

# Assessing the Social and Economic Value of *Ecosystem Services* in the Northern Forest Region: A Geographic Information System (GIS) Approach to Landscape Valuation

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- The economic values of ecosystem goods and services were linked to land cover types found in the northern forest states.
- A web-based map allows an individual to graphically select a geographic area of interest (e.g. a county) and generate ecosystem service values for that area.

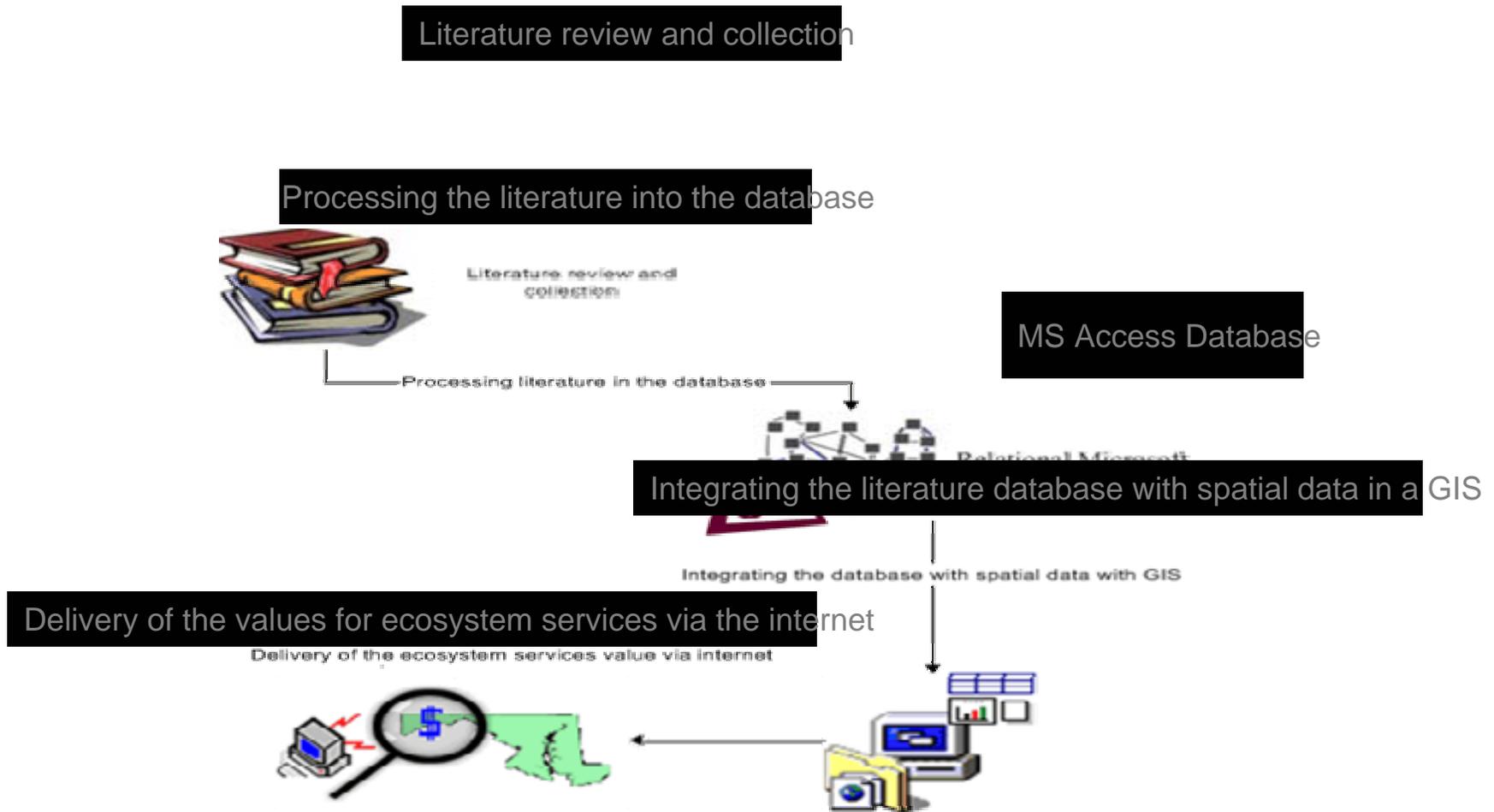
Funding support for this project was provided by the Northeastern States Research Cooperative (NSRC), a partnership of Northern Forest states (New Hampshire, Vermont, Maine, and New York), in coordination with the USDA Forest Service.

