Economics of Water Resource Protection

Valuing Activities that Improve our Water Quality

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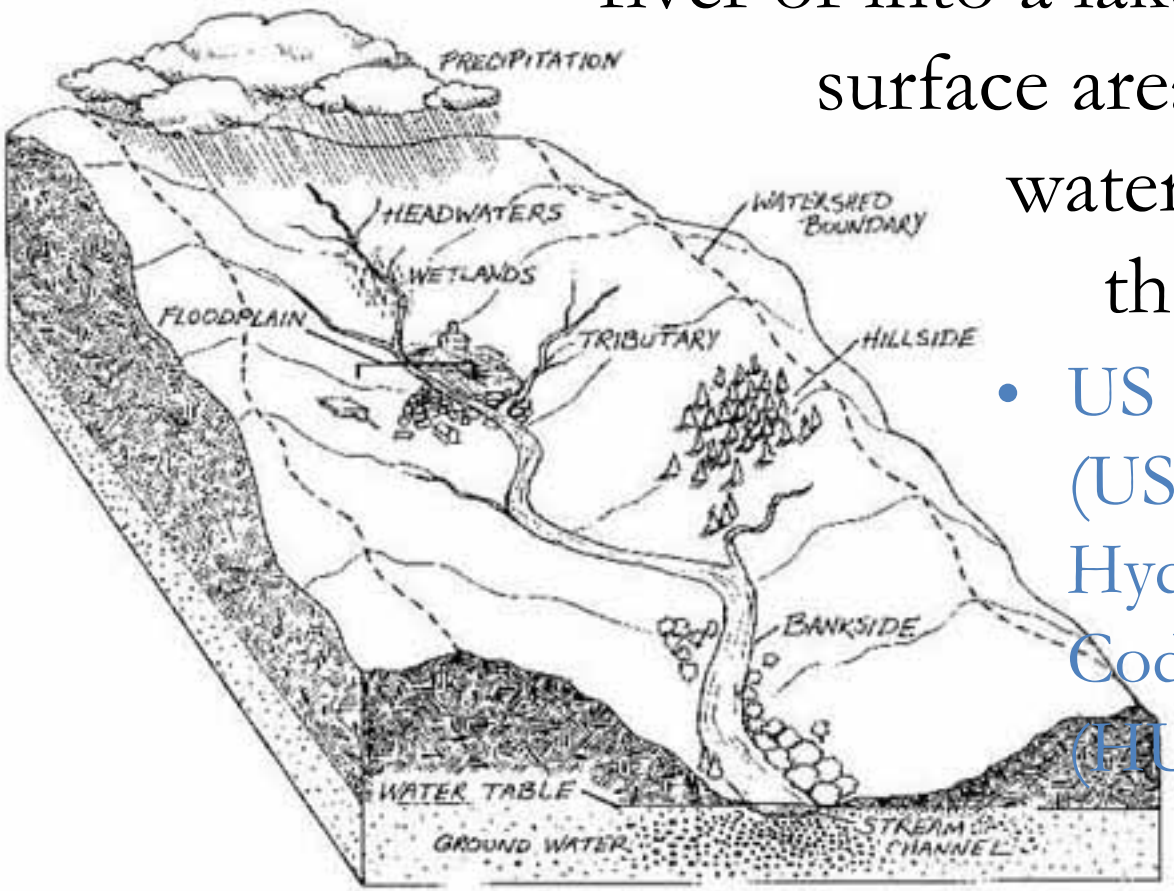
Valuing Improvements of Water Quality

- Clean water has **benefits**, but is also **costly** to keep clean.
- Natural waters are public goods:
  - Everyone enjoys the benefits,
  - Few voluntarily bear the costs.
- Regulation and other incentives often needed.
- Nonprofit groups located within the watersheds have a strong role in water quality improvement and maintenance.

