

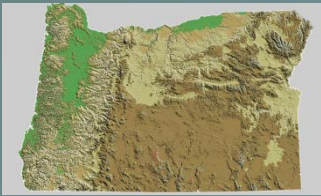
Oregon's Forest Carbon Picture

The Forest Carbon Picture in Oregon: *A Key Role in the State's Carbon Footprint and Performance*

(A preliminary summary of task force report results)

May 2018 (updated from September 2017 version)

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

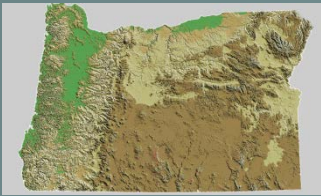


Oregon's Forest Carbon Picture

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:



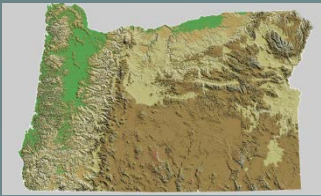
Obtain and analyze new forestry data to help determine Oregon's forest carbon picture *by carbon pool and flux across pools*.



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.

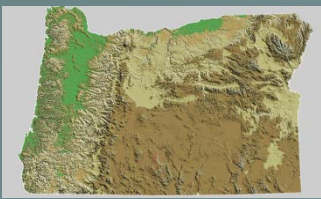


Full forest carbon life-cycle - analysis considers all aspects of carbon source and sink life-cycle: harvest, transportation to mill, product processing; life span of product. *Processing harvested logs into lumber releases 62% of CO₂e stored in harvested logs; 38% carbon retained in lumber.* **



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

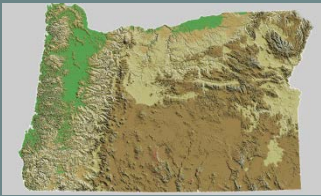
** See Next Slide



Oregon's Forest Carbon Picture

** For this analysis, focused *only on lumber production* as :

- **84%** of logs harvested in state is **processed in-state**
- **~70%** of processed in-state volume goes to sawmills for ***lumber production***
- **~20%** of processed in-state volume goes to ***veneer/plywood***
- **~10%** of processed in-state volume goes to ***pulp/paper***



Oregon's Forest Carbon Picture

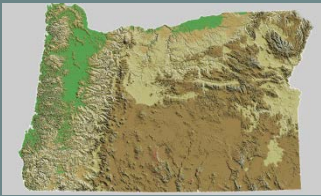
Key Sources of Data: *(In peer-review for publication)*

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

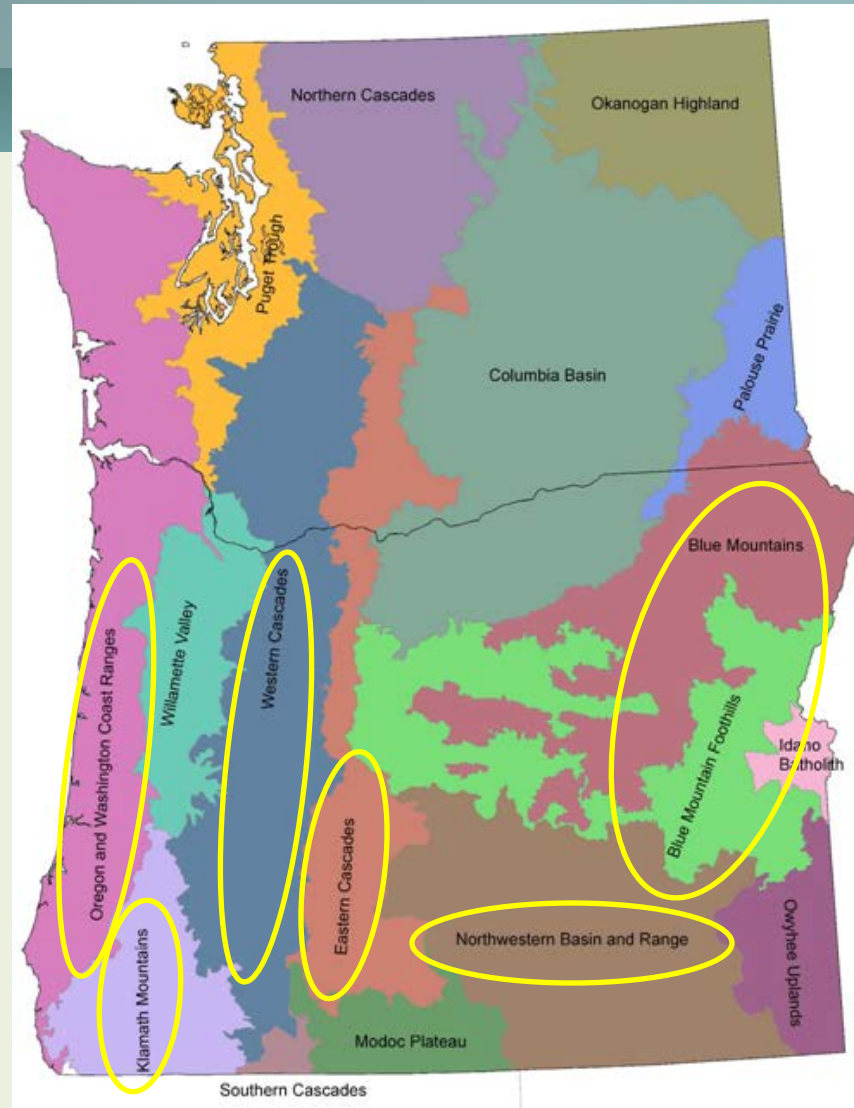
Eco-Region Optics

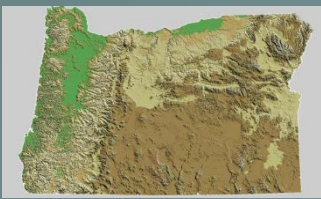
All data sorted by six eco-regions . . .

