New Markets for Northeastern Forest Owners?
An intro to Ecosystem Markets

John S. Gunn, Ph.D.

Research Assistant Professor of Forest Management

Dept. of Natural Resources and the Environment

NH Agriculture Experiment Station

UNH Cooperative Extension

Northeast Silviculture Institute for Foresters
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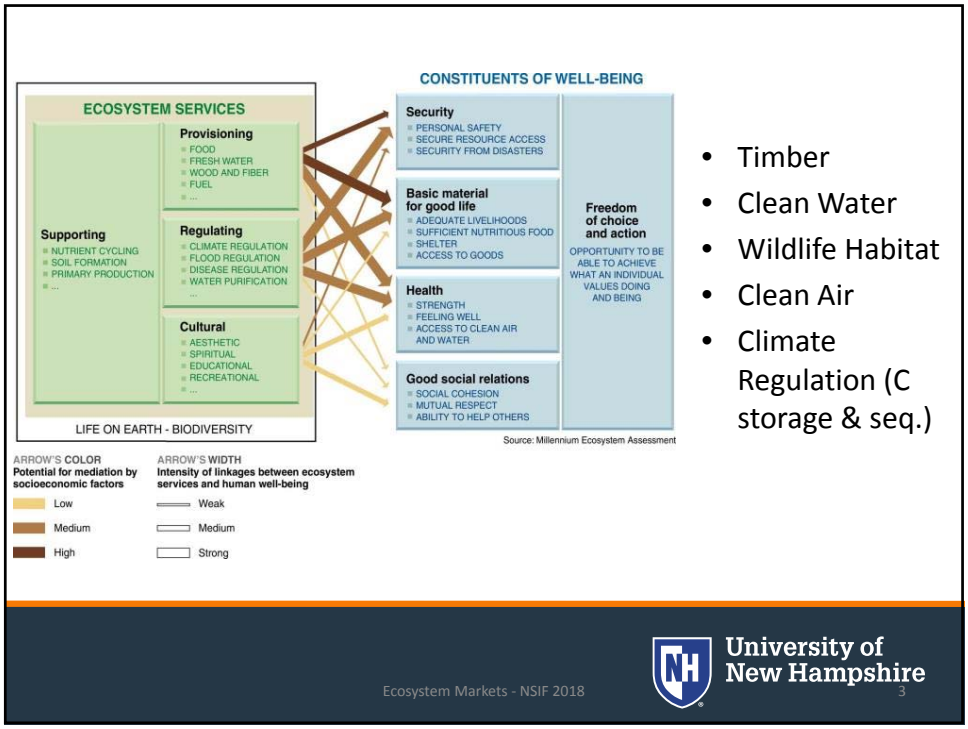
Outline

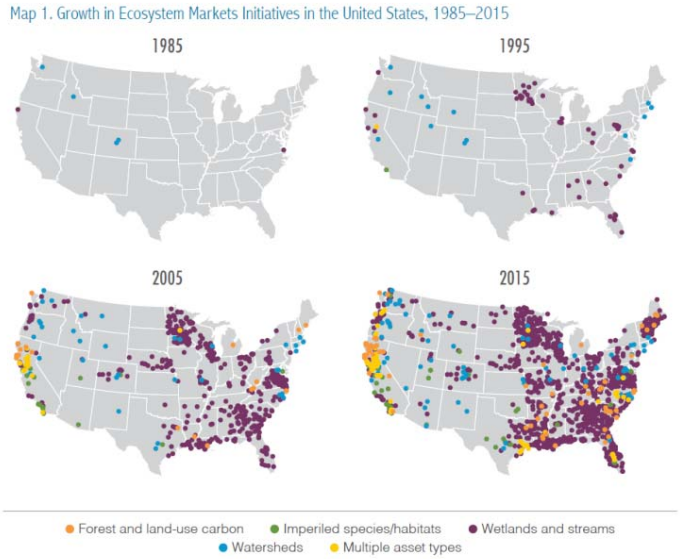
- What are Ecosystem Services?
- Ecosystem Markets
  - What needs to be in place?
  - What markets are there?
    - Water, Carbon (but really just carbon)
- Carbon Markets 101
  - Silviculture and C



- Timber
- Clean Water
- Wildlife Habitat
- Clean Air
- Climate Regulation (C storage & seq.)

