EPA

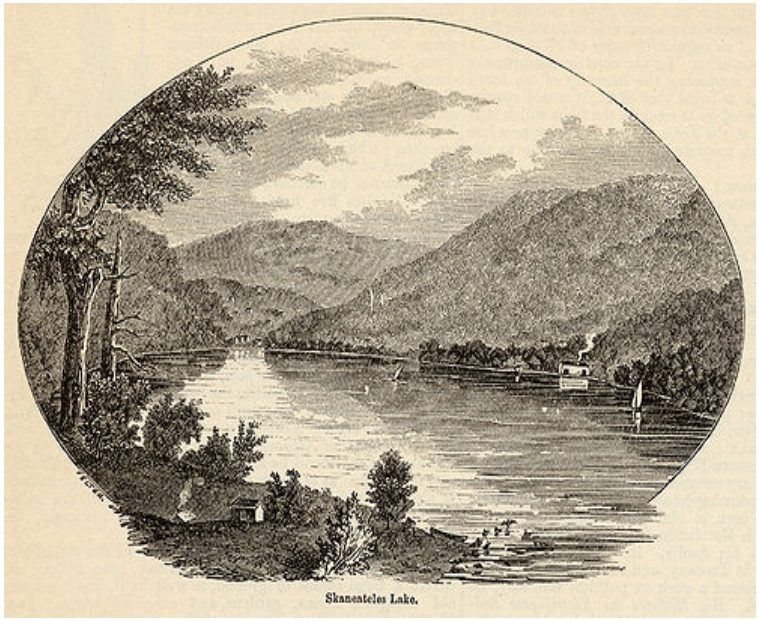
www.epa.gov/ord

ECOLOGICAL RESEARCH PROGRAM

BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

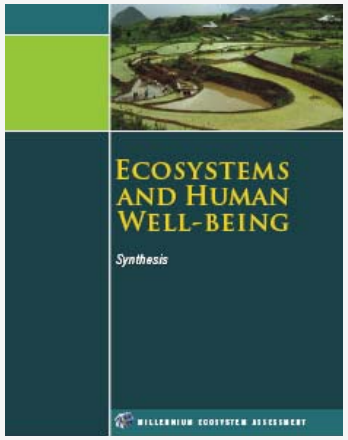
The Benefits of Protecting and Restoring Northeastern Lakes: an Ecosystem Services Perspective

Bryan Milstead
Environmental Protection Agency
Atlantic Ecology Division
Narragansett, RI
401-782-3015
milstead.bryan@epa.gov



U.S. Environmental Protection Agency
Office of Research and Development

What is the Value of Nature?
What do we Value in Nature?



Ecosystem Services

The explicit acknowledgement that naturally functioning ecosystems benefit human beings.

Ecosystem Services Research Program (ESRP) Elements: a three pronged approach to research on ecosystem services

- Pollutant-driven research – reactive N
  - How does a regulated pollutant affect, positively and/or negatively, the suite of ecosystem services at multiple scales?
- Ecosystem-based research – wetlands &coral reefs
  - How does the suite of ecosystem services provided by a single ecosystem type change under alternative management options at multiple scales?
- Place-based research – 5 studies: urban to regional
  - How does the suite of ecosystem services for within a defined area change under alternative management options/drivers?

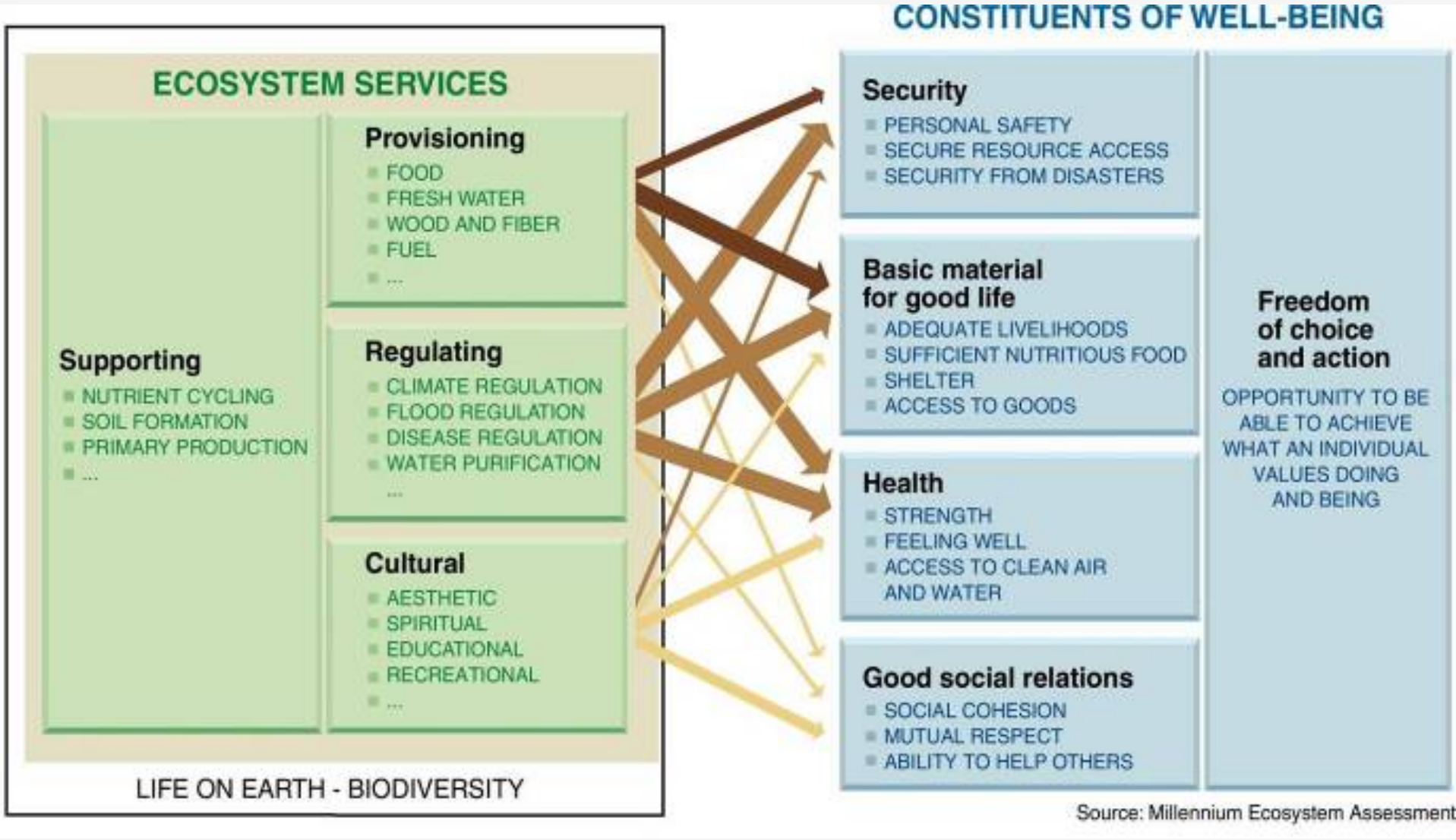
For information and questions, comments feedback

- Science connector: http://portal.epa.gov/ESC
- Visit Our Web Site: http://www.epa.gov/ecology

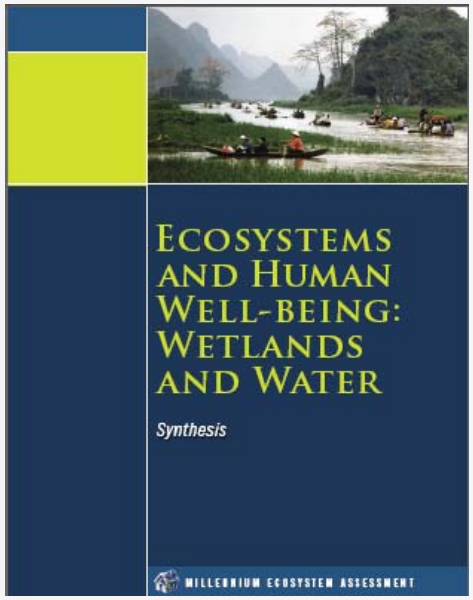
  or
- http://www.epa.gov/ord/npd

- Goodman.iris@epa.gov
- Linthurst.rick@epa.gov

Consequences for People

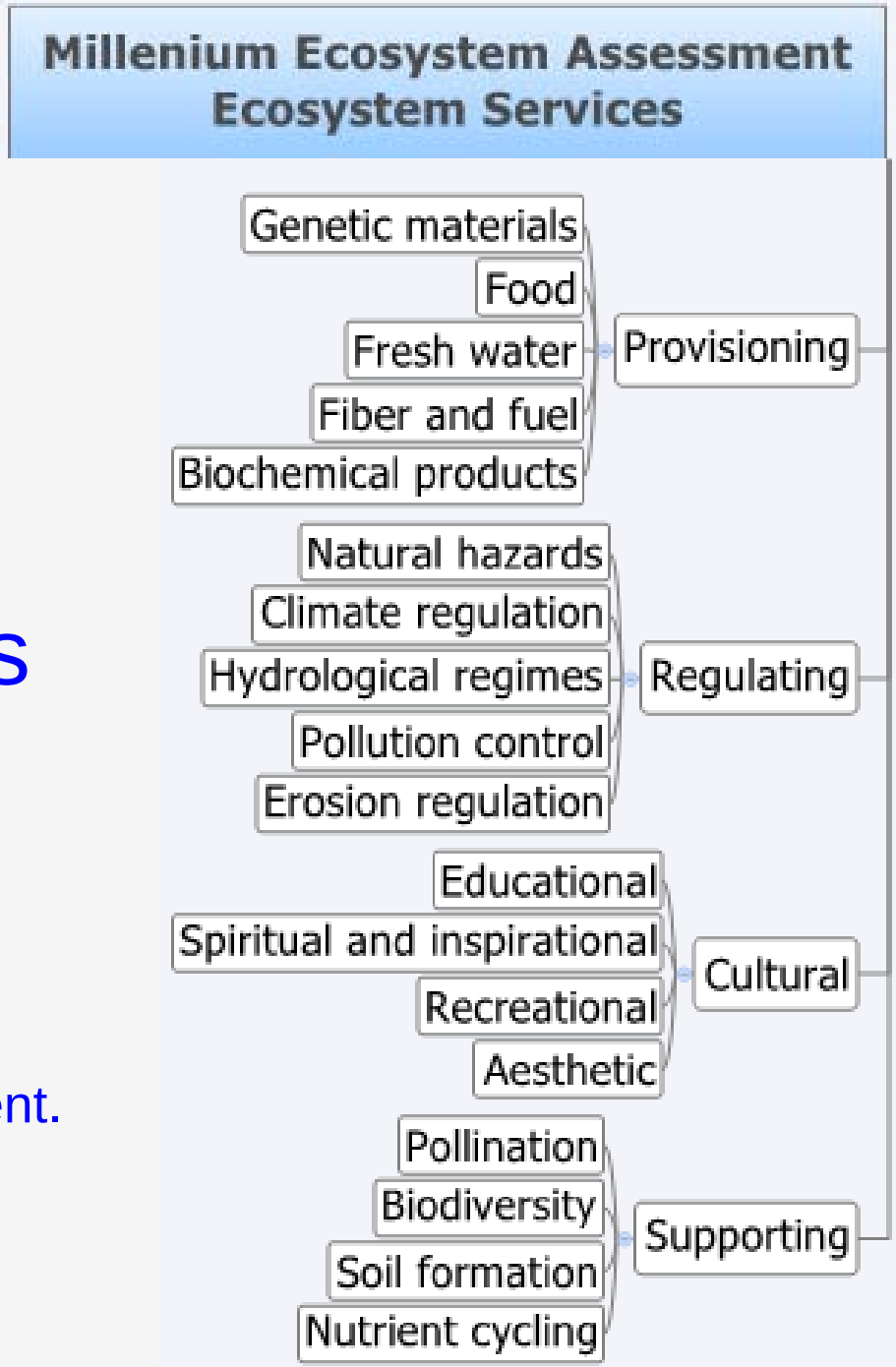


Source: Millennium Ecosystem Assessment



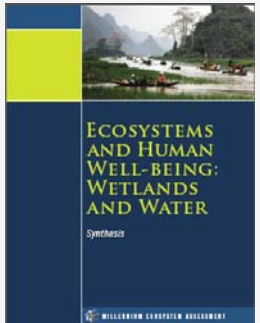
"Ecosystem services are the **benefits** people obtain from ecosystems"

