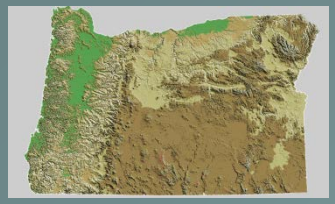


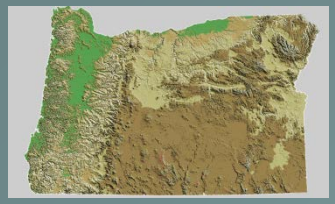
The Forest Carbon Picture in Oregon:

A Key Role in the State's Carbon Footprint and Performance

(A summary of task force report results)

September 2017

Prepared by Catherine M. Mater
Oregon Global Warming Commission Member
Chair – Commission Forest Advisory Task Force

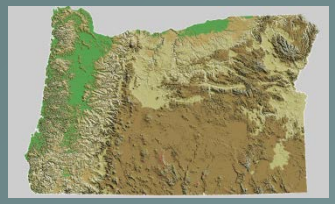


Oregon's Forest Carbon Picture

Task Force member representation:

Oregon State University
US Forest Service Forestry Sciences Lab
Geos Institute
The Nature Conservancy
Weyerhaeuser
Green Diamond Resources Co.
Mater Ltd.
Pinchot Institute for Conservation
Spatial Informatics Group

Agency Assist: ***ODOE***
ODOF
ODEQ



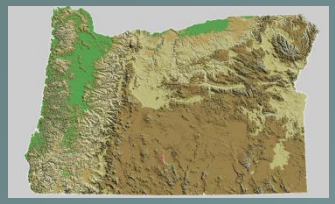
Oregon's Forest Carbon Picture

OGWC Forest Advisory Task Force challenges:

✓ Obtain and analyze new forestry data to help determine Oregon's forest carbon picture *by carbon pool and flux across pools*.

✓ ***Analyze by eco-region.*** This analysis should include *carbon releases due to forest fire.*

? Develop *forest carbon annual monitoring and reporting template* by eco-region to be used by OGWC in their future reporting to the legislature. Sound, uniform protocol established but intervals for updates likely every five years.



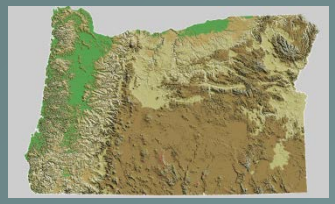
Oregon's Forest Carbon Picture

Analysis choices:
2001-2005 compared to 2011-2015 (ten years)

✓ In-boundary forest carbon only – analysis intentionally stays within forest boundaries; no product processing considered.

✓ Full forest carbon life-cycle - analysis considers all aspects of carbon source and sink life-cycle: harvest, transportation to mill, product processing; life span of product. *Processing harvested logs into lumber releases 62% of CO2e stored in harvested logs; 38% carbon retained in lumber.*

? Product substitution (wood vs concrete, steel, etc). *Not in this analysis*



Oregon's Forest Carbon Picture

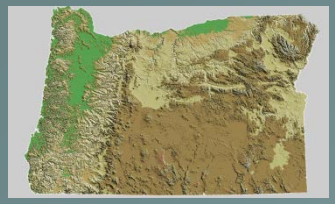
Key Sources of Data: *(In peer-review for publication)*

USFS PNW Research Station: *(Fried, Gray, et al)*

- Updated ***forest inventory*** data *(gross carbon, emissions, net carbon)*
- Statewide; by eco-region; by landowner type
- **No modeling**
- All Oregon field-based data (4800 field plots; 150,000 trees; 10 years)

OSU College of Forestry: *(Law, et al)*

- New field data on carbon ***emissions due to fire***
- Statewide; by eco-region; by public and private ownership
- **No modeling**
- All Oregon field-based data (analysis covers 32 years)



