WESTCARB Annual Business Meeting

Carbon Market Opportunities for Terrestrial Sequestration?

John Kadyszewski
Director, Innovation Investment Program
Winrock International
jkadyszewski@winrock.org

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Summary

- Definition
- Status of Carbon Markets
- Project Options
- Project Issues

Carbon Market Volume and Value

Market	Volume $MtCO_2e$		Value $US million	
	2006	2007	2006	2007
OTC Voluntary	14	42	59	258
CCX	10	23	38	72
Total Voluntary Market	24	65	97	330
EU ETS	1044	2061	24,436	50,097
CDM	562	791	6249	12,877
Other	36	66	366	723
Total Regulated Market	1642	2918	31,051	63,697

Source: Ecosystem Marketplace, New Carbon Finance, World Bank, 2008

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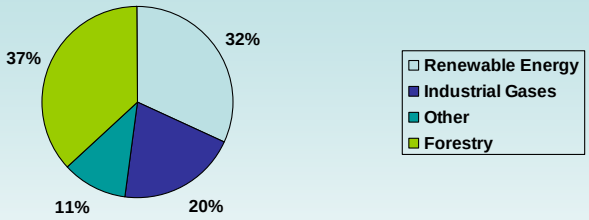
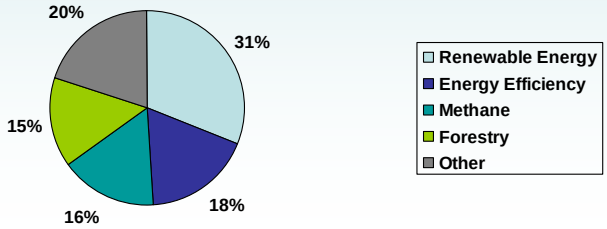
Sources of Carbon Offsets in the OTC Market

2006



2007



Source: "*Forging a Frontier: State of the Voluntary Carbon Markets 2008*," Hamilton et al., May 2008.

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Market Trends

- Private businesses purchased more than 75% of the offsets sold in the voluntary OTC market in 2007
- Most offsets are retired to meet voluntary commitments
- ***Forestry projects accounted for about 25% of voluntary OTC offsets in 2007 in the U.S.***
- ***Renewable energy and forestry offsets have received the highest average prices ($7-8/ton)***
- North America is no longer the largest buyer of voluntary credits
- Around half of voluntary purchases were verified to a third-party standard

Market Prices for Carbon Offsets Vary Widely

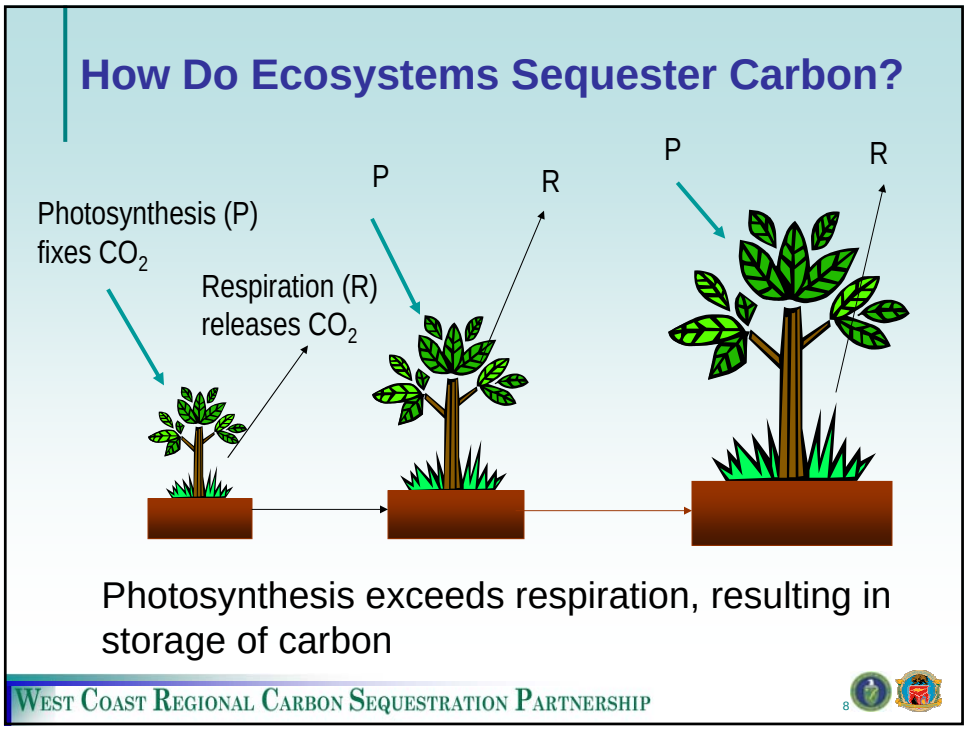
Type	Price ($/tCO$_2$e)
CDM	20 – 44
VGS VERs	14 – 29
VCS	7 – 22
VER+	7 – 22
CCX	1.8 – 4.5
Other Voluntary	5 – 12

