Role of Forest Ecosystems in Climate Change Mitigation and Adaptation

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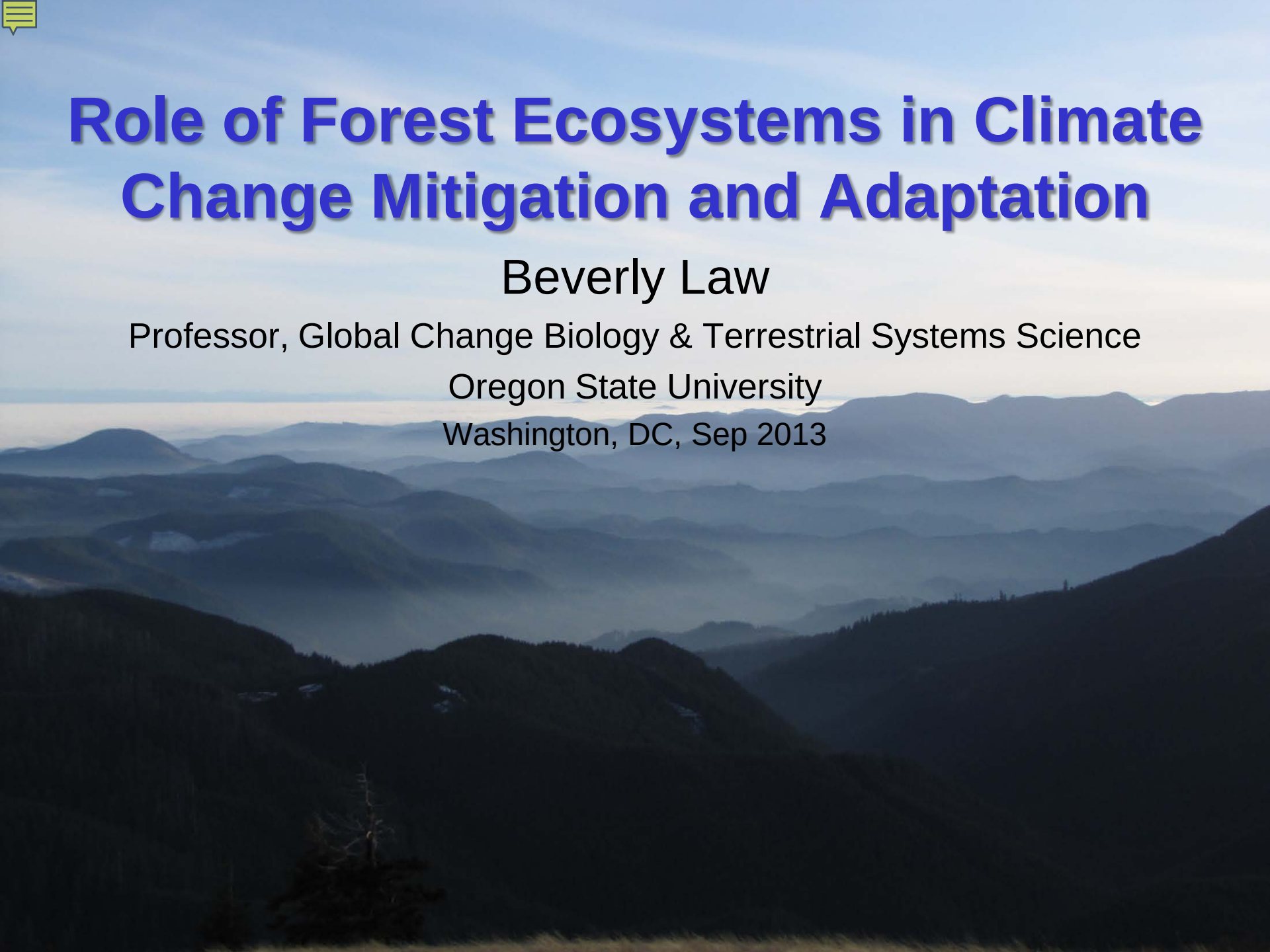
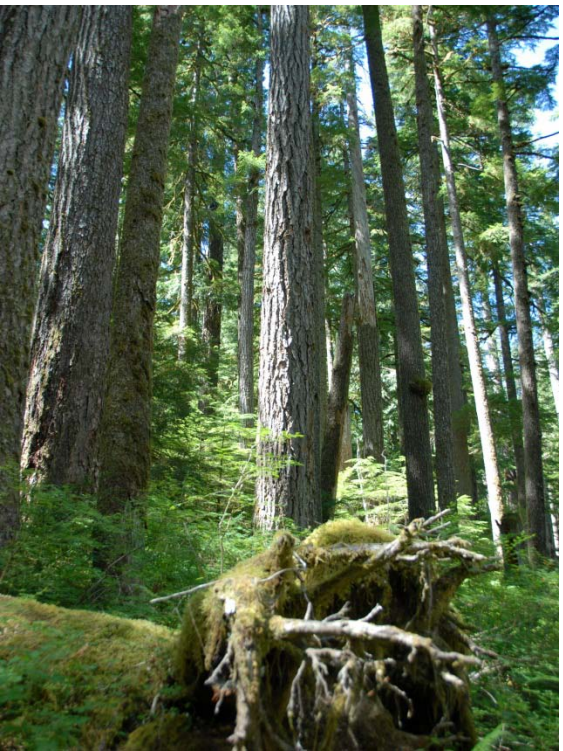


