



Ecosystem Services Monitoring and Valuation for Better Environmental Decision-making

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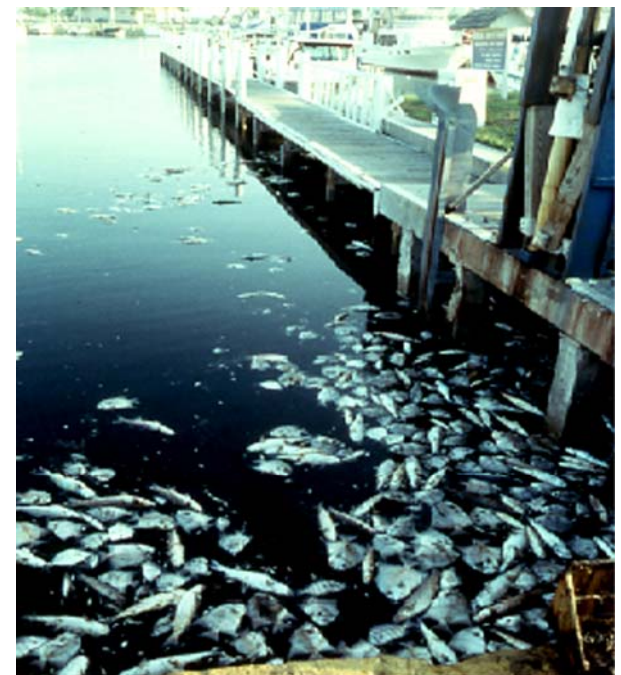
National Health and Environmental Effects
Laboratory, Office of Research and
Development, EPA

What are Ecosystem Services?

- **Ecosystem services (ES) are the goods and services provided by ecosystems that directly or indirectly contribute to human well-being.**
- **Human society is dependent on these ES, including clean air, clean water, productive soils, and generation of food and fiber.**

Some Desired Water ES

- Provision of drinking waters
- Provision of swimming waters
- Provision of fishing waters
- Provision of sufficient quantity of water



Why Monitor for ES?

- Statutory Protection of Ecosystem Services - Clean Air Act, Clean Water Act, CERCLA, RCRA, NFMA, ESA, NEPA, EIAs
- To allow currently available ecosystem services to be incorporated into market-based environmental decisions with full cost accounting. – Avoid tragedy of the commons
- To provide regional and national policy-makers with necessary information about the quantity and quality of ecological services and to track changes in these services due to regulation, use, and trading

Value of Existing ES

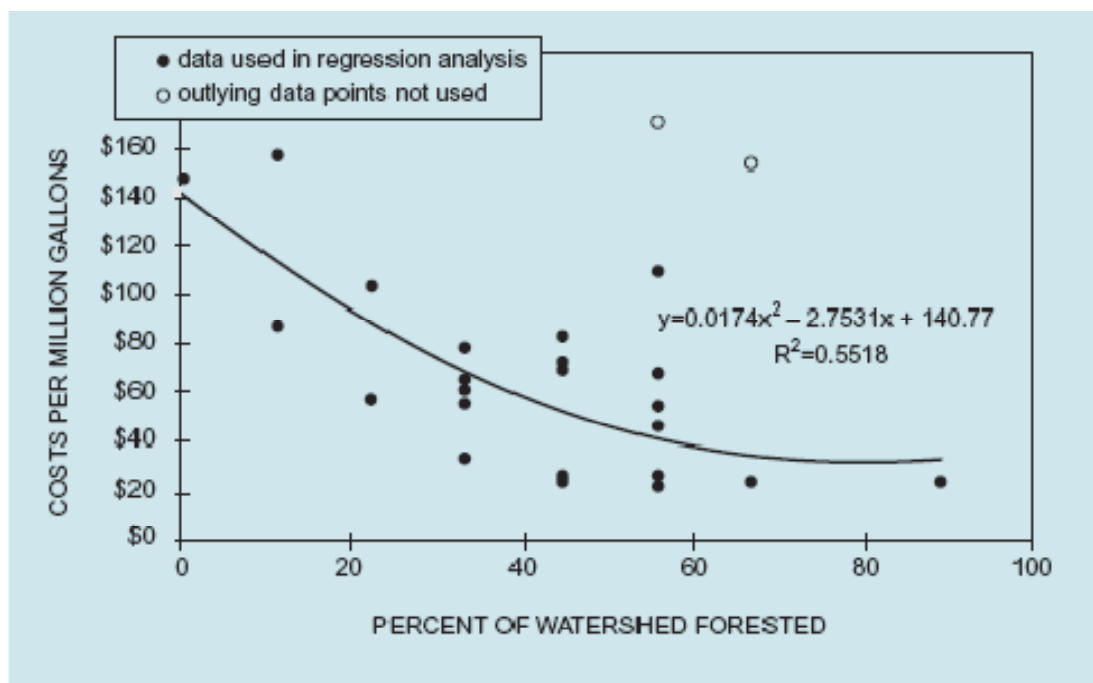
Estimated Values (low and high) of Coastal Recreation in the United States (in millions of dollars per year).