The Millennium Ecosystem Assessment.
http://www.millenniumassessment.org



Freshwater Benefits

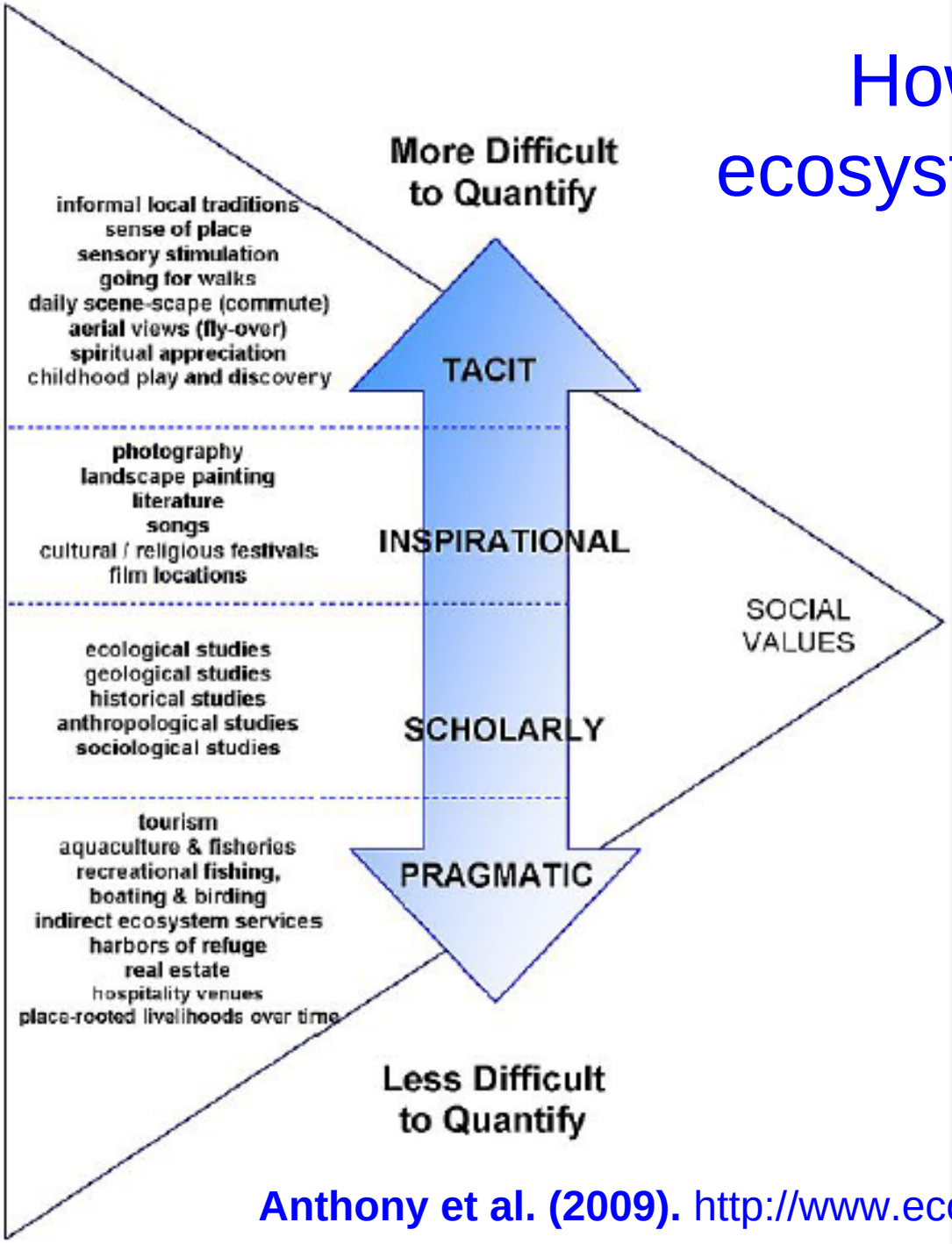
- Water Supply
- In Situ, Non-extractive Use
- Useful Biomass
- Navigation & Transportation
- Waste Assimilation
- Flood Protection
- Carbon Sequestration



Millenium Ecosystem Assessment Ecosystem Services

- Provisioning
  - Genetic materials
  - Food
  - Fresh water
  - Fiber and fuel
  - Biochemical products
- Regulating
  - Natural hazards
  - Climate regulation
  - Hydrological regimes
  - Pollution control
  - Erosion regulation
- Cultural
  - Educational
  - Spiritual and inspirational
  - Recreational
  - Aesthetic
- Supporting
  - Pollination
  - Biodiversity
  - Soil formation
  - Nutrient cycling

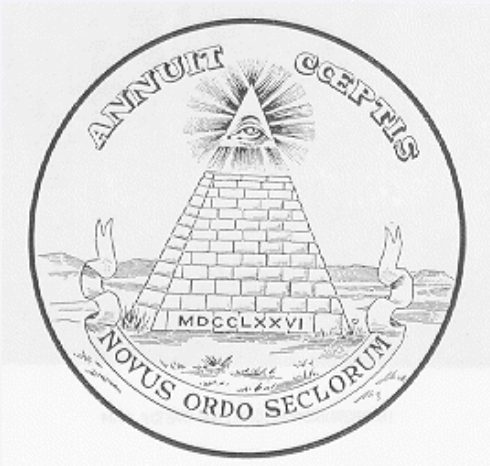
How do we quantify ecosystem service benefits?



Anthony et al. (2009). http://www.ecologyandsociety.org/vol14/iss1/art8/

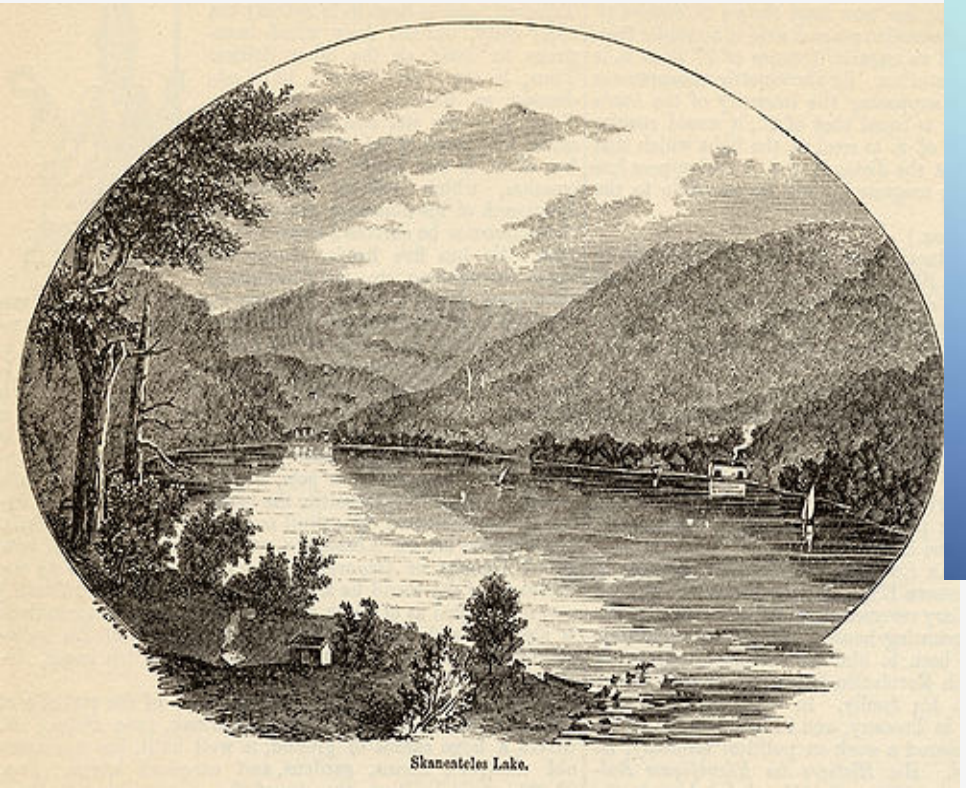
Ecosystem Services Valuation

- Revealed Willingness to Pay
  - Market Price
  - Production Function
  - Hedonic Pricing
  - Travel Cost
- Imputed Willingness to Pay
  - Cost Avoided
- Expressed Willingness to Pay
  - Contingent Valuation
  - Contingent Choice
- Benefit Transfer

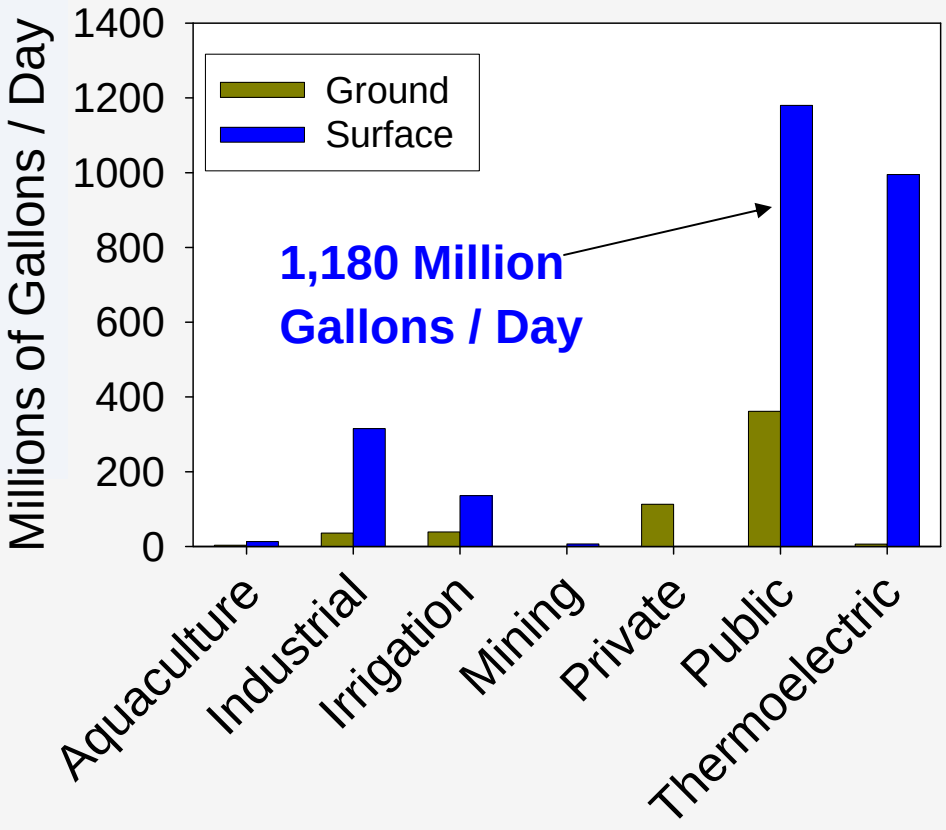


www.ecosystemvaluation.org

How do people in New England benefit from access to clean fresh water?



2000
New England
Water Withdrawls



How much would it cost to replace this with Evian Water?