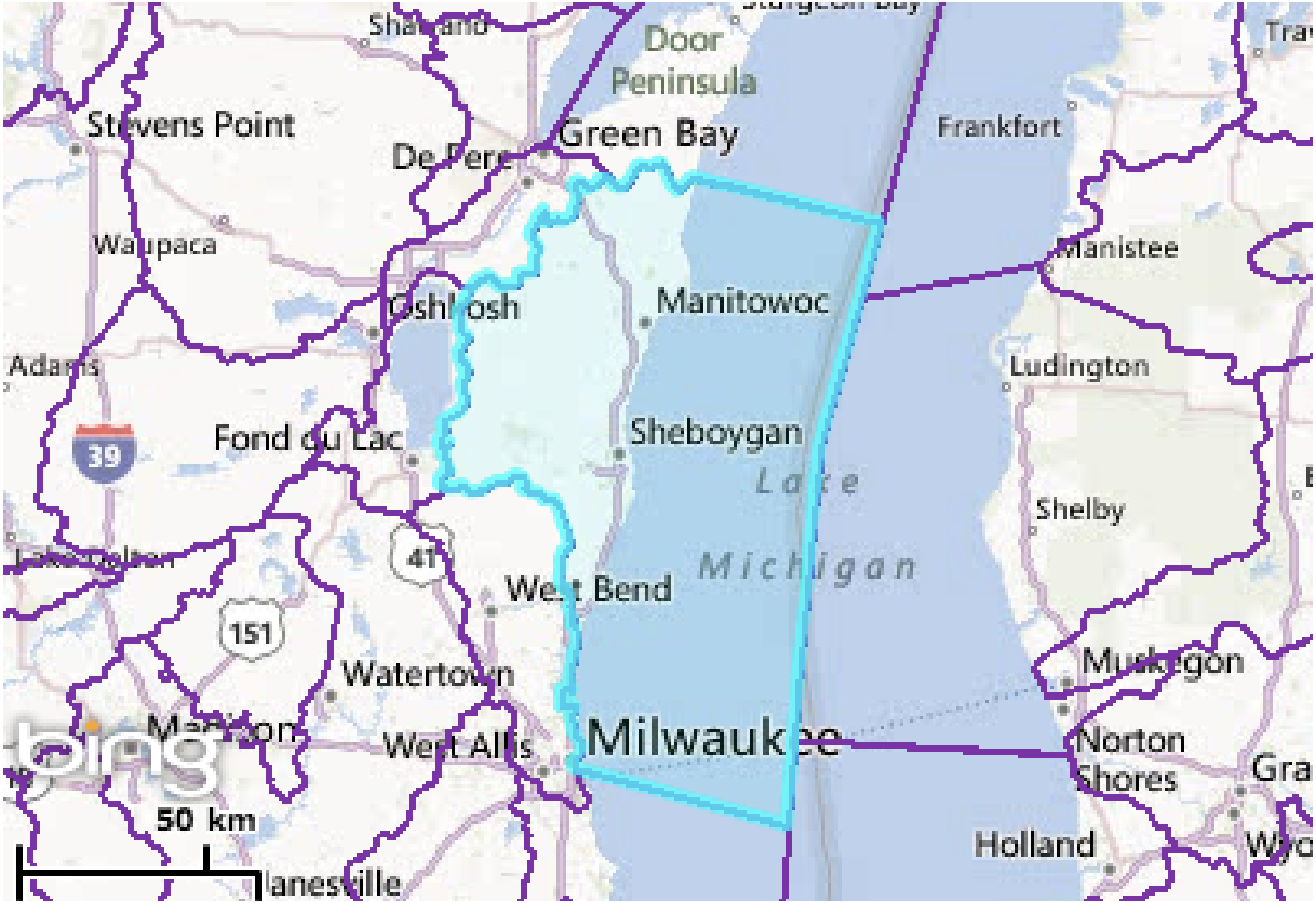
Watersheds

- Defined by an outlet point on a river or into a lake/sea & the surface area such that water flows through the outlet.
  - US Geological Survey (USGS) defines Hydrological Unit Codes (HUC)