- Beach going: \$5,950 to \$20,883
- Recreational Fishing: \$9,873 to \$26,138
- Wildlife Viewing: \$4,877 to \$48,770

Pendleton, Linwood (Ed.). 2009. The Economic and Market Value of Coasts and Estuaries: What's at stake? Coastal Ocean Values Press, Washington, DC

Value of Improved ES - DW

- **Percent forest cover in source water watersheds**
 - Reduced costs for treatment and chemicals used for drinking water



	Cost
San Diego	115
Tampa	115
New York	104
Tucson	104
Boston	93
Milwaukee	93
Atlanta	73
Fort Worth	73
WASHINGTON D.C.	73
Portland (Or.)	58

ES Value for DW

- In 1996 NYC invested ~\$1B in natural capital (restored Catskill watershed)
- Cost of technological solution for NYC ~\$6B + \$300M/y
- US DW infrastructure investment >\$140B over next 20 y
- >140 US cities are examining restoring watershed ES as alternative to enhanced water purification technology

Costs of ES Losses

Direct

- Annual economic impacts of harmful algal blooms (HABs) in the United States: \$97 million (median value) over the period 1987-2006

Replacement

- Capital expenditures: \$ 5.9 billion
 - Air pollution: 3.9
 - Water pollution: 1.3
 - Solid waste: 0.7
- Operating costs: \$ 20.7 billion
 - Air pollution: 8.6
 - Water pollution: 6.7

Coastal Demand for ES

- Half of the US population (>141 million people) reside within 50 miles of the coast, (NOAA, 1999; 2005)
- U.S. population has increased by 33 million since 1980 and is expected to increase by another 12 million by 2015 (Crossett et al.; 2004)
- 25% of all conversion of rural land to suburban/urban has occurred from 1982-1997 (NRI, 2000)
- This influx of people has resulted in significant modification of the hydrological cycle, resulting in increased discharges of toxic chemicals, nutrients, and microbes.



