The EcoValue Project: A Web-based, Geographic Approach to the Delivery of the Economic Values of Ecosystem Services

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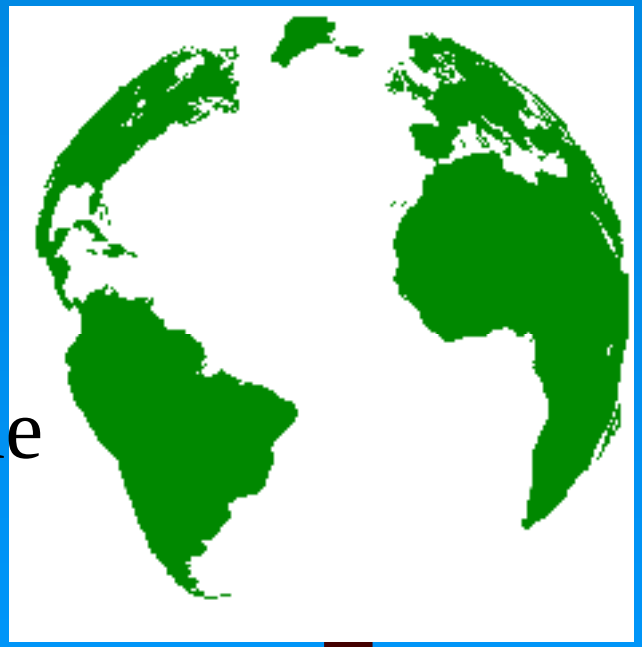
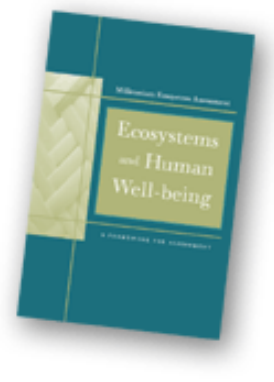
Presentation Outline

- Introduction to the Economic Valuation of Ecosystem Goods and Services
- Goals and Steps of the EcoValue Project
- Example Applications
- Limitations and Future Directions



The Ecosystem Service Concept



Ecosystem services are the benefits people obtain either directly or indirectly from ecological systems (Millennium Ecosystem Assessment 2003). They include products such as food, fuel, and fiber; regulating services such as climate and water regulation and flood control; and nonmaterial assets such as cultural or aesthetic benefits (de Groot *et al* 2002).

http://www.millenniumassessment.org

DeGroot, Wilson and Boumans 2002 "A typology for the description, classification, and valuation of ecosystem functions, goods and services" *Ecological Economics 41(3*) pp. 393-420.

Millennium Assessment (MA) 2003 Typology of Ecosystem Goods and Services

Provisioning	**Regulating**	**Cultural**
Goods produced or provided by ecosystems • food • fresh water • fuel wood • genetic resources	Benefits obtained from regulation of ecosystem processes • climate regulation • disease regulation • flood regulation	Non-material benefits from ecosystems • spiritual • recreational • aesthetic • inspirational • educational
Supporting Services necessary for production of other ecosystem services • Soil formation • Waste Treatment and Nutrient cycling • Primary production		

Adapted from Millennium Ecosystem Assessment *Ecosystems and Human Well Being* (2003)

Why Use *Ecosystem Services* as the cornerstone of the EcoValue Project?

Advantages:

- ❑ **Brings together ecological and economic concepts in a dynamic conceptual system**
- ❑ **Makes use of best-available economic tools and methods to reveal meaningful values for non-marketed environmental systems**
- ❑ **Can be used to by decision makers to evaluate tradeoffs between land use change and human values.**

Valuation Techniques used in the EcoValue Project

•**Avoided Cost** (AC): services allow society to avoid costs that would have been incurred in the absence of those services; flood control (barrier islands) avoids property damages, and waste treatment by wetlands avoids incurred health costs.

•**Marginal Product Estimation** (MP): Service demand is generated in a dynamic modeling environment using production function (i.e., Cobb-Douglas) to estimate value of output in response to corresponding material input.

•**Factor Income** (FI): services provide for the enhancement of incomes; water quality improvements increase commercial fisheries harvest and thus, incomes of fishermen.

•**Travel Cost** (TC): service demand may require travel, whose costs can reflect the implied value of the service; recreation areas attract distant visitors whose value placed on that area must be at least what they were willing to pay to travel to it.

• **Hedonic Pricing** (HP): service demand may be reflected in the prices people will pay for associated goods: For example, housing prices along the shore of pristine freshwater lakes tend to exceed the prices of inland homes.

•**Contingent Valuation** (CV): service demand may be elicited by posing hypothetical scenarios that involve some valuation of alternatives; people would be willing to pay for increased water quality in freshwater lakes and streams.

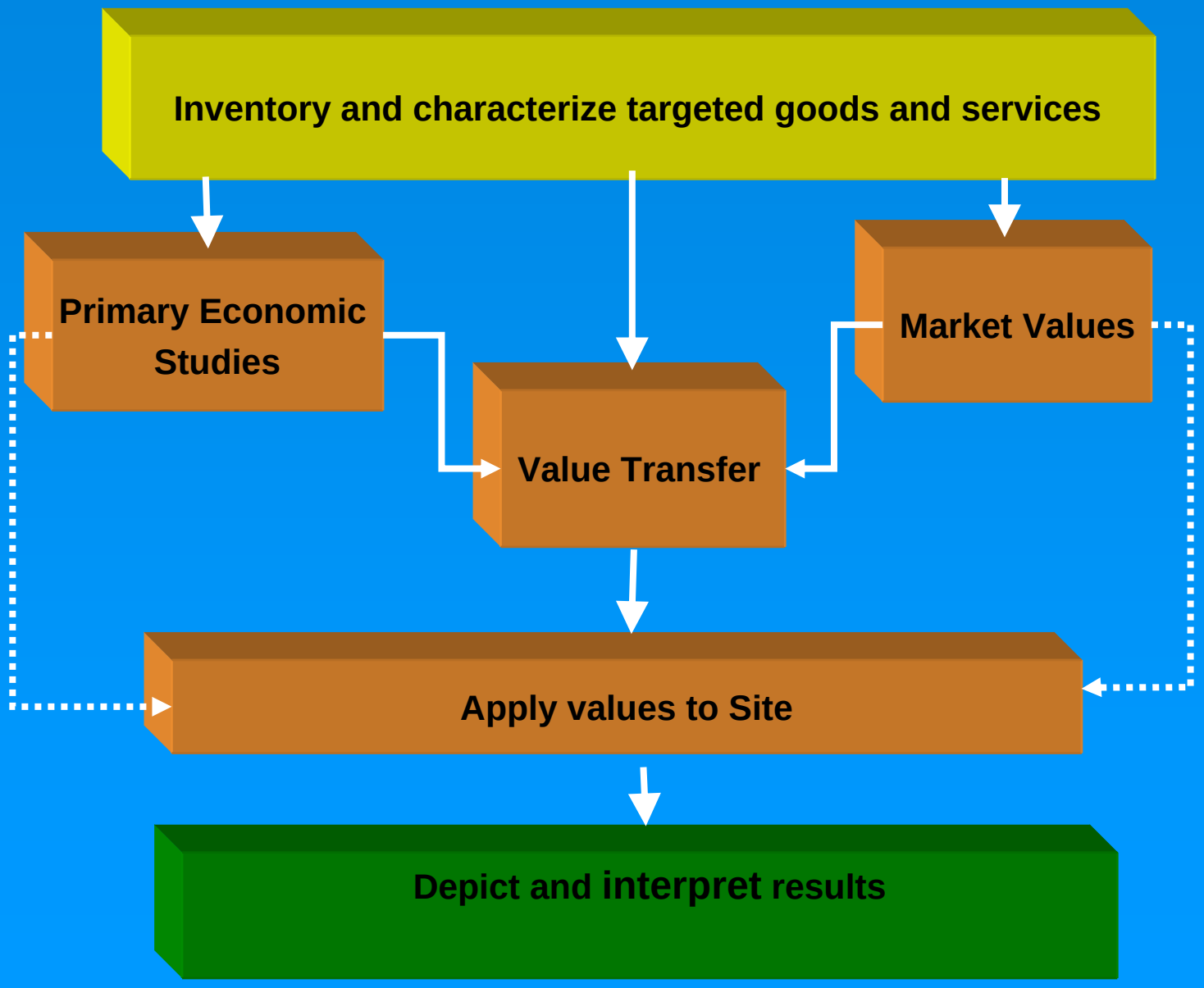
•**Group Valuation** (GV): This approach is based on principles of deliberative democracy and the assumption that public decision making should result, not from the aggregation of separately measured individual preferences, but from *open public debate*.