Manitowoc-Sheboygan Watershed

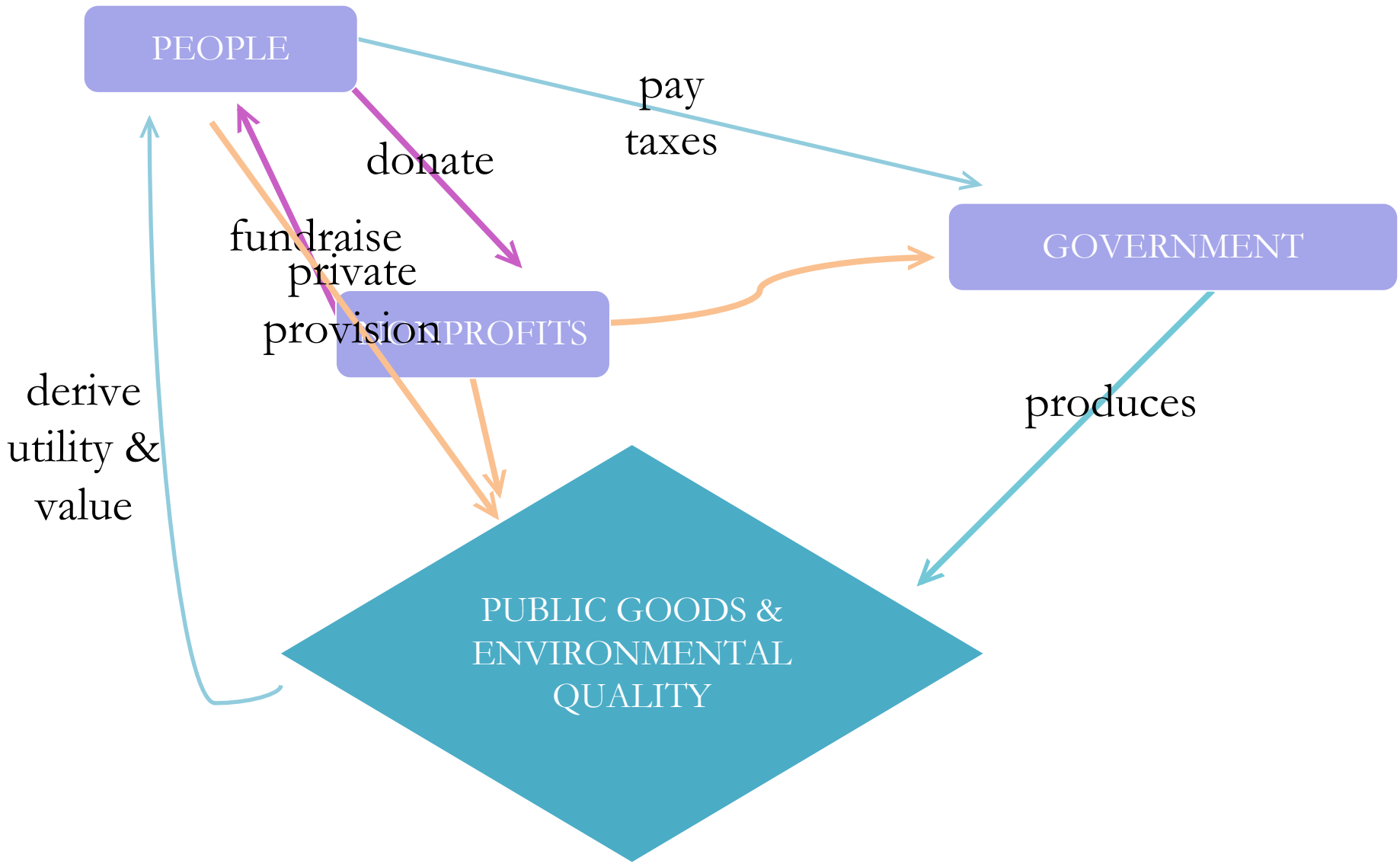
HUC8: 04030101



My current research areas

- The roles of nonprofits in water quality compliance and improvement.
- Can we show that watershed groups effectively enforce and improve water?
- Two current projects: outcome variables of interest are compliance and water quality.

A simple model of improving environmental quality



Measure environmental impact, US-wide

- Watershed groups have sprung up across the US as stewards of local rivers.
- Over 3,500 nonprofit groups classified as working in the area of "Water Resource, Wetlands Conservation & Management."
- Link data from inspections, violations & enforcement and water quality with the river organizations' characteristics and watershed-specific spending by year.
- Perform analysis to determine how effective these watershed organizations are in helping meet the Clean Water Act standards.