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BUILDING A SCIENTIFIC FOUNDATION FOR SOUND ENVIRONMENTAL DECISIONS

EPA COASTAL CONDITION REPORT

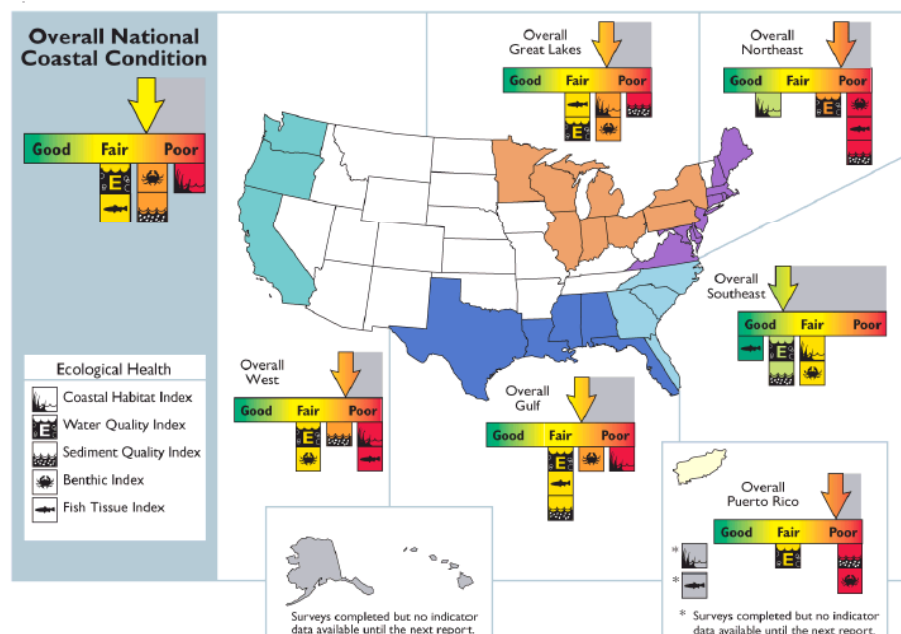
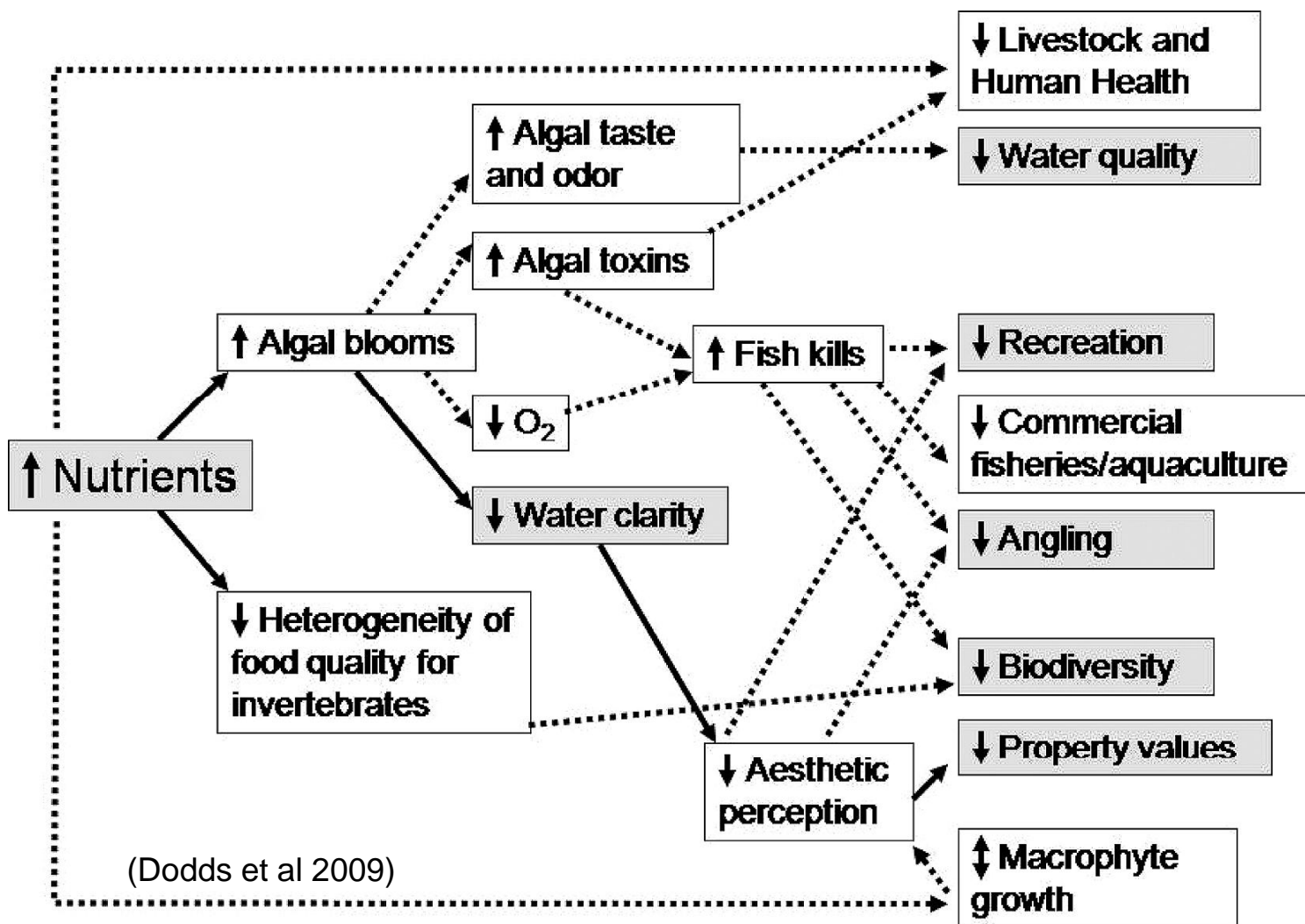


Figure 2-1. Overall national and regional coastal condition.

A national survey conducted by NOAA: Two thirds of our estuaries and bays in the U.S. are moderately or severely impacted by eutrophication

Eutrophication Impacts on ES





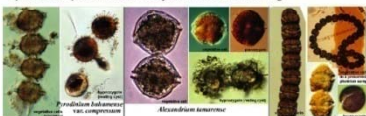
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Harmful Algal Blooms (HABs)

Toxic Microalgae

WESTPACIOCEANSCO
Vol. 3.2, 2003.1.1

Species Responsible for Paralytic Shellfish Poisoning



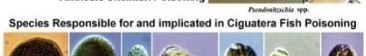
Species Responsible for Diarrhetic Shellfish Poisoning



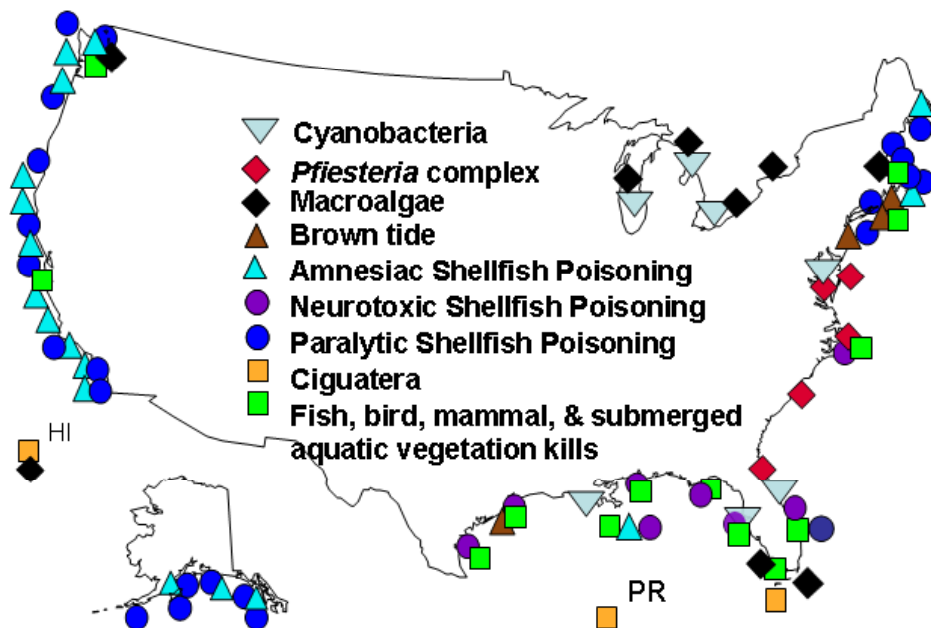
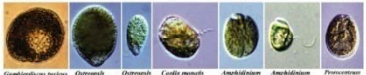
Species Responsible for Neurotoxic Shellfish Poisoning