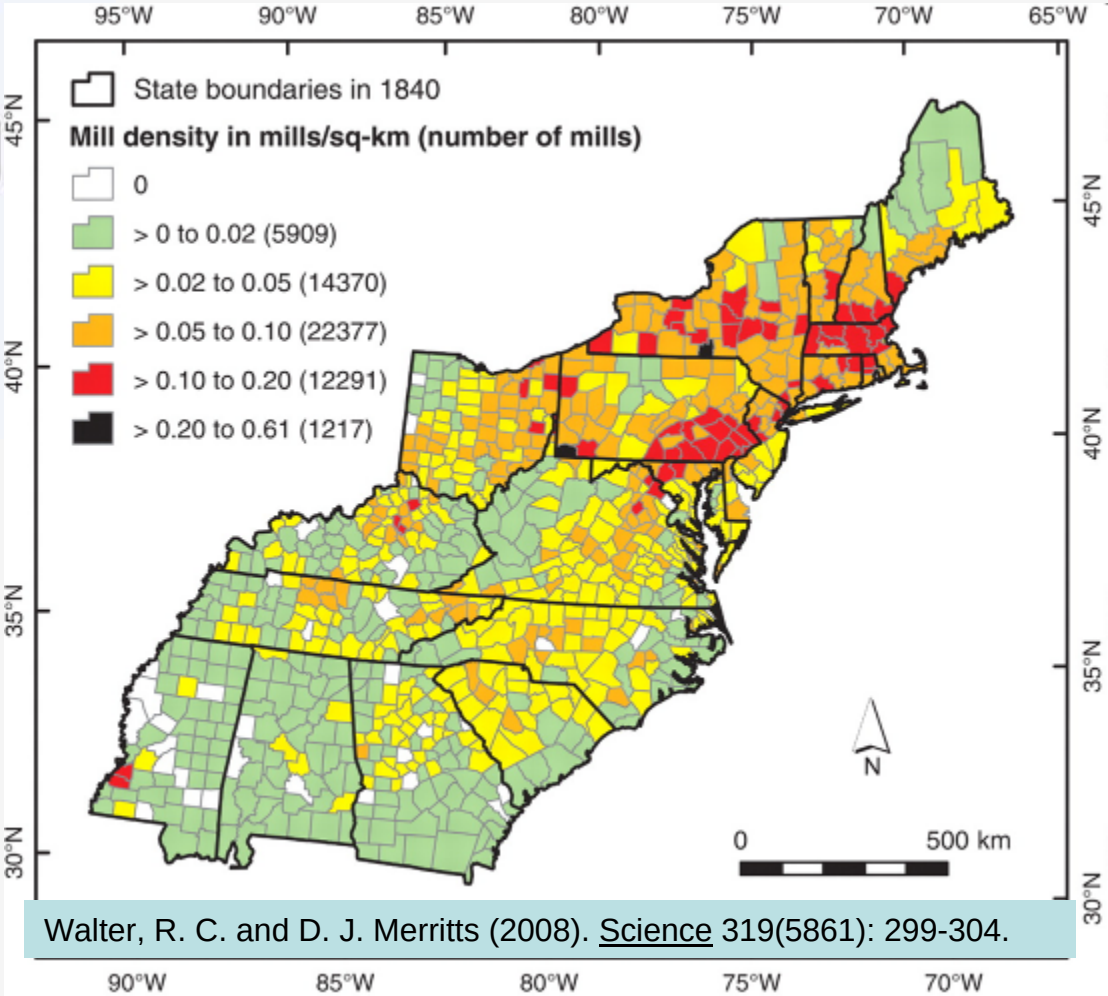
$7 Billion / day

Freshwater Benefits

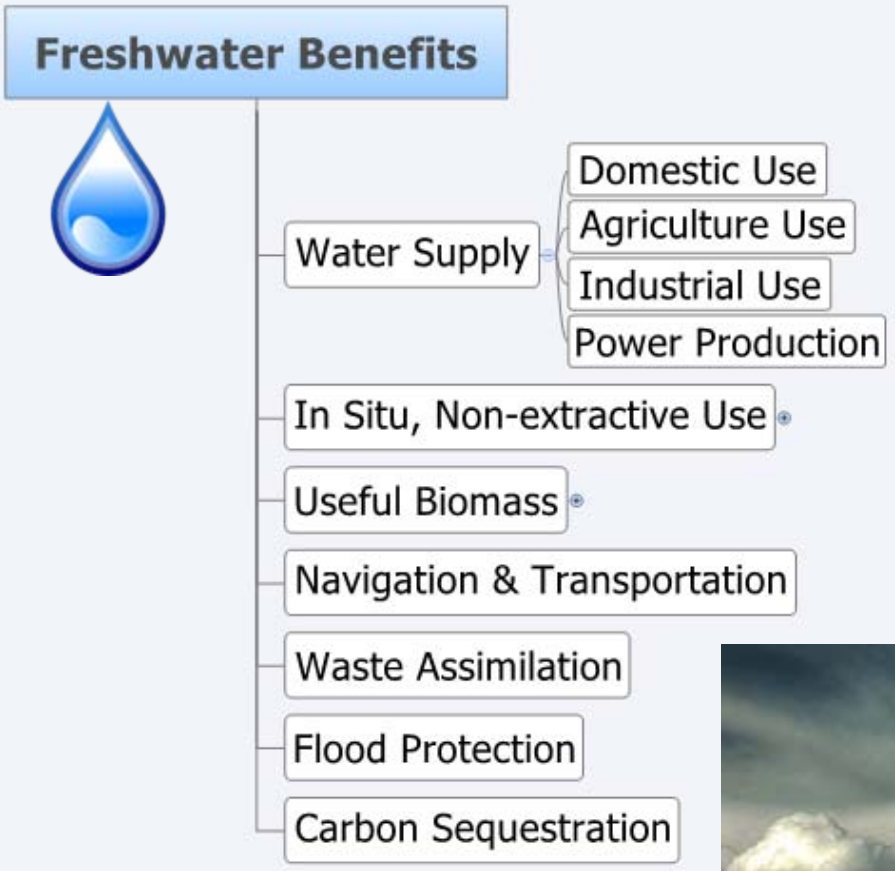
- Water Supply
  - Domestic Use
  - Agriculture Use
  - Industrial Use
  - Power Production

In 1840 there were ~10,000 mills and >16,000 Dams in Pennsylvania

The National Inventory of Dams identifies 1,517 in Pennsylvania



Walter, R. C. and D. J. Merritts (2008). Science 319(5861): 299-304.



New England

≥ 537 Hydroelectric Dams Produced 6.8 TWH of Electricity in 2007

http://tonto.eia.doe.gov

What would consumers pay for this power?

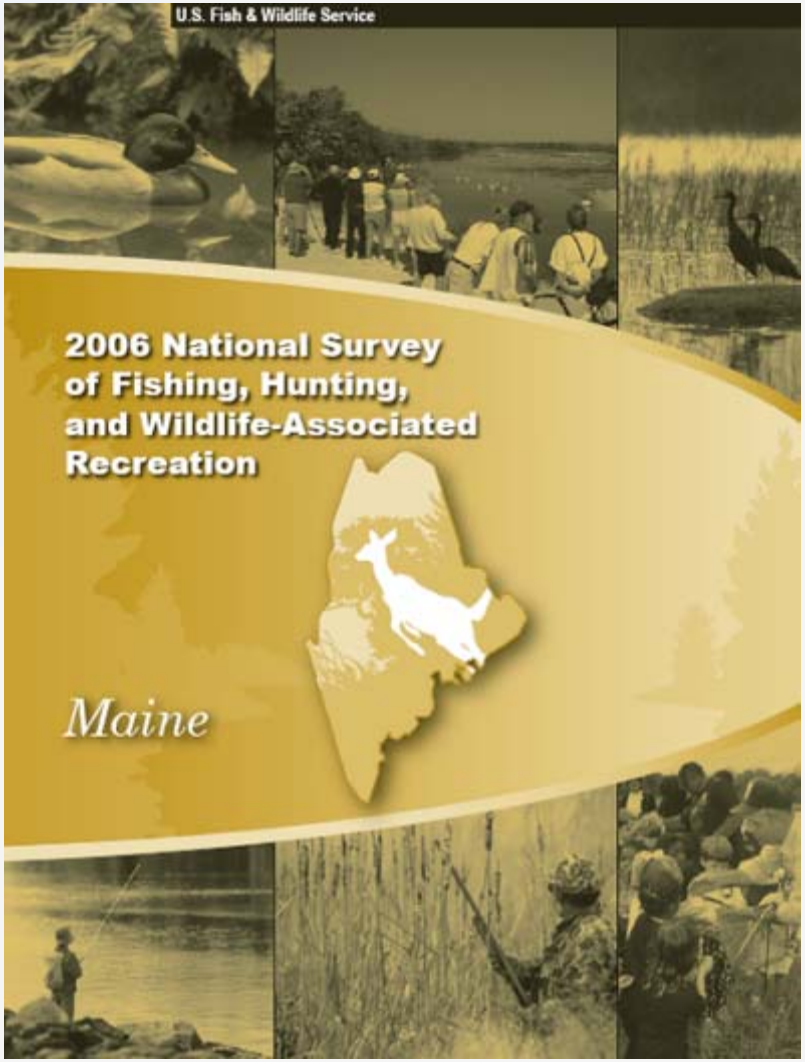
$954 Million

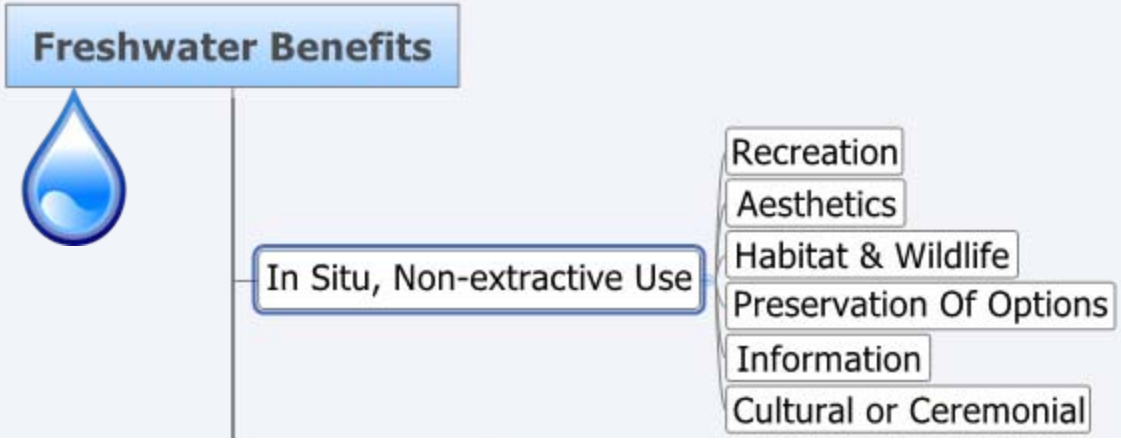
- **Freshwater Benefits**
  - In Situ, Non-extractive Use
    - Recreation
    - Aesthetics
    - Habitat & Wildlife
    - Preservation Of Options
    - Information
    - Cultural or Ceremonial
  - Water Supply
  - Useful Biomass
  - Navigation & Transportation
  - Waste Assimilation
  - Flood Protection
  - Carbon Sequestration

Recreational Fishing in New England 2006

1,652,000 Participants

$1.6 Billion in Expenditures





Water Clarity Affects Housing Prices in New Hampshire

Table 4. Average Estimated Impacts of Water Clarity Variables by Market Area

Description	Implicit Prices [a]	Value of One-Meter Change in Secchi Reading, [b] (Standard Error) [c]		% Increase in Average *HP* Due to One-Meter Change
Conway/Milton Market:				
$HP = \$125{,}915.00 + 4.4806 LKALWC$	\$1,134.63	\$1,268.24	(492.58)	0.91
Winnipesaukee Market:				
$HP = \$172{,}225.30 + 17.338 LKALWC$	\$5,541.43	\$6,122.33	(2,101.60)	3.50
Derry/Amherst Market:				
$HP = \$132{,}924.27 + 76.775 LKALWC$	\$3,922.62	\$4,411.39	(2,004.51)	3.39
Spofford/Greenfield Market:				
$HP = \$171{,}028.81 + 149.6 LKALWC$	\$9,756.33	\$11,094.09	(2,154.99)	6.64