Key Points

- Promote conservation of carbon storage in forests
- Natural disturbance (fire, insects) has small impact on forest carbon compared to intensive harvest
- Thinning does not reduce emissions and fire occurrence



Role of Forests:

More Carbon in Forests = Less Carbon in the Atmosphere

- **Old forests store up to ~10 times more carbon per unit ground area than young forests**
- **Old forests store carbon for hundreds of years**
- **Low hanging fruit: Allow existing forests to continue to store and accumulate carbon**

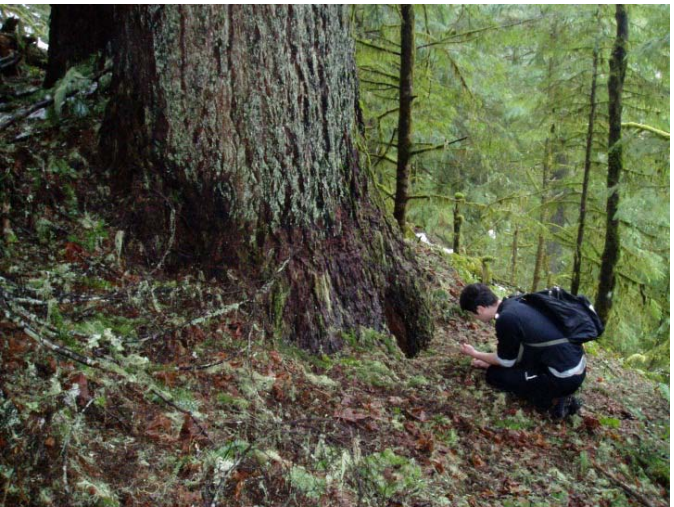
Old (>200)

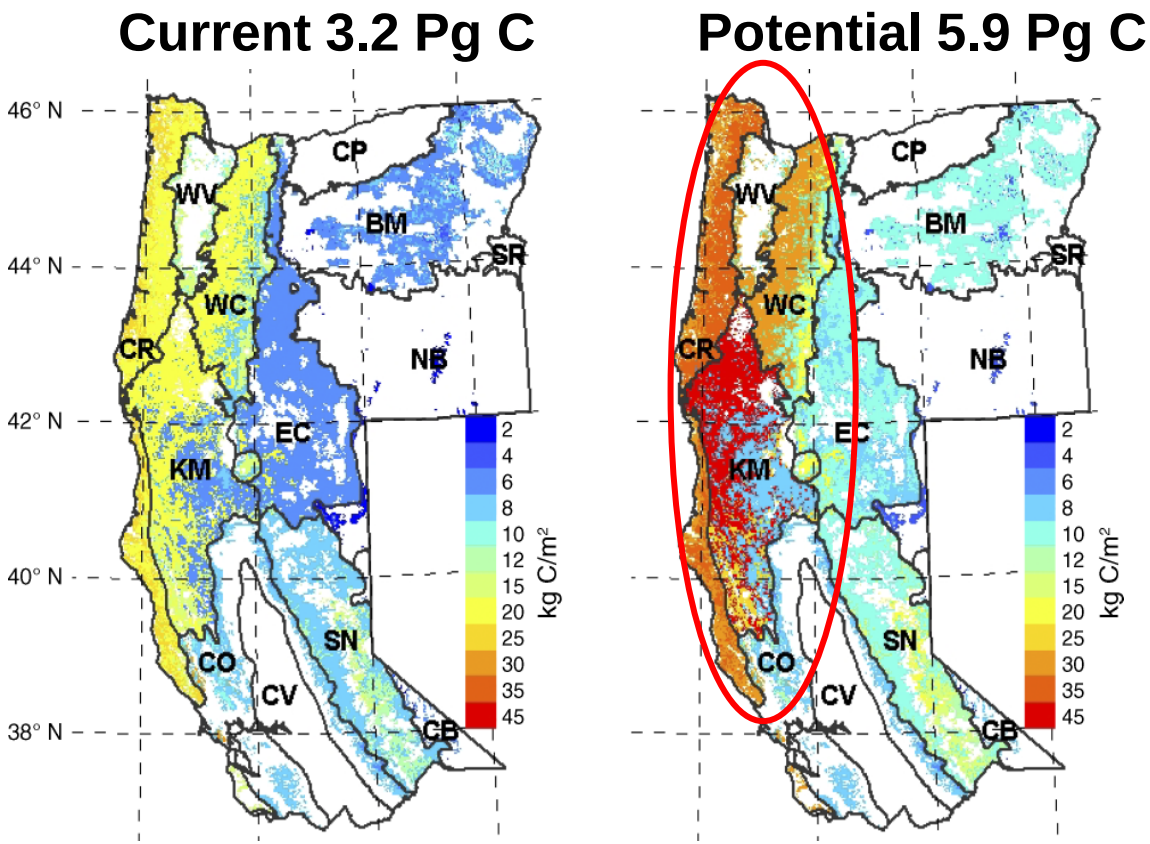
Young (0<80)