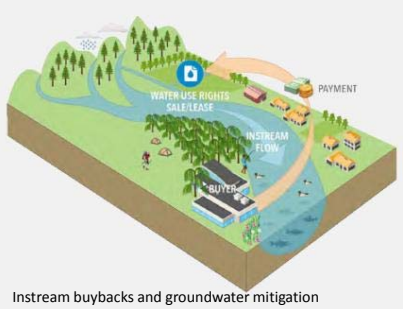
Elements of Ecosystem Service Markets

- Clear identification of a "**beneficiary**" (buyer)
- Clear Drivers create "**demand**"
- Clear identification of a "**seller**"



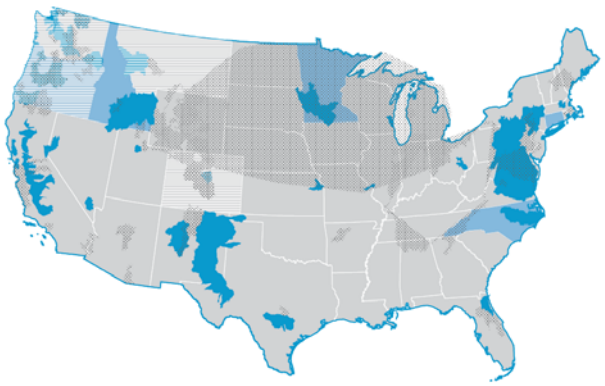
Types of Watershed Markets

Water quality trading & offsets



Instream buybacks and groundwater mitigation

Map 6. Watershed Markets Distribution in the United States



Watershed markets by scale and driver type

- State-scale compliance watershed markets (7)
- State-scale voluntary watershed markets (5)
- Regional-scale compliance watershed markets (42)
- Regional-scale voluntary watershed markets (45)
- National-scale voluntary watershed markets (2)

Water Quality ES Marketplace

Sellers

Users
- Water District/Utility
- Rate Payers
- PWD Stewardship Incentive Fund
- Recreation
- Industry
- Ground Water Users

NRCS
- EQIP
- Dedicated Pool

State/Town
- Current Use Tax
- Zoning/TDR

Mitigation Funds
- In-Lieu Fee Compensation Program (ME DEP/TNC)

Buyers

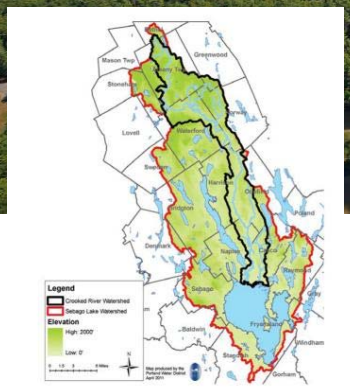
1. Failure: 200,000 free riding consumers (also the beneficiaries)
2. Demand Drivers: Safe Drinking Water Act, EPA filtration exemption
3. Market Challenge: 190 mi^2 ; 82% forested (mostly private FF owners)

Green vs. Gray Investments

Figure 3 | Preliminary Analysis for Portland, Maine—Optimistic Scenario ($ millions)

SEBAGO CLEAN WATERS

PROTECTING OUR CLEAN WATER BY CONSERVING OUR FORESTS

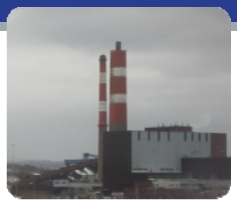


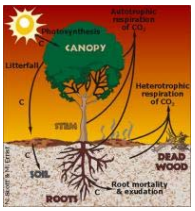
Carbon Offsets

- "real, verifiable, additional, and permanent"
- Voluntary Markets
- Compliance Markets

What Is A Carbon Offset?

