Delaware River, Inc.

"What if the Delaware River was managed as a firm or business?"

September 8, 2014

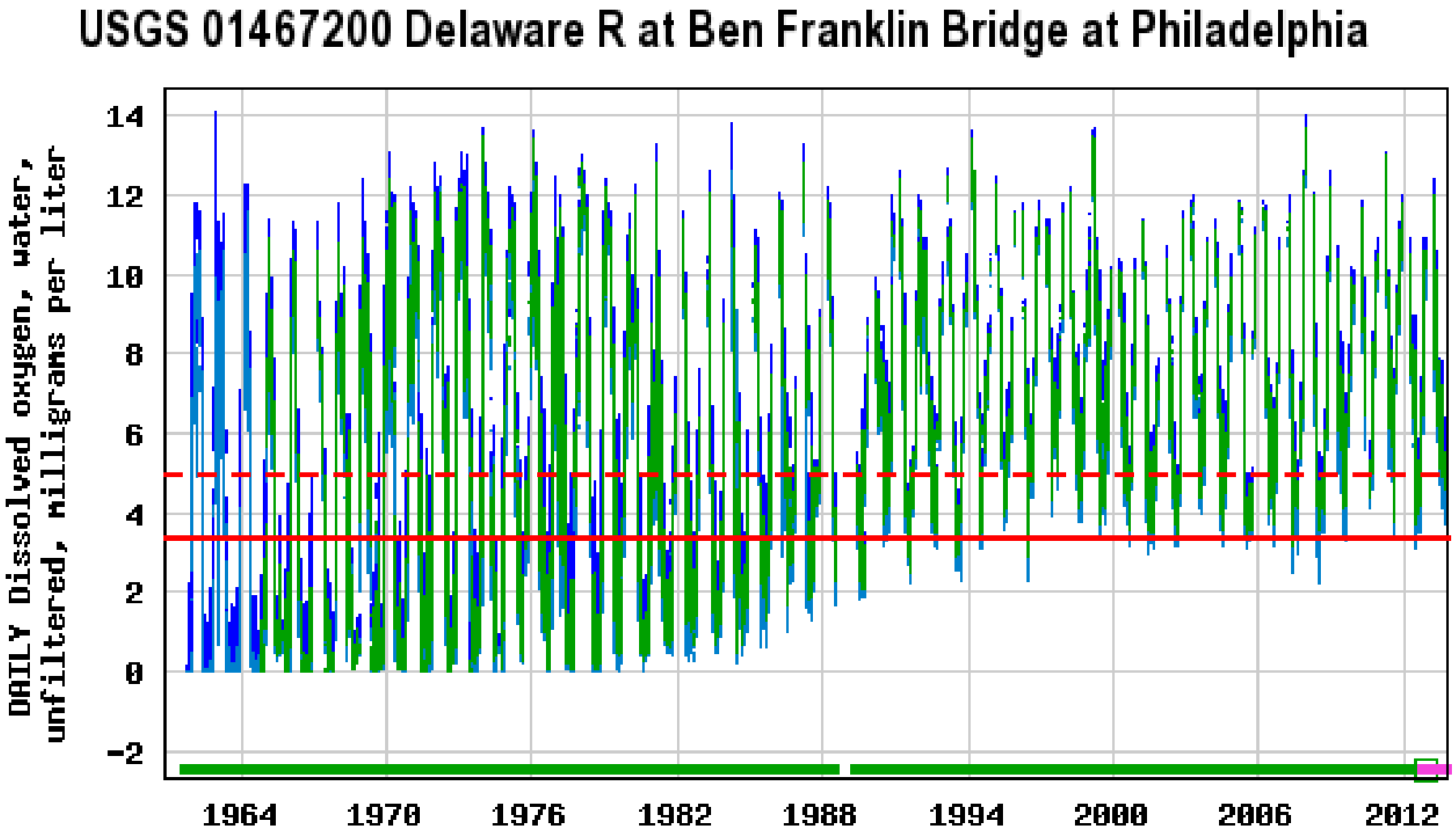
Delaware River Watershed Initiative
Academy of Natural Sciences

Cherry Street Tavern
Philadelphia, Pennsylvania

Jerry Kauffman

University of Delaware

JFK signs the DRBC Compact on Nov 2, 1961



The Delaware River has recovered from anoxia during the 1960's.

DRBC DO criteria = 3.5 mg/l Future DO criteria = 5.0 mg/l?

Research Questions

- The Delaware River is governed by a complex 50-yr old interstate river basin compact.
- Little is known about the benefits and costs of achieving improved water quality in the Delaware River.
- What are the benefits and costs of improved water quality to achieve a more protective DO standard in the river?
- What is the optimal level of water quality defined by the intersection of marginal cost and marginal benefits curves?
- What types of watershed funding can pay for water pollution controls within the context of a Federal-state river basin agency.

Research Design

1. Review the evolution of the river basin and watershed approach.
2. Describe watershed governance structures in the Delaware Basin.
3. Examine the state of water quality along the Delaware River.
4. Summarize a first-ever 1966 Delaware Estuary economic study.
5. Estimate costs of N reductions to improve DO in the Delaware R.
6. Estimate benefits of improved water quality in the Delaware R.
7. Conduct benefit-cost analysis to meet future, more protective DRBC DO criteria
8. Examine funding vehicles to pay for water quality programs in the Delaware Basin.

Policy Contributions

- The Delaware River is one of just a few river basins with a governance structure capable of funding a water quality program with the economic approach.
- 1961 DRBC Compact provides unique power by Federal/state law to administer water resources in the four states under one umbrella and levy fees and charges.
- Based on nitrogen (MAC) curves, agricultural /wastewater reduction costs are orders of magnitude less than airborne and urban/suburban controls.
- MAC curves reveal that 30 million lb/yr of N can be reduced for $160 mil or 90% of pollutant load reduced for 30% of the total cost of $449 mil.
- A benefit-cost analysis utilized modern ecological economics techniques to define the cost-effectiveness of water pollution control measures.

- Based on this economic approach, the BCA suggests the DRBC has several options in setting a higher DO standard in the Delaware River.

- Option 1 - $449 million/yr to achieve year-round DO of 5.0 mg/l
  - Benefits of $371 million to $1.1 billion/yr
  - Monthly cost $2.39/capita (16 M people) to $4.46/capita (8.2 M residents)
  - Generate 12,600 direct water jobs and boost GDP by $3.1 billion.

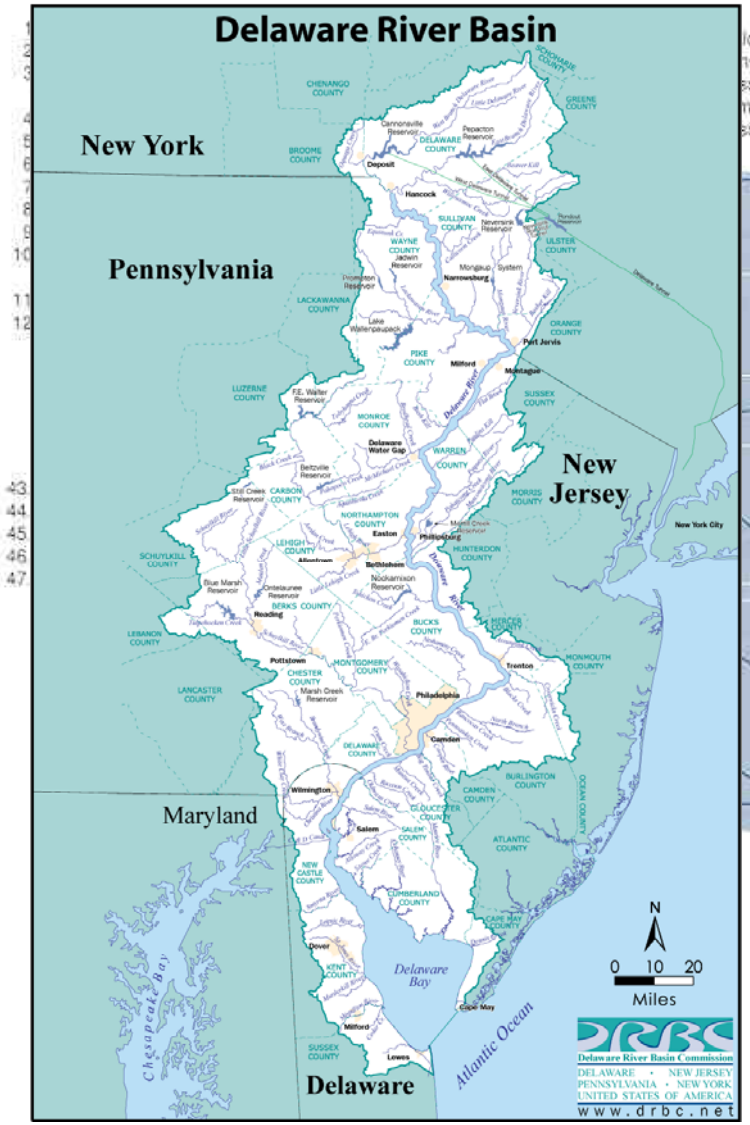
- Option 2 - $150-$250 million/yr for less protective DO of 4.5 mg/l where MC = MB
  - Benefits of at least $247 million/yr
  - Monthly cost $0.78/capita (16 M people) to $1.52/capita (8.2 M residents)
  - Generate 4,200 direct water jobs and boost GDP by $1.0 billion.

- Beneficiary pays models can finance a few hundred-million dollar water quality program in the Delaware Basin for just a few dollars per month per capita.

- Since the 1970s, the DRBC has administered a water use charge ($0.08/1000 gal) on water withdrawals that earn $3 million per year storage projects and might be persuaded to expand or redirect this user charge to fund water quality programs.

- But even with this governance framework, the political and administrative challenges are daunting…

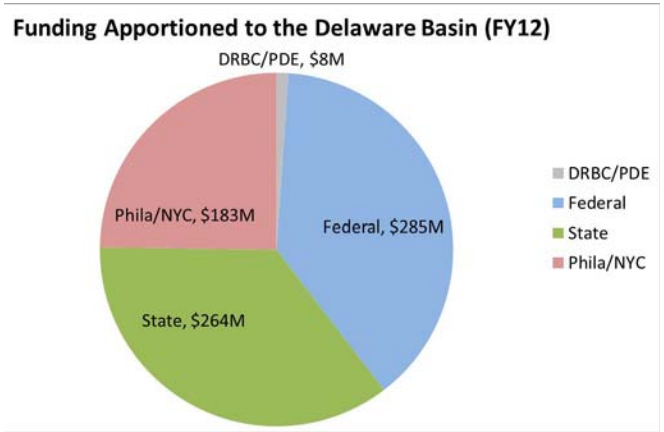
Watersheds often do not coincide with political boundaries in the United States (Kauffman 2002).