Oregon's Forest Carbon Picture

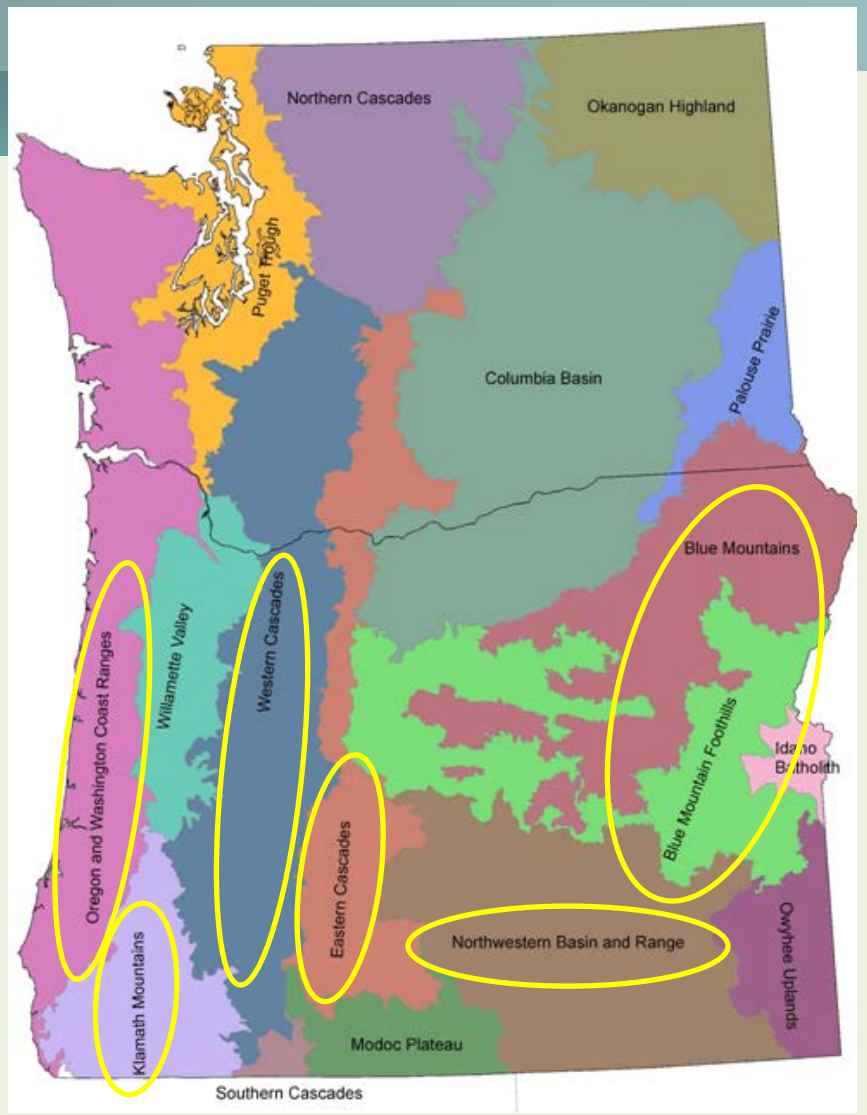
Eco-Region Optics

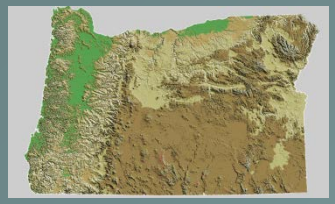
All data sorted by six eco-regions . . .

- **Coast Ranges**
- **Klamath**
- **Western Cascades**
- **Eastern Cascades**
- **Blue Mountain**
- **Northwest Basin**
  (very small carbon contribution)

. . . then analyzed by forestland owner in the eco-regions:

- **National Forest System (NFS)**
- **National Park Service (NPS)**
- **BLM**
- **State**
- **Private Industrial (PI)**
- **Private Non-Industrial (PNI)**
  (*"family forests"*)
- **"Other"**



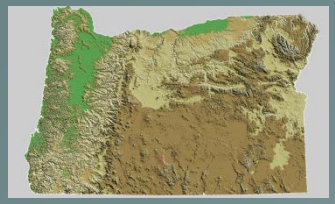


Oregon's Forest Carbon Picture

Where the forest carbon "pools" are in Oregon:

	Cton/ac	above ground live tree	above ground snag	downed and woody material	forest floor	carbon/ soil/org
Average Statewide	~90	35%	*Ranges between 3% to 7% for each pool no matter which eco-regions*			47%

- Biggest pools in above-ground live tree and soils (70%-80% for every eco-region).
- Above-ground live tree most dynamic carbon pool; soil carbon fairly constant per eco-region and over time.
- State average ~ 90 metric tons/of carbon per acre. West Cascades, Coast Range, and Klamath eco-regions highest metric tons of carbon per acre.



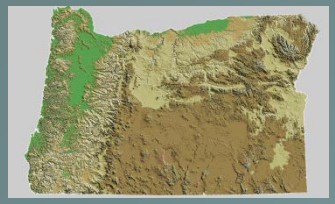
4 Important Carbon Numbers to Track in Forest Carbon

1. ***Gross carbon acquisitions***: due to tree growth

2. ***Carbon release***: due to **mortality** (includes fires); trees dying

3. ***Carbon release***: due to **harvested logs processed into lumber** (equivalent of 62% of carbon stored in logs. Only 38% of gross carbon in logs continues to be stored as net carbon in lumber product.)

4. ***Net carbon acquisitions***: gross minus release due to a) mortality and b) processing of logs into lumber.



Oregon's Forest Carbon Picture

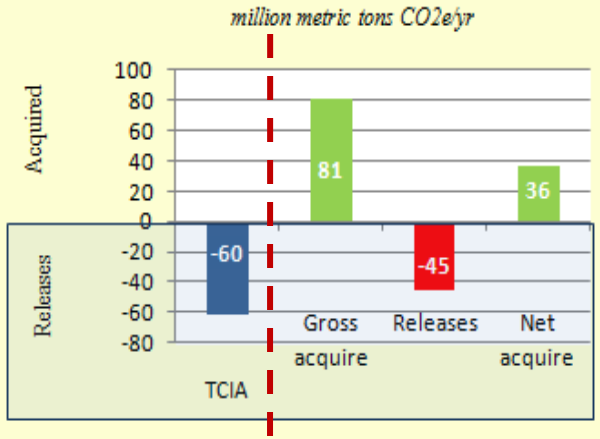
Forest carbon by the numbers . . . Now!
(with 38% carbon store in product)

Oregon Carbon Acquired and Released per Year
(2012 all other statewide sources; 2010-2015 forest carbon)

Annual statewide releases from:

T = Transportation
C = Construction
I = Industrial
A = Agriculture

Total 60 million metric tons CO2e/yr releases

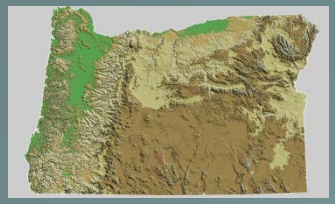


Forests key carbon performer

Net carbon acquire per year = 36 milllion metric tons CO2e . . .

. . . equivalent to 60% of all other statewide releases per year

81 45 36



Oregon's Forest Carbon Picture

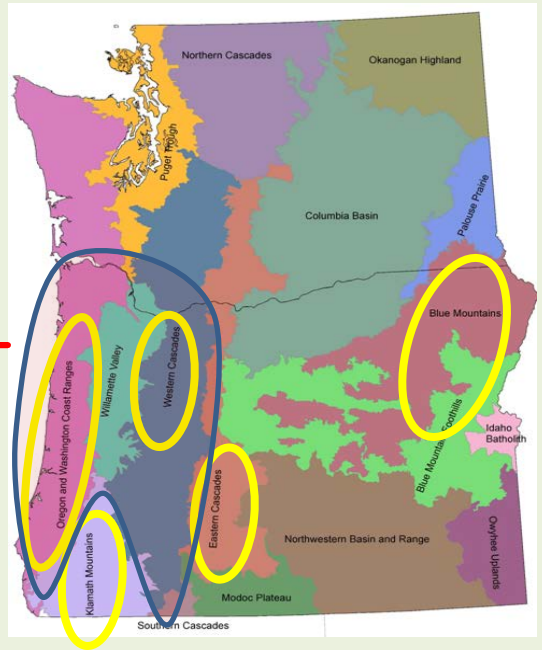
Overall Carbon Performance by Eco-Region

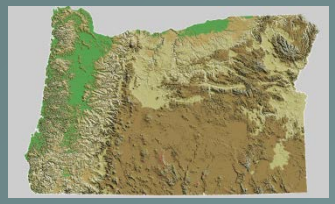
. . . most carbon activity happens in Coast Range and West Cascades eco-regions . . .