Sources: Schulze et al. 2012, Hudiburg et al. 2009

Regional Potential to Store More Biomass Carbon

- **Mesic temperate forests in PNW among highest biomass in the world**
- **Centuries to make up for carbon lost**



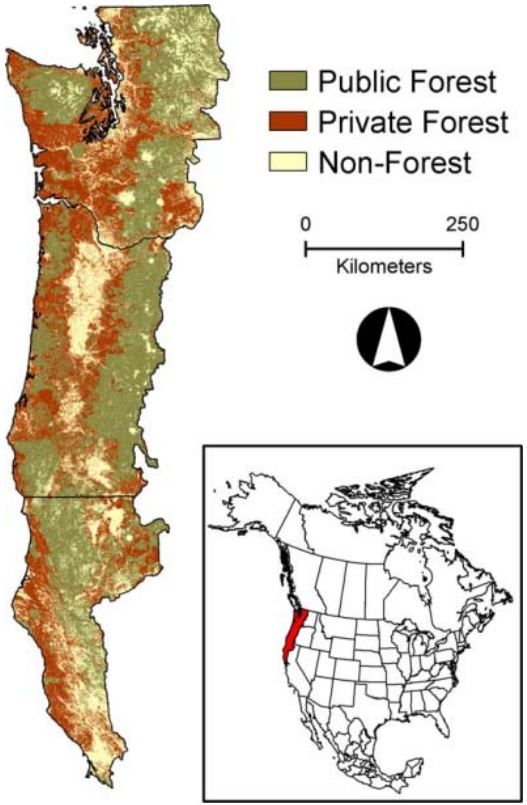


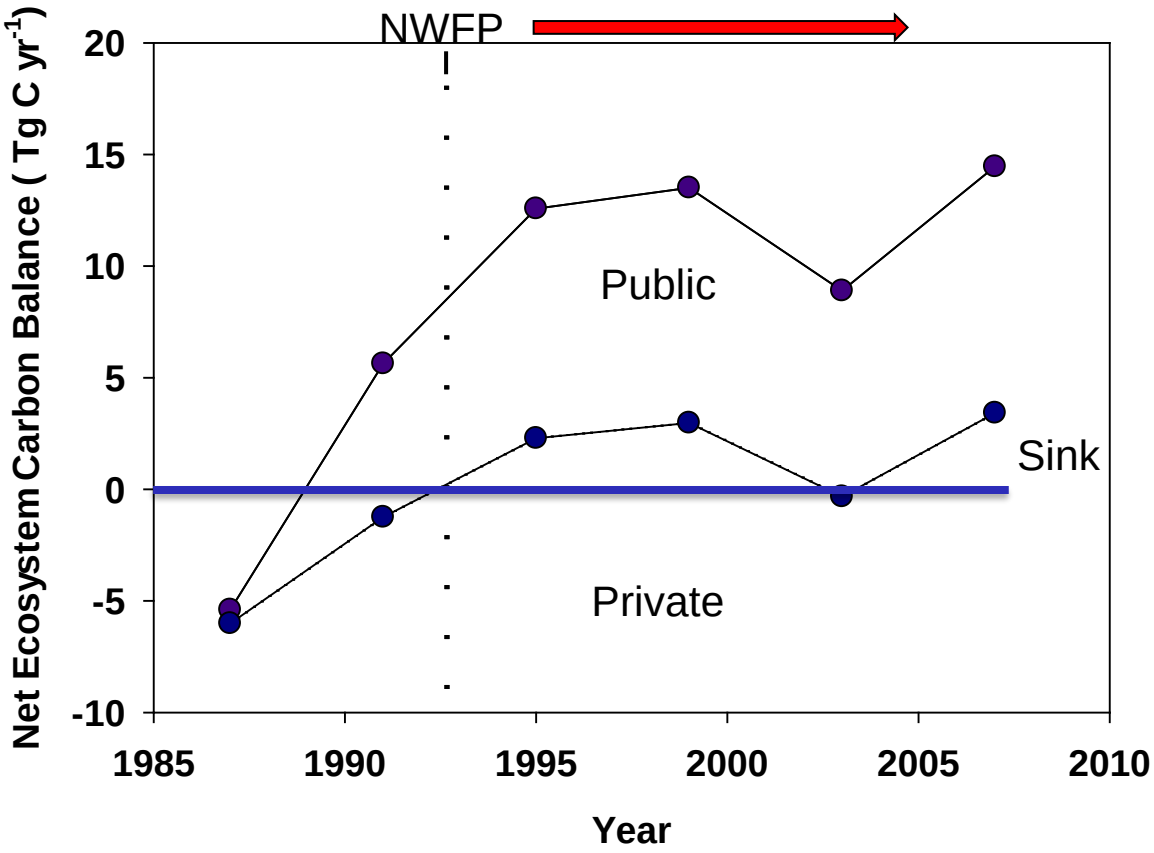
Sources: Hudiburg et al. 2009, Leighty et al. 2006