<http://www.uvm.edu/envnr/nsrc/>

# Project Summary

- This project combines research into the economic valuation of ecosystem services, with a web-based, map of the of the Northern Forest region. The services provided by nature contribute significantly to human welfare, both directly and indirectly. Thus when ecosystem service values are not fully accounted for in economics and land use decisions, the long-term health of nature and society may be compromised by the focus on readily-apparent, short term economic benefits. Our web-based map provides valuation data to researchers, decision-makers, and public stakeholders throughout the Northern Forest region.
- Economic data is extracted from a number of studies quantifying the values of ecosystem goods and services. This data is then stored in a valuation database where economic values, land cover types and ecosystem services are linked together. Maps of land cover, derived from 1992 satellite imagery, is connected to this database and displayed on the uvm website: <http://ecovalue.uvm.edu/NorthernForests> . Users of this website may then select geographic areas within the northern forests and view monetary estimates of ecosystem services for that area. The value of this geographic unit can be disaggregated into values by land cover or by specific ecosystem services linked to each land cover type.
- This project will help to resolve that problem for decision makers and public stakeholders in the Northern Forest region. The identification and classification of ecosystem goods and services via computer-generated maps will provide a critical planning tool for the efficient allocation of resources among competing land use demands in the region. Once quantified and mapped, the economic value of ecosystem services can help decision-makers and landowners rationally evaluate trade-offs among the different management options they will face as the forests come under increasing pressure from humans.

# Fig 1. Steps in the EcoValue Project



# Background and Justification

- Ecosystem goods and services in the Northern Forests cover a broad range of natural functions at multiple scales, from climate regulation and carbon sequestration at the global scale, to flood protection, water supply, soil formation, nutrient cycling, waste treatment and pollination at the local and regional scales. Thus when ecosystem service values are not fully accounted for in economics and land use decisions, the long-term health of nature and society may be compromised by an emphasis on readily-apparent, short-term economic benefits from development and industry.
- The concept of ecosystem services brings together both human and biophysical processes into a common framework. The international *Millennium Ecosystem Assessment* (2003) recently adopted it:
  - **“The MA focuses on ecosystem services (the benefits people obtain from ecosystems), how changes in ecosystem services have affected human well-being, how ecosystem changes may affect people in future decades, and response options that might be adopted at local, national, or global scales to improve ecosystem management and thereby contribute to human well-being”**  
**<http://www.millenniumassessment.org>**