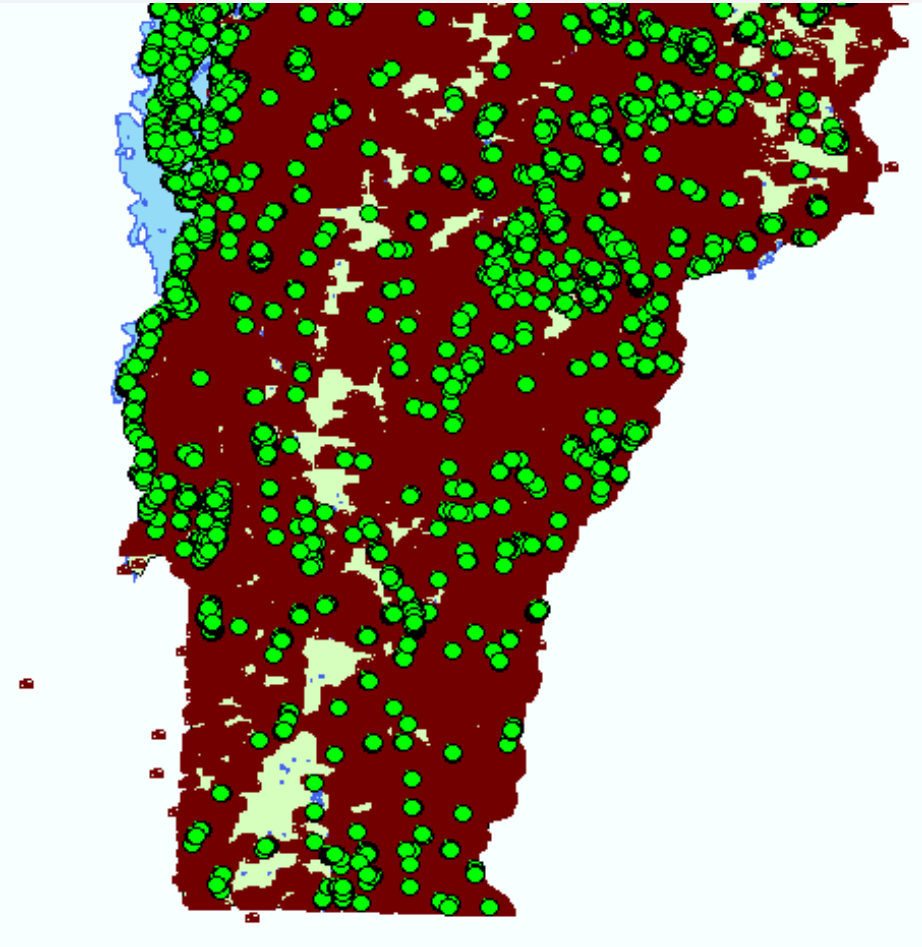
Gibbs et al. (2002). Agricultural and Resource Economics Review 31(1): 39-46.

Freshwater Benefits

- In Situ, Non-extractive Use
  - Recreation
  - Aesthetics
  - Habitat & Wildlife
  - Preservation Of Options
  - Information
  - Cultural or Ceremonial
- Water Supply
- Useful Biomass
- Navigation & Transportation
- Waste Assimilation
- Flood Protection
- Carbon Sequestration

Vermont

13% of Houses are Lakefront Properties



Freshwater Benefits

- Useful Biomass
  - Fishing, Hunting, & Gathering
  - Aquaculture
  - Hatcheries

Barramundi
Indoor Aquaculture in Massachusetts
http://www.thebetterfish.com/

Freshwater Benefits

- Water Supply
  - Domestic Use
  - Agriculture Use
  - Industrial Use
  - Power Production
- In Situ, Non-extractive Use
  - Recreation
  - Aesthetics
  - Habitat & Wildlife
  - Preservation Of Options
  - Information
  - Cultural or Ceremonial
- Useful Biomass
  - Fishing, Hunting, & Gathering
  - Aquaculture
  - Hatcheries
- Navigation & Transportation
- Waste Assimilation
- Flood Protection
- Carbon Sequestration

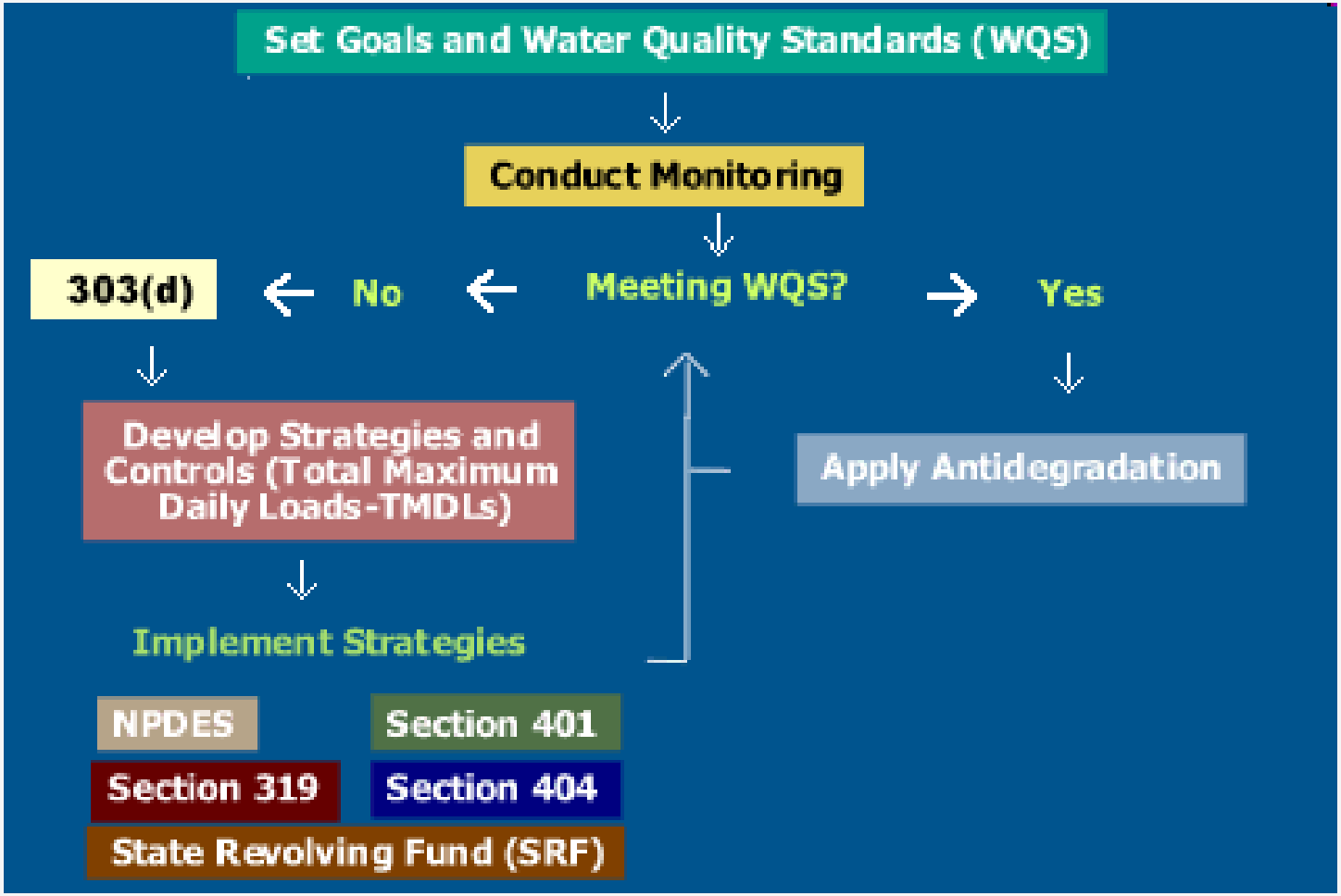
Freshwater Benefits

- Water Supply
- In Situ, Non-extractive Use
- Useful Biomass
- Navigation & Transportation
- Waste Assimilation
- Flood Protection
- Carbon Sequestration

Designated Uses

- CT MA ME NH RI VT — Primary Contact Recreation
- CT MA ME NH RI VT — Secondary Contact Recreation
- MA VT — Aesthetic Value
- MA — Exceptional & Outstanding Significance
- CT MA ME NH RI VT — Aquatic Life & Wildlife
- Cultural or Ceremonial
- CT MA ME NH RI VT — Fish Consumption
- CT MA ME NH RI — Shellfish Consumption
- CT MA ME NH RI VT — Drinking Water
- CT MA VT — Agricultural Water Supply
- CT MA ME — Industrial Water Supply
- CT ME — Navigation