Potential for Reforestation, Regrowth Improve Connectivity for Migration

Decreasing Harvest Intensity Increases Carbon Sequestration: NW Forest Plan

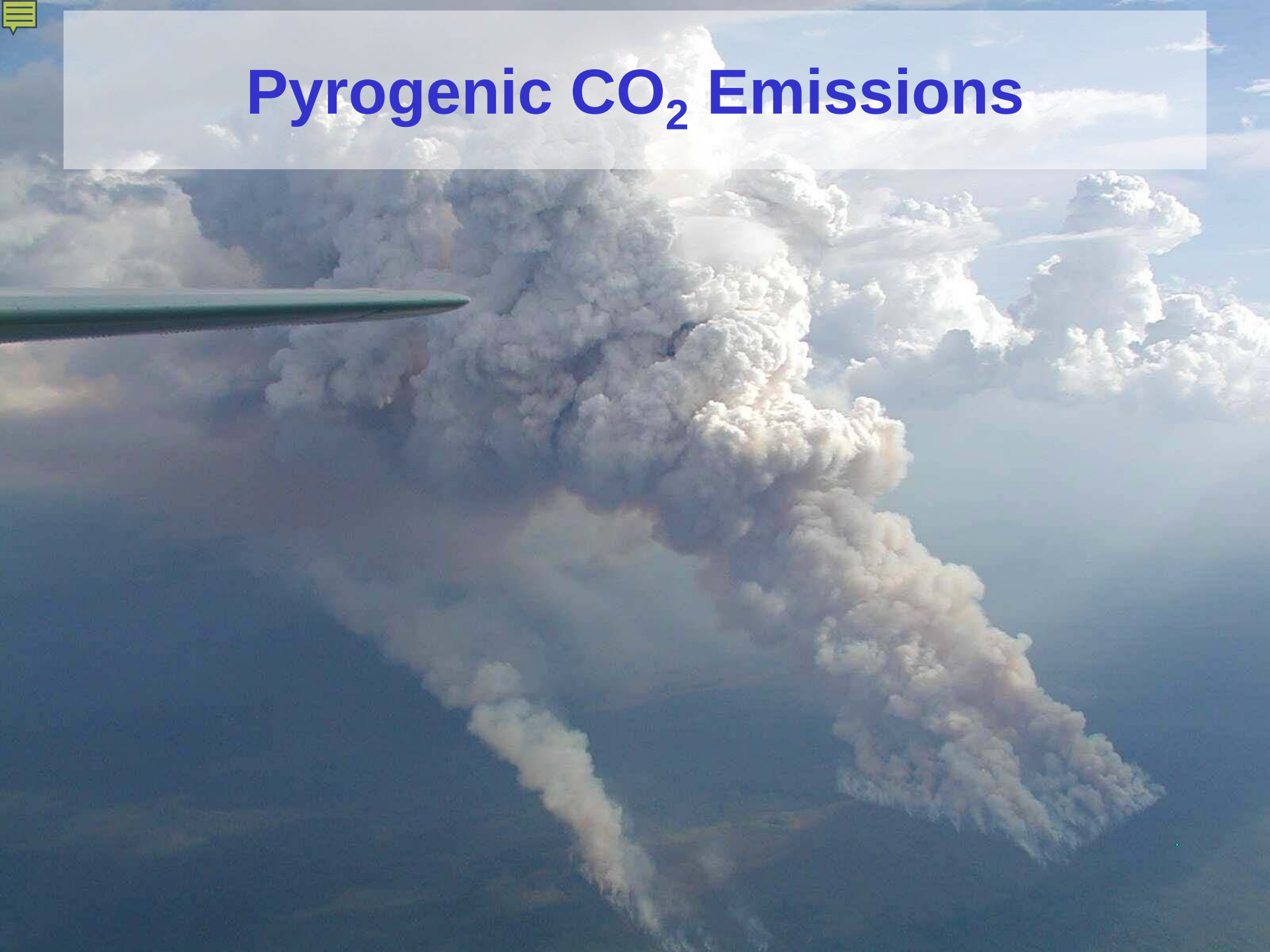
- **Public lands were source of carbon before NWFP, changed to a sink in the decades after ~80% reduction harvest rate**





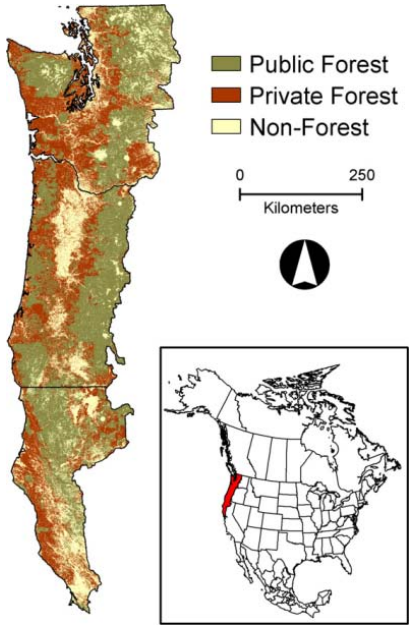
Source: Turner et al. 2011, Law et al. 2013

Pyrogenic CO_2 Emissions



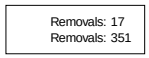
Fire has Small Effect on Forest Carbon Compared to Intensive Harvest

- **Decomposition after fire takes decades to centuries**
- **~Half of fire-produced carbon in soil remains ~90 yrs, other half >1000 yrs**
- **If fire doesn't significantly reduce carbon stored in forests, it isn't going to materially worsen climate change**