The EcoValue Project

Goals :

- Scaling-up economic studies using value transfer techniques
- Modifying estimates to better account for spatio-temporal context and scale
- Disseminating new information using maps and graphics to stakeholders via the web

Spatially Explicit Value Transfer

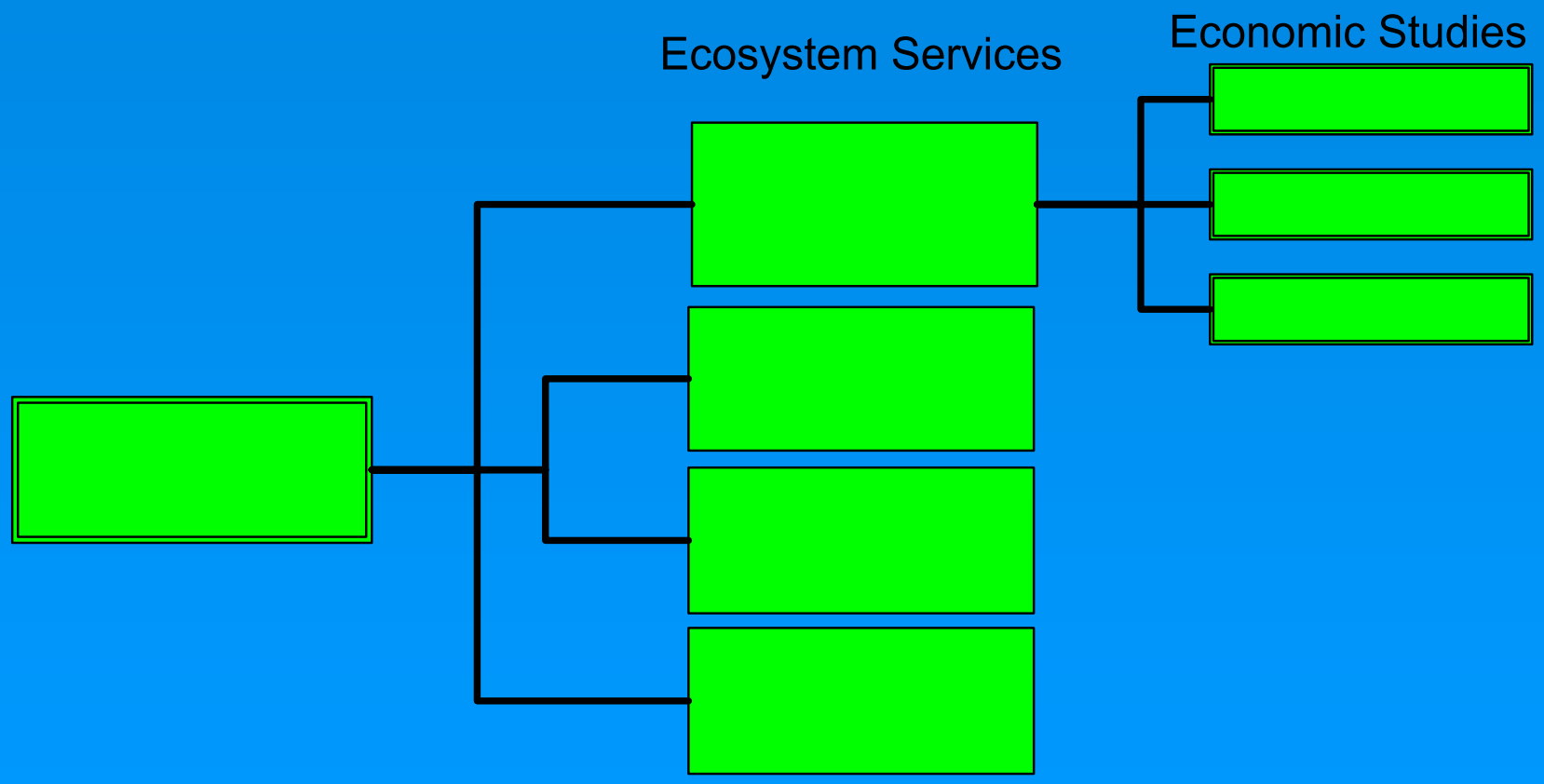


Transfer Study Selection

Current Decision rules for selecting empirical studies:

- **Published in peer-reviewed journals or books**
- **Limited to results that can readily be translated into spatial equivalencies—(i.e., per ha; per acre)**
- **Focused on regions in North America, Europe, New Zealand and Australia**
- **Focused primarily on non-consumptive resource use and ecosystem services**

Relationship Between Land Cover and Ecosystem Services



Spatial Aggregation

Value of Ecosystem Services ($ ha^{-1} per year)**:**

$$V(ES_k) = \sum_{i=1}^{n} A(LU_i) \times V(ES_{ki})$$

Where A(LUi) = Area of i^{ln} (Land Use in hectares)
and $V(ES_{ki})$ = Annual value of k^{ln} ES (Ecosystem Services) for each i^{ln} LU (in $/ha/yr).

Spatial Boundary Units Tried Thus Far:

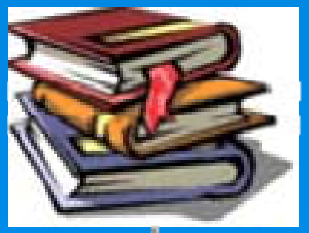
Biogeophysical

- Watersheds and Tributaries (Huc 6, Huc 8, Huc 12)
- Ecoregions

Socioeconomic

- State
- County
- Individual Property Parcels

Putting it All Together



Literature review and collection

Processing the literature into the database

MS Access Database

Integrating the literature database with spatial data in a GIS

Delivery of the values for ecosystem services via the internet

The EcoValue WebSite©

http://ecovalue.uvm.edu

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Currently, this website is designed for academic and research purposes only. Information from this site should not be used for any commercial or legal purposes. References to this site should include the following information:

Wilson, Matthew A., Robert Costanza, and Austin Troy (2004). The EcoValue Project. Retrieved from the University of Vermont EcoValue Web site: http://ecovalue.uvm.edu

The EcoValue Project's web interface

The University of Vermont

The EcoValue Project

The Northern Forest EcoValue Module

EVP Modules: Maryland | Northern Forest | New Zealand

The Northern Forest Map Viewer

This module of the EcoValue project was developed with support from the Northeastern States Research Cooperative and is intended to provide a web-accessible, GIS ecosystem valuation tool for citizens and decision makers in the northeastern States of New Hampshire, New York, Maine, and Vermont.

The ecological goods and services provided by natural systems within the northern forests are critical to the healthy functioning of the natural environment; but importantly, they also contribute significantly to human welfare, both directly and indirectly, and thus represent a significant portion of the total social and economic value of the natural landscape. When ecosystem service values are not fully accounted for, they remain outside of forest land use planning, potentially compromising the long-term sustainability of ecologically significant landscapes.

The interactive decision-support module, NF Map Viewer, is designed to provide the best available maps, graphs and figures that explain the economic value of ecosystem goods and services to researchers, decision-makers, and public stakeholders throughout the Northern Forest region. Because of its open-access design, results will cut across, and provide critical support for, several research themes listed under the Northeastern States Research Cooperative: Forest Watershed planning, Ecological and economic implications of rural-suburban transition, Conflict resolution in the N. Forest, and Shared databases.

The principal mapping unit of analysis is the watershed. Results of all queries using the Map Viewer are downloadable in both spreadsheet and graphic interchange formats so that the information can be readily used.

General Information
- The EcoValue Project
- Welcome to the Northern Forest Module
- NF Map Viewer

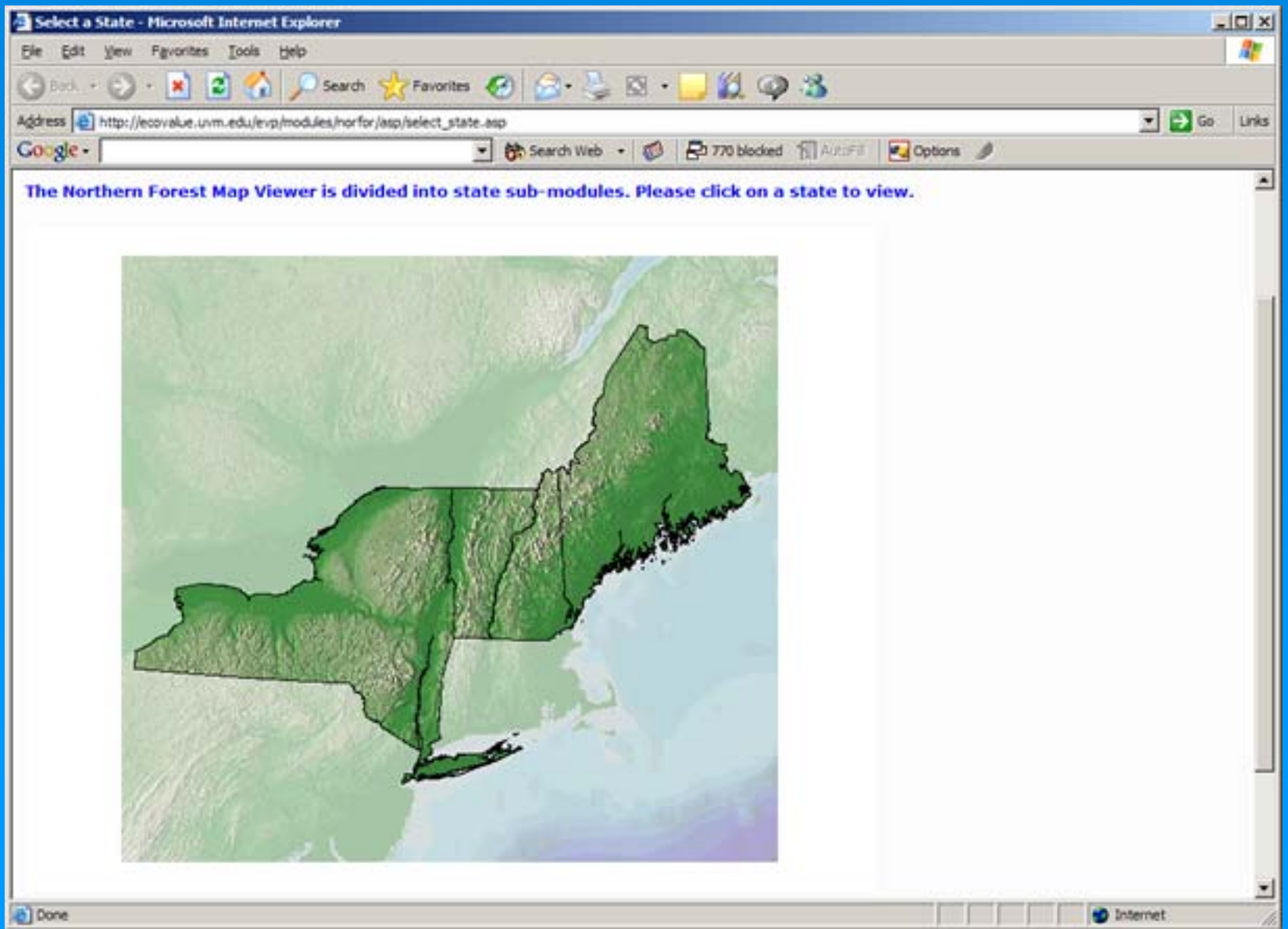
Valuation
- Land Cover/Services Crosswalk Table
- Land Use / Land Cover Definitions
- Ecosystem Services Definitions

