Carbon and California Forests: Forest Inventory and Analysis Results

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Presentation Outline

- What is FIA?
- Carbon storage versus carbon sequestration
- Carbon storage by ownership
- Harvest versus growth by ownership
- Carbon storage by forest type
- Carbon storage and site productivity
- Opportunities for enhancing carbon storage

Forest Inventory and Analysis Program

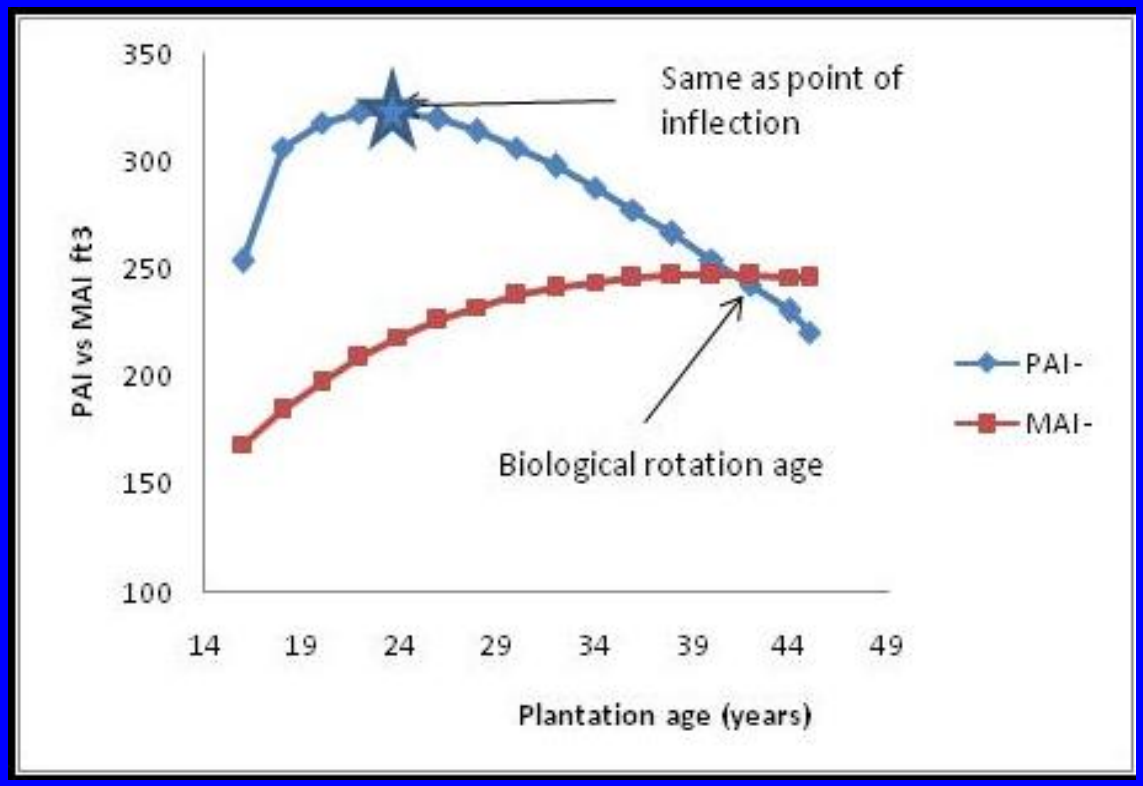
- The Forest Inventory and Analysis (FIA) Program was created within the Forest Service in 1928 to conduct unbiased assessments of all the Nation's forested lands for use in economic and forest management planning.
- There are nearly 6000 permanent plots on public and private forestland in California.
- The most recent results represent sampling of all plots conducted between 2001-2010. The report of findings is currently in press.


Forest Plots
Forest
Nonforest
Water
Counties
N
W
E
S
Miles
0 25 50 100

Sequestration versus Storage

- Carbon sequestration is the capture of CO2 from the atmosphere. The maximum rate of sequestration occurs at culmination of periodic annual increment when leaf area is at a maximum (John Helms).
  - Periodic annual increment is growth over a period of time divided by the length of the period
- The maximum storage of carbon probably occurs at about the culmination of mean annual increment when rates of carbon uptake equal the losses of carbon through respiration, decomposition and mortality (John Helms).
  - Mean annual increment is total volume, basal area or size divided by the total age of the tree or stand. At culmination MAI equals PAI.