Harvest Removals

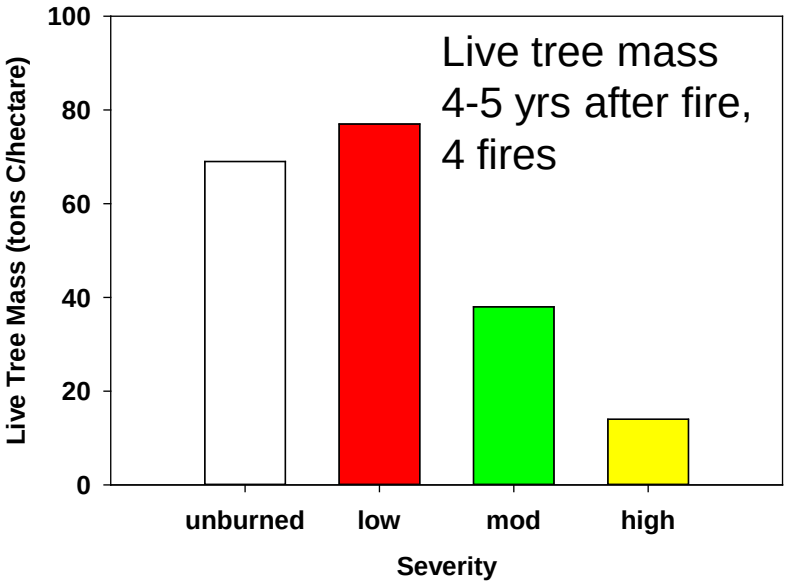
Fire Emissions



1985-2007 cumulative effects on forest carbon in NWFP area

Source: Turner et al. 2011

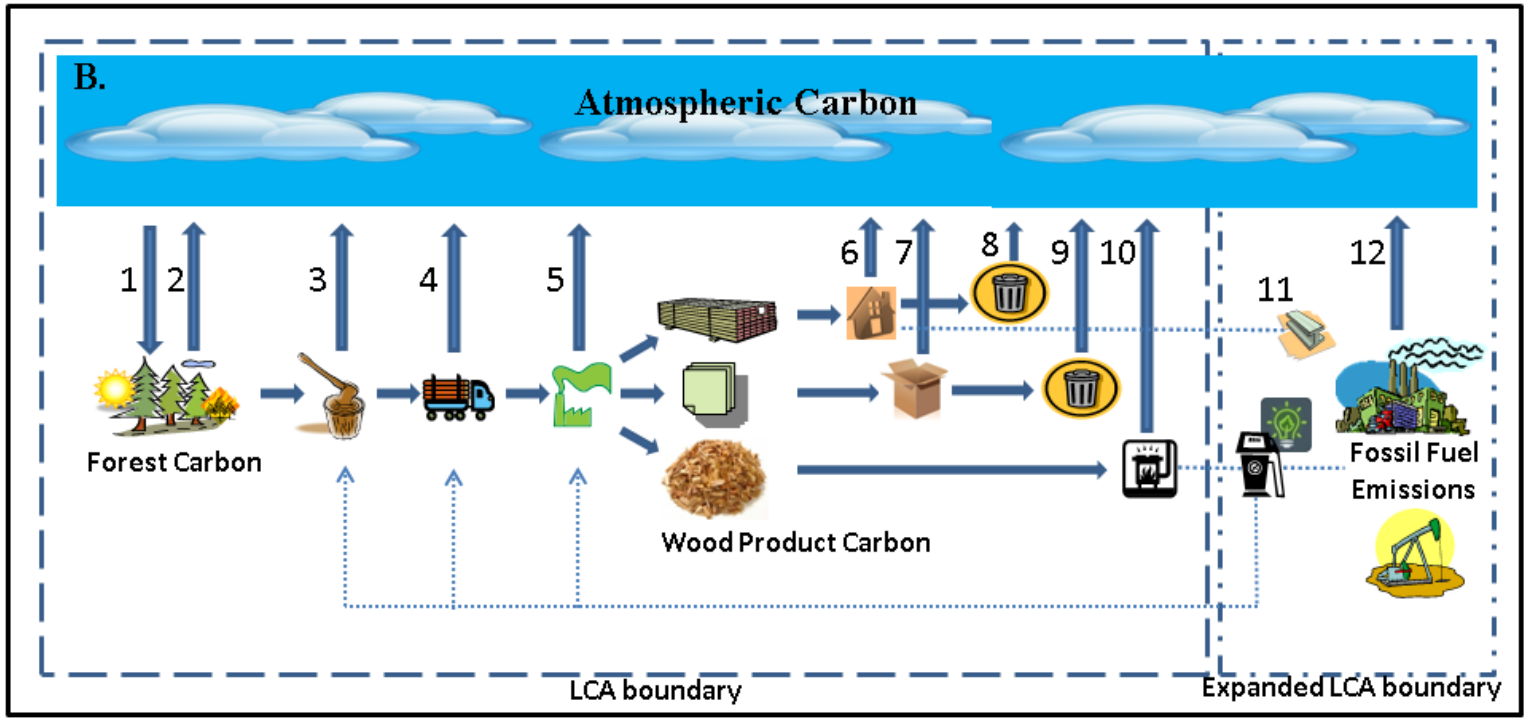
Survivors are Still Productive – C Sequestration & Seed Source