Papers and Links
- NF EVP Proposal
- NF Links

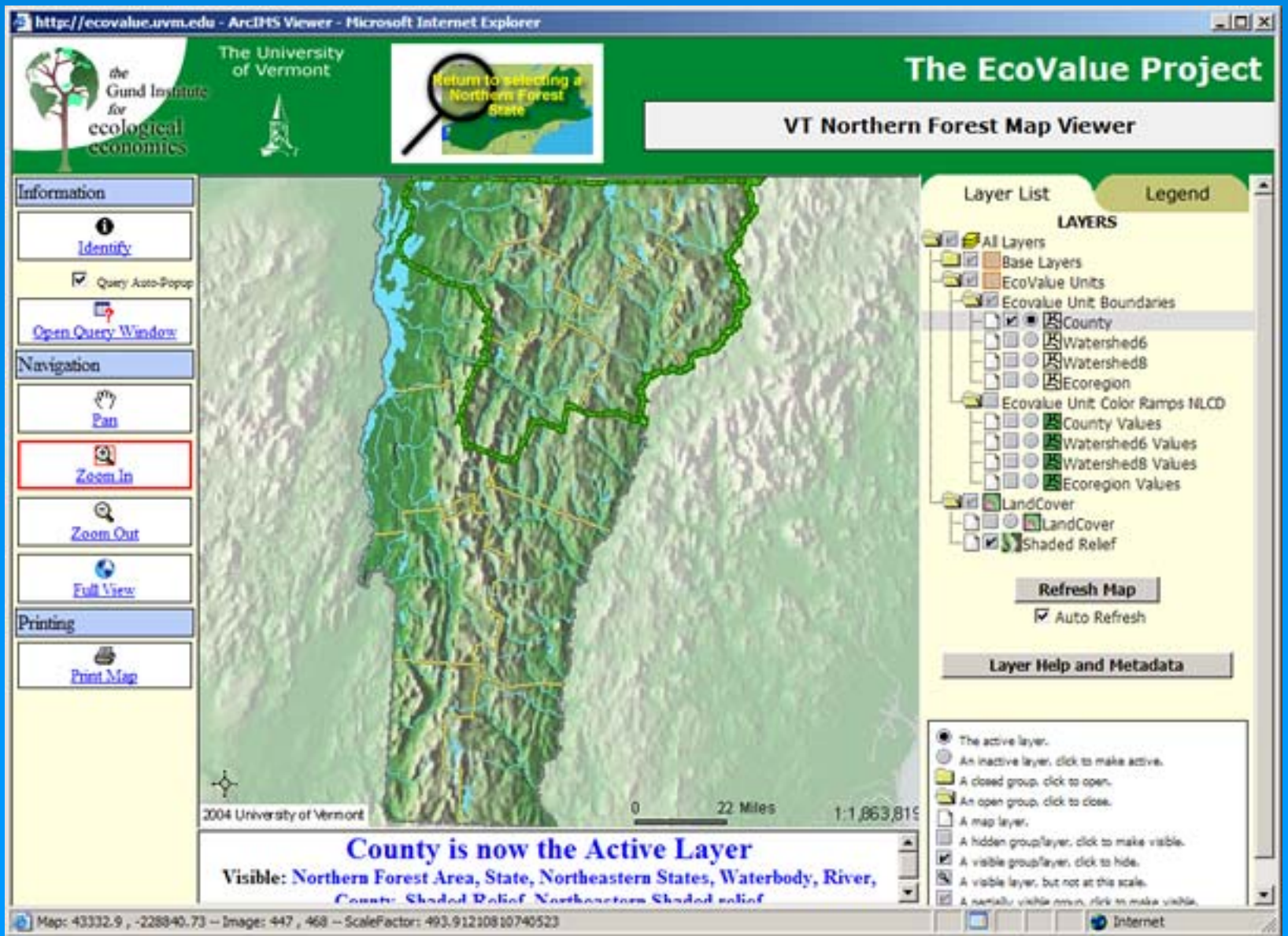
Contact Info

Acknowledgment:
The northern forest module of the EcoValue Project was developed with support from the Northeastern States Research Cooperative.