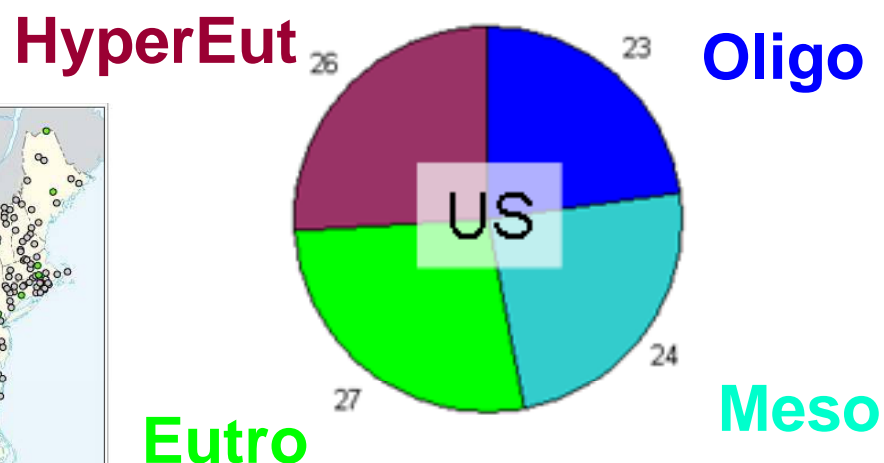
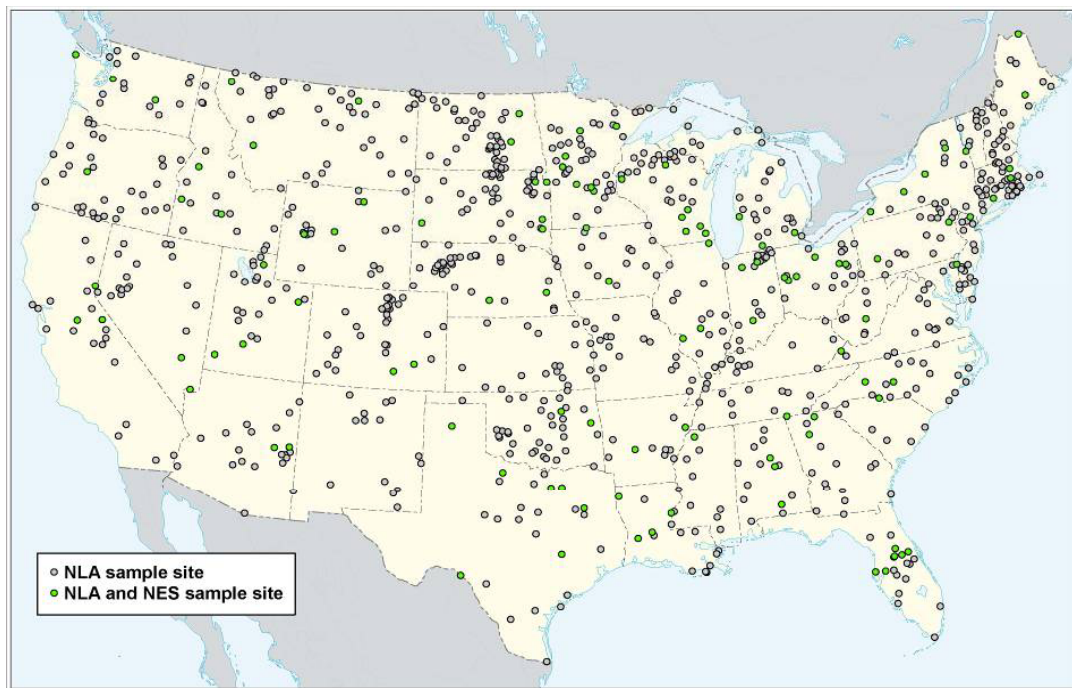
Species Responsible for Amnesic Shellfish Poisoning