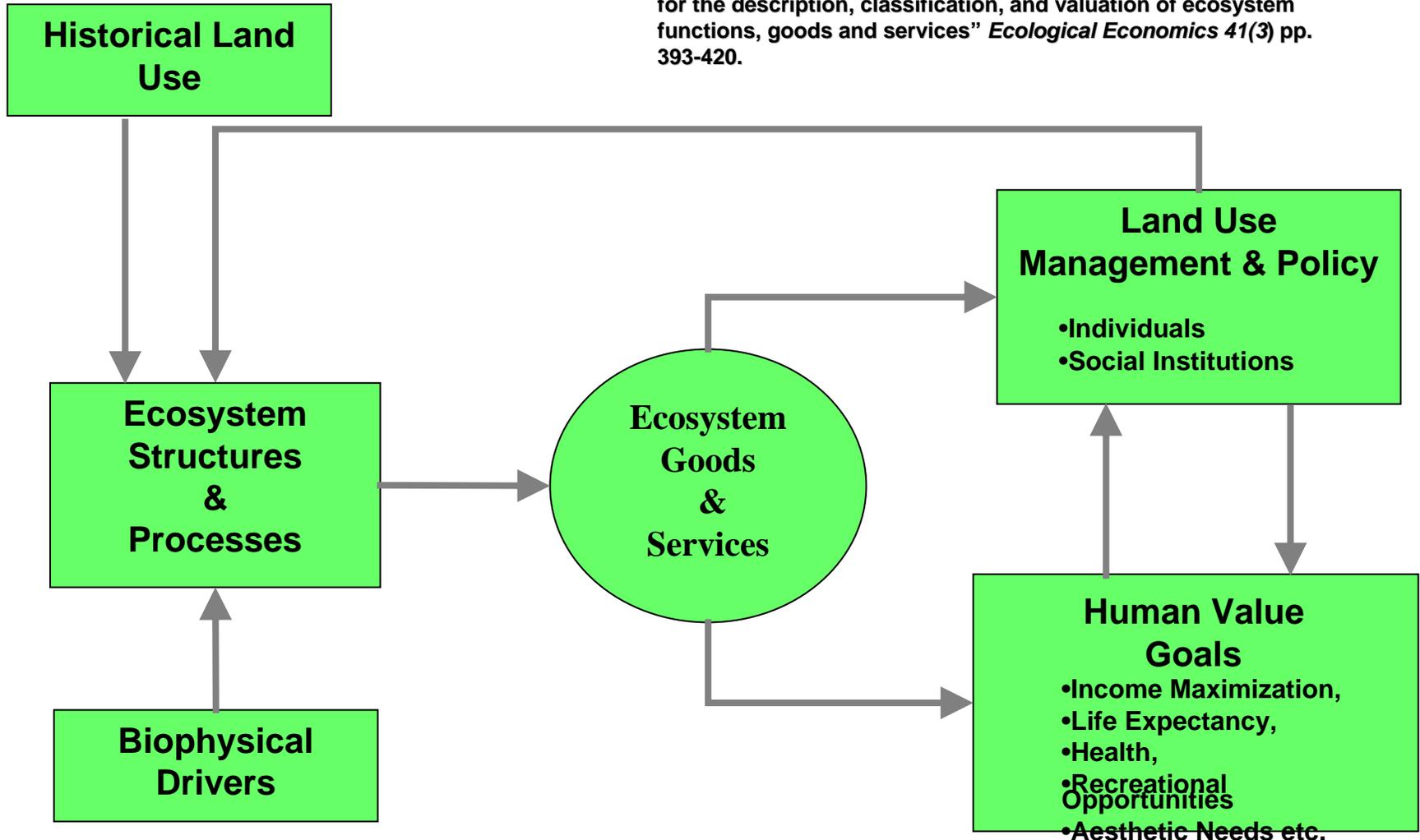
Costanza, R., R. d'Arge, et al. (1997). "The value of the world's ecosystem services and natural capital." *Nature* **387**(6630): 253-260.

De Groot, R. S., M. A. Wilson, et al. (2002). "A typology for the classification, description and valuation of ecosystem functions, goods and services." *Ecological Economics* **41**(3): 393-408.

Turner, R. K., J. Paavola, et al. (2003). "Valuing nature: lessons learned and future research directions." *Ecological Economics* **46**(3): 493-510.

# Framework for Integrated Assessment and Valuation of Ecosystem Functions, Goods and Services

Adapted from 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.



