The Nelson A. Rockefeller Center at Dartmouth College
The Center for Public Policy and the Social Sciences

The Class of 1964
Policy Research Shop

Valuing the Connecticut River

An Economic Analysis of Benefits and Costs

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This report was written by undergraduate students at Dartmouth College under the direction of professors in the Rockefeller Center. Policy Research Shop (PRS) students produce non-partisan policy analyses and present their findings in a non-advocacy manner. The PRS is fully endowed by the Dartmouth Class of 1964 through a class gift in celebration of its 50th Anniversary given to the Center. This endowment ensures that the Policy Research Shop will continue to produce high-quality, non-partisan policy research for policymakers in New Hampshire and Vermont.

Overview

I. Purpose and Background

II. Previous Research and Methods

III. Eight Valuation Metrics

IV. Conclusion and Summary Table

Purpose

- **Valuing the Connecticut River for citizens, businesses, visitors**

- **Focuses on eight specific valuation metrics**
    1. **Community Value Added**
    2. **Recreation**
    3. **Fishing**
    4. **Managed Resources**
    5. **River Health**
    6. **Flooding**
    7. **Ecosystem Services**
    8. **Intrinsic Value**

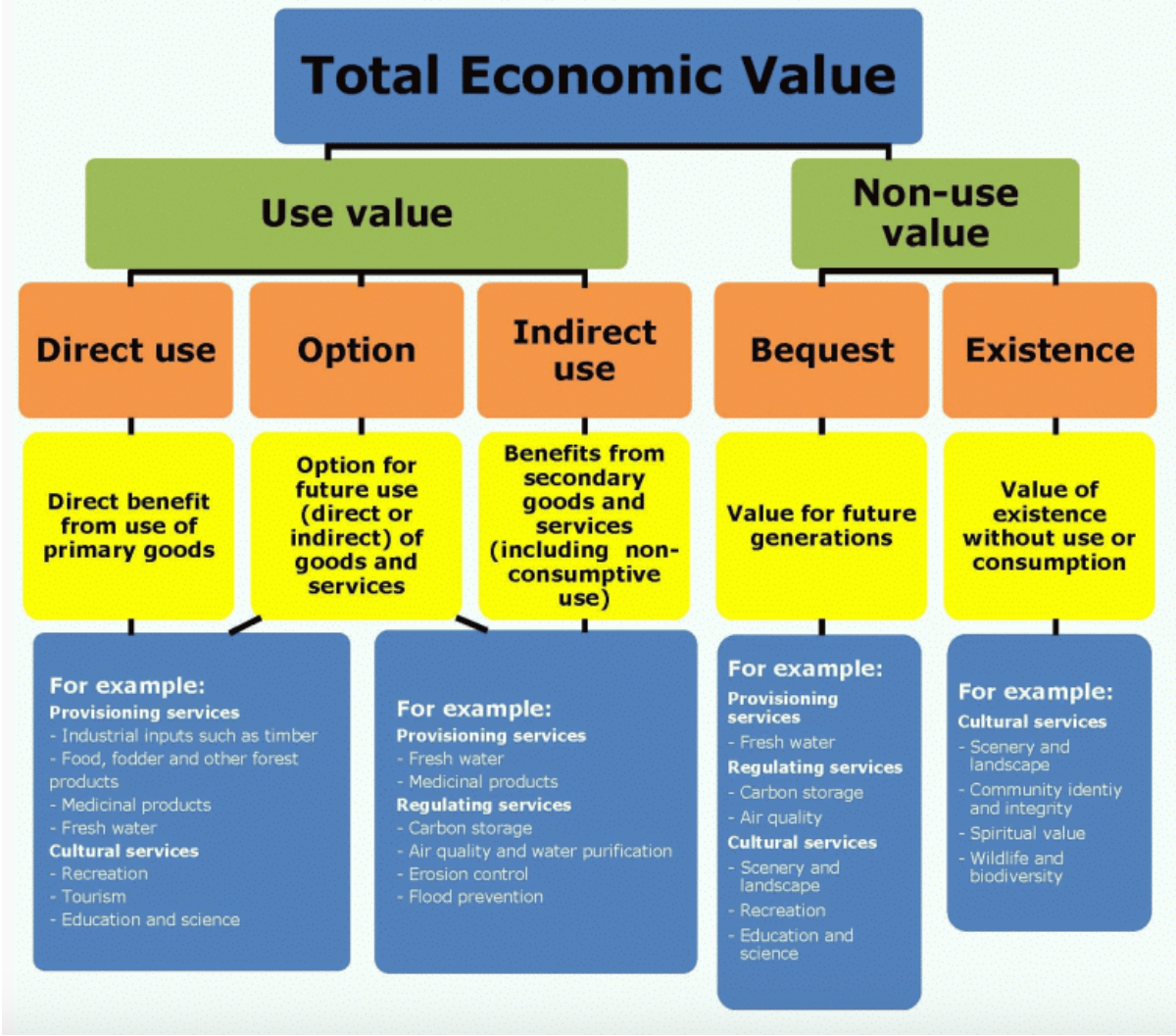
Background

- **Role as a geographic border**
  - **275-mile river corridor delineates Vermont and New Hampshire**
  - **Watershed drains 11,000 sq. miles of land**