70% of statewide *gross and net forest carbon acquisition*

60% of statewide *releases due to mortality*

77% of statewide *releases due to harvest*

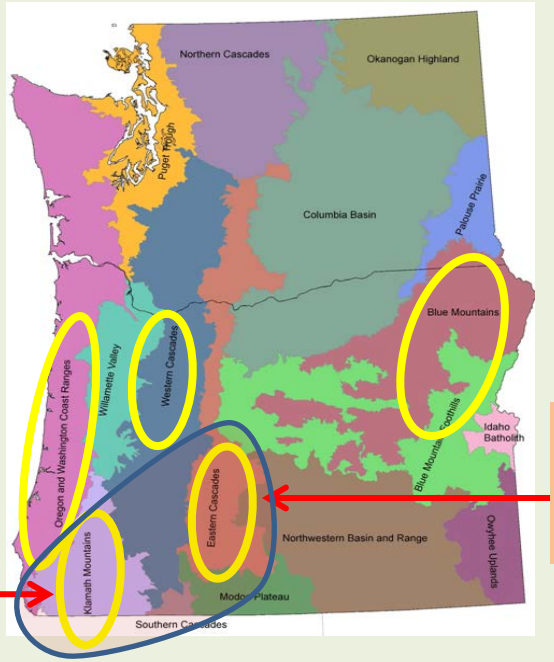




Oregon's Forest Carbon Picture

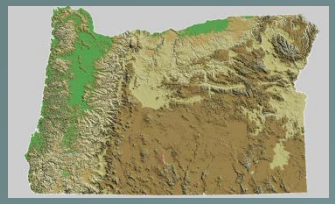
But CO2e releases <u>due to high severity fires</u> over last decade is a different story.

. . . over 60% of releases from Klamath and East Cascades eco-regions



31% of statewide *releases from Klamath eco-region*

30% of statewide *releases from East Cascades*

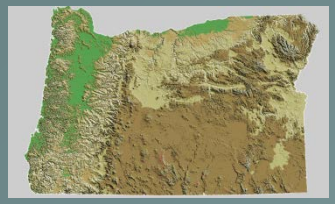


Oregon's Forest Carbon Picture

Overall. (2001-'05 compared to 2010-'15)

All eco-regions show a net growth in CO2e acquisition per year . . .

	% of forestland acres *(~26 million acres)*	% release due to mortality *(~ 22 mmt CO2e/yr)*	% release due to harvest @ 38% *(~ 24 mmt CO2e/yr)*	% gross carbon acquire *(~ 81 mmt CO2e/yr)*	% net carbon acquire *(~ 36 mmt CO2e/yr)*
Blue Mountain	31%	17%	5%	11%	13%
West Cascades	22%	41%	31%	32%	26%
East Cascades	14%	9%	4%	7%	7%
Coast Range	20%	19%	46%	38%	45%
Klamath	13%	14%	13%	12%	9%

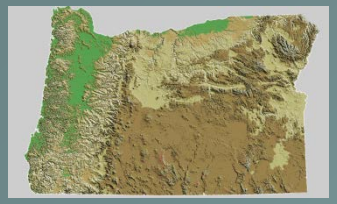


Oregon's Forest Carbon Picture

. . . and all forestland owners show a net growth in CO2e acquisition per year

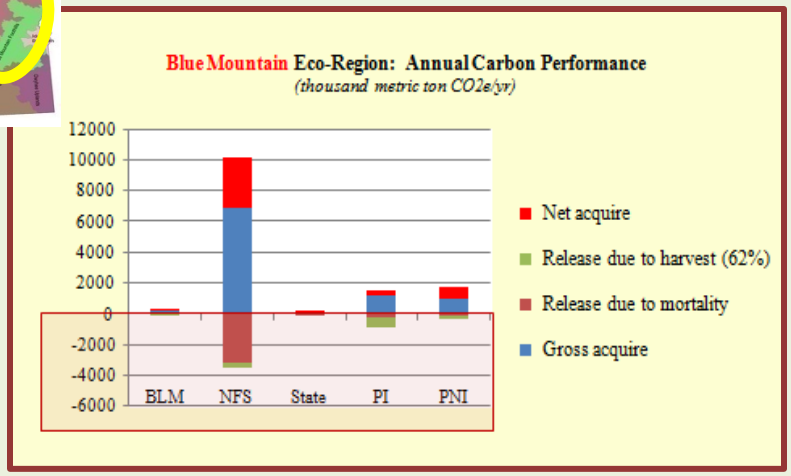
	% of forestland acres *(~26 million acres)*	% release due to mortality *(~ 22 mmt CO2e/yr)*	% release due to harvest @ 38% *(~ 24 mmt CO2e/yr)*	% gross carbon acquire *(~ 81 mmt CO2e/yr)*	% net carbon acquire *(~ 36 mmt CO2e/yr)*
BLM	13%	8%	2%	14%	26%
NFS	48%	71%	9%	40%	41%
State	4%	4%	7%	6%	6%
Private Industrial	26%	13%	73%	33%	19%
Private non-industrial	10%	3%	9%	7%	9%

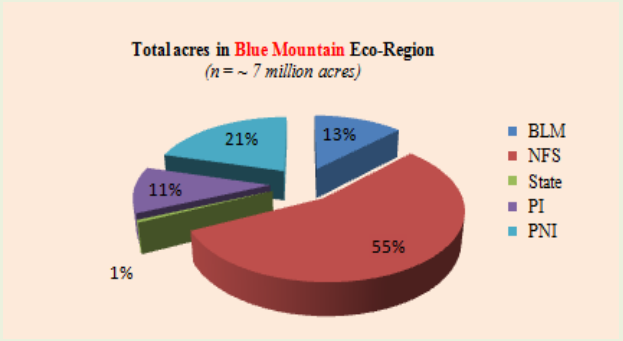
But real forest carbon story is in the detail . . .