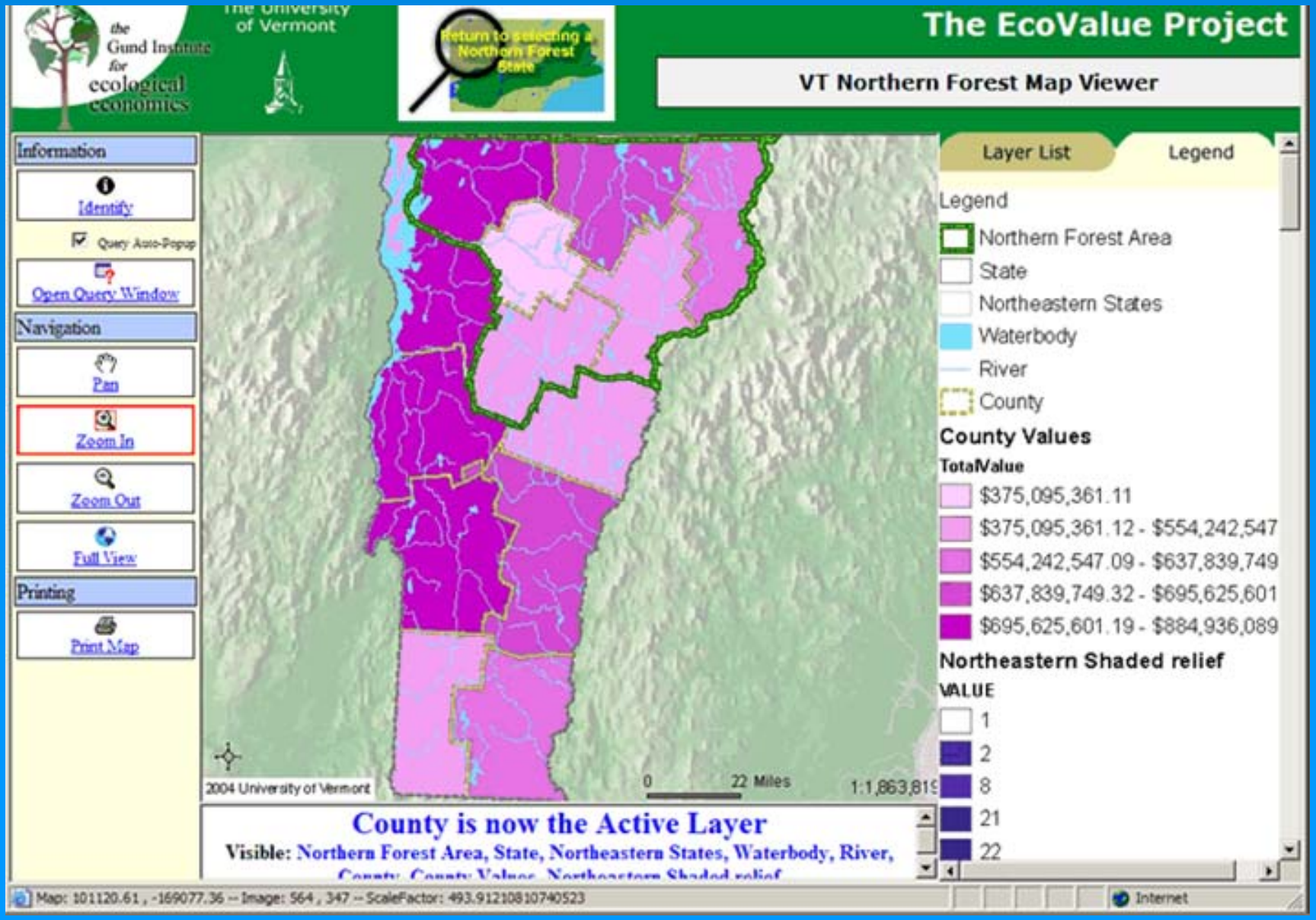
Select a state in the northern forests



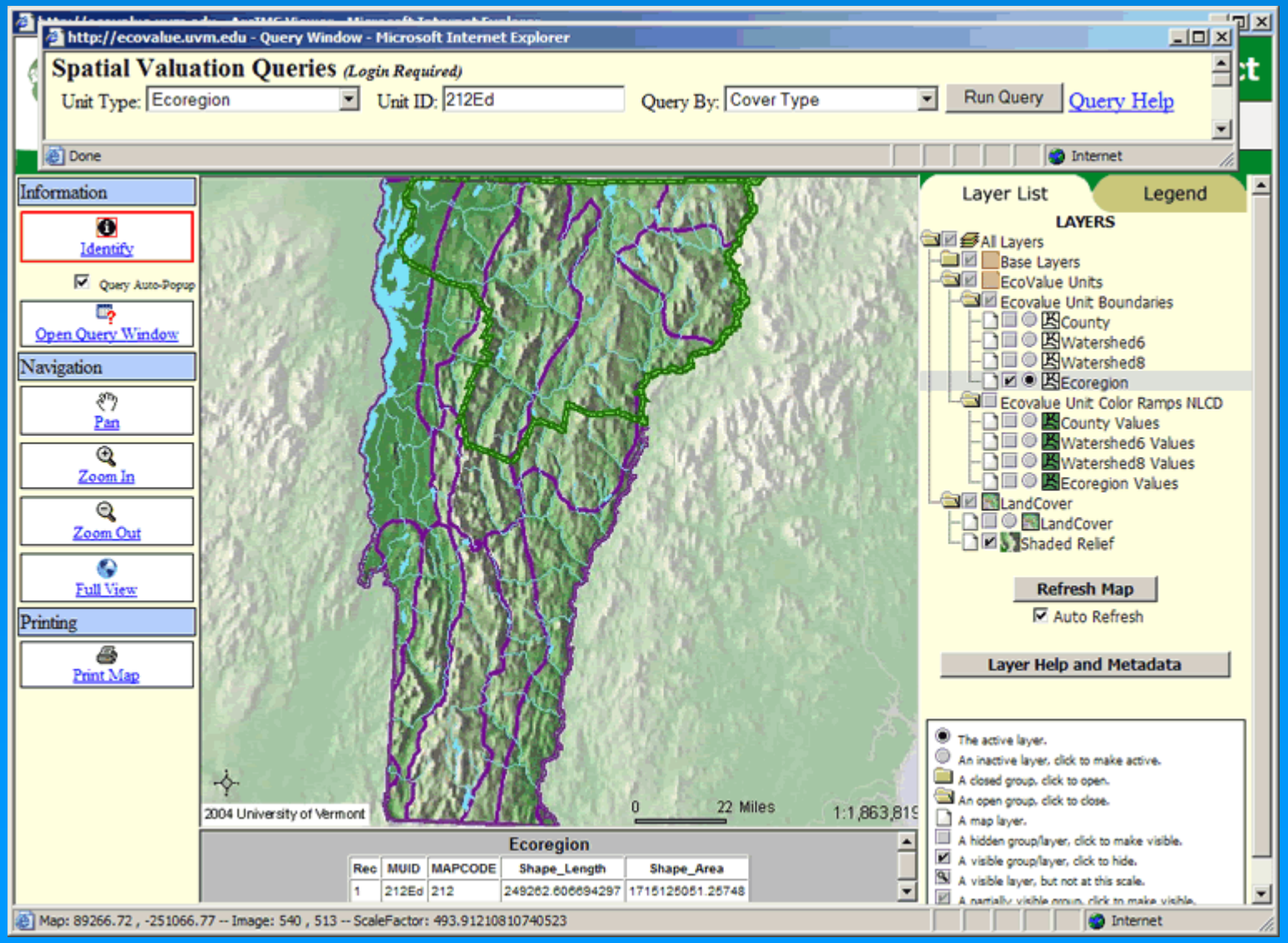
Vermont Map Viewer



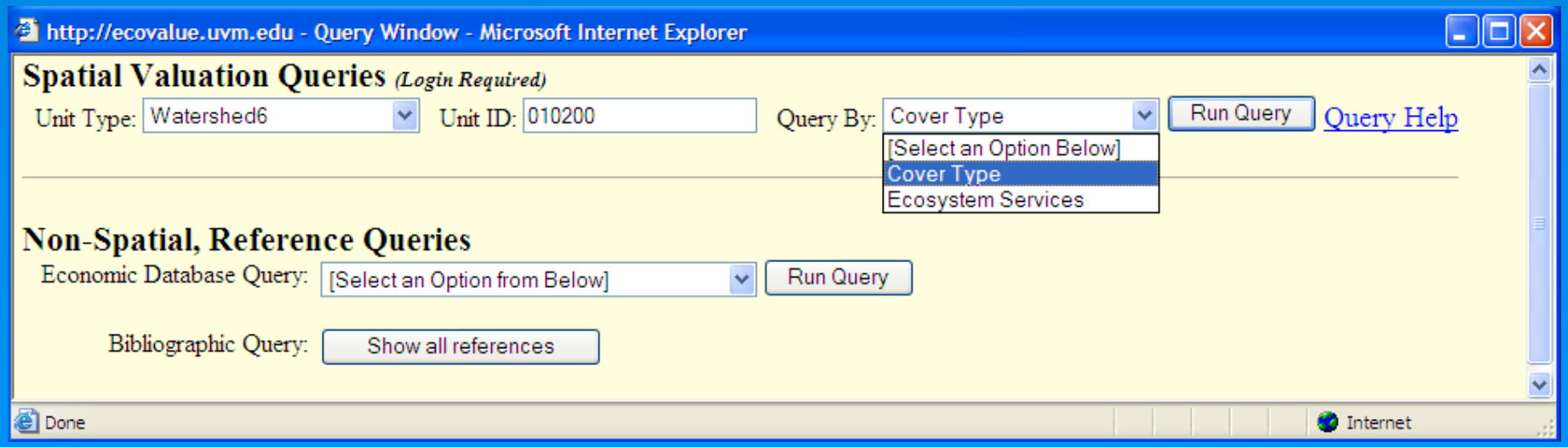
A color ramp of total economic value by county



Identifying a spatial unit



The Query Window



Spatial Query: by Cover Type

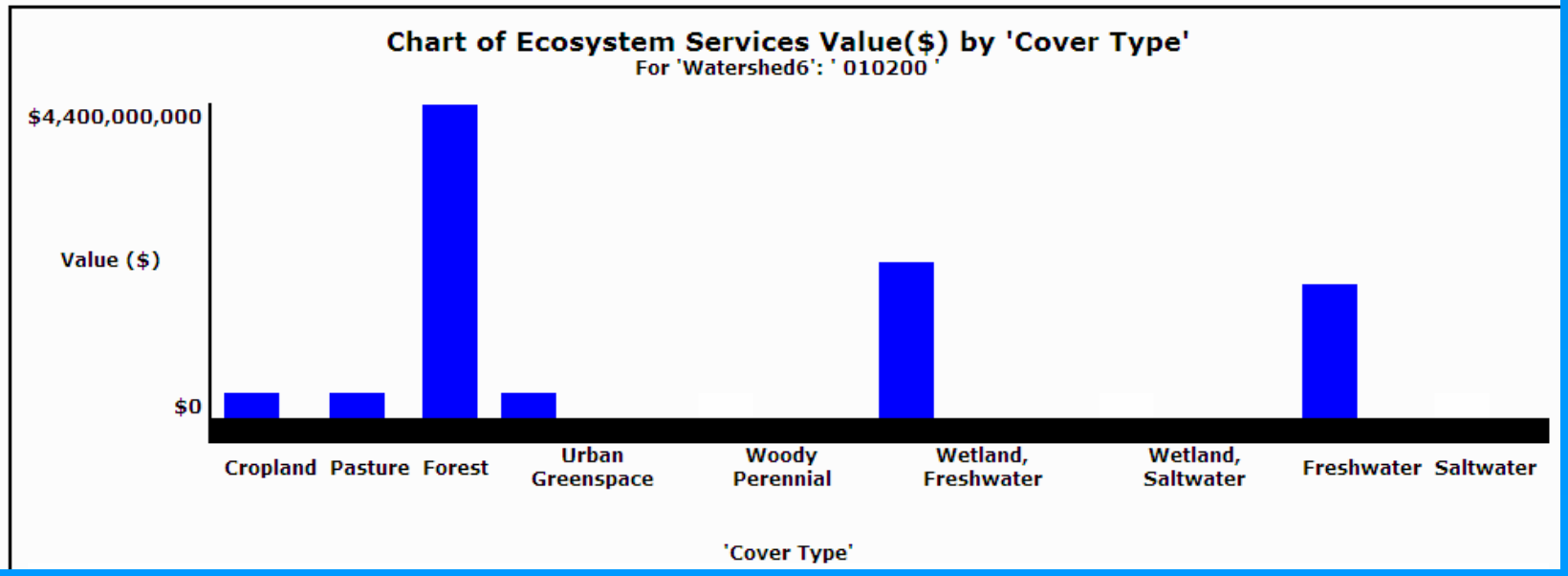
Query Results for Penobscot Watershed (Land Cover)