- **Vermont Act 64: recognizing the "at-risk" elements of the River**
- **Economic and sustainability tradeoffs**

  - **Understanding the value of the river may support stakeholder decisions and improve policymaking at the local and state level.**

Framework: Total Economic Value

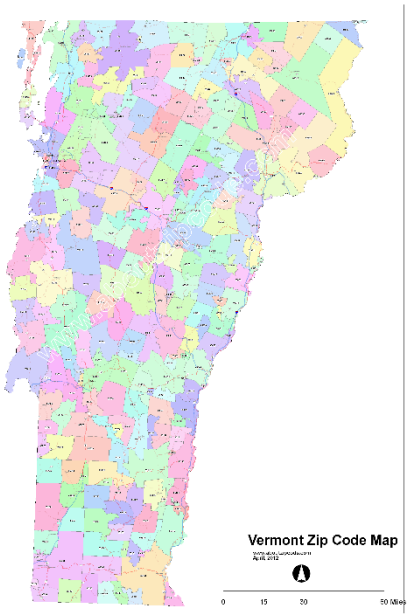


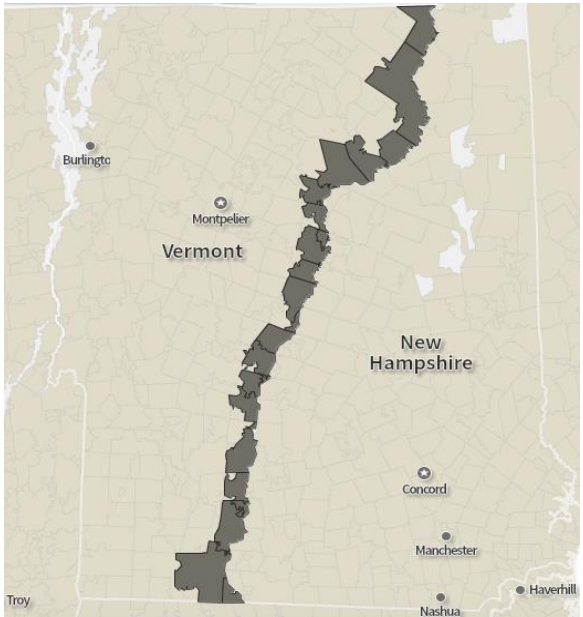
Common Ecological Valuation Techniques

- **Willingness to Pay**
- **Travel Cost Method**
- **Benefit Transfer**
- **Hedonic Pricing Model**

Community Value Added

- **Adjacent ZIP Code Approach**
  - **Three groups**
- **Two Parts: impact on (1) real estate and (2) income**





Descriptive Statistics

Table 1: Descriptive Statistics for ZIP Code Specifications

	(1) ZIP Codes Bordering River	(2) One ZIP Code Away from River	(3) Two ZIP Codes away from River
Population	3,561	1,053	1,054
	(4,077)	(1,373)	(719)
Area (in sq. miles)	50	36	32
	(44)	(27)	(14)
Population Density	78	35	33
	(50)	(30)	(15)
Occupied Units	1,507	443	452
	(1,749)	(570)	(313)
Median Year Built	1,969	1,973	1,975
	(11)	(8)	(7)
Median Value	187,070	217,991	215,041
	(66,738)	(71,756)	(86,754)
Median Gross Rent	823	915	887
	(144)	(308)	(218)
Average Household Income	64,452	71,379	68,166
	(17,665)	(19,817)	(16,817)
Average Family Income	76,964	82,293	81,597
	(24,745)	(25,504)	(22,328)
Per Capita Income	28,235	31,438	30,478
	(6,541)	(9,790)	(8,457)
Real Estate Value Per Sq. Mile	5,562,335	3,449,085	2,903,177
	(3,915,766)	(2,950,503)	(1,329,617)
Observations	23	34	37

