EVALUATING LAND USE AND FOREST MANAGEMENT RESPONSES TO A POTENTIAL FOREST CARBON OFFSET SALES PROGRAM IN WESTERN OREGON

Greg Latta, Darius Adams,
Kathleen Bell, Jeff Kline

FUNDING FROM USEPA, CORVALLIS LAB

EVALUATING LAND USE AND FOREST MANAGEMENT RESPONSES TO A POTENTIAL FOREST CARBON OFFSET SALES PROGRAM IN WESTERN OREGON

WOULD A FOREST CARBON OFFSET SALES PROGRAM IN WESTERN OREGON INFLUENCE:

(1) THE RATES AT WHICH FOREST LAND IS SHIFTED INTO NON-FOREST USES?

(2) THE TYPES OF SILVICULTURAL ACTIVITIES UNDERTAKEN ON LANDS THAT REMAIN IN FORESTRY?

MODELING APPROACH AND MODEL SOLUTIONS

- **LAND USE MODEL = CHANGE IN NUMBER OF BUILDINGS**
  - Look only at FOREST → DEVELOPMENT; AG → DEVELOPMENT
  - Land rent maximization within policy constraints.
  - Explains change in number of buildings over time by 80-acre plot: areas with more than 1 building per 10 acres classed as **developed → SHIFT OUT OF FOREST**
  - Change in number of buildings depends on:
    - **Baseline building count** **(+)**
    - **Population-based gravity index** **(+)**
    - **Mean slope and elevation** **(- / ±)**
    - **Oregon land use laws and zones** **(+ in development zones)**
    - **Agricultural and forest returns** **(- / -) ← INPUT FROM FOREST MODEL**
  - Final count regression model (negative binomial form):
    - Employs pooled data set from '74-'84, '84-'94, '94-'09 periods (21,000 sample points at three times in WOR)
    - All parameter estimates significant at .01 (including ag and forest returns)
    - All signs as expected

MODELING APPROACH AND MODEL SOLUTIONS

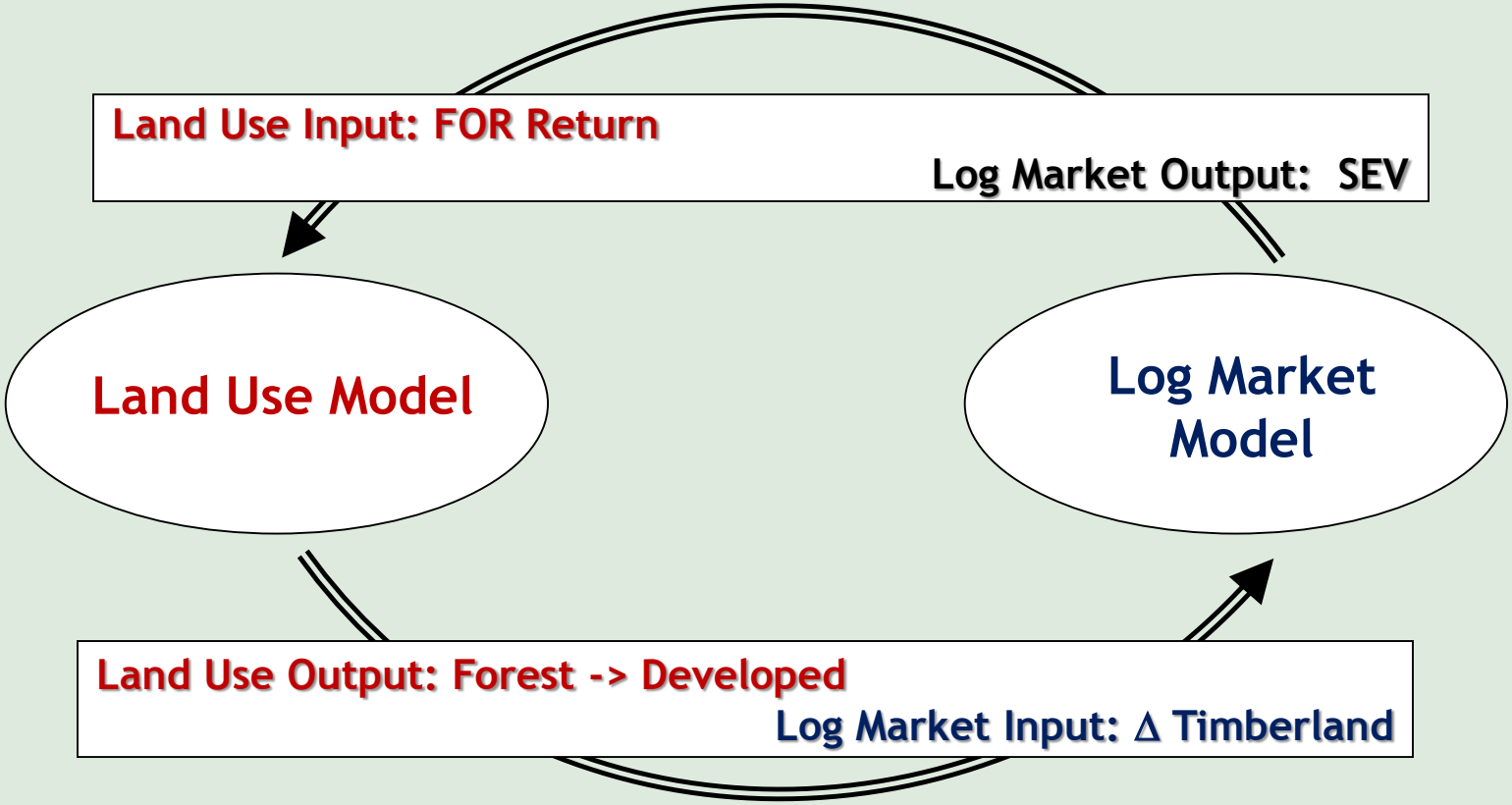
- **FOREST SECTOR MODEL**
  - Spatial, intertemporal log market model
  - Log demand relations derived from estimated profit functions for saw and veneer mills
  - Supply of logs based on land value maximizing harvesting decisions
  - Silvicultural investment determines yields -- regime choices endogenous
  - Inventory depends on yields and