Close Window

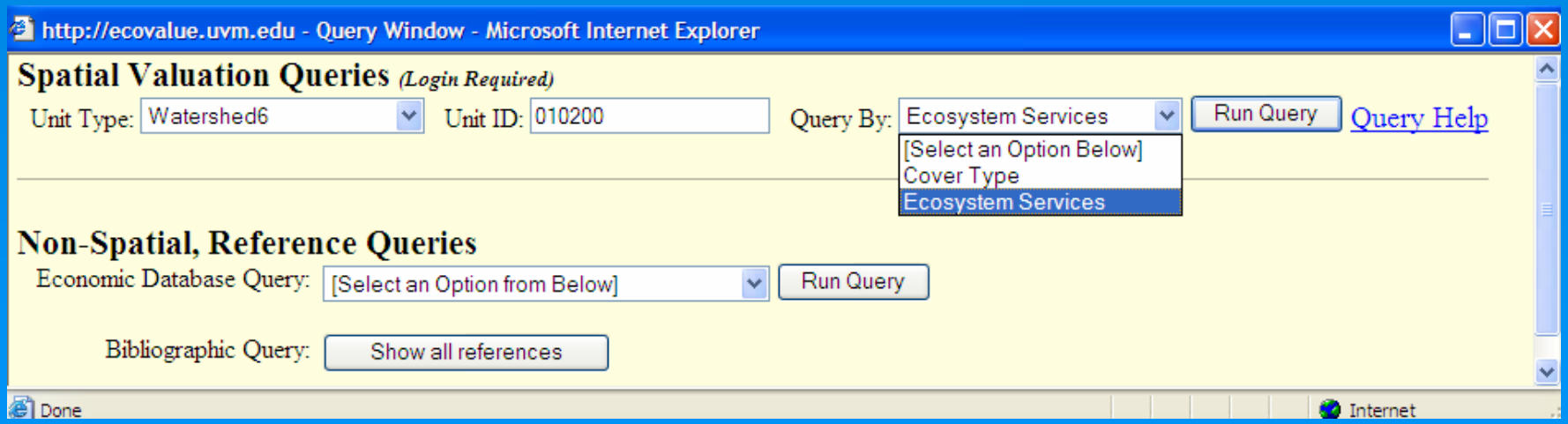
Query: Total Value by Land Cover for Watershed6: 010200

CoverID	CoverName	Area(Ha)	Mean Value($)	Min Value($)	Max Value($)
1	Cropland	34,987	123,668,421	123,668,421	123,668,421
2	Pasture	6,929	24,397,356	24,397,356	24,397,356
3	Forest	1,801,833	4,379,210,292	1,811,150,648	8,893,818,217
5	Urban Greenspace	4,487	24,556,968	215,999	48,897,827
6	Woody Perennial	66	8,105	8,105	8,105
10	Wetland, Freshwater	111,585	2,172,435,082	501,937,790	6,389,715,636
11	Wetland, Saltwater	14	386,758	366,610	422,337
12	Freshwater	129,123	1,860,613,679	445,855,293	6,361,931,474
13	Saltwater	154	2,225,887	533,385	7,610,896

Save Query to Excel File



The Query Window



Spatial Query: by Ecosystem Service

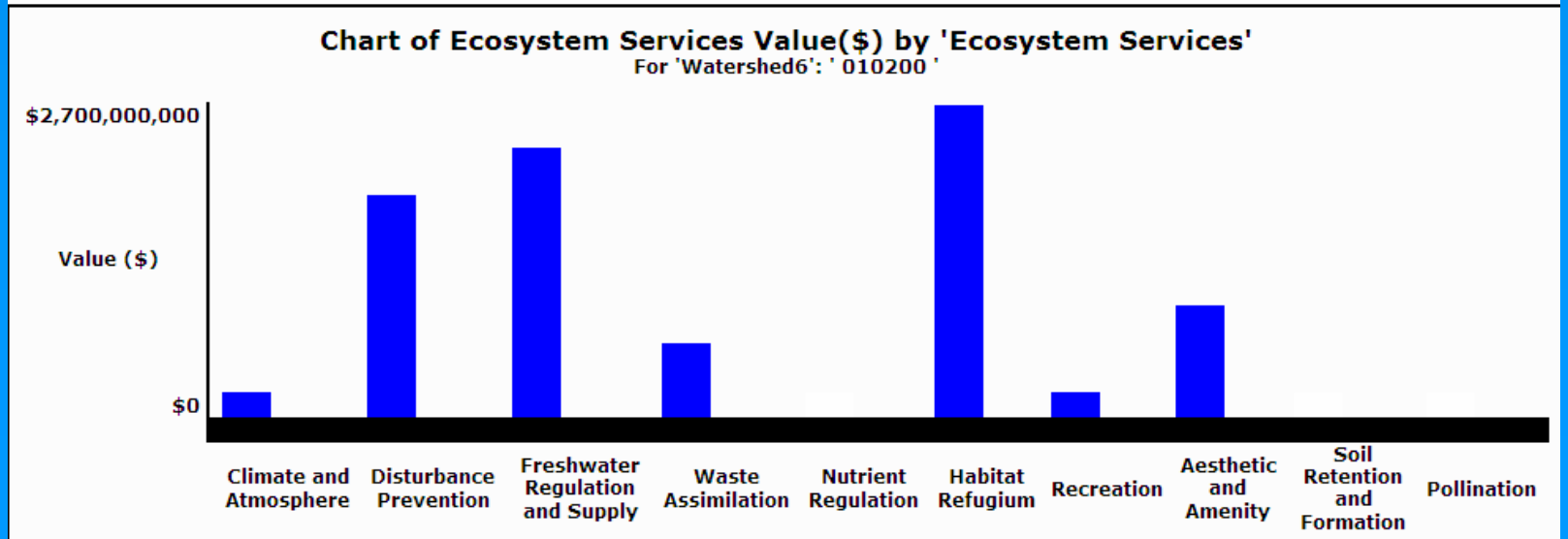
Query Results for Penobscot Watershed (Ecosystem Service)

Close Window

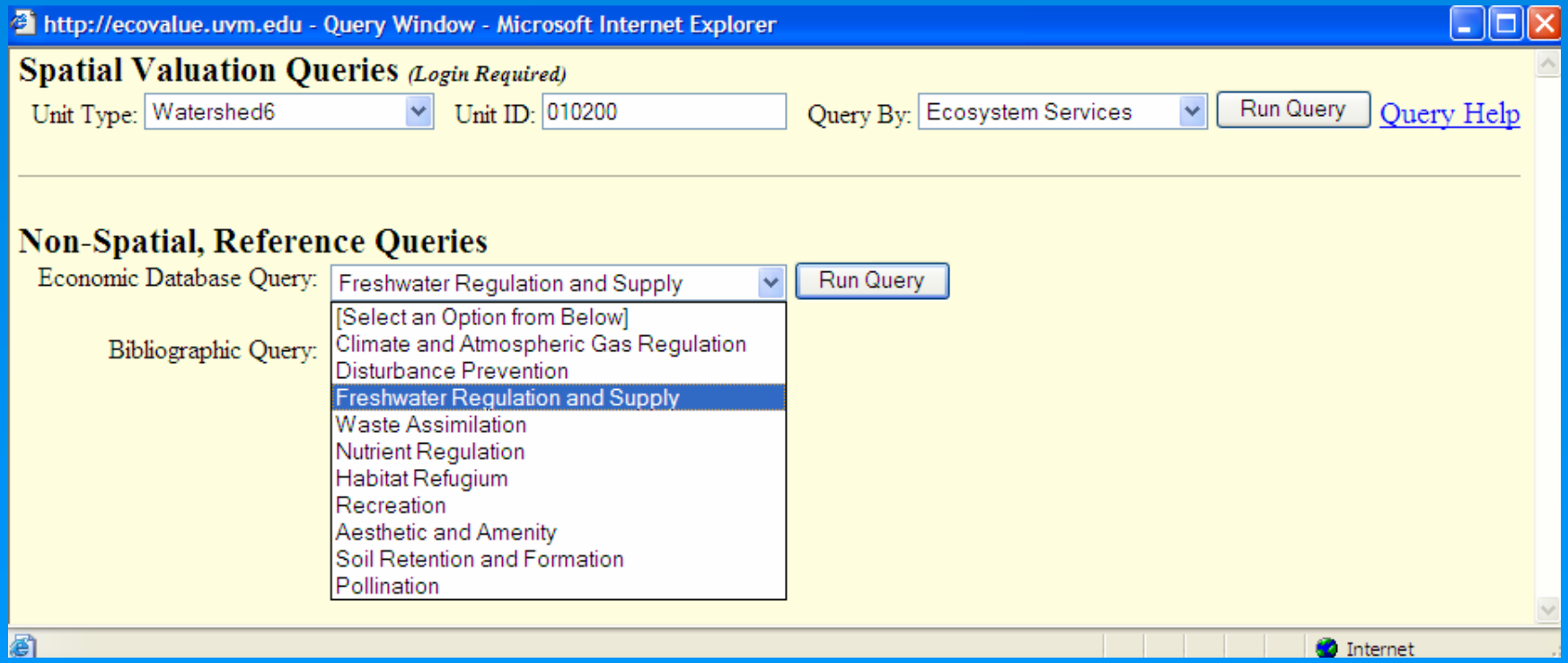
Query: Total Value by Ecosystem Service for Watershed6: 010200

Services ID	Services Name	Area (Ha)	Mean Value($)	Min Value($)	Max Value($)
1	Climate and Atmosphere	1,801,833	29,385,909	2,849,598	55,966,724
2	Disturbance Prevention	1,913,432	1,901,152,114	1,901,152,114	1,901,152,114
3	Freshwater Regulation and Supply	240,863	2,309,896,676	10,588,328	10,106,585,146
4	Waste Assimilation	116,073	631,315,176	5,541,378	1,257,086,117
5	Nutrient Regulation	14	352,274	352,274	352,274
6	Habitat Refugium	1,931,125	2,678,273,595	18,562,745	7,424,161,253
7	Recreation	2,047,198	68,849,095	809,462	136,888,933
8	Aesthetic and Amenity	282,779	961,158,830	961,158,830	961,158,830
9	Soil Retention and Formation	146,573	1,992,024	1,992,024	1,992,024
10	Pollination	41,982	5,126,855	5,126,855	5,126,855

