

Estimating carbon storage in Californian forests and other working lands: 2001-2010

(CARB 10-778)

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In review at Forest Ecology and Management.
Please do not post.

Collaborators

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Tim Robards, SIG

(Ex-officio: Klaus Scott, CARB)



Guidelines from CARB



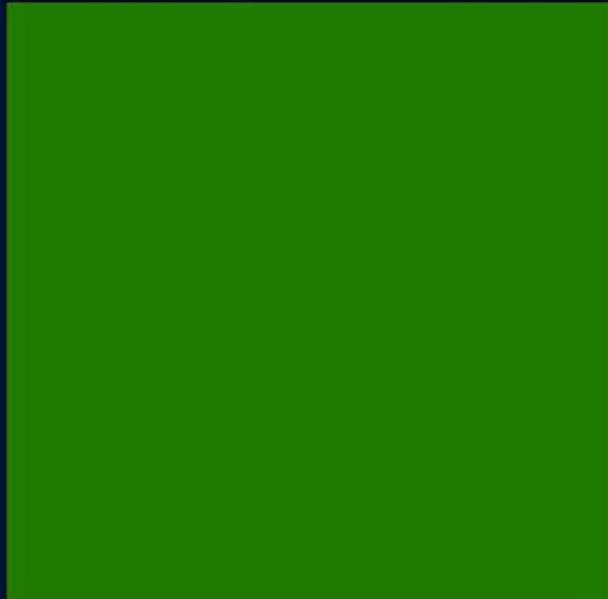
Five major design principles

1. Inventory based on data-driven estimates of carbon stocks with an emphasis on live vegetation.
2. Changes measured with reliable biophysical measurement (remote sensing) that are scheduled national efforts.
3. Scale
 - temporal : hope for annual but at least “sub-decadal.”
 - spatial: statewide lands excluding urban and agricultural
4. Inventory approach that is tractable and defensible
5. Inventory follows IPCC guidelines with estimates of uncertainty

Some Remote Sensing Options for Forest Carbon

North Yuba Forest Carbon Plot B4, California

Terra Satellite
MODIS sensor
250 m spatial resolution



36 spectral bands
Data 2000-present, free
Carbon by land class
Plot Image August 1, 2005

Landsat Satellite
ETM+ sensor
30 m spatial resolution



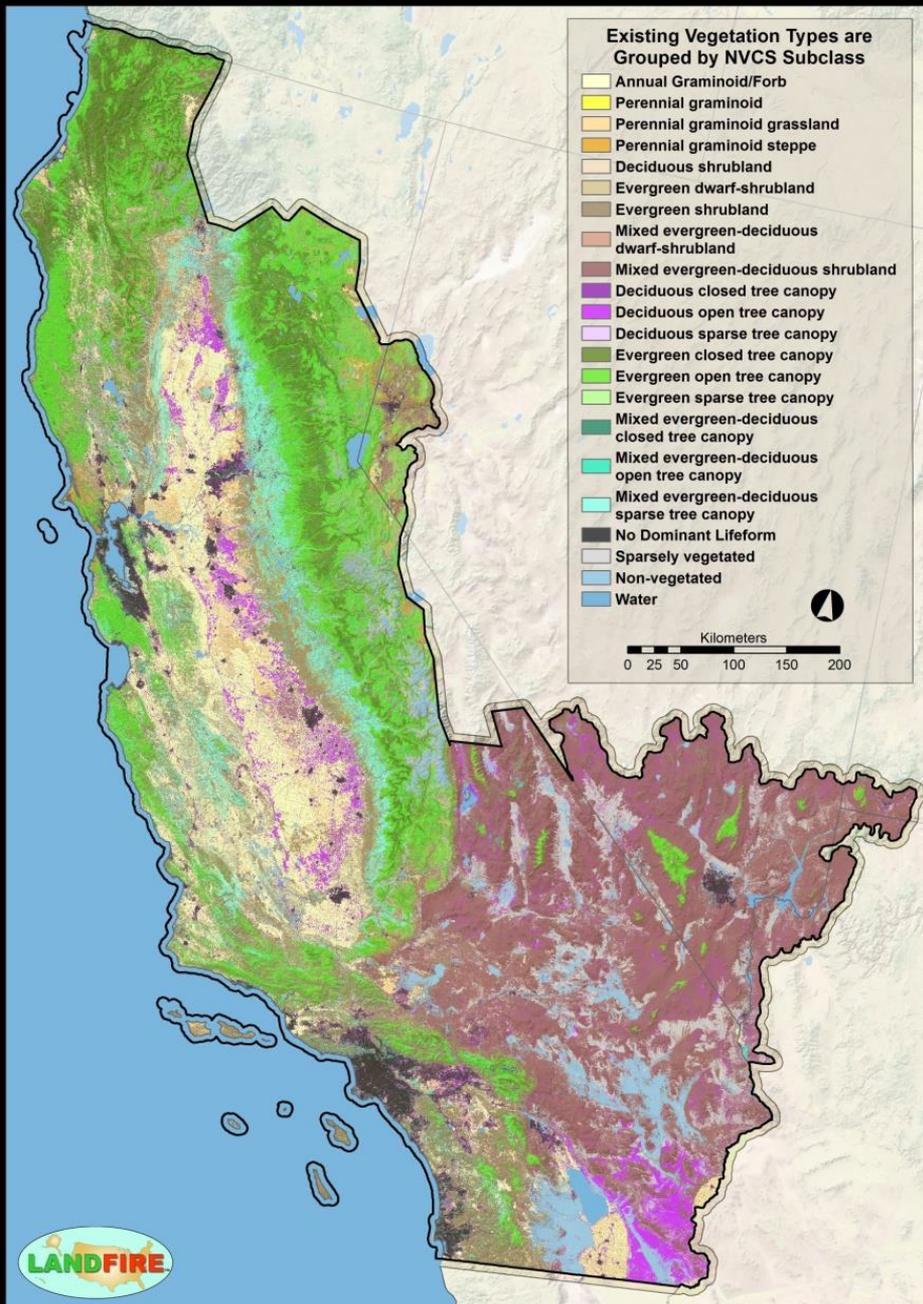
9 spectral bands
Data 1972-present, free
Carbon by land class
Plot Image July 18, 2000