- 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"



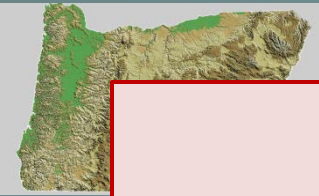


Oregon's Forest Carbon Picture

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% | <i>Ranges between 3% to 7% for each pool no matter which eco-regions</i> | | | 47% |

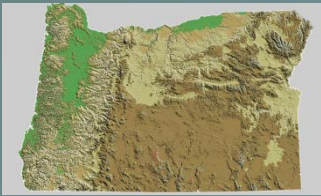
- Biggest pools in above-ground live tree and soils (70%-80% for every eco-region).
- Above-ground live tree most dynamic carbon pool; soil carbon fairly constant per eco-region and over time.
- State average ~ 90 metric tons/of carbon per acre. West Cascades and Coast Range eco-regions highest tons of carbon per acre. (130 C tons/ac). Blue Mountain and East Cascades eco-regions lowest (63 C tons/ac).



Four Important Annual Carbon Numbers to Track Oregon Forest Carbon

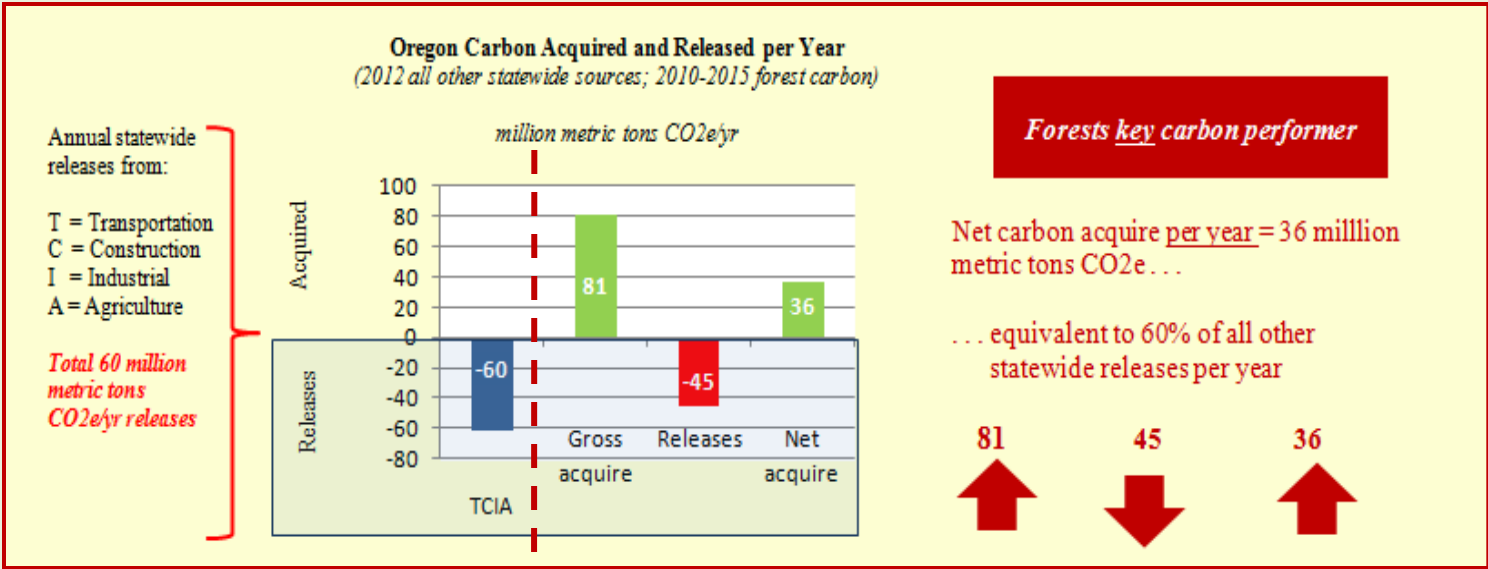
| | | <i>mmt CO₂e/yr</i> |
|--|---|-------------------------------|
| <u>Gross</u> carbon growth: | Gross carbon sink due to <i>tree growth</i> | 81 |
| Releases due to <u>mortality</u> : | Carbon released due to <i>tree death</i> (disease, insect, fires) | 22 |
| Unutilized wood from <u>harvest</u> : | 38% log carbon retained in lumber; (62% undetermined). | 23 |
| | | 45 |
| <u>Net</u> forest carbon gain : | Gross carbon growth minus <i>mortality</i> and <i>unutilized wood from harvest</i> | 36** |