Save Query to Excel File



Non-Spatial Reference Query



Non-Spatial, Query Results for Freshwater Regulation and Supply (incomplete list)

Author(s)	Year	Title	Label
Bouwes, N. W. and Scheider, R.	1979	Procedures in estimating benefits of water quality change	Aggregate value of water quality change in Pike Lake, Wisconsin
d'Arge, R.	1989	Okoboji experiment:comparing non-market valuation techniques in an unusually well-defined market for water quality	Willingness-to-pay for better water quality of West Okioboji lake compared to East Okioboji lake, Iowa
Desvousages, W. H., Smith, V. K. and Fisher, A.	1987	Option price estimates for water quality improvements: a contingent valuation study for the Monongahele River	Estimated option price from direct-question-method for changes in water quality of the Monongahela River, Montana
Desvousages, W. H., Smith, V. K. and Fisher, A.	1987	Option price estimates for water quality improvements: a contingent valuation study for the Monongahele River	Estimated option price from interative-bidding-method for changes in water quality of the Monongahela River, Montana
Goffe, L.	1995	The benefits of improvements in coastal water quality: a contingent approach	Willingness-to-pay per household for the ecosystem preservation against eutrophication at Brest Natural Harbour, France
Lant, C. L. and Tobin, G.	1989	The economic value of reparian corridors in cornbelt floodplains: a research framework	Estimated value of reparian wetlands necessary to raise the quality of the Edwards River to the level of the South Skunk River
Lant, C. L. and Tobin, G.	1989	The economic value of reparian corridors in cornbelt floodplains: a research framework	Estimated value of riparian wetlands necessary to raise the quality of the South Skunk river to the level of the Wapsipinicon river
Pate, J. and Loomis, J.	1997	The effect of distance on willingness to pay values: A case study of wetlands and salmon in California	Aggregate wliingness-to-pay for wetland improvement in the San Joaquin Valley, CA.
Ribaudo, M. and Epp, D. J.	1984	The importance of sample descrimination in using the travel cost method to estimate the benefits of improved water quality	Improved water quality value of St. Albans Bay, Vermont
Suherland, R. and Walsh, R. G.	1985	Effect of Distance on the preservation value of water quality	Aggregate willingness-to-pay to preserve water quality of the Flathead Lake and the lake area, Montana
Thibodeau, F. R. and Ostro, B. D.	1981	An economic analysis of wetland protection	Water supply service provided by the Charles River Basin, Massachusetts

Save Query to Excel File

Practical Applications

In addition to advancing the scientific research agenda, the methodology is applicable in a wide-variety of Decision Making situations and can be used to clarify tradeoffs involved with:

- New Infrastructure Construction
- Resource Development
- Community Planning
- Remediation and Mitigation efforts
- Conservation Planning and Prioritization
- Sustainable Business Strategy and Growth Management

Applying Spatially Explicit Ecosystem Service Transfer Methodology in Massachusetts

University of Vermont, School of Business Administration, Rubenstein School of Environment and Natural Resources, Gund Institute for Ecological Economics

Applied Project: Massachusetts Commonwealth, MA.

- In 2003, Spatial Informatics Group, LLC. (www.sig-gis.com) used the NaturalAssets™ information system to help the Massachusetts Audubon Society to develop a baseline value Massachusetts' ecosystem services by sub-watershed as part of their "Losing Ground" report on the effects of continued urban development

CHAPTER 6

Accounting for the Economic Value of Ecosystem Services in Massachusetts

Thus far, we have laid out the costs of unchecked development in the Commonwealth in traditional conservation terms. Deforestation destroys wildlife habitat, fragmentation threatens biodiversity, and sprawling development affects quality of life. Protecting land is important for ecological as well as aesthetic and cultural reasons. As important as these factors are, however, most day-to-day land use decisions are based on market economics. Landowners are influenced by land prices as well as property tax assessments that value land based on its "fair market value." Similarly, local and state governments must often weigh the economic costs and benefits of infrastructure development while policy makers evaluate the tradeoffs between competing stakeholder demands in the marketplace.

The forests, rivers, wetlands, estuaries, and beaches throughout Massachusetts provide many different goods and services to the people of the Commonwealth. An ecosystem service, by definition, contains "the conditions and processes through which natural ecosystems, and the species that make them up, sustain and fulfill human life."[16] While these natural processes have been well understood from a scientific perspective for some time, only recently has there been an effort to quantify the economic value of these services.

© Mass Audubon 2003 - Downloaded from www.massaudubon.org/losingground

Estimating the Value of Ecosystem Services in Massachusetts

For this chapter, Mass Audubon worked with Dr. Matthew A. Wilson and Dr. Austin Troy, professors associated with the Gund Institute for Ecological Economics at the University of Vermont, to create a spatially explicit economic model of ecosystem service values for the Massachusetts landscape.

Our primary interest is to shed light on the nonmarket economic benefits of ecosystem services associated with habitat and open land when it is left in its natural state, as opposed to direct or extractive uses such as forestry, fishing, and agriculture. To estimate the economic value of ecosystem services in Massachusetts, we relied on secondary analysis of published results drawn from the peer-reviewed economic literature. When analyzed carefully, information from studies published in the economic literature can form a meaningful basis for directing environmental policy and management.[17]

The forests, rivers, wetlands, estuaries, and beaches throughout Massachusetts provide many different goods and services to the people of the Commonwealth.

Report: http://www.massaudubon.org/news/index.php?id=19&type=news#download

A Scoping Tool: Revealing Gaps in Value-Transfer Data

Figure 17

Ecosystem Services and Available Research

Simplified Land Use Category	Cropland	Pasture	Forest	Wetland-Fresh	Wetland-Salt	Open Land	Urban Green Space*	Woody Perennial	Water and Coastal Embayment	Water-based Recreation	Highly Impacted+
Climate Regulation	▲	▲	▲	▲	▲	▲	▲	▲			
Freshwater Regulation and Supply			▲	▲	▲	▲			▲		
Waste Assimilation and Water Quality			▲	▲	▲	▲	▲		▲		
Nutrient Regulation	▲	▲	▲	▲	▲	▲	▲	▲	▲		
Habitat Refugium	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	
Soil Retention and Formation	▲	▲	▲	▲	▲	▲	▲	▲			
Disturbance Prevention	▲	▲	▲	▲	▲	▲					
Pollination	▲	▲	▲	▲	▲	▲	▲	▲			
Recreation and Aesthetics	▲	▲	▲	▲	▲	▲	▲	▲	▲	▲	

Mapping of ecosystem services to Massachusetts land cover types.

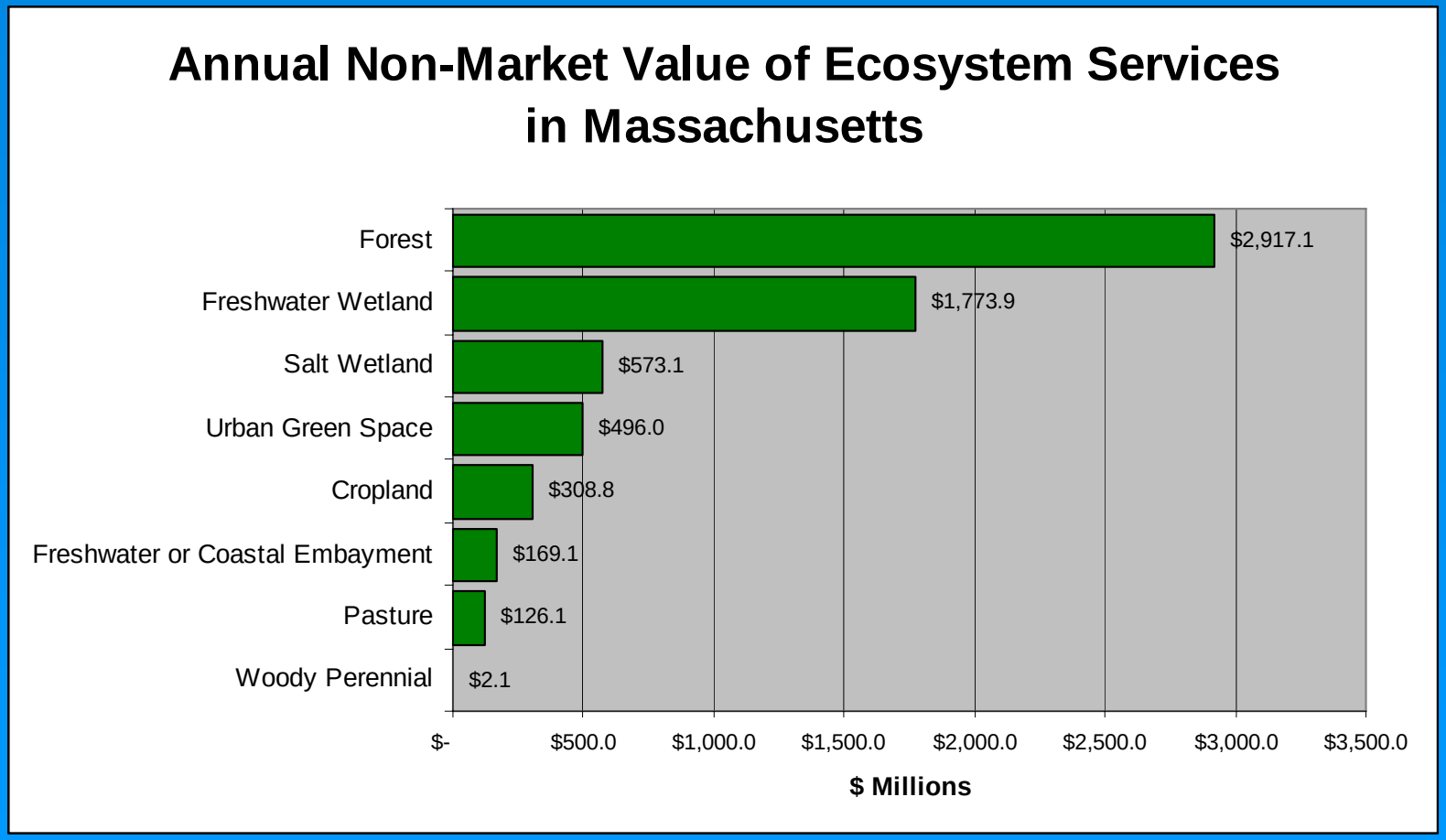
▲ Service provided by land cover type, with sufficient peer-reviewed research for valuation in **MA**