    Area of forest land ← BASED IN PART ON LAND USE MODEL
  - Land area accounting (constraints for a model II)
    - Existing stands must be allocated to some harvest regime or not cut
    - No more area can be planted in a given period than is harvested from existing stands or stands created since the start of the simulation – NEW LAND BALANCE

      Shadow price of New Land Balance constraint is

      Forest Land Return / SEV → SENT TO LAND USE MODEL

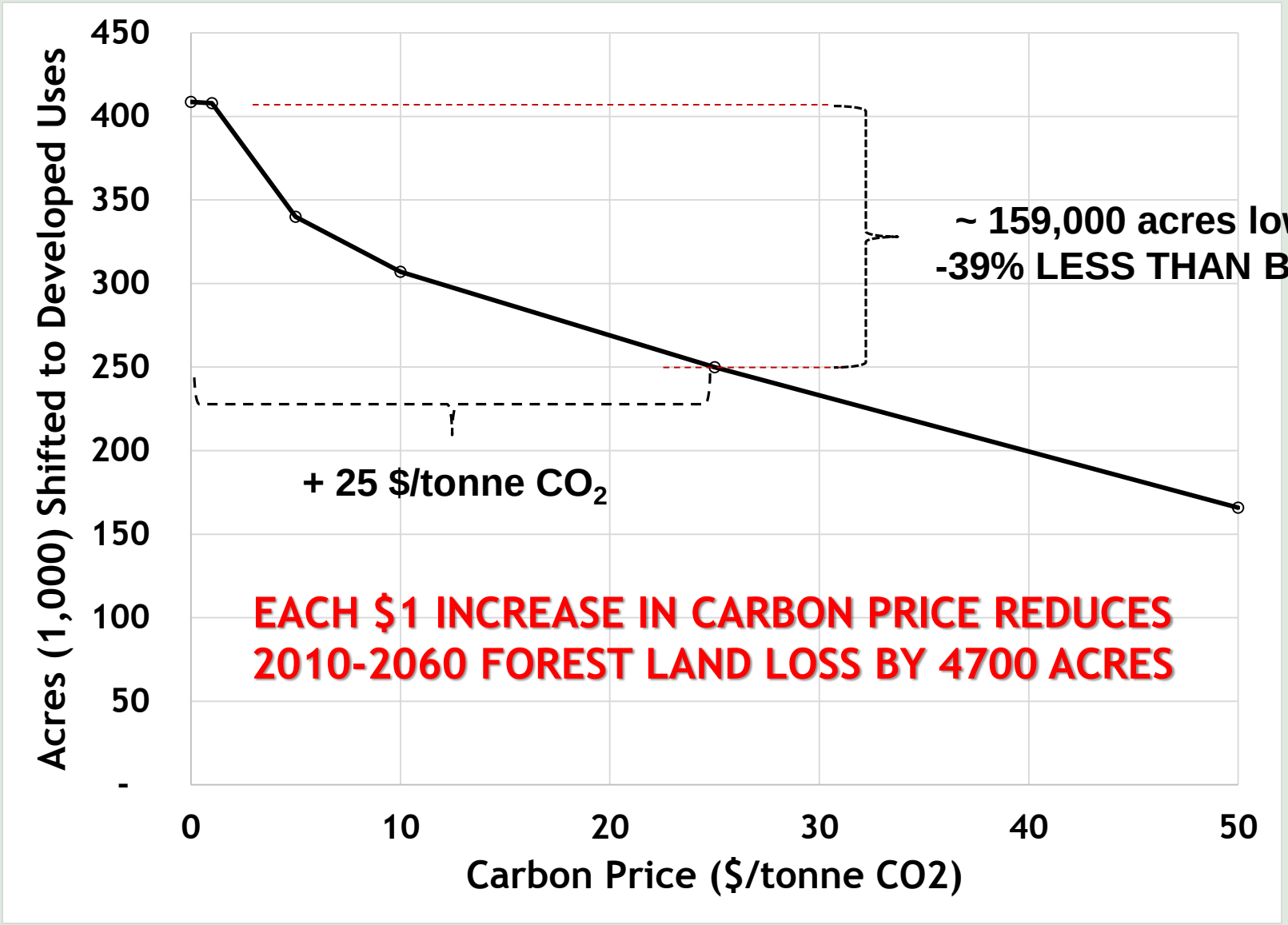
MODEL INTERACTION and GAUSS-SEIDEL ITERATION