Oregon's Forest Carbon Picture

Overall Blue Mountain Eco-Region



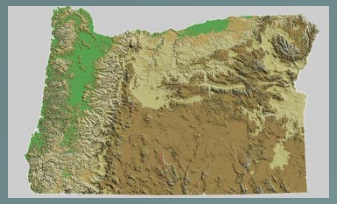


Blue Mt.	*Thousand metric tons CO2e/yr*					
	BLM	NFS	State	PI	PNI	Overall
Net carbon acquire	150	3336	32	350	701	4569
	3%	73%	1%	8%	15%	

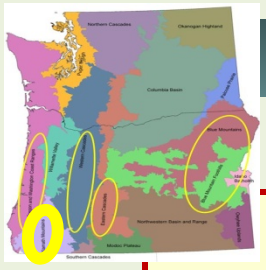
Gross carbon acquire	9291
Release due to mortality	-3566
Release due to harvest (62%)	-1156
Net carbon acquire	4569

Observations:

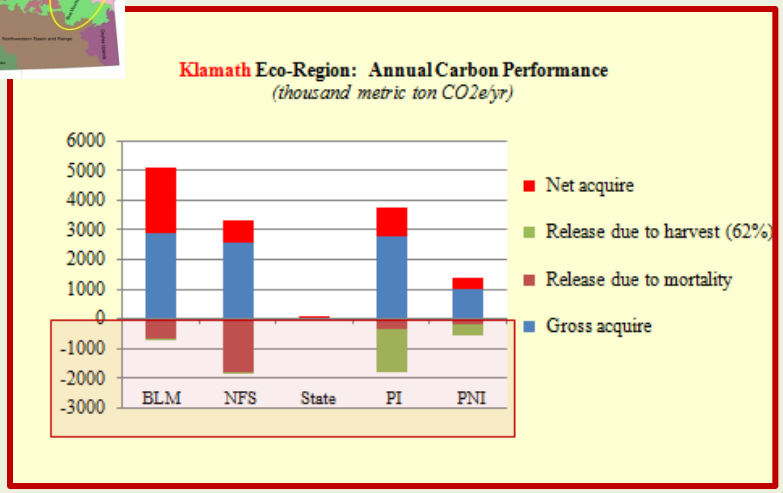
- **Carbon loss due to mortality primarily on NFS lands. Why?**
- **BLM has 13% of acres (~ same as PI lands) but very little gross carbon acquire compared to private lands. Why?**

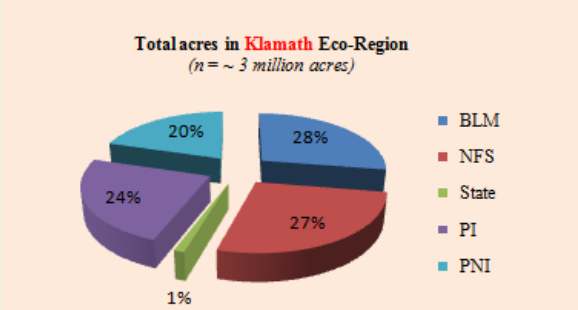


Oregon's Forest Carbon Picture



Overall Klamath Eco-Region



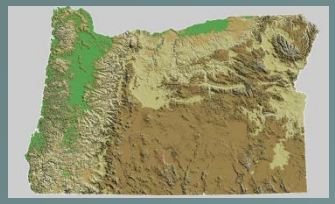


Klamath	BLM	NFS	State	PI	PNI	Overall
	thousand metric tons CO2e/yr					
Net carbon acquire	2194	719	34	972	402	4321
	51%	17%	1%	22%	9%	

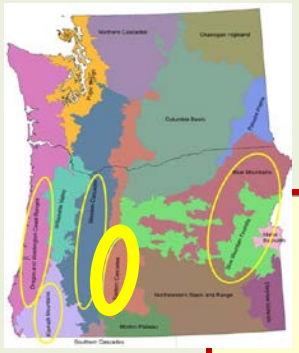
Gross carbon acquire	9324
Release due to mortality	-3017
Release due to harvest (62%)	-1986
Net carbon acquire	4320.52

Observations:

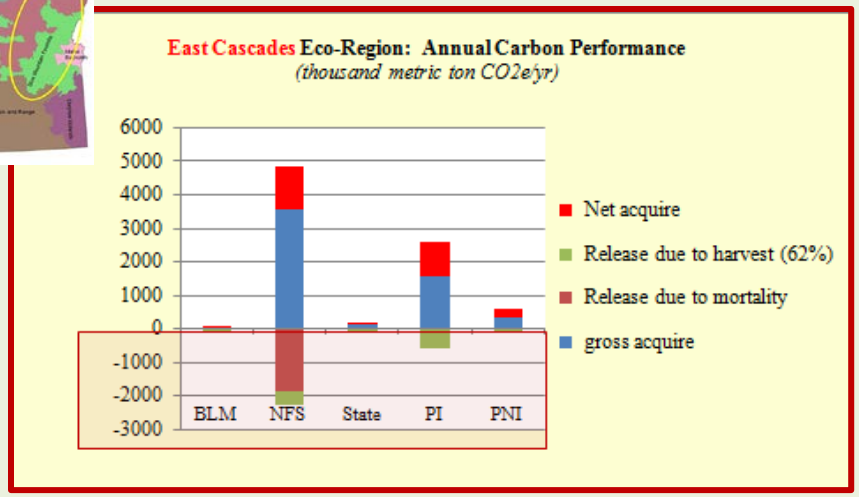
- **<u>Land ownership is fairly evenly distributed</u> between all landowners . . .**
- **. . . but release due to mortality strictly from federal lands, with bulk from NFS lands. Why?**
- **Release from harvest primarily derived from PI activities.**
- **Gross carbon acquisition at equal levels across land ownerships except PNI landowners where gross carbon acquisition notably lower. Why?**