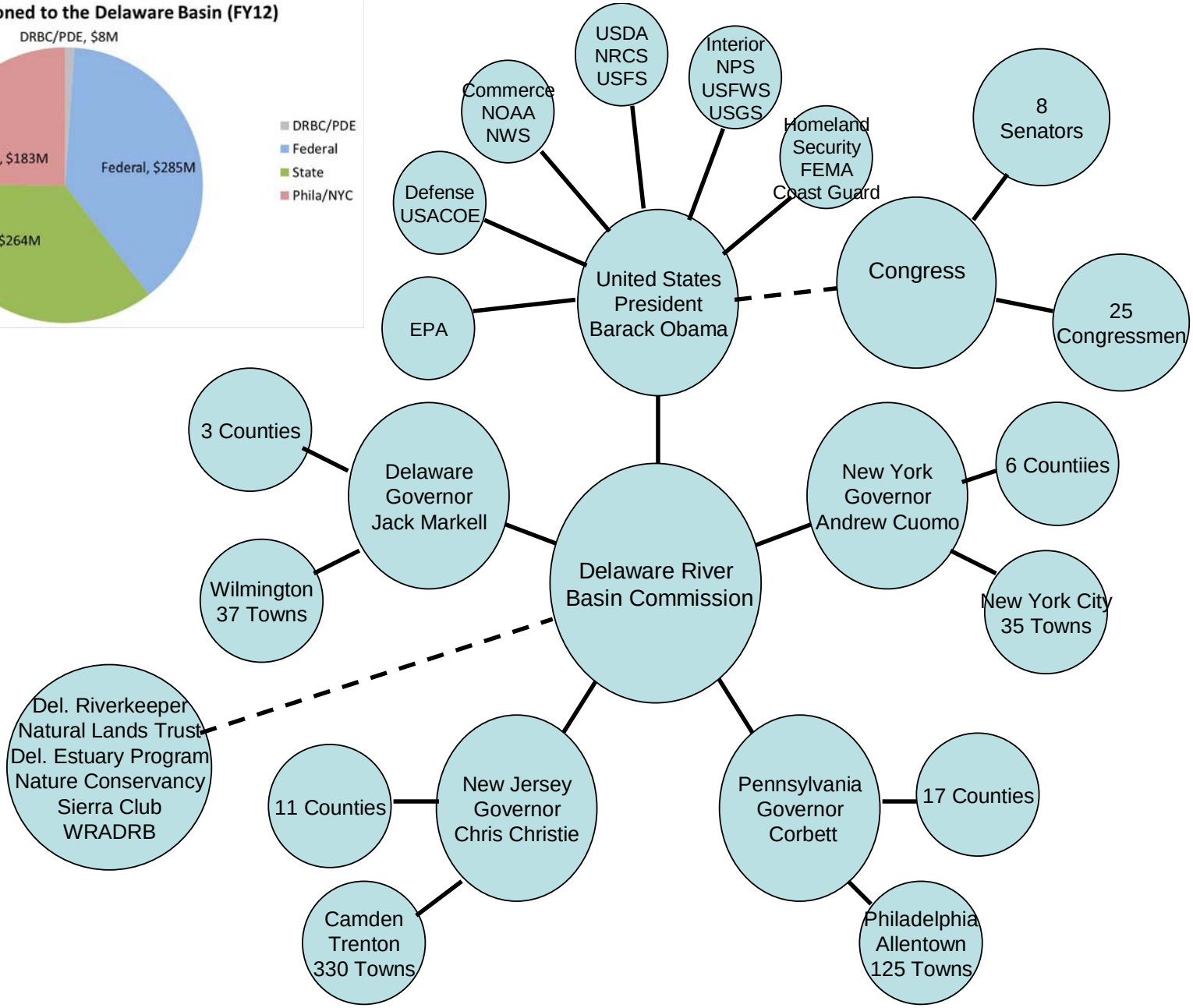


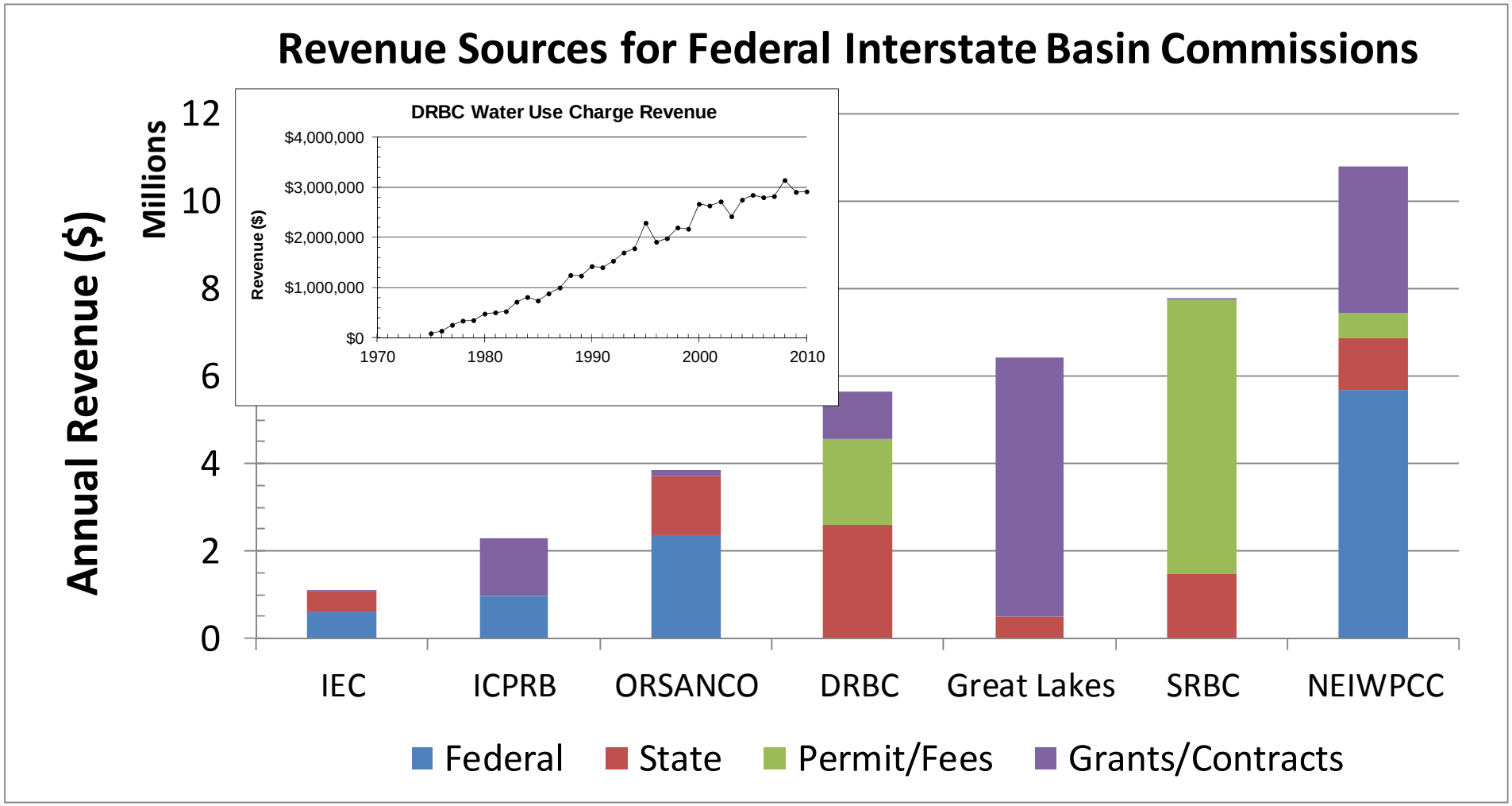
River basin governance organizations in the U.S.

Type	Description	Strength	Weakness	Example
Single Federal Administrator	Sole federal official (Sec. of Interior) has authority over single watershed.	Line of authority is clear. decision making is responsive, single leader sets policy. More power to Federal government.	Single administrator focused on single issue. Shortcomings in "intergovernmental collaboration. Less power to states.	Colorado River Compact (1922)
Regional Authority	Centralized regional governmental agency.	Central authority minimizes inter-governmental coordination. Projects implemented efficiently by single agency.	Command and control approach with reluctance to employ checks and balances. Diminished consensus by public. Undue reliance on federal government.	Tennessee Valley Authority (1933)
Watershed Councils	Agreements between states through federal /state legislation, resolutions, or MOA.	Good collaboration with public. Consensus driven, and non-threatening to stakeholders and businesses.	Lack formal legal and enforcement power. Less power than a compact authority. States usually only members (little Federal role).	Chesapeake Bay Partnership (1983)
Title II Interstate-Basin Commissions	Organizations directed by commissions where each member had one vote.	Best way to manage water resources in an integrated basis. Permanent staff. Treated states as equals to the Federal government.	Seen as unnecessary layer of government and competing with Federal water agencies for turf and funding	New England, Great Lakes, Ohio, Upper Mississippi, Missouri Basins
Federal-State Interstate Basin Compact Commissions	Congress consent needed to address Constitutional concerns about interstate treaties	Based on comity or collegiality, builds trust between states and minimizes disputes. Commissioners have equal, one state, one vote.	Time consuming process for Compact ratification. Hesitant to surrender Federal/state sovereignty to third party and competition for Federal/state funding.	Delaware River Basin Commission

Water resources governance in the Delaware Basin

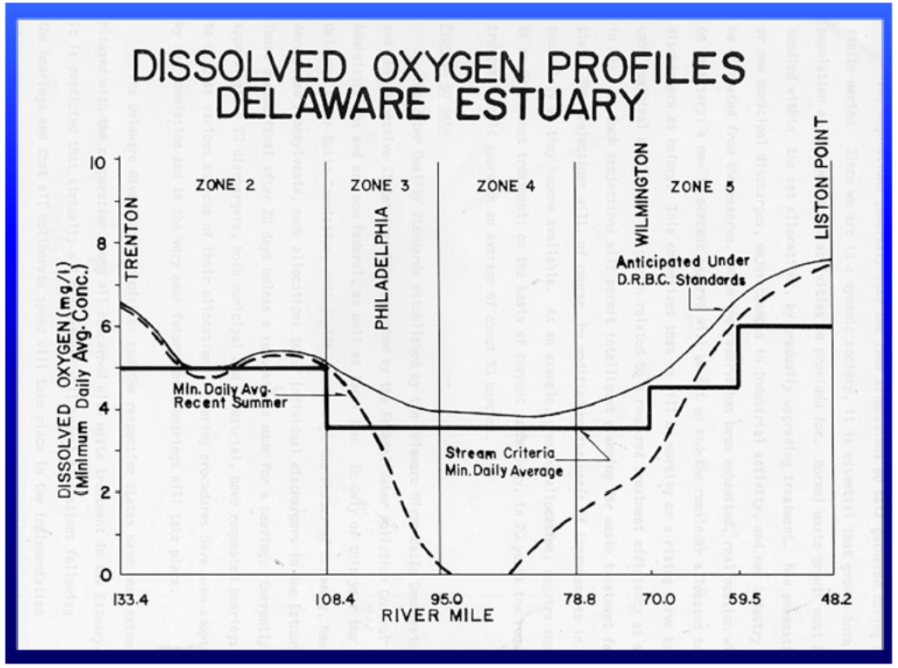




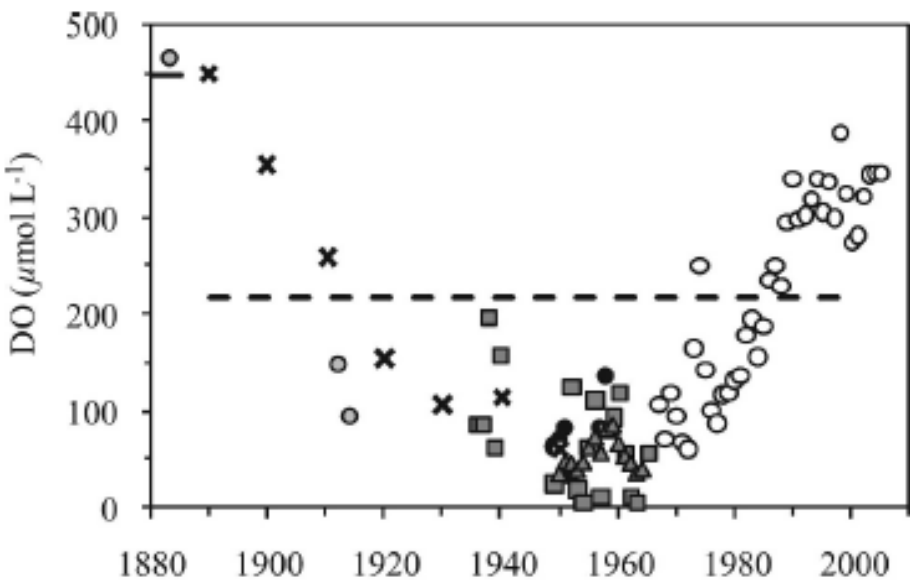


Nearly 45% of the DRBC budget is from state appropriations whereas over 80% of the SRBC budget is derived from fees.

