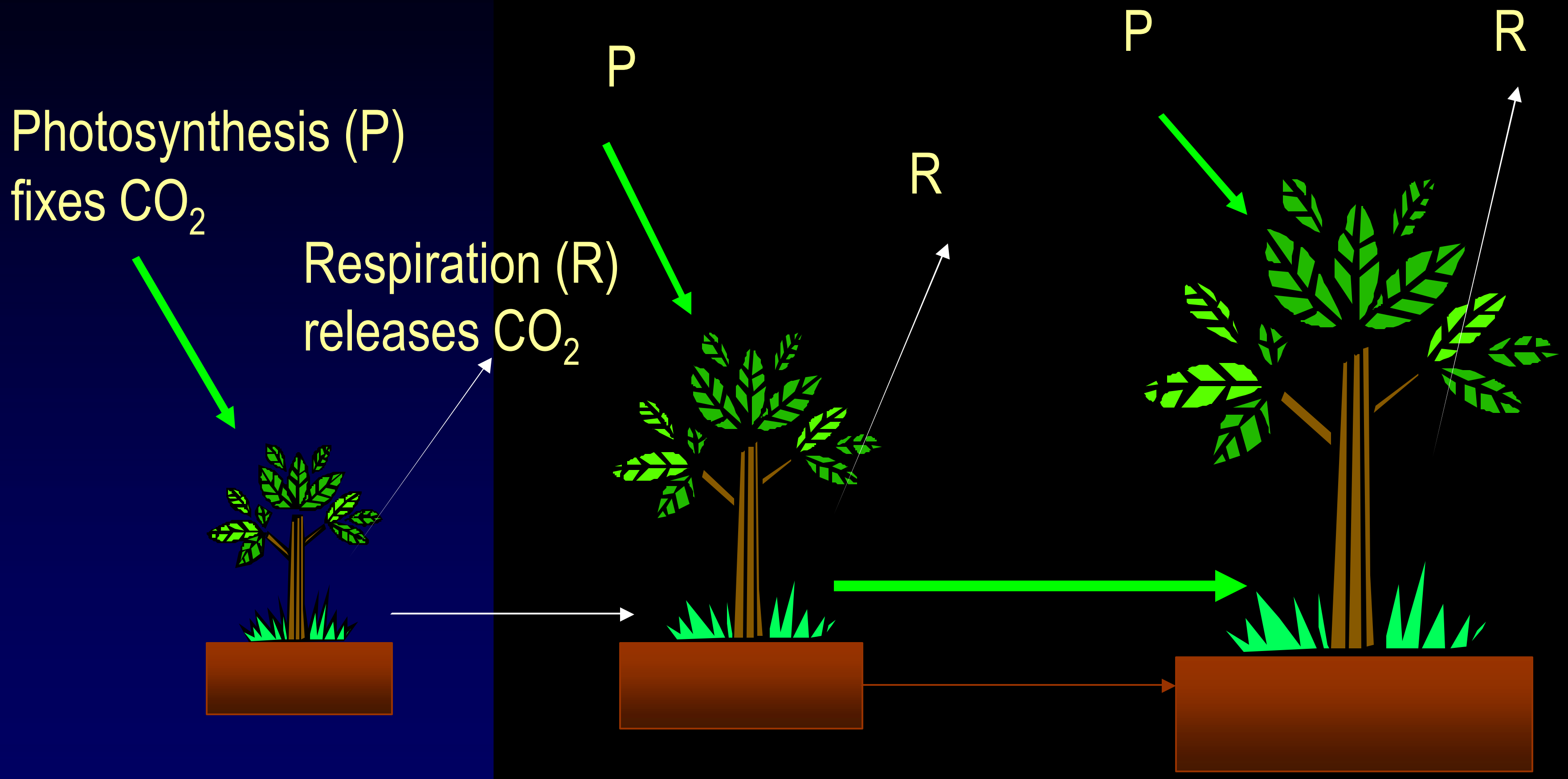
West Coast Carbon Partnership
Annual Meeting

What is Terrestrial Carbon Sequestration?

John Kadyszewski
Winrock International
Portland, Oregon
October 27, 2004

Photo from Union Lumber Company Collection, Andrews 1965

How do Ecosystems Sequester Carbon?



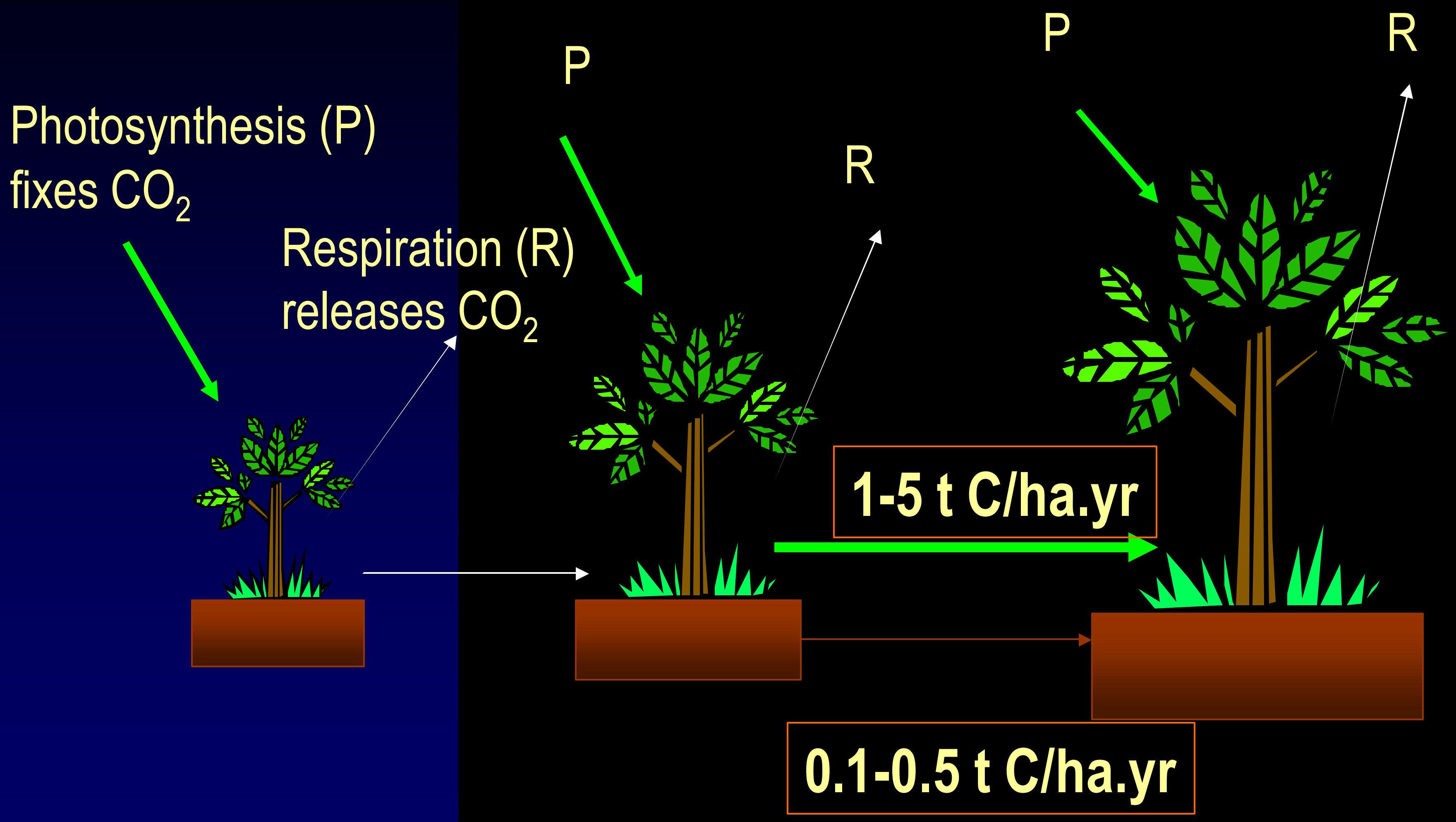
Photosynthesis exceeds respiration, resulting in storage of carbon