Species Responsible for and implicated in Ciguatera Fish Poisoning



OW's National Lakes Survey



***Compromised Delivery
of ES***

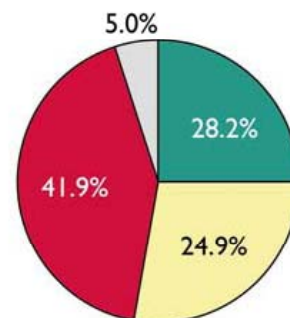
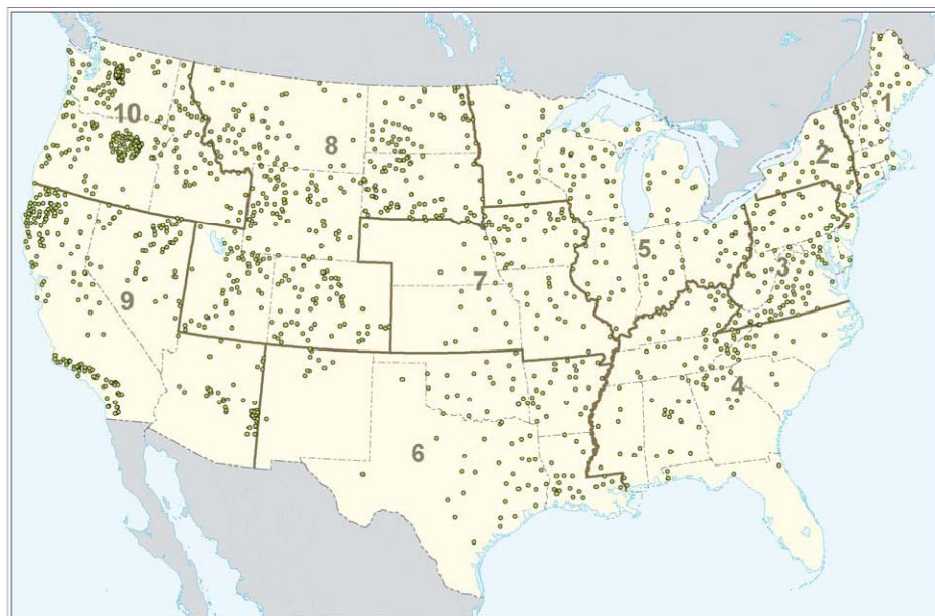
Microcystins in Lakes

- ***32% of lakes with measurable levels (mean 3 ppb MC-LR equivalents where detected)***