▲ Service provided by land cover type, but insufficient peer-reviewed research for valuation in **MA**

* Includes urban open space and participation recreation

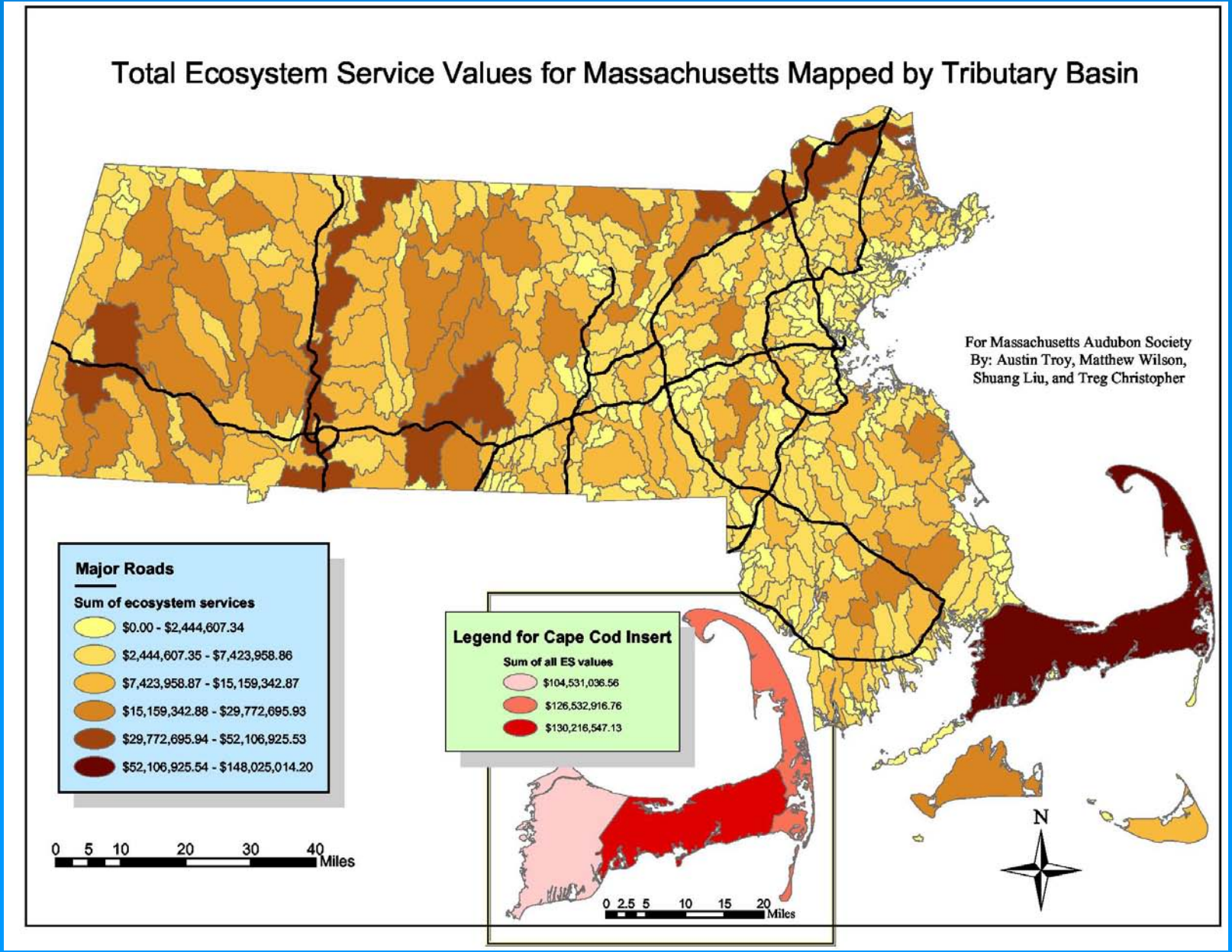
\+ Includes commercial, industrial, and residential development

A Decision Tool: Ecosystem Services by Land Cover



Based on 1999 land cover data.

A Planning Tool: GIS Mapping



Value Transfer Application: Tracking Natural Capital Carbon Stock Values in the Northern Forest Region

University of Vermont, School of Business Administration, Rubenstein School of Environment and Natural Resources, Gund Institute for Ecological Economics

Carbon 'Storage' Value Estimates in Northern Forest Region 1987-1997

	Area Forestlands (Ha)		Tons/ha		Total Tree Carbon (Tons)		Avg. $ Value*	Total $ Value (Millions)	
State	1987	1997	1987	1997	1987	1997	Ton/Carbon	1987	1997
ME	7,168,197	7,166,983	48	47	344,755,594	339,613,311	$50	$17,238	$16,981
NH	2,031,927	2,005,217	68	83	138,214,412	165,878,018	$50	$6,911	$8,294
NY	7,598,378	7,519,464	56	62	426,210,892	465,243,737	$50	$21,311	$23,262
VT	1,824,728	1,864,387	60	83	108,961,273	154,957,419	$50	$5,448	$7,748

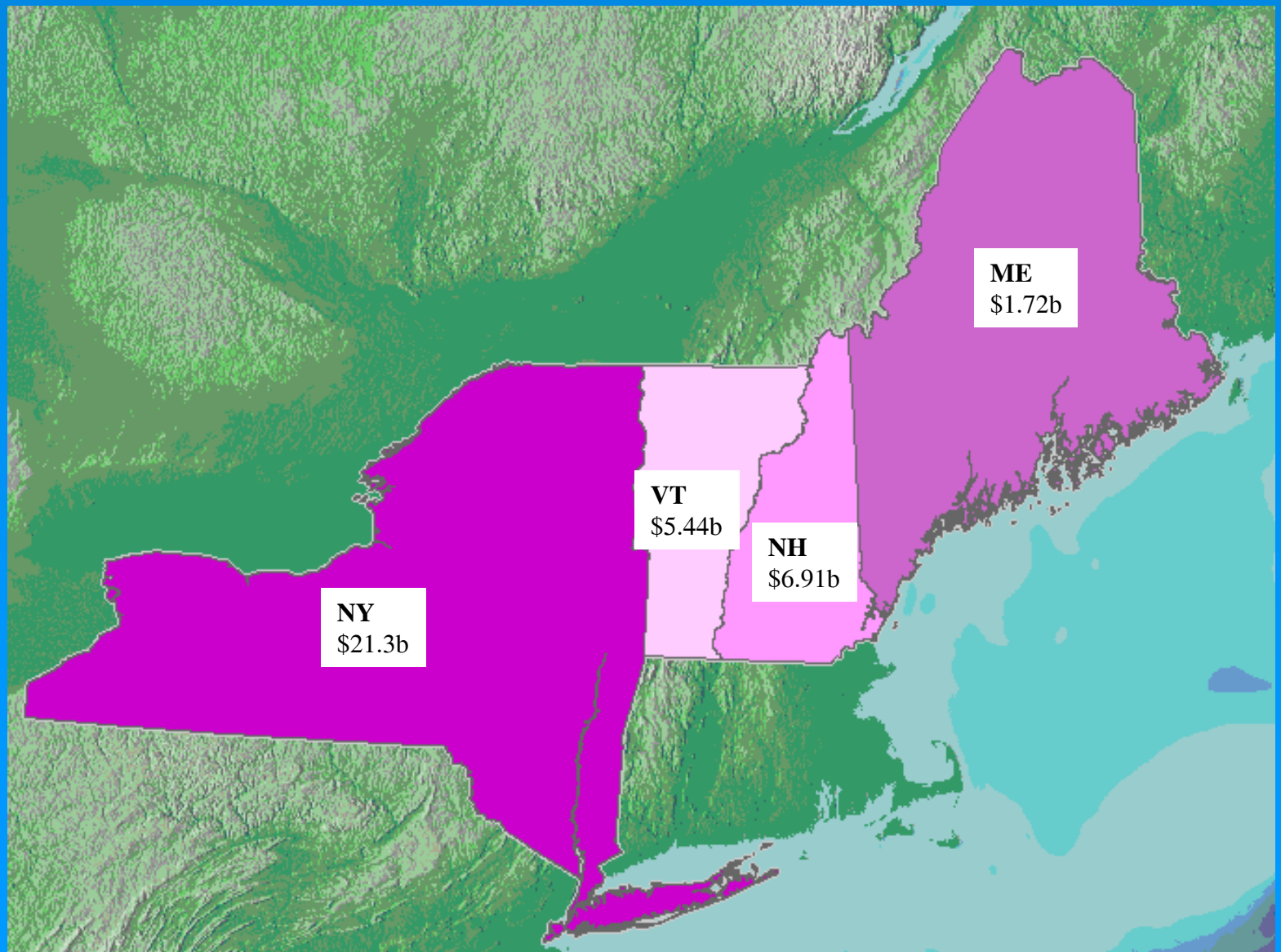
*** Dollar Estimates are in $2004 equivalents**