QuickBird
Satellite
0.6 m spatial resolution



5 spectral bands
Data 2001-present, for sale
Carbon by tree or stand
Plot Image August 2, 2009

LANDFIRE 2001 Refresh Enhancements: Existing Vegetation Type for the Pacific Southwest



Landfire Vegetation

(hierarchical to subclass)

Order (5)

Tree

Shrub

Herb

No dominant lifeform

No vegetation

Class (9)

Tree

Closed-canopy

Open canopy

Sparse tree canopy

Subclass (19)

Tree

Closed-canopy

Evergreen

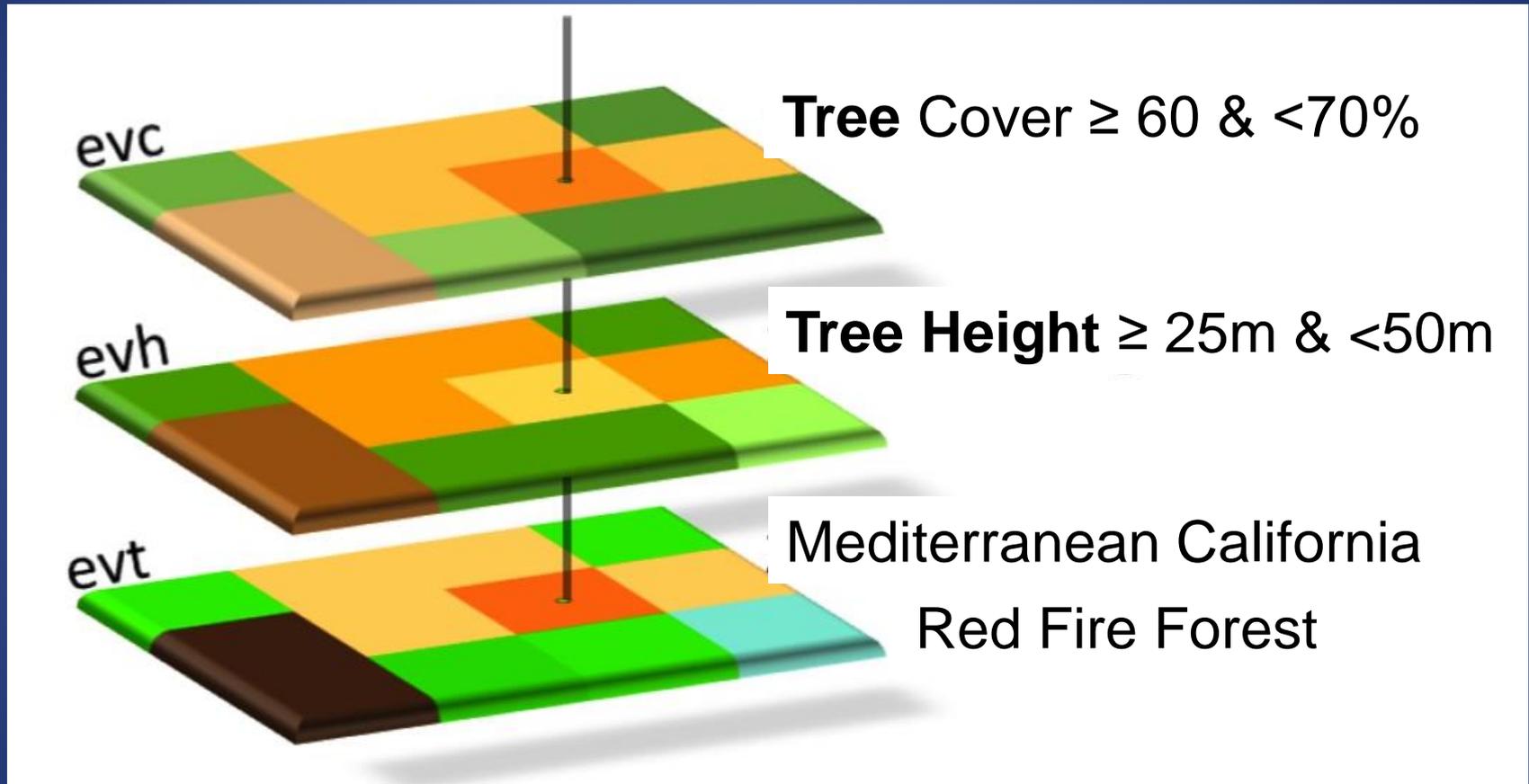
Mixed deciduous

Year

2001, 2008, 2010

Example: Landfire assignment of features

Vegetation Type (evt), Height Class (evh), and Cover Class (evc)



Note: the “e” represents existing conditions.