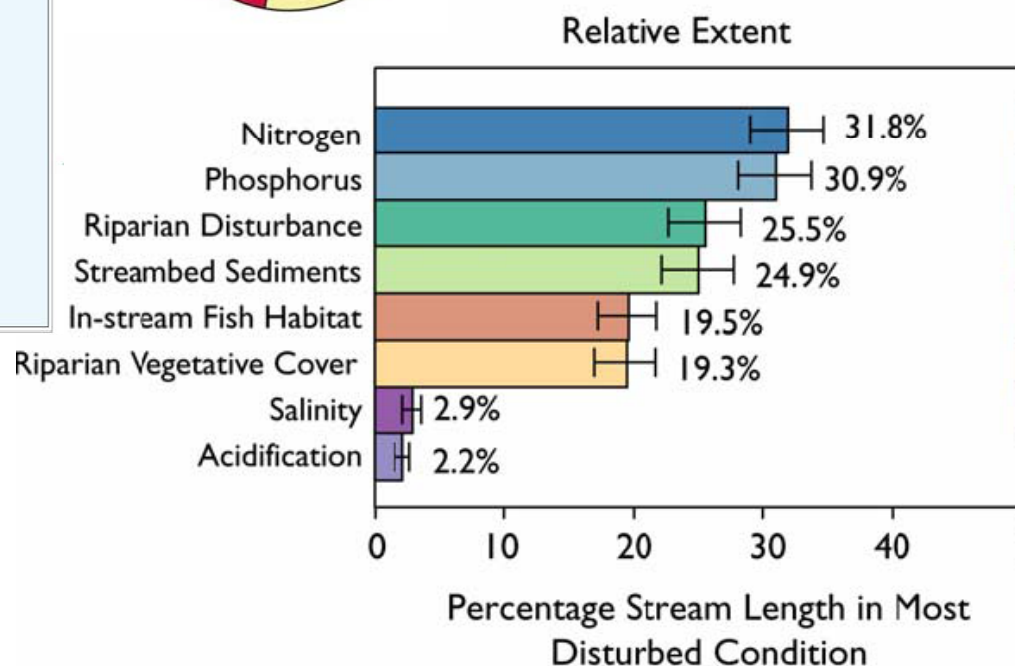


● No Detectable Microcystin
● Detectable Microcystin

OW's National Stream Survey



***Compromised
Delivery of ES***

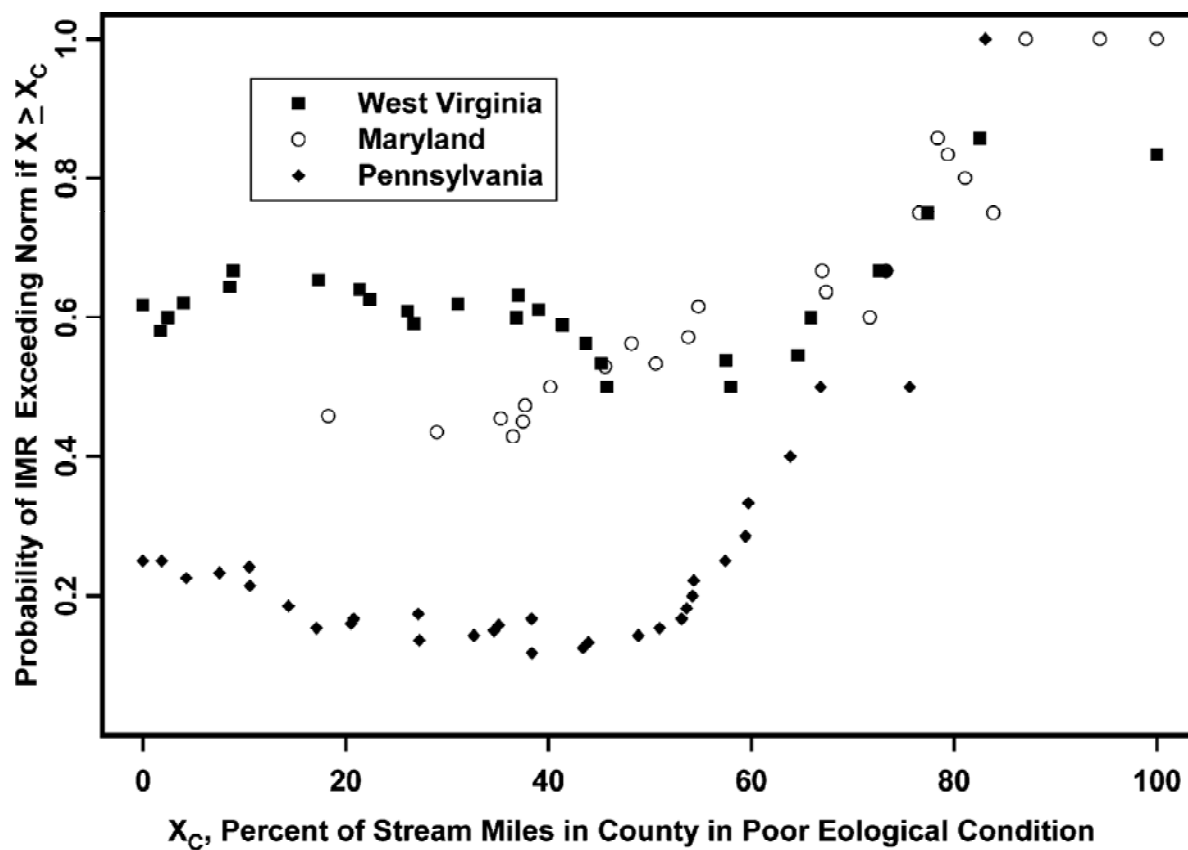


Costs of ES Lost - Nutrients

- >\$2.2 B annually lost due to nutrient degradation of lakes and streams (Dodds et al 2009, ES&T)
- Losses from recreational use, waterfront real estate, T & E species, and DW – ES bundles



Lost ES and Human Health?



Lost ES – HABs & Health



Inhalation of airborne HAB toxins at beaches is a common occurrence and growing concern, especially for people with asthma or other pre-existing breathing problems.

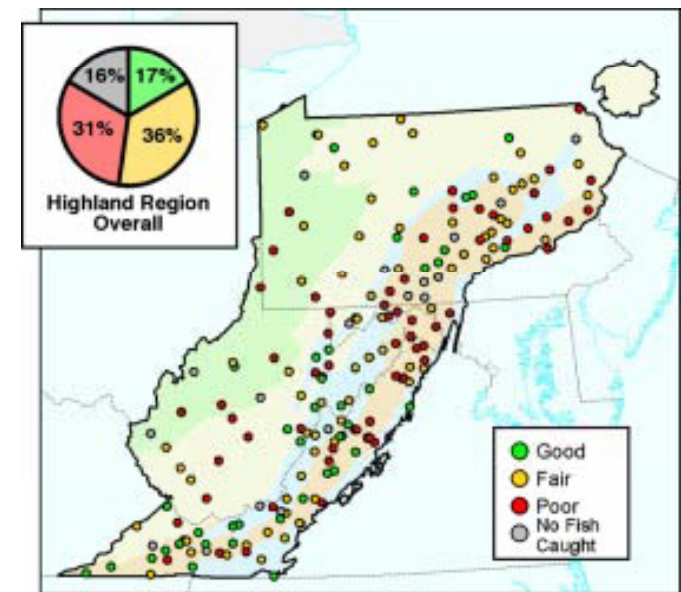
New NOAA research indicates that inhaling brevetoxin causes damage in the lung that may increase risks of cancer formation.