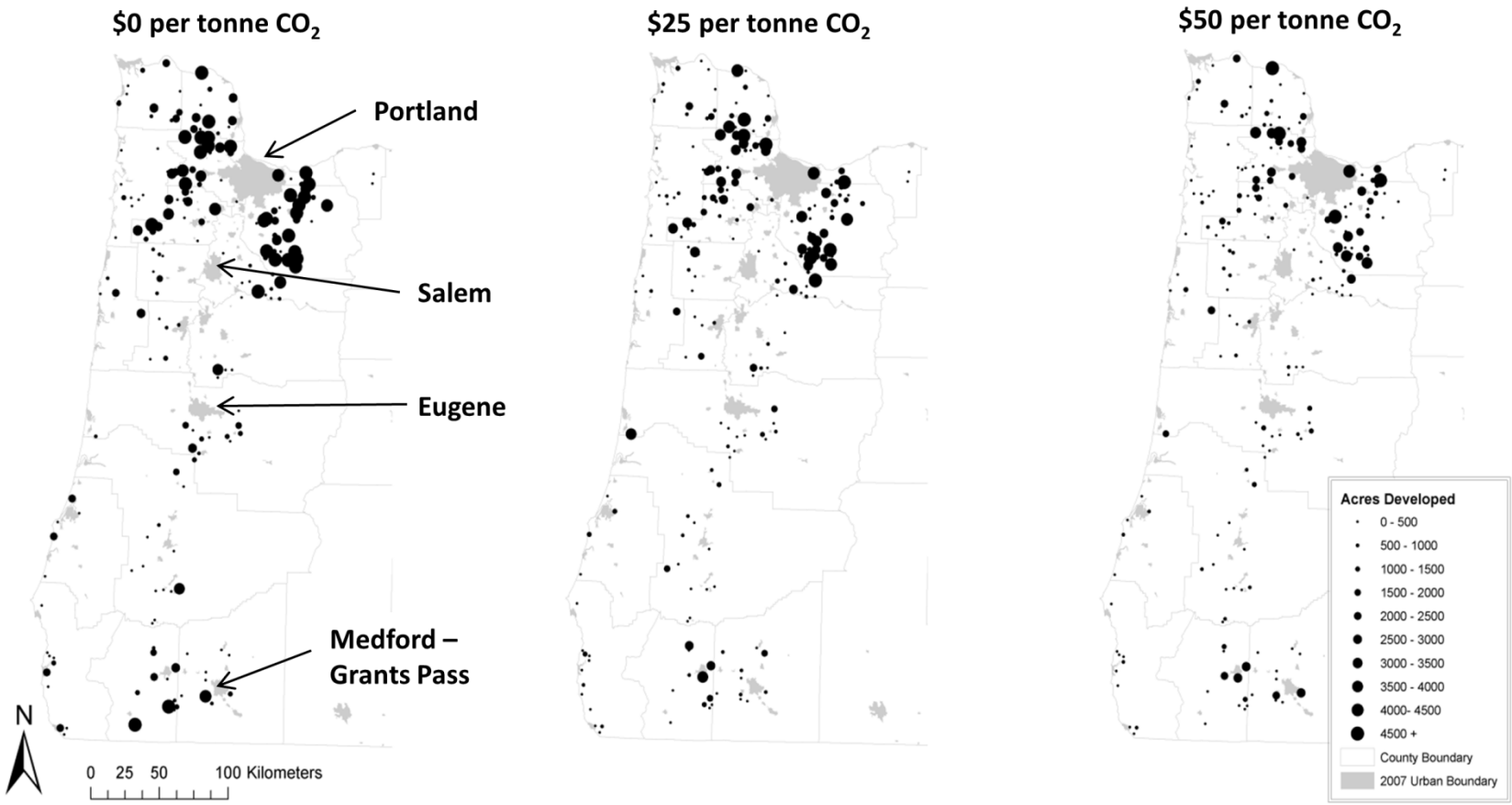
CARBON POLICY SCENARIOS

- **CARBON OFFSET SALES PROGRAM**
  - Voluntary not mandatory
  - Mimic Climate Action Reserve (CAR) program
    - Carbon pools counted (live tree: merch, non-merch, below ground)
    - Benchmarks against which to measure change (offsets awarded when C stock exceeds regional averages)
    - Minimum time commitment (100 years)
    - Treatment of harvested wood products (CAR regional product percentages and deterioration)
    - Once an acre is enrolled it can't be shifted to development
- **CARBON PRICES**
  - \$1, \$5, \$10, \$25, \$50 tonne CO_2

FOREST LAND SHIFTED TO "DEVELOPED" BY CO_2 PRICE – TOTAL 2010-2060



PROJECTED CONCENTRATIONS OF LAND USE CHANGE FROM FORESTRY TO DEVELOPMENT 2010-2060 IN WESTERN OREGON AT VARIOUS CO_2 PRICES