- **~50 to 75% of live biomass survives moderate + low severity fire which accounts for 80% of burn area in PNW**
- **Removing surviving trees will reduce carbon storage, and in many cases sequestration and regeneration**

Sources: Meigs et al. 2009, Irvine et al. 2007, Waring 2005

Full Life Cycle Assessment to Account for Carbon Losses



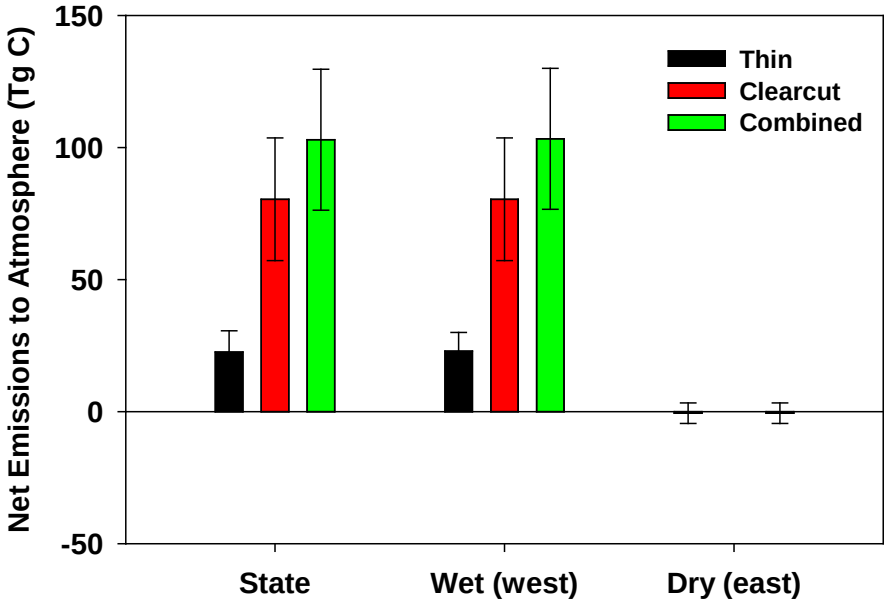
- **Changes in carbon on land**
- **Emissions associated with harvest, production, transport, usage of wood**
- **Substitution and displacement of fossil fuel emissions associated with extraction and use**

Sources: Law & Harmon 2011, Hudiburg et al. 2011

Regional Analysis: Effects of Harvest Strategies, Future Climate, CO_2

- **Over next 20 yrs, thinning forests of WA, OR, CA for crown fire risk reduction & bioenergy production increases net C emissions**
- **By 2100, enhanced productivity from CO_2 fertilization & warming overshadows increased fire emissions at current harvest rates**
- **Harvest strategies lead to long-term increased C emissions, semi-arid region contributes little**

Net emissions (Tg C) over current harvest rates by 2100



Earth System Modeling, inventories, Life Cycle Assessment

Sources: Hudiburg et al. in press, Hudiburg et al. 2011

Repeated Thinning for Bioenergy Production Can Impact Soil Fertility

- **Shorter rotations (30-50 yr) increase nutrient removal, decrease productivity**
- **Residue removal increases soil nitrogen losses**
- **Depleted soil fertility would require fertilization, which increases GHG emissions (N_2O)**

Aber et al. 1989, Peckham & Gower 2011

Thinning Does Not Necessarily Reduce Fire Occurrence

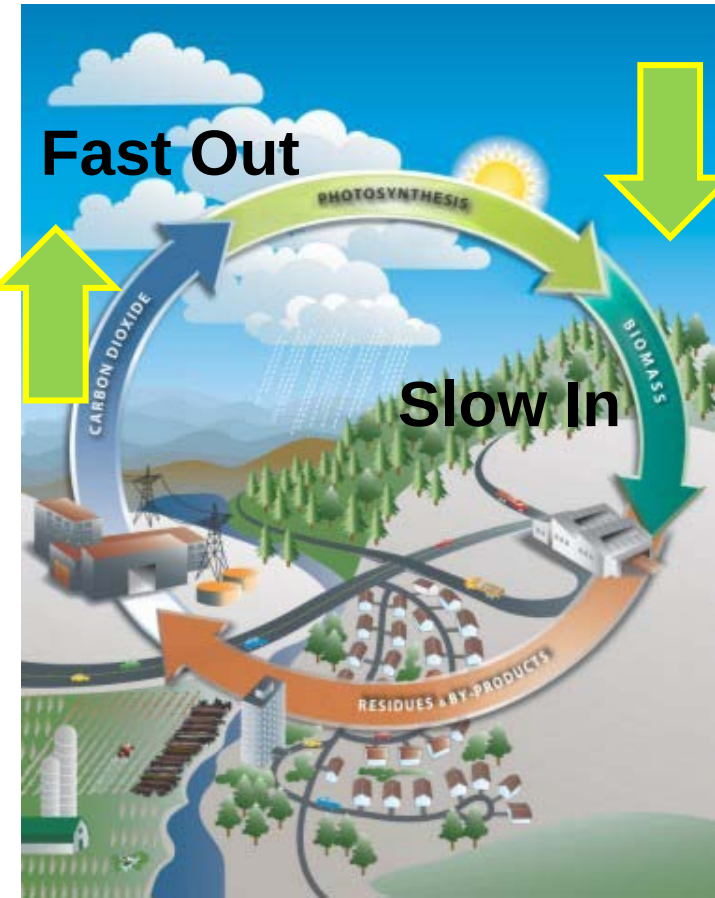
Photos: Brian Hines

- **Fuel treatments may do little to mitigate fire spread or severity in extreme weather conditions (drought, high winds)**
- **Removal of small diameter trees can reduce crown fire hazard, reduce severity (if treated within 10-20 yrs of fire)**