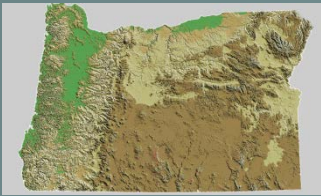
** Total CO₂e/yr emissions from all other sectors in Oregon
(transportation, utilities, construction, etc.) = 60 mmt CO₂e/yr



Oregon's Forest Carbon Picture

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





Oregon's Forest Carbon Picture

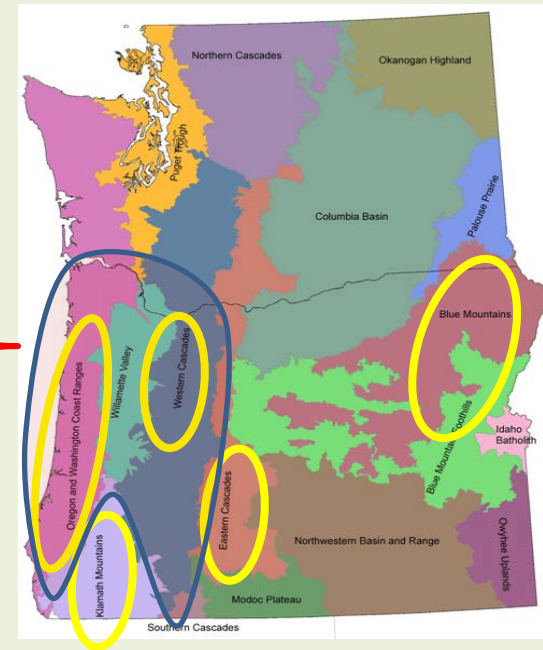
Overall Carbon Performance by Eco-Region

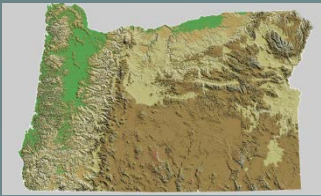
... most carbon activity happens in Coast Range and West Cascades eco-regions ...

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

60% of statewide *releases due to mortality*

77% of statewide *releases due to harvest*

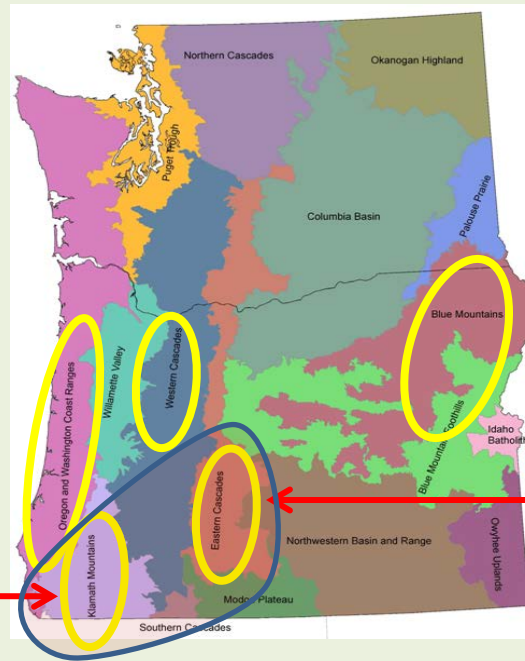




Oregon's Forest Carbon Picture

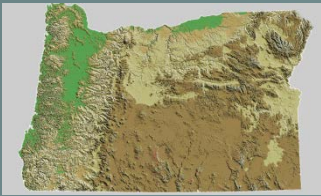
But CO₂e releases due to high severity fires over last decade is a different story.

... 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*

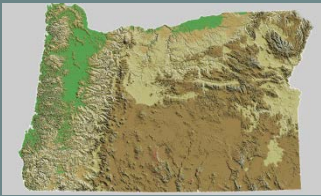


Oregon's Forest Carbon Picture

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% |

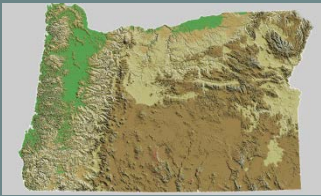


Oregon's Forest Carbon Picture

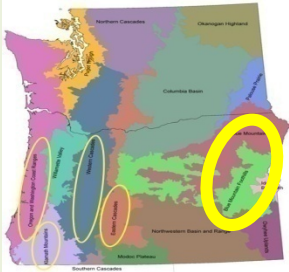
... and all forestland owners show a net growth in CO2e acquisition per year