Landfire Vegetation Types (EVT)

136 types in forest/natural lands (82% of the state)
match NatureServ Ecological Classification scheme

Land cover by order (2008)

Trees	40%
Shrubs	36%
Herb	12%
Non-vegetated	6%
No dom lifeform	5%

Top five EVT by area (2008)

Desert scrub	16.3%
Mixed conifer forest	11.5%
Barren	6.0%
Annual grassland	5.5%
Oak woodland	5.0%

Stratify and multiply approach

BUT with fine-scaled classes from LANDFIRE

AND detailed biomass data from other sources

TREE

FIA plots linked to Landfire EVT
(FIADB 5.1 2009)

5,249 plots defined as forest land (2001-2009)
removed dups (used latest measurement)

3,659 classified as tree-dominated by
Landfire designation.

SHRUB

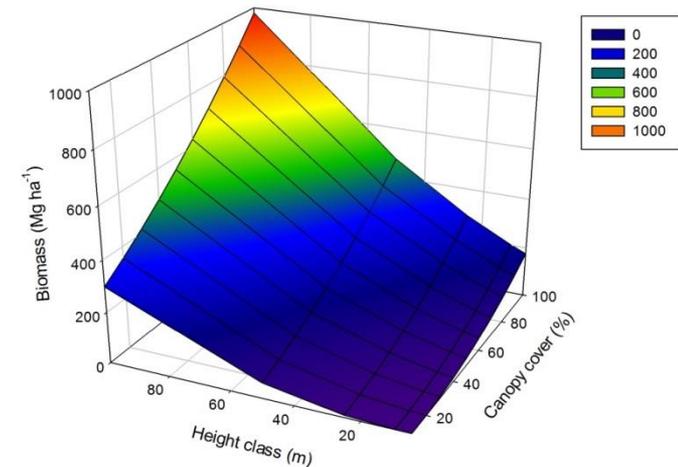
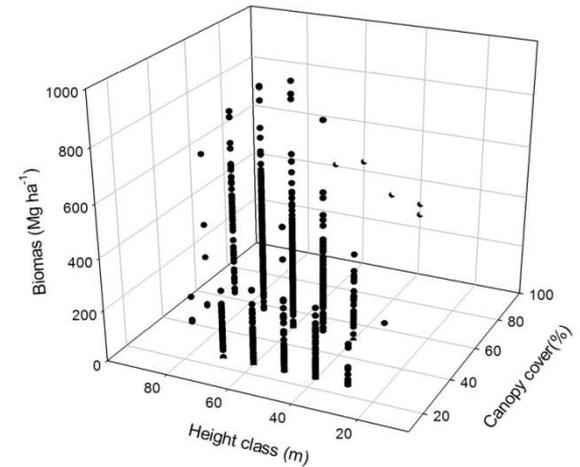
Landfire veg databases (fuels)

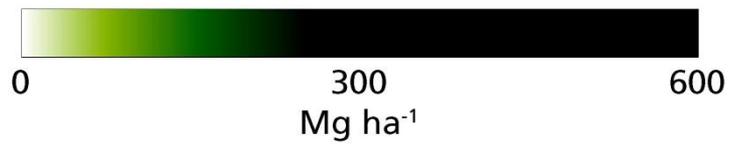
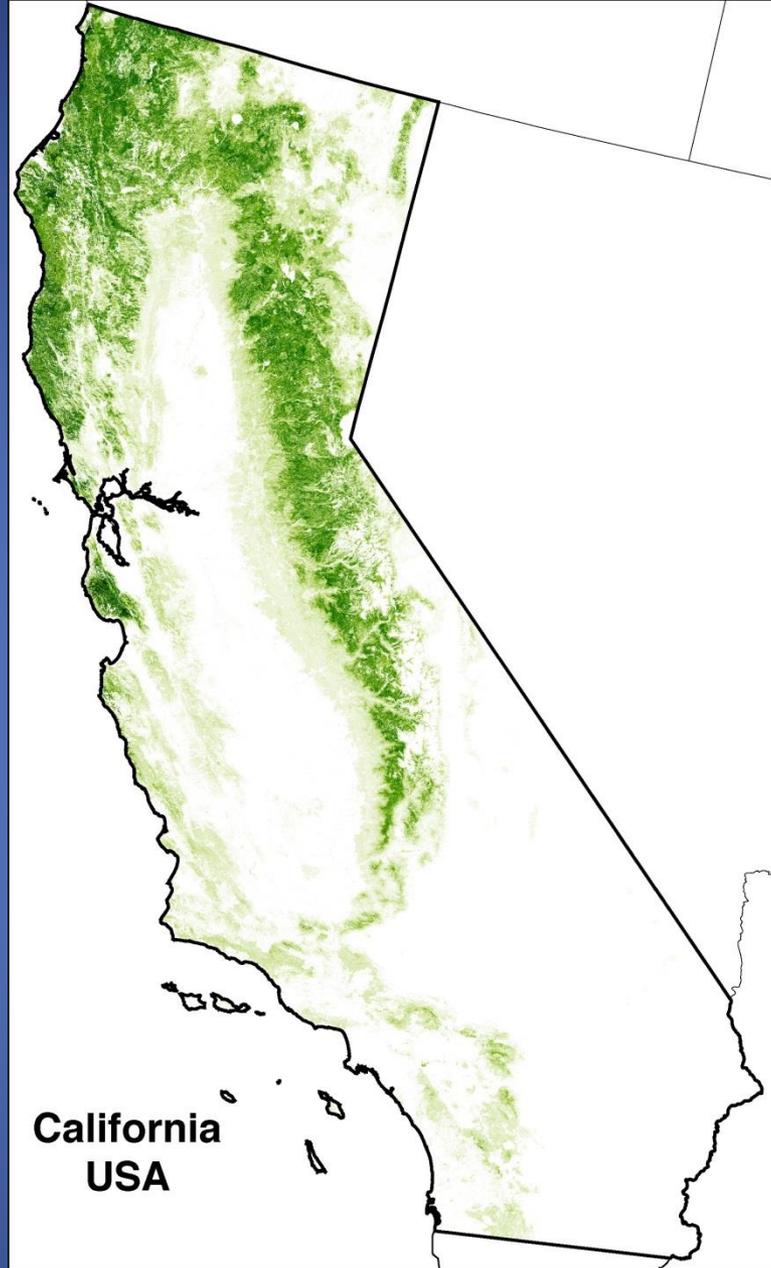
Literature search (34 independent refs)

