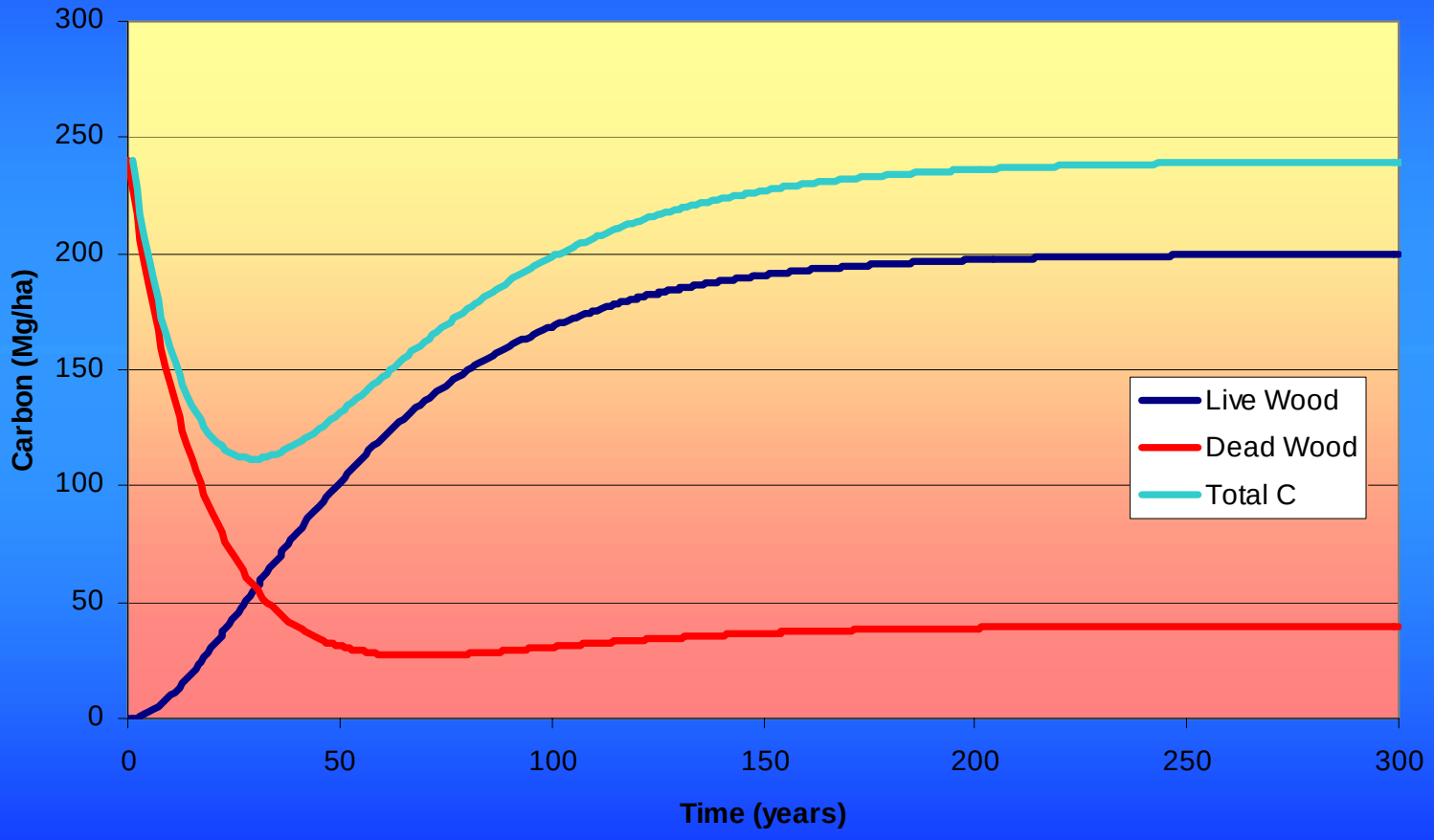
Modeling Carbon Dynamics and their Economic Implications

W. Cohen, Mark Harmon, Joe Kerkvliet, Olga Krankina, David Wallin

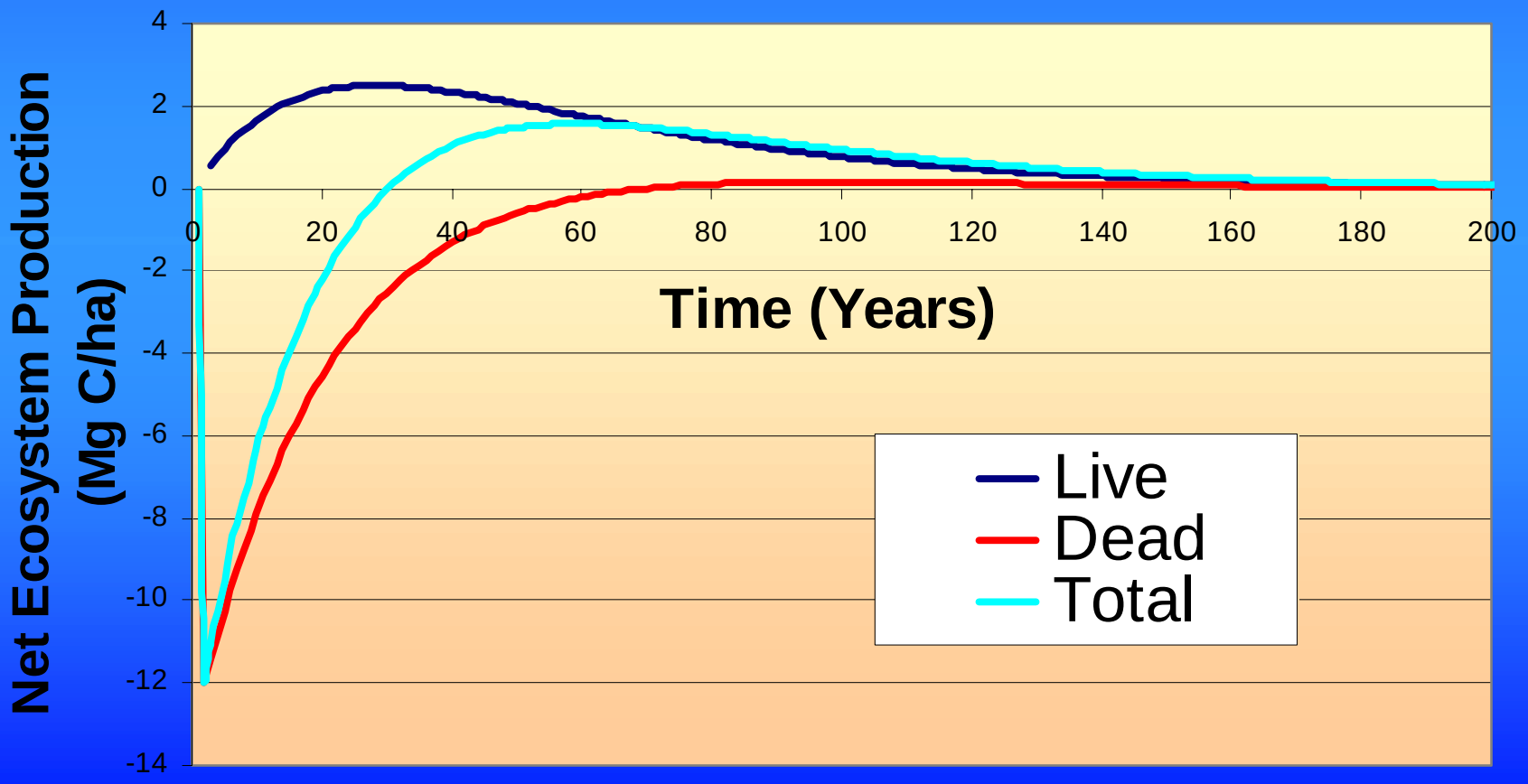
It Depends on How We Treat Them

- Deforestation
- Aforestation
- Reforestation
- New Forestation

Change in Carbon Stores



Change in Exchange of Carbon



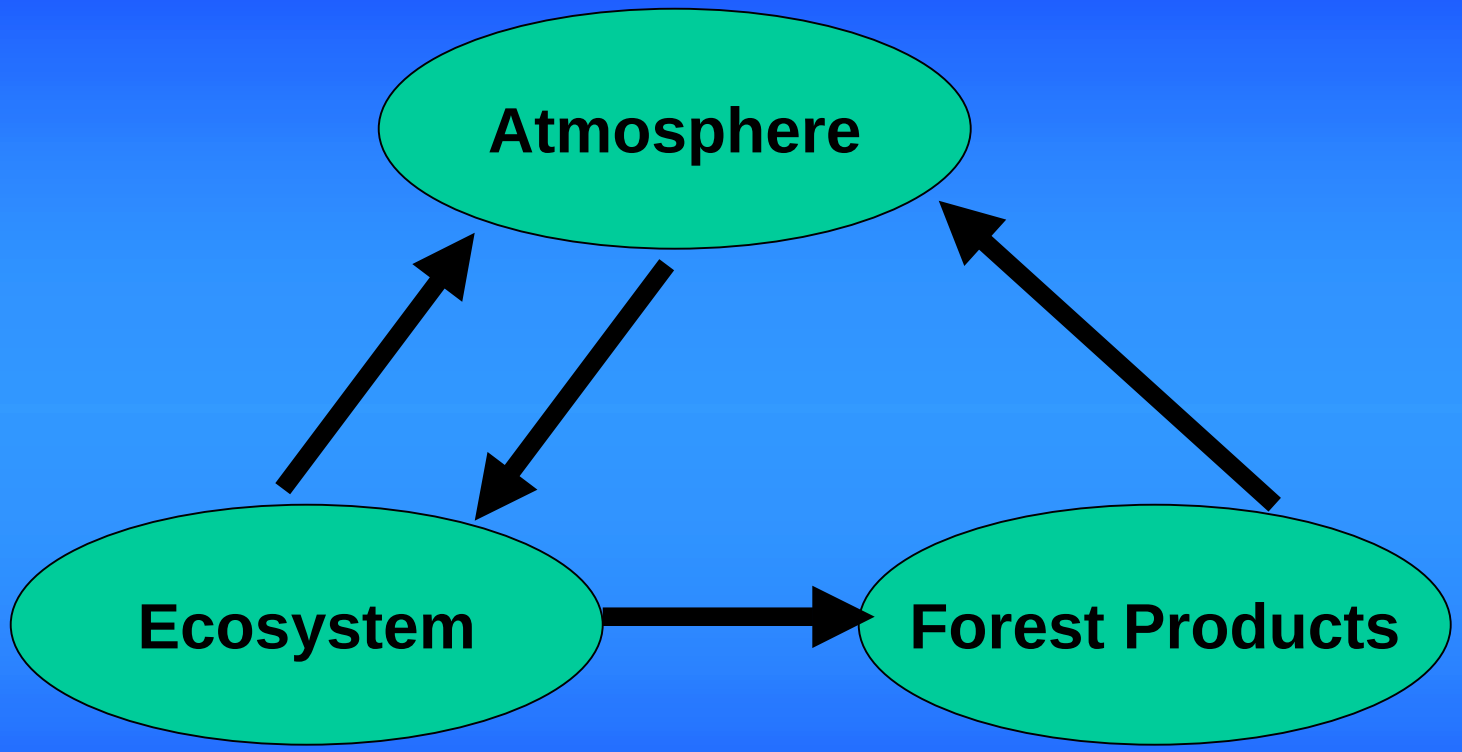
Effects on Carbon Storage of Conversion of Old-Growth Forests to Young Forests

MARK E. HARMON, WILLIAM K. FERRELL, JERRY F. FRANKLIN

Pool	60 year-old	Old-growth
Foliage	5	6
Live Wood	152	349
Roots	35	77
Detritus	26	123
Soil	56	56
Total	**274**	**611**

If Not Here Then Where Else?

Expanding the System



Two Approaches

- Measurement--Harvest and Forest Cover Maps of Oregon Forests
- Modeling-Standcarb-Micro Forest Dynamics. Computes transitions after disturbance
- Modeling-Regioncarb-Steady-state landscape. No transitions, but fast.