A carbon offset is a reduction in greenhouse gas emissions, or an increase in carbon sequestration, used to neutralize or cancel out an equivalent amount of emissions. Offsets are a tradable commodity generated by one party and sold to another party looking to offset its emissions. One offset is equal to one metric ton of carbon dioxide equivalent—the amount of carbon dioxide emitted by consuming 112 gallons of gasoline.





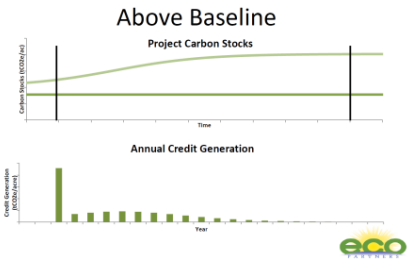
Navigating the Carbon Offset World

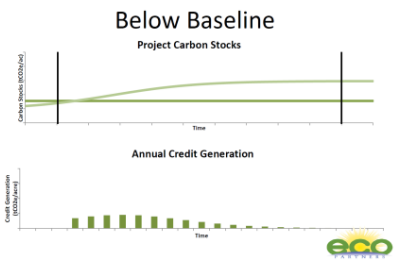
Relevant US Standards

1. Verified Carbon Standard **(VCS)**
2. California Air Resources Board **(ARB)**
3. American Carbon Registry **(ACR)**
4. Climate Action Reserve **(CAR)**

Baselines and Additionality

Generating Credits





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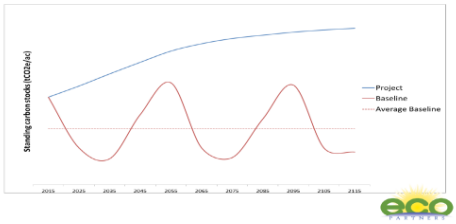
Project-Specific Baseline

- maximize net present value (NPV) of perpetual wood products harvests

Improved Forest Management



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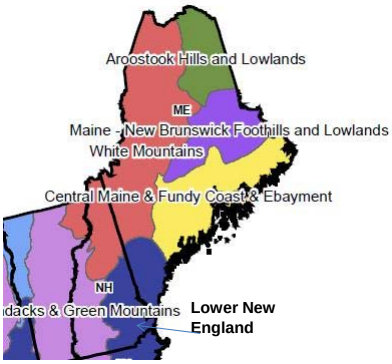
Stocks and Flows

- Stocks – how much C is stored in a given acre of forest?
- Flow – what is the rate of accumulation?
- Depends on: Site Class; Forest Type; Development Stage; Current Management; Mgmt & Disturbance History

Some Notes On Units

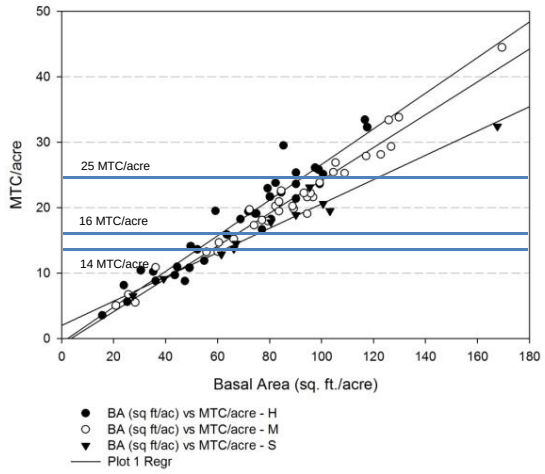
- Green Tons (green cord = 3,000 – 5,500 lbs)
- Dry Tons = ½ green ton weight
- **Carbon (C) = ½ dry ton weight (or ¼ green ton weight)**
- Metric Tons (MT) = 2,204 lbs
- Metric Tons Carbon Equivalent (MTCO2e) = MTC *X* 44/12 (3.667) - **Credits based on this #**
- Biomass volume generally calculated using allometric scaling equation

