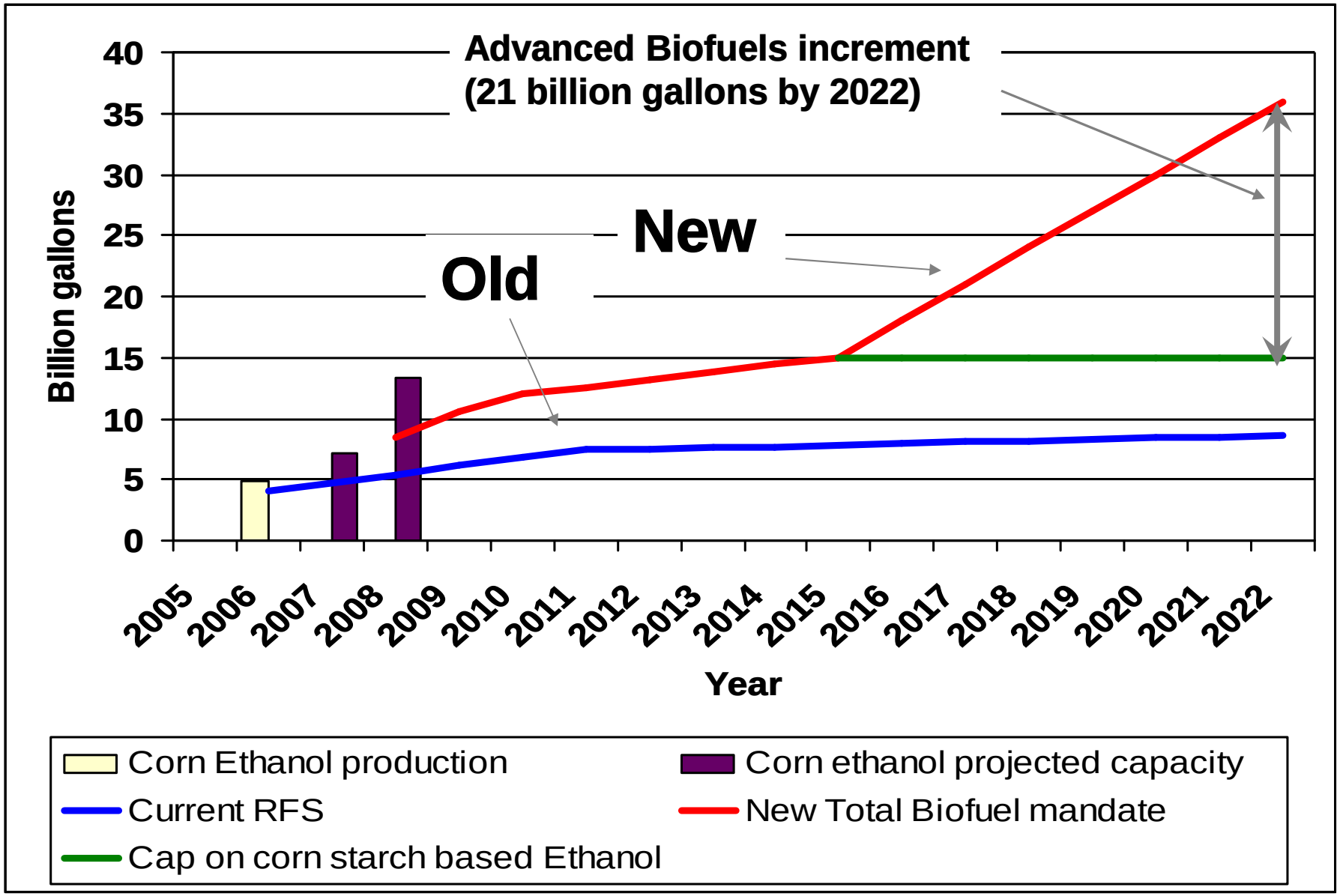
Other FASOM-GHG Modeling Work

- Crowding out in markets—public and private forest lands; domestic and international markets
- Indirect land-use change and global modeling—collaboration with Bruce McCarl, Brent Sohngen, etc.
- Co-benefits of land-use change
- Forest bioenergy modeling, in collaboration with other FASOM-GHG team members and Ken Skog, Peter Ince, etc.
- Landowner responses to policies and incentives

Documentation

- FASOM-GHG: Bruce McCarl's web site at Texas A&M; Ralph Alig's team web site (Land Use and Land Cover Dynamics)
- RPA Assessments: Linda Langner, USDA Forest Service, WO and other RPA Specialists at this meeting
- RPA Land Base Assessment—Gen. Tech. Report for review