Where is Carbon Sequestered?

- Live biomass
  - Trees
  - Understory
  - Roots
- Dead biomass
  - Standing
  - Down
    - Coarse
    - Fine
- Wood products
- Soil

"Carbon Pools"

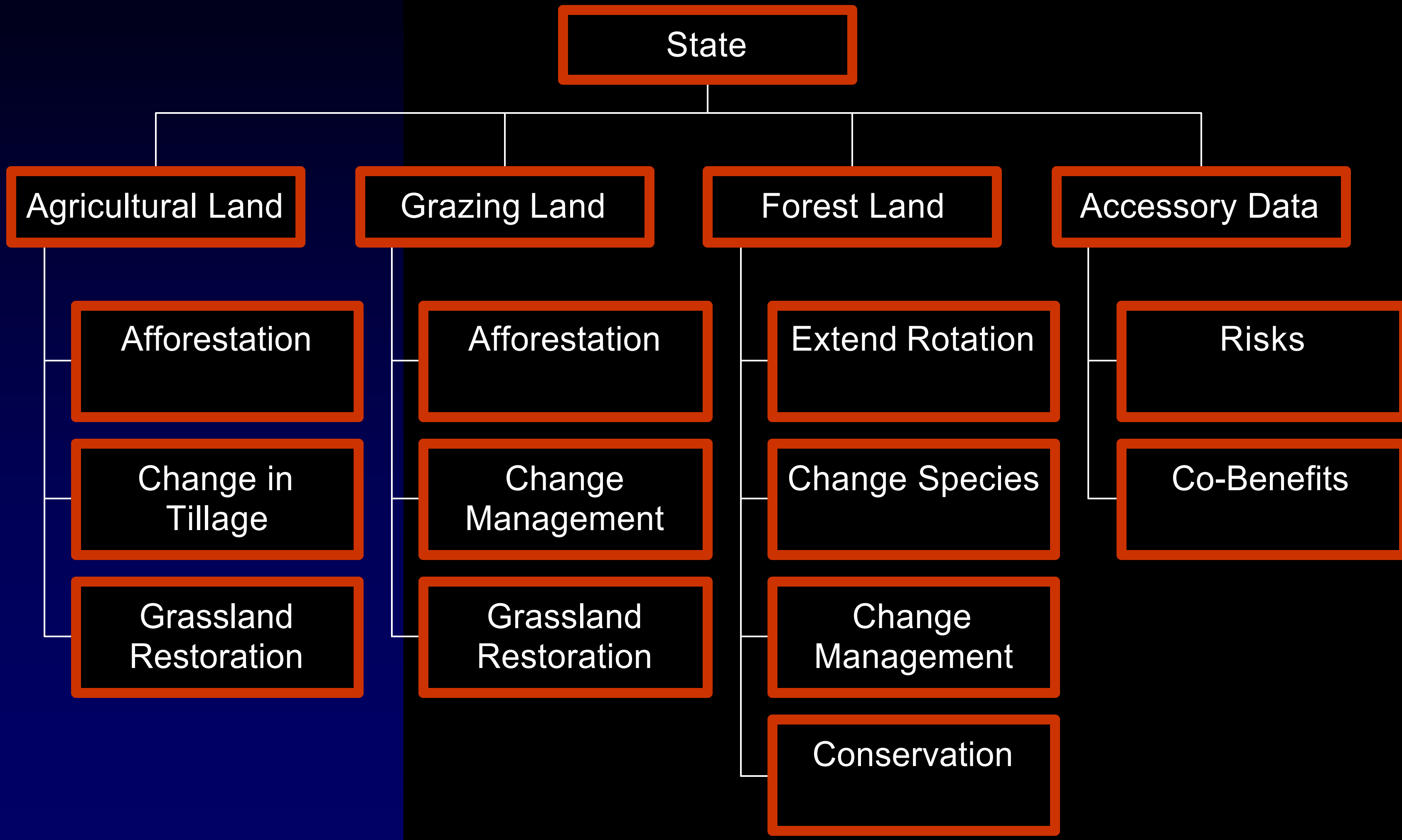
At What Rate Does Carbon Accumulate?



What is a Terrestrial Carbon Sequestration Project?