# Methods

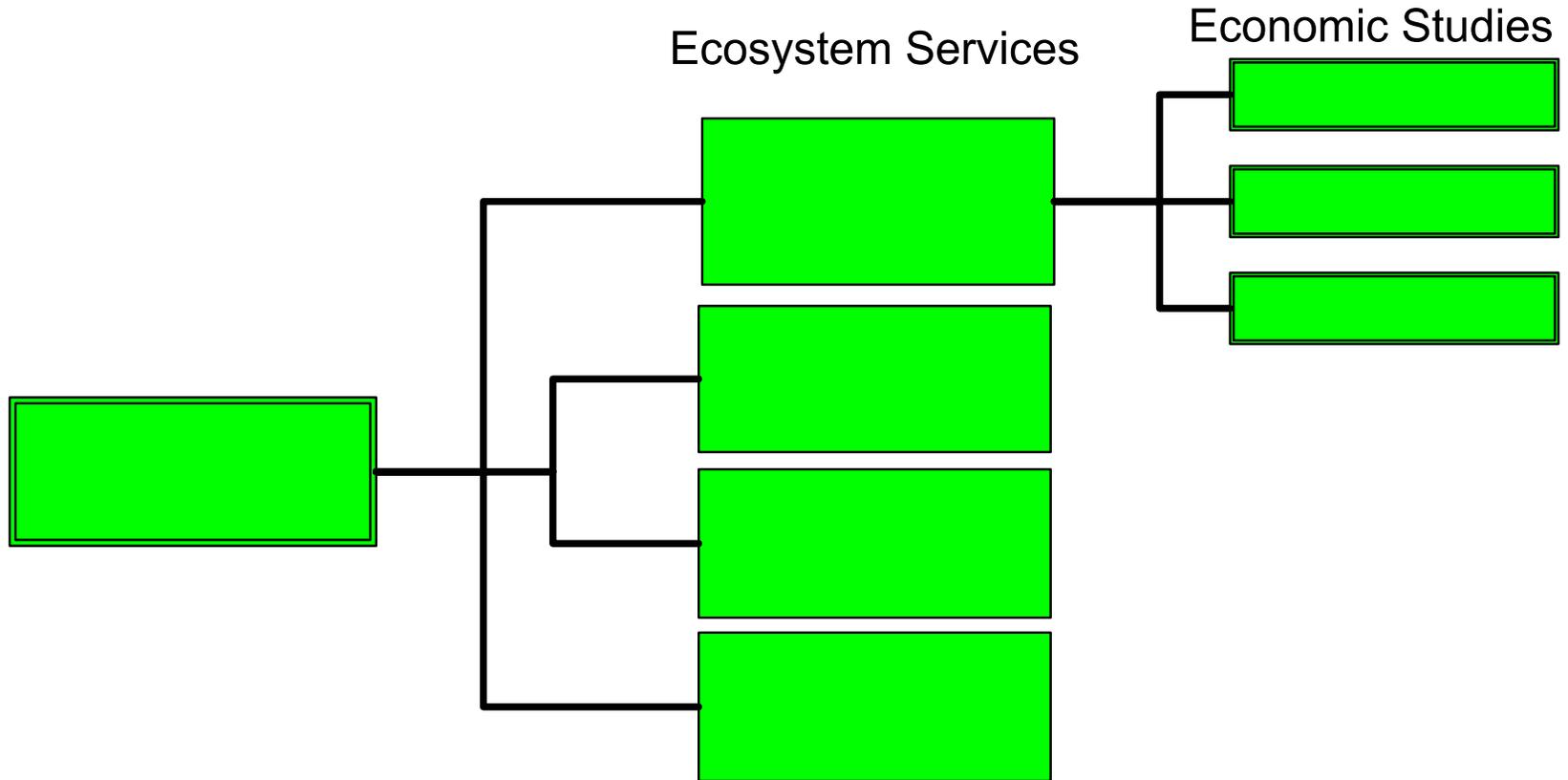
- As shown in Figure 1, there are a number of steps involved in the EcoValue Project. In general, the economic values derived from many, separate research studies are translated to a new (target) area. This involves linking \$\$'s to specific services and land cover types found in the northern forests. This is shown in the following slides.

Howarth, R. B. and S. Farber (2002). "Accounting for the value of ecosystem services." Ecological Economics **41**(3): 421-429.

Loomis, J. B. (2000). "Can environment economic valuation techniques aid ecological economics and wildlife conservation?" Wildlife Society Bulletin **28**(1): 52-60.

Pearce, D. W. (2001). "The economic value of forest ecosystems." Ecosystem Health **7**(4): 284-296.

# Relationship Between Land Cover and Ecosystem Services



# Typology of Ecosystem Goods and Services

ECOSYSTEM FUNCTION	ECOSYSTEM SERVICE (Examples)
REGULATING	<p><b>Disturbance Moderation</b></p> <ul style="list-style-type: none"> <li>•Regulation of surface runoff and discharge to nearby streams and the Merrimack river</li> <li>•Flood control services provided by redeveloped wetlands and dams in nearby ponds</li> </ul>
	<p><b>Freshwater Regulation</b></p> <ul style="list-style-type: none"> <li>•Improved groundwater recharge capacity</li> <li>•Improved surface water quality through mitigating runoff from the site into nearby streams</li> </ul>
	<p><b>Waste Treatment</b></p> <ul style="list-style-type: none"> <li>•Pollution control and detoxification capacity restored on site and at off-site wetlands</li> </ul>
	<p><b>Wildlife Habitat</b></p> <ul style="list-style-type: none"> <li>•Feeding and breeding ground for identified freshwater fish species</li> <li>•Habitat for migratory waterfowl</li> </ul>
SUPPORTING	<p><b>Nutrient Regulation</b></p> <ul style="list-style-type: none"> <li>•Improved nutrient filtration capacity of off-site freshwater wetlands and stream buffers</li> <li>•Improved trapping of sediments and pollutants on-site.</li> </ul>
CULTURAL	<p><b>Recreation and Amenity</b></p> <ul style="list-style-type: none"> <li>•Improvement of aesthetics and associated re-sale values for nearby residential properties and commercial developments</li> <li>•Improvement of greenspace recreation opportunities through off-site wetland revegetation and stream remediation</li> </ul>