BIGGER DOTS REPRESENT MORE ACRES LOST

PARTICIPATION IN COSP

CO_2_Price	IN COSP	OUT OF COSP	% IN
	----------acres---------		
0	0	6,469,550	0%
1	334,552	6,134,999	5%
5	1,845,675	4,623,875	29%
10	2,390,395	4,079,155	37%
25	3,100,907	3,368,643	48%
50	3,440,477	3,029,073	53%

SILVICULTURAL CHANGES

AVERAGE AGE OF HARVESTED EXISTING STANDS

CO_2 Price	In COSP	Out of COSP
	---------- years ----------	
0		54
5	61	52
50	66	49

AVERAGE AGE OF HARVESTED REGENERATED STANDS

CO_2 Price	In COSP	Out of COSP
	---------- years ----------	
0		44
5	45	44
50	61	43

SILVICULTURAL CHANGES

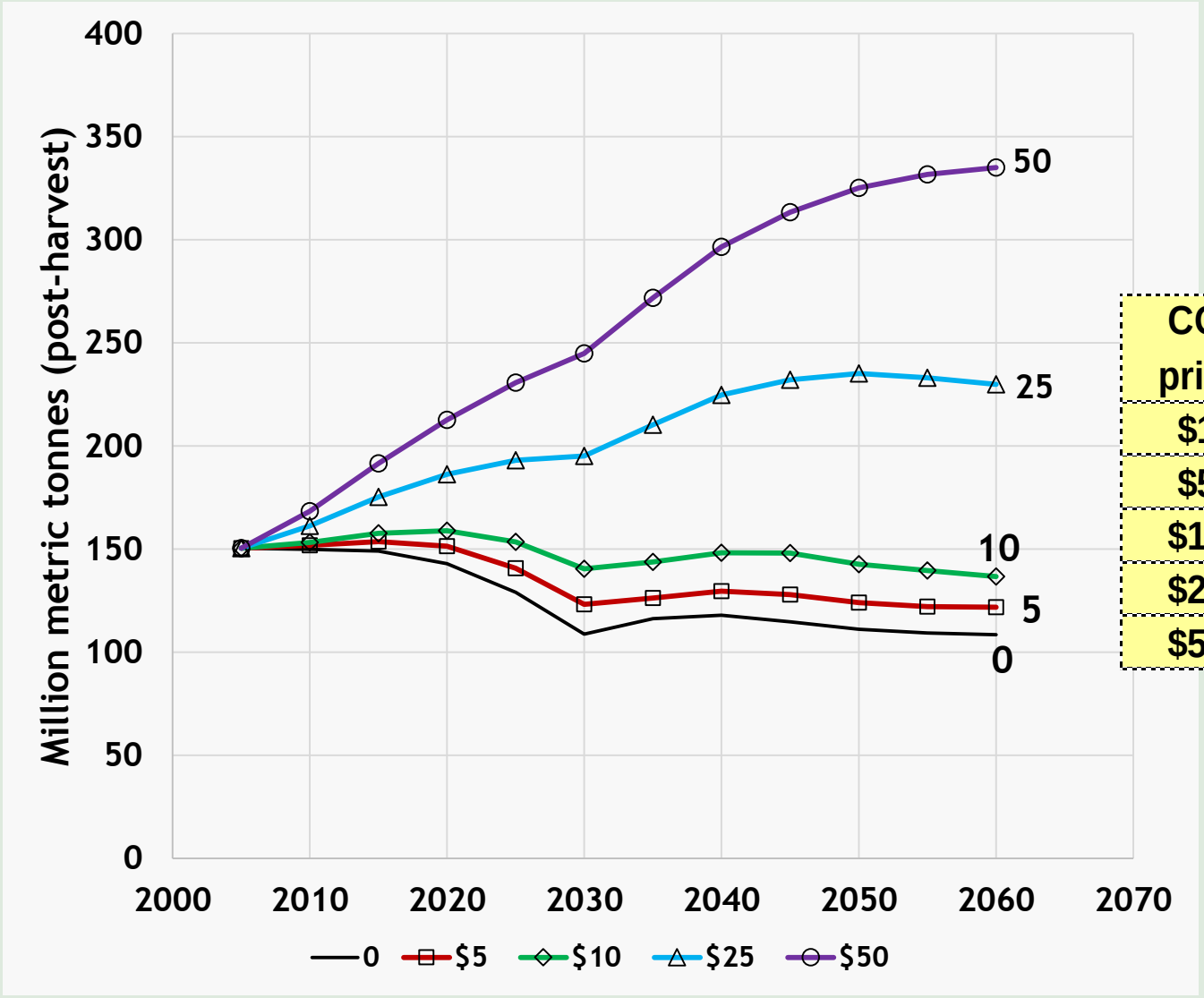
"UNEVEN-AGED" MANAGEMENT OF EXISTING FORESTS

	In COSP	Out of COSP	
C price	ACRES		% Out
0		374,001	6%
5	0	170,045	6%
10	0	125,356	4%
50	0	85,877	2%