Two Decades of Carbon Flux from Forests of the Pacific Northwest

Estimates from a new modeling strategy

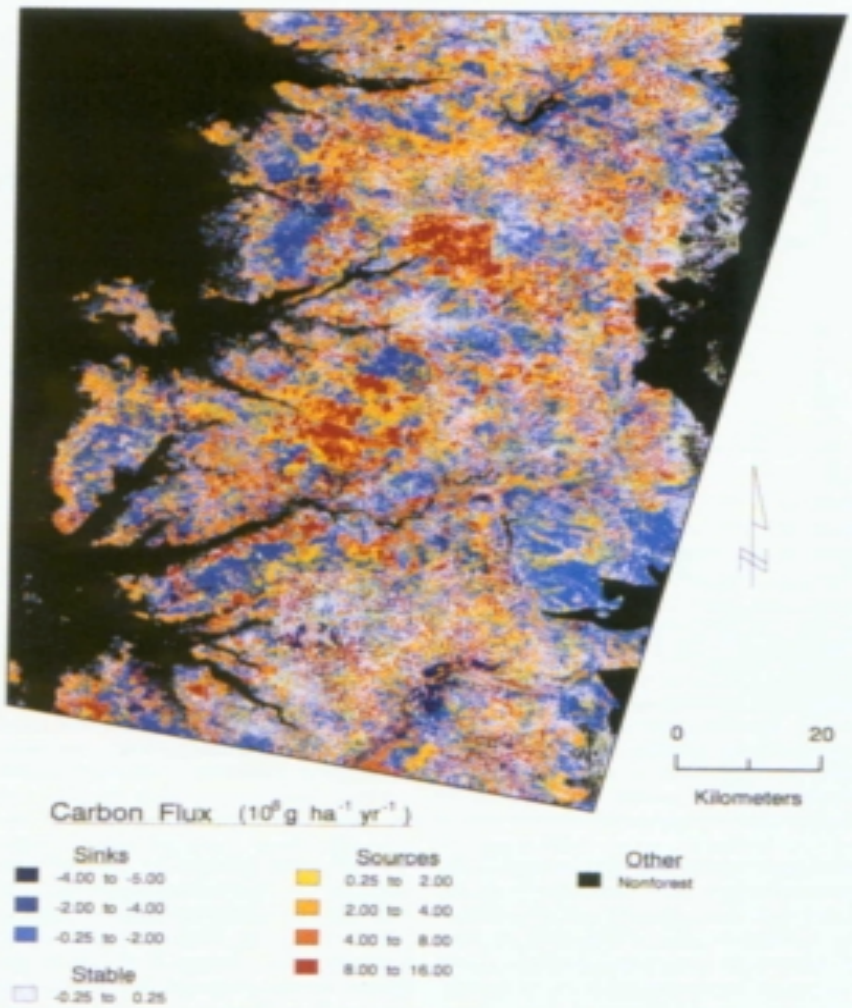


Figure 3. Net carbon flux over the subset study area between 1972 and 1991.

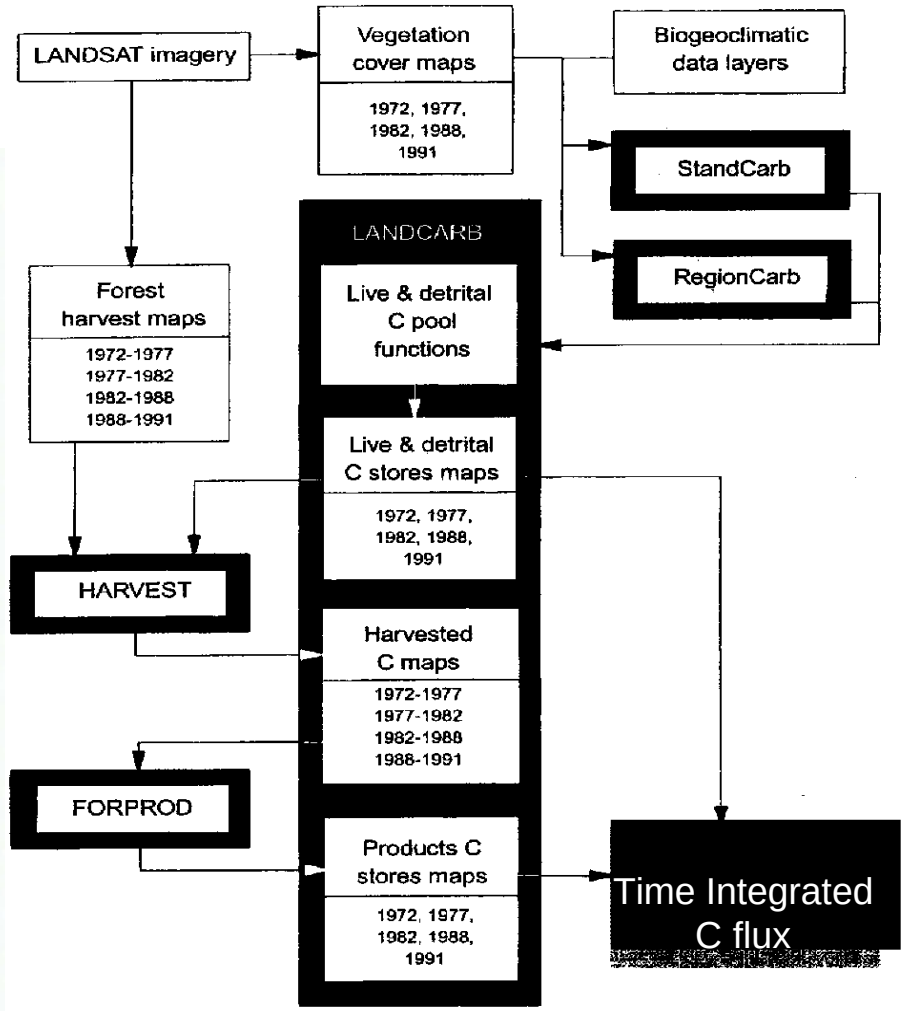


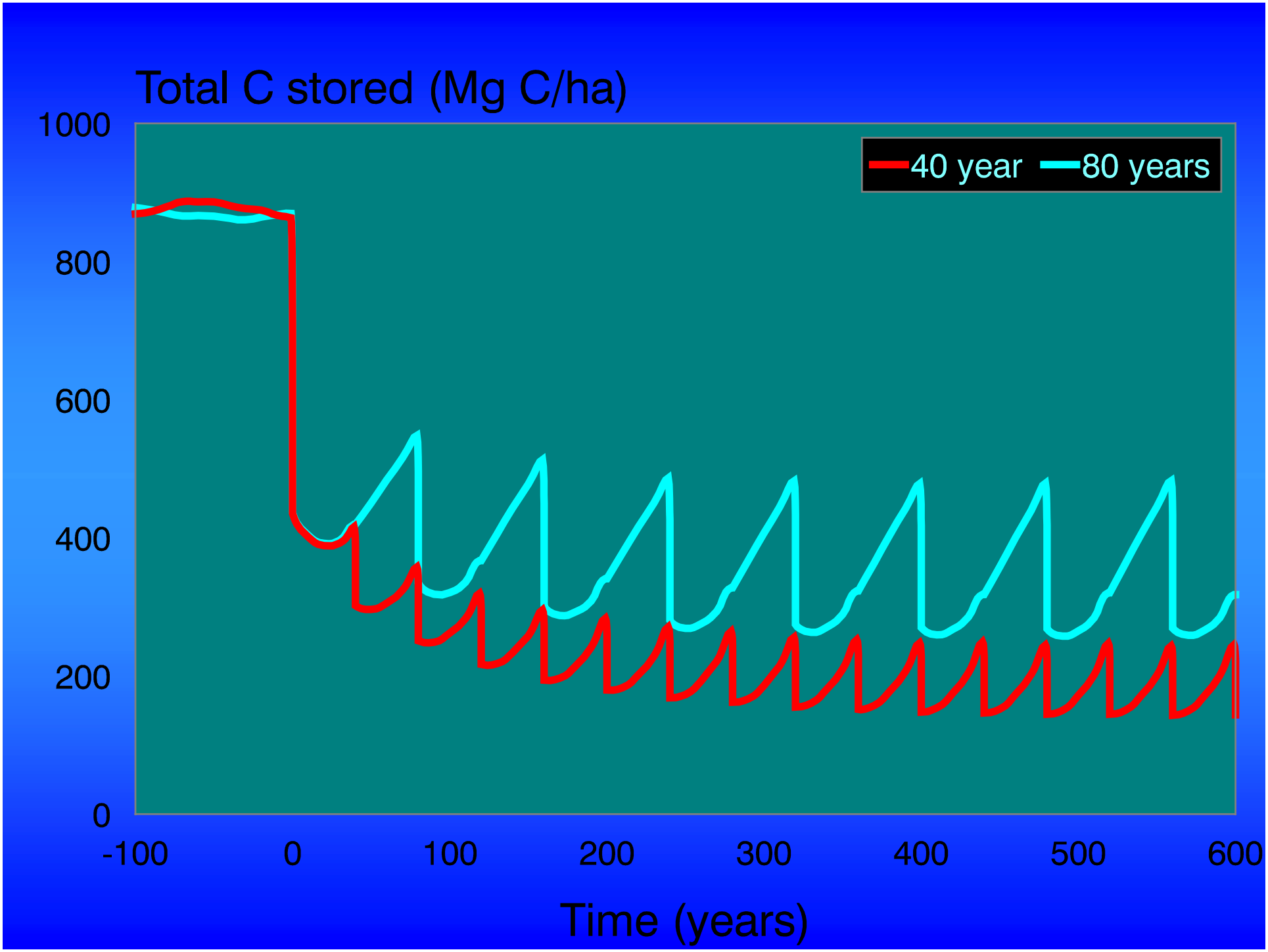
Figure 1. Schematic for the overall modeling strategy used to estimate carbon flux.