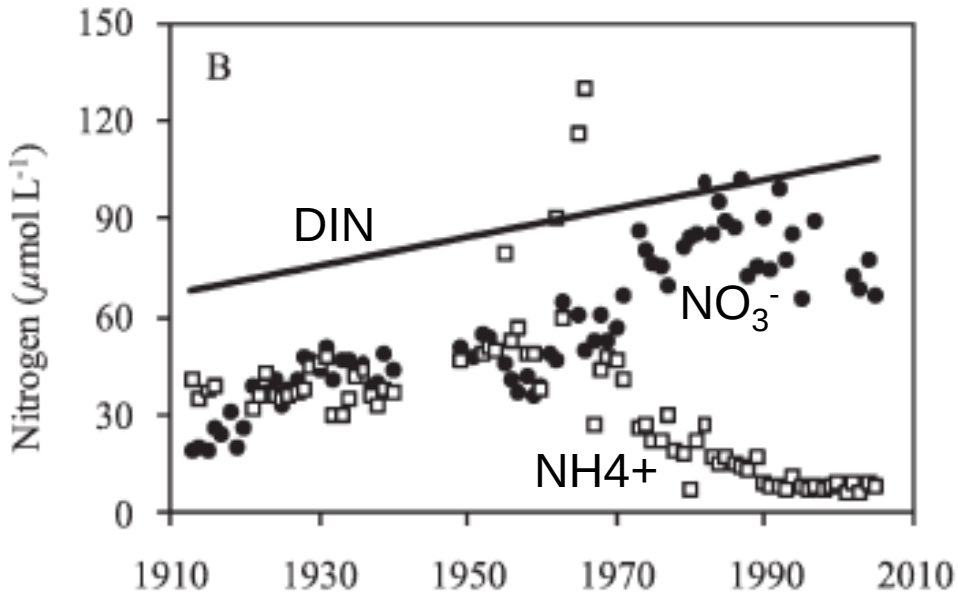
DRBC Water Quality Zone	DO Criteria (mg/l)
2. Trenton, NJ to RM 108.4 (maintenance/ propagation resident fish)	5.0 (24 hr) 6.5 (Spr/fall)
3. R.M. 108.4 to Big Timber Cr., NJ (maintenance of resident fish/aquatic life)	3.5 (24 hr) 6.5 (spr./fall)
4. Big Timber Cr., NJ to PA-DE line (maintenance of resident fish/aquatic life)	3.5 (24 hr) 6.5 (spr/fall)
5. DE-PA Line to Liston Point (maintenance of resident fish/aquatic life propagation of resident fish RM 70.0-48.2)	3.5 (RM 78.8) 4.5 (RM 70.0) 6.0 (RM 59.5) 6.5 (spr./fall)
6. Liston Point - Atlantic Ocean	6.0 (24 hr)



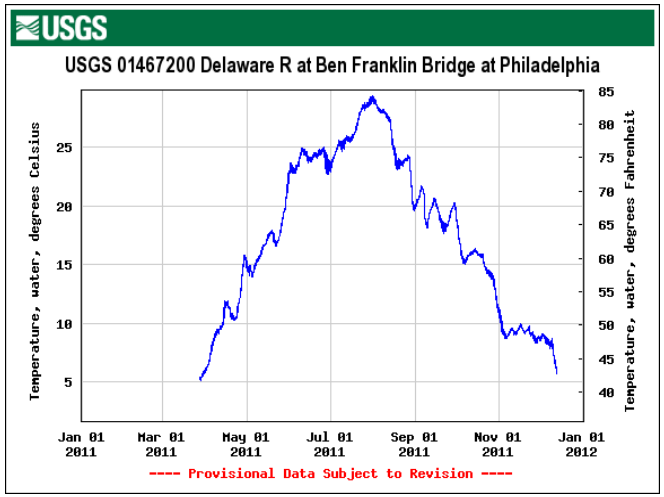
DO in the Delaware R. near Philadelphia (Sharp 2010)

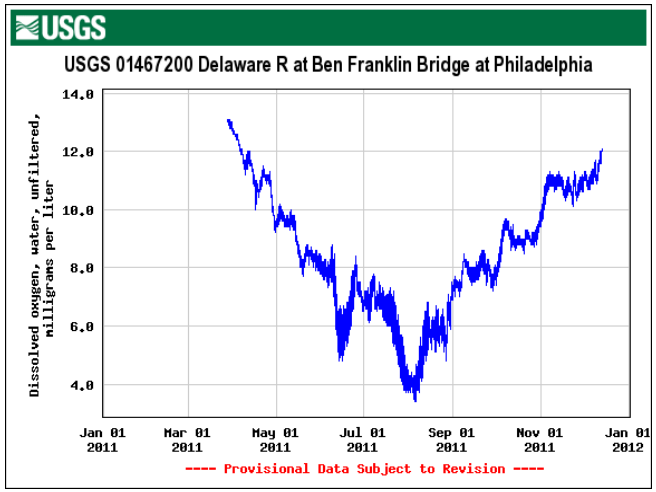


Nitrogen in the Delaware R. near Philadelphia (Sharp 2010)



Temp. (°C)	100% DO Saturation (mg/l)
20	9.07
25	8.24
30	7.54
35	6.93
40	6.41





Future DO criteria along the Delaware River

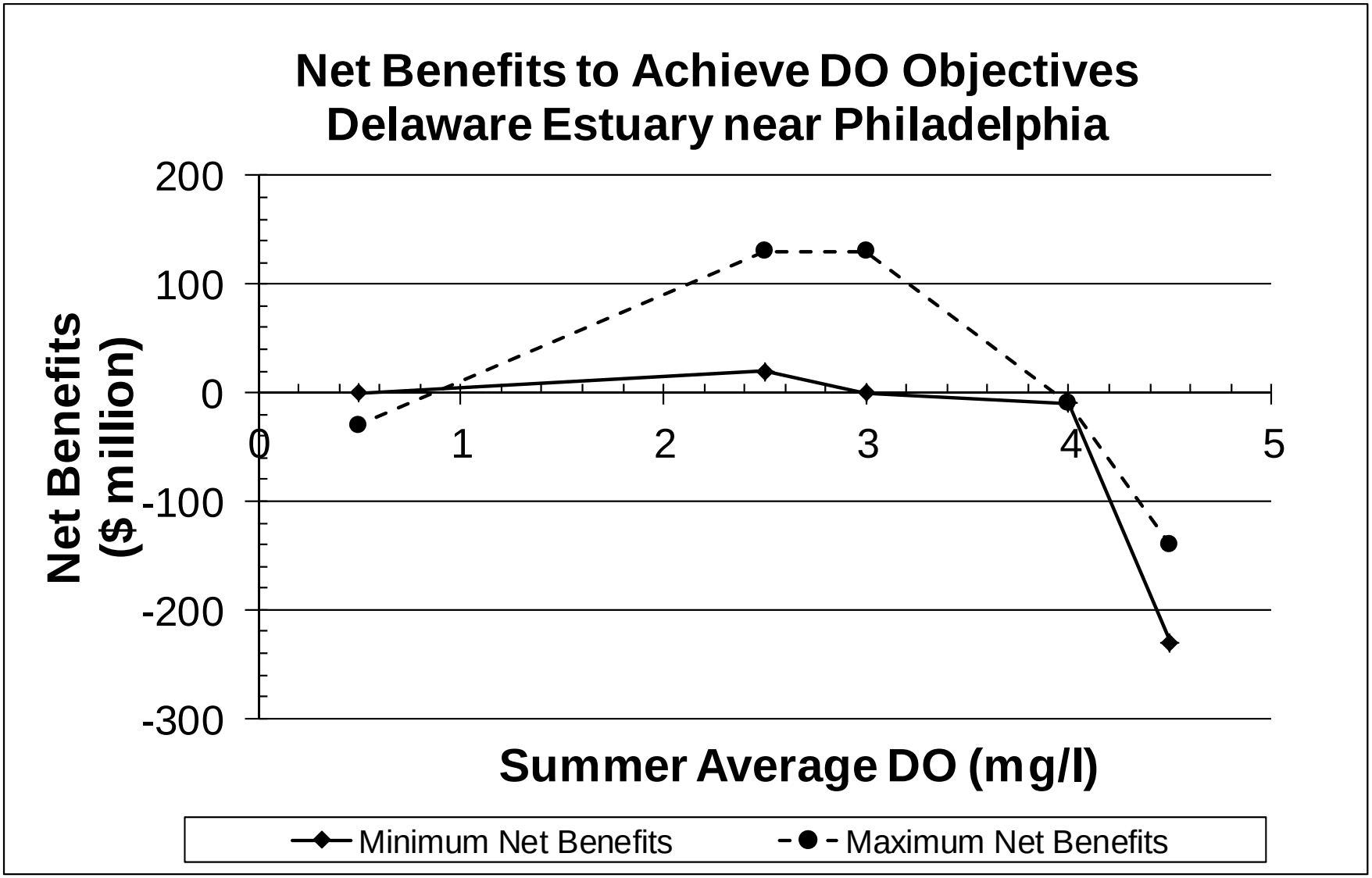
- DRBC considering setting more stringent DO criteria in Zones 3, 4, 5 along Delaware R. from Wilmington to Philadelphia.
- To support year-round (not just seasonal spawning and migration) propagation of domestic and anadromous fish.
- Existing DO criteria (3.5 mg/l) inadequate to sustain year-round propagation of anadromous fish such as sturgeon (Campbell and Goodman 2004, Secor and Gunderson 1998).
- Atmospheric warming may increase river temperatures and raise sea level as warmer, saltier water reduces DO saturation.
- Compliance with higher DO standard may be constrained by DO saturation during summer water temps that exceed 30 deg C.

1960's costs/benefits to meet water quality objectives in the Delaware Estuary

(FWPCA 1966 and Thoman 1972)

Objective	DO Summer (mg/l)	% Pollution Removal	Annual Costs ($ million)		Annual Benefits ($ million)	
			$1964	**$2010[1]**	**$1964**	**$2010[1]**
I	4.5	98%	98	284	32-70	93-203
II	4.0	90%	46-66	133-191	28-64	81-186
III	3.0	75%	26-36	75-104	26-62	75-180
IV	2.5	50%	20-30	58-87	24-56	70-162
V	0.5		6	17	0	0