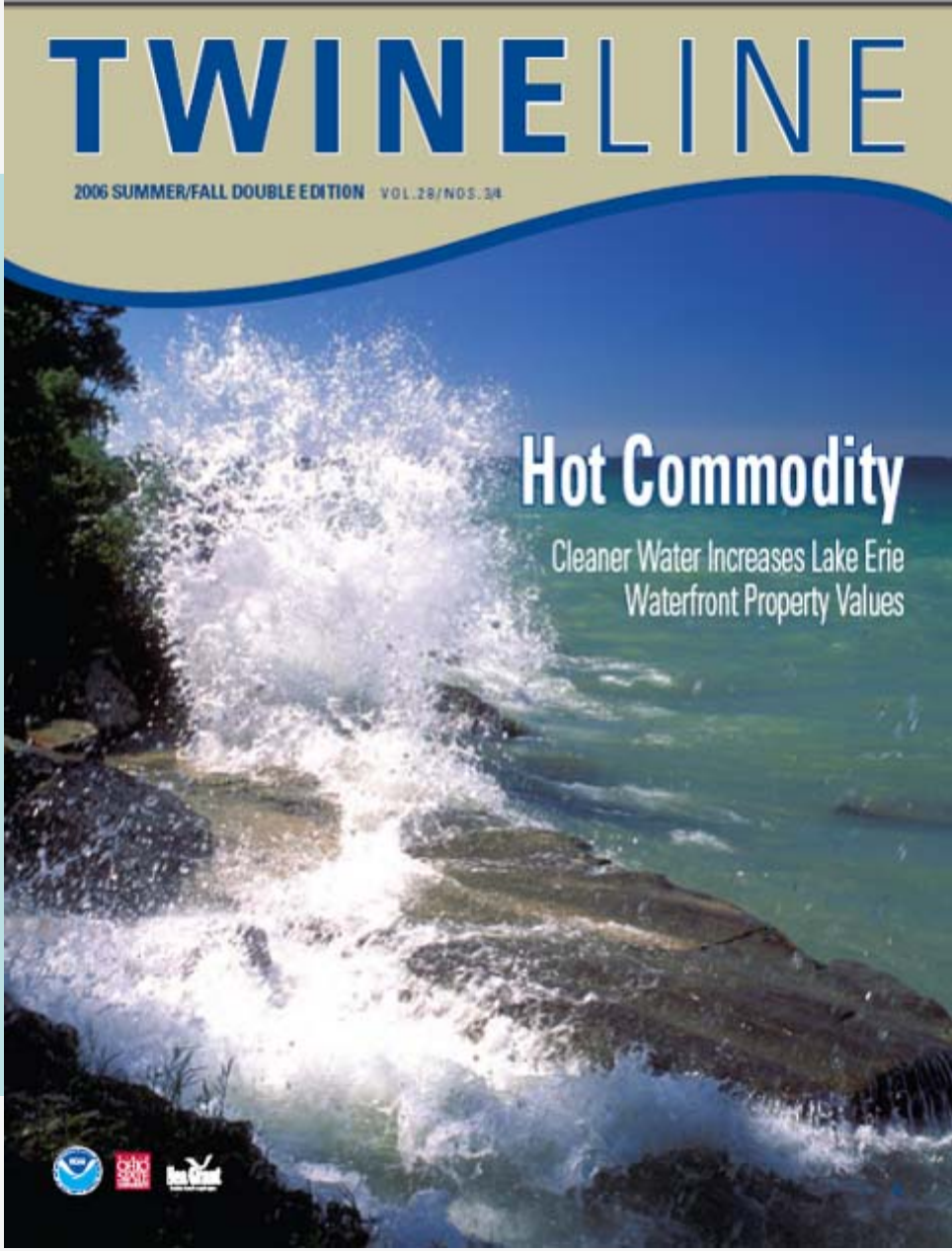
The Clean Water Act



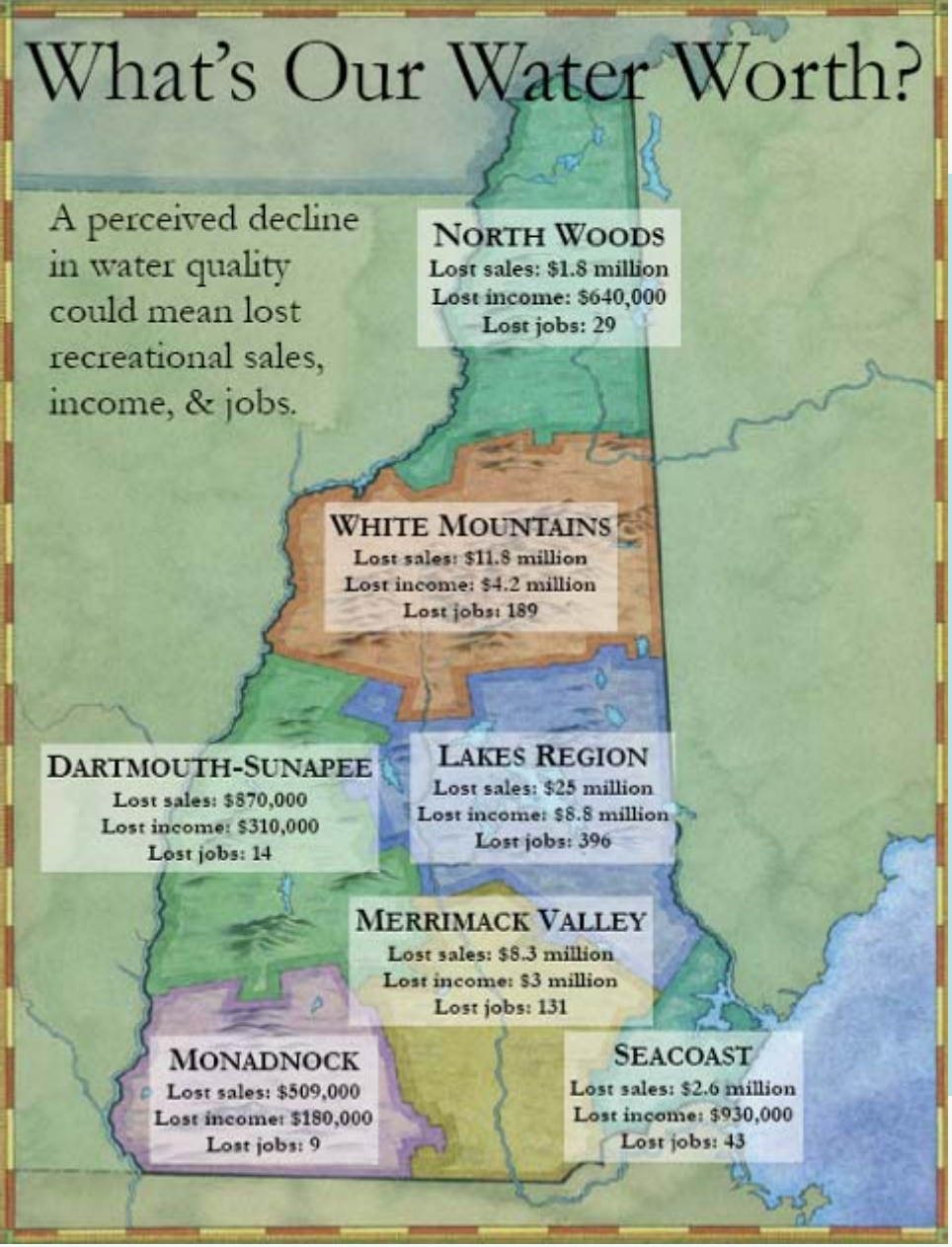
Regulatory Approach: What does it cost to keep our waters clean?

Ecosystem Services Approach is Benefits Based

What can be gained?



http://www.in.gov/dnr/files/fw-Cleaner_Water_Increases_Lake_Erie_Waterfront_Property_Values.pdf

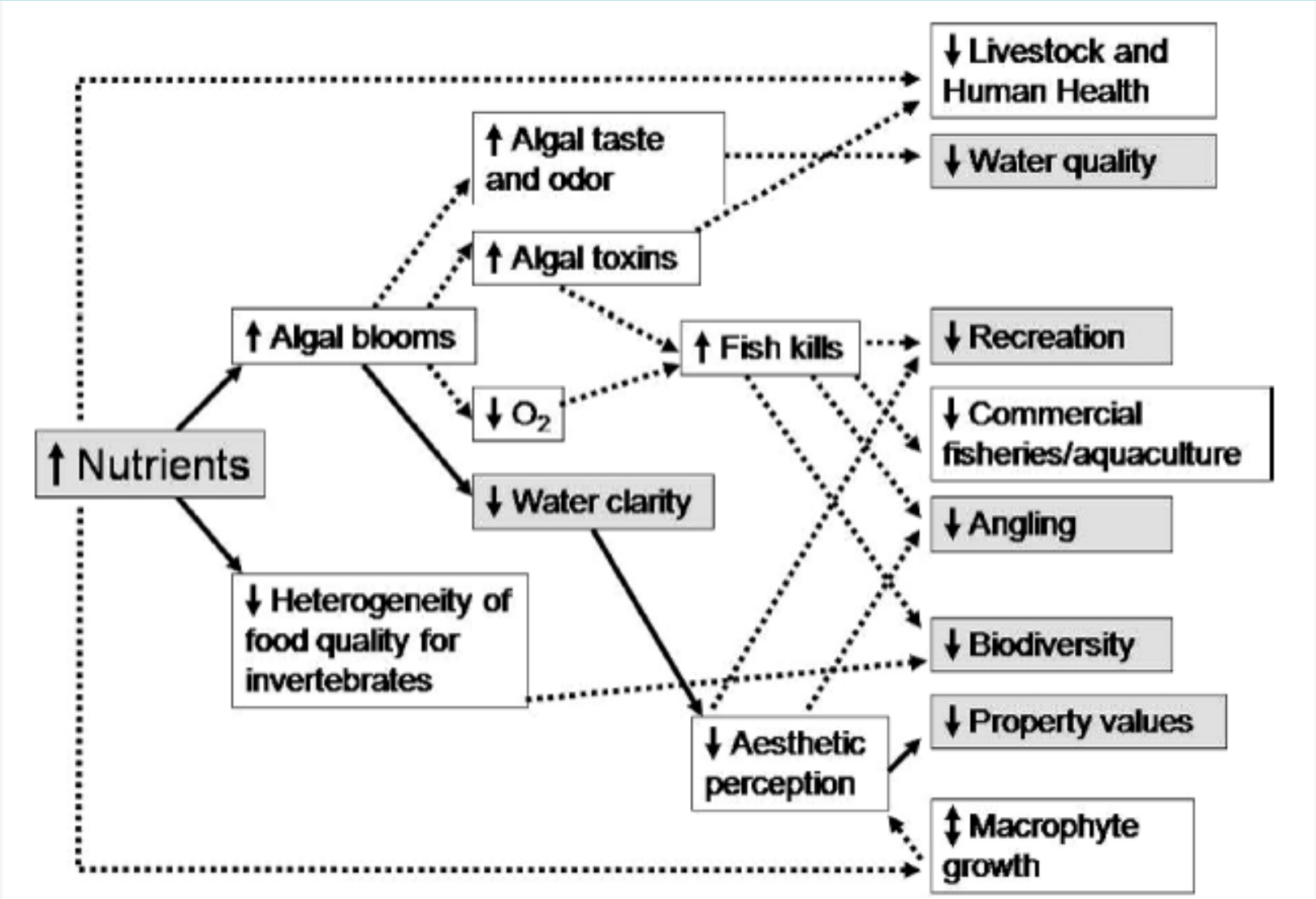


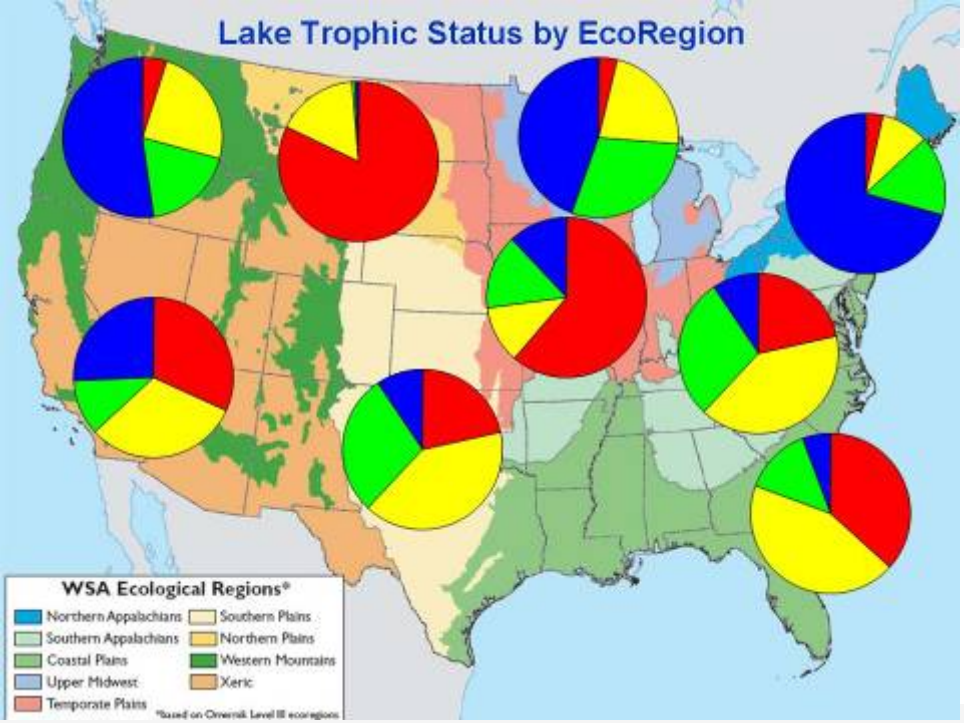
Ecosystem Services Approach is Benefits Based

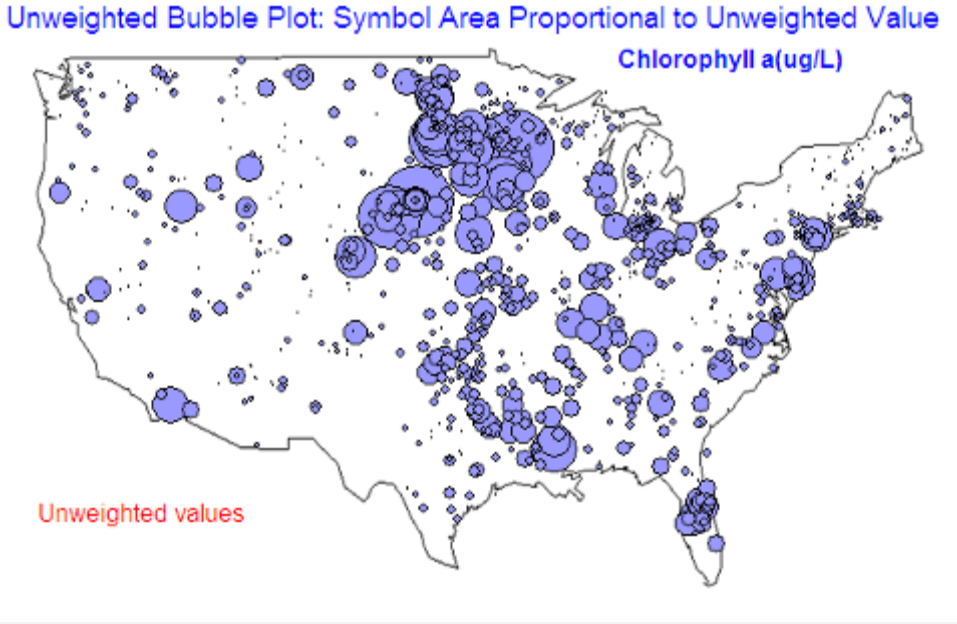
What can be lost?