CMAI versus PAI: Concepts Applicable to Even-aged Forests



Questions

What is the objective?

- Maximize sequestration rates?
- Maximize carbon storage?
- Both?
- Does maximizing storage also increase the risk of reversal through wild fire, insects and disease?

Carbon Storage by Ownership

- Forest area by ownership (1000's of acres): reserves are unavailable for timber management

Ownership	Unreserved Forests			Reserves	Grand Total
	Timberland	Other Forest	Total		
Federal	9200	3600	12800	5700	18500
Other Public	100	200	300	800	1100
Private/Tribal	7400	5200	12600	0	12600
All	16700	9000	25700	6500	32200

- Volume by ownership (millions of cubic feet)

Ownership	Unreserved	Reserves	Total
Federal*	42,000	22,000	64,000
Other Public**	1000	4000	5000
Private/tribal	33,000	0	33,000
All	76,000	26,000	102,000

Carbon Storage by Ownership (cont.)

- Carbon stored in above ground dead and living plant materials (millions of tons)

Ownership	Unreserved Forests			Reserves	Grand Total
	Timberland	Other Forest	Total		
Federal	430	40	470	240	710
Other Public	10	-	10	40	50
Private/Tribal	300	80	380	0	380
All	740	120	860	280	1140

- Carbon stored below ground (millions of tons)

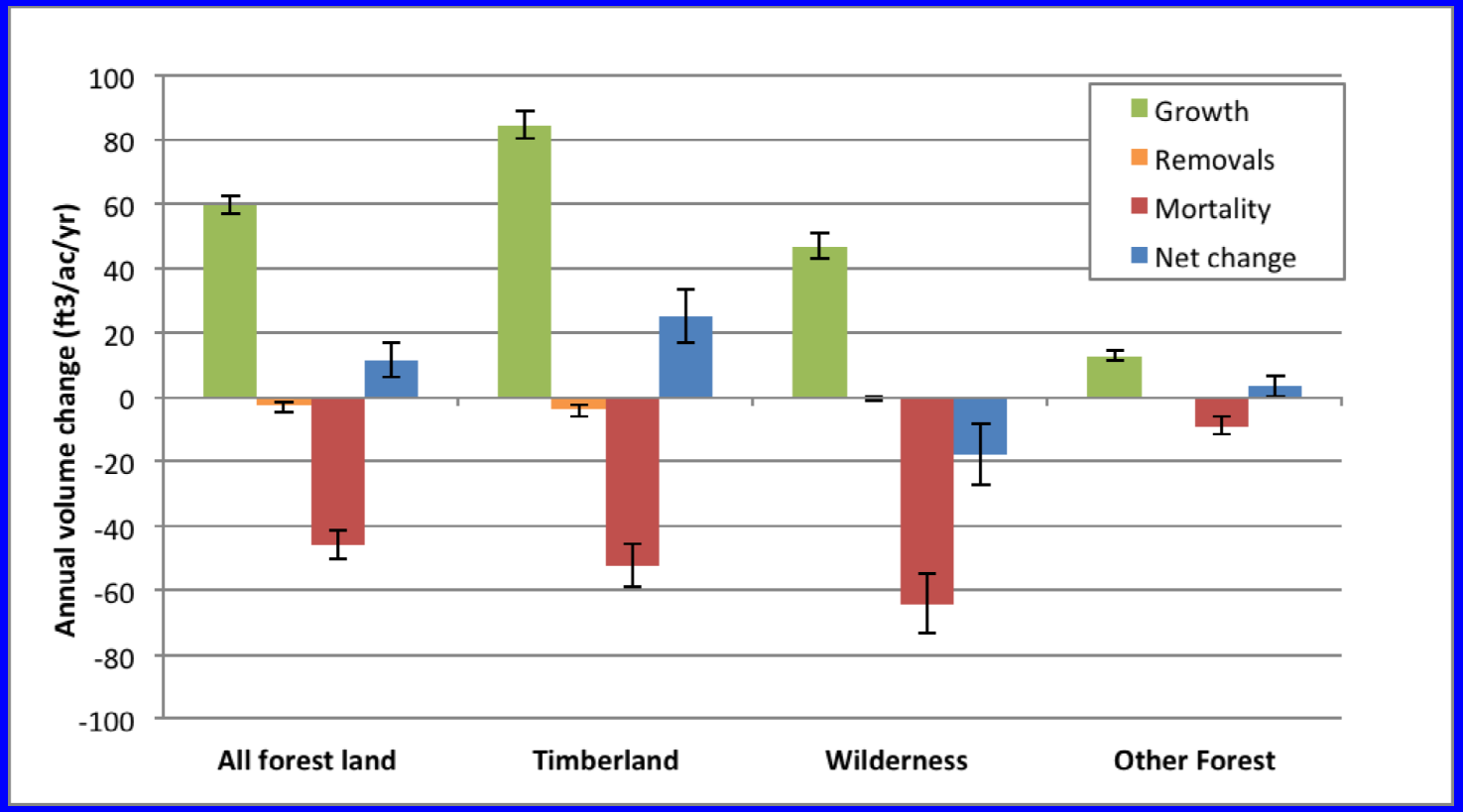
Ownership	Unreserved Forests			Reserves	Grand Total
	Timberland	Other Forest	Total		
Federal*	90	10	100	50	150
Other Public**	2	1	3	9	12
Private/Tribal	70	20	90	0	90
All	162	31	193	59	252