6/17/2010

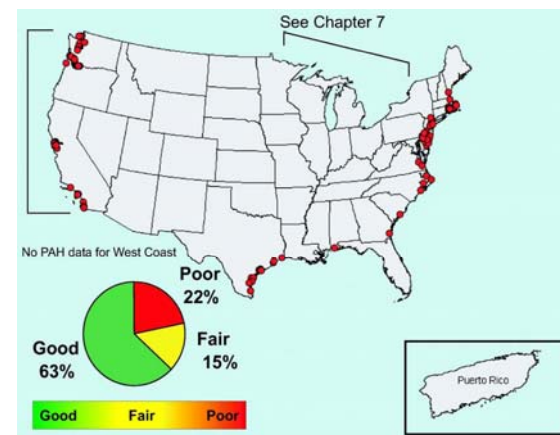
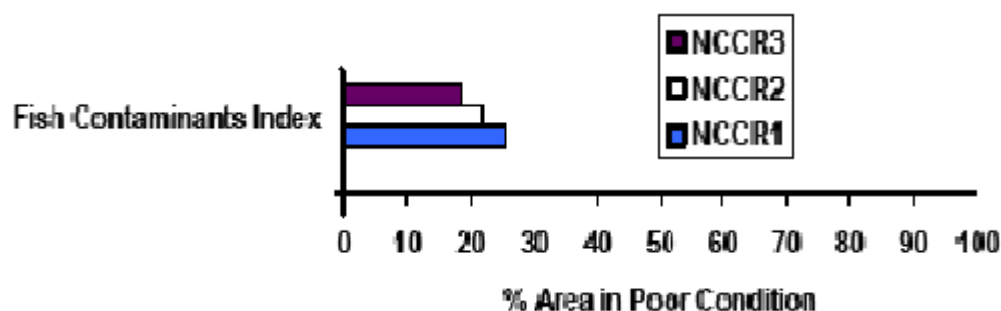
Restoration Value of Lost Recreational Angling *

- An estimate of the loss of recreational fish stocks in the streams and small rivers of the Mid-Atlantic Highlands was made based on data similar to future OW-NARS
- Loss of recreational ES provided by these systems was valued at \$148M/y



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Value of Recreational Estuarine Fisheries

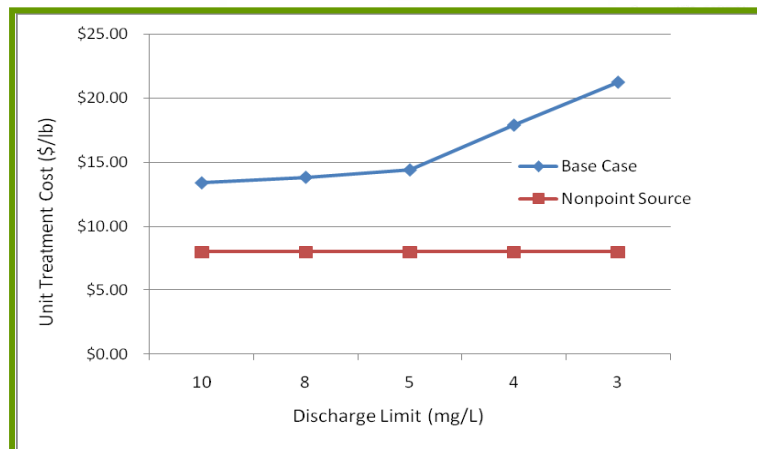
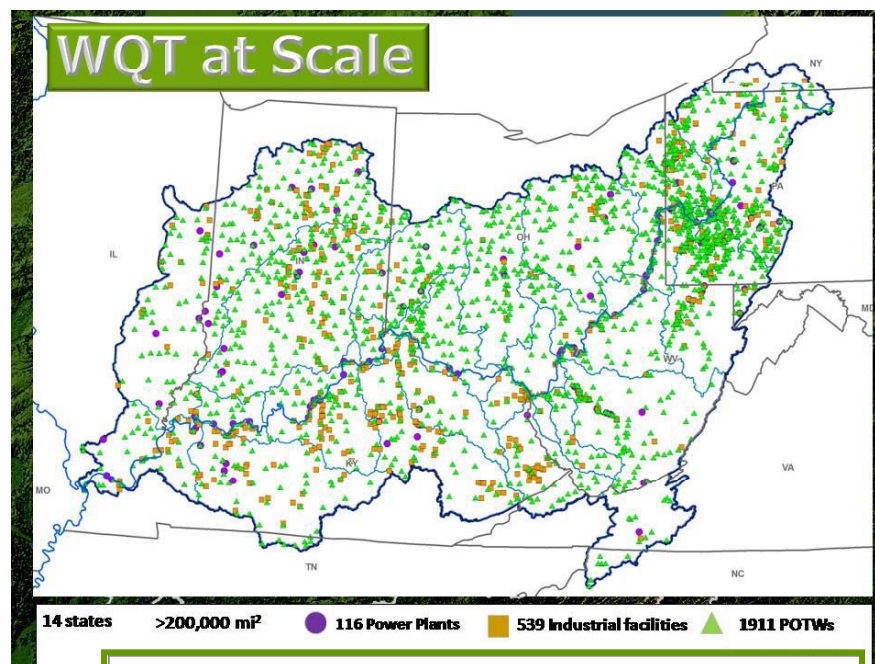
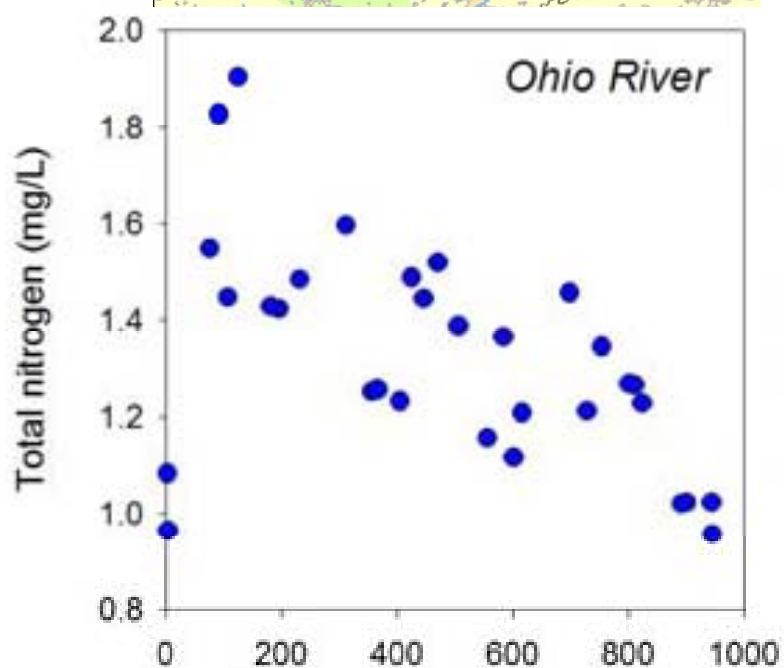