Sources: Pollet & Omi 2002, Omi & Martinson 2002

Slow In, Fast Out – Opportunity Cost

- Today's harvest took decades to centuries to accumulate
- Returns to atmosphere quickly via bioenergy use
- Increased GHG emissions mostly due to:
  - Consumption of current forest carbon
  - Long-term reduction of C stock



Summary

- **Activities that promote conservation of carbon storage in forests**
  - allowing existing forests to accumulate carbon
  - forestation of lands that once carried forests
- **Natural disturbance has small impact on forest carbon stores compared to intensive harvest regime**
- **Full accounting shows thinning results in increased carbon emissions to the atmosphere for at least many decades**

Extras

Fossil Fuel Displacement

Assumption behind expected GHG benefits of bioenergy:

- **A unit of energy supplied by bioenergy takes the place of a unit of energy supplied by fossil fuel sources**

Finding: Not true.

- **Non-hydro renewables do not displace, and may do the opposite**
- **Per unit of energy, the amount of CO_2 released from biomass combustion is ~ as high as coal and substantially larger than oil, natural gas**

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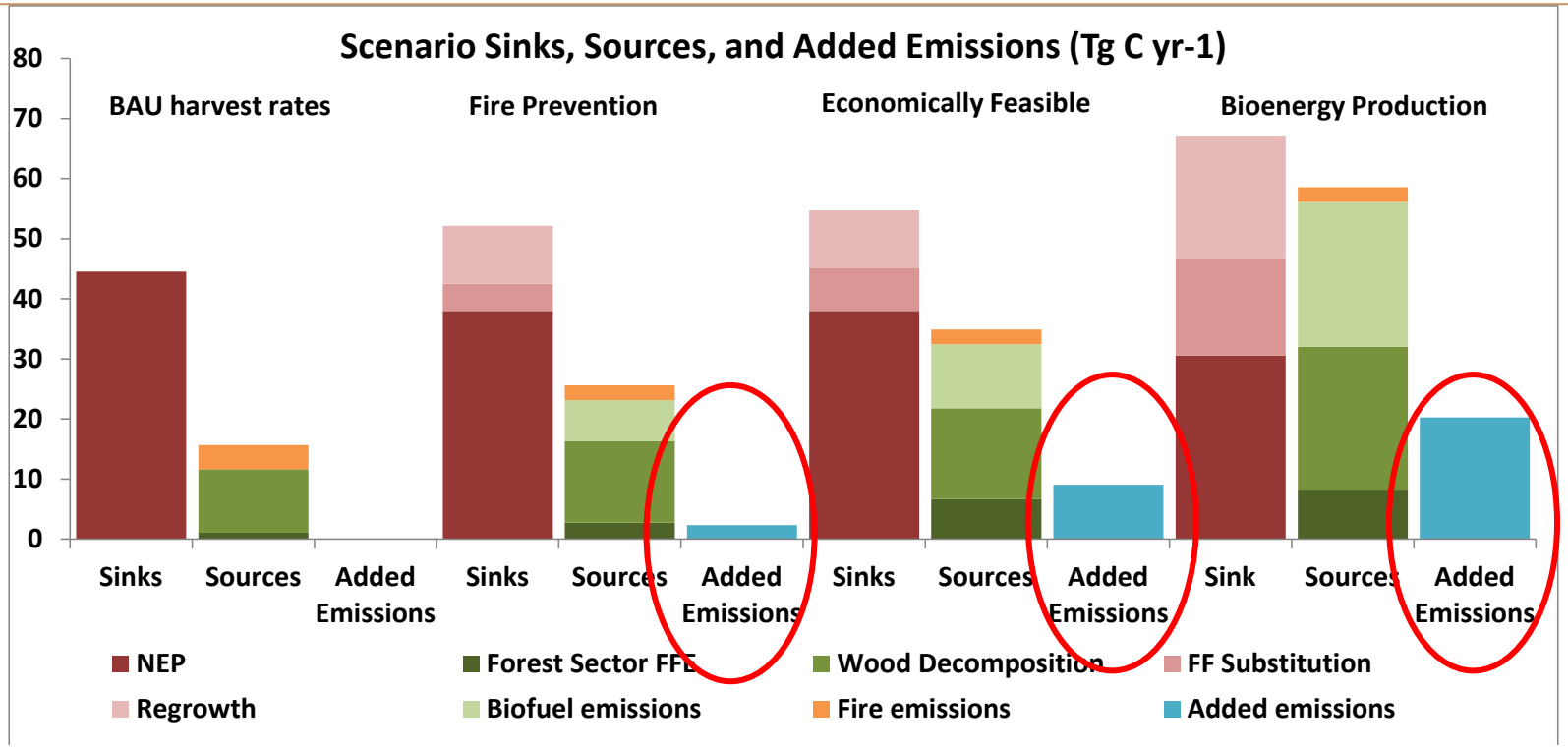
Sources: York 2012, Haberl et al. 2012