| | % 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% |

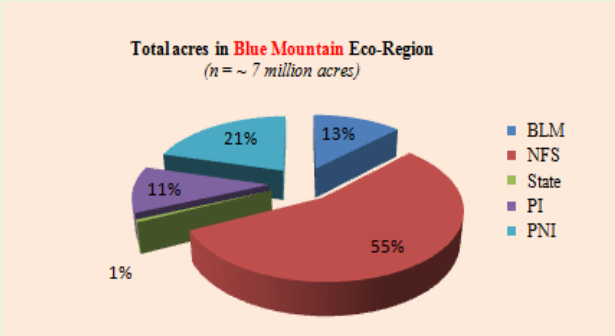
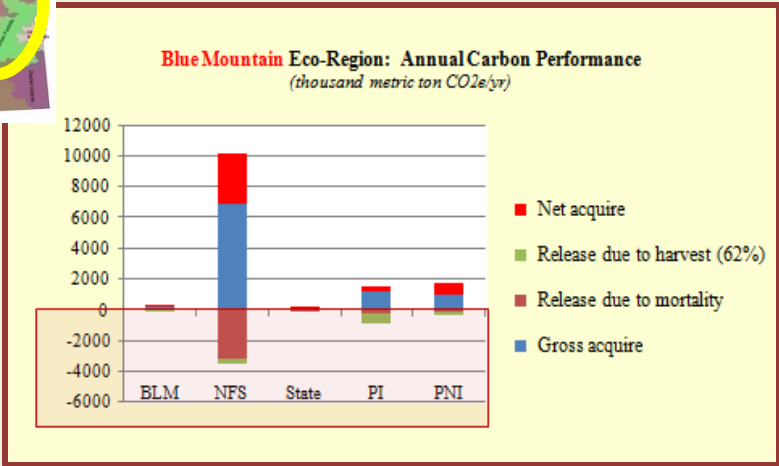
But real forest carbon story is in the detail . . .



Oregon's Forest Carbon Picture



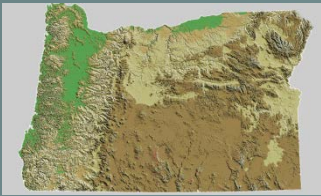
Overall Blue Mountain Eco-Region



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?

| Blue Mt. | Thousand metric tons CO ₂ e/yr | | | | | Overall |
|--------------------|---|------|-------|-----|-------|---------|
| | BLM | NFS | State | PI | PNI | |
| 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 | |

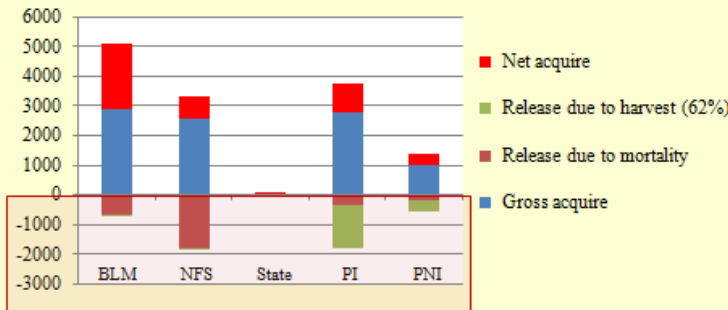


Oregon's Forest Carbon Picture

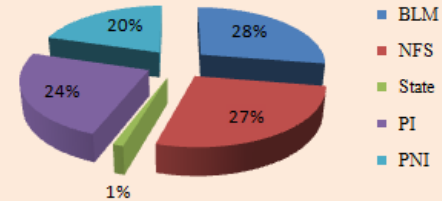


Overall Klamath Eco-Region

Klamath Eco-Region: Annual Carbon Performance
(thousand metric ton CO₂e/yr)



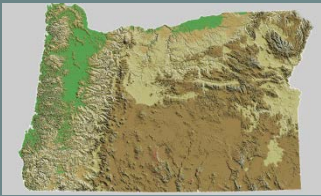
Total acres in Klamath Eco-Region
(n = ~ 3 million acres)



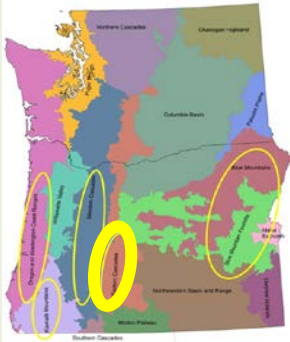
Observations:

- Land ownership is fairly evenly distributed 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?

| Klamath | thousand metric tons CO ₂ e/yr | | | | | Overall |
|--------------------|---|-----|-------|---------|-----|---------|
| | BLM | NFS | State | PI | PNI | |
| 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 | | |

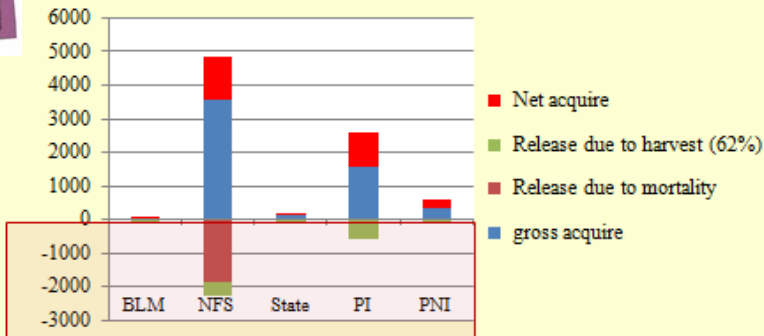


Oregon's Forest Carbon Picture

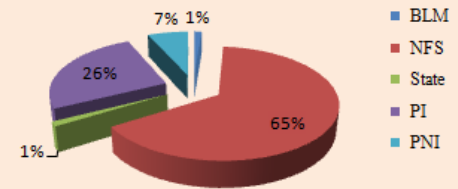


Overall East Cascades Eco-Region

East Cascades Eco-Region: Annual Carbon Performance
(thousand metric ton CO₂e/yr)