1. Adjusted from $1964 to $2010 by 3% annually based on change in CPI.

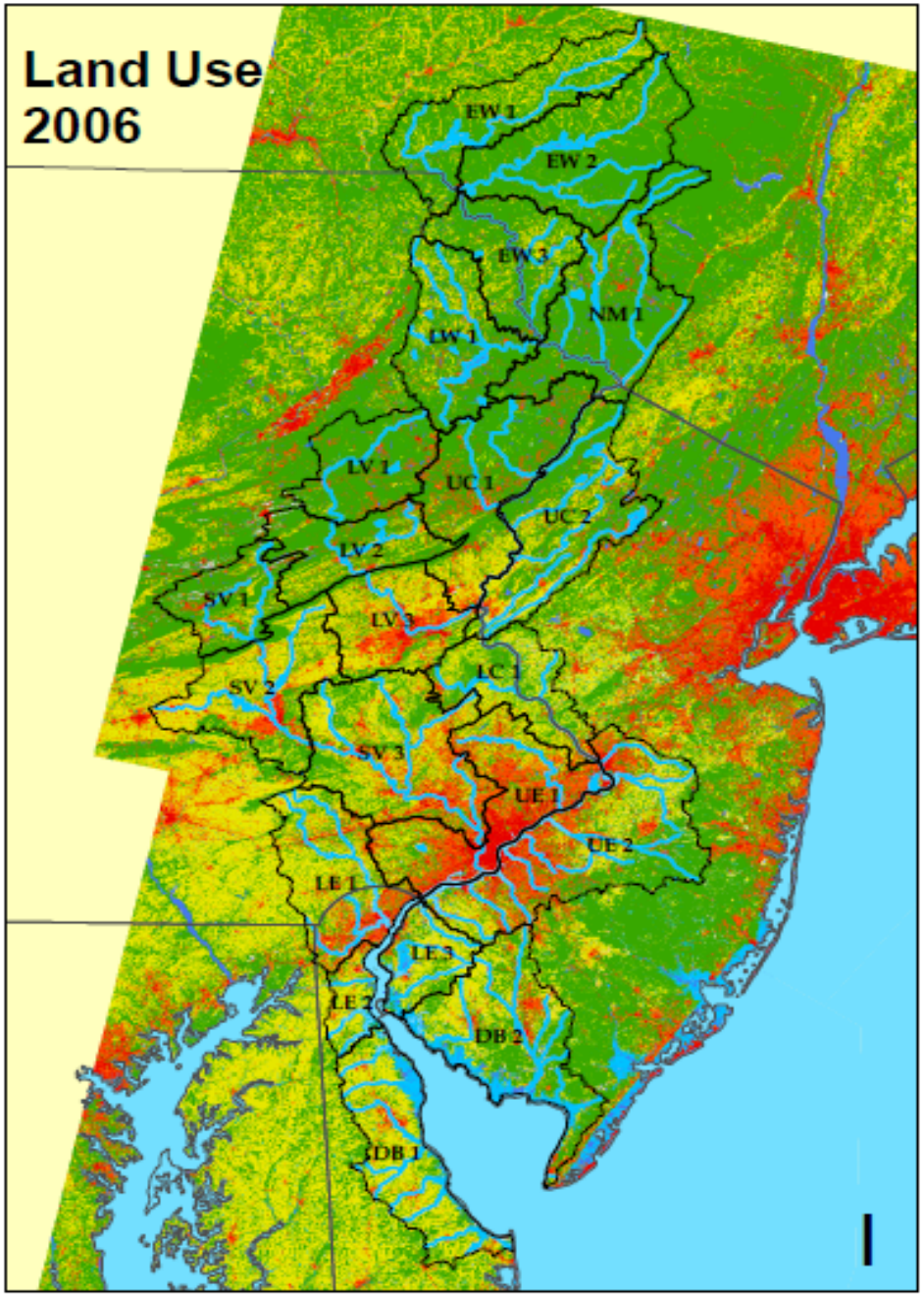


1964 dollars to achieve water quality by 1975-1980

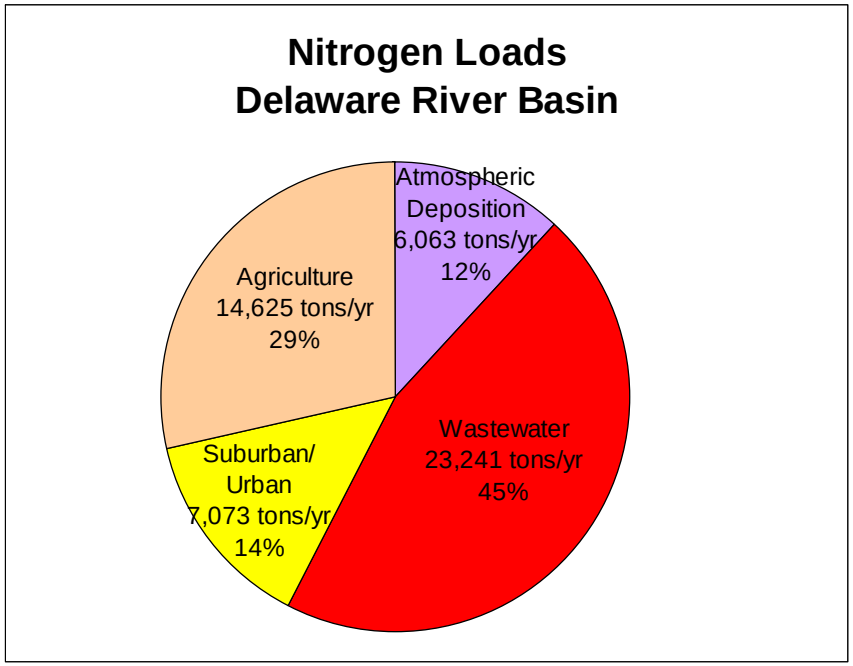
Costs ($2010)

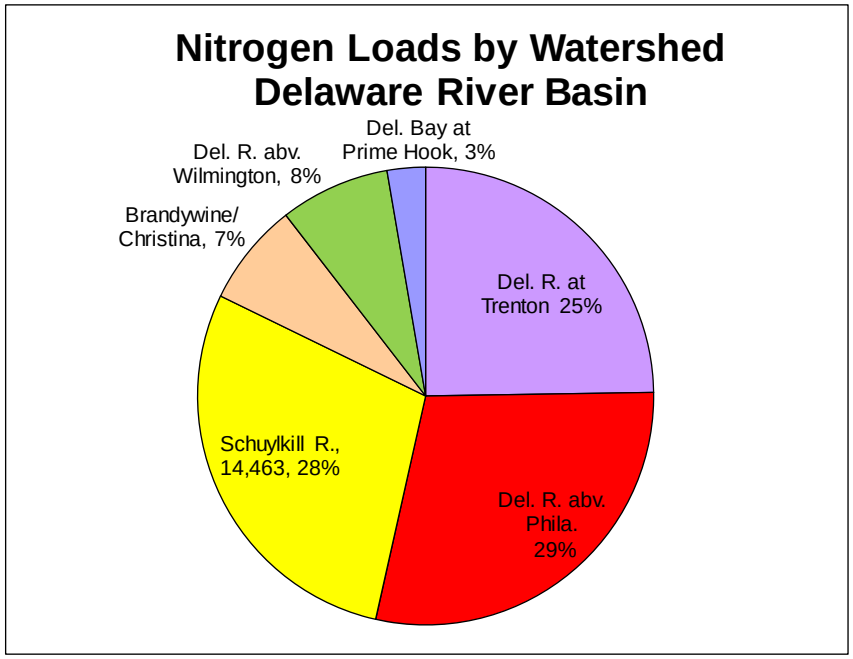
Define 2010 costs of nitrogen load reductions to achieve improved water quality in the Delaware Basin:

1. Quantify N loads from the Delaware Basin for atmospheric, urban/suburban, wastewater, and agricultural sources.
2. Estimate N load reductions to increase dissolved oxygen levels to meet a more stringent water quality standard.
3. Define BMPs to reduce N loads from point and nonpoint sources and estimate unit N load reduction costs ($/lb N/yr).
4. Compute N reduction costs ($/yr) for each of the options.
5. Estimate cost effective N load reduction practices from marginal abatement cost (MAC) curves.