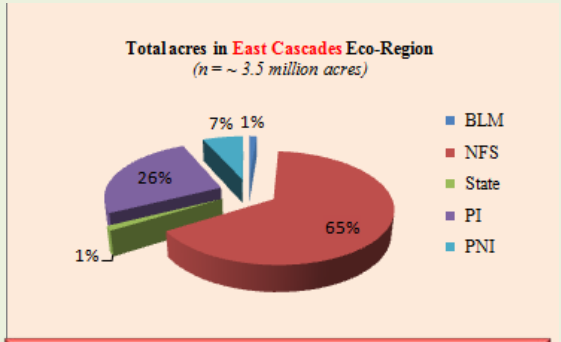


Oregon's Forest Carbon Picture



Overall East Cascades Eco-Region

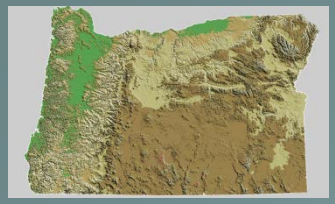




East Cascades	BLM	NFS	State	PI	PNI	Overall
	thousand metric tons CO2e/yr					
Net carbon acquire	8	1298	63	999	283	2651
	0%	49%	2%	38%	11%	
Gross carbon acquire				5647		
Release due to mortality				-1978		
Release due to harvest (62%)				-1018		
Net carbon acquire				2651		

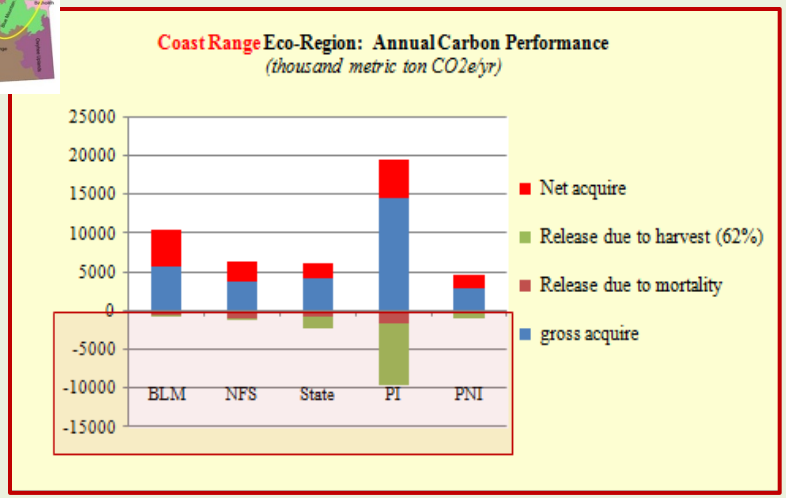
Observations:

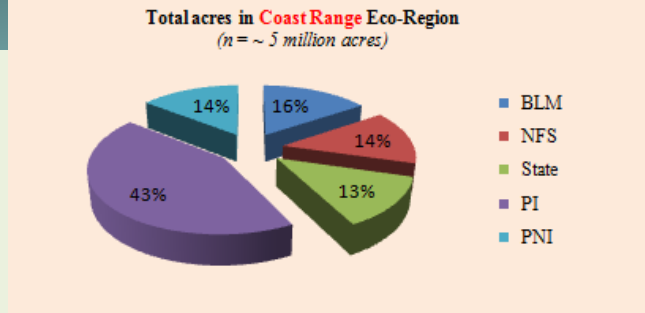
- **Release due to mortality almost exclusively from NFS lands. Why?**
- **PI owns 50% of acres owned by NFS in same eco-region, but shows no release due to mortality. Why?**



Oregon's Forest Carbon Picture

Overall Coast Range Eco-Region



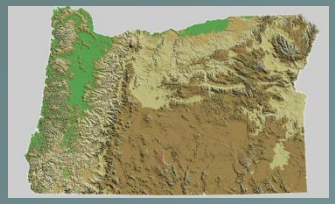


Coast Range	thousand metric tons CO2e/yr					
	BLM	NFS	State	PI	PNI	Overall
Net carbon acquire	4824	2521	1836	4924	1814	15919
	30%	16%	12%	31%	11%	

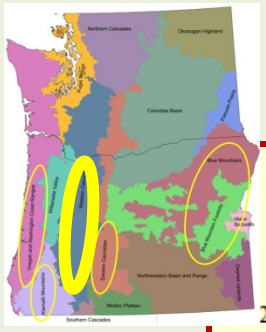
Gross carbon acquire	31094
Release due to mortality	-4146
Release due to harvest (62%)	-11029
Net carbon acquire	15919

Observations:

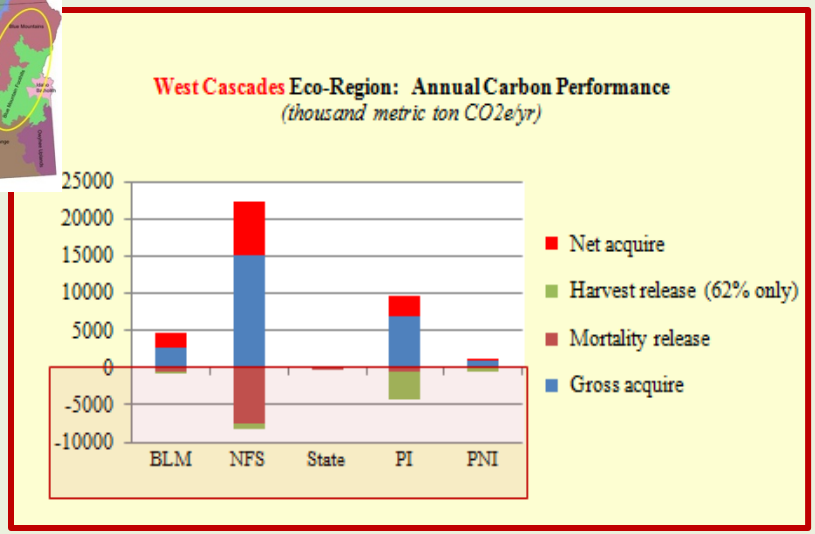
- Unlike other eco-regions, **land ownership is fairly evenly distributed** between landowners save the PI.
- Gross acquired carbon and net acquired carbon are fairly matched across landowners, save PI.
- The PI landowners clearly own the lions share of the forestland, and contribute over 90% of the carbon release due to harvest activities. Equally important, they contribute almost 50% of the gross carbon acquire in the eco-region