Standard deviations in parentheses
All Values in 2015 dollars

Results

Table 2. Regression Results

	(1) ZIP Code Density	(2) ZIP Land Value	(3) Land Value per sq. mile	(4) Percent Change in Value	(5) Aggregate ZIP Income	(6) Percent Change Income
ZIP Specification	-20.71***	-77.98***	-1.395***	-0.220**	-33.59***	-0.338*
	(5.053)	(25.63)	(0.356)	(0.0913)	(11.48)	(0.129)
Per Capita Income		0.00315	0.000142***	4.22e-05***		
		(0.00206)	(3.11e-05)	(8.09e-06)		
Constant	68.72***	125.1*	1.050	13.81***	87.30***	17.50**
	(8.528)	(67.59)	(0.971)	(0.324)	(19.46)	(0.218)
Observations	94	94	94	94	94	94
R-squared	0.197	0.156	0.288	0.193	0.137	0.063

Robust standard errors in parentheses, clustered around ZIP Codes.
*** p<0.01, ** p<0.05, * p<0.1
Note: The coefficients of specifications 2, 3, and 5 are in millions of dollars.

Discussion

- **Real Estate**
  - **ZIP codes bordering the river are worth $2.8 million more per square mile (versus control group)**
  - **The river is estimated to contribute $3.2 billion in real estate prices (with 1,150 square miles in treatment group)**
- **Aggregate ZIP Code Income**
  - **Being one ZIP code closer to the river predicts an additional $70 million annual income**
  - **Connecticut River is estimated to contribute $1.6 billion in added annual income (with 23 ZIP codes along the river)**
- **Correlation vs. Causation**
- **Concentration Assumption**

Recreation

- **Sonter et. al (2016): Flickr photos**
- **CRWC: River recreation in Vermont is a $109 million business, producing $5.5 million in tax revenues**

- **Obstacle: to consider what portion of Vermont recreation is linked directly to the river**

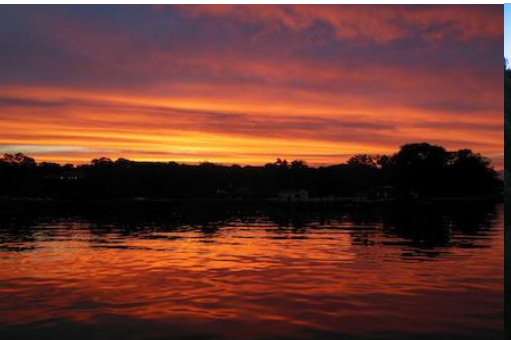
Calculation

The recreation/tourism value of the Connecticut River can be determined by:

1. **Multiplying the total state river recreation value by 22 percent to account for the share from the Connecticut River**
2. **Plus the $22,880 from the spending of visitors**
3. **Therefore, the total value of recreational resources to Vermont is $24 million**

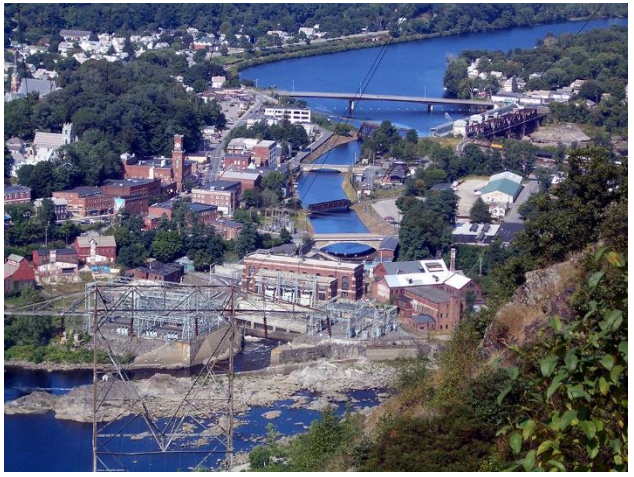
Fishing

- **Loo et al. (2015): Connecticut River Watershed contributes $175 million in recreational fishing**
- **With 5 states sharing the fishing recreation, Vermont likely captures 20%**
- **Therefore, the total value of fishing recreation to Vermont is estimated to be approximately $35 million annually**