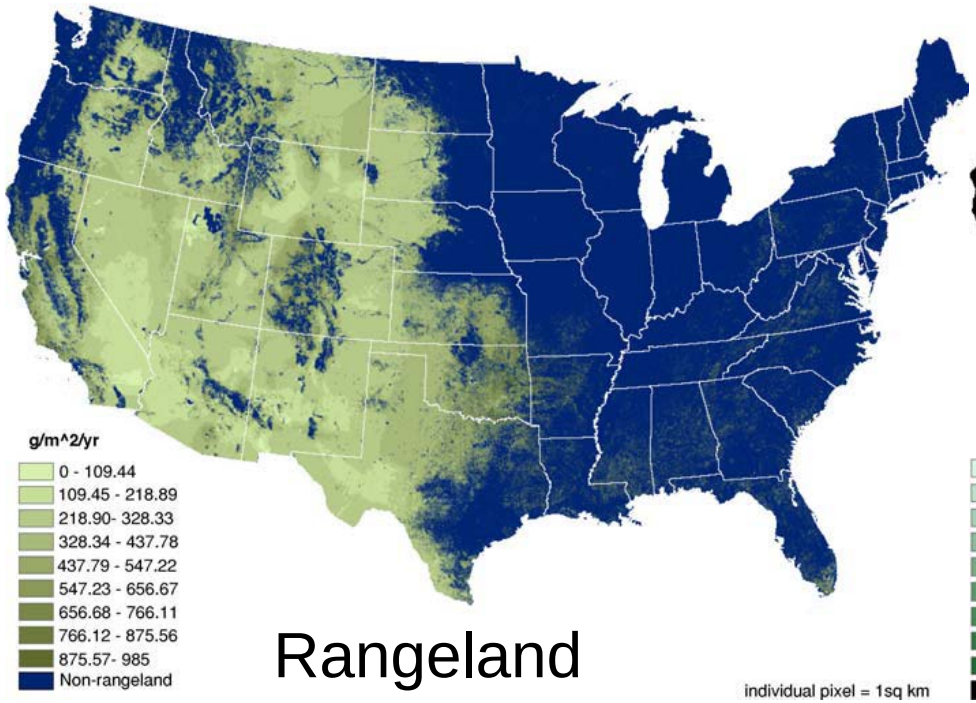
PNW Region: None of Harvest Scenarios Reduce GHG Emissions



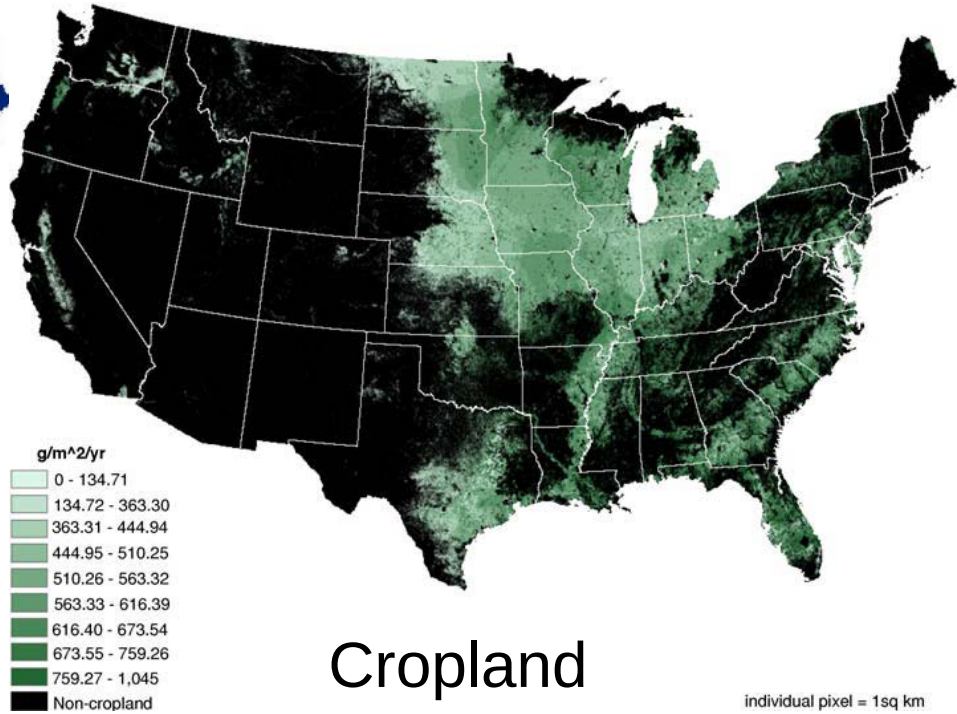
- **Regional analysis of PNW forests, observation-based**
- **20 year timeframe, three harvest scenarios**
- **Increase emissions relative to BAU harvest rates**

Source: Hudiburg et al. 2011

Potential Forestation Carbon Gains



Rangeland



Cropland

Forestation of 25% of relatively low-production crop or rangeland has capacity to offset ~20% of annual fossil fuel emissions

Source: Potter et al. 2007