Price estimates courtesy of:

American Carbon Registry

Non-profit voluntary registry operated by the Environmental Resources Trust at Winrock International


Photo from Union Lumber Company Collection, Andrews 1965

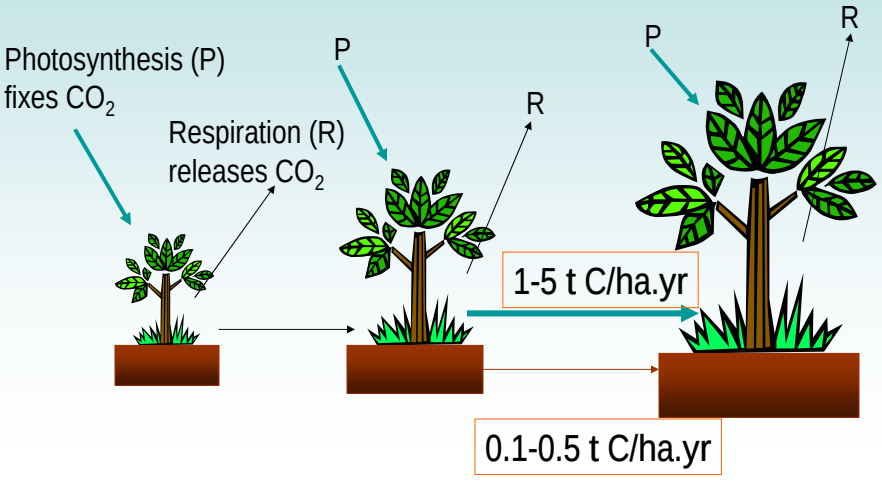

How Do Ecosystems Sequester Carbon?
Photosynthesis (P) fixes CO_2
Respiration (R) releases CO_2
P
R
P
R
Photosynthesis exceeds respiration, resulting in storage of carbon
West Coast Regional Carbon Sequestration Partnership
8

Where Is Carbon Sequestered?

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

"Carbon Pools"

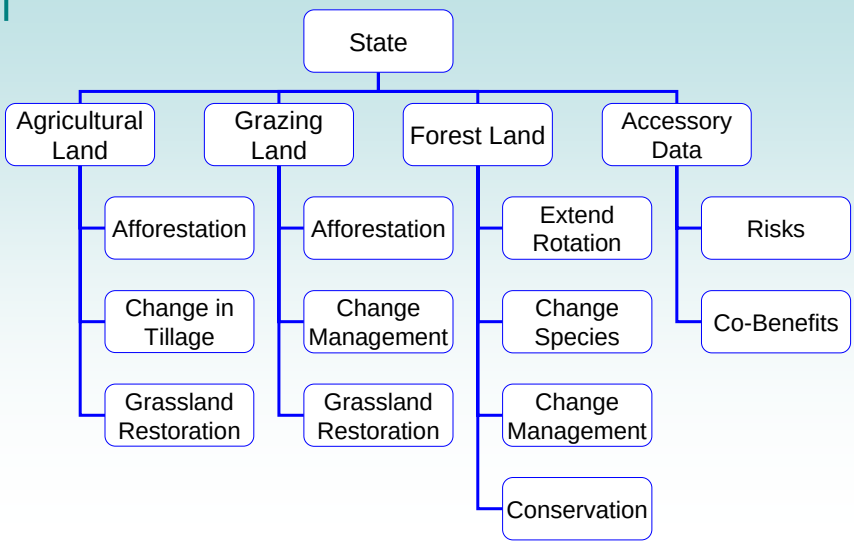
At What Rate Does Carbon Accumulate?