http://nhlakes.org/docs/Economic-Study-Phase-IV-Brochure.pdf

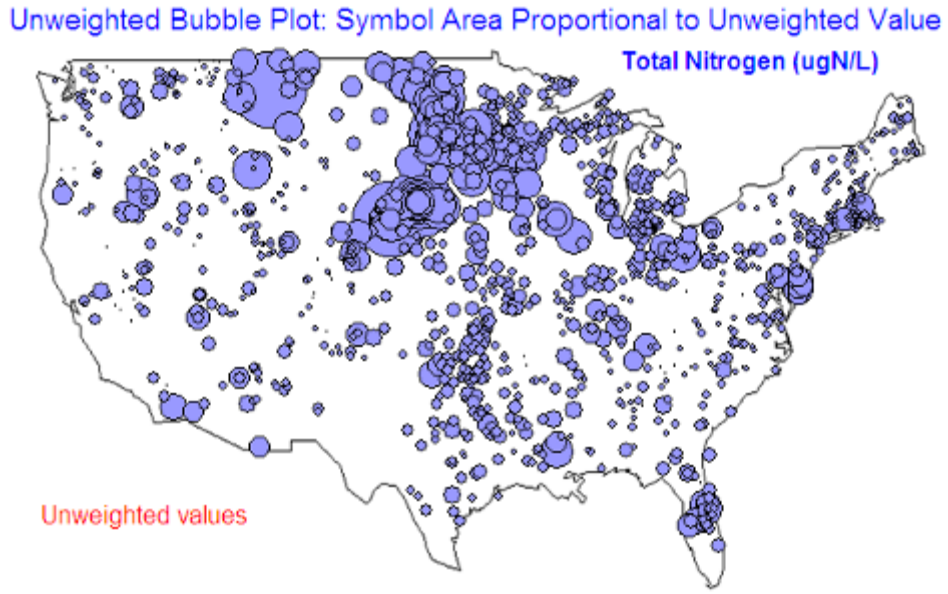
Ecosystem Service Benefits are Affected by Water Quality, Water Quantity and Timing of Flow

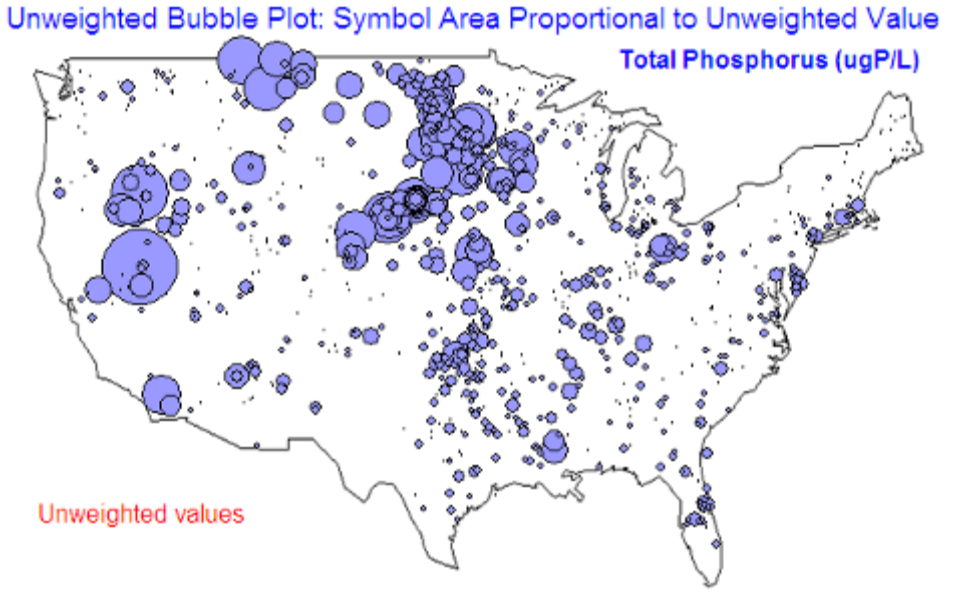






Oligo-	Meso-	Eutrophic	Hypertrophic

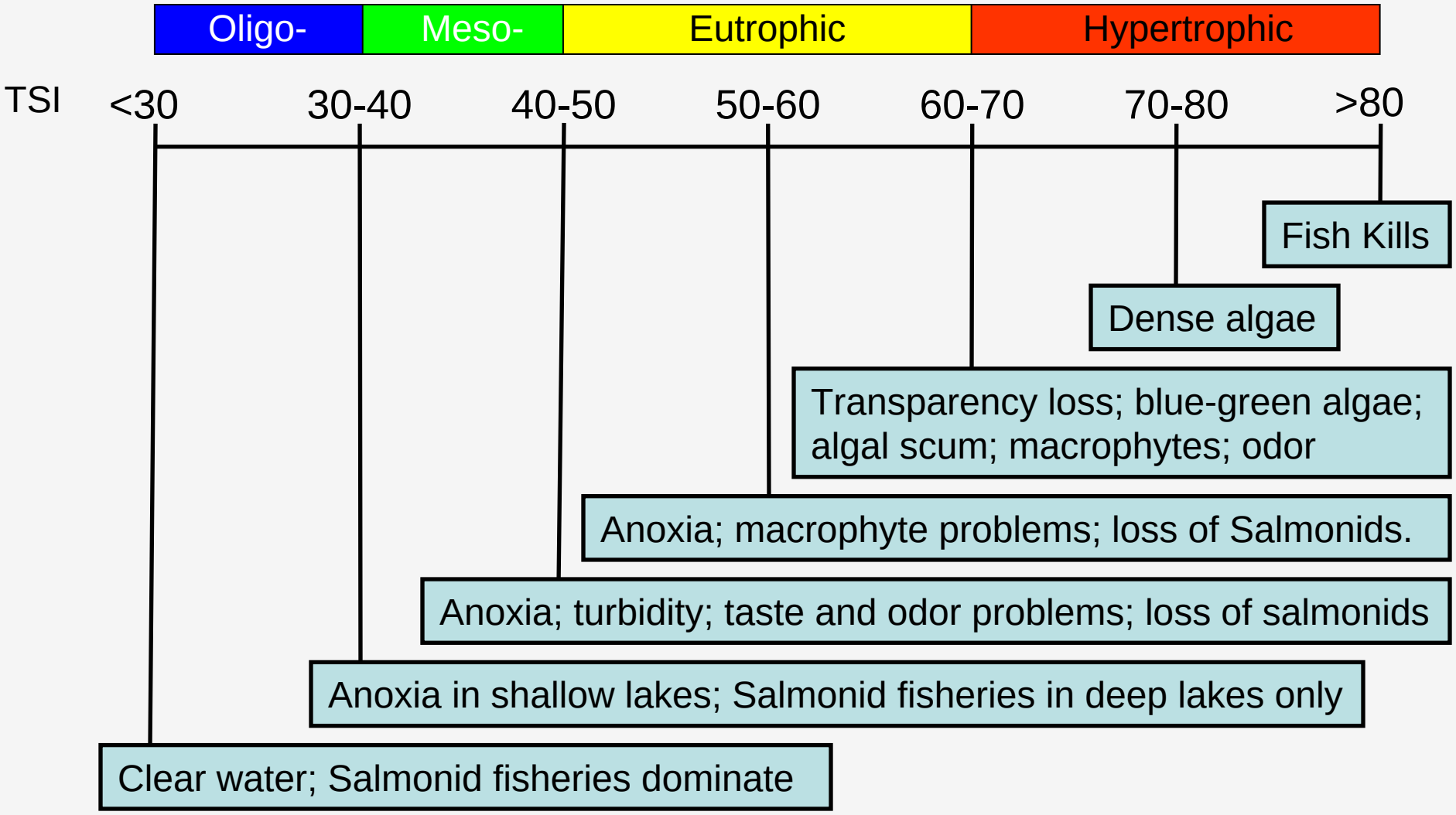


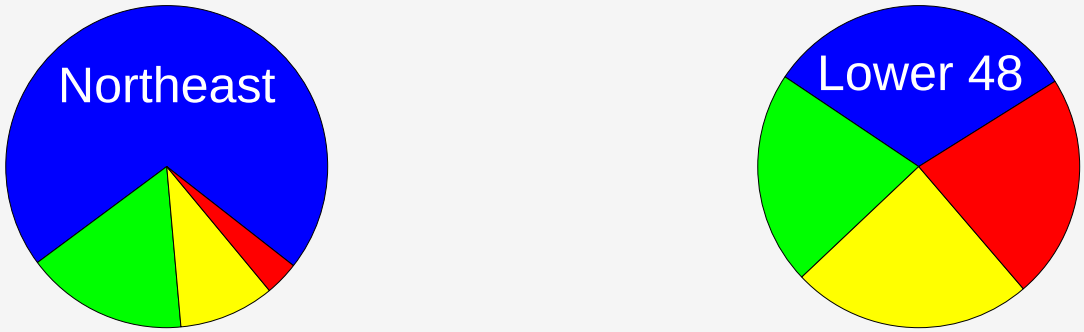


Trophic Status Indicator for Total Phosphorus

TSI(TP) = 14.42 ln(TP) + 4.15

http://castlehs.com/users/johlsen/ecology/A%20Trophic%20State%20Index.doc





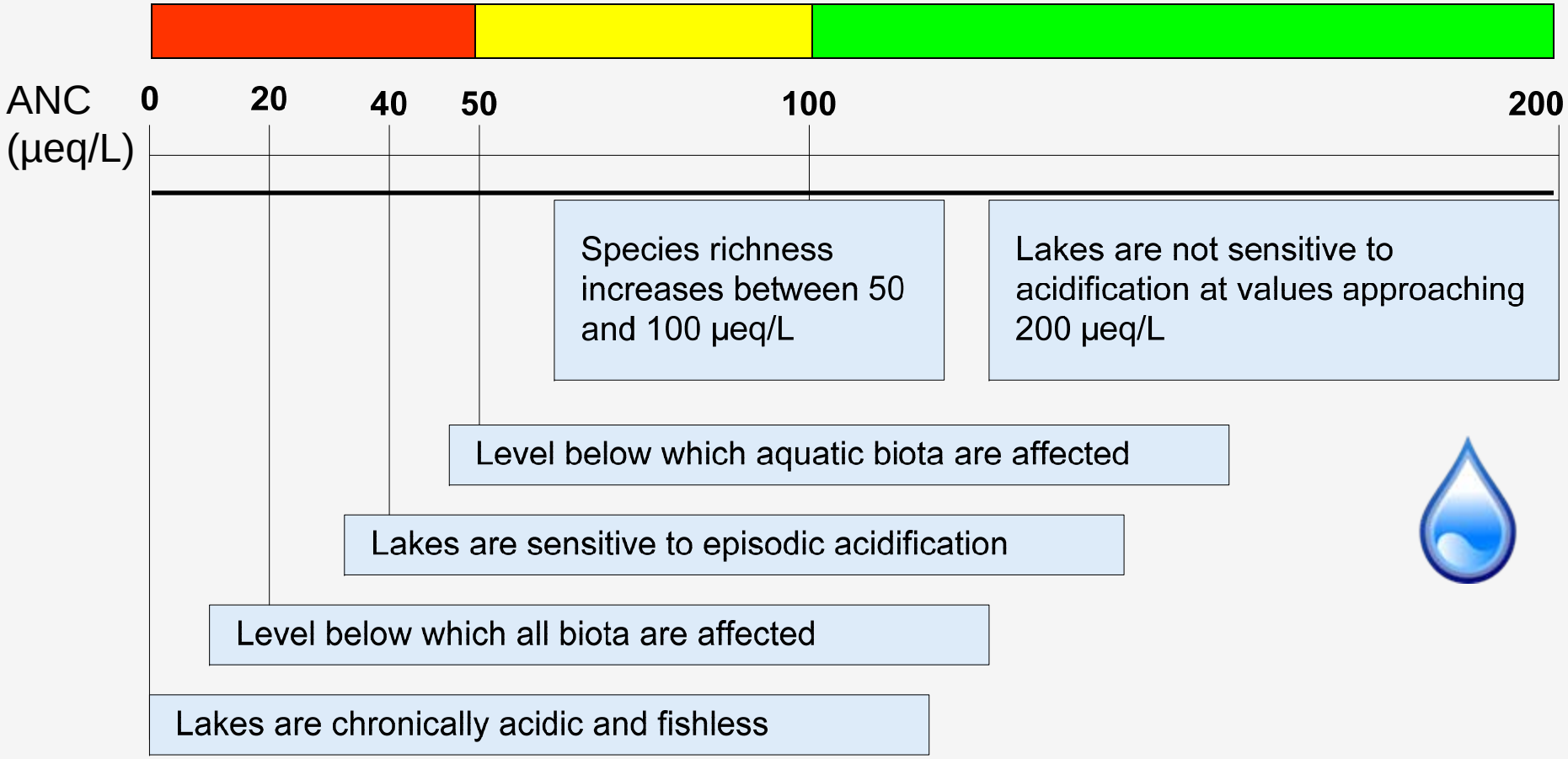
Oligo- | Meso- | Eutrophic | Hypertrophic