Managed Resources: Dams

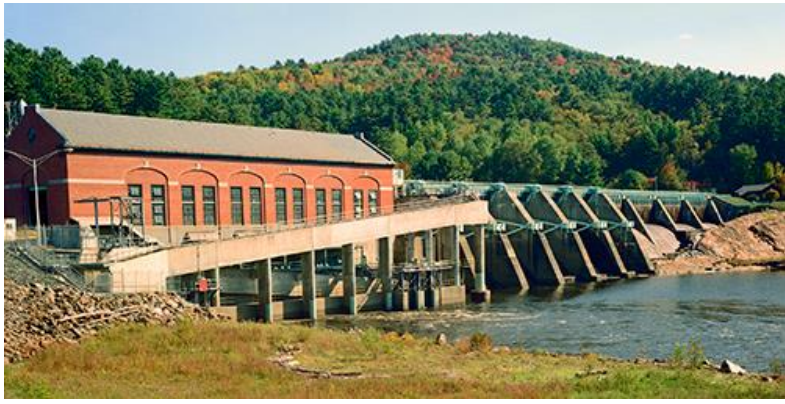
- **Most easily quantifiable managed resources**
- **Eleven hydroelectric dams along the portion of the Connecticut River in Vermont**



Hydroelectric Value Methodology

1. **Value of energy produced**
   - **Sum of total power generation from each dam times the value of the electricity consumers paid for the hydroelectricity**

2. **Tax Assessment Value of each dam assessed by the state**



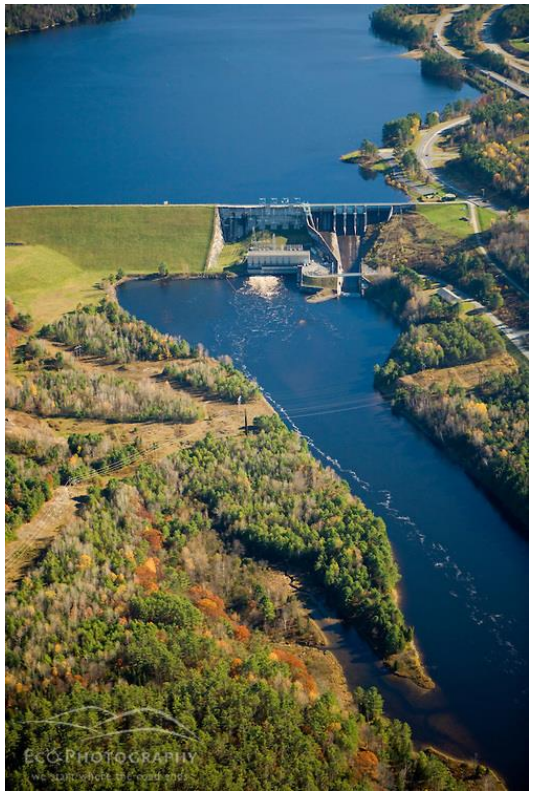
Dams

Table 3. Hydroelectric Connecticut River Dams

Name	Location	Annual Output	Vermont Assessed Value	Value of Electricity
Canaan Dam	Canaan, VT	7.3 Gigawatt-Hour[1]	$3,123,400*	$1,039,520
Lynman Falls Dam	Bloomfield, VT	0 GWh	$0	$0
Wyoming Dam	Guildhall, VT	0 GWh	$0	$0
Gilman Dam	Lunenberg, VT	25 GWh[1]	$1,876,000*	$3,560,000
15-Mile Falls Project	Waterford, VT	662.95 GWh[1]	$86,000,000	$94,404,080
Dodge Falls Dam	Ryegate, VT	26 GWh[1]	$1,240,000*	$3,702,400
Wilder Dam	Hartford, VT	158.47 GWh[2]	$32,400,000	$22,565,985
Bellows Falls Dam	Bellows Falls, VT	248.9 GWh[2]	$129,000,000	$35,441,508
Vernon Dam	Vernon, VT	168.85 GWh[2]	$30,500,000	$24,043,900
Total	**-**	**1,297.46 GWh**	**$284,139,400**	**$184,757,393/year**