- Activity focused on ecosystems resulting in less greenhouse gases (primarily CO2) in the atmosphere
  - Avoid new emissions
  - Remove CO2 from the atmosphere
- Project-based carbon benefits are the difference between the selected “carbon pools” in the with-project and without-project cases

Terrestrial Sequestration Options



Conserve Forests


Source: Tim Pearson, Winrock International

- Stop forest conversion to non-forest
- Sierra Mixed Conifer (150 year old forest)
  - 376 tC/ha
- Redwood (150 year old forest)
  - 478 tC/ha

Afforestation

- Convert agricultural or grazing land back to forest
  - Return to native forest
  - Convert to forest land for timber production

Mixed Conifers

Reforest Degraded Land

- Rate of Carbon Sequestration for Douglas Fir

  5 tC/ha yr x 20 yrs

  =100 tC/ha

Afforestation

- Convert to forest land with fast-growing species

Hybrid Poplar
28 years old
110 feet tall
32 in. dbh

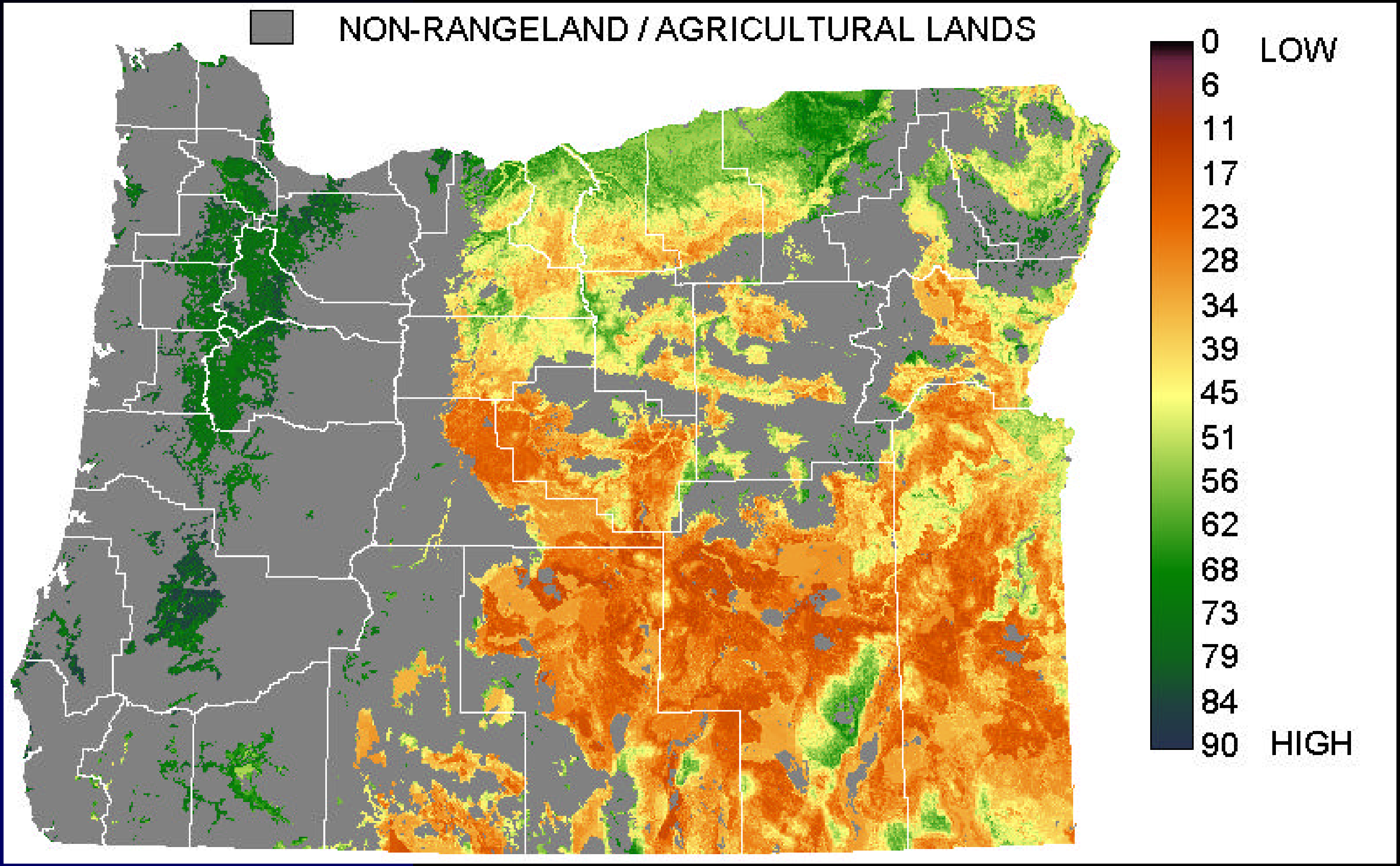
Growth Rates for Trees

- Douglas Fir 4 dry t/acre/yr
  ~50 year rotation
- Hybrid Poplar 10 dry t/acre/yr
  6-8 year rotation