Stocks in Context



Ecoregional Supersection	Common Practice - Above Ground Carbon Mean in Metric Tonnes/acre (BA)	Range (depends on site class, forest type)
Lower New England - Northern Appalachia	**25 (111)**	**16-32**
Maine - New Brunswick Foothills and Lowlands	14 (97)	7-22
Central Maine & Fundy Coast & Ebayment	16 (103)	11-23
Aroostook Hills and Lowlands	16 (107)	7-45
White Mountains	16 (100)	11-23

Basal Area - Aboveground Live Carbon Relationship
(Western and Central Maine, Hardwood, Softwood, and Mixed Wood Stands)



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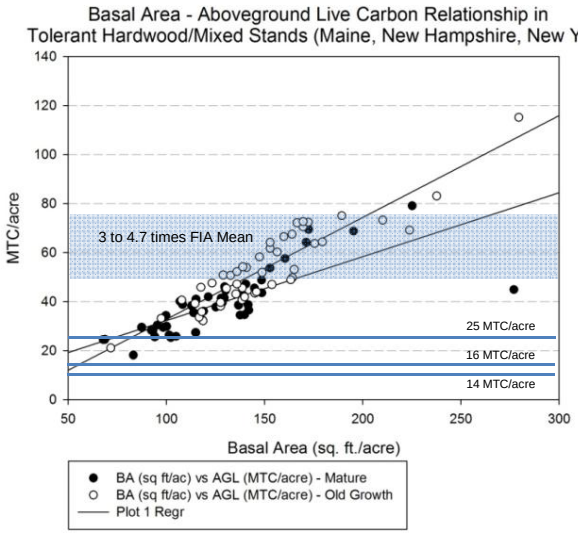
Maine Family Forest Carbon Project Data (12 landowners, 82 stands)
Western, Central, & Eastern Maine
Carbon Stocks in "Typical" Stands



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Data from: Keeton, W.S., A. A. Whitman, G.G. McGee, and C.L. Goodale. *Forest Science* December 2011. Late-successional biomass development in northern hardwood-conifer forests of the northeastern United States. Forest Science.
Mature = 80-150 yrs; Old Growth= >150 yrs
n=94

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Study	Mean AGL (MTC/ac/yr) [1]	Range
Brownfield OCSWCD	**0.30 (100 yr mean)**	**0.08 - 1.10**
Maine FF Data	**0.62 (50 yr mean)**	**0.31 – 0.71 (range of means)**
Smith et al. 2006[2] (Tol HW)	**0.53 (125 yr mean)**	**0.23 (120-125 yrs) to 0.99 (5-15 yrs)**
Smith et al. 2006 (Spr/Fir)	**0.41 (125 yr mean)**	**0.26 (120-125 yrs) to 0.56 (5-15 yrs)**
Smith et al. 2006 (Oak-Pine)	**0.52 (125 yr mean)**	**0.23 (120-125 yrs) to 0.88 (15-25 yrs)**

Maine C Accumulation Rates

[1] Multiply by 3.667 for $MTCO_2e$
[2] USDA Forest Service GTR-343

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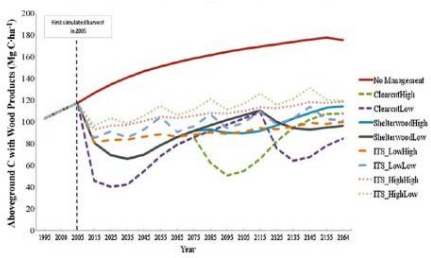
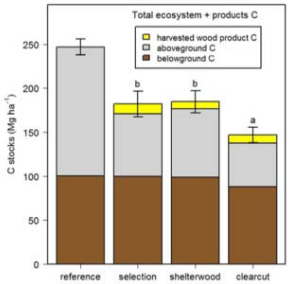
Silviculture & Carbon

- "improved forest management"
  - Greater within-stand retention
  - Uneven-aged management (where appropriate)
  - Set-asides/reserve areas
  - Extended rotation (even- and uneven-aged systems)

Silviculture & Carbon



Nunery & Keeton, 2010. Forest carbon storage in the northeastern United States: net effects of harvesting frequency, post-harvest retention, and wood products. Forest Ecology & Mgmt.