HERB

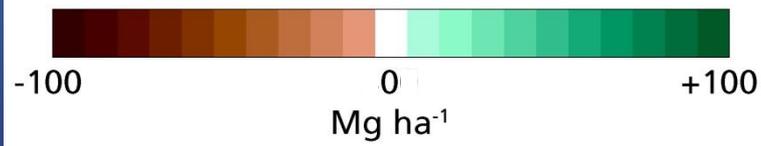
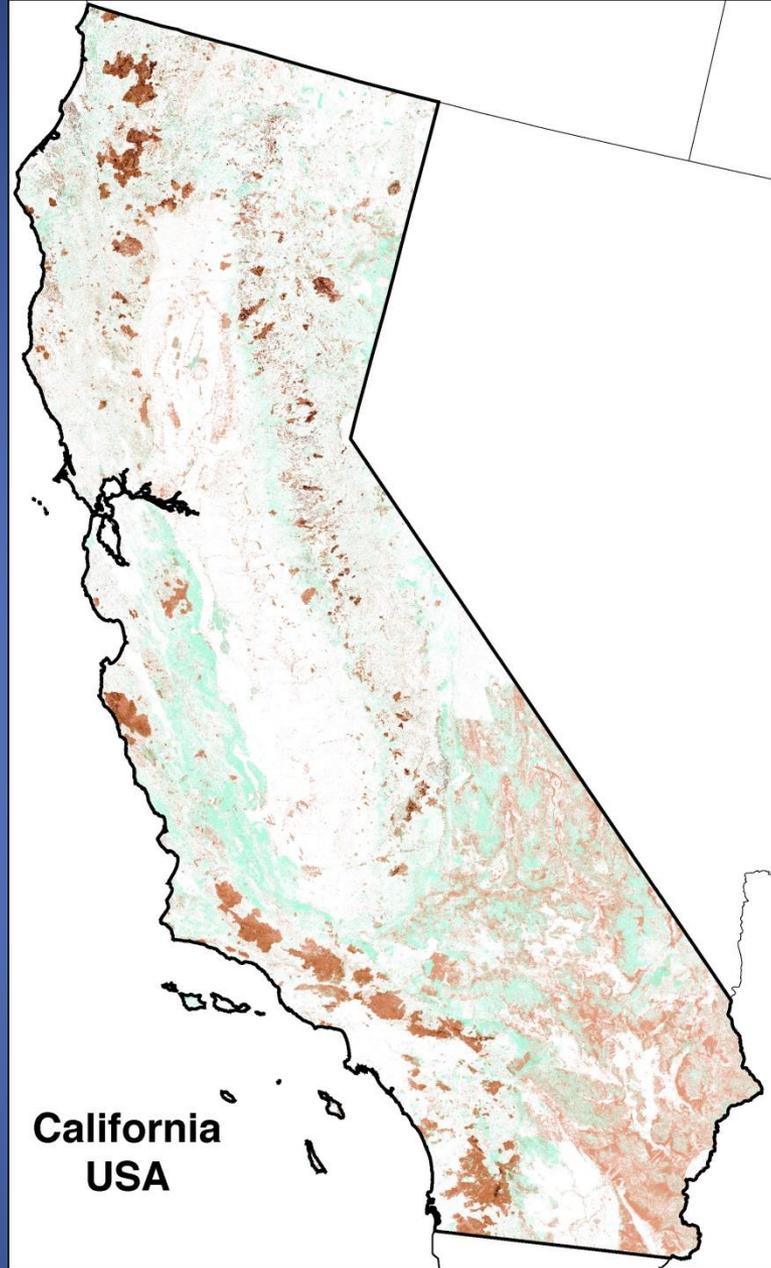
MODIS NPP estimates

Mesic Mixed Conifer Forest (n= 766)





Gonzalez, P., J.J. Battles,
B.M. Collins, T. Robards, and D.S. Saah.
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manuscript in review.