# Spatial Aggregation

Value of Ecosystem Services (\$ ha<sup>-1</sup> per year):

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

Where  $A(LU_i)$  = Area of  $i^{\text{th}}$  (Land Use in hectares)  
and  $V(ES_{ki})$  = Annual value of  $k^{\text{th}}$  ES (Ecosystem Services) for each  $i^{\text{th}}$  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

# Results/Project outcomes

- Website (<http://ecovalue.uvm.edu/northernforests> ) that provides information on ecosystem services, economic methods for valuing these services and references to further information
- Web-based map ([http://ecovalue.uvm.edu/evp/modules/norfor/asp/select\\_state.asp](http://ecovalue.uvm.edu/evp/modules/norfor/asp/select_state.asp) ) for each of the northern forest states that allows a user to select a geographic area and estimate the ecosystem service values for that area

# The EcoValue Project's website for the Northern Forests

## <http://ecovalue.uvm.edu/northernforests>

**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**



# Select a state in the northern forests

Select a State - Microsoft Internet Explorer

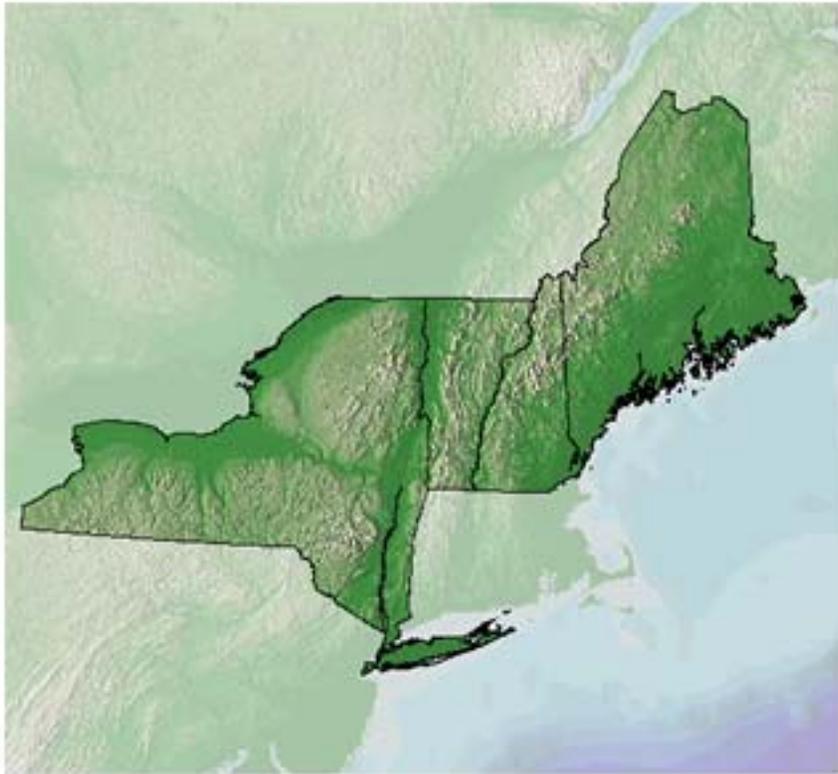
File Edit View Favorites Tools Help

Back Forward Stop Home Search Favorites Refresh Print Mail Stop 770 blocked Add-ons Options

Address [http://ecovalu.uvm.edu/evp/modules/norfor/asp/select\\_state.asp](http://ecovalu.uvm.edu/evp/modules/norfor/asp/select_state.asp) Go Links

Google Search Web

The Northern Forest Map Viewer is divided into state sub-modules. Please click on a state to view.