- Total annual surplus loss from recreational anglers due to fish contaminant advisories is ~ \$2.42 per day × the number of angler days/yr for a body of water or the estuarine waters of a state or a region (80.8 million trips in 2004)
- \$8.83M lost from Chesapeake Bay



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Ohio River N Trading



Dorchester County, SC Trade-offs

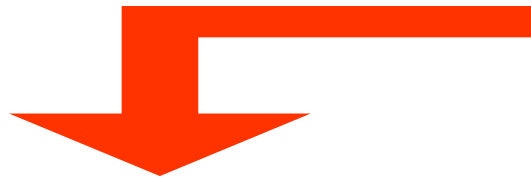
- **What's Coming the Next 20 Years**

- 11,305 New Homes
- 43,600 New Residents
- 8,503 New Students



- **Infrastructure**

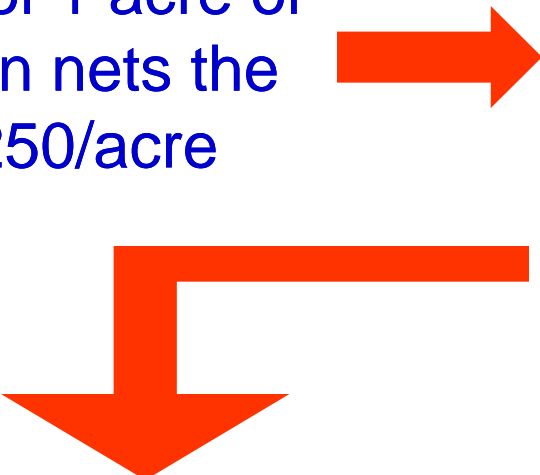
- 5 New Police Stations
- 88 New Jail Cells
- 3 New Ambulances
- 3 New EMS Stations
- More Library Space
- More Parks
- 9 New Elementary Schools
- 4 New Middle Schools
- 2 New High Schools
- New Sewer and Water
- More Fire Protection



\$39,080 TOTAL COSTS PER NEW HOUSEHOLD

(Source: Charleston Post and Courier April 28, 2007)

Trade-offs in Corn for Biofuel

- Production of 1 acre of irrigated corn nets the farmer of \$250/acre
 - 0.5M gallons of water used
 - 1 T of topsoil lost
 - ~35 lbs of N to be removed from runoff waters
- 

- What are these public ES worth?
- Who benefits and who pays?

Future Monitoring Will Include ES

- **Human society is dependent on ES for clean air, clean water, food production, recreation, etc.**
- **For full cost accounting of ES in environmental decisions and avoid tragedy of the commons**
- **To provide policy-makers with necessary information about the quantity and quality of ES resulting from their regulation, use, and trading**