PERCENT OF REGENERATED FORESTS BY MANAGEMENT CHOICE

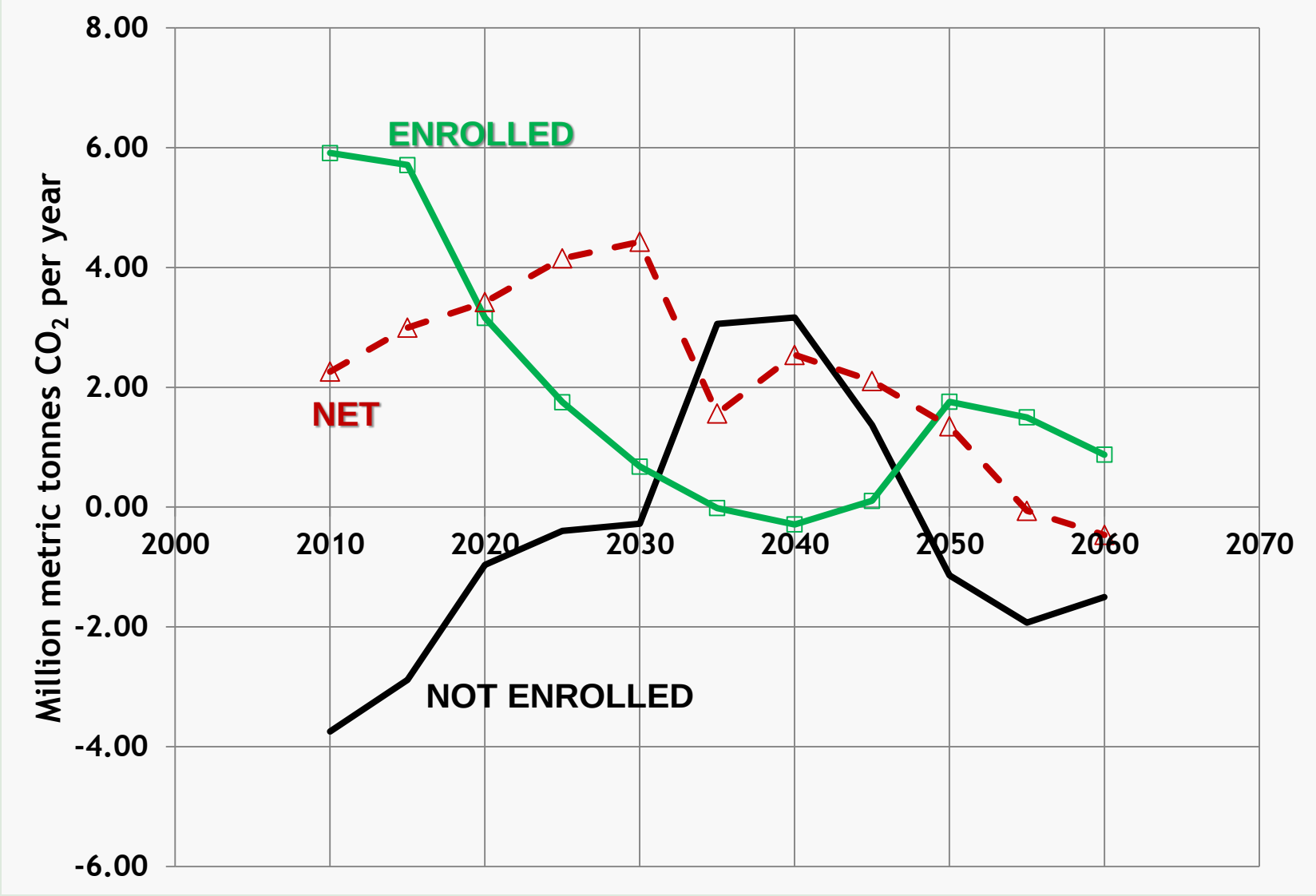
		NATURAL		PLANT	
	CO_2 price	THIN	NO THIN	THIN	NO THIN
IN	5	0.9%	8.3%	73.8%	14.8%
	50	0.0%	0.4%	4.8%	94.8%
	0	1.6%	15.9%	79.4%	3.1%
OUT	5	2.8%	24.0%	70.8%	2.4%
	50	4.6%	34.3%	60.2%	0.9%