NET RESULT OF MEASUREMENT

- THREE DECADES OF PACIFIC NORTHWEST FOREST MANAGEMENT
- NET SOURCE OF ATMOSPERIC CARBON

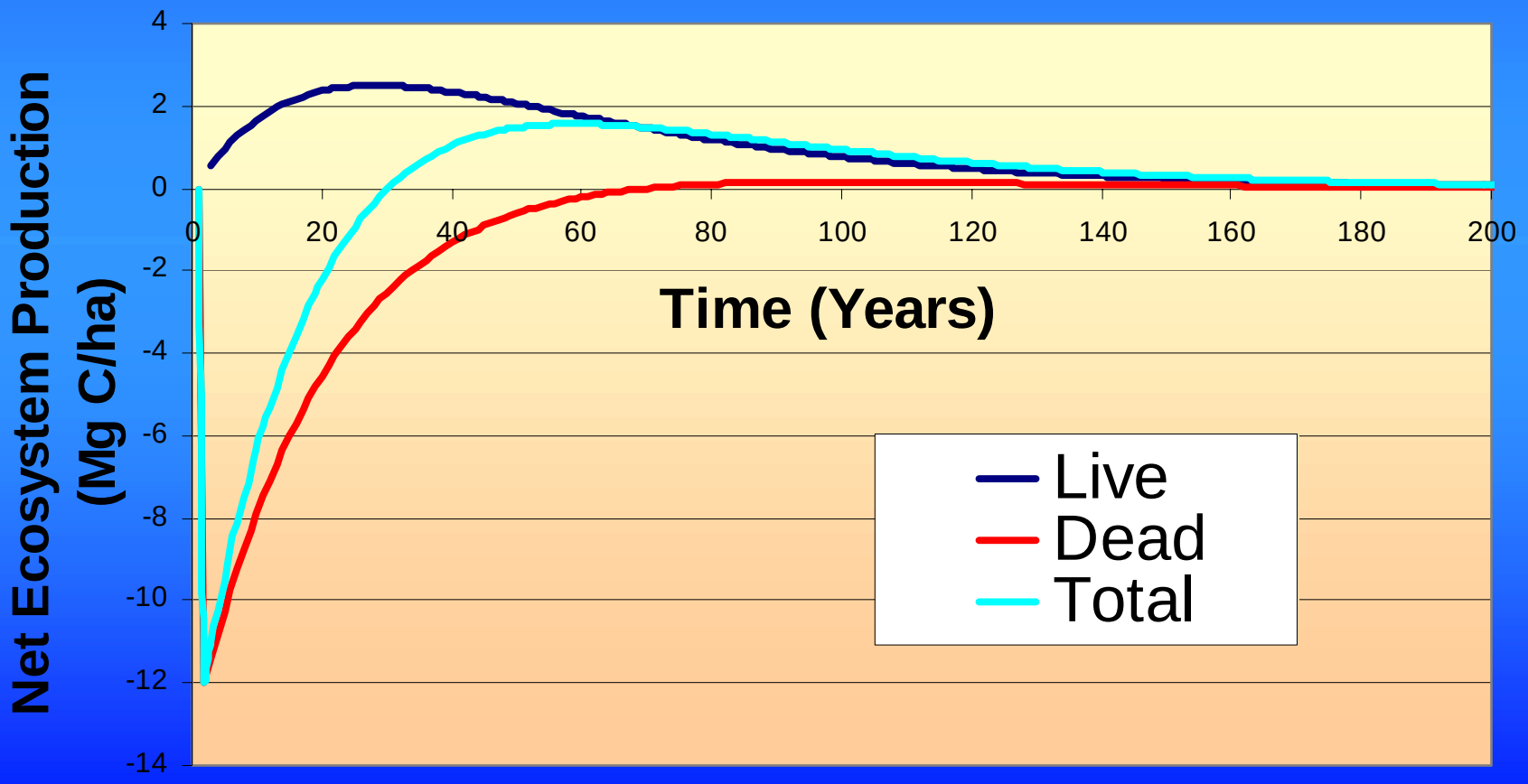
CARBON STORAGE SENSITIVE TO FOREST MANAGEMENT

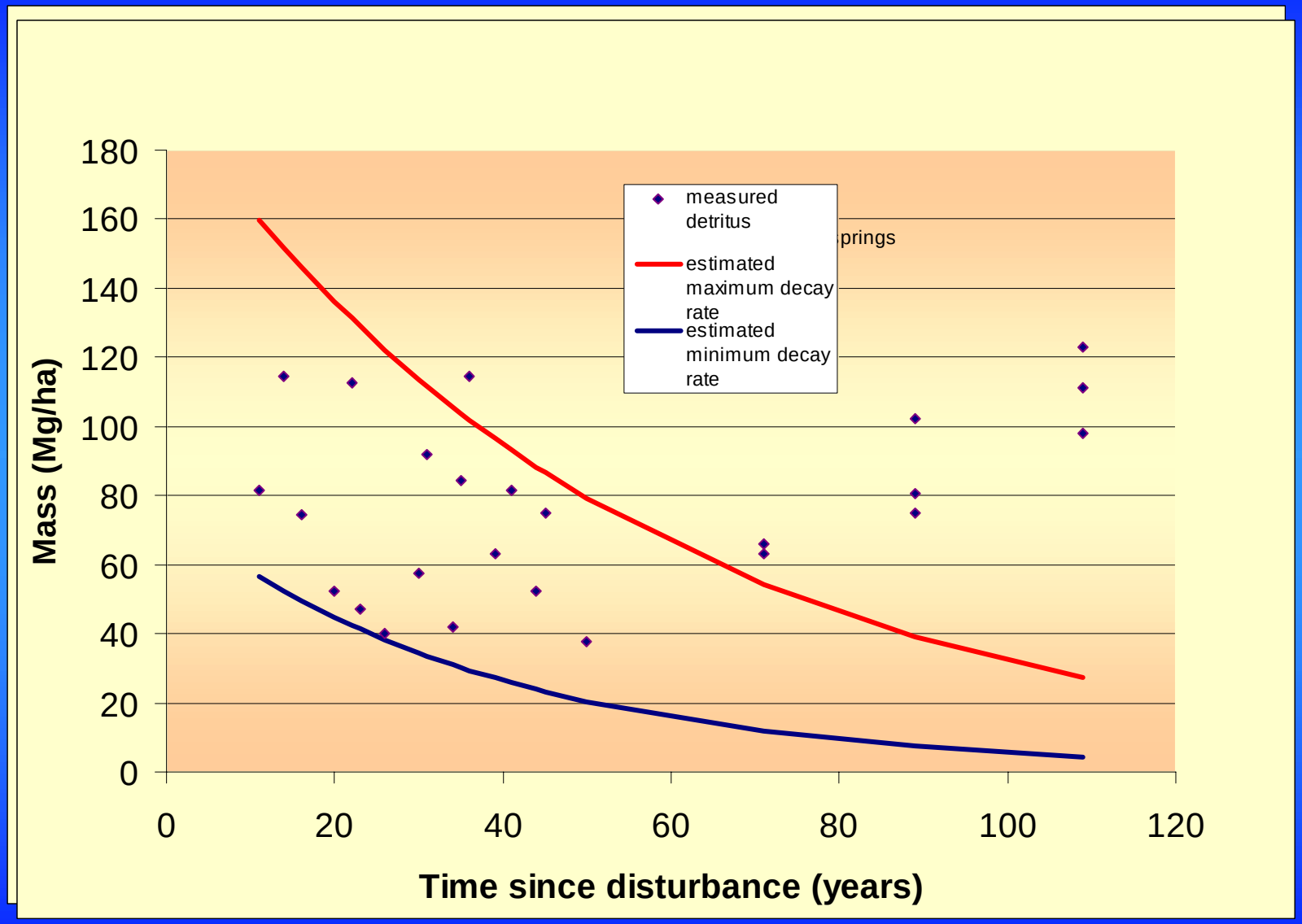
- ROTATION LENGTH
- CLEARCUTTING VERSUS OTHER METHODS
- PRE-COMMERCIAL AND COMMERCIAL THINNING
- PLANTING
- HIGH INTENSITY VERSUS LOW INTENSITY HARVESTING

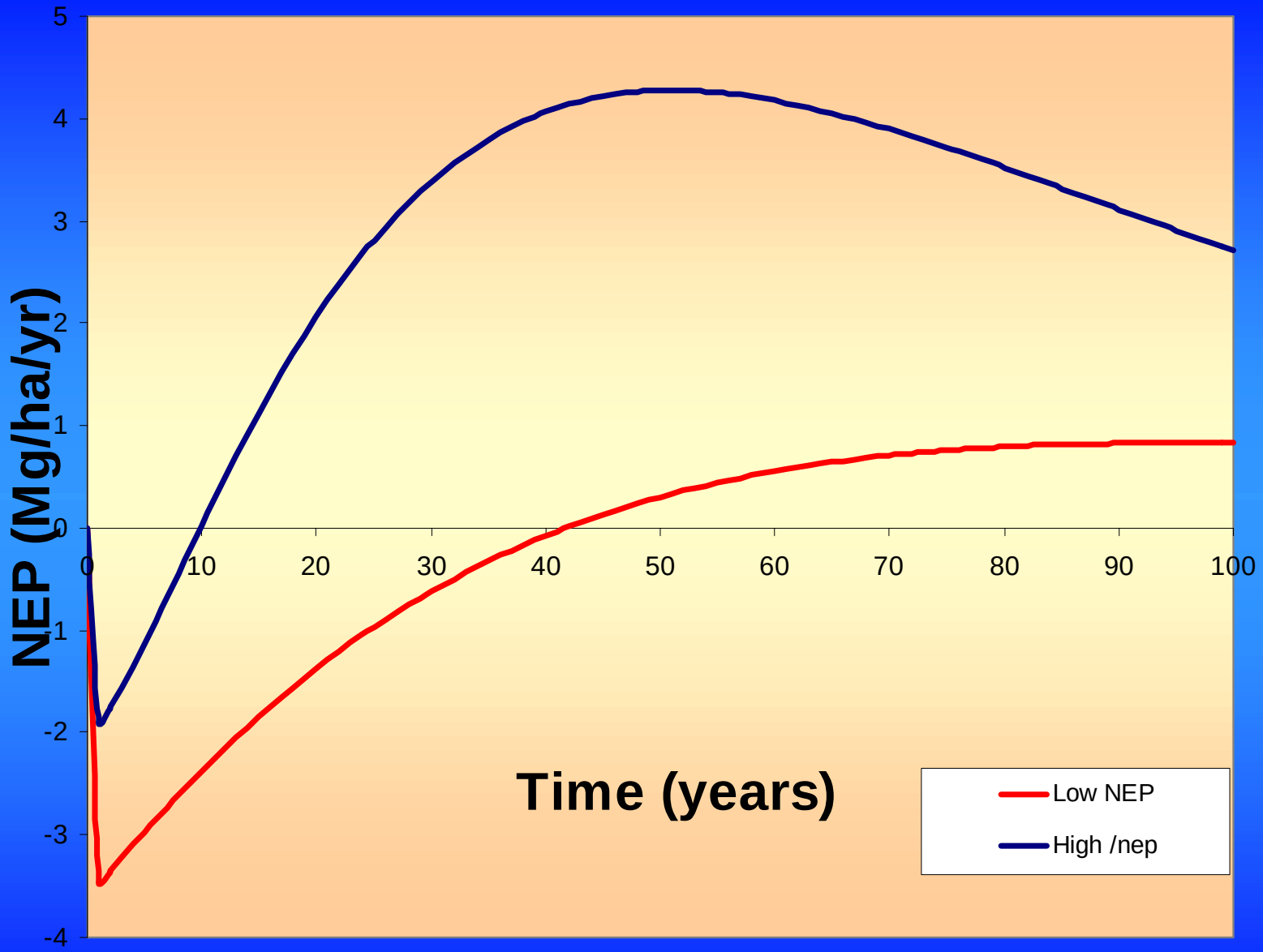

Total C stored (Mg C/ha)
1000
800
600
400
200
0
-100
0
100
200
300
400
500
600
Time (years)
40 year
80 years

BUT ALWAYS A TRANSITION PERIOD OF NEGATIVE N.E.P.

Change in Exchange of Carbon

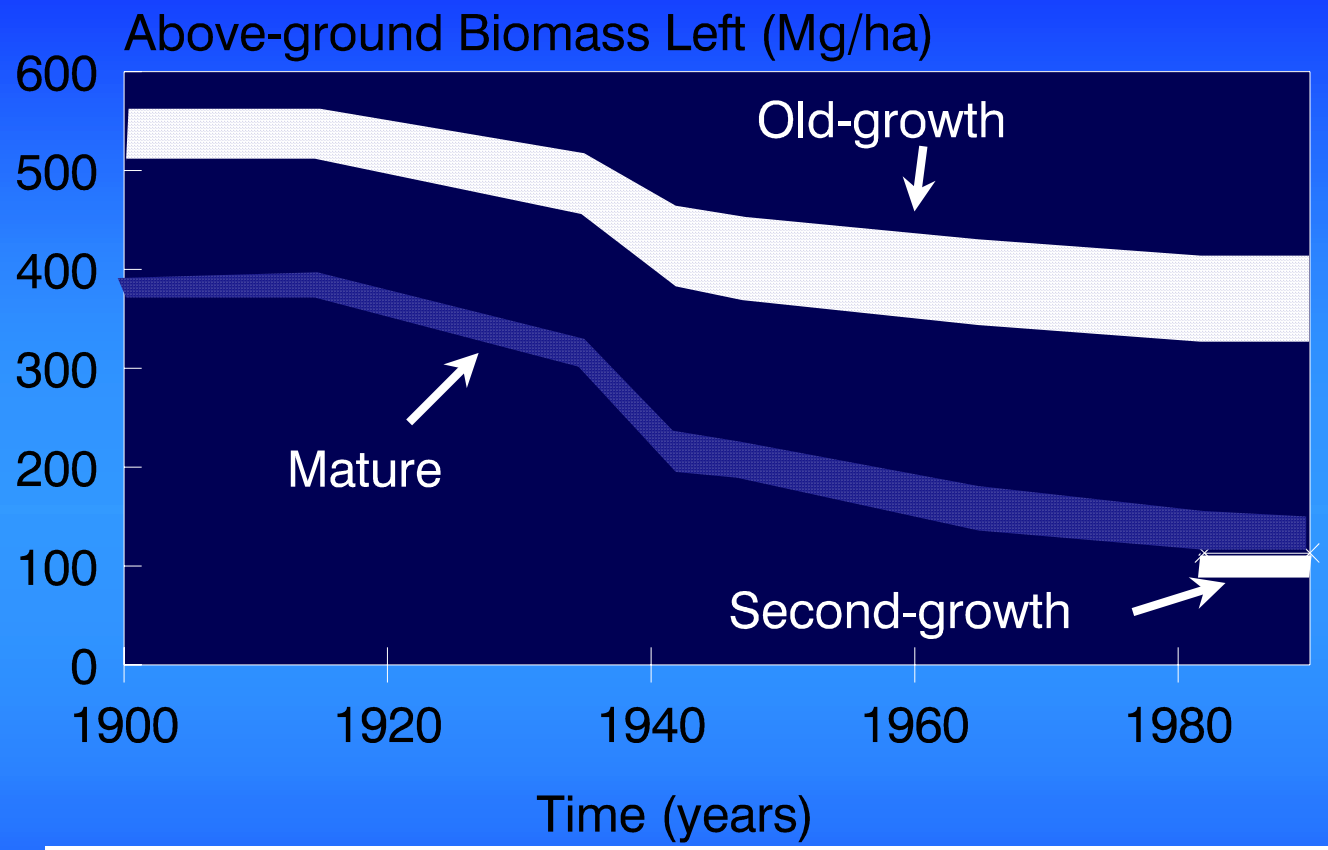



180
160
140
120
100
80
60
40
20
0
Mass (Mg/ha)
0
20
40
60
80
100
120
Time since disturbance (years)
measured detritus
estimated maximum decay rate
estimated minimum decay rate
prings


NEP (Mg/ha/yr)
5
4
3
2
1
0
-1
-2
-3
-4
0
10
20
30
40
50
60
70
80
90
100
Time (years)
Low NEP
High /nep

FORESTRY PRACTICES ARE ALWAYS CHANGING

Historical Changes in Harvest



MODELING HISTORICAL PATTERNS OF TREE UTILIZATION IN THE PACIFIC NORTHWEST: CARBON SEQUESTRATION IMPLICATIONS[1]