Carbon Storage by Forest Type

- Top two forest types are California mixed conifer (366 million tons of C) and western oak group (184 million tons of C) due to areal extent
- Types with highest average levels of above ground living tree storage of C per acre are:
  - Redwood: 100 tons/acre
  - Douglas-fir: 60 tons/acre
  - Fir/spruce/mountain hemlock: 59 tons/acre
  - An independent estimate by Stewart et al. (2011) indicated 55 tons/acre for mixed conifer

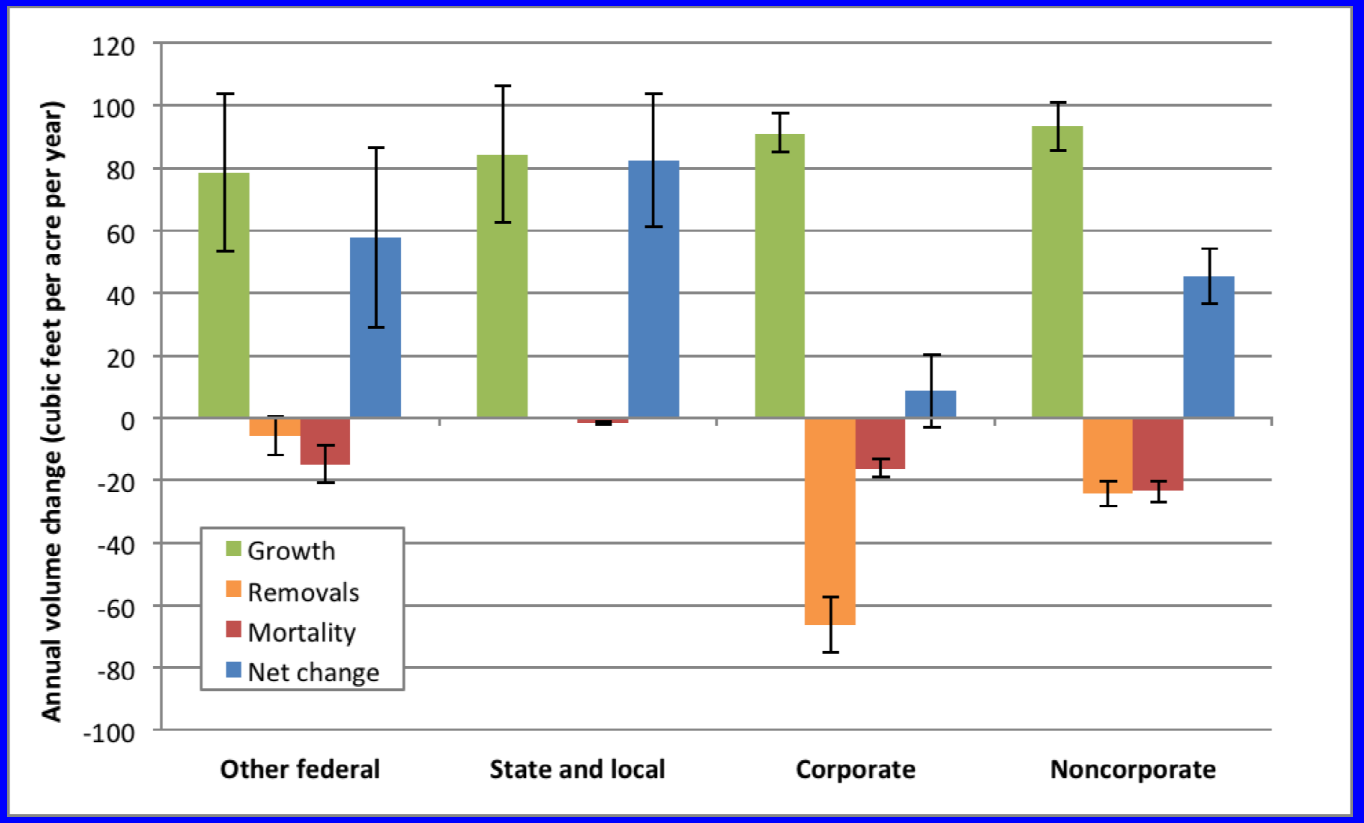
Harvest, Mortality and Growth

- National Forests:



Harvest, Mortality, Growth (cont.)

- Private and other public lands (timberland only):



Carbon and Site Productivity

- Mixed conifer: above ground carbon (one tonne = 1.1 tons)

Site Class	Acres	Total Carbon Storage (tonnes)	Average Carbon Storage (tonnes/acre)	Average CO2 Storage (tonnes/acre)
1	21,324	1,864,453	87	321
2	305,408	18,936,423	62	228
3	1,041,628	64,039,776	61	226
4	1,099,173	59,732,658	54	199

- Top five forest types when fully stocked:
  - Redwood, fir/spruce/mountain hemlock, Douglas-fir, California mixed conifer, tanoak/laurel

Opportunities

- Increase stocking in under-stocked stands:

Ownership	Forest Type	Site Class (thousand acres)			Total
		1	2	3	
National Forests	Mixed Conifer	6	50	256	312
	Douglas-fir	0	0	0	0
	Redwood	0	3	0	3
	Ponderosa pine	0	14	49	63
Private	Mixed Conifer	0	102	317	419
	Douglas-fir	14	8	71	93
	Redwood	41	99	74	214
	Ponderosa pine	0	22	112	134
Totals		61	298	879	1238

- Focus on Site Class 2 mixed conifer on National Forests and Site Class 1 and 2 redwood on private lands

Opportunities (cont.)

- Restore forest cover on lands affected by wildfire, insects and disease
  - Estimated at least 156 thousand acres of private land prior to the recent fires (King, Rim, etc.)
  - Estimated at about 4 million acres on National Forests of which about 400 thousand acres require planting
  - Restoring forest cover = increased rates of sequestration
  - How does this get done?

Opportunities (cont.)