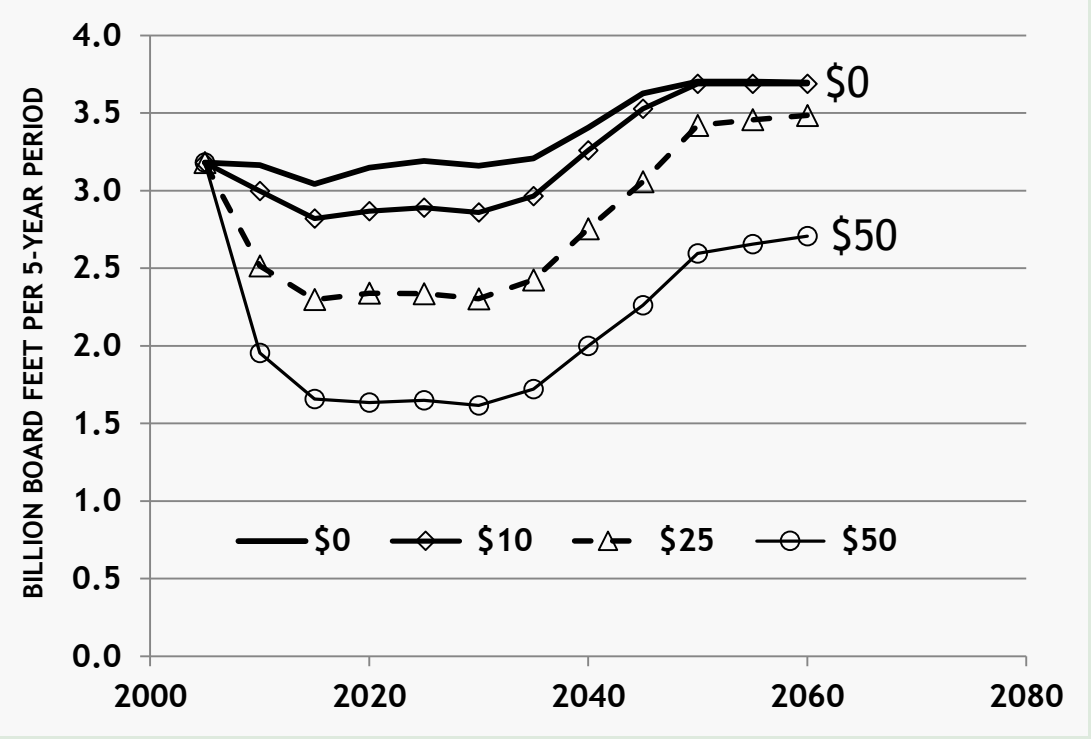
PRIVATE FOREST LIVE TREE CARBON STOCKS BY CO_2 PRICE



CO_2 price	Flux loss/gain
$1	95%
$5	70%
$10	54%
$25	19%
$50	5%

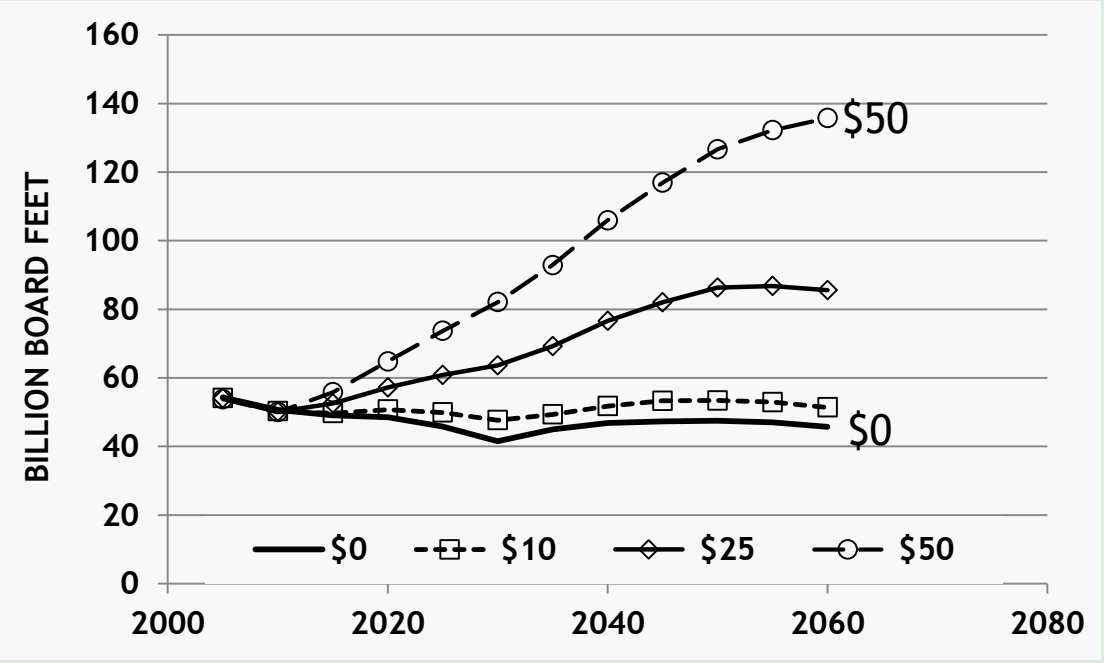
ANNUALIZED PERIOD-TO-PERIOD FOREST CARBON FLUX BY LANDS IN AND OUT OF COSP: $25 / tonne CO_2, LIVE TREE, PRIVATE ONLY