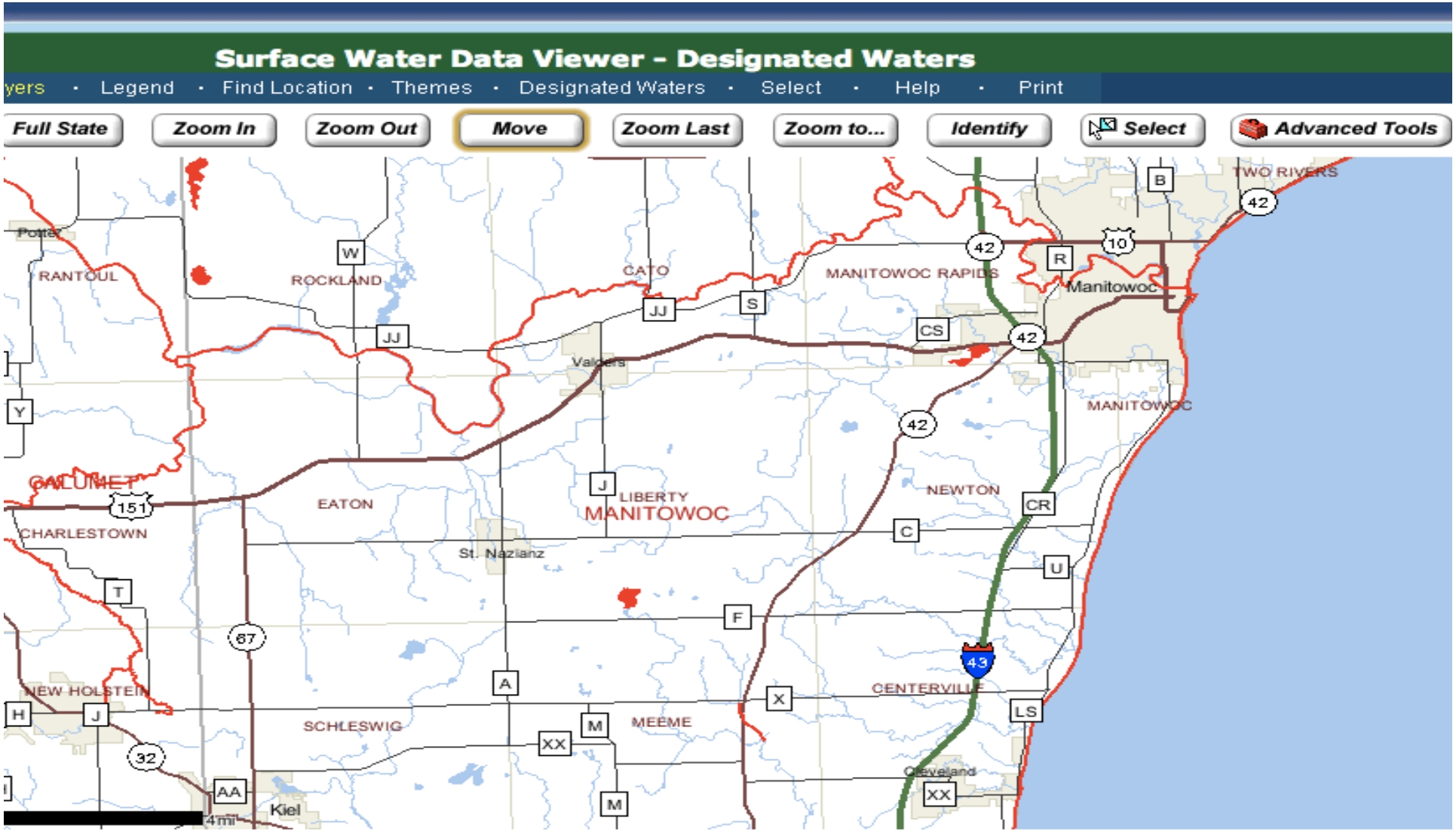
Water quality is a huge concern

- Water is a critical **benefit**, a resource required for
  - the public: drinking, recreation, aesthetic value.
  - business: agriculture, industry, mining.
  - ecosystem function, and more.
- Water has no substitutes.