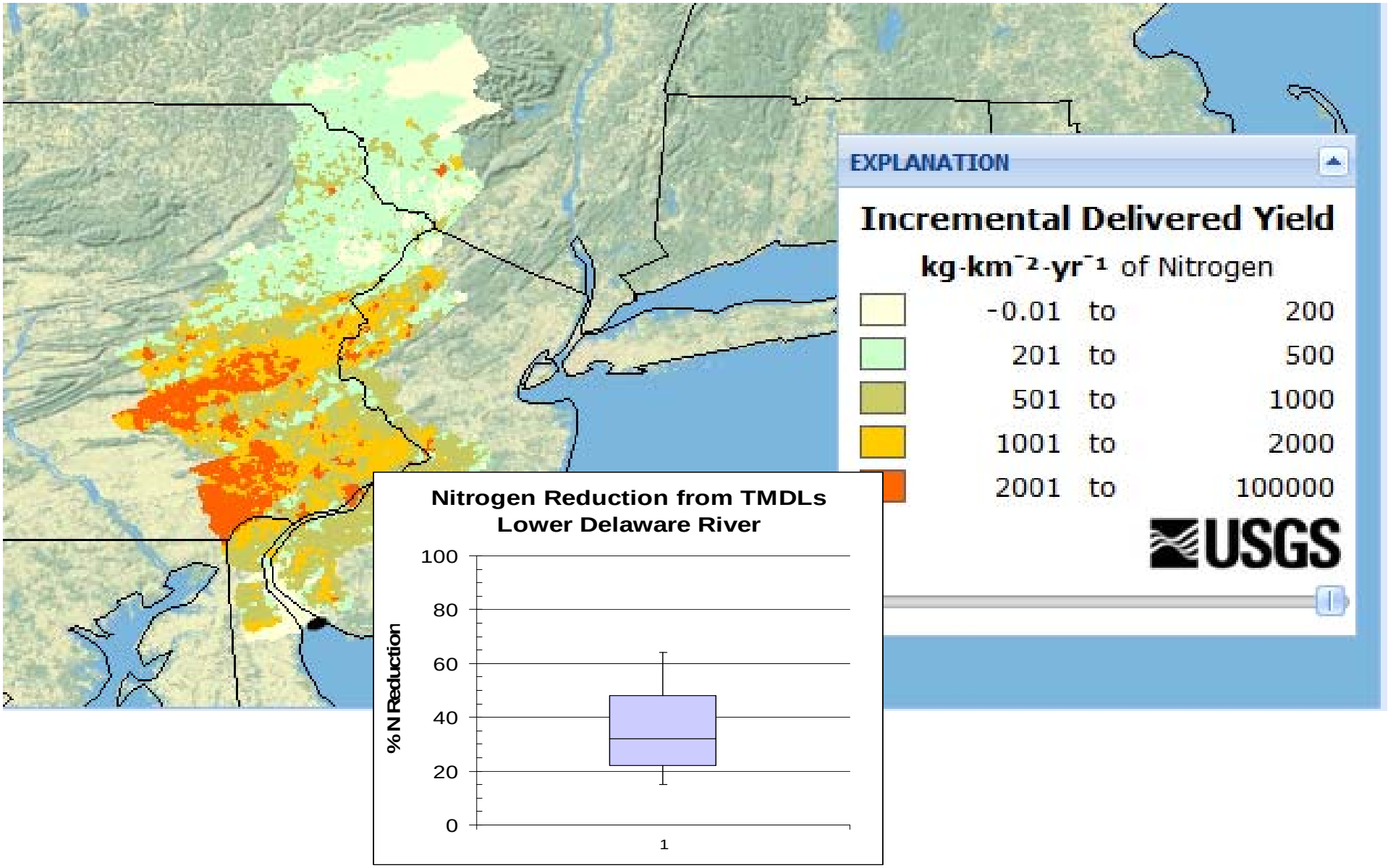
NOAA CSC 2006

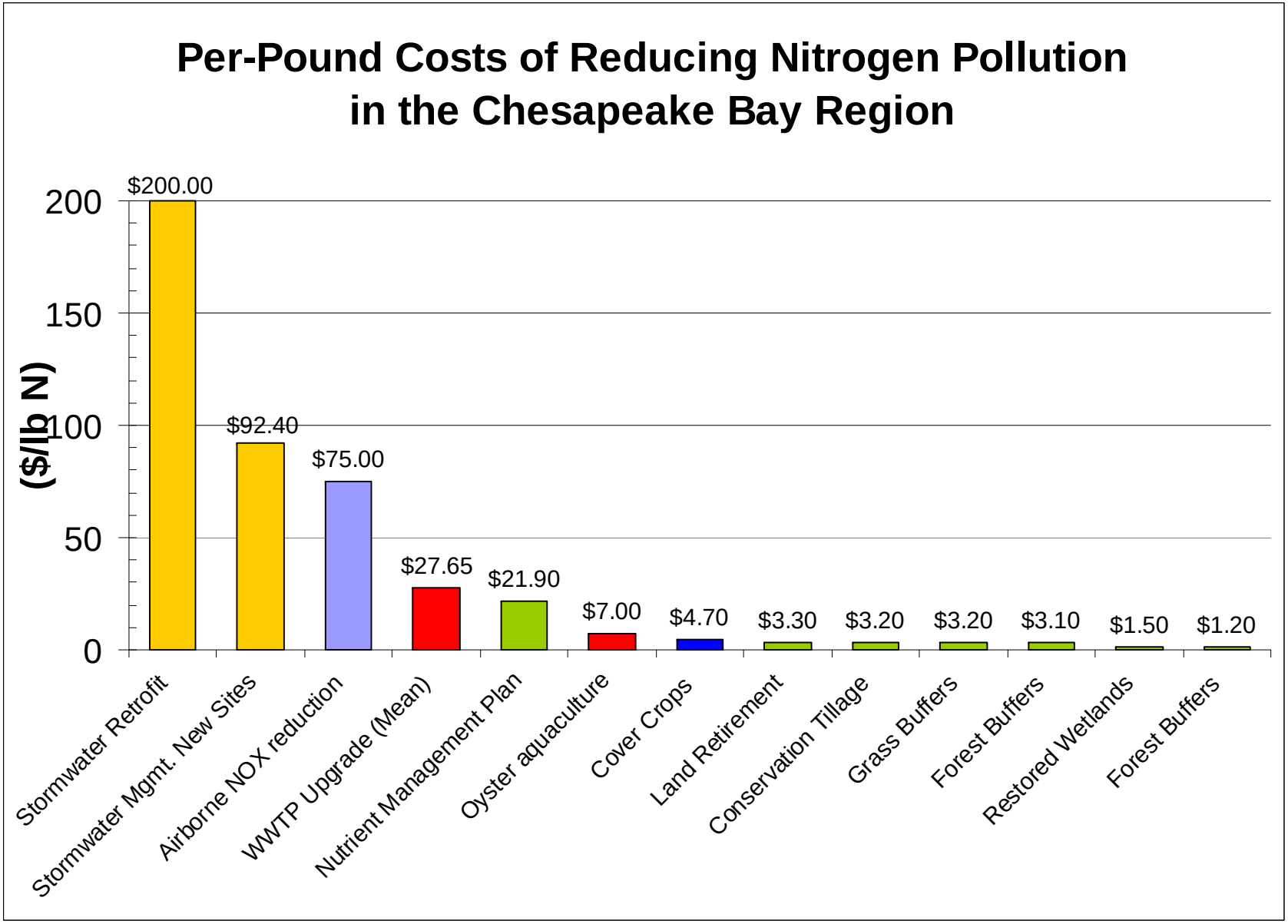




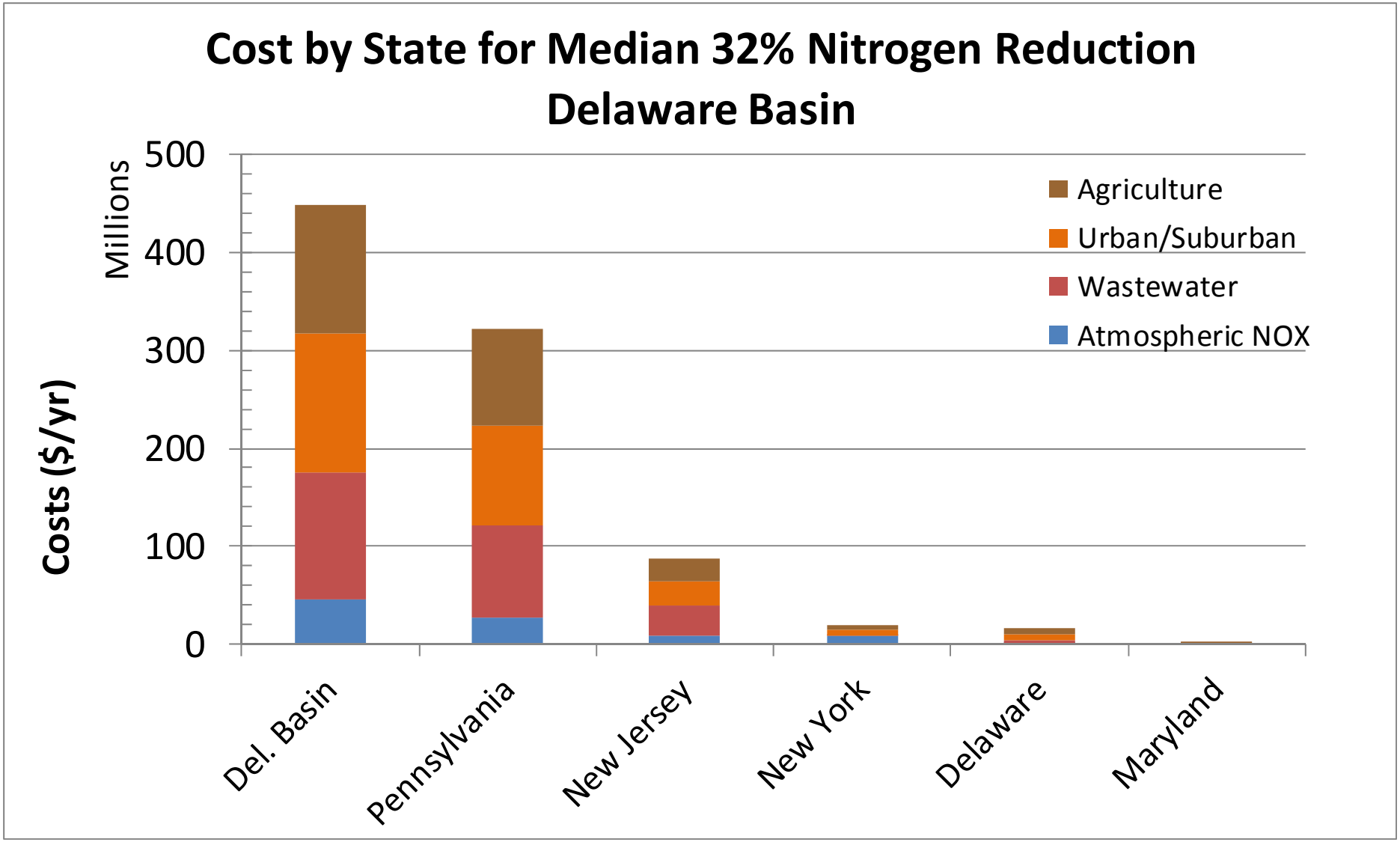
Moore et al. 2011

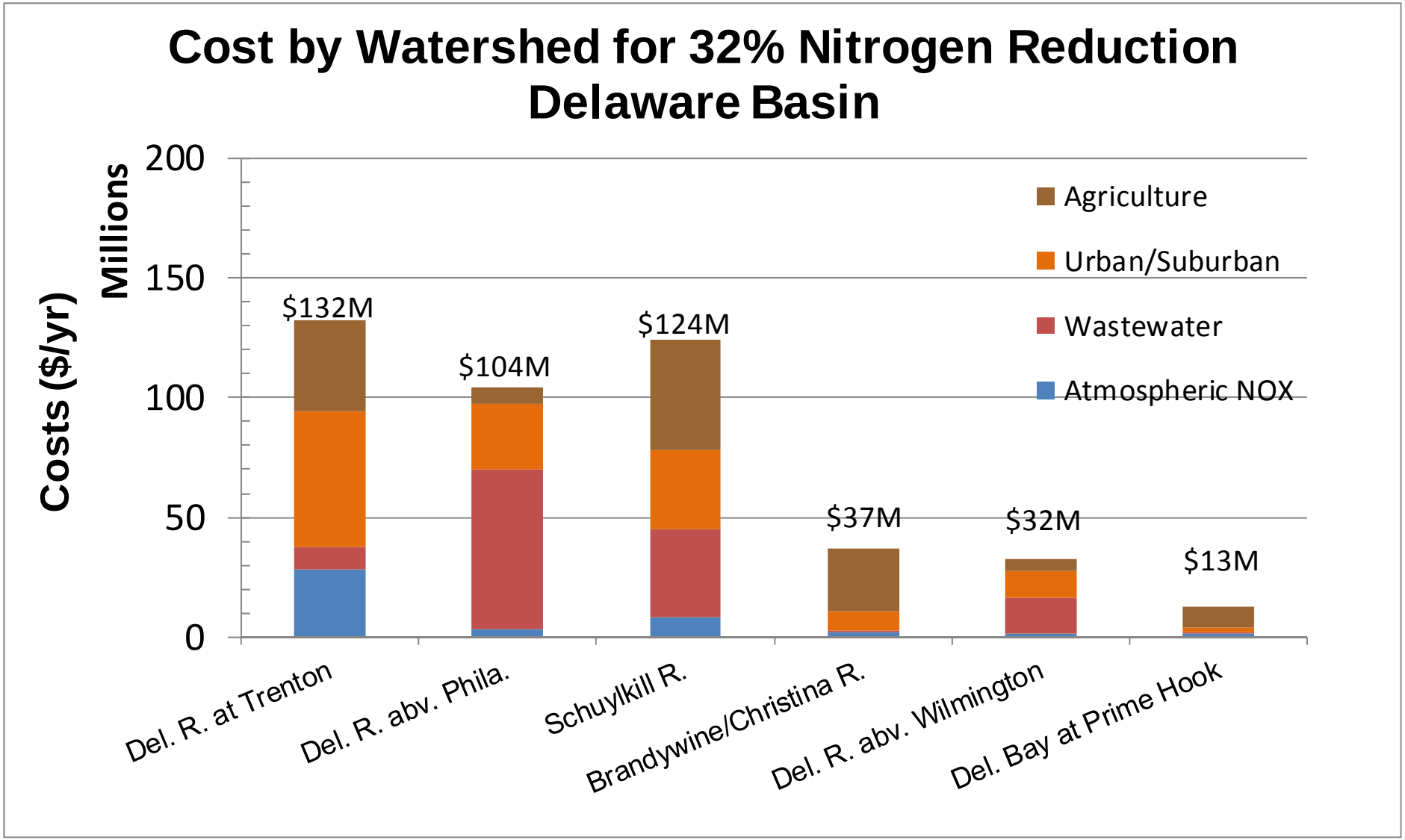
Incremental delivered nitrogen yield to Delaware Basin from SPARROW model

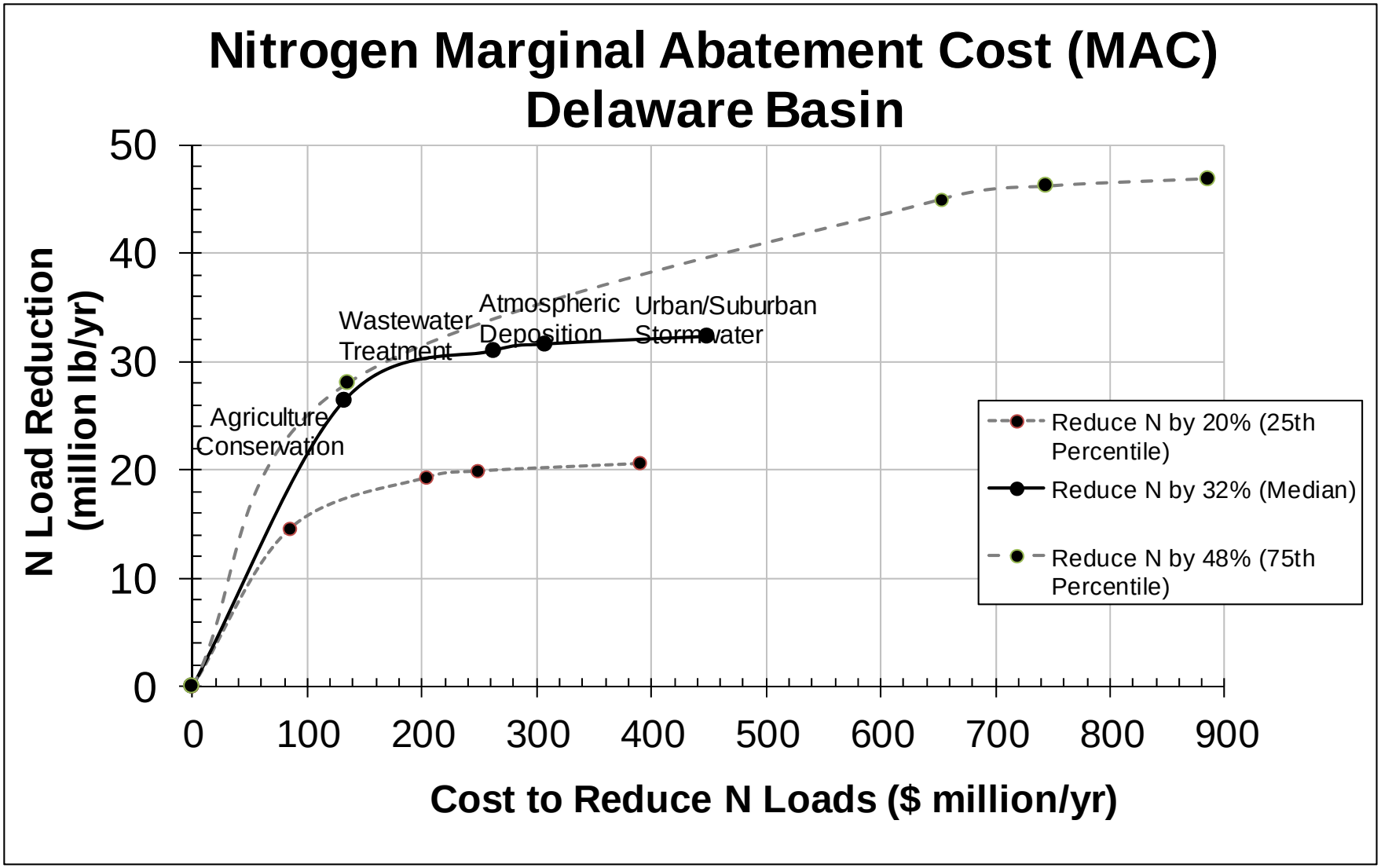




(Chesapeake Bay Foundation 2010 and World Resources Institute)