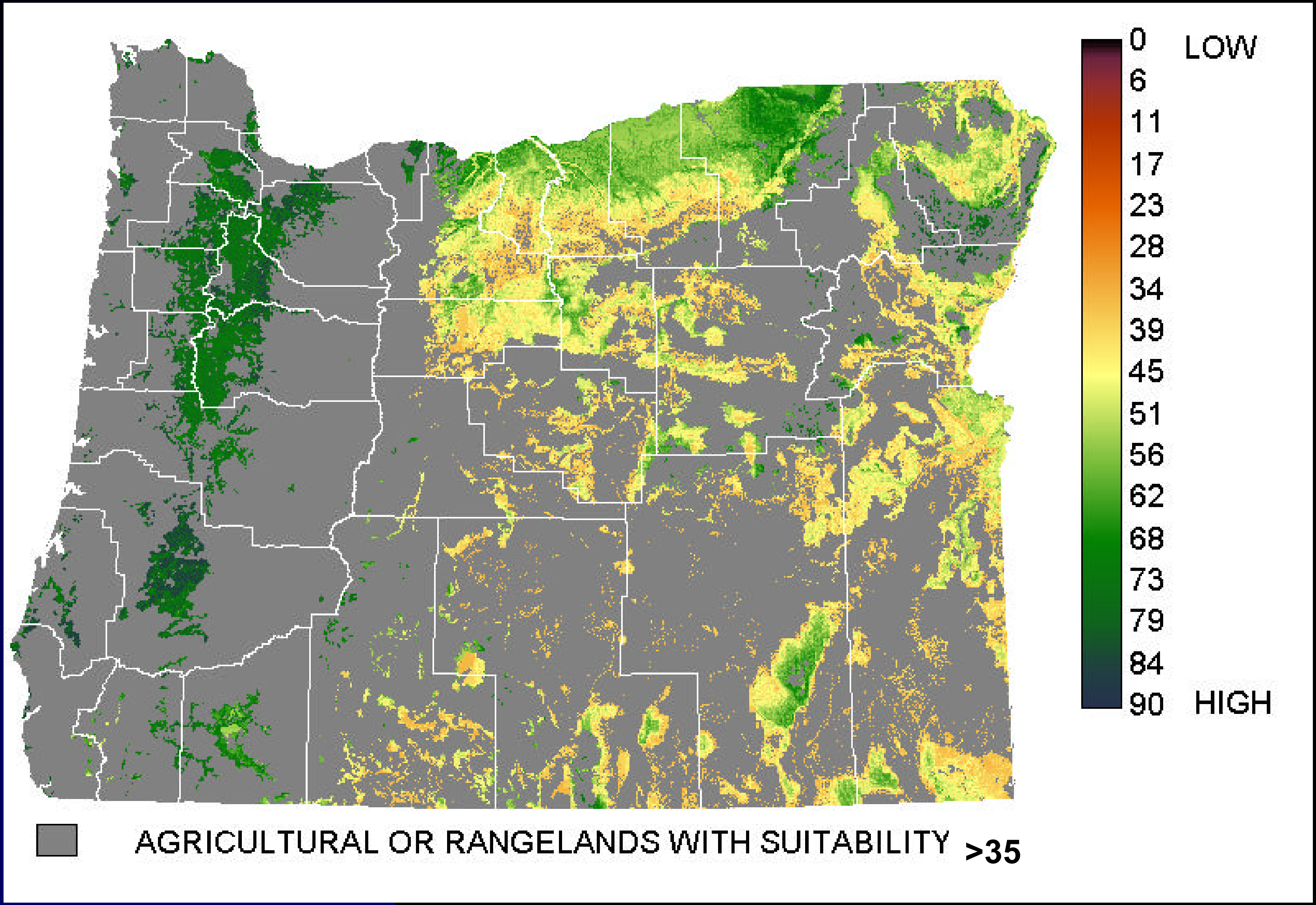
9 years diameter growth

Source: Jon Johnson
Associate Professor
Washington State University

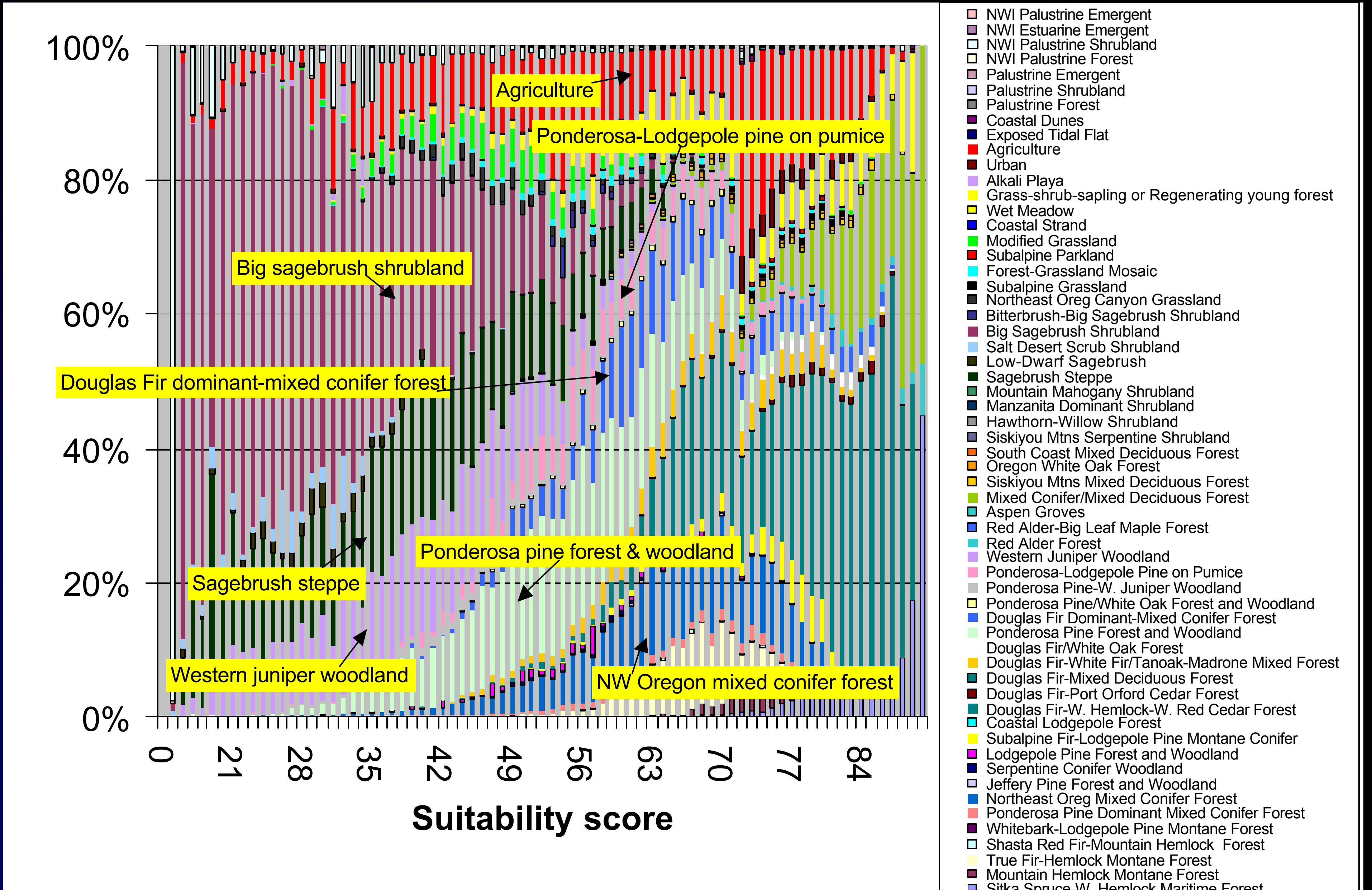
Oregon Agricultural and Grazing Lands Suitable for Afforestation



Suitability Greater Than 35



Species Mix for Various Suitability Scores



Fuels and Fire Management

Not all fires are the same

Source of Photos: Dr. Sam Sandberg, USDA Forest Service PacificWildland Fire Sciences Laboratory

Potential Sequestration Benefits from Improved Fire Management

Source: Dr. Sam Sandberg, USDA Forest Service
PacificWildland Fire Sciences Laboratory