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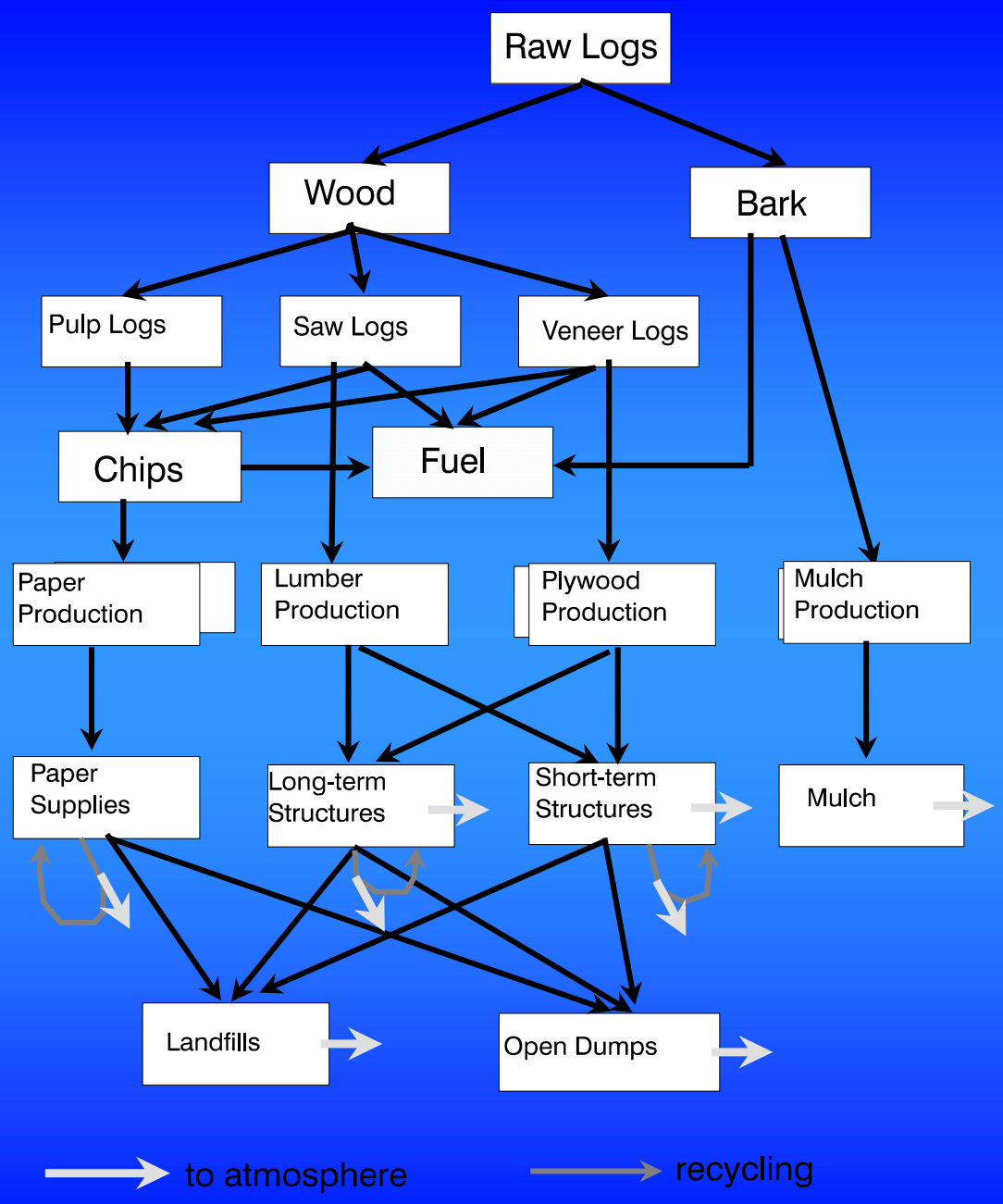
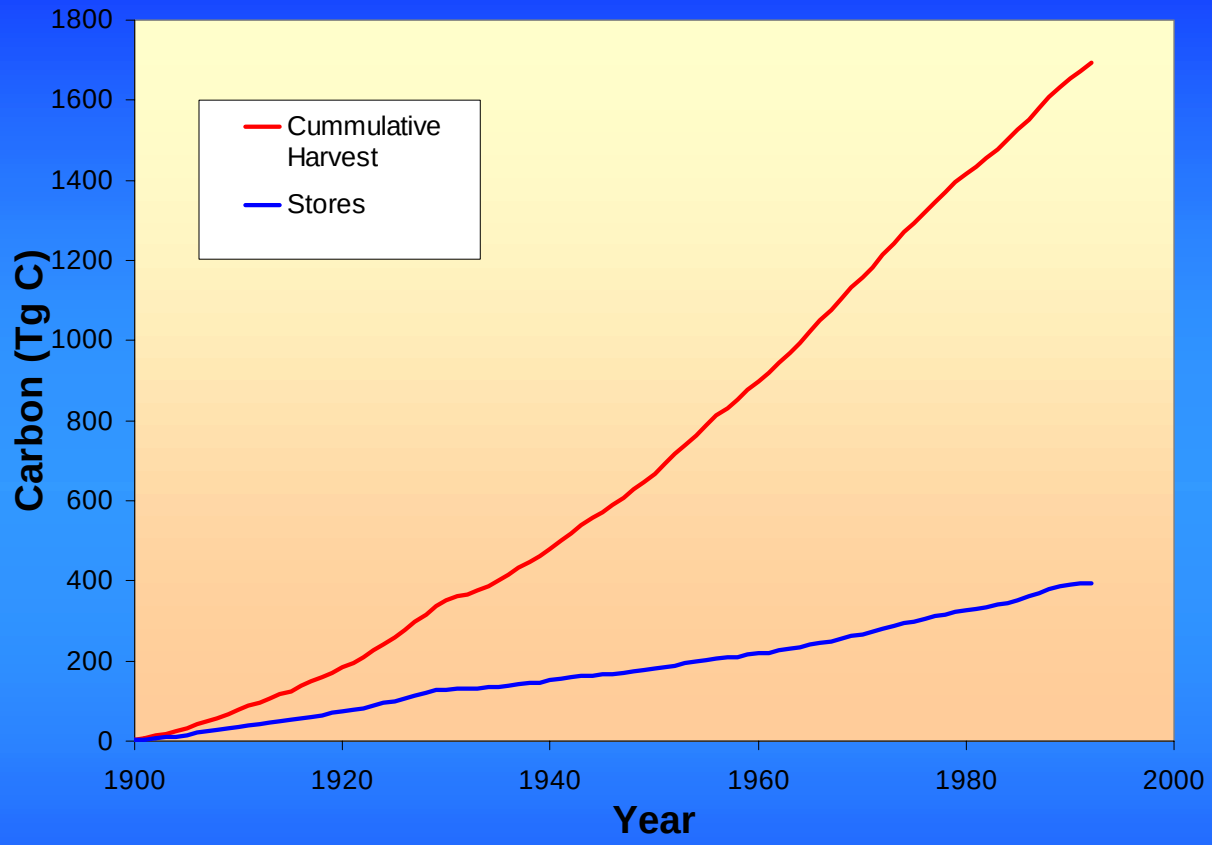
Department of Forest Science, Oregon State University, Corvallis, Oregon 97331-7501 USA

The Changing Nature of Harvests

AND FOREST PRODUCT USE IS ALWAYS CHANGING


Raw Logs
Wood
Bark
Pulp Logs
Saw Logs
Veneer Logs
Chips
Fuel
Paper Production
Lumber Production
Plywood Production
Mulch Production
Paper Supplies
Long-term Structures
Short-term Structures
Mulch
Landfills
Open Dumps
to atmosphere
recycling