Sources:

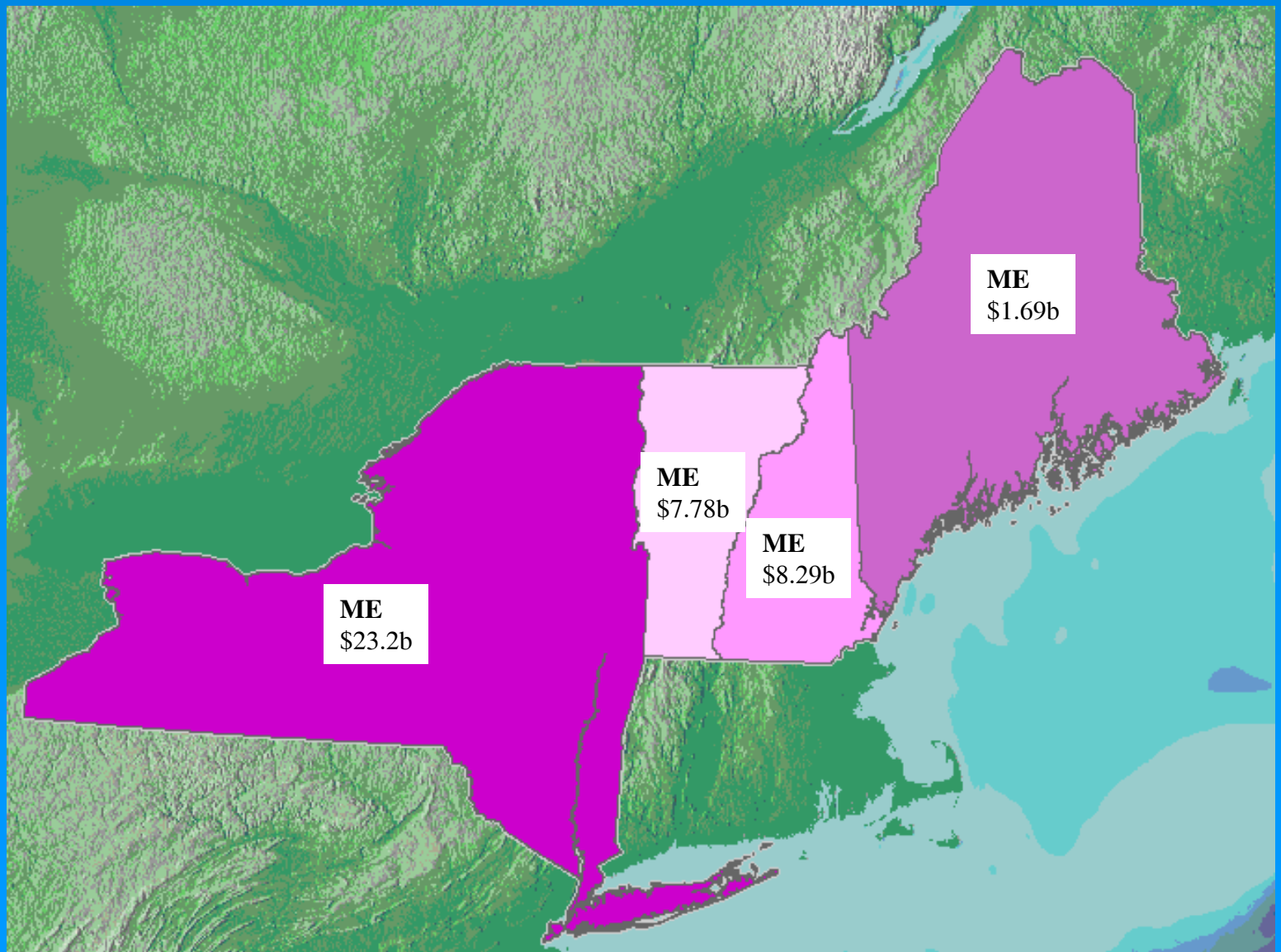
Birdsey, R.A. and G.M. Lewis (2003) Carbon in US Forests and Forest Products, 1987-1997: State by State Estimates. Northeastern Forest Experiment Station: United States Department of Agriculture Forest Service. *General Technical Report NE-310.* http://www.fs.fed.us/ne/global/pubs/books/epa/national/avg_carbon87.html

*Tol, R. S. J. (2005). The marginal damage costs of carbon dioxide emissions: an assessment of the uncertainties. *Energy Policy* 33: 2064-74.

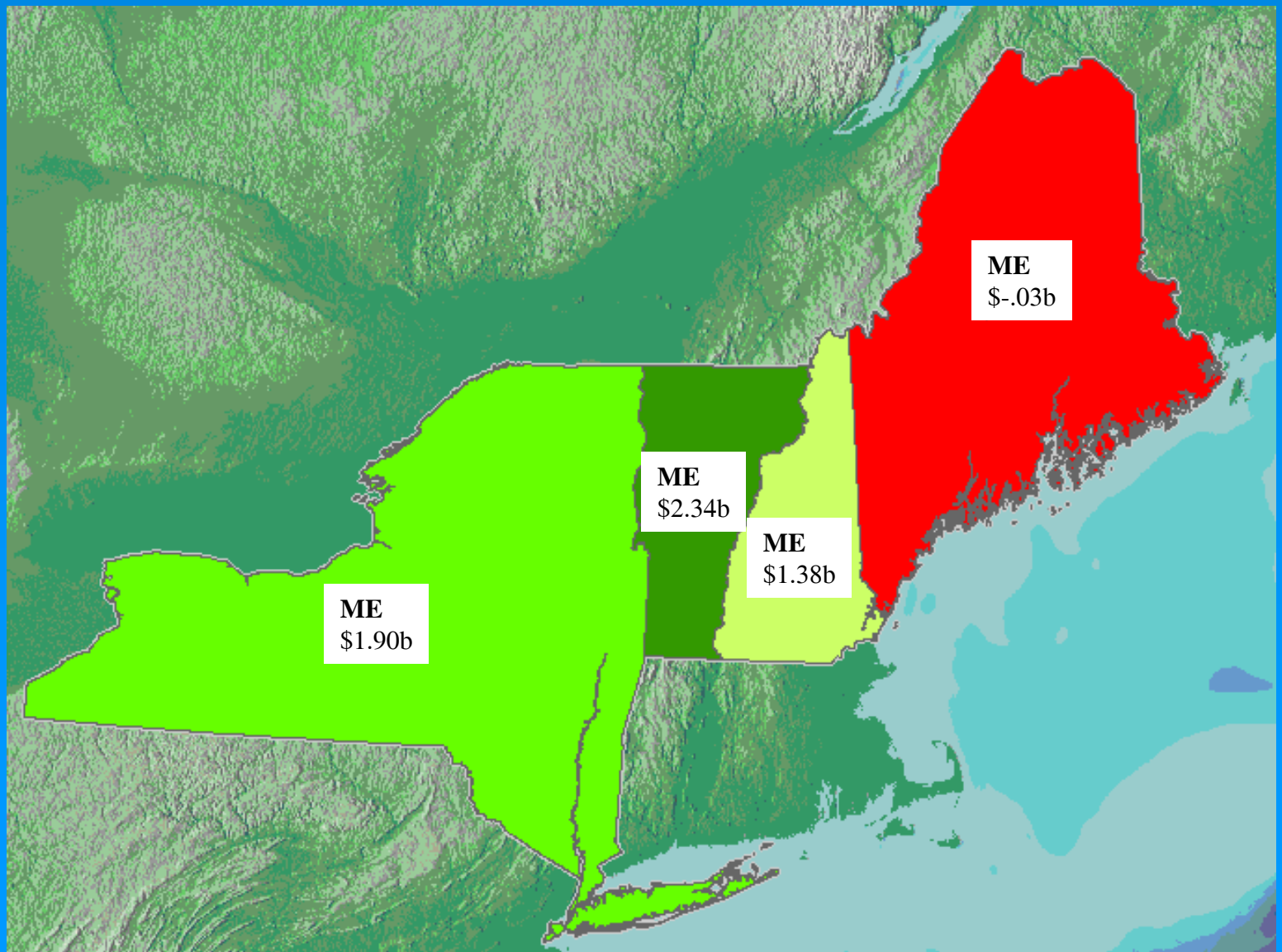
Economic Value of Carbon Storage For Trees on Timberlands (1987)



Economic Value of Carbon Storage For Trees on Timberlands (1997)



Change in Value of Carbon Storage For Trees on Timberlands (1987-1997)



Challenges and Future Directions

- Standardizing Quality of original Economic studies
- Aggregation of economic values to account for:
  - Socio-Economic context (e.g. scarcity)
  - Spatio-temporal context (e.g., scarcity)
  - Spatio-temporal scale
- Increasing Availability of Reliable Land Cover data
  - Forest Carbon Sequestration rates
  - Change-detection in Carbon Stocks
  - Global Applications

Thank You!

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EcoValue Project website: http://ecovalue.uvm.edu

Acknowledgment:
The northern forest module of the EcoValue Project was developed with support from the Northeastern States Research Cooperative.