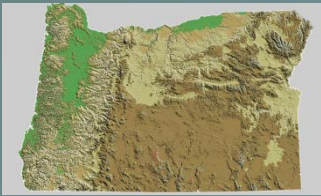
Total acres in East Cascades Eco-Region
(n = ~ 3.5 million acres)



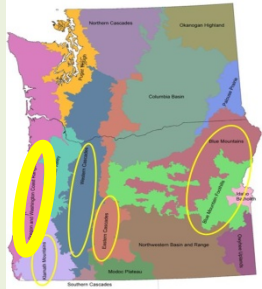
Observations:

- 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?

| East Cascades | thousand metric tons CO ₂ e/yr | | | | | Overall |
|--------------------|---|------------------------------|-------|-------|-----|---------|
| | BLM | NFS | State | PI | PNI | |
| 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 | | |

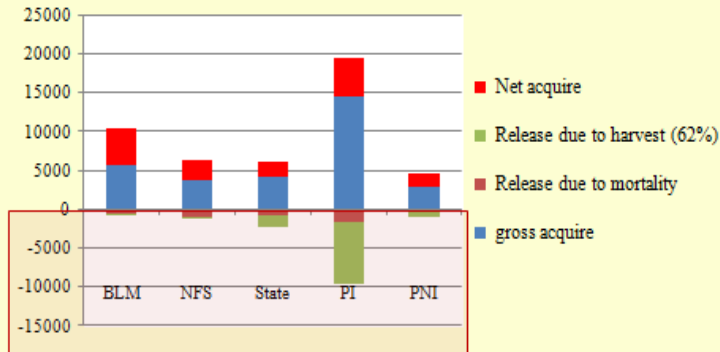


Oregon's Forest Carbon Picture

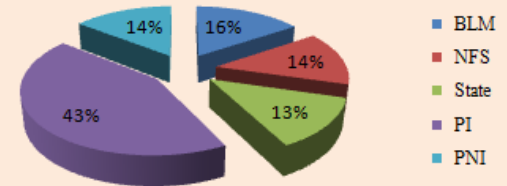


Overall Coast Range Eco-Region

Coast Range Eco-Region: Annual Carbon Performance
(thousand metric ton CO₂e/yr)



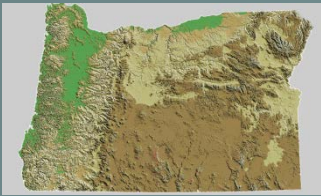
Total acres in Coast Range Eco-Region
(n = ~ 5 million acres)



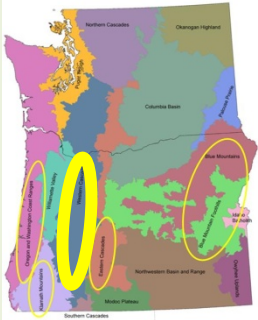
Observations:

- 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

| Coast Range | thousand metric tons CO ₂ e/yr | | | | | Overall |
|--------------------|---|------|-------|--------|------|---------|
| | BLM | NFS | State | PI | PNI | |
| 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 | | |

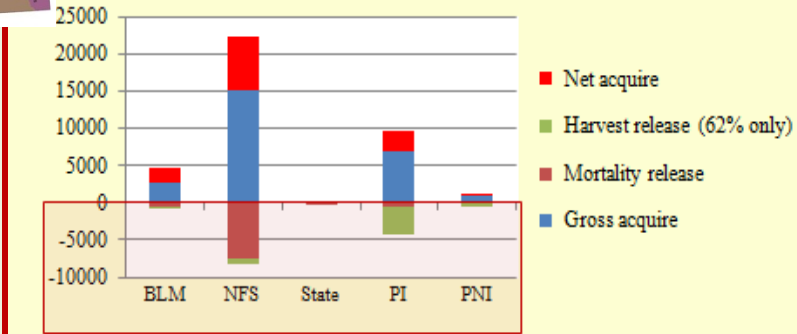


Oregon's Forest Carbon Picture

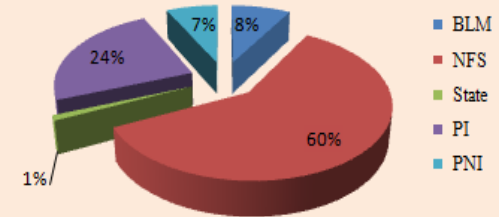


Overall West Cascades Eco-Region

West Cascades Eco-Region: Annual Carbon Performance
(thousand metric ton CO₂e/yr)



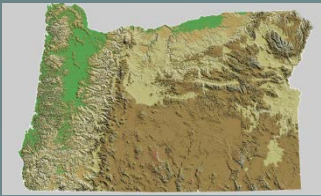
Total acres in West Cascades Eco-Region
(n = ~ 5.4 million acres)



Observations:

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

| West Cascades | thousand metric tons CO ₂ e/yr | | | | | Overall |
|--------------------|---|------|-------|-------|-----|---------|
| | BLM | NFS | State | PI | PNI | |
| 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 | | |

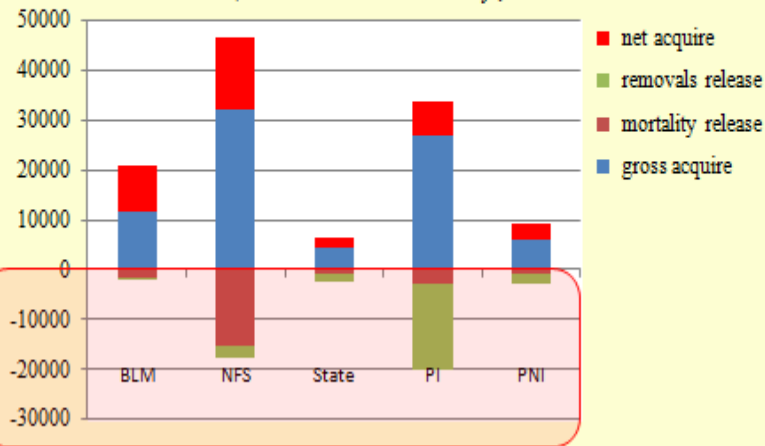


Oregon's Forest Carbon Picture

Net carbon acquire performance/yr.

Net Carbon Acquire Performance
(2001-'05 compared to 2010 - '15)

(Thousand metric tons CO₂e/yr)



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

% statewide *net* carbon acquire/yr.

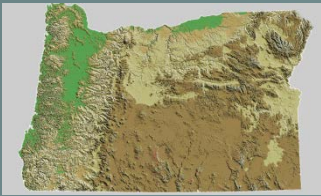
36 million metric tons CO₂e/yr net acquire

% of forest acres

| | % statewide <i>net</i> carbon acquire/yr. | % of forest acres |
|-------|---|-------------------|
| BLM | 26% | 13% |
| NFS | 41% | 48% |
| State | 6% | 4% |
| PI | 19% | 26% |
| PNI | 9% | 10% |

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 CO ₂ e/yr | PNW RMA | Gray GRM | Change from prior period |
| | | Thous Mg/yr | Statewide | |
| | | | Period | |
| 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 |

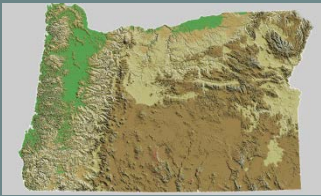
NFS: 12% loss

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?



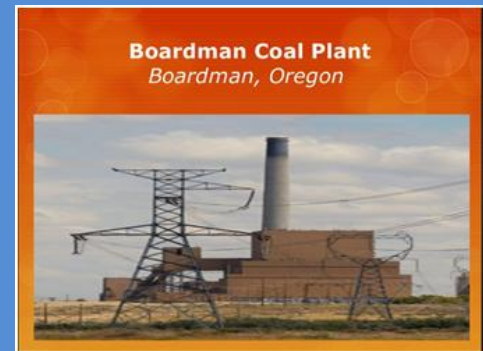
Oregon's Forest Carbon Picture

GHG releases due to fire:

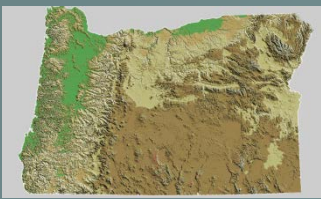
Of 45 million metric tons CO₂e/yr releases generated from Oregon forests each year, *how much due to forest fires?*

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

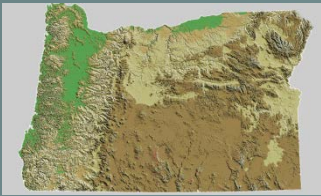
Average annual CO₂e loss due to fire:

Public lands: 2- 4 million metric tons CO₂e.
 Private lands: .4 to .7 million metric tons CO₂e

| Ecoregion | Average annual CO ₂ e loss due to fire | | | |
|---------------------|---|-------------|-------------|-------------|
| | Public | Private | Public | Private |
| | million metric tons per yr | | | |
| | 2001-2005* | | 2011-2014** | |
| Blue Mountains | 0.16 | 0.02 | 0.27 | 0.08 |
| Cascades | 0.93 | 0.13 | 0.32 | 0.16 |
| Coast Range | 0.00 | 0.00 | 0.00 | 0.01 |
| Columbia Plateau | 0.00 | 0.00 | 0.00 | 0.01 |
| East Cascades | 0.54 | 0.15 | 0.43 | 0.24 |
| Klamath | 2.02 | 0.05 | 0.55 | 0.14 |
| Northern Basin | 0.00 | 0.00 | 0.00 | 0.00 |
| Total Oregon | 3.65 | 0.36 | 1.57 | 0.65 |

* includes Biscuit Fire (500,000 ac; Klamath 2002), and B&B Complex Fire (91,000 ac; Cascades; 2003)

** includes Long Draw Fire (558,198 ac; Northern Basin; 2012); Holloway Fire (245,000 ac; Northern Basin; 2012); and Miller Homestead Fire (160,853 ac; Northern Basin; 2012)