Only 20% of Harvest is Stored



MODELING CARBON STORES IN OREGON AND WASHINGTON FOREST PRODUCTS: 1900–1992

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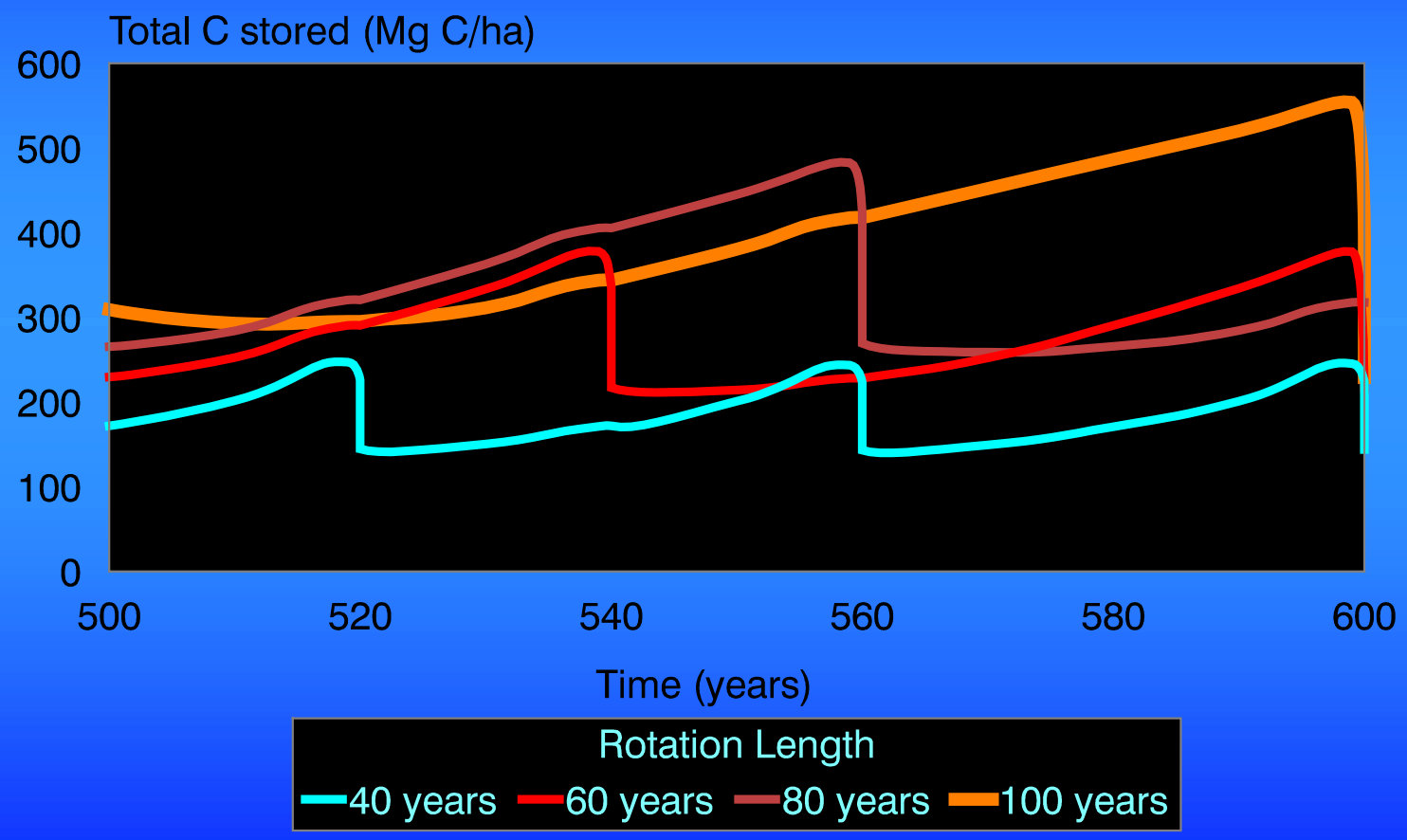
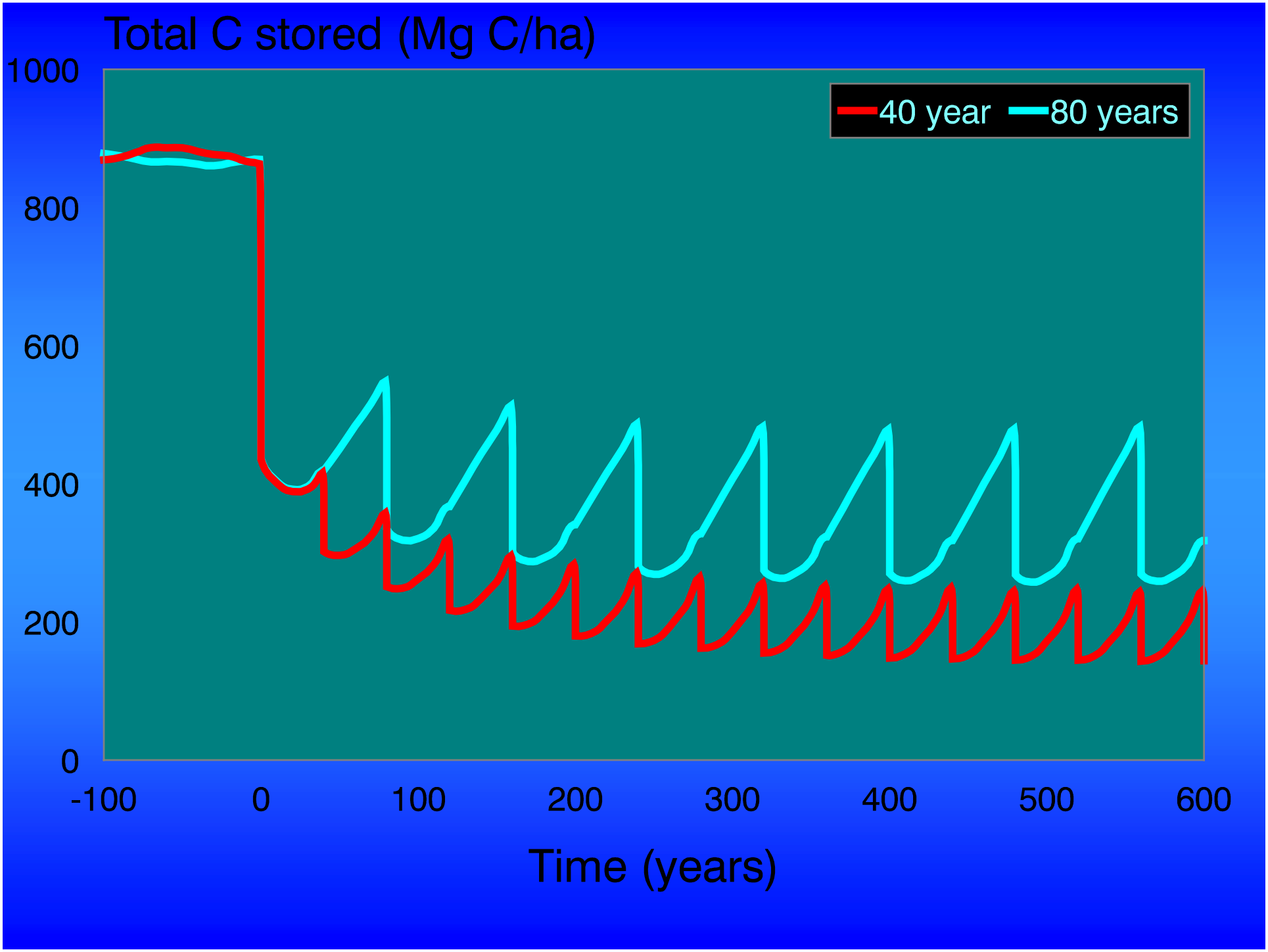
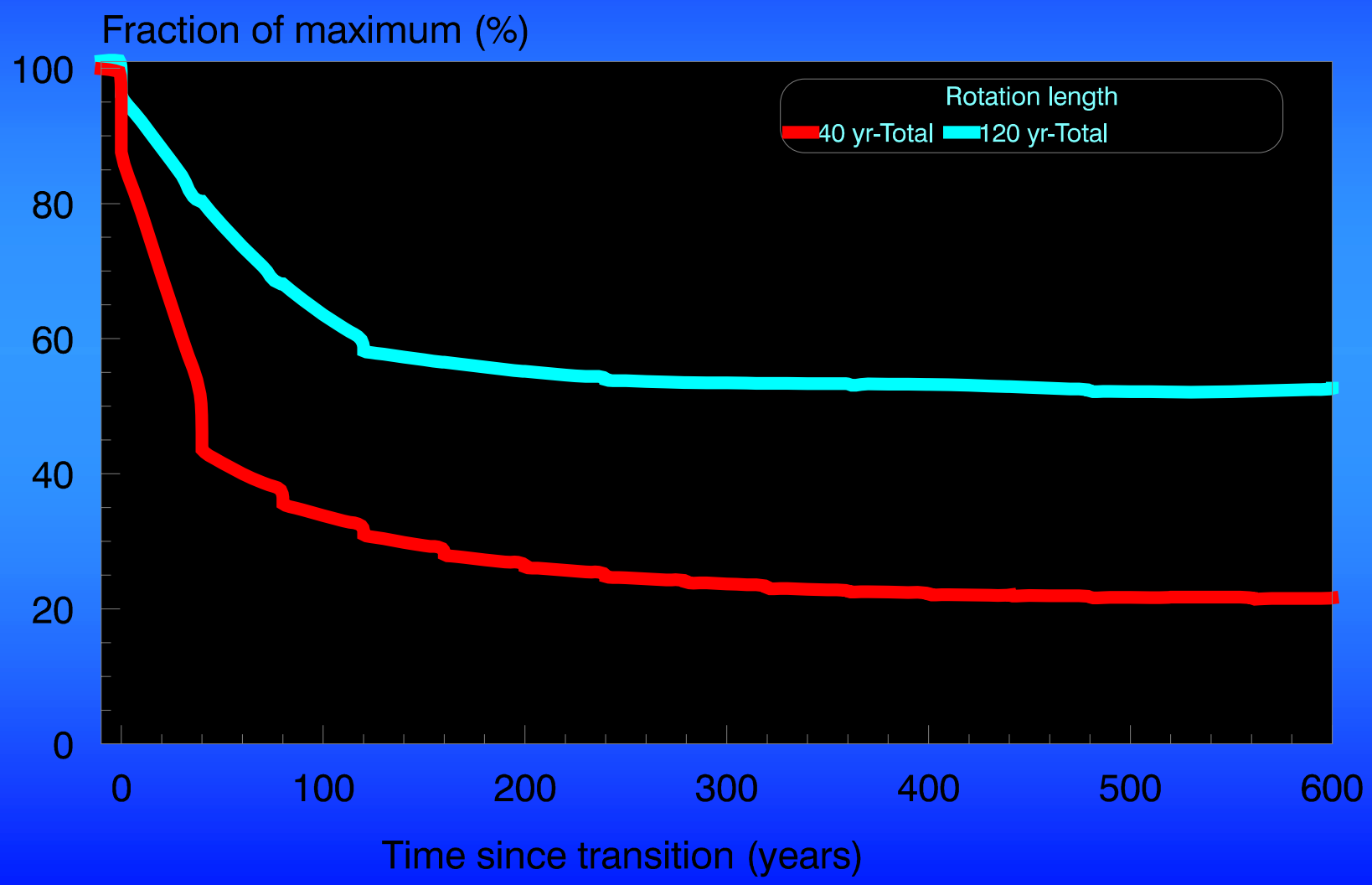
DAVID BROOKS
USDA Forest Service, Forestry Sciences Laboratory, Corvallis, OR 97331, U.S.A.

Which One Stores More Carbon?????

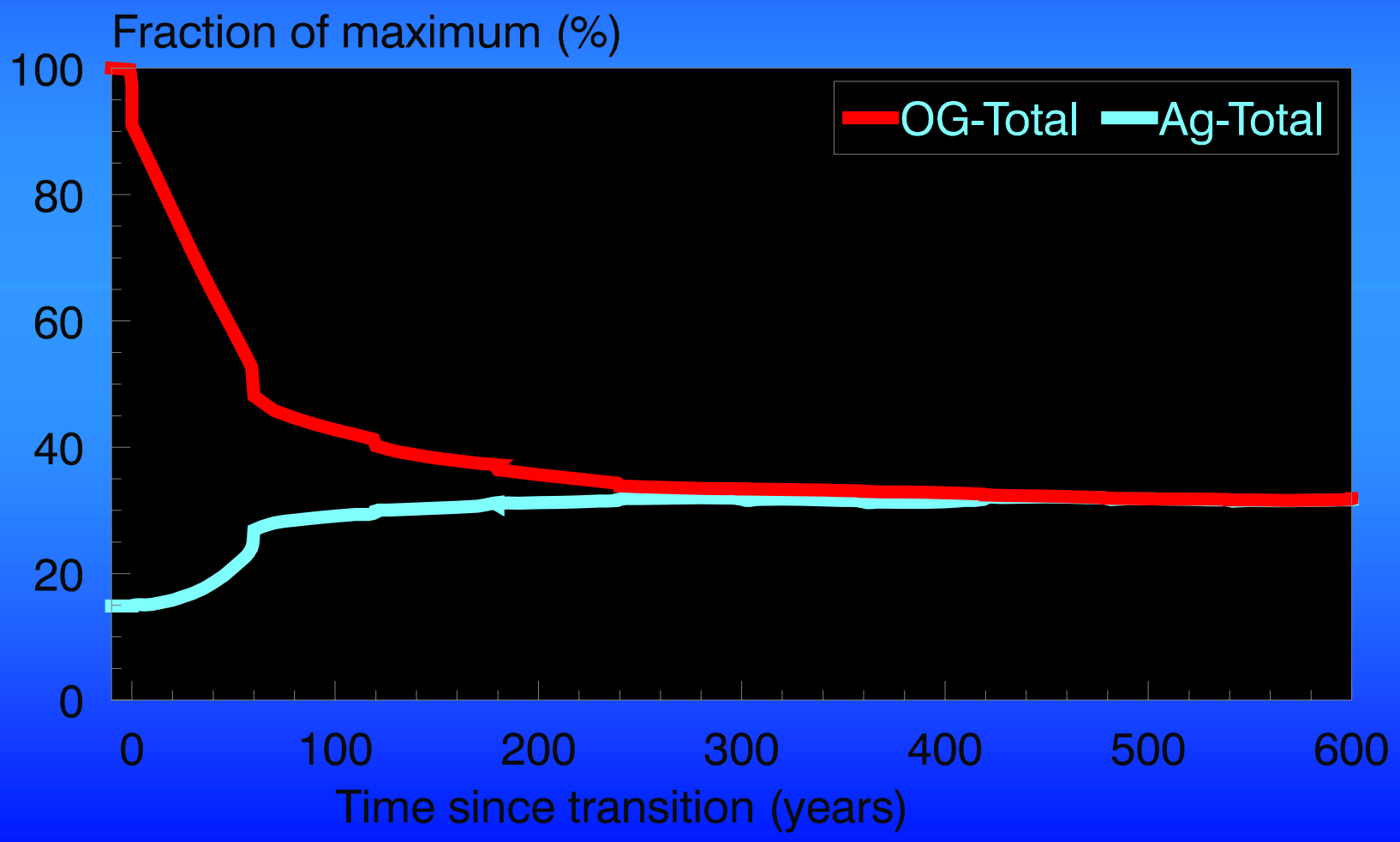



Total C stored (Mg C/ha)
1000
800
600
400
200
0
-100
0
100
200
300
400
500
600
Time (years)
40 year
80 years