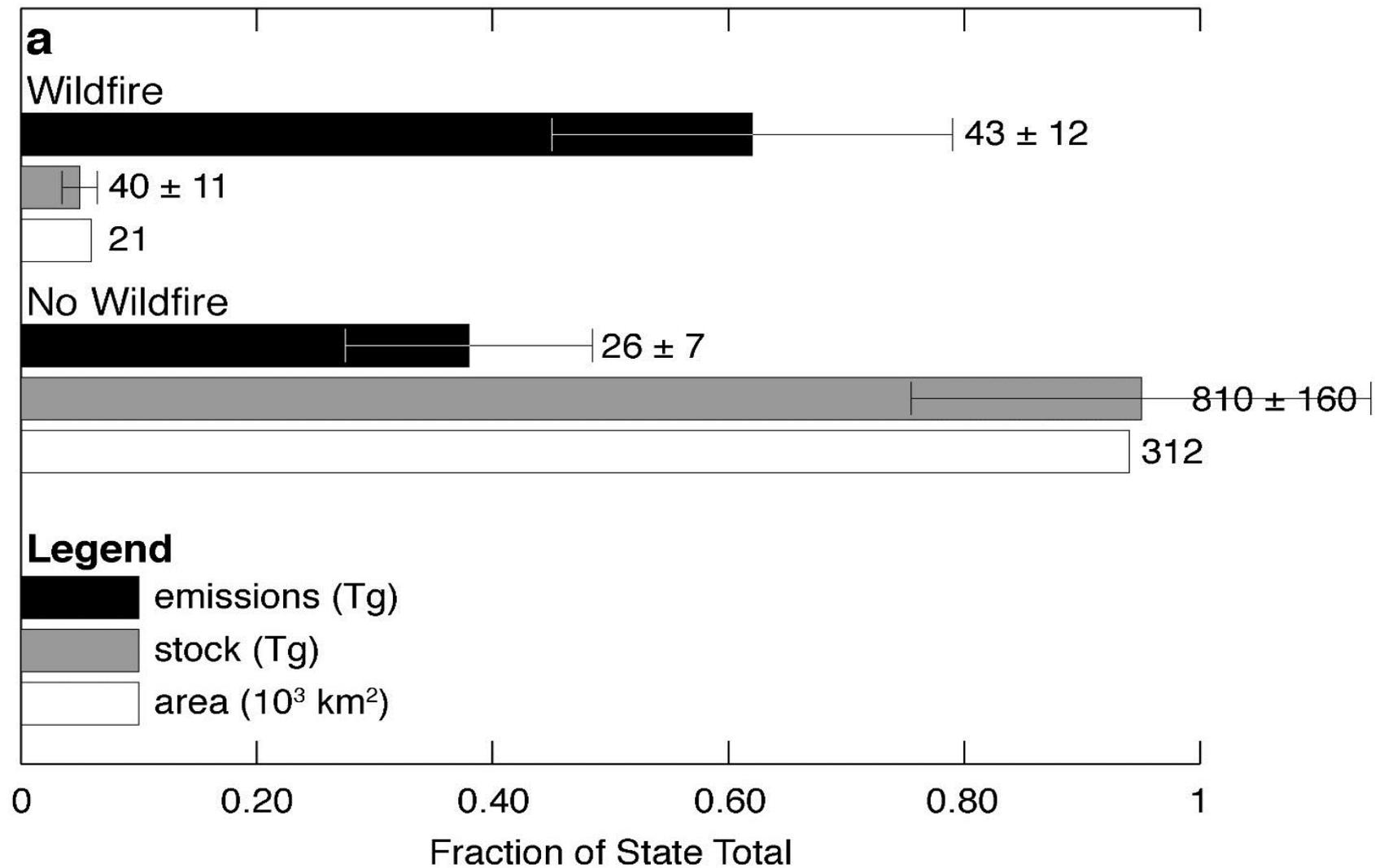


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Carbon stock change in aboveground live vegetation

	2001			2010			2001-2010		
	Carbon	Area		Carbon	Area		Carbon	95% CI	Area
	Tg	10 ³ km ²		Tg	10 ³ km ²		Tg	Tg	10 ³ km ²
California	920	337		850	333		-69	15	-3
Trees	830	125		782	122		-48	14	-3
Shrub	89	144		66	131		-23	14	-13
Herbs	3	7		5	41		2	4	11

Annual change in carbon storage for trees: - 5.3 MMT/yr



Transitions in the tree-dominated landscapes

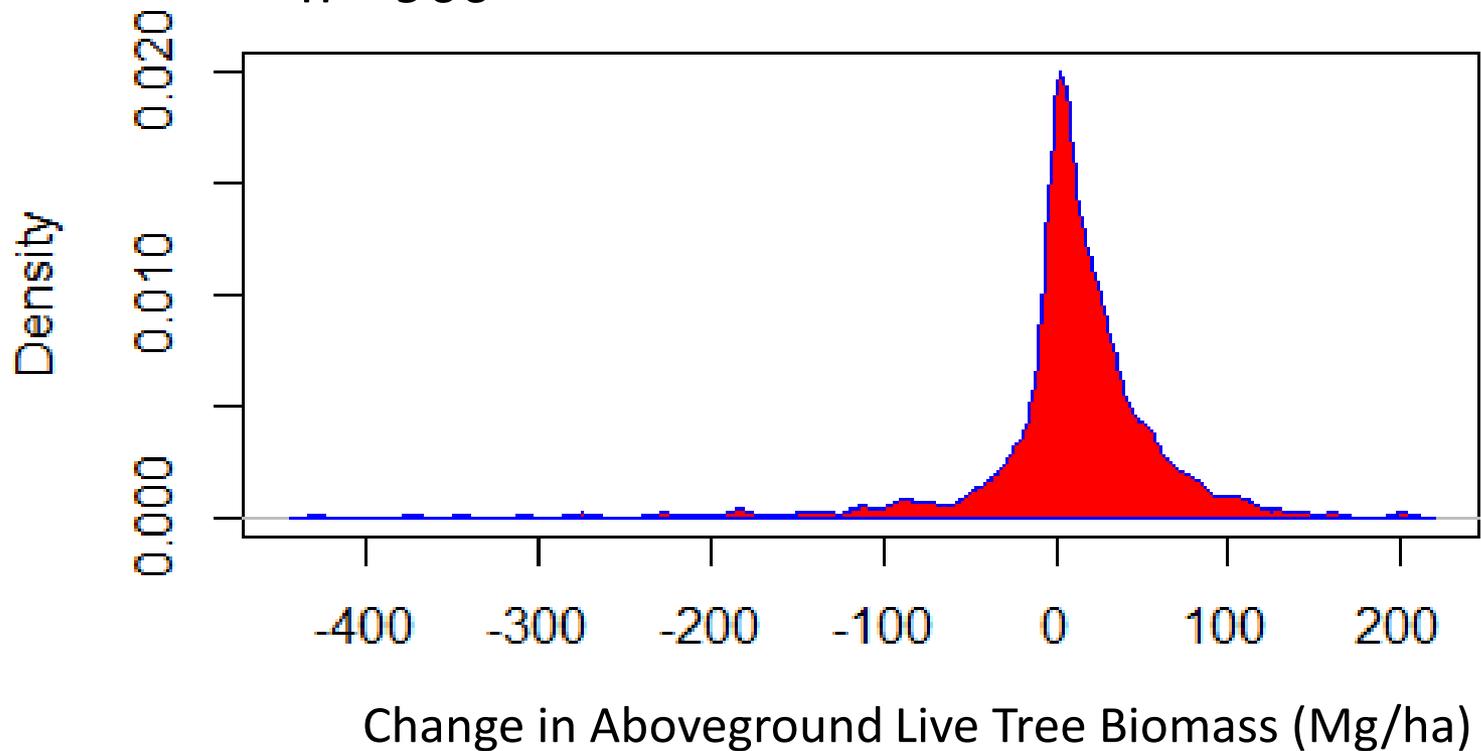
	2001			2010			Change
Transitions	Carbon	Area		Carbon	Area		Carbon
	Tg	10 ³ km ²		Tg	10 ³ km ²		Tg
Tree-tree	790	123		773	123		-17
Tree-shrub	15	7		6	7		-9
Tree-other	25	6		2	6		-23
Initial Tree	830	136		782	136		-48*