Done Internet

# The Vermont Map Viewer

http://ecovalue.uvm.edu - ArcGIS Viewer - Microsoft Internet Explorer

 **The EcoValue Project**

**VT Northern Forest Map Viewer**

[Return to selecting a Northern Forest State](#)

**Information**

**Identify**

Query Auto-Popup

[Open Query Window](#)

**Navigation**

[Pan](#)

[Zoom In](#)

[Zoom Out](#)

[Full View](#)

**Printing**

[Print Map](#)



2004 University of Vermont

0 22 Miles 1:1,863,819

**Layer List** **Legend**

**LAYERS**

- All Layers
  - Base Layers
  - EcoValue Units
    - EcoValue Unit Boundaries
      - County
      - Watershed6
      - Watershed8
      - Ecoregion
    - EcoValue Unit Color Ramps NLCD
      - County Values
      - Watershed6 Values
      - Watershed8 Values
      - Ecoregion Values
  - LandCover
    - LandCover
    - Shaded Relief

[Refresh Map](#)

Auto Refresh

[Layer Help and Metadata](#)

- The active layer.
- An inactive layer, click to make active.
- A closed group, click to open.
- An open group, click to close.
- A map layer.
- A hidden group/layer, click to make visible.
- A visible group/layer, click to hide.
- A visible layer, but not at this scale.
- A partially visible group, click to make visible.