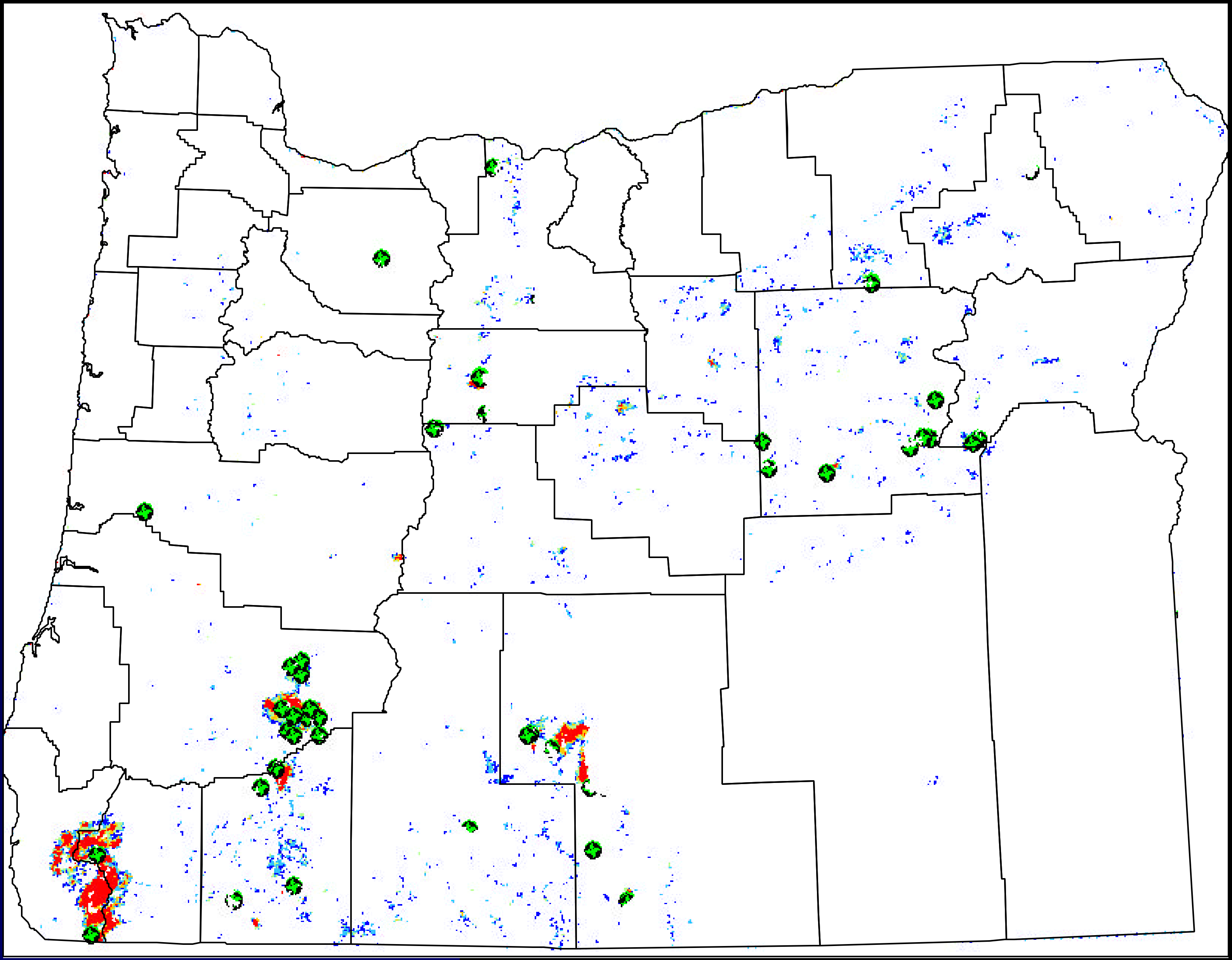
- Reduce net GHG emissions from combustion
- Reduce loss of carbon stocks from large trees
- Reduce loss of carbon stocks from duff
- Maintain carbon accumulation rates during recovery
- Avoid ecosystem-changing fires

Ecosystem Conversion

San Francisco Peaks, AZ

Fire can change forest ecosystems to non-forest ecosystems

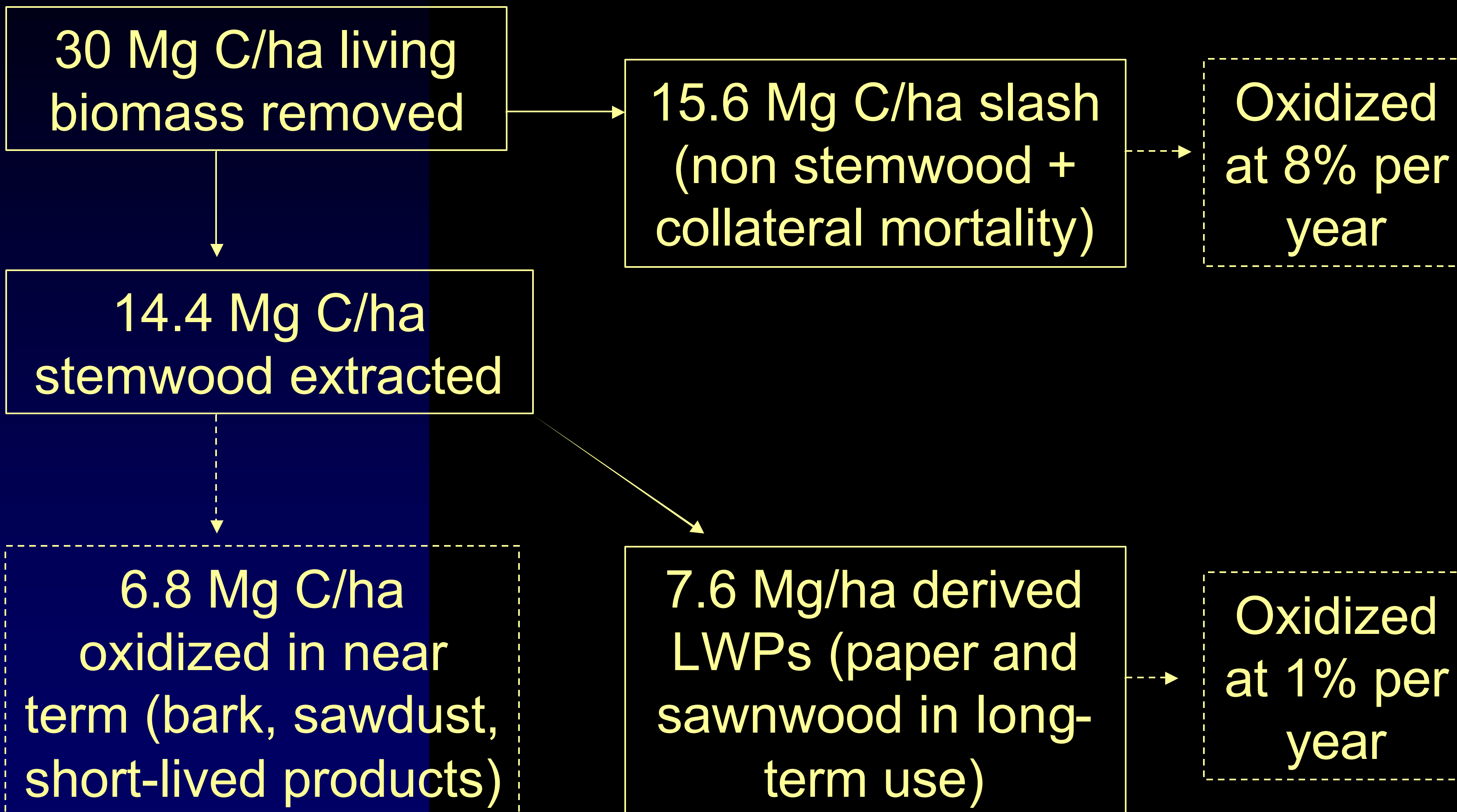
Source: Dr. Sam Sandberg, USDA Forest Service
PacificWildland Fire Sciences Laboratory