In review at Forest Ecology and Management.
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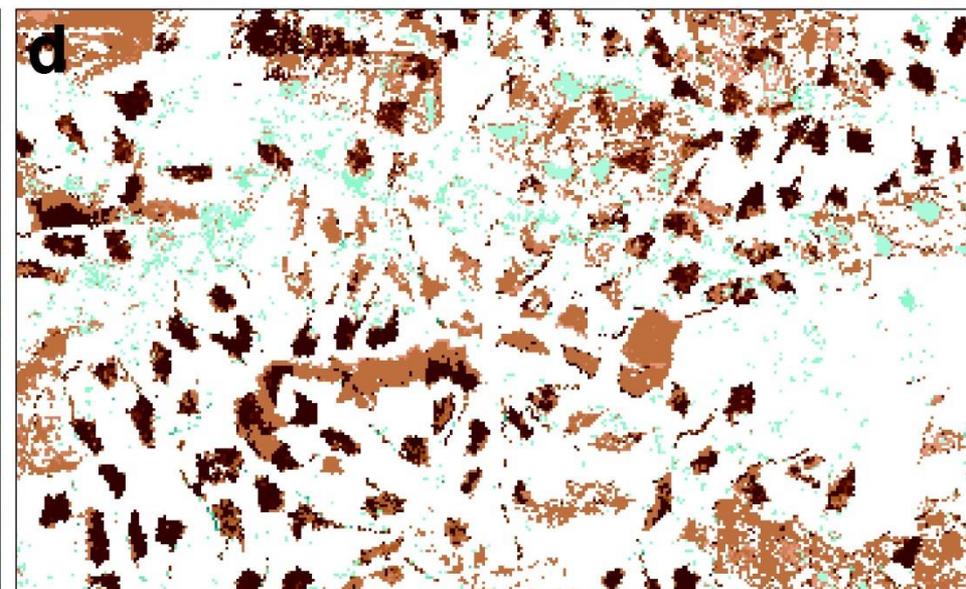
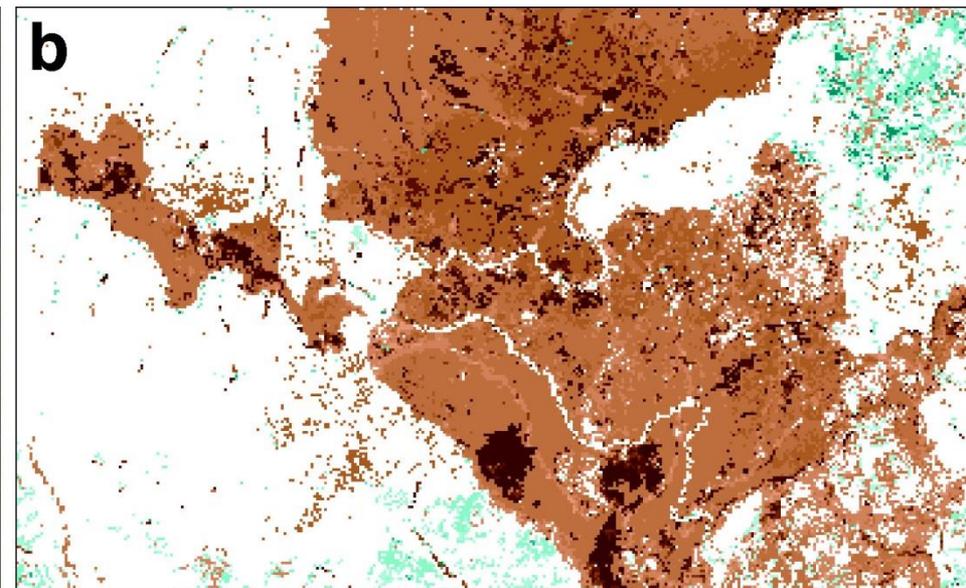
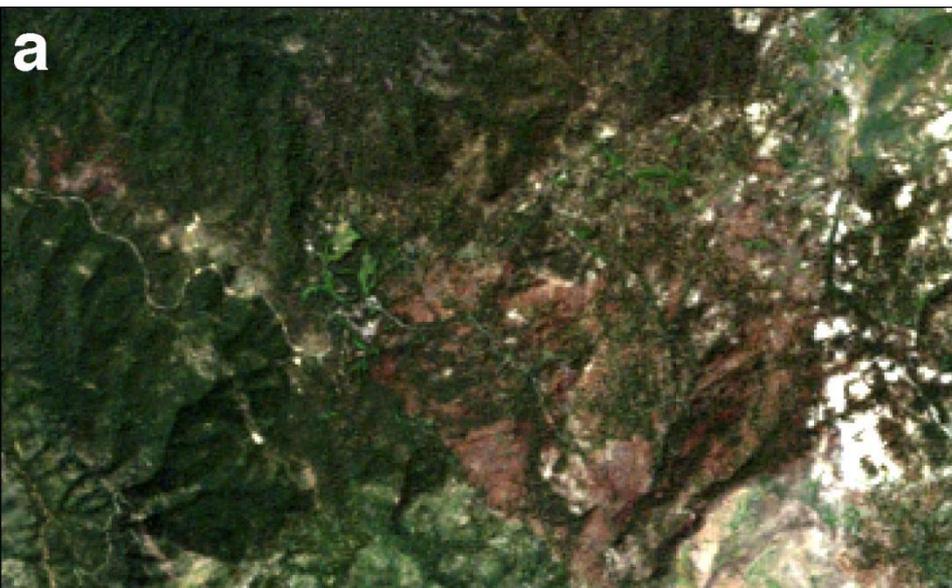
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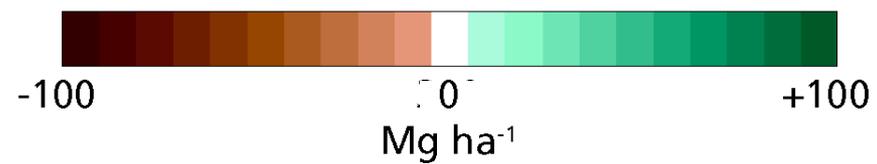
FIA Repeat Tree Plots (2001/02 to 2010/11)
n = 966