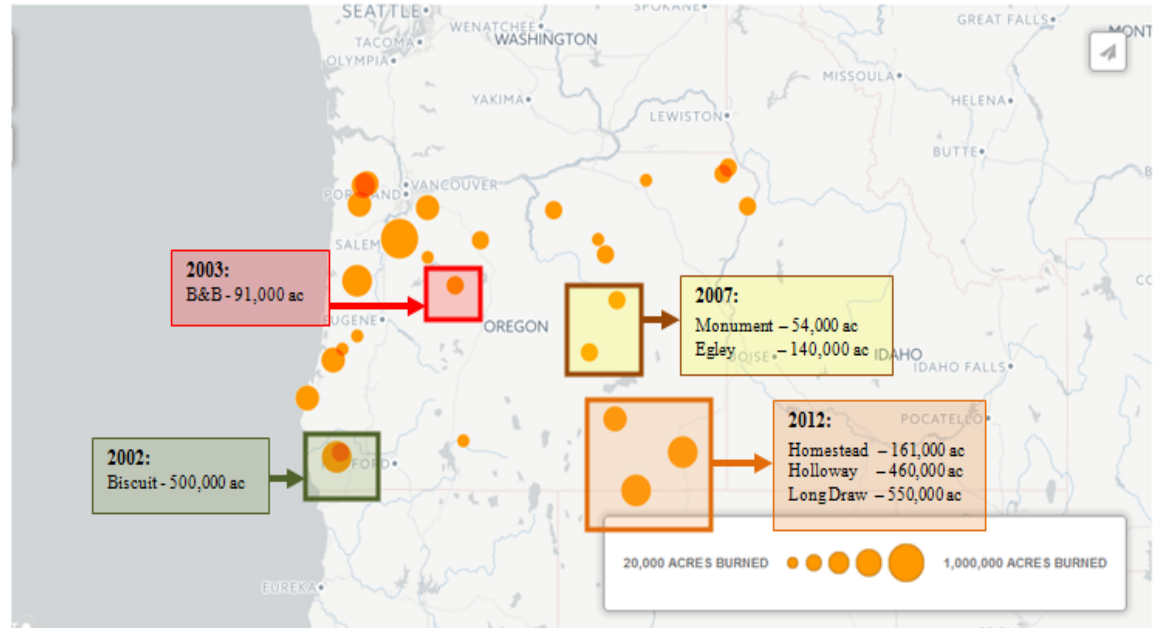
Oregon's Forest Carbon Picture

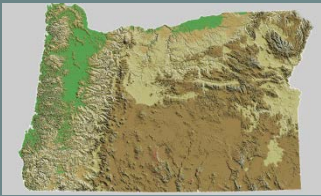
Burned acres don't directly translate to CO2e releases . . .

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

Oregon's largest wildfires

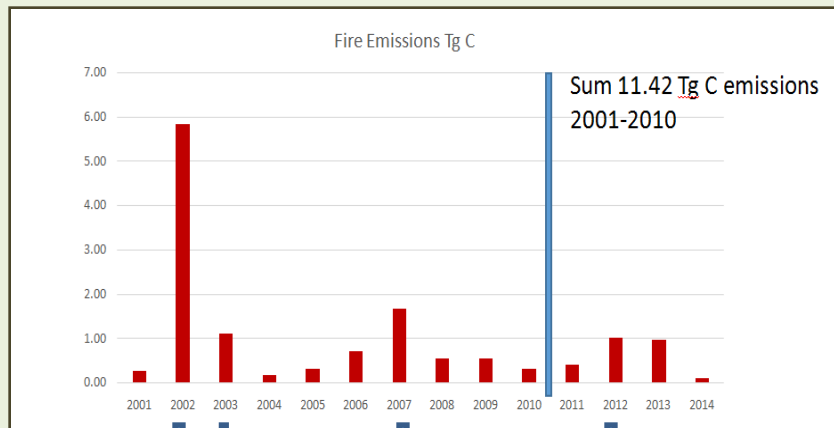
The map shows the largest wildfires on record by acreage. Original data are from Oregon Department of Forestry, with additional information from news accounts.



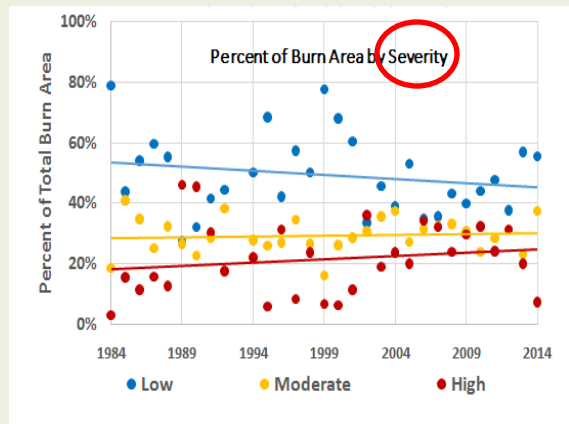


Oregon's Forest Carbon Picture

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



Acres burned don't tell the story . . .