Puhlick, J.J. et al., 2016. Long-term influence of alternative forest management treatments on total ecosystem and wood product carbon storage. Canadian Journal of Forest Research

Structural Complexity Enhancement

Treatment	Target residual basal area (m^2/ha)	Max diameter (cm)	*q*-factor	Structural objective	Silvicultural prescription
SCE	34	90	2.0/1.1/1.3	Re-allocation of basal area to larger size class	Rotated sigmoid diameter dist. High max d and target basal area Retention of trees >60 cm dbh
				Vertically differentiated canopy	Single-tree sel. with target diameter dist. Release advanced regeneration
				Growth acceleration of larger trees	Full (three- or four-sided) and partial (two-sided) crown release
				Elevated coarse woody material inputs for added structure	Tree girdling/felling and leaving trees

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Enhanced carbon storage through management for old-growth characteristics in northern hardwood-conifer forests

Sarah E. Ford, William S. Keeton

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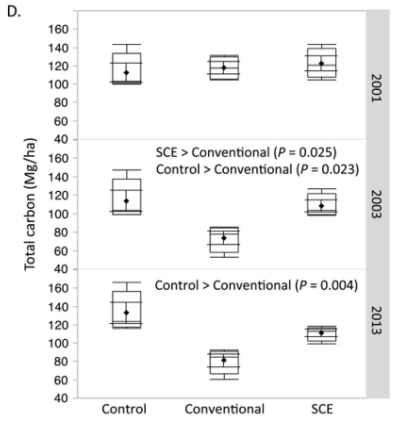

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Forest sector greenhouse gas emissions sensitivity to changes in forest management in Maine (USA)
John S. Gunn and Thomas Buchholz
Forestry, 2018

Proportion of forest area in Maine (7.1 million ha) allocated to 7 management scenarios

	Area allocated to management type (%)						
		Clearcut rotation					
Scenario	Set Aside	≥60-yr	≥100-yr	Spruce plantation	Uneven-aged	Heavy Harvest	Shelter wood
Baseline	3.72	3.85	-	0.96	23.59	23.59	44.29
Double Set Aside	7.44	3.70	-	0.93	22.68	22.68	42.58
Quadruple Set Aside	14.88	3.40	-	0.85	20.85	20.85	39.16
60-yr Clearcut	3.72	51.99	-	-	-	-	44.29
100-yr Clearcut	3.72	-	51.99	-	-	-	44.29
Uneven-aged	3.72	-	-	-	51.99	-	44.29
Heavy Harvest	3.72	-	-	-	-	51.99	44.29

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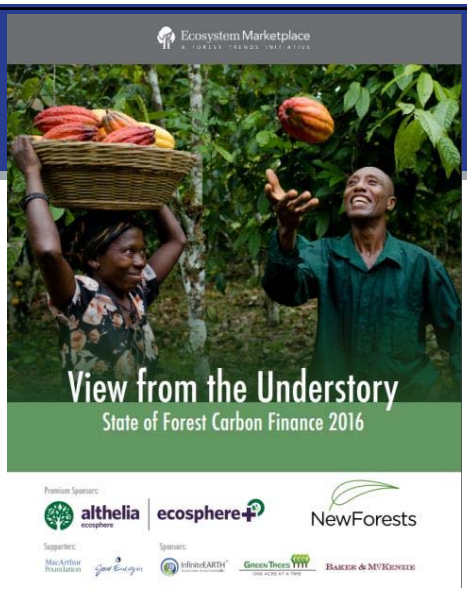
	Net % Change in Sequestration from BAU at Year 100		Net % Change in Sequestration from BAU at Year 300	
	Without Product Substitution	With Substitution	Without Product Substitution	With Substitution
Quadruple Set Aside Area	47%	4%	22%	-3%
Double Set Aside Area	16%	1%	7%	-1%
Uneven-aged	33%	14%	18%	10%
100 year Clearcut rotation	-43%	-22%	-24%	-17%
60 year Clearcut rotation	-71%	-30%	-39%	-22%
Heavy Harvest	-19%	-8%	-10%	-5%