TSI

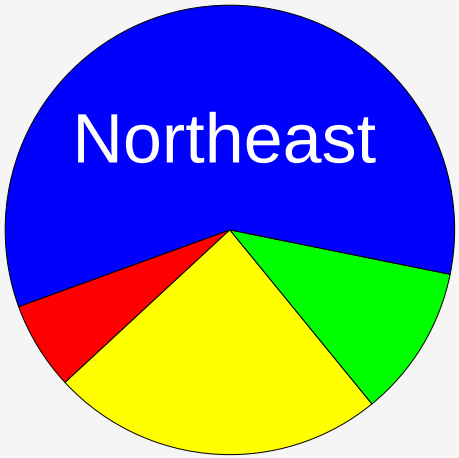
<30 | 30-40 | 40-50 | 50-60 | 60-70 | 70-80 | >80

- Fish Kills
- Dense algae
- Transparency loss; blue-green algae; algal scum; macrophytes; odor
- Anoxia; macrophyte problems; loss of Salmonids.
- Anoxia; turbidity; taste and odor problems; loss of salmonids
- Anoxia in shallow lakes; Salmonid fisheries in deep lakes only
- Clear water; Salmonid fisheries dominate

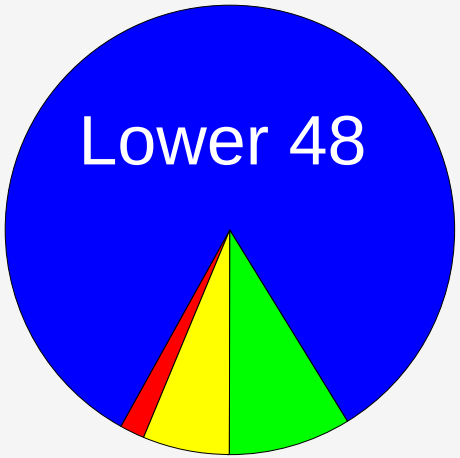
Acid Neutralizing Capacity Thresholds Relevant for Lake and Fish Health

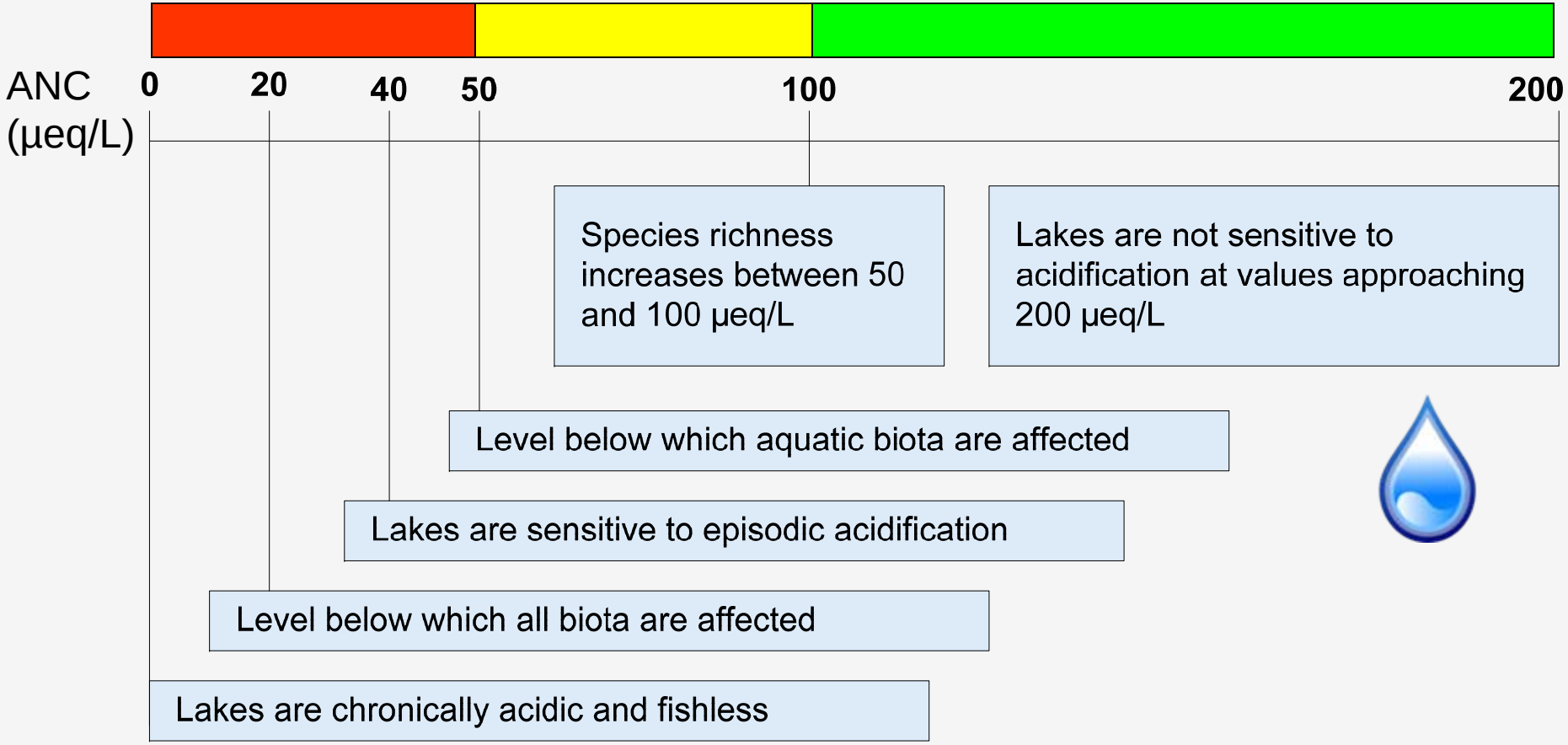


Industrial Economics, Inc. June 2008. “The Economic Impact of the Clean Air Interstate Rule on Recreational Fishing in the Adirondack Region of New York State.” Prepared for the Clean Air Markets Division, Office of Air and Radiation, U.S. EPA



Weighted National Lakes Assessment Data

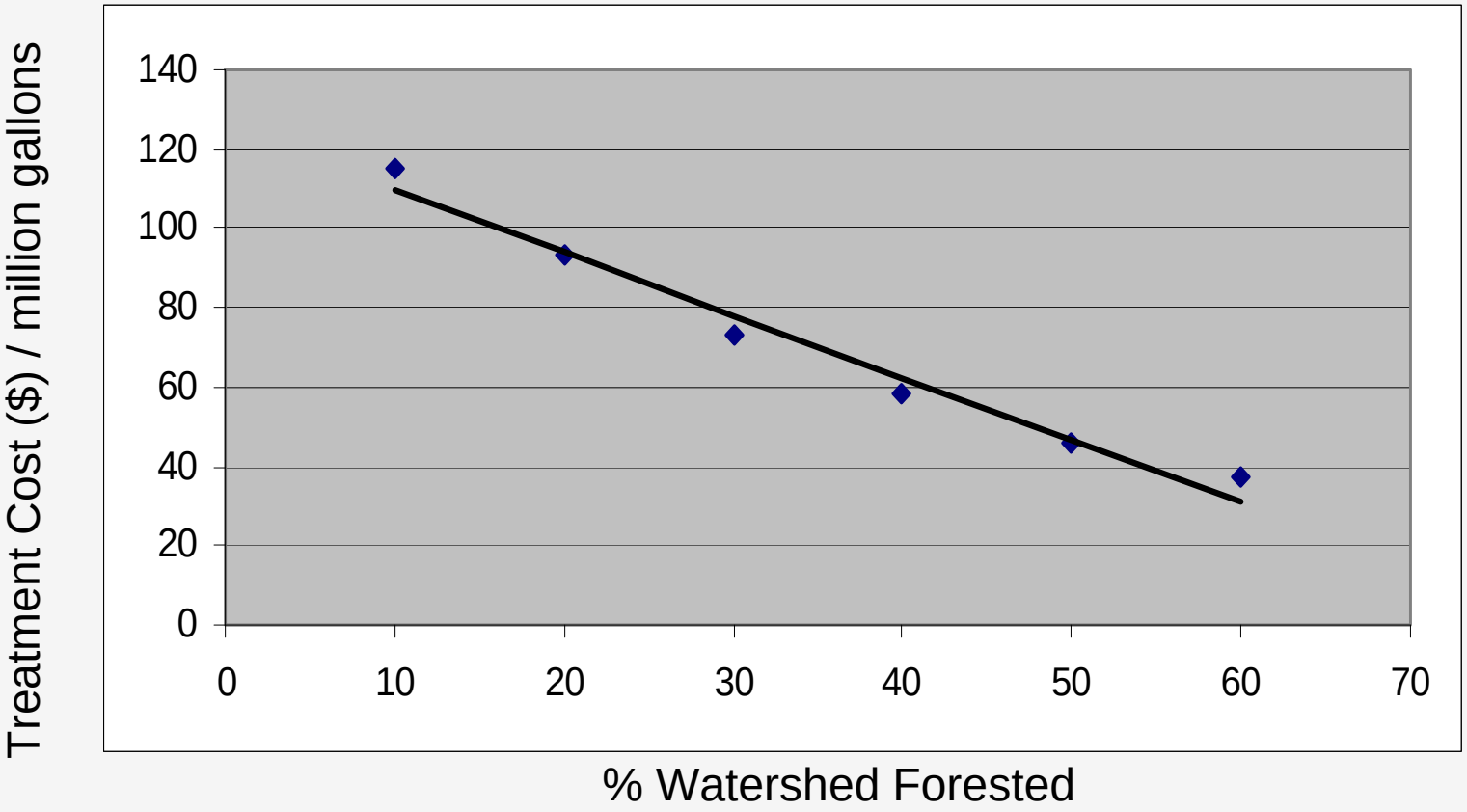




Conflicts will arise among user groups.

Who receives the benefits?

Who will pay the cost of unintended consequences and lost opportunities?