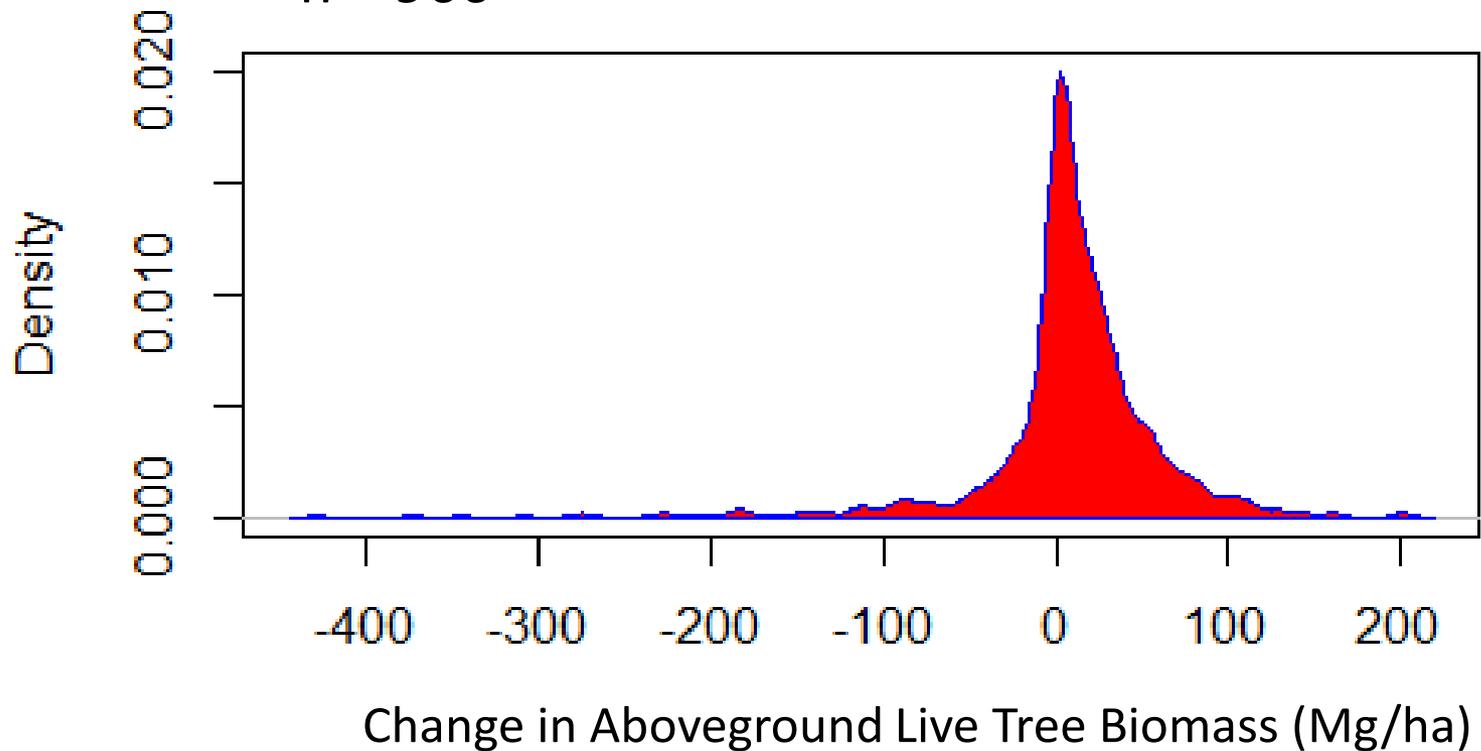
FIA results from tree-dominated plots remaining tree-dominated -- 6% increase in growth