Old and new Renewable Fuels Standards



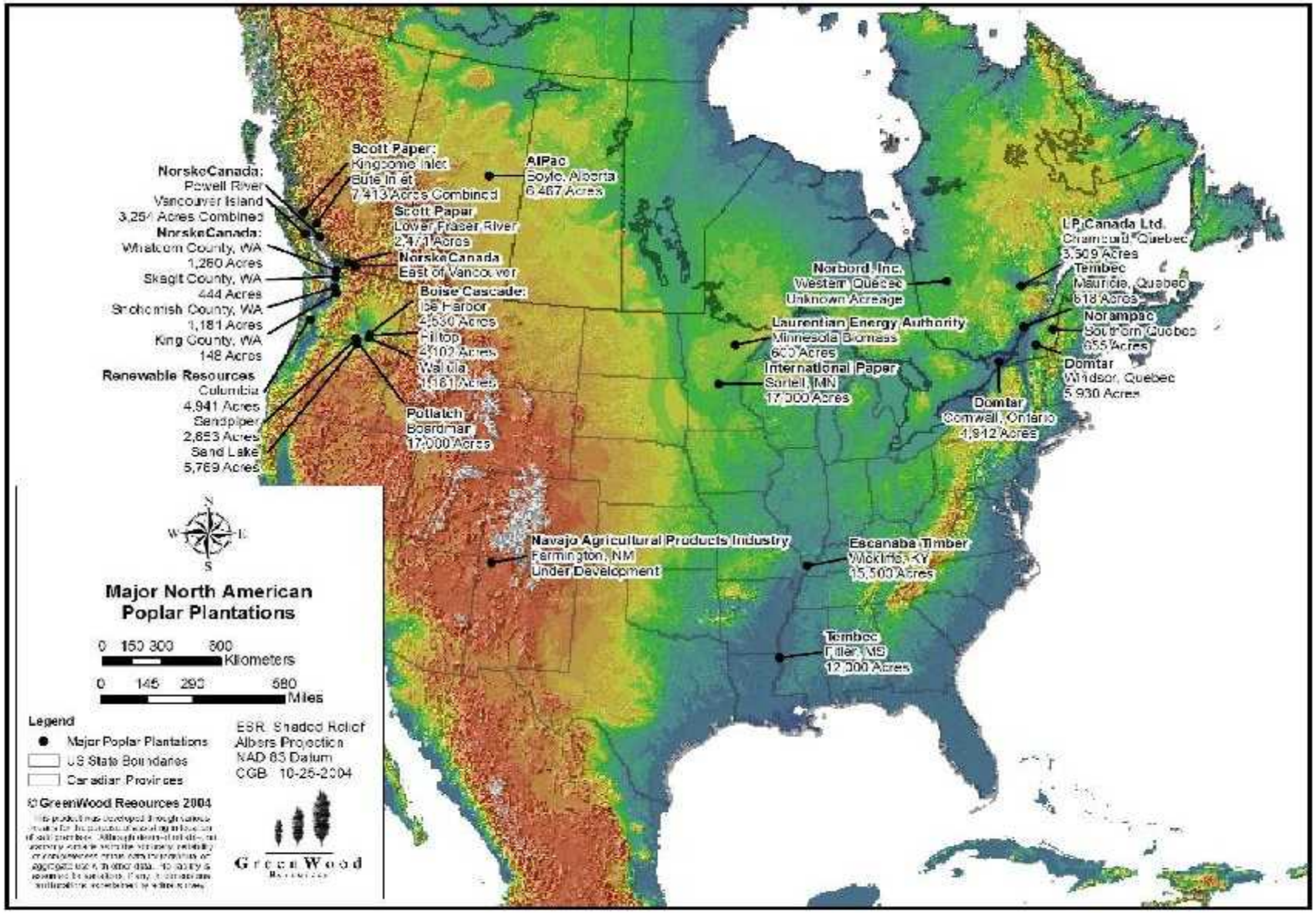
Biomass feedstock economics

"Wall of Wood": Hybrid Poplar Plantation in Oregon

Foresters can grow biomass much faster, but when it becomes more economical is as uncertain as future oil and timber prices.

If bioenergy places demands on land areas used for fiber production, then wood fiber competition is inevitable.

Also, expansion in biomass energy could result in higher wood prices and more SRWC's.