- Reduce stocking in stands that are excessively stocked and at risk of wildfire, insects and disease (table in thousands of acres):

Forest Type	National Forests	Private Ownership
Western oak	114	97
Tanoak/laurel	2	312
California mixed conifer	240	53
Fir/spruce/mountain hemlock	86	0
Redwood group	0	57
Douglas-fir group	14	29
Ponderosa pine group	36	11
Total	492	559

- Stand Density Index $SDI = Trees\ per\ acre * (Diameter / 10)^{1.605}$ is used as an indicator of optimal stocking
- SDI is used by forest health specialists as a risk factor for insect attacks

Summary

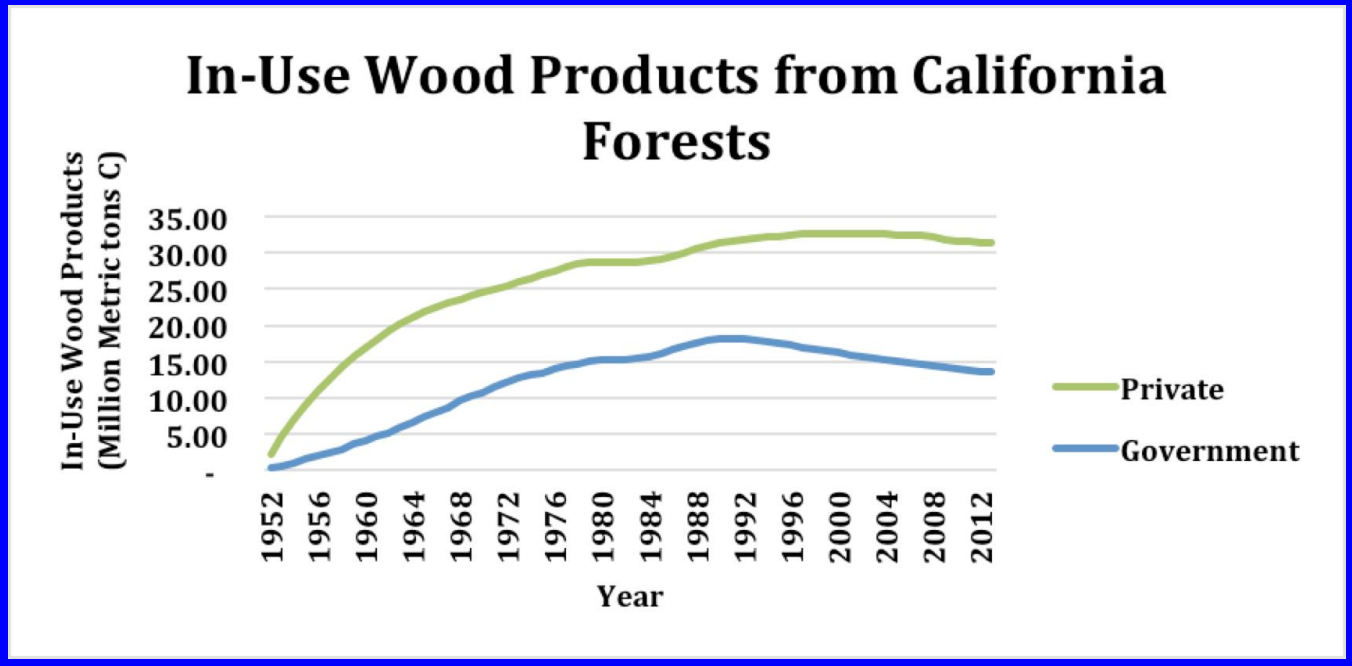
- There are over 32 million acres of forest land in California that currently store almost 1.4 million tons of above and below ground carbon.
- On all ownerships except National Forest wilderness, growth exceeds harvest and mortality, implying that carbon storage is increasing (based on data obtained between 2001-2006 and 2006-2010).
- But, see Gonzalez and others, Forest Ecology and Management 348 (2015) 68-77 for contradictory findings.

Summary (cont.)

- Mixed conifer and oak have the most carbon storage while redwood, Douglas-fir and spruce/fir/mountain hemlock store the most carbon per acre.
- Carbon sequestration and storage vary by site productivity and forest type. Redwood is the clear winner.
- Opportunities exist to increase carbon storage in under-stocked or un-stocked stands and to reduce risk in over-stocked stands.

How About Carbon Storage in Wood Products?

- Storage in California-sourced wood products 1952-2013



Questions?