Negative Change in Forest Areas between Mean & 2002 NDVIs

Fire records come from ODF and USFS. There are a few overlapping points such as the Biscuit fire.

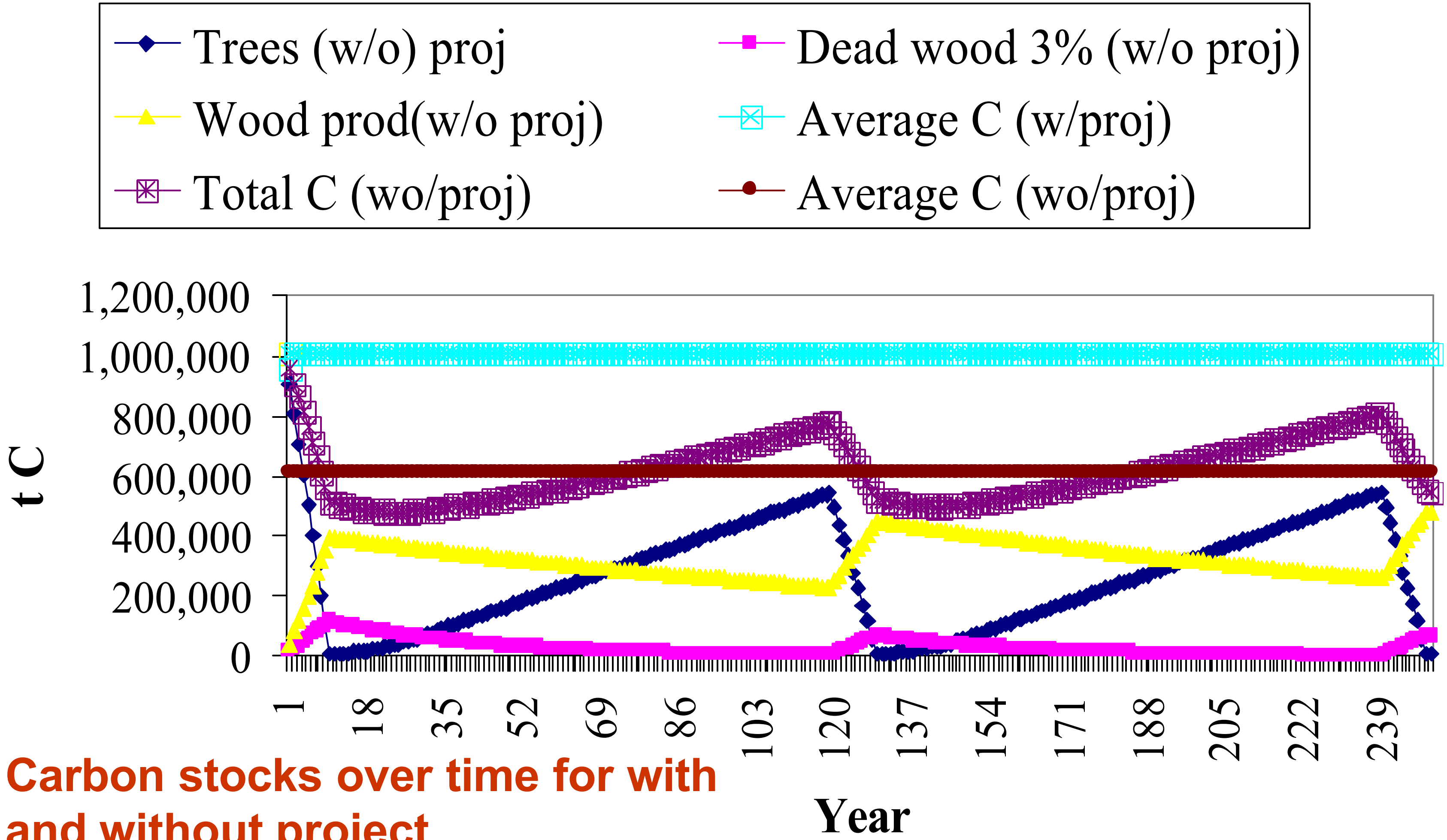
Change Logging Practices



Change From Logging to Conservation

- Collect data on logging
  - Rotation length
  - Growth rates
  - Slash left in forest
  - Volume logged
- Determine decomposition rates
- Assess wood products
  - Quantity
  - Type
  - Turnover
- Simulate over 2-3 rotations

Accounting model for changes in forest management: logging to conservation



Carbon stocks over time for with and without project

Inputs to accounting model for changes in forest management

Empirical data from project area—based on measurements

Activity	Conservation of forest by prevention of logging		
	Area suitable for logging		ha/yr
Inputs	Area harvested per year		ha/yr
	Amount of abovground biomass in forest		t/ha
	Slash		t biomass
	Total biomass removed = slash plus extracted wood		t/ha.yr
	Decomposition rate of wood		per year
	Decomposition rate of wood		per year
	Fraction biomass removed		
	Fraction converted to wood products		
	Wood product decomposition rate		per year
	Regrowth rates: period 1		t/ha.year
	period 2		t/ha.year
	period 3		t/ha.year
	Rotation period		years

Can these activities make a difference?

Global estimates of the potential amount of land available and potential amount of C that could be sequestered and conserved by forest management practices on this land between 1995 to 2050.