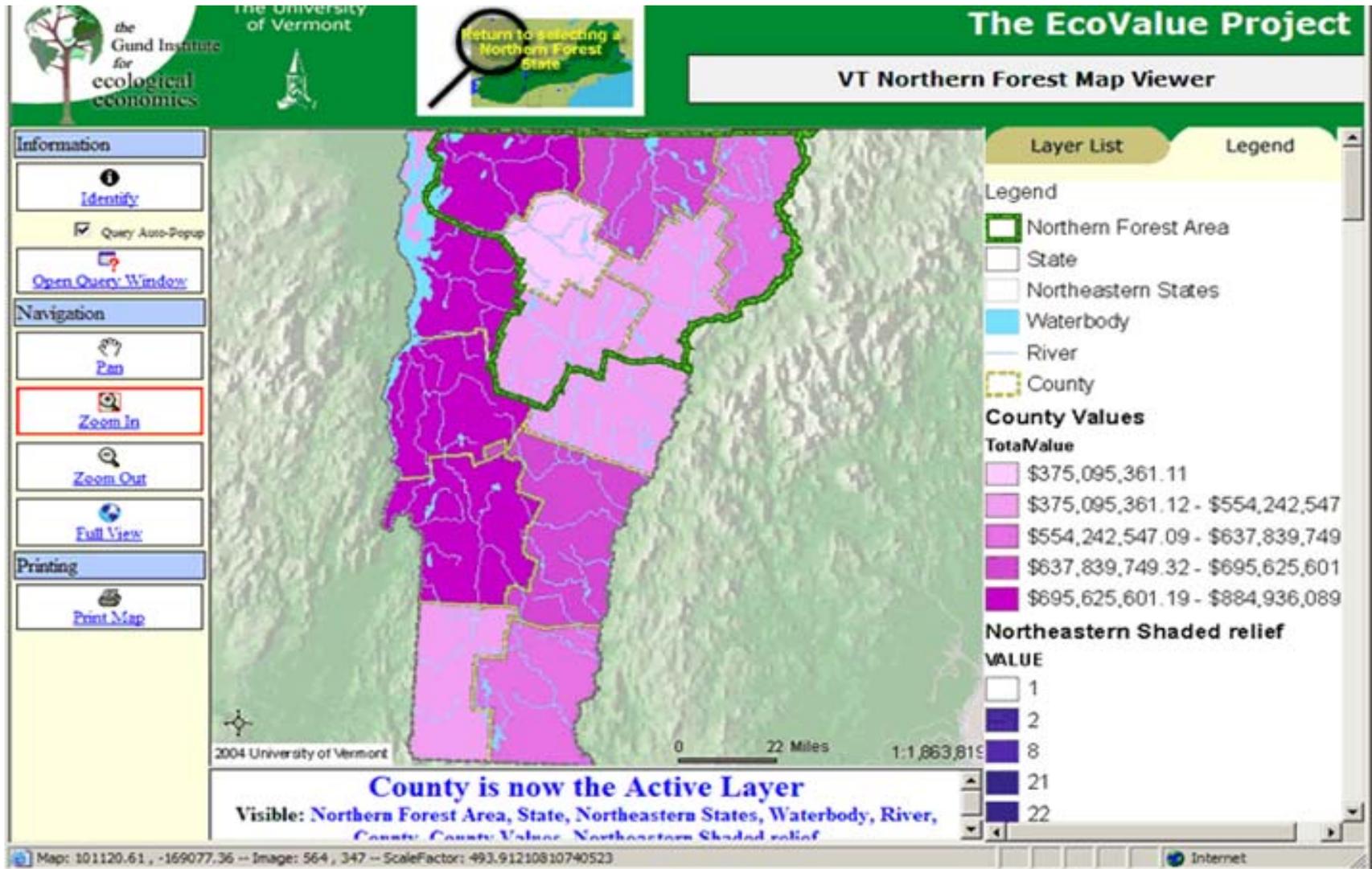
**County is now the Active Layer**

Visible: Northern Forest Area, State, Northeastern States, Waterbody, River,  
County: Shaded Relief, Northeastern Shaded relief

Map: 43332.9, -228840.73 -- Image: 447, 468 -- ScaleFactor: 493.91210810740523

Internet

# A color ramp of total ecosystem service value (aggregated to counties)



# Query of a spatial unit

http://ecovalue.uvm.edu - Query Window - Microsoft Internet Explorer

## Spatial Valuation Queries *(Login Required)*

Unit Type:  Unit ID:  Query By:   [Query Help](#)

[Select an Option Below]  
Cover Type  
Ecosystem Services

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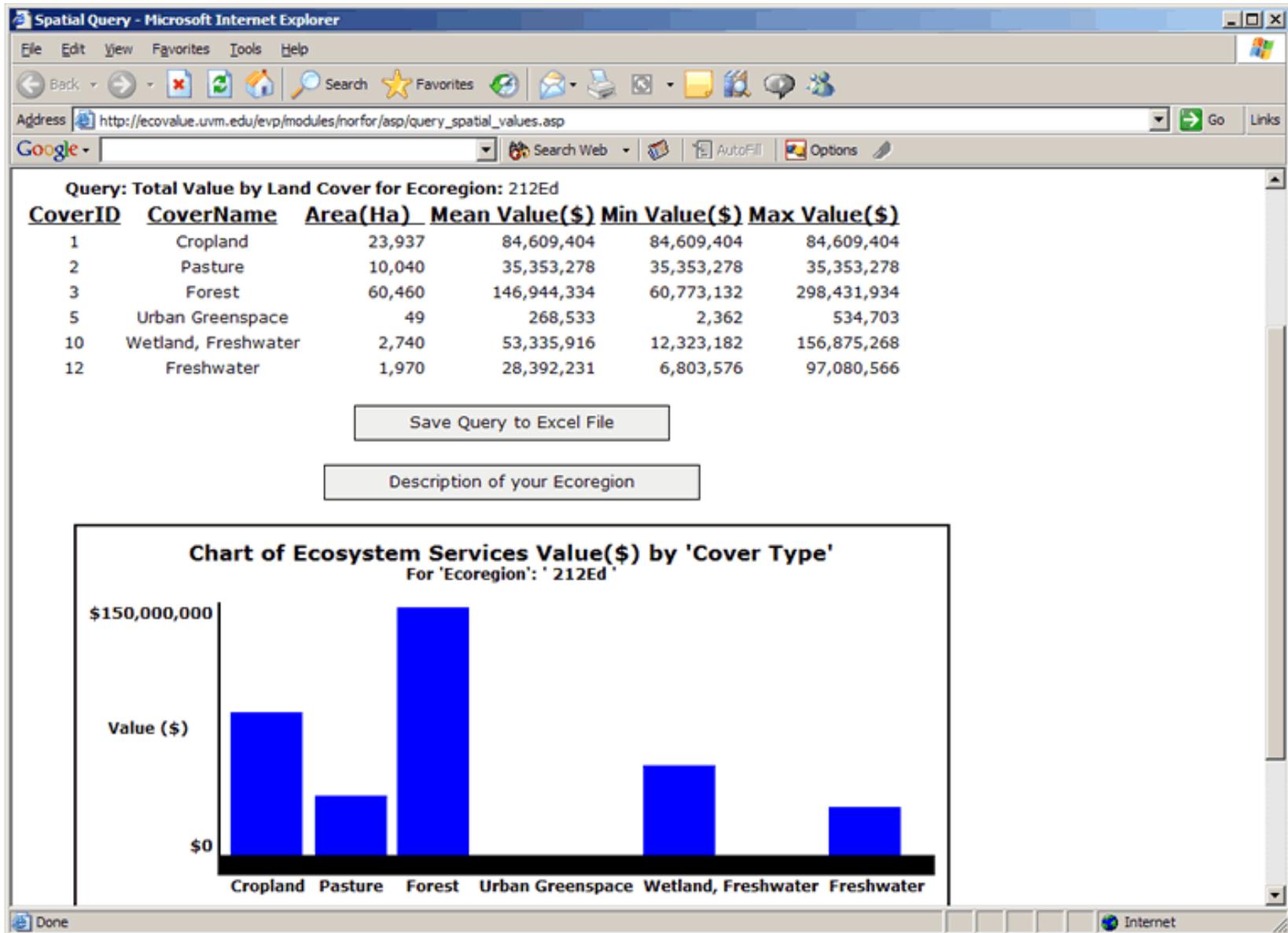
## Non-Spatial, Reference Queries