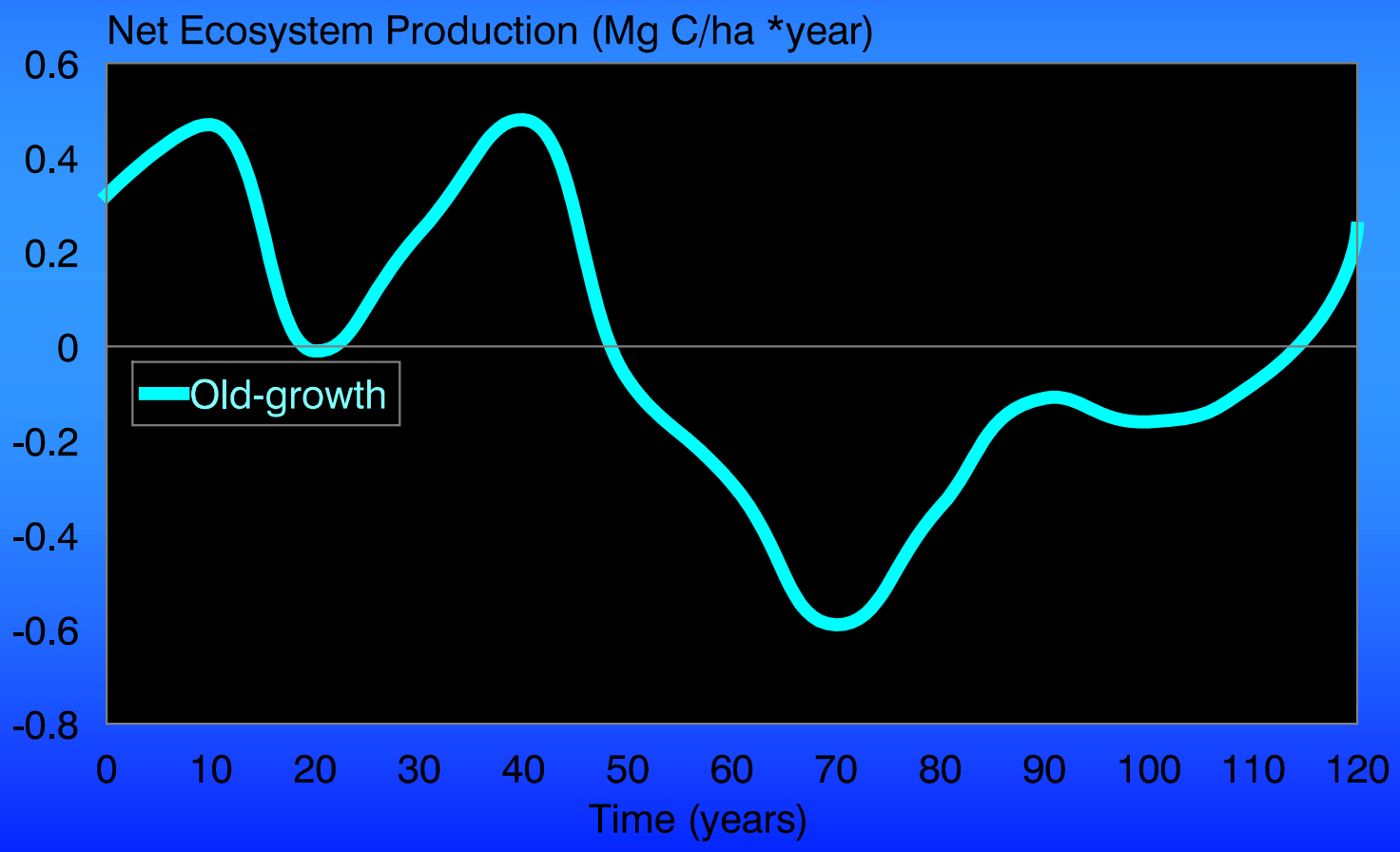
Landscape Level



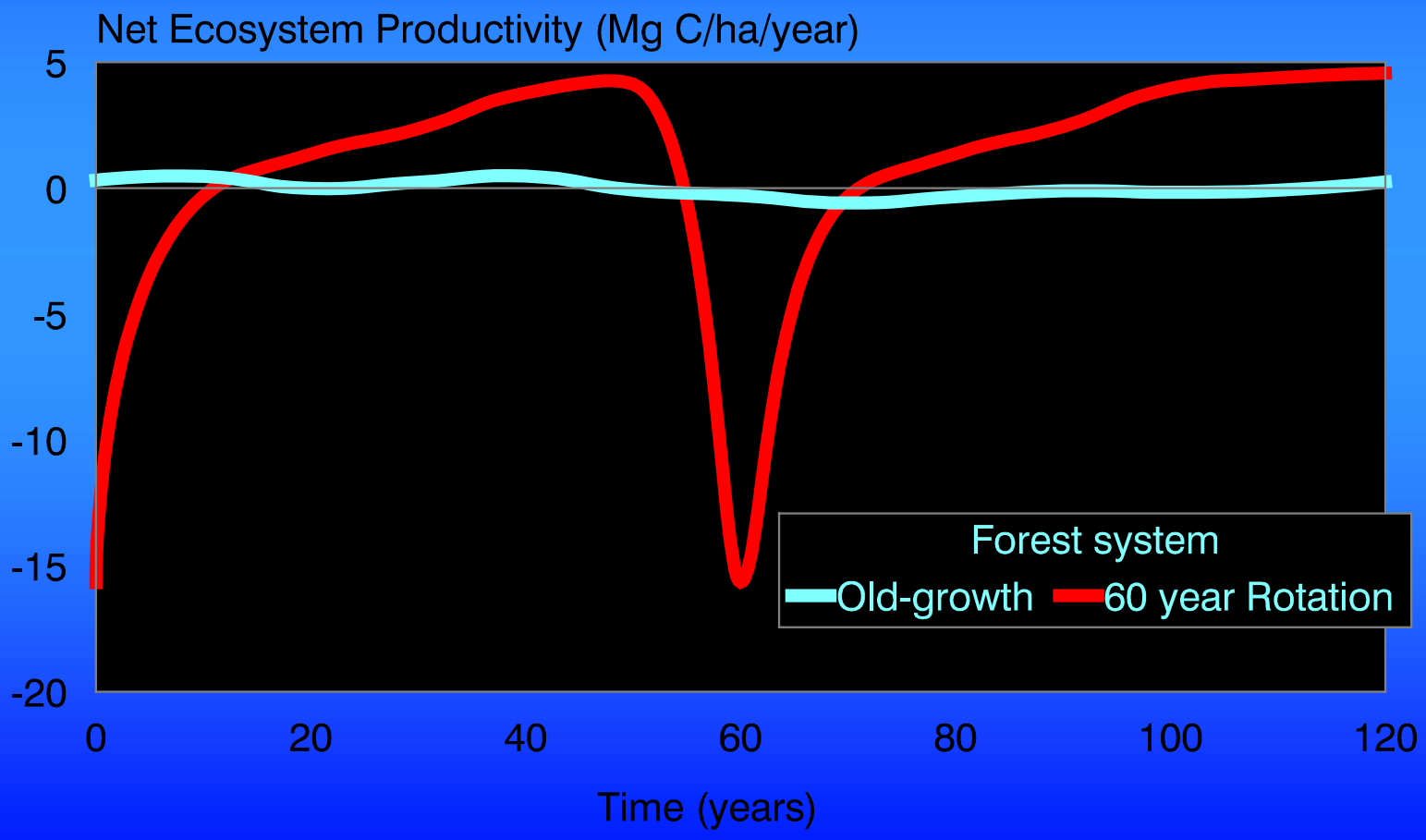
All Roads Lead to ??????



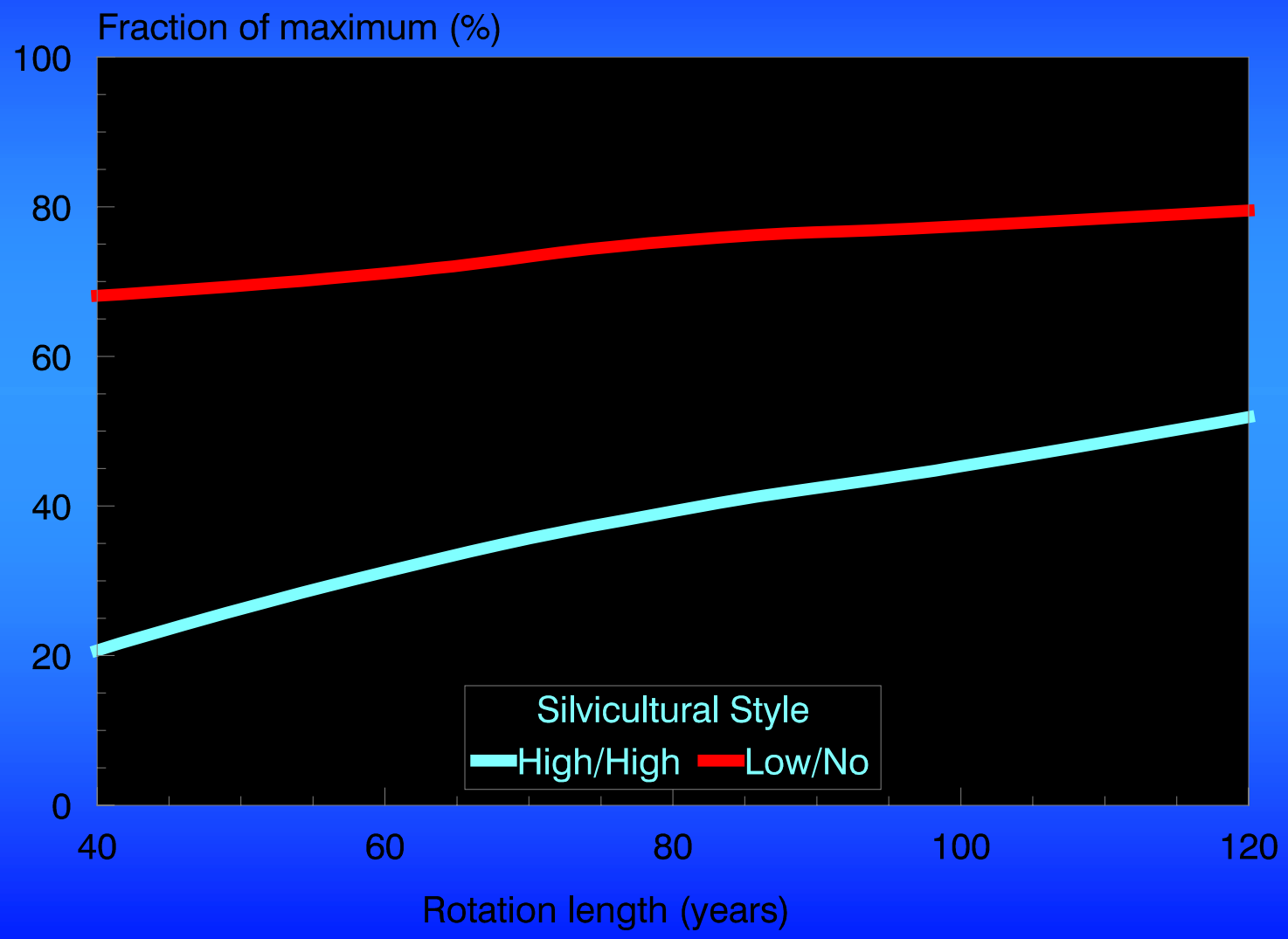
Old-growth Systems are in Balance



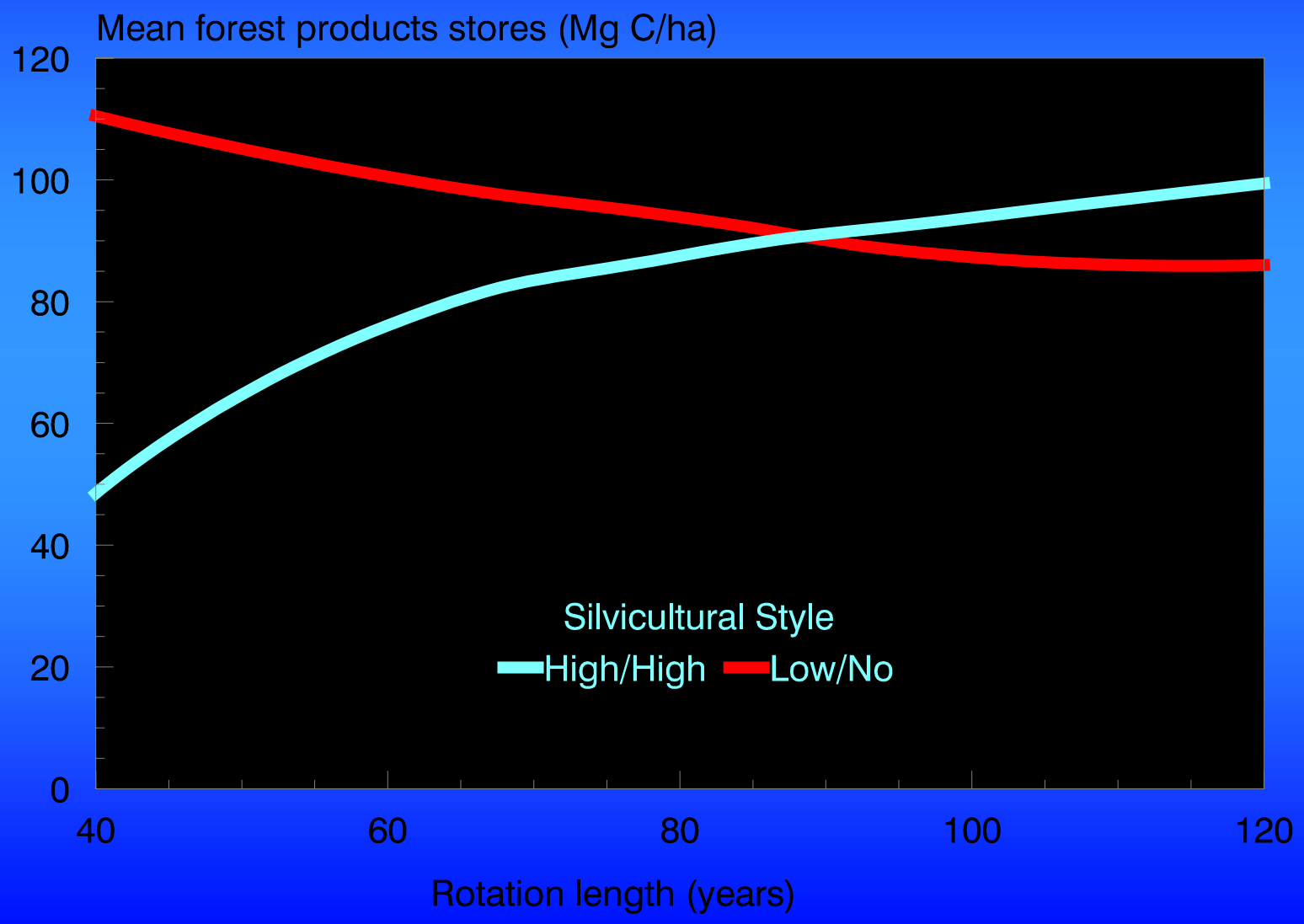
Net Exchange at Landscape Level is the Same



Can We Store More?



Do We Have to Do Without?