Water quality is a huge concern

- Most water quality issues are human-induced & exacerbated.
  - Industry and the public use water flow to wash away waste.
- Major water quality problems:
  - Sedimentation and silt build up from land erosion.
  - Pathogens such as bacteria, pesticides, and organics lead to low levels of dissolved oxygen.
  - Nitrogen and phosphorus create excessive growth of plant and algae species
- Water pollution is **costly** to society.

Current local water quality



Local listings under Clean Water Act

Causes of Impairment for Reporting Year 2006

Wisconsin, Manitowoc-Sheboygan

Description of this table

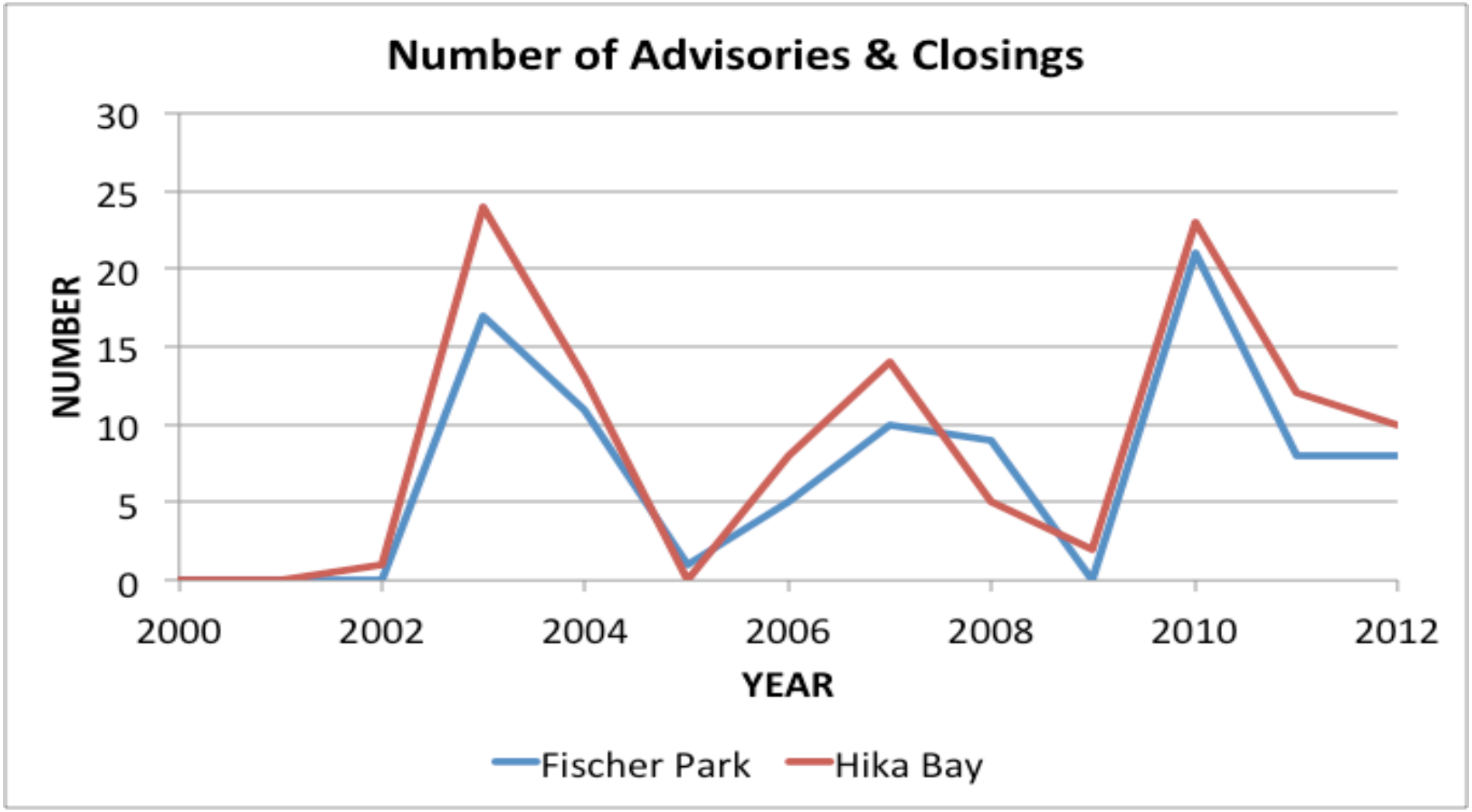
Cause of Impairment	Number of Causes Reported
Bacteria	15
Fish Consumption Advisory - PCBs	10
Degraded Habitat	5
Fish Consumption Advisory - Mercury	5
Sediment	5
Dissolved Oxygen	4
Phosphorus	4
Aquatic Toxicity	2
Polycyclic Aromatic Hydrocarbons (PAHs) (Aquatic Ecosystems)	1