Scott Paper:
Kingcome Inlet
Bute Inlet
7,413 Acres Combined
AlPac
Boyle, Alberta
6,467 Acres
NorskeCanada:
Powell River
Vancouver Island
3,251 Acres Combined
NorskeCanada:
Whatcom County, WA
1,260 Acres
Skagit County, WA
444 Acres
Snohomish County, WA
1,181 Acres
King County, WA
148 Acres
Scott Paper
Lower Fraser River
2,471 Acres
NorskeCanada
East of Vancouver
Boise Cascade:
Ile Harbor
2,530 Acres
Hilltop
4,102 Acres
Walula
1,161 Acres
Renewable Resources
Columbia
4,941 Acres
Sandpiper
2,853 Acres
Sand Lake
5,769 Acres
Potlatch
Boardman
17,000 Acres
LP Canada Ltd.
Chambord, Quebec
3,509 Acres
Tembec
Mauricie, Quebec
618 Acres
Norbord Inc.
Western Quebec
Unknown Acreage
Norampac
Southern Quebec
655 Acres
Laurentian Energy Authority
Minnesota Biomass
600 Acres
International Paper
Sartell, MN
17,000 Acres
Domtar
Windsor, Quebec
5,930 Acres
Domtar
Cornwall, Ontario
4,912 Acres
Navajo Agricultural Products Industry
Farmington, NM
Under Development
Escanaba Timber
Wickliffe, KY
15,500 Acres
Tembec
Filer, MS
12,200 Acres
N
W
E
S
Major North American
Poplar Plantations
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Kilometers
0 145 290 580
Miles
Legend
Major Poplar Plantations
US State Boundaries
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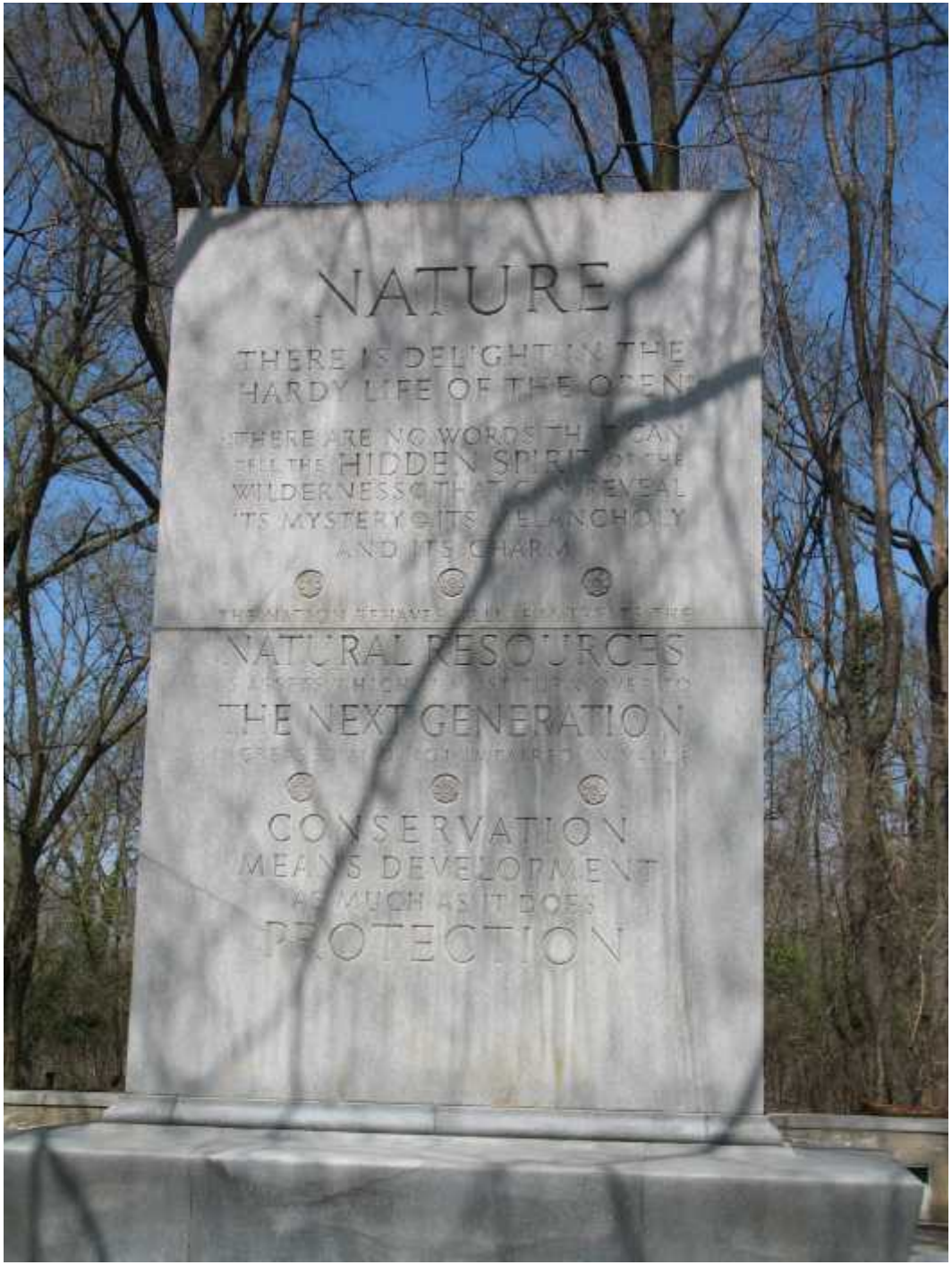
NATURE
NATURAL RESOURCES
THE NEXT GENERATION
CONSERVATION
MEANS DEVELOPMENT
PROTECTION