Reservoir Withdrawals

- Importance of water resource
- 15-Mile Falls Project has over three billion cubic feet of water
- Calculation: multiply the average cost per gallon of water by the amount of water withdrawn annually.
- The 2008 Municipal Water Rate Census in Vermont reports the average cost of 5,000 gallons of water to be worth $41.85



Reservoir Withdrawals

- This represents a value of $8.37 per 1,000 gallons.
- According to a report on water withdrawals and use in Vermont, the Upper Connecticut and Middle Connecticut Watersheds account for 2.85 million gallons per day in withdrawals.
- This would generate $23,855 in daily revenues and $8.7 million per year
- Underestimate: not the entire watershed and does not account for tributaries

River Health Fines

- **Trade-offs required for policy makers**
  - **prioritizing competing needs**
- **Conserving a resource vs. recreational opportunity**
- **Conservation can pay off in the long-run**
- **Research: Water quality and clarity can benefit environmental services including recreation and human health**

River Health Costs

- **Present Day costs: EPA fines total over $500,000 for water pollution in Vermont**
- **Vermont business specific fines have ranged from $10k to $90k**
- **Penalties might not reflect full value damage to water quality in Vermont**

Flooding

- **Flooding causes over $7 billion in damage in the U.S. annually**
- **Freely flowing rivers can reduce the impacts of severe storms and flooding**
- **Watson et al. (2016): VT flood plain value**

Flooding, Continued

- **Hurricane Irene is estimated to have cost Vermont $700 million in damages**
  - **With over 800 homes, 300 bridges, and 2,400 roads damaged**
- **Even if Hurricane Irene was a once in 100 year storm, spending $7 million in flooding damages annually would outweigh the cost of flood protection**

Ecosystem Services

- **Ecosystem Wildlife Multiplier (NH Land Trust research)**
- **Need to consider wildlife, biogeochemical processes**
- **Unable to determine a fair net present value**

Intrinsic Value

- **Refers to non-use values of an environmental resource**
  - **Represents passive value of the river as an end-in-itself**
- **Natural and cultural values**

Intrinsic Value, Continued

Table 4. Cultural Resources along the Connecticut River in Vermont

Cultural Site	Location	Description of the Site
Fort Dummer – Fort Dummer State	Brattleboro, VT	British fort built in 1724
Moore and Thompson Paper Mill Complex	Bellows Falls, VT	Major late 19th century industrial paper mill
Adams Gristmill	Bellows Falls, VT	Historical industrial building along the river
Rockingham Art and Museum Project	Bellows Falls, VT	Museum that hosts a series of festivals along the river throughout the year
Bellows Falls Petroglyph Site	Bellows Falls, VT	Site with pre-contact Native American petroglyphs
Tory's Cave	Springfield, VT	Secret Tory meeting place during the Revolutionary War
Barnet (Village)	Bradford Falls, VT	Historic, walkable town center and village green alongside the river
Old Constitution House	Windsor, VT	Where delegates met to form the Republic of Vermont in 1777

Source: The Connecticut River Valley and Shoreline Travel Information

Summary Table

Source of Value	Value Provided to Vermont
ZIP Code Property Value	$3.2 billion in value added
ZIP Code Aggregate Income	$1.6 billion per year
Recreational Resources	$24 million per year
Fishing	$35 million per year
Hydroelectricity	$185 million
Hydroelectric Dam Value	$278 million
Reservoirs	Over $8.7 million per year
Pollution Fines	Up to $500,000
Flooding	Significant Potential Costs
Ecosystem Services	Potential Monetary Benefits
Intrinsic Non-use Value	Historical, Cultural, Generational

Conclusions

Multiple Sources

- There are several crucial sources of value that contribute to making the Connecticut River an asset to Vermont

Tradeoffs

- An aggregate value was not calculated since it is important to view each source as a value by itself
- There will be tradeoffs

Identify

- Tough to clearly identify the river
- Large magnitudes definitely highlight importance of understanding of costs and benefits