Acres burned ➤

2002: ~500,000 ac
2003: ~91,000 acres
2007: ~200,000

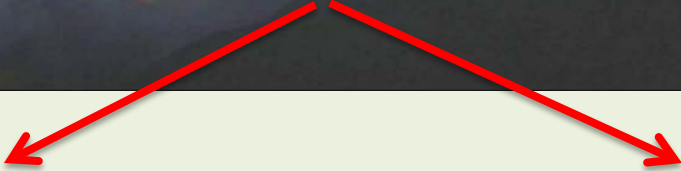
BUT, in 2012: 1.2 million acres

Same emissions levels as 2003
 but over twice the acres burned?
Why?

Statistically, no changes in fire severity over last 30 years

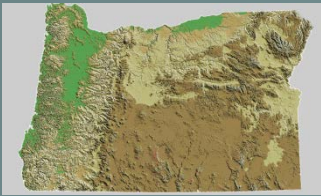


Of 22 million metric tons CO₂e/yr releases due to non-harvest activity
... how much due to forest fires?



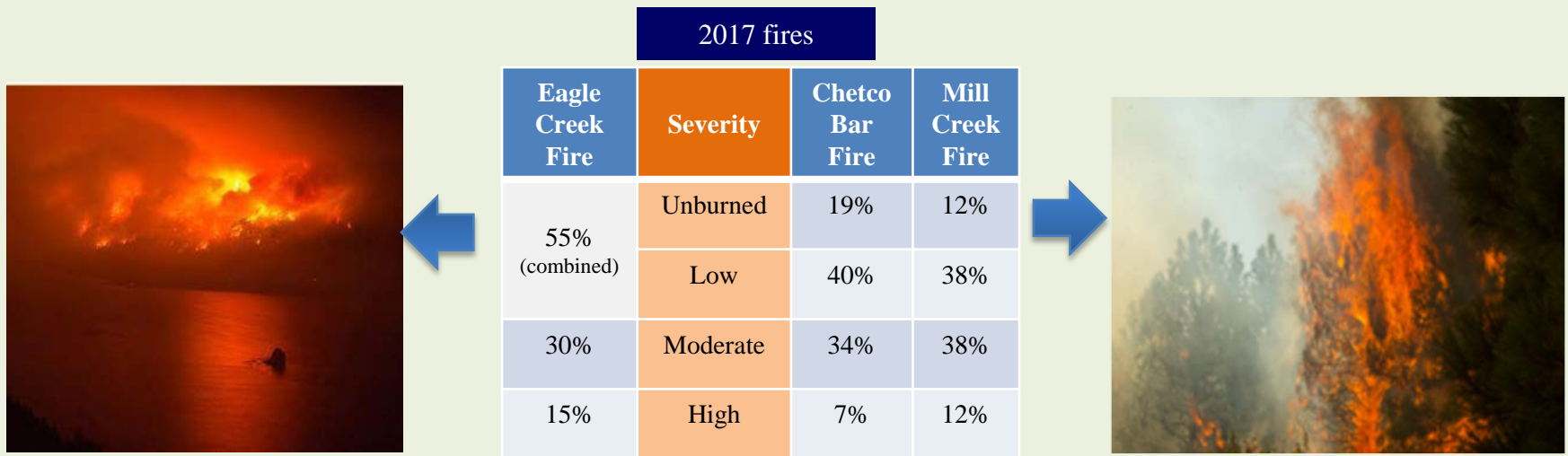
Black carbon particles (“soot”):
Lasts 2 weeks in atmosphere
(“short-lived” - highly visible)

CO₂: a greenhouse gas:
Lasts 100+ years in atmosphere
(“long-lived” – invisible)

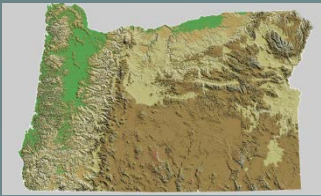


Oregon's Forest Carbon Picture

Fires classified by “severity”: *low, moderate, high*. Long-lived emissions result primarily from *high severity burn spots*.



The occurrence of high severity fires in Oregon appears statistically unchanged 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:

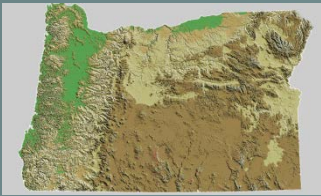
23 million metric tons CO₂e/yr
77% from West Cascades and Coast Range eco-regions.
73% from PI forestlands

- 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 CO₂e releases last 100+ years in the atmosphere. Short-lived black 'soot' carbon lasts ~2 weeks in the atmosphere. *Statewide long term CO₂e releases due to fire have decreased over the last decade: from 4 million metric tons CO₂e/yr in 2001 to 2.2 million metric tons CO₂e/yr by 2014. Short-term black carbon releases due to fire have yet to be analyzed.*
- *Fire severity determines CO₂e release* (must be high severity fire to release long-term CO₂e). 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 *CO₂e 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* region where releases increased from 160,000 metric tons CO₂e/yr in 2001 to 270,000 metric tons CO₂e/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 CO₂e/yr in 2001 compared to 140,000/yr by 2014) *and the East Cascades* eco-region (150,000 metric tons CO₂e/yr in 2001 compared to 240,000/yr by 2014).