Data from http://iaspub.epa.gov/tmdl_waters10/attains_watershed.control?p_huc=04030101&p_cycle=&p_report_type=T

Basics of valuing local water quality

- Measure the foregone **benefits**
  - beach closures,
  - tourism losses,
  - reductions in home value,
  - and health impacts.
- Compare to the **costs** of clean up
  - reducing municipal, personal, and industrial inputs,
  - creating barriers & buffers to waste entering the streams and waterways.

Local beach closures



Data from http://iaspub.epa.gov/waters10/beacon_county_page.main?p_county_fips=071&p_state_fips=55

Impacts on local recreation & tourism

- Eutrophication of rivers and lakes: plant and algal blooms
  - Displeasing smell, increases water treatment costs
  - Visual impairment
  - Ecosystem disruption; degrades fishing
  - A prominent example is *Cladophora*
- Associated with excess nutrients from agriculture (farming and livestock) and urban (lawns) wastewater: fertilizers, detergents, and sewage treatment plant discharges.
- Nutrients such as nitrogen and phosphorus.
- Measure value based on travel costs to use the area.

Home values capture water quality

- Real estate prices reflect characteristics of the house and property itself, the neighborhood and community.
- Some differences in price can be attributed to differences in environmental quality.
- For example, if all characteristics of houses and neighborhoods throughout an area were the same, except for the level of water pollution, then houses with better water quality would cost more.
- This higher price reflects the value of cleaner water to people who purchase houses in the area.

Value to avoiding illnesses

- Blue-green algae, also know as cyanobacteria, produce neurotoxins and liver toxins.
- E. Coli bacteria causes gastrointestinal illness
- Can calculate time lost from work and costs of health care.

Why calculate social value?

- Need to demonstrate programs/policies are not simply conservation for the sake of itself.
- Only worthwhile estimating value of water quality if that knowledge will be used for decision making and policies.
- Values help determine where largest benefits are, who stands to gain, and why.
- Used to compare with costs of water quality improvements.

Getting water quality improvements

Three waves of regulations:

- 'Command-and-control'
  - Quotas
  - Specified technologies
- Market-oriented regulations
  - Taxes, subsidies (prices on each unit of pollution)
  - Cap-and-Trade (another form of pollution pricing)
- Voluntary & decentralized mechanisms
  - Organic and biodynamic food production
  - Offsets
  - Payments for ecosystems services
  - Bargaining between stakeholders

Which mechanism to use?

- Economists (and policy analysts) evaluate the potential for policy approaches to achieve the optimal level.
- The most efficient laws and social institutions are the ones that place the burden of adjustment on those who can accomplish at least cost.
- Laws governing harmful effects can be informed by how much it costs different parties.

Watershed groups can enforce & produce environmental improvements

- Enforcing industry compliance indirectly:
  - Communication, feedback, mitigation programs
  - Reprimanding & sanctioning
- Directly monitoring and improving the quality:
  - River restoration and cleanups
  - Water quality testing
  - Education
- Lobbying or suing the government:
  - Introducing/supporting policies
  - Deterring harmful proposed legislation
  - Encouraging direct spending on projects
  - Requesting enforcement

Current Activities of the Friends of Hika Bay

- Restoration
  - Centerville Creek and Hika Park is about 85% complete. Additional native landscaping occurring this spring, summer, and fall.
- Stream monitoring
  - 2011: Descriptive logs online
    - "Water flow is calm today, with a temperature of 16.7 °c. The water is clear, and still producing rapids. The water level at this site is lower today than it normally is. The sky is sunny and the air is humid today."
  - 2012: Extending sites and specificity of measurements
    - Rain_event water_temp pH turbidity streamflow conductivity dissolved_Oxy phosphate nitrogen e_Coli