What Is a Terrestrial Carbon Sequestration Project?

- Activity focused on ecosystems resulting in less greenhouse gases (primarily CO_2) in the atmosphere
  - Avoid new emissions
  - Remove CO_2 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



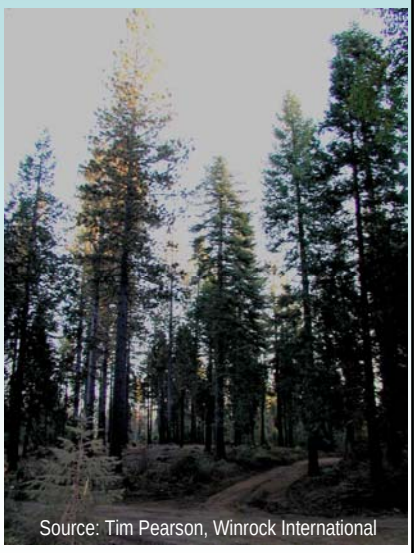
Conserve Forests


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


Source: Tim Pearson, Winrock International

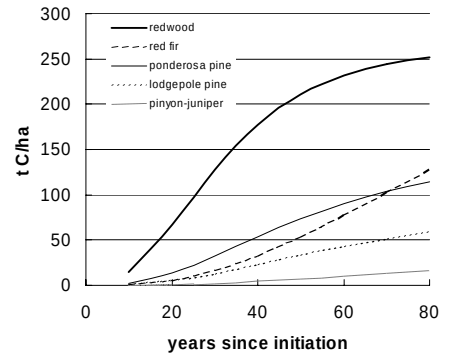
Mixed Conifers

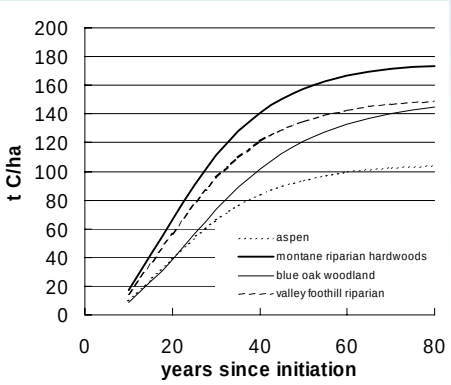
Reforest Degraded Land

- Rate of Carbon Sequestration for Douglas Fir
  - 5 tC/ha yr x 20 yrs
  - =100 tC/ha

Source: Tim Pearson, Winrock International

Growth Curves





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

9 years diameter growth

Source: Jon Johnson, Associate Professor
Washington State University

Fuels and Fire Management

Not all fires are the same

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

Change Logging Practices

30 Mg C/ha living biomass removed → 15.6 Mg C/ha slash (non stemwood + collateral mortality) → Oxidized at 8% per year

30 Mg C/ha living biomass removed → 14.4 Mg C/ha stemwood extracted → 6.8 Mg C/ha oxidized in near term (bark, sawdust, short-lived products)

14.4 Mg C/ha stemwood extracted → 7.6 Mg/ha derived LWPs (paper and sawn wood in long-term use) → Oxidized at 1% per year