Cost by State for Median 32% Nitrogen Reduction
Delaware Basin
Costs ($/yr)
Millions
500
400
300
200
100
0
Agriculture
Urban/Suburban
Wastewater
Atmospheric NOX
Del. Basin
Pennsylvania
New Jersey
New York
Delaware
Maryland

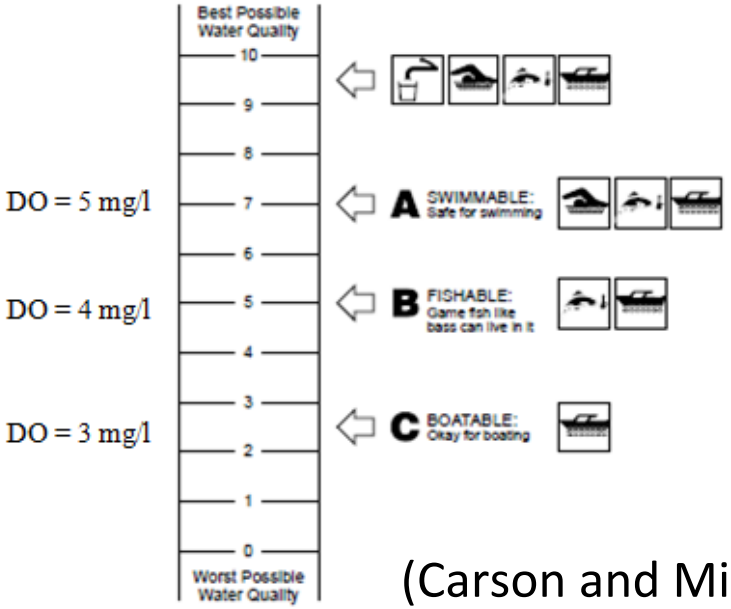

Cost by Watershed for 32% Nitrogen Reduction
Delaware Basin
Costs ($/yr)
Millions
200
150
100
50
0
$132M
$104M
$124M
$37M
$32M
$13M
Agriculture
Urban/Suburban
Wastewater
Atmospheric NOX
Del. R. at Trenton
Del. R. abv. Phila.
Schuylkill R.
Brandywine/Christina R.
Del. R. abv. Wilmington
Del. Bay at Prime Hook


Nitrogen Marginal Abatement Cost (MAC)
Delaware Basin
N Load Reduction (million lb/yr)
Cost to Reduce N Loads ($ million/yr)
0
10
20
30
40
50
0
100
200
300
400
500
600
700
800
900
Agriculture Conservation
Wastewater Treatment
Atmospheric Deposition
Urban/Suburban Stormwater
Reduce N by 20% (25th Percentile)
Reduce N by 32% (Median)
Reduce N by 48% (75th Percentile)

Benefits ($2010)

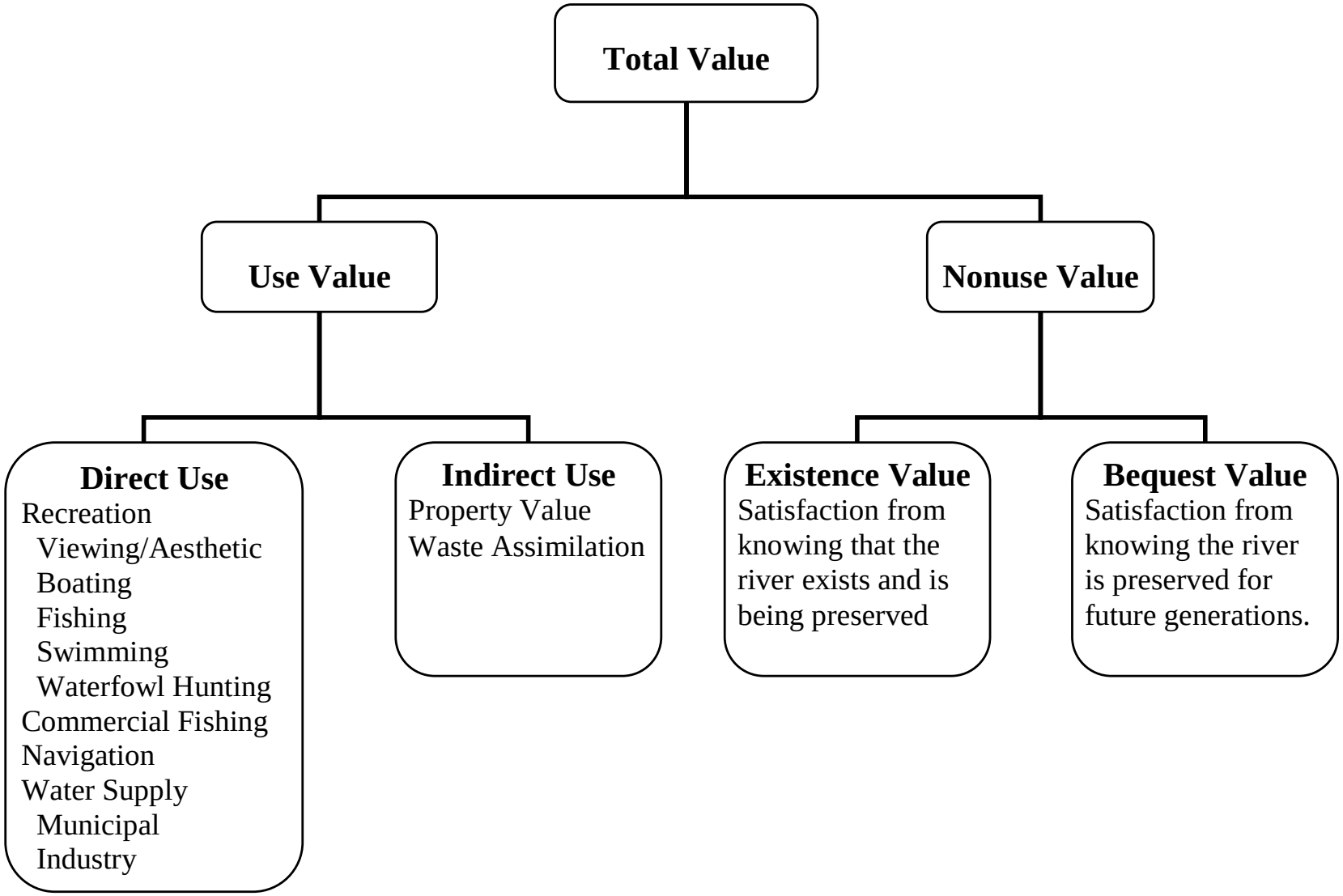
What are the economic benefits of improved water quality under the water rights system of the DRBC Compact? This chapter defines:

- Benefits of improved water quality for recreation, boating, fishing, wildlife-viewing, property value, agriculture, navigation and water supply uses.
- Marginal benefits (MB) or change in benefits as WQ improves from current (DO 3.5 mg/l) to a future condition (4.0 - 5.0 mg/l).



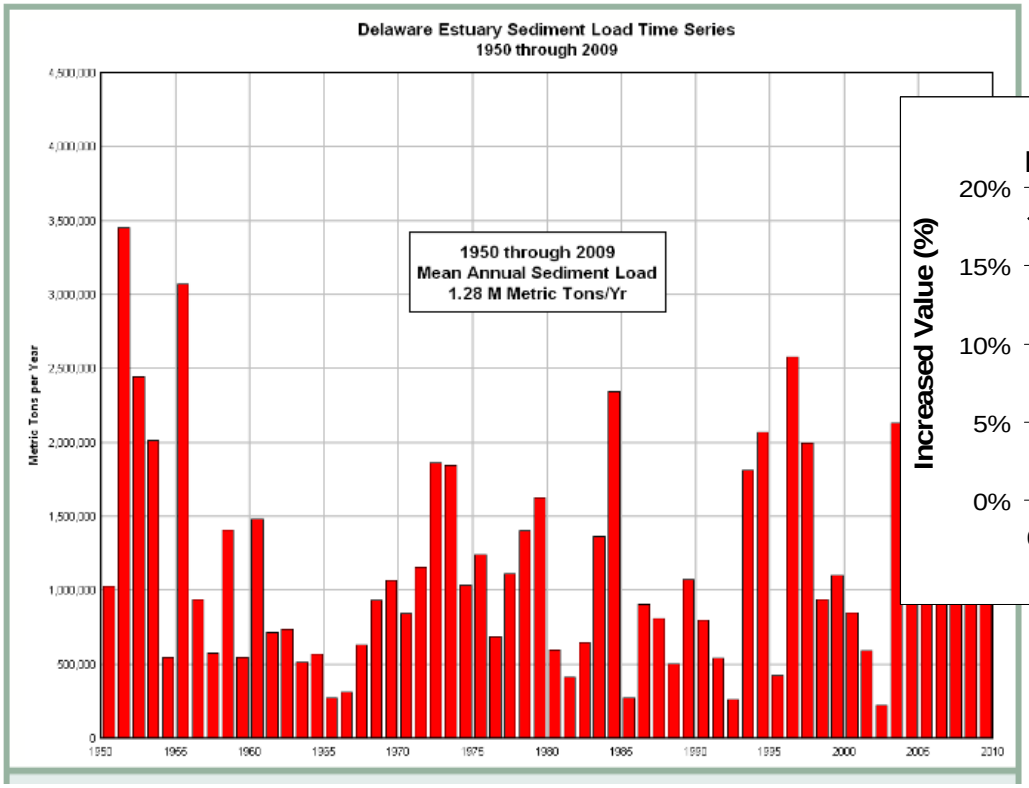
Water quality ladder
(Carson and Mitchell 1993 from Resources for the Future)

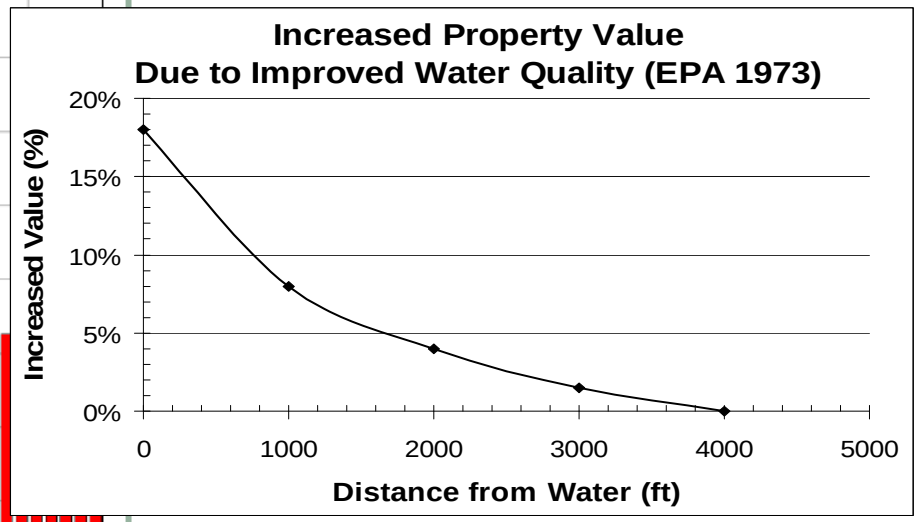
Economic benefits of improved water quality in the Delaware Basin