Economic Database Query:

Bibliographic Query:

Done Internet

# Query Result



# Implications and applications in the Northern Forest region

- This project will help to resolve that problem for decision makers and public stakeholders in the Northern Forest region. The identification and classification of ecosystem goods and services via computer-generated maps will provide a critical planning tool for the efficient allocation of resources among competing land use demands in the region.
- Once quantified and mapped, the economic value of ecosystem services can help decision-makers and landowners rationally evaluate trade-offs among the different management options they will face as the forests come under increasing pressure from humans.

# Future directions

- Economic values for ecosystem goods and services are derived from studies that measure individuals' ability to make tradeoffs between clearly defined alternatives. That is, between a reference condition and the condition after a proposed change. These studies are sensitive to the specific circumstances of the study site. Therefore, the validity of our current project is dependent on a number of assumptions concerning alternative scenarios of development and the benefits transfer of economic values.
- Future valuation projects will improve valuation estimates and increase the flexibility of the web-based tools:
  - Filter the economic database by date, quality and location of original study
  - Account and compare for socio-economic details of a geographic area (study site vs target site)
  - Account for ecological details (rather than just land cover) to adjust valuation estimates
  - Account for several, alternative scenarios (i.e. marginal changes in quality and quantity of land cover or ecosystem service)
  - Expand the number of economic valuation studies available in the valuation database
  - Use land cover change-detection imagery to analyze loss or gains in ecosystem service values of a geographic area

# List of products

- Wilson, M.A. 10/17/2005. *Valuing Ecological Services* Northeastern Forest Resource Planners Association Annual Meeting, Annapolis, MD.
- Christopher, T., Wilson, M. and Troy, A. 7/21/2005. *The EcoValue Project: A Web-based, Geographic Approach to the Delivery of the Economic Value of Ecosystem Services: Current Status and Issues of Concern* – 3rd Biennial Conference of the United States Society for Ecological Economics(USSEE) – Tacoma WA.
- Wilson, M.A. and A. Troy 03/21/2005. *Accounting for Ecosystem Services in a Spatially Explicit Format: Value Transfer and Geographic Information Systems*. International Workshop on Benefits Transfer and Valuation Databases: Are We Heading in the Right Direction? U.S. Environmental Protection Agency and Environment Canada. March 21-22, Washington DC.
- Wilson, Matthew A, Austin Troy, and Robert Costanza **2004**. *The Economic Geography of Ecosystem Goods and Services: Revealing the Monetary Value of Landscapes through Transfer Methods and Geographic Information Systems*. In Dietrich and Van Der Straaten (eds.) *Cultural Landscapes and Land Use*. London: Kluwer Academic Publishers.