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Change Forest Management

Source: Tim Pearson, Winrock International

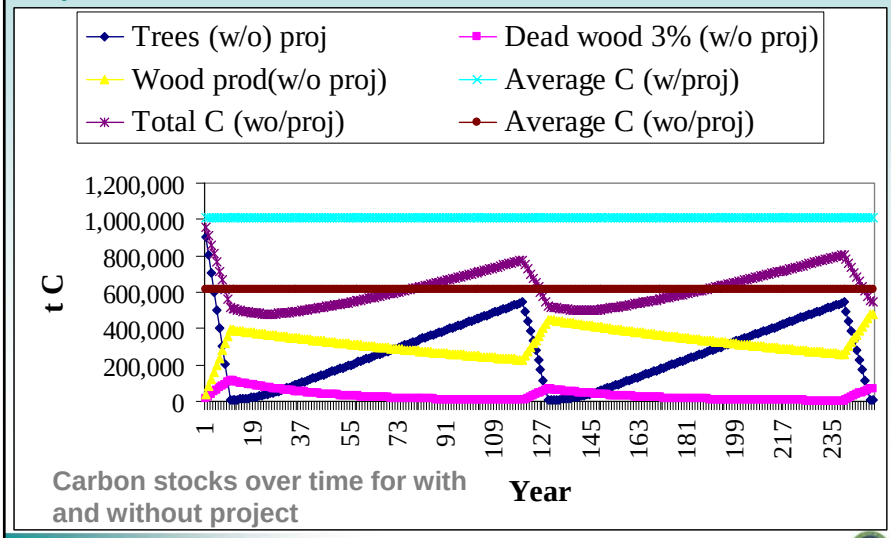
- Rotation length
- Slash left in forest
- Volume logged
- Determine decomposition rates
- Assess wood products
  - Quantity
  - Type
  - Turnover
- Simulate over 2–3 rotations

Inputs to accounting model for changes in forest management

Empirical data from project area—based on measurements

Inputs	Area suitable for logging	ha/yr
	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

Accounting model for changes in management: logging to conservation



Carbon stocks over time for with and without project

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

Project Issues

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

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"

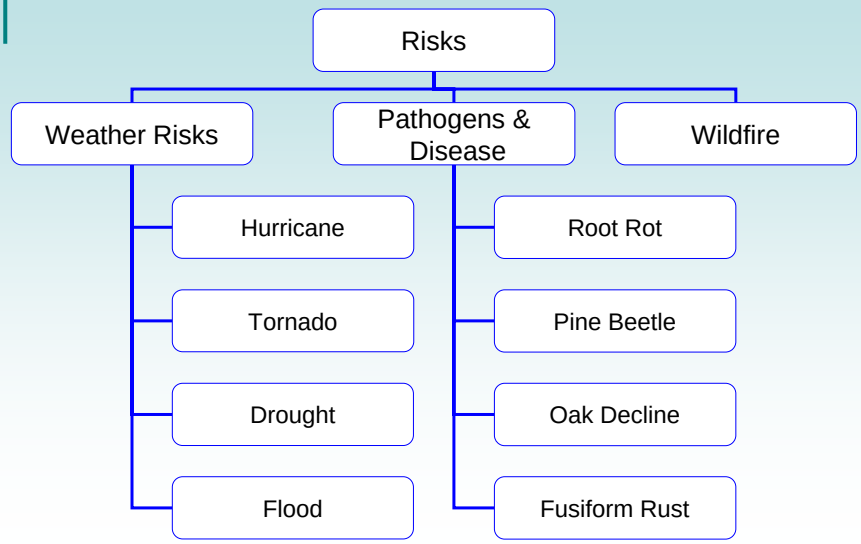
Leakage can be divided into two types

- Activity shifting occurs when the activity causing carbon loss is displaced outside the project boundary
- Market effects occur when project activities change supply and demand equilibrium

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



Contact info

John Kadyszewski
Winrock International
(703) 525-9430, ext. 618
jkadyszewski@winrock.org