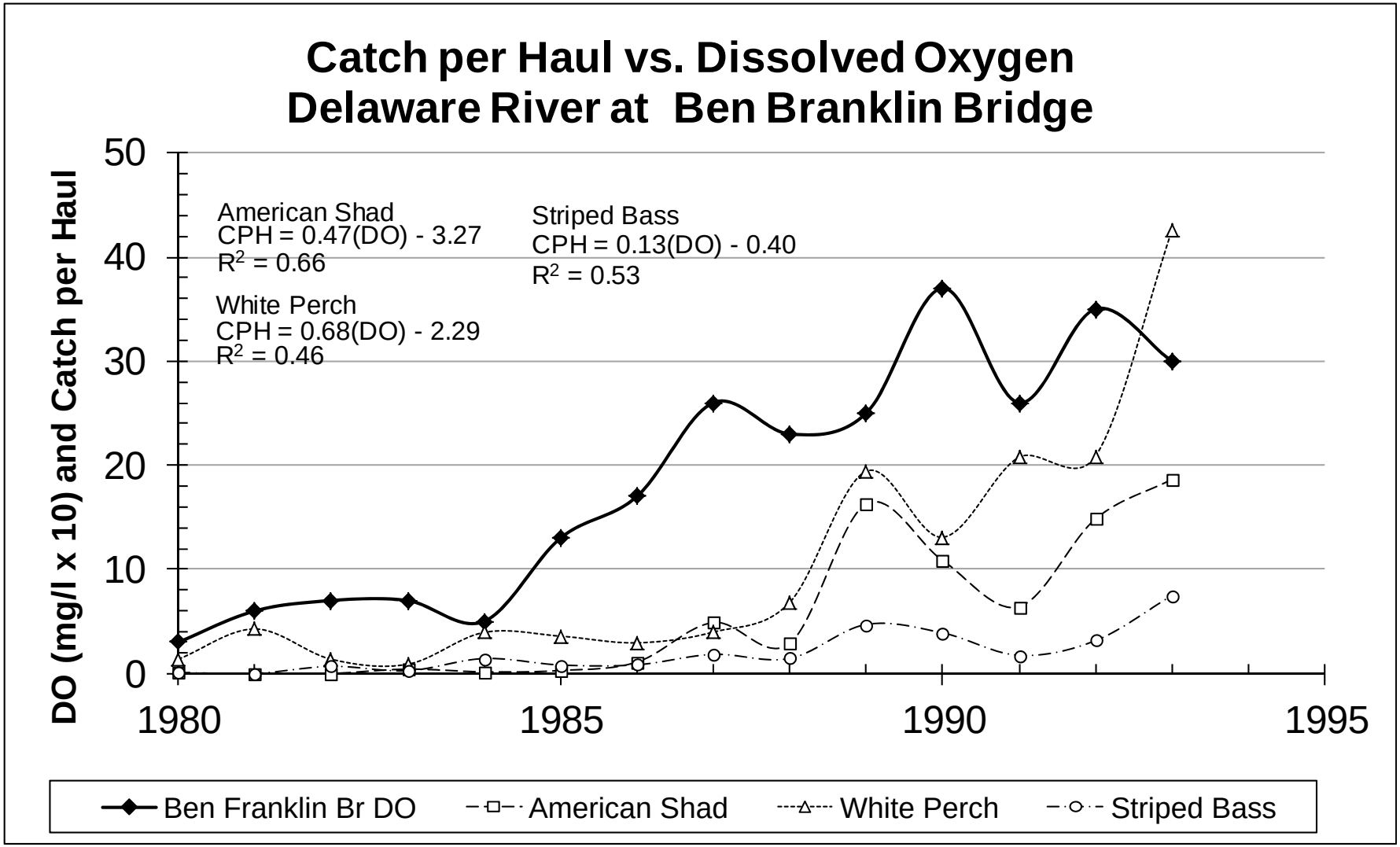
Recreational boating benefits

Estimate	Unit Value ($2010/day)	Activity (million days)	Existing Value ($ million)	Boating Participants	WQ Benefit ($)	Benefit ($ million)
Lower Bound	30	5.3	159	394,000	$116/boater	46
Upper Bound	66	5.3	350	394,000	$63/trip	334

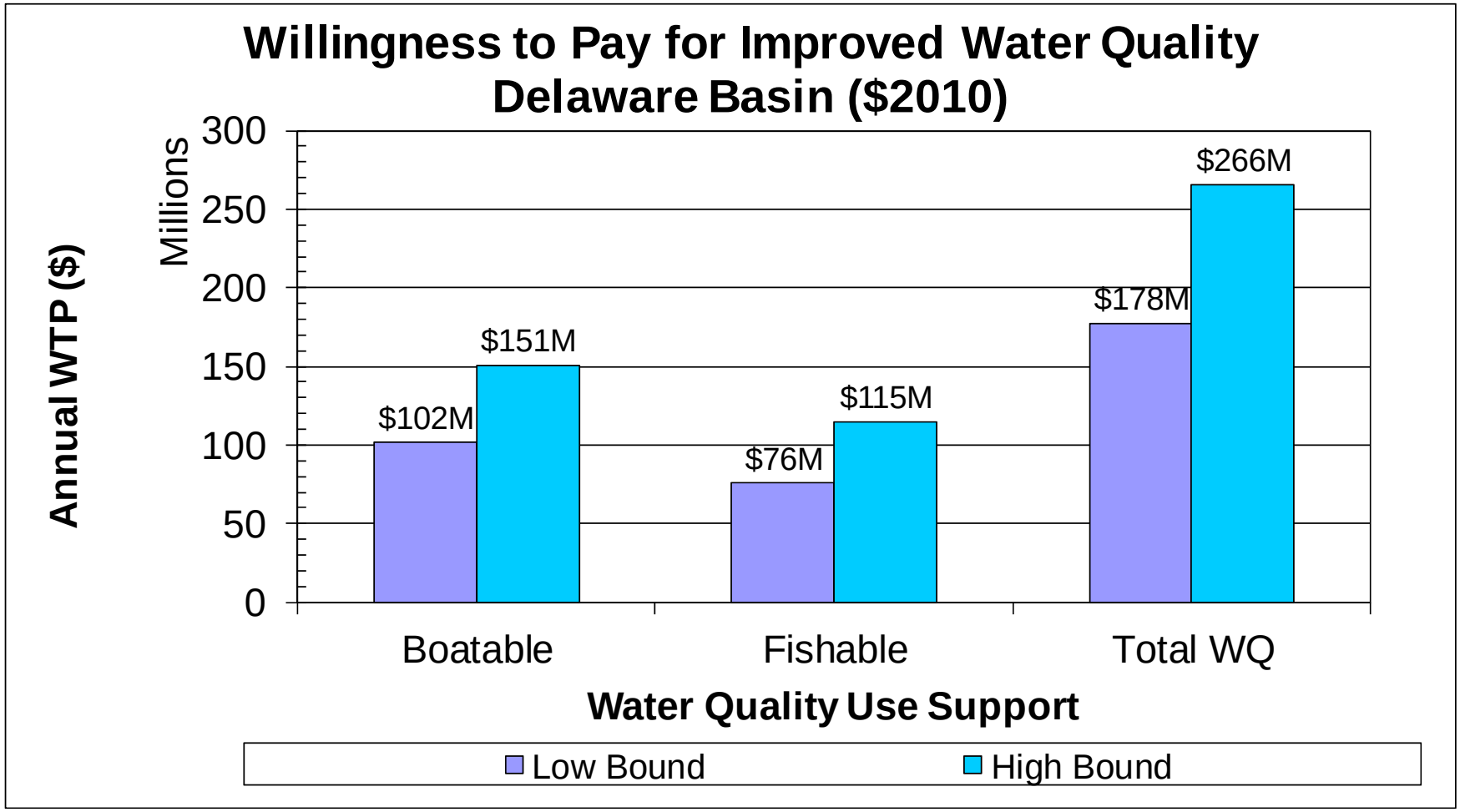




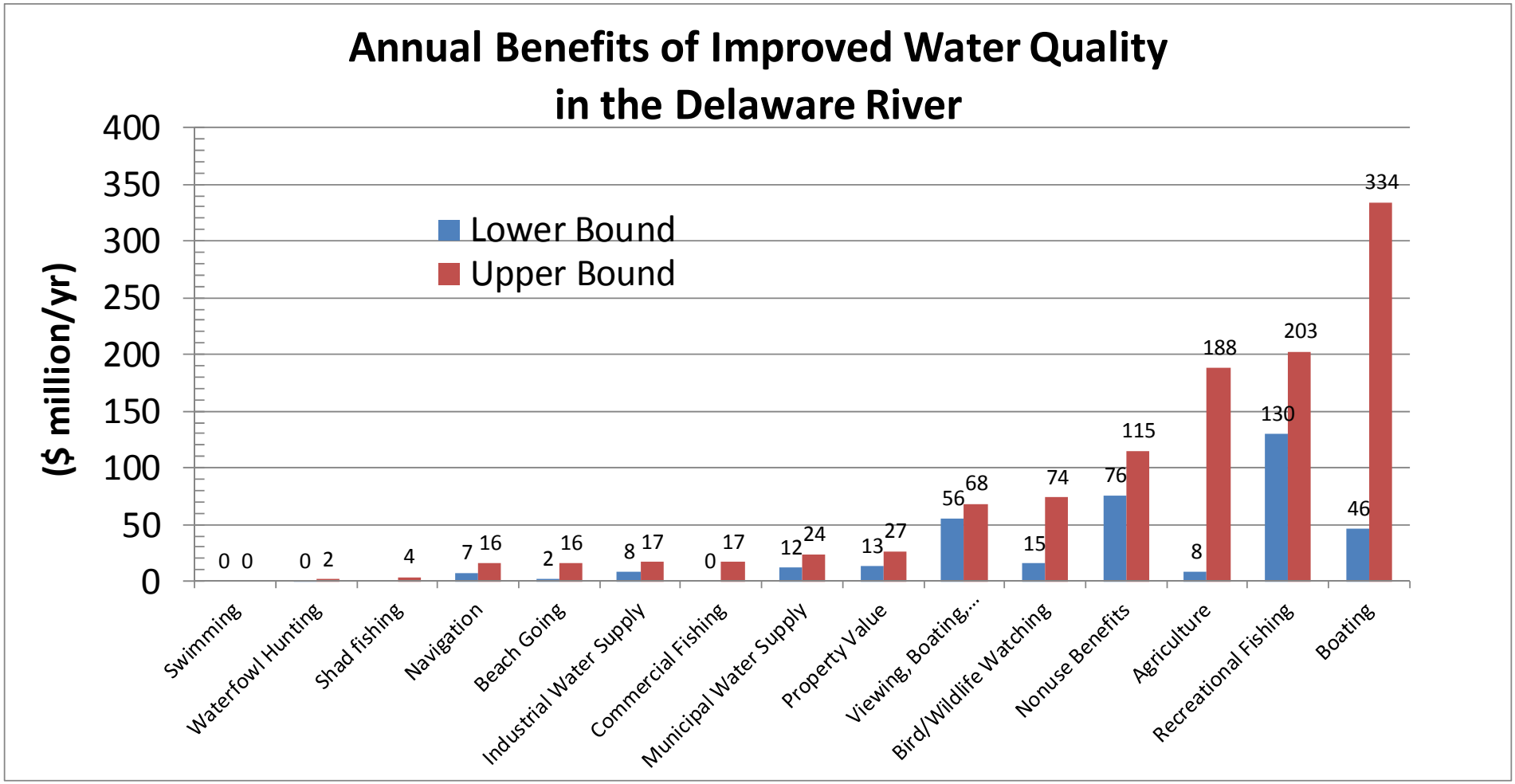
Relationship between DO and fish catch in the Delaware Estuary (Weisberg et al. 1996)