Latitudinal belt	Practice	Area (Mha)	C sequestered & conserved (billion tons)	
Boreal	Forestation	95	2.4	
Temperate	Forestation	113	11.8	
	Agroforestry	7	0.7	14
Tropics	Forestation	67	16.4	
	Agroforestry	63	6.3	
	Regeneration	217	11.5-28.7	
	Slow deforestation	138	10.8-20.8	46-73
Total		**700**	**60-87**	

*The amount of C conserved and sequestered here is equivalent to 12-15% of the business-as-usual fossil fuel emissions over the same time period

From Brown et al. 1996, Second Assessment Report of IPCC; Kauppi and Sedjo 2000, Third Assessment Report, IPCC

Multiple Additional Environmental Benefits

- Co-Benefits
  - Water
    - Watershed Integrity
    - Water Quality
    - Reduced Non-Point
  - Flood Control
    - Reduced Cost for Insurance
    - Reduced Flood Damage
    - Reduced Non-Point
  - Biodiversity
    - Endangered Species
    - Parks and Reserves
    - Wetlands
    - Streams
    - Expanded Habitat
  - New Income Sources
    - Non-timber forest products
    - Tourism
    - Forest Products
    - Water Supply

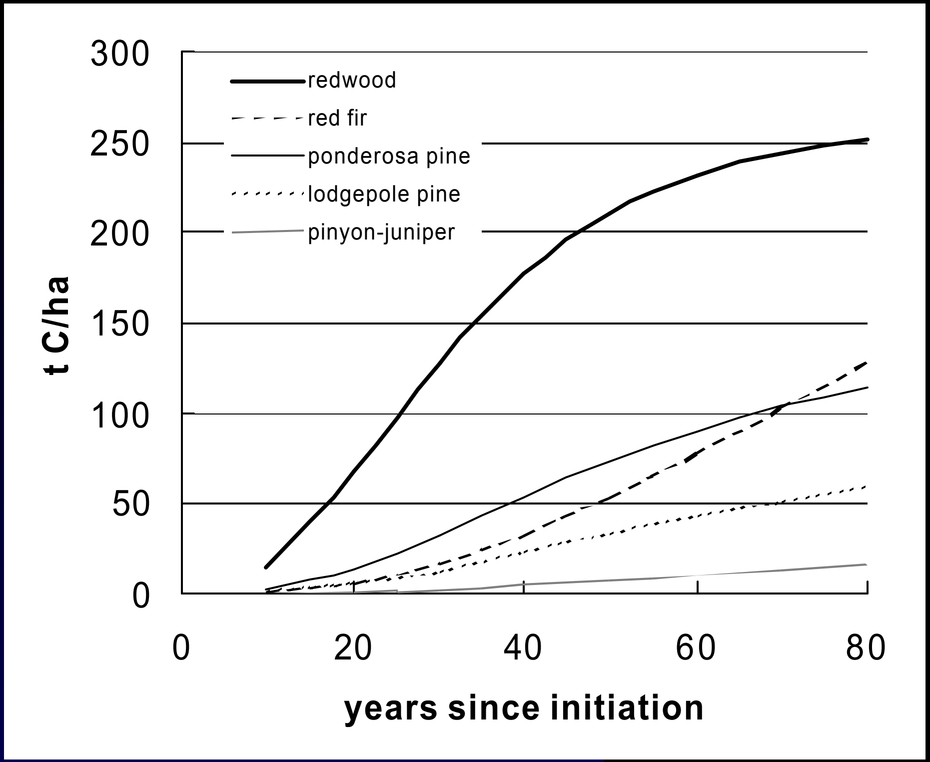
Project Issues

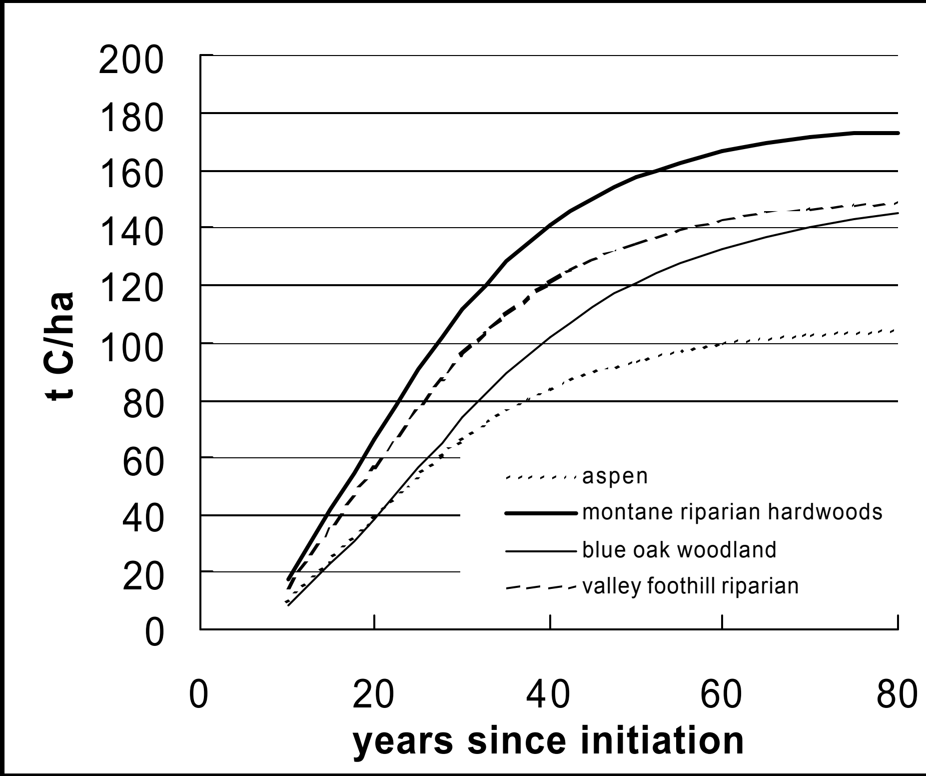
- Baselines
- Leakage
- Reversibility (Permanence)
  - Duration
  - Risk of Loss
- Additionality
- Measurement and Monitoring

Baselines

- Setting a baseline requires projecting future activities in the absence of a project
- Baseline has two components—land use/cover and corresponding carbon
- Land use component:
  - for afforestation activities simplest approach is a base year
  - for changes in forest management, need projection of practices prior to a base year
  - for conservation from threat of deforestation, need projection of existing practice into future (how far?)