Increasing credibility of water quality monitoring

- Citizen-based science is very important.
- Look to other groups as models.
- Extend season and locations.
- Make data count & most useful:
  - Work with Northeast Wisconsin DNR
  - http://dnr.wi.gov/news/contact.asp?regionscope=Northeast&timeinterval=&searched=
    - Christina Anderson
      - Water Resources Management Specialist
      - Citizen Water Monitoring
      - Central Office
    - Carrie Webb
      - Water Regulations and Zoning Specialist
      - Waterway Permits, Irrigation
      - Northeast Office, including Manitowoc County

Highlighting water quality improvements/activities

Add information to the following sites:

- EPA Adopt Your Watershed page
  - http://water.epa.gov/action/adopt/index.cfm
- National Directory of Volunteer Monitoring Program
  - http://yosemite.epa.gov/water/volmon.nsf/Home?OpenForm

Introducing & supporting policies

- Example:
  - Reduce phosphorous loading
- Technical paper:
  - The Use of Economic Instruments to Resolve Water Quality Problems from Agriculture
    - By Weersink and Livernois, Canadian Journal of Agricultural Economics, 2010 Vol 44: 345-353

Economic Instruments for Improving Water Quality

- Tools:
  - efficient pricing accounts for all associated costs,
  - permits,
  - or trading water quality.
- Based on incentives and disincentives.
- Allow for water polluters to make trade-offs by determining the net value of activities.
- Choice based on total benefits outweighing the total costs (including, monitoring and administration) relative to alternative policy instruments.

Economic Instruments for Improving Water Quality

- Economic instruments that improve water quality are underutilized.
- Water not seen as economic good.
- Theory and policy experience suggests that using market-based instruments together with traditional regulation can achieve desirable water-policy outcomes at a lower economic cost than regulation alone.

Policies restricting the total discharge of water contaminants

- Design a water quality limit, then issue permits and offsets.
- New activities that result in the discharge of contaminants must create no net change in pollutant.
- Arrange for conservation measures that indirectly offset their impacts.
- Acceptable offset activities should only be those that would not otherwise be carried out if there were no scheme in place.
- Offsets activities are considered to be above and beyond the actions required under existing regulations.

Communication & mitigation programs with agricultural partners

- Invite experienced and retired farmers as liaisons.
- Brainstorm the range of options for "ecosystem services:"
  - Fencing
  - Buffer zones and bioswales
  - No/low till practices
- Create a payment for ecosystem services scheme
  - raise a funding pool from the community,
  - solicit bids for water quality improvement practices from agricultural areas,
  - distribute payments in order of best value.

Friends of Hika Bay: Already ahead of the curve

- Monitoring is typically an issue with many ecosystem service programs and offset schemes, particularly for non-point sources of pollutants (like phosphorus run-off from agricultural land).
- Physical relationships may not be sufficiently known to accurately determine cause and effect, creates difficulties for estimating the potential benefits of mitigation measures.

- Data gathered helps model changes in water quality and how new practices can improve water resources.
- Working toward "results-based actions."

Friends of Hika Bay: 2012 Data analysis

	Beach closures	
Rain event	0.316	+
	(3.91)**	
Water temp	0.053	+
	(5.31)**	
E. Coli	0.00004	+
	(2.26)*	
Conductivity	0.0002	
	(0.16)	
Streamflow	0.266	+
	(2.23)*	
Dissolved O	0.001	
	(1.32)	
pH	-0.121	-
	(2.35)*	
Phosphate	-1.005	
	(1.21)	
Observations	269	
Number of sites	26	
R-squared	0.39	

* significant at 5%; ** significant at 1%

Conclusions & Recommendations

- Continued & expanded stream water quality monitoring.
- Further valuation of area's costs and benefits to reducing phosphorus loading and other pollutants.
- Potential pilot program: Payments for pollution reduction.
- Continuing integration into larger state-wide discussions for pollutant management.