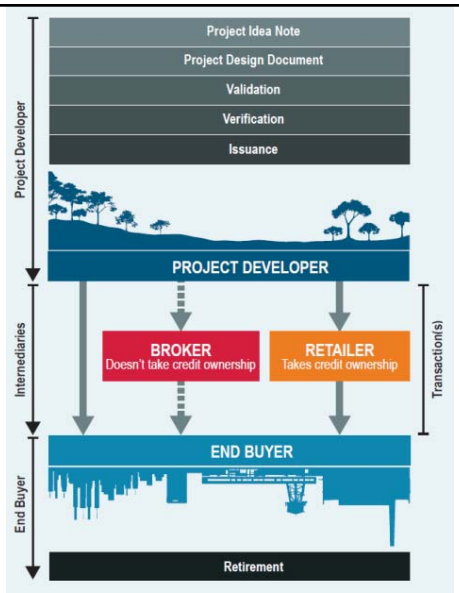
Moving C Stocks and Flows to the Offset Marketplace



California Air Resources Board (ARB)

- state agency charged with implementing California's cap-and-trade program (AB 32) since 2012
- A 100 year commitment from the date of the last credit issuance
- annual monitoring and verification at least once every 6 years.
- % of buffer credits based on risk evaluation and is reduced by the use of a qualified easement

	American Carbon Registry (ACR) v2.1	Climate Action Reserve (CAR) v3.3	Verified Carbon Standard (VCS)
Description	ACR is a non-profit U.S. carbon market registry operated by Winrock International. Eligible forest offsets include: • Afforestation/Reforestation • Improved Forest Management • Reducing Emissions from Deforestation and Degradation *40 year commitment period	CAR is a voluntary carbon offset standard that grew out of the California Climate Action Registry, a voluntary carbon market created by the State of California in 2001. Eligible forest offsets include: • Improved Forest Management • Reforestation • Avoided Conversion Currently, projects must be located in the U.S. but changes are being drafted to expand eligibility internationally. *100 year commitment period	VCS was established in 2005 and offers standards and a registry system for creating verified carbon credits throughout the world. Eligible forest offsets include: • Afforestation, Reforestation & Re-vegetation • Improved Forest Management • Reduced Emissions from Deforestation and Degradation *20 year commitment period



Process for Developing a Carbon Offset

Transaction Costs

- It is not cheap to get a project to market
- Economy of scale
- Project developers/brokers willing to "front" transaction costs
- Make forest offsets expensive relative to other categories

Transaction Costs

Category	Description/examples
Transaction Costs Associated with Credits Traded	
Credit Transaction Costs	*cost per verified tonne associated with the issuance and transaction costs at the registry*
Brokerage Fee	*cost per verified tonne associated with finding a buyer using a brokerage service*
Insurance Cost	*insurance premium in lieu of a buffer pool for first verification (periodic as well)*

Transaction Costs

Category	Description/examples
Annual Costs	
Annual Reporting Costs	*internal time and registry fees*
Annual Membership Fee	*registry fees*
Post-Project Monitoring Costs Associated with Monitoring Cycle	
Periodic Monitoring Cost	*internal field and office time*
Post-Project Periodic Monitoring Costs	*Internal field and office time*
Other Costs/Deductions	
Project Ending Costs	*account closing fees*
Inventory Deduction	*e.g., if > ±10% of the mean at 90% confidence interval*
Buffer Pool	*generally 20% of project credits*