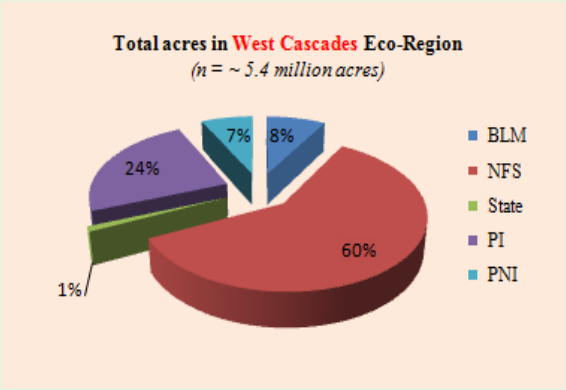


Oregon's Forest Carbon Picture



Overall West Cascades Eco-Region

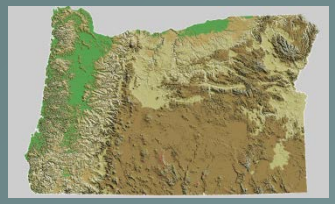




West Cascades	thousand metric tons CO2e/yr					
	BLM	NFS	State	PI	PNI	Overall
Net carbon acquire	2101	7020	19	2665	386	12191
	17%	58%	0%	22%	3%	
Gross carbon acquire				25664		
Release due to mortality				-8852		
Release due to harvest (62%				-4621		
Net carbon acquire				12191		

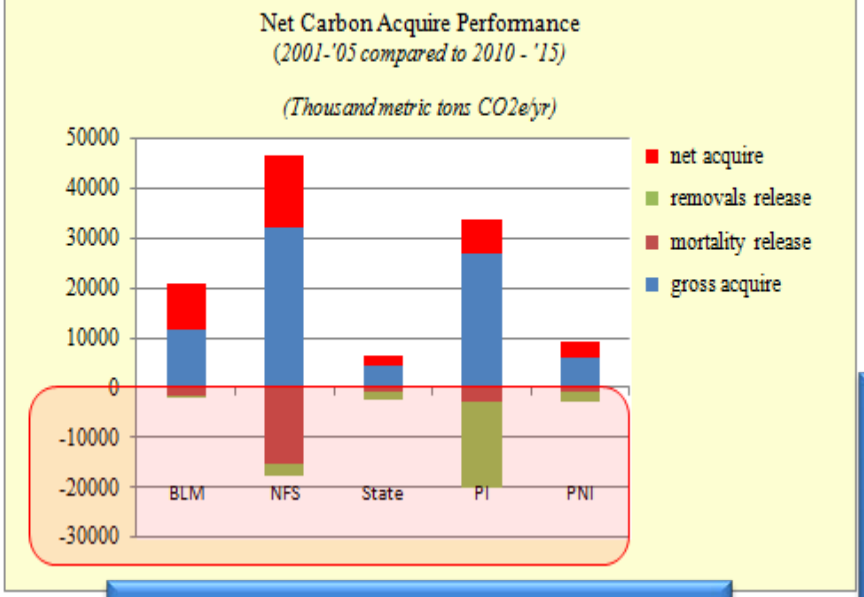
Observations:

- Release primarily due to mortality on NFS lands
- Another smaller portion of release due to harvesting from PI lands.



Oregon's Forest Carbon Picture

Net carbon acquire performance/yr.



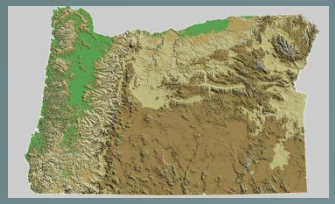
	% statewide *net* carbon acquire/yr.	
	36 million metric tons CO2e/yr net acquire	% of forest acres
BLM	26%	13%
NFS	41%	48%
State	6%	4%
PI	19%	26%
PNI	9%	10%

Observations on carbon releases:

- **Approximately *50% of carbon release per year is due to mortality* almost exclusively off of NFS lands**
- **The other *50% of carbon release is due to harvest* conducted by PI landowners**

Observations on net carbon contribution:

BLM and the State appear to be the only forestland owner types that are 'punching above weight' when it comes to adding net carbon acquire each year matched with acres owned. *BLM owns 13% of the forestland base but contributes 26% of the net carbon acquire each year. The State owns 4% of the forestland base and contributes 6% of net carbon acquire/yr.*



Oregon's Forest Carbon Picture

A worrisome trend: Gross growth in carbon acquisition declining since 1986 . . .

2010-2015

		gross growth			
Thousand met	*Thousand metric tons CO2e/yr*	PNW RMA	Gray GRM Statewide		Change from prior period
		Thous Mg/yr	*Thous Mg/yr*	Period	*Thous Mg/yr*
Public	BLM	12,175			
	NFS	32,893	37,392	*1996-2002	-4,499
	NPS	334	228	1986-1996	106
	State	4,845	5,377	1986-1996	-532
	Other	559	74	1986-1996	485
Private	PI	28,568	22,714	1986-1996	5,854
	PNI	8,268	11,475	1986-1996	-3,207
Totals		75,467	77,260		-1,793

NFS: 12% loss

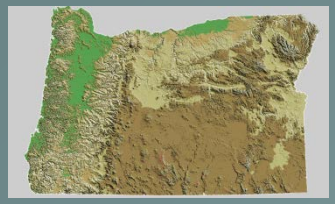
State: 10% loss

PNI: ~30% loss

Over 350,000 acres forestland have been lost to non-forest use in Oregon since 1974

92% of those lands lost were PNI forestlands.

Significant gross carbon loss in private non-industrial forestlands (PNI). Why?



Oregon's Forest Carbon Picture

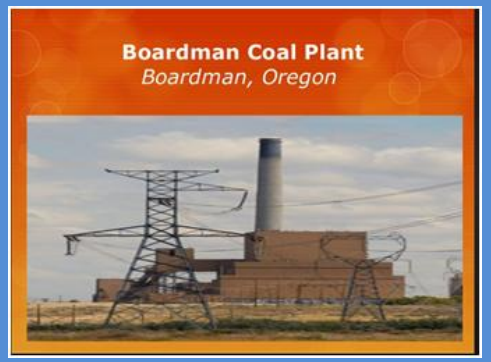
GHG releases due to fire:

Of 45 million metric tons CO2e/yr releases generated from Oregon forests each year, *how much due to forest fires?*

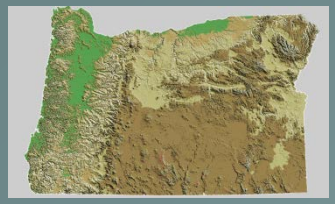
Answer:

Public lands: ~2-4 million metric tons CO2e/yr

…. only 5% of total forest carbon releases/yr but as much as generated by …..