Growth Curves





Leakage

- Leakage is the unanticipated loss or gain in carbon benefits outside of the project's boundary as a result of the project activities
  - Carbon emissions from leakage could offset gains from a carbon project, resulting in a reduction of the carbon "credits"

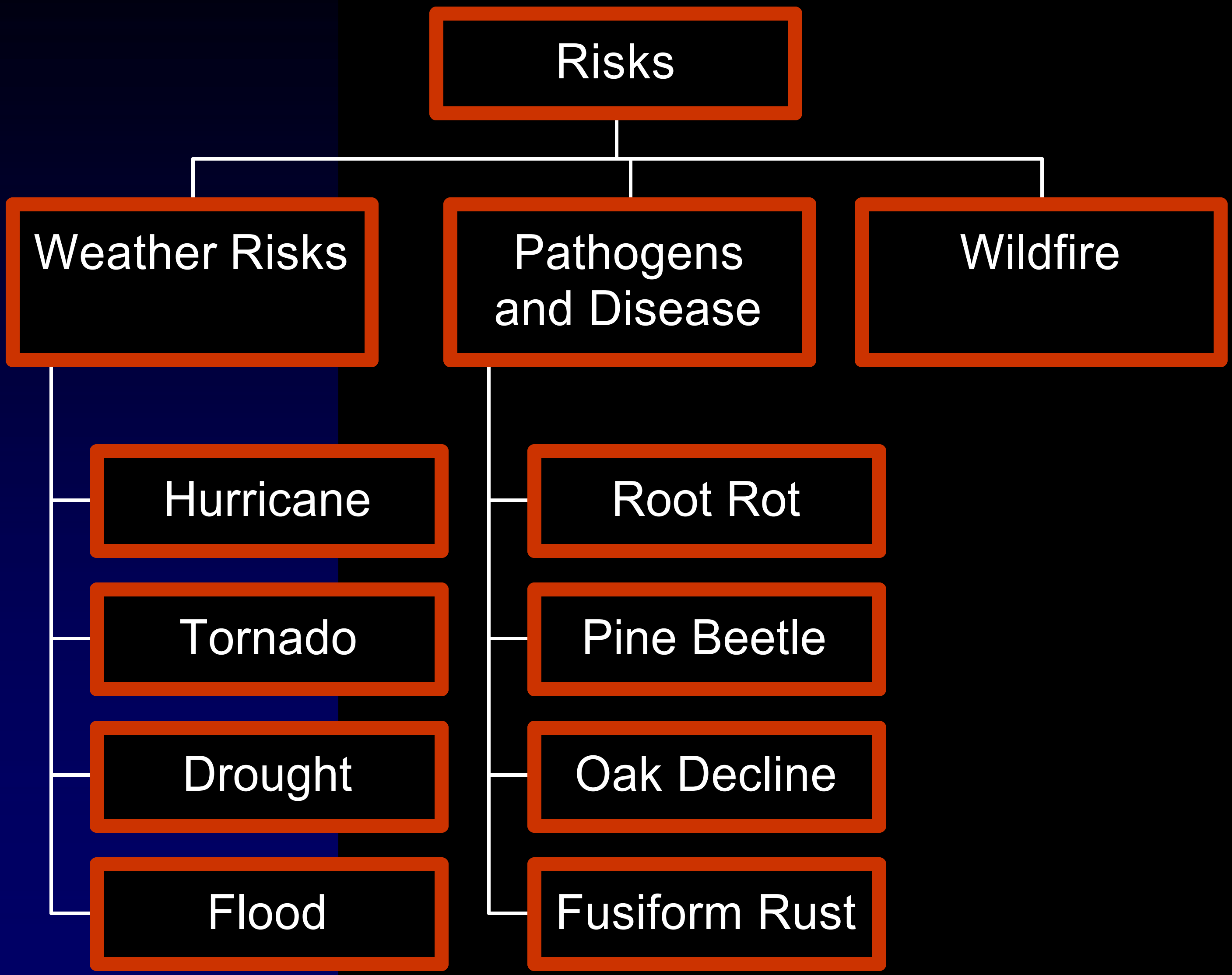
Leakage can be divided into two types:

- Activity shifting occurs when the activity causing carbon loss in the project area is displaced outside project boundary—primary leakage
  - e.g. stopping logging at one site may stimulate logging at another site.
- Market effects occur when project activities change supply and demand equilibrium—secondary leakage
  - e.g. if demand is unmet because a project reduces supply (timber supply) or it increases demand (plantation projects may depress the price of wood, causing nearby plantations to be replaced with low-biomass land uses).
  - e.g. a reduction in price of timber may reduce pressure on native forests for timber supply, in essence having a spillover effect

Duration and Risk of Loss (Permanence)

- Land-based systems are subject to reversal by human and natural disturbances
- Risk increase with project duration
  - Credits can be permanent or temporary
- Risk of loss
  - Quantify potential loss for range of risks
  - Manage risk with insurance methods internal or external to the project

Risks


Risks
Weather Risks
Pathogens and Disease
Wildfire
Hurricane
Tornado
Drought
Flood
Root Rot
Pine Beetle
Oak Decline
Fusiform Rust

Additionality

- A project activity is additional if the activity would not have taken place in the absence of the sale of carbon credits
  - Financial additionality
  - Environmental additionality

Decide which carbon pools to measure and monitor

- Carbon pools: aboveground biomass, belowground biomass, litter, dead wood, and soil organic carbon
- Can choose not to monitor all of them if evidence provided that they are not a source of GHG
  - E.g. soil can be more expensive to measure and changes are often small and in an afforestation activity on degraded lands soil is unlikely to be a source of GHGs

Which carbon pools to include in a project?

Project type	**Carbon pools**						
	Live biomass			Dead biomass			Wood
	Trees	Understory	Roots	Fine	Coarse	Soil	products
Avoid emissions							
•Stop logging and protect	**Y**	M	R	M	**Y**	N	**Y**
•Change forest management	**Y**	M	R	M	**Y**	N	**Y**
Sequester carbon							
•Restore native forests	**Y**	M	R	R	**Y**	R	N
•Plantations for timber	**Y**	N	R	M	M	R	**Y**
•Agroforestry	**Y**	**Y**	R	N	N	R	M
•Short-rotation plantations	**Y**	N	M	N	N	**Y**	*

*Stores carbon in unburned fossil fuels
Y=yes, R=recommended, M=maybe, N=not recommended

No "one size fits all"—different project types can select to measure different pools

Modified from IPCC Special Report on LULUCF/Draft GPG

Questions or Comments:

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