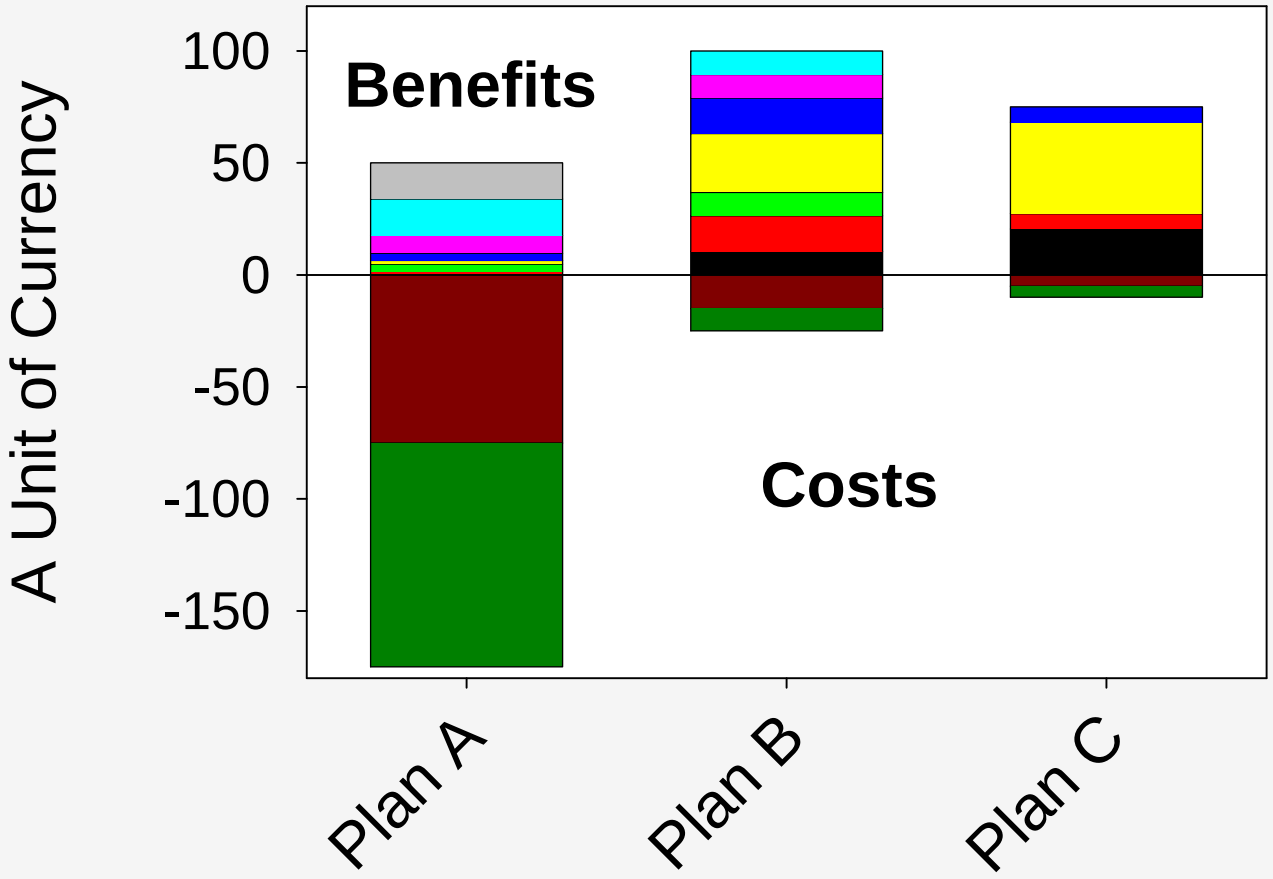
Modified from: Ernst et al. (2004). Opflow (American Water Works Association) 30(5).

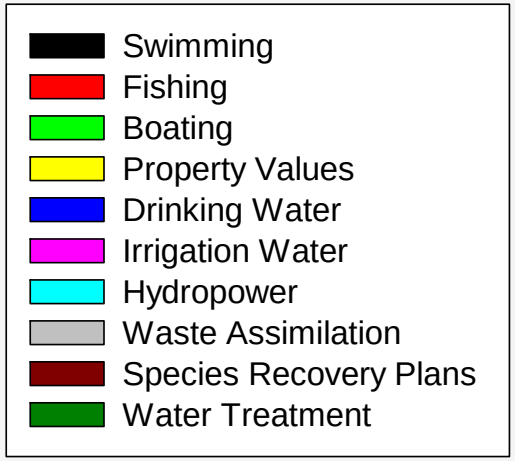
Evaluation of Management Alternatives

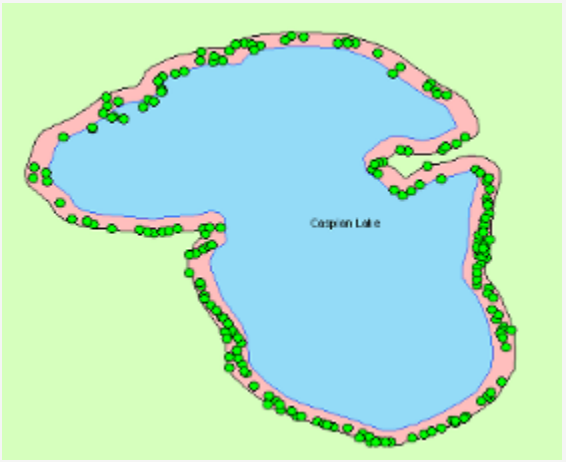
How will local or regional management choices affect the delivery of ecosystem service benefits to stakeholders?

What tradeoff and conflicts will occur among users?

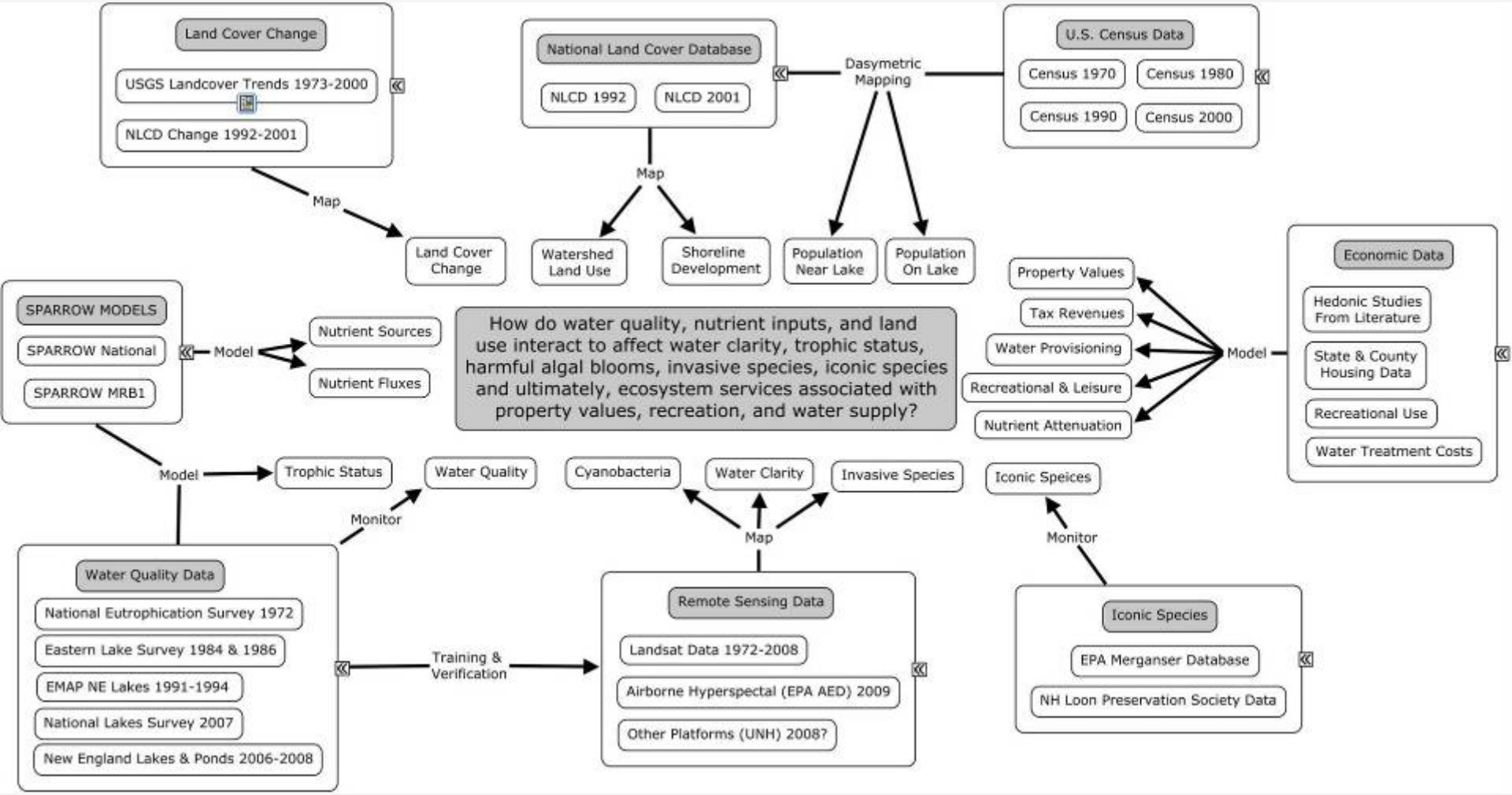
Who will benefit from management choices and who will pay the cost of unintended consequences and lost opportunities?





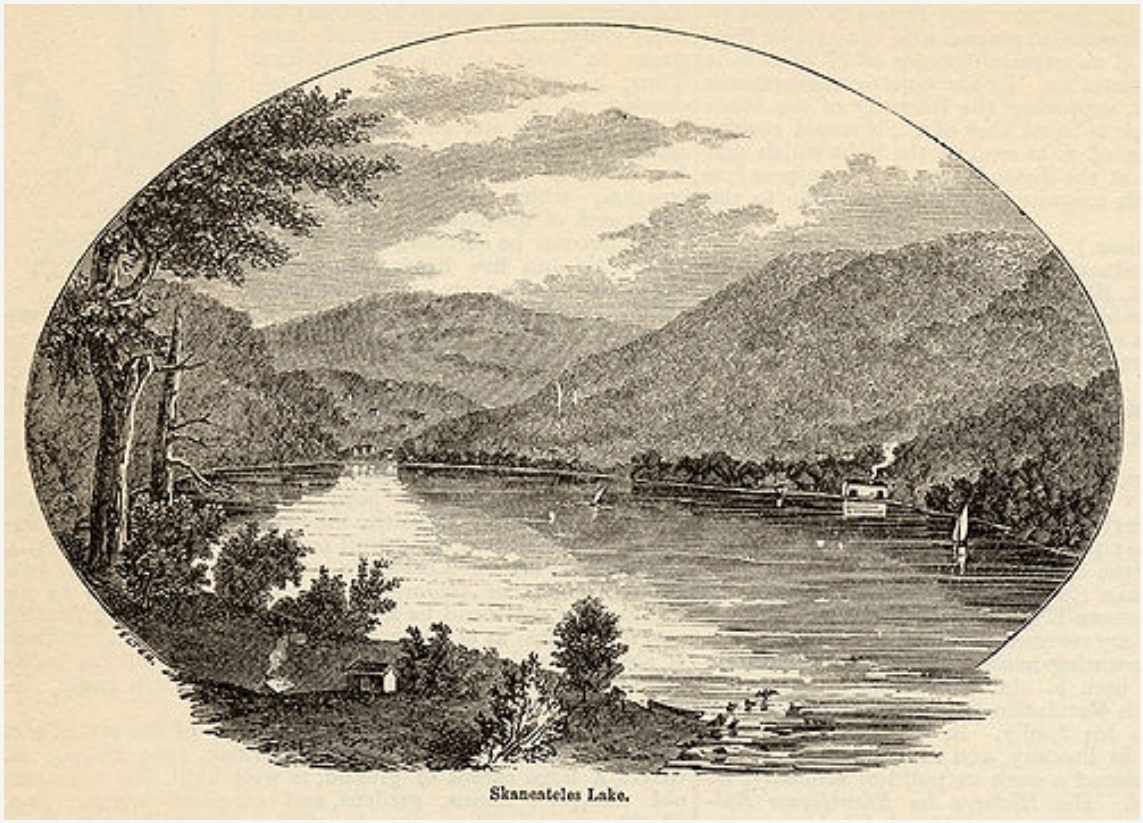


The EPA Atlantic Ecology Division Northeast Lakes Concept Map



Suggestion on how to define & quantify benefits and to make the ecosystem services approach relevant to state programs will be greatly appreciated.

Bryan Milstead 401-782-3015
milstead.bryan@epa.gov



Thank You