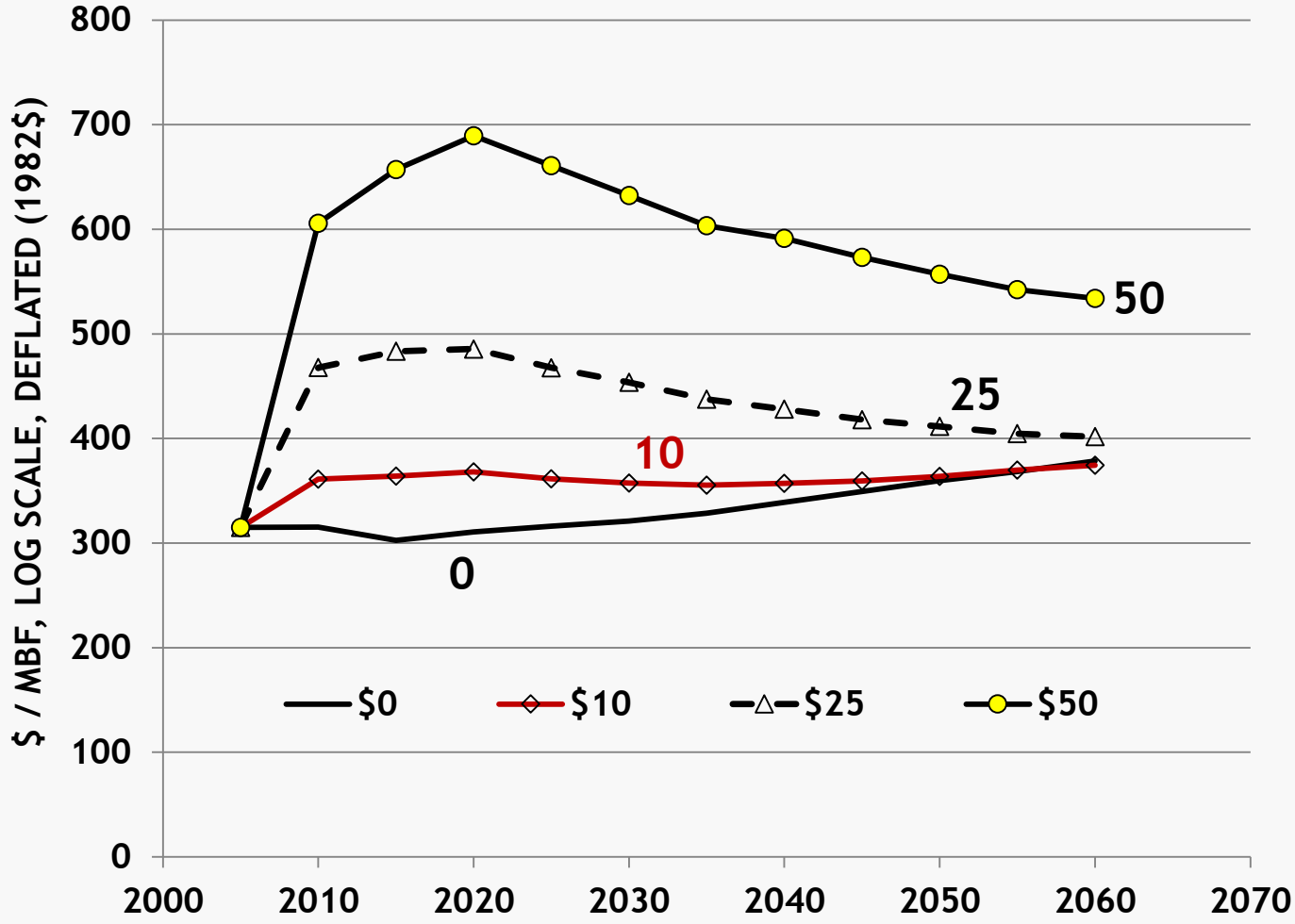
HARVEST

WESTERN OREGON PRIVATE SOFTWOOD HARVEST AND INVENTORY BY CO_2 PRICE

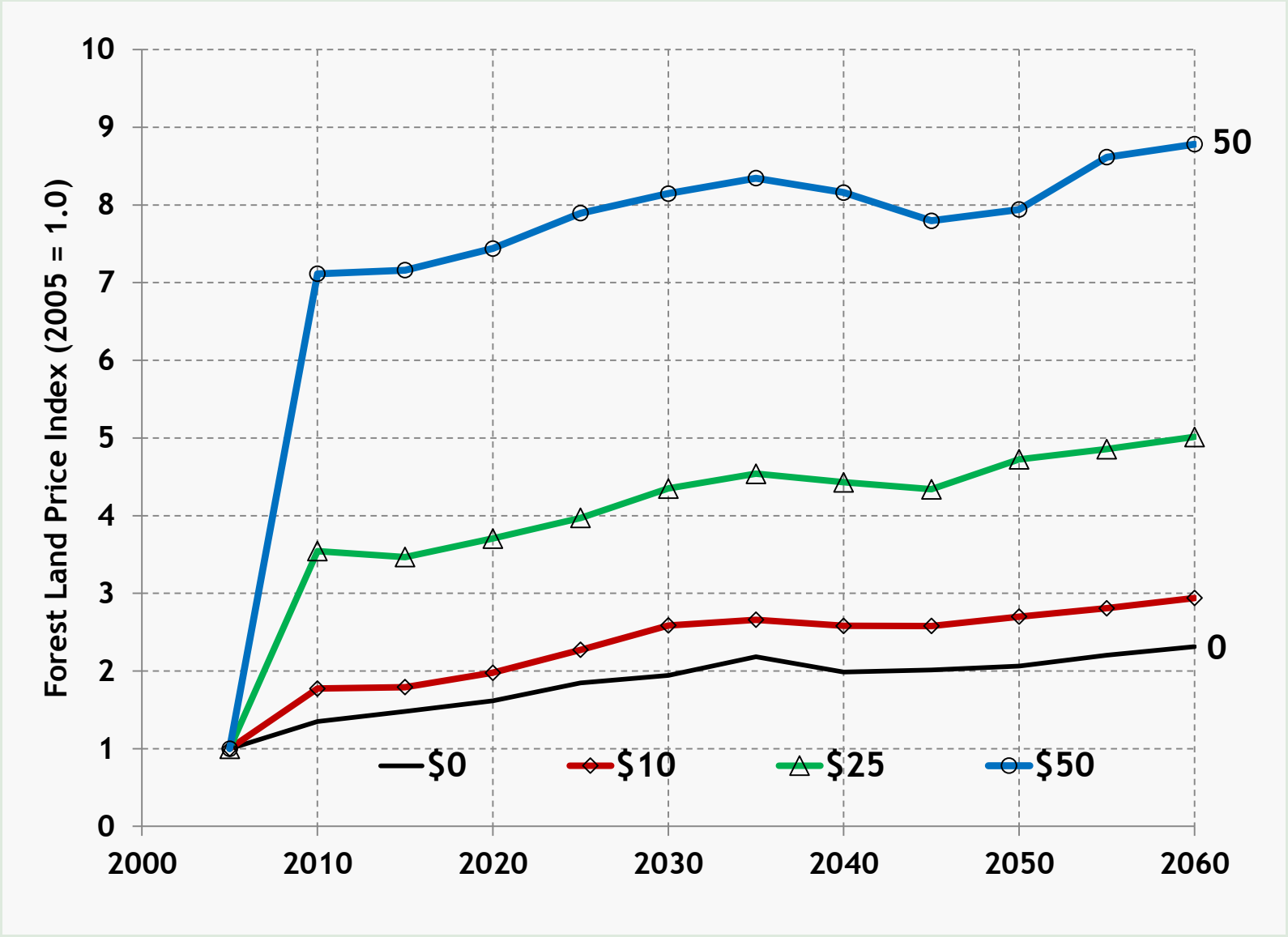


INVENTORY

REAL DELIVERED SOFTWOOD LOG PRICES BY CO_2 PRICE



FOREST LAND VALUE INDEX BY CO_2 PRICE



SUMMARY

- COSP could reduce land loss to developed uses over the next 50 years in WOR by 4700 acres for every $1 increase in CO_2 price.
- Reduced land losses are concentrated around largest metro areas but appear in other areas as well.
- COSP leads to longer rotations, reduced partial cutting (all types), and more planting on enrolled acres; less partial cutting and less planting on non-enrolled acres.
- $10 CO_2 could roughly stabilize private carbon stocks in WOR to 2060.
- Actual response patterns of carbon flux over time are complex across areas in and out of COSP – MAY NOT GET A CARBON GAIN IN EVERY PERIOD.
- Market impacts can be substantial even for low CO_2 prices.
- High CO_2 prices ($50 +) may effectively preclude forestry practice.

SOLUTION METHOD: GAUSS-SEIDEL ITERATION