Revenue

- $/Credit
  - Ecosystem Marketplace Summary
  - Compliance vs. Voluntary
- Credit Volume
  - Summary of transactions in forest sector

Market Volume and Prices

Table 2: Overview of Market-based Payments for Emissions Reductions in 2013, 2014, and 2015

		Volume (tCO_2e)			Value ($ M)			Average Price ($/tonne)		
		2013	2014	2015	2013	2014	2015	2013	2014	2015
Voluntary markets		21 M	23.7 M	18.2 M	$100 M	$128 M	$88 M	$4.7	$5.4	$4.9
Compliance markets	California-Quebec cap-and-trade	1.7 M	6.1 M	6.5 M	$16 M	$55 M	$63 M	$9.4	$8.9	$9.7
	Australia carbon tax/ ERF*	1.5 M	4 M	60.7 M	$32 M	$71 M	$588 M	$20.8	$17.7	$9.7
	New Zealand ETS	–	–	1.3 M	–	–	$10 M	–	–	$3.1
Other		0.4 M	0.5 M	1.3 M	$3.9 M	$4 M	$11 M	–	–	–
Total		**24.7 M**	**34.3 M**	**87.9 M**	**$151.9 M**	**$257 M**	**$762 M**	**$35**	**$32**	**$27.4**

Volume Trends (voluntary)

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Transaction Volume Examples

Market	State	Acres	Registered Tons	Tons/acre	Notes
Voluntary (CAR)	NH	2,141	69,051	32	NEFF (Hersey Mtn)
Voluntary (CAR)	NH	141,000	1,442,576	10	TFG (CT Lakes)
Compliance (ARB)	WI	29,087	852,630	29	
Voluntary (VCS)	PA	17,591	21,770	1	annually (100 year project)
Voluntary (VCS)	PA	4,905	6,384	1	ex ante 6,384 VCUs annually and 370,301 VCUs total, after deduction of the 10% buffer.
Compliance (ARB)	ME	19,118	284,043	15	Downeast Lakes Land Trust (Grand Lake Str.)
Compliance (ARB)	ME	1,460	36,596	25	Northeast Wilderness Trust (Alder Stream)

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Making Sense of Costs and Revenue

Understanding the amount and timing of transaction costs and potential revenue is fundamental to making the decision to engage in the marketplace.

Carbon Markets in Pine-Oak-Hemlock?

- 25 properties evaluated
- Property size and C stocking determined viability
- Not viable when under "common practice" baseline" and under 12,000 acres


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California's regulatory forest carbon market: Viability for northeast landowners

Charles D. Kerchner, William S. Keeton *

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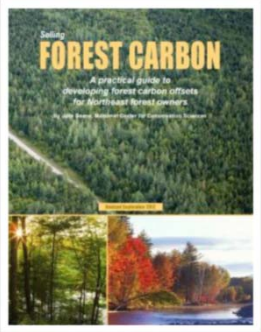

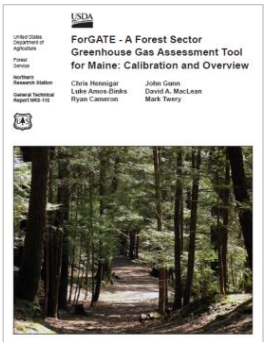

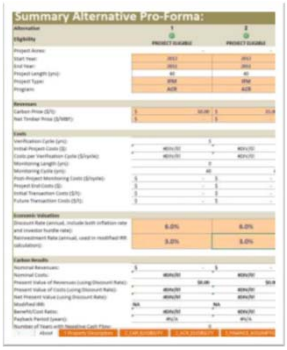

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John S. Gunn, Ph.D.
john.gunn@unh.edu