Private lands: between 350,000 to 650,000 metric tons CO2e/year.



Oregon's Forest Carbon Picture

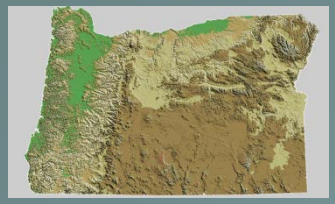
Releases due to fire . . . a worrisome trend for private forestlands?

% change in releases due to fire 2001-'05 compared to 2011 –'14

Ecoregion:	Public	Private
Blue Mountains	69%	300%
Cascades	-66%	23%
Coast Range	*no fires*	
Columbia Plateau	*no fires*	
East Cascades	-20%	60%
Klamath	-73%	180%
Northern Basin	*no fires*	
	-57%	81%

Public lands: Decreased by ~60% .
Decreases occurred in every eco-region where fire occurred save the Blue Mountain eco-region.

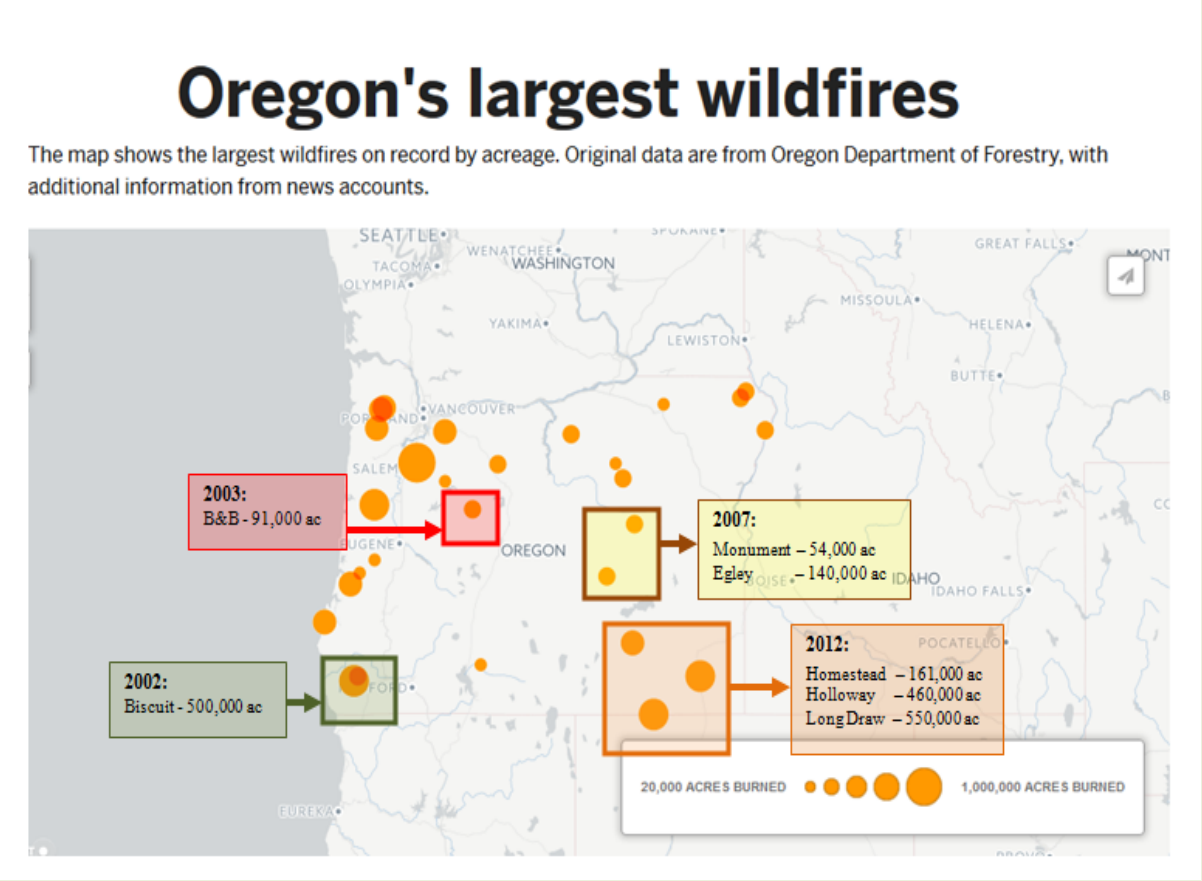
Private lands: Increased by ~ 80%,
Increases occurred in every eco-region where fire occurred.

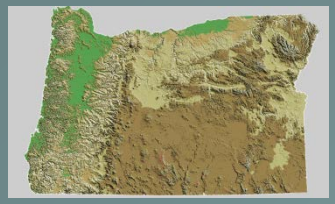


Oregon's Forest Carbon Picture

Burned acres don't directly translate to CO_2e releases . . .