$$y_1 = f_1(y_2, z_1) \quad \text{LAND USE MODEL}$$

$$y_2 = f_2(y_1, z_2) \quad \text{LOG MARKET MODEL}$$

Make an initial guess of a solution $y_i^{(0)}$ substitute on right-hand side, take results and substitute again, and so on…….

$$y_1^{(i+1)} = f_1(y_2^{(i)}, z_1)$$

$$y_2^{(i+1)} = f_2(y_1^{(i)}, z_2)$$

Stop when $|y_j^{(i+1)} - y_j^{(i)}| <$ small tolerance

CARBON POLICY SCENARIOS

- **ASSUMPTIONS**
  - **PUBIC LAND HARVESTS FIXED AT PRESET LEVELS**
  - **AGRICULTURAL LAND VALUES CONSTANT IN REAL TERMS**
  - **NORTH AMERICAN FOREST PRODUCTS PRICES DO NOT RESPOND TO REGIONAL CHANGES (IGNORE LEAKAGE OUT OF REGION)**
  - **FIXED CARBON PRICES OVER TIME**

LAND AND SILVICULTURAL CHANGES

PARTICIPATION IN COSP

CO_2_Price	IN COSP	OUT OF COSP	% IN
	----------acres---------		
0	0	6,469,550	0%
1	334,552	6,134,999	5%
5	1,845,675	4,623,875	29%
10	2,390,395	4,079,155	37%
25	3,100,907	3,368,643	48%
50	3,440,477	3,029,073	53%

FOREST LAND AREA NOT HARVESTED DURING PROJECTION

CO_2_Price	IN COSP	OUT OF COSP
	------ acres -------	
0		945,831
10	374,229	523,956
25	992,115	497,973
50	2,040,706	472,882