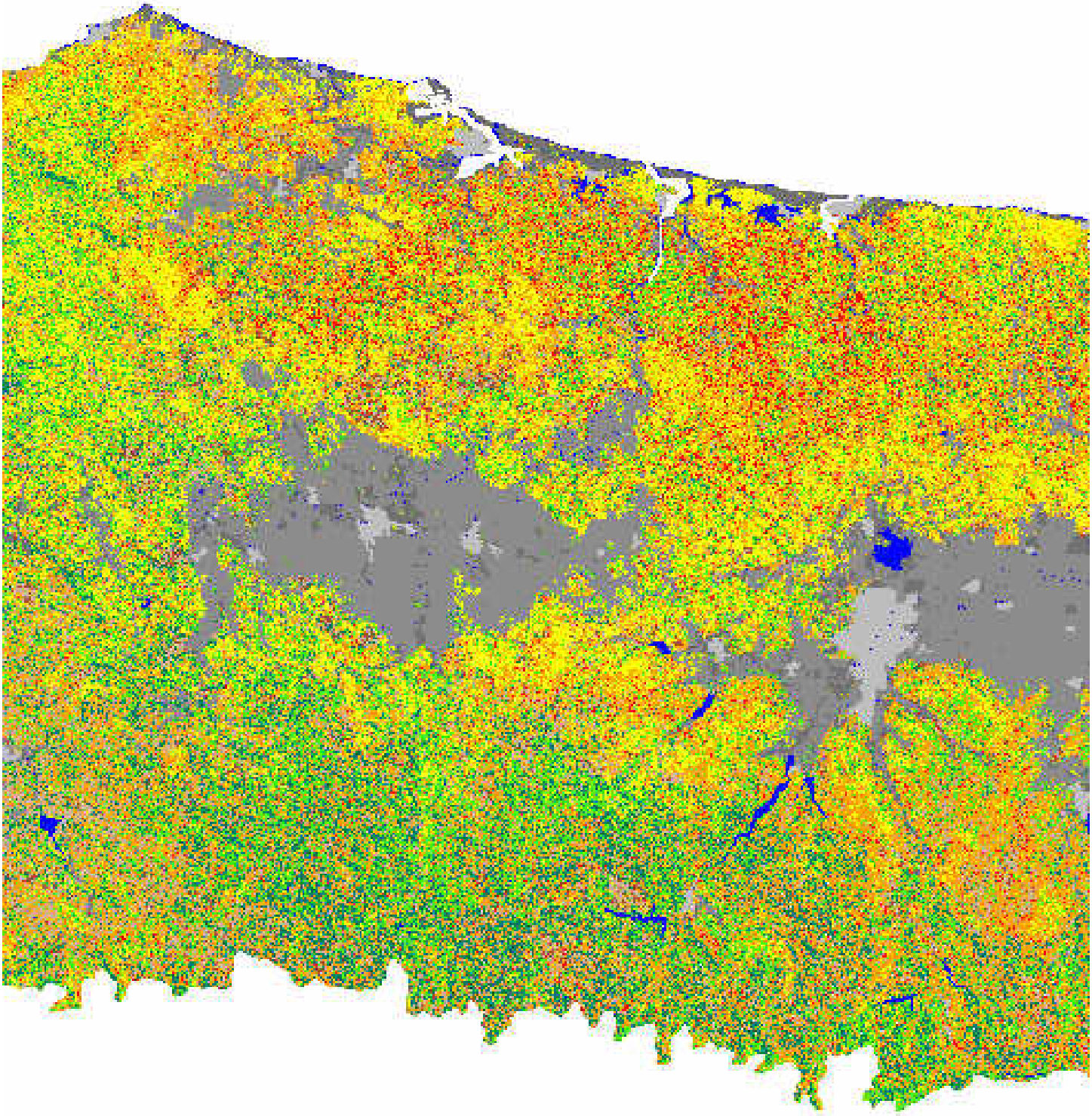
KEY PLAYERS IN FOREST MANAGMENT

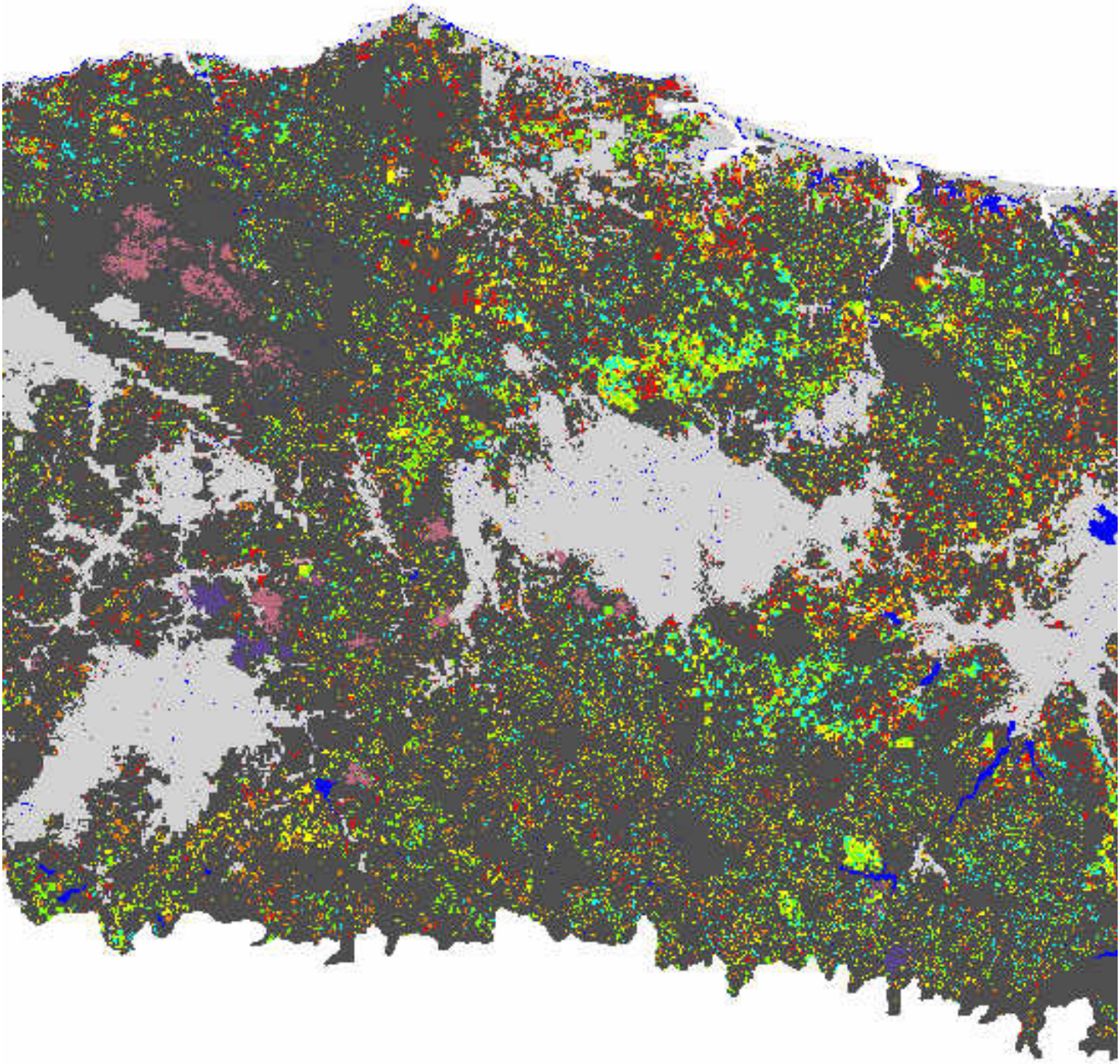
- FOREST OWNERSHIP VARIES
- FEDERAL LANDS -- 41 %
- STATE LANDS--5 %
- INDIAN LANDS--3 %
- NON-INDUSTRIAL--16 %
- INDUSTRIAL--35 %

ECONOMIC INCENTIVES FOR AT LEAST 60 % OF FOREST LANDS

3 Billion tons of Carbon

WHAT IS THE PRIVATE COST OF STORING CARBON????