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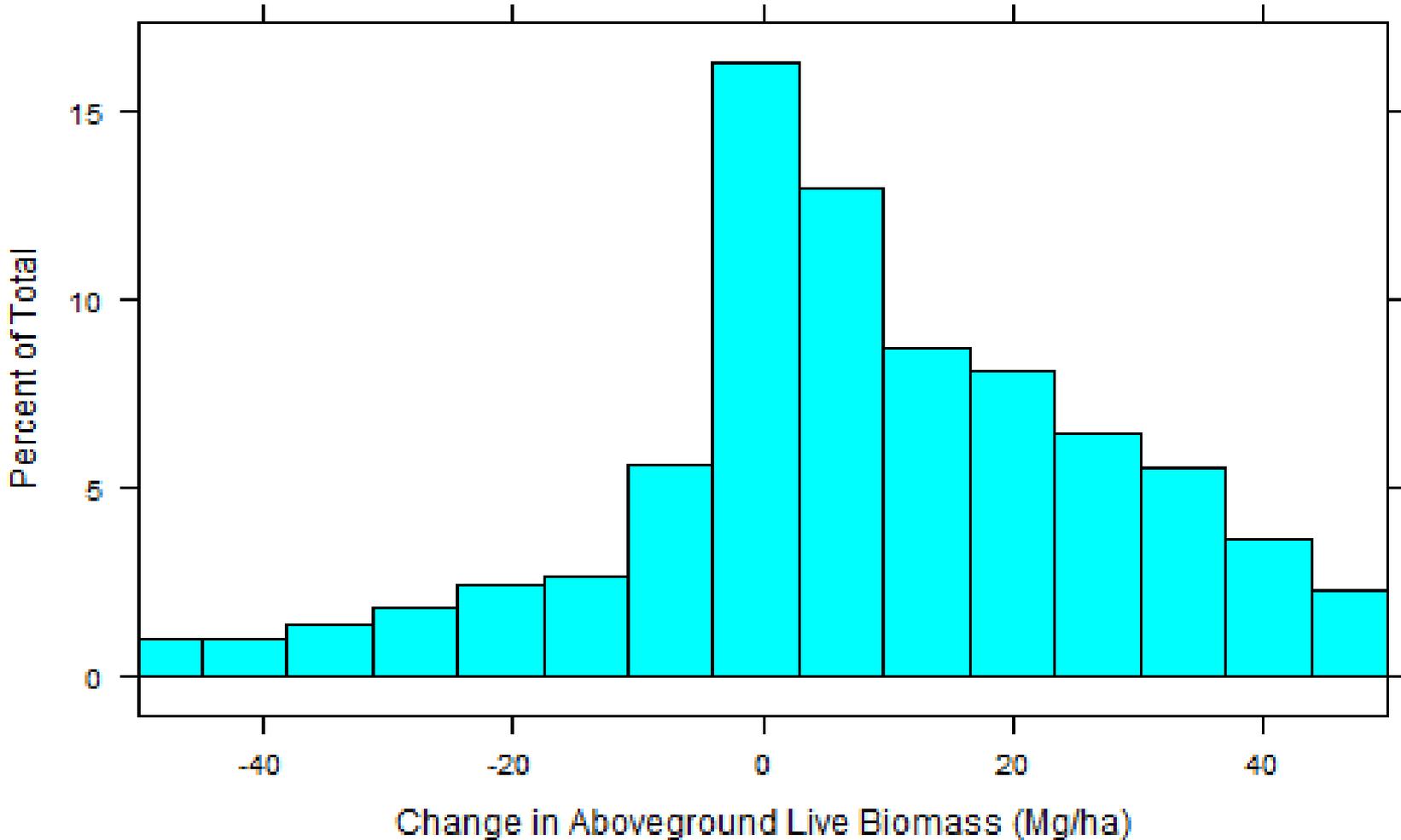


FIA Repeat Tree Plots (2001/02 to 2010/11)
n = 966



FIA results from tree-dominated plots remaining tree-dominated -- 6% increase in growth

Small changes in biomass – skewed toward growth. Lag in detection



Transitions in the tree-dominated landscapes with FIA growth rate

	2001			2010			Change
Transitions	Carbon	Area		Carbon	Area		Carbon
	Tg	10 ³ km ²		Tg	10 ³ km ²		Tg
Tree-tree	790	123		837	123		47
Tree-shrub	15	7		6	7		-9
Tree-other	25	6		2	6		-23
Initial Tree	830	136		845	136		15

Annual change in carbon storage for trees: 1.7 MMT/yr

Preliminary results. Please do not post.

Carbon stock change in aboveground live vegetation (FIA growth “revision”)

	2001			2010			2001-2010		
	Carbon	Area		Carbon	Area		Carbon	95% CI	Area
	Tg	10 ³ km ²		Tg	10 ³ km ²		Tg	Tg	10 ³ km ²
California	920	337		915	333		-4.7	?	-3

Annual change in carbon storage : - 0.5 MMT/yr

2001-2010 Range of estimates

-0.5 MMT/yr to -5.3 MMT/yr

Preliminary results. Please do not post.