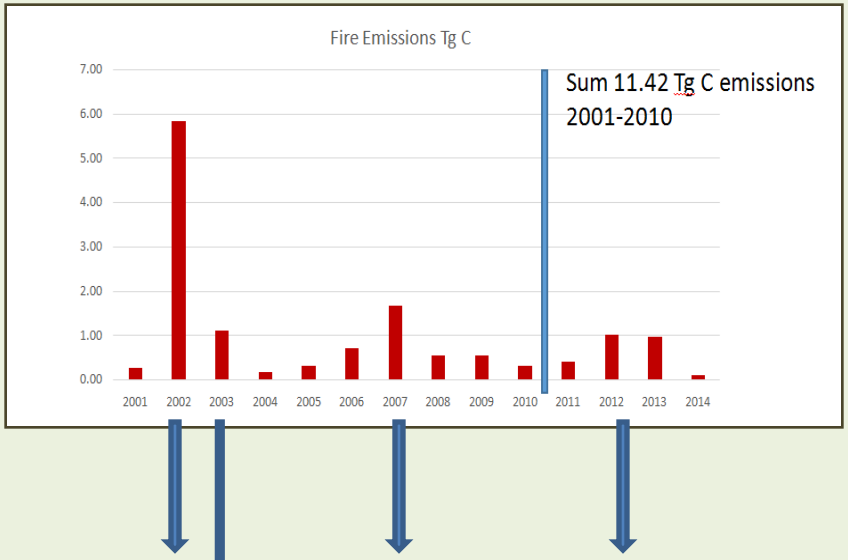
2002: 500,000 acres
2003: 91,000 acres
2007: 195,000 acres
2012: 1.17 million acres





Oregon's Forest Carbon Picture

Average annual CO2e releases from fire
(2001-2005 compared to 2011-2014)



Comparable

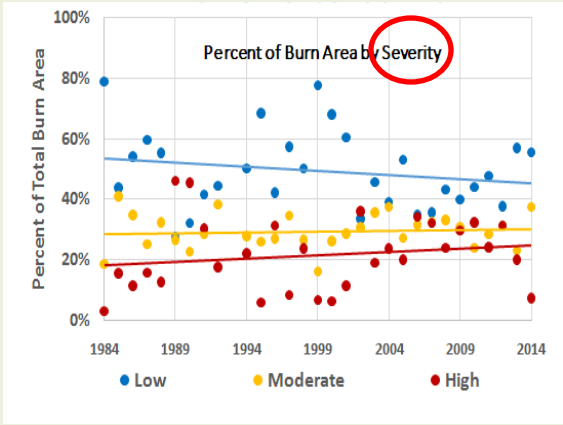
2002: -~500,000 ac **2007:** ~200,000

2003 -~91,000 acres

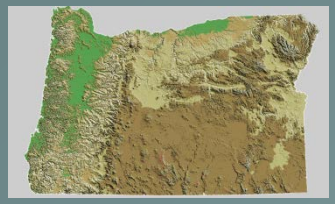
BUT, in 2012: ~1 million acres

Why the difference?
Forestlands vs grasslands…

Acres burned don't tell the story . . .



Statistically, no changes in fire severity over last 30 years



Oregon's Forest Carbon Picture

Overall findings:

- *81 million metric tons gross CO2e* are captured and stored in trees due to increased tree growth each year. 70% of this statewide gross carbon capture comes from forests in the *West Cascades and Coast Range* eco-regions, where over 70% of captured carbon volume comes from *National Forest Service (NFS) and private industrial (PI) forestlands.*

- *Oregon forests release 45 million metric tons CO2e/yr due to tree mortality and harvest activity*. However, Oregon forests also capture and store 81 million metric tons CO2e/yr. The result is a *36 million metric ton CO2e/yr net forest carbon capture* (equivalent to 60% of all combined statewide emissions produced by all other reporting sectors per year).

- Carbon release per year due to *tree mortality*:

  22 million metric tons CO2e/yr
  60% from West Cascades and Coast Range eco-regions.
  71% from NFS forestlands

- Carbon release per year due to *harvest activity*:

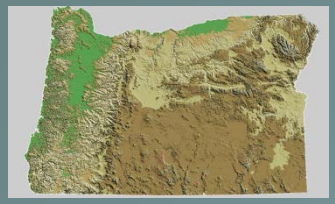
  23 million metric tons CO2e/yr
  77% from West Cascades and Coast Range eco-regions.
  73% from PI forestlands

- *Net* statewide carbon capture/yr (36 million metric tons CO2e) by landowner type:

  NFS: owns 48% of Oregon's forests; *contributes 41% of net carbon capture*
  BLM: owns 13%; *contributes 26%*
  State: owns 4%; *contributes 3%*
  PI: owns 26%; *contributes 19%*
  PNI: owns 10%; *contributes 9%*

- Over 70% of the state's *net forest carbon capture* comes from the *Coast Range and West Cascades* eco-regions. The Blue Mountain eco-region produces the third largest net forest carbon capture/yr (13% of state total).

- *Gross carbon capture per year* appears to be *decreasing on NFS, State, and private non-industrial (PNI) forestlands*. PNI lands experienced the largest decline (30%) from 1986 levels (Note: Decrease of ~ 320,000 acres of PNI forestlands in Oregon since 1977).



Oregon's Forest Carbon Picture

Fire-related findings:

- Long-term CO_2e releases last 100+ years in the atmosphere. Short-lived black 'soot' carbon lasts ~2 weeks in the atmosphere. *Statewide long term CO_2e releases due to fire have decreased over the last decade:* from 4 million metric tons CO_2e/yr in 2001 to 2.2 million metric tons CO_2e/yr by 2014. *Short-term black carbon releases due to fire have yet to be analyzed.*

- *Fire severity determines CO_2e release* (must be high severity fire to release long-term CO_2e). The occurrence of high severity fires in Oregon *has not statistically changed* during the last 30 years.

- Long-term carbon releases appear less correlated to actual fire events, but *significantly correlated to tree mortality that creates arid forest conditions conducive for fire occurrence*. The high severity 'hotspots' in forest fires appear more in the forest litter and duff on the ground (dead needles and leaves, twigs, bark, etc.), than the standing dead or downed trees.

- Of the 2.2 million metric ton *CO_2e releases due to high severity fire*, 31% came from the *Klamath* eco-region and another 30% came from the *East Cascades* eco-region.

- Long-term carbon releases/yr have *decreased on publicly-owned forestlands* across all eco-regions *save the Blue Mountain r*egion where releases increased from 160,000 metric tons CO_2e/yr in 2001 to 270,000 metric tons CO_2e/yr by 2014.

- Long-term carbon releases/yr have *increased on privately-owned forestlands* in all eco-regions in the state, *especially the Klamath* eco-region (50,000 metric tons CO_2e/yr in 2001 compared to 140,000/yr by 2014) *and the East Cascades* eco-region (150,000 metric tons CO_2e/yr in 2001 compared to 240,000/yr by 2014).