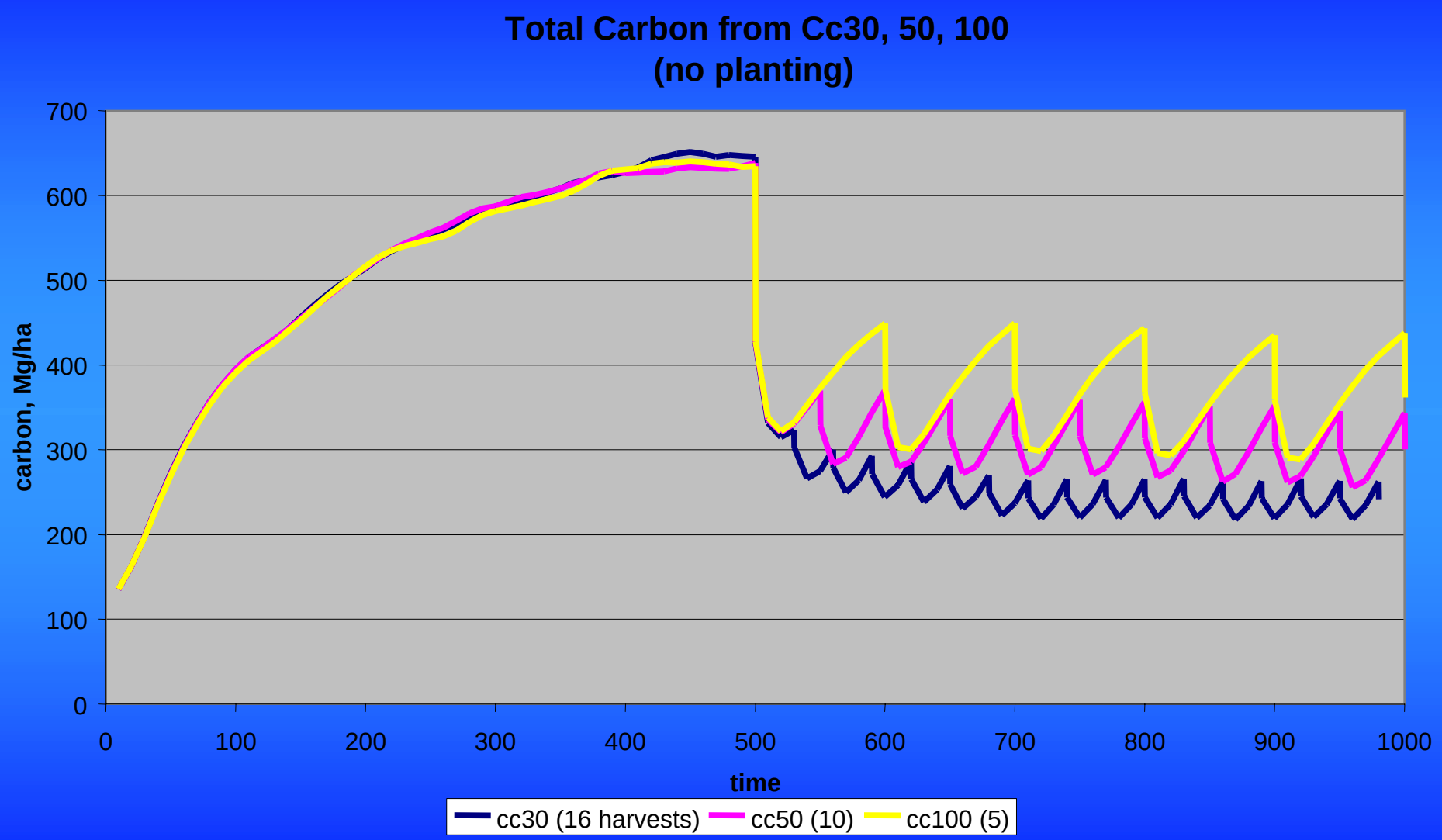


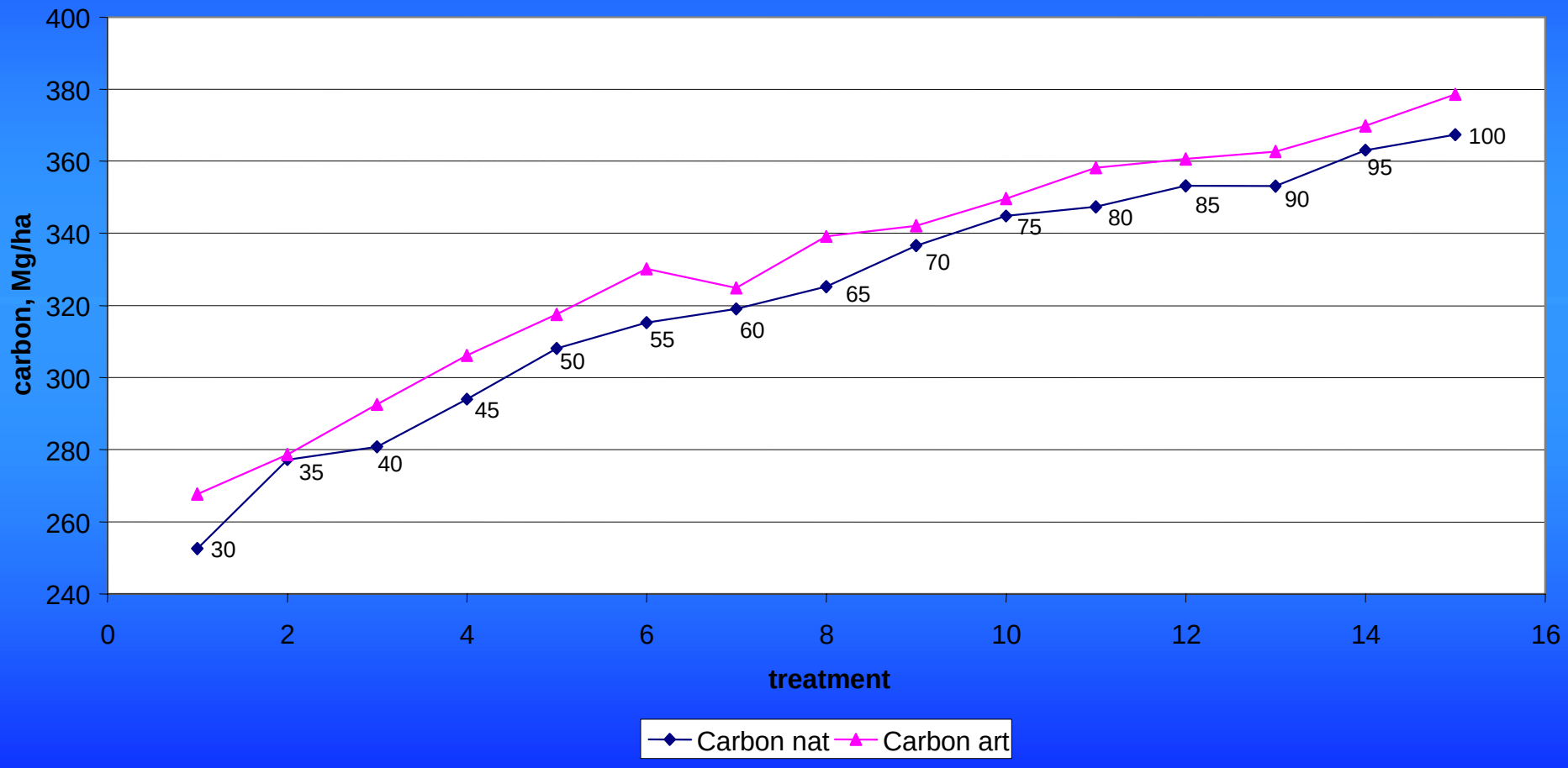
MODELLING APPROACH

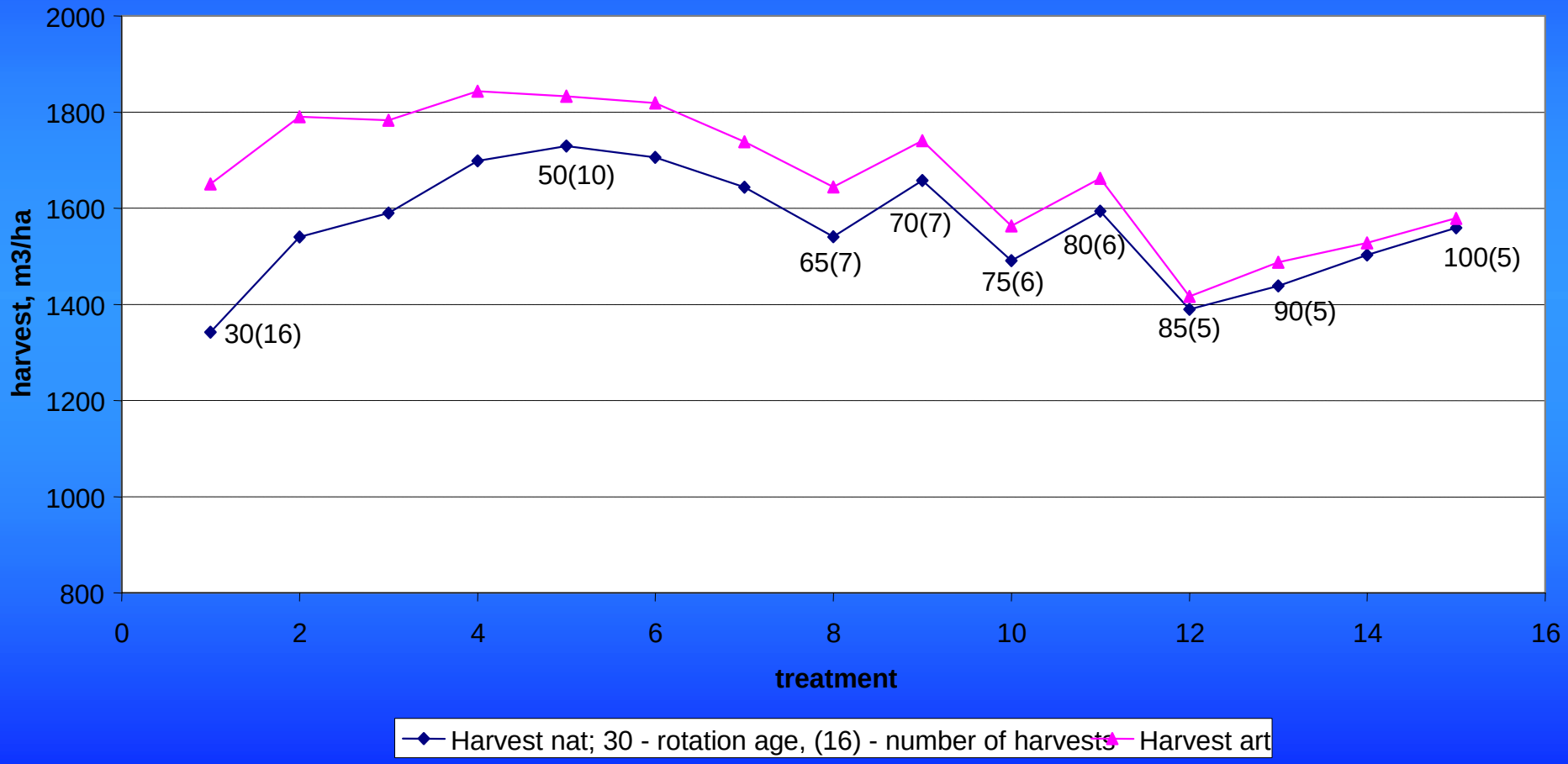
- USE STANDCARB TO SIMULATE OUTPUTS OF FORESTRY PRACTICES
- ESTIMATE NET VALUE OF THESE OUTPUTS IN A TIME SENSITIVE MANNER

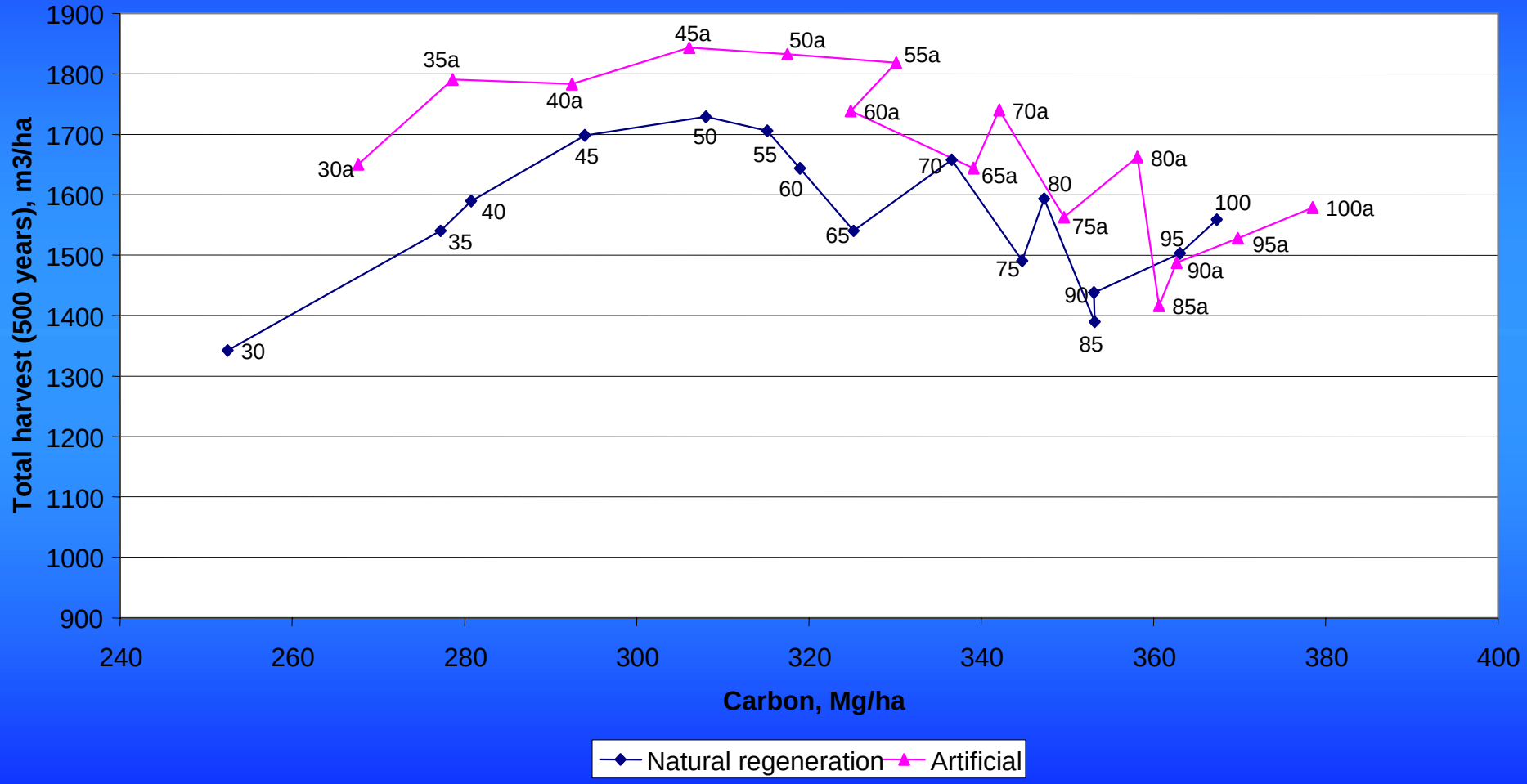
- ROTATION LENGTH
- PLANTING
- PRE-COMMERCIAL THINNING
- COMMERCIAL THINNING
- HIGH INTENSITY OR LOW INTENSITY

SOME EARLY RESULTS


Total Carbon from Cc30, 50, 100
(no planting)
carbon, Mg/ha
700
600
500
400
300
200
100
0
0
100
200
300
400
500
600
700
800
900
1000
time
cc30 (16 harvests)
cc50 (10)
cc100 (5)


Average carbon
for rotations 30 through 100 with natural and artificial regeneration
carbon, Mg/ha
400
380
360
340
320
300
280
260
240
0
2
4
6
8
10
12
14
16
treatment
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
Carbon nat
Carbon art


Total harvest
for rotations 30 through 100 over period of 500 years
harvest, m3/ha
2000
1800
1600
1400
1200
1000
800
0
2
4
6
8
10
12
14
16
treatment
30(16)
50(10)
65(7)
70(7)
75(6)
80(6)
85(5)
90(5)
100(5)
Harvest nat; 30 - rotation age, (16) - number of harvests
Harvest art


Carbon and Harvest
Total harvest (500 years), m3/ha
1900
1800
1700
1600
1500
1400
1300
1200
1100
1000
900
240
260
280
300
320
340
360
380
400
Carbon, Mg/ha
30
35
40
45
50
55
60
65
70
75
80
85
90
95
100
30a
35a
40a
45a
50a
55a
60a
65a
70a
75a
80a
85a
90a
95a
100a
Natural regeneration
Artificial

EARLY CONCLUSIONS

- PLANTING CAN INCREASE BOTH HARVEST AND CARBON, BUT IS IT PROFITABLE?
- AT LONG ROTATIONS, PROBABLY NOT.
- AT LONGER ROTATION HARVEST MUST BE GIVEN UP TO OBTAIN MORE CARBON STORAGE
- TREATMENT OF TERMINAL VALUES IMPORTANT

STILL TO DO

- DETAILS, DETAILS….
- SENSITIVITY TO MANAGEMENT COST PARAMETERS
- FOCUS ON ONLY PROFITABLE TYPES OF MANAGMENT
- *THORNY PROBLEMS…..*
- *RATES OF TIME PREFERENCE FOR FOREST OWNERS*
- *WHAT DO PRIVATE NON-INDUSTRIAL OWNERS WANT?*