Nonuse benefits of WTP for improved water quality in the Delaware Basin

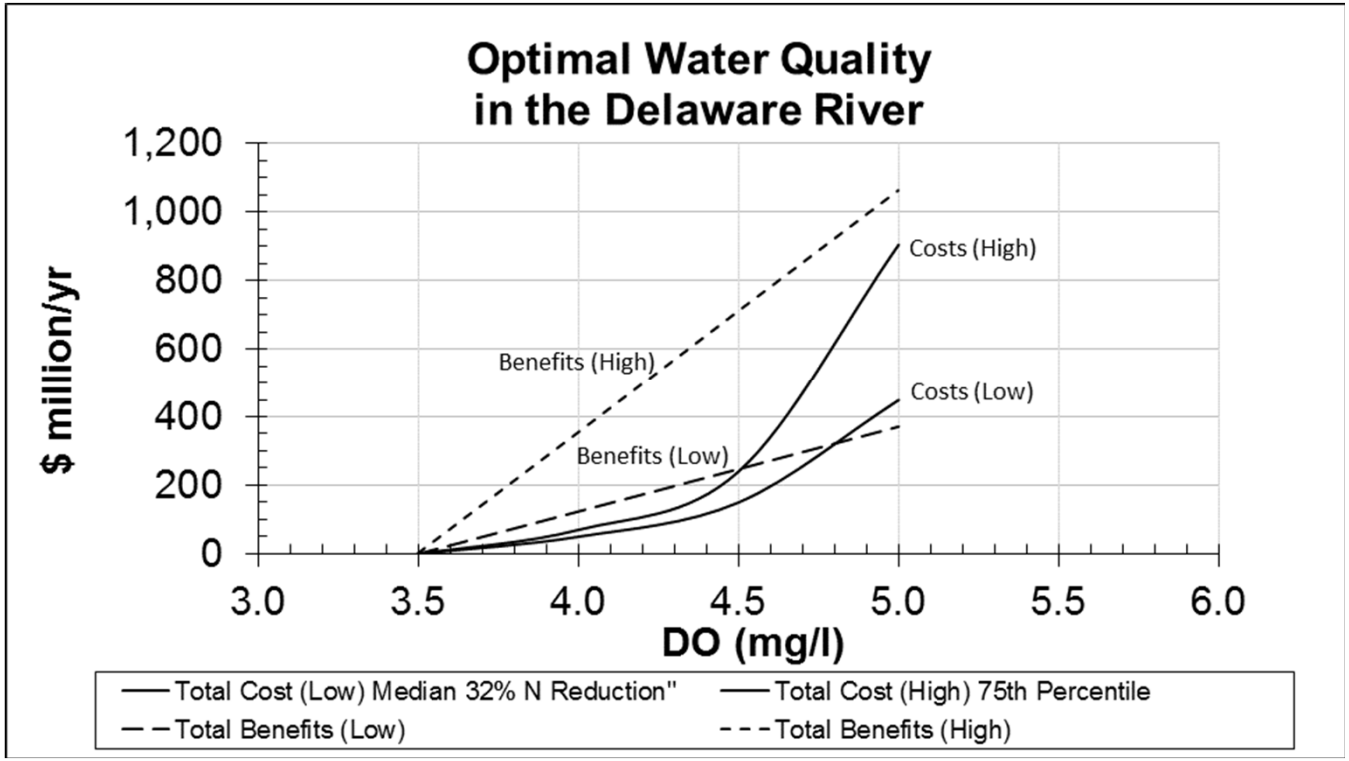


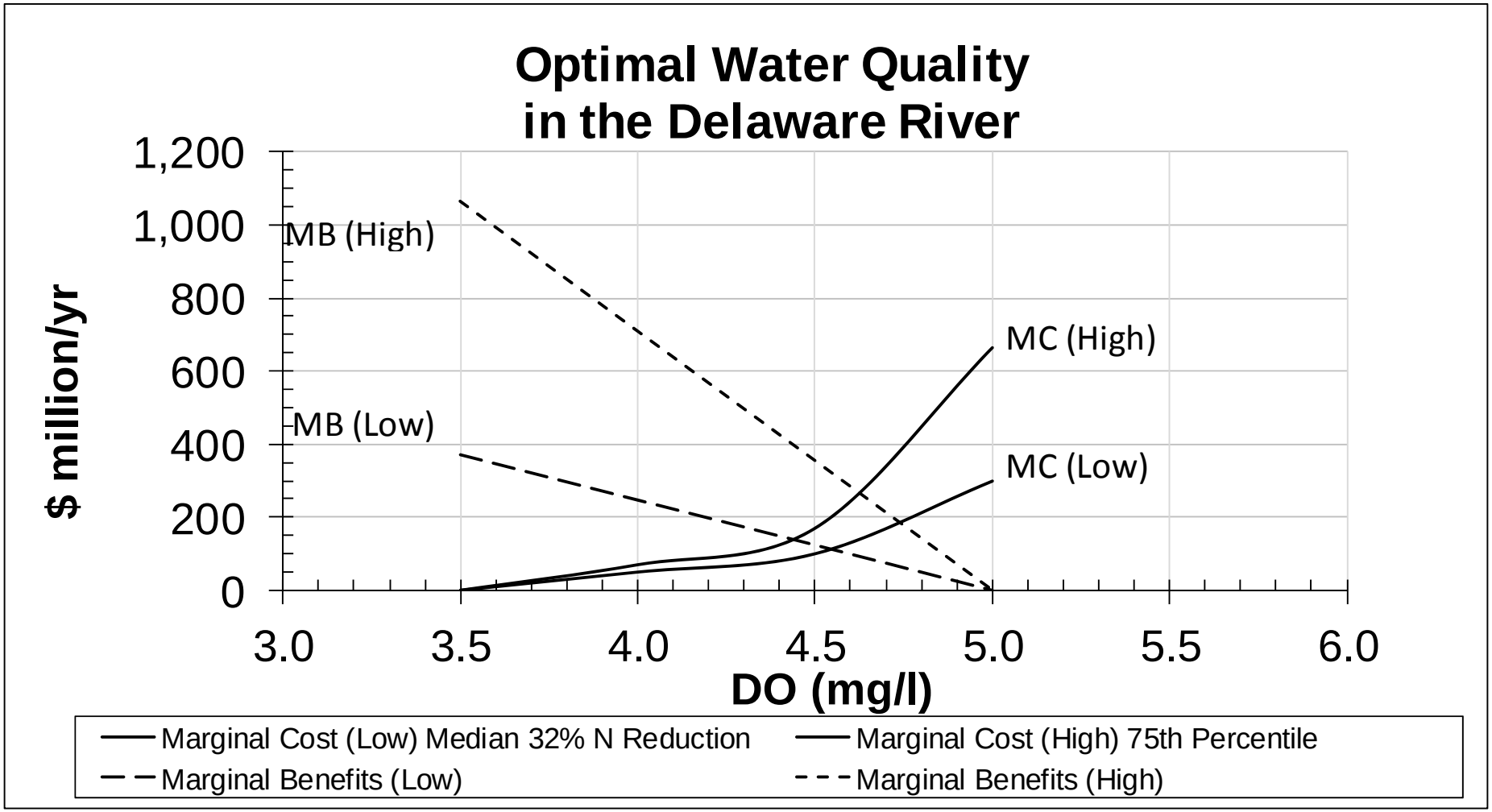
(Carson and Mitchell 1993 adjusted to $2010 at 3% annually. Nonuse benefits are 33% of WTP)


Annual Benefits of Improved Water Quality
in the Delaware River
($ million/yr)
400
350
300
250
200
150
100
50
0
Lower Bound
Upper Bound
0 0
0 2
4
7 16
2 16
8 17
0 17
12 24
13 27
56 68
15 74
76 115
8 188
130 203
46 334
Swimming
Waterfowl Hunting
Shad fishing
Navigation
Beach Going
Industrial Water Supply
Commercial Fishing
Municipal Water Supply
Property Value
Viewing, Boating,...
Bird/Wildlife Watching
Nonuse Benefits
Agriculture
Recreational Fishing
Boating

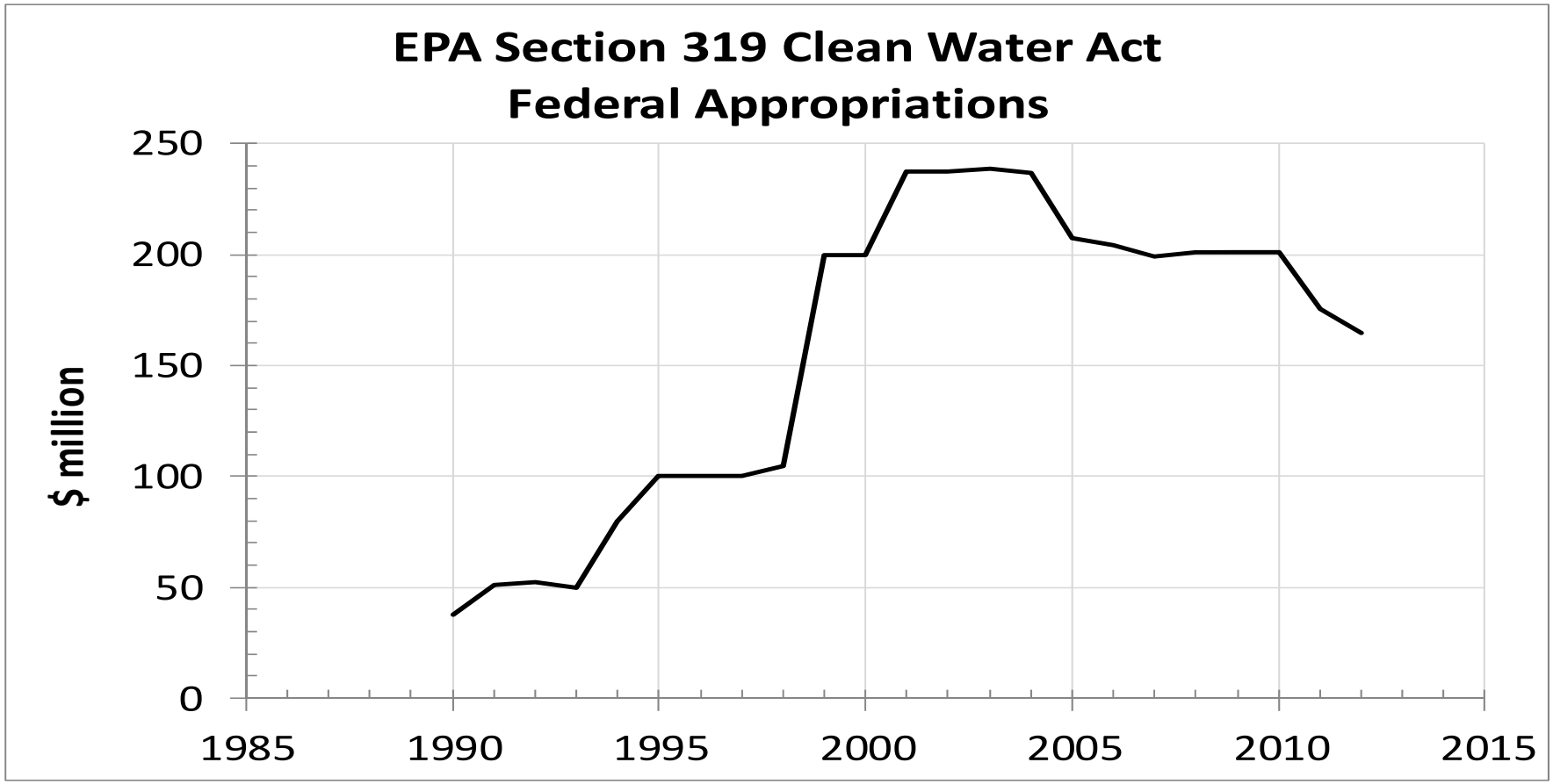
21st Century Benefit- Cost Analysis

DRBC Criteria	DO (mg/L)	N Load (ton/yr)	Reduction (ton N/yr)	% N Reduction	Costs ($ million	Benefits ($ million)		Net Benefits ($ million)		B/C	
						Low	High	Low	High	Low	High
Existing	3.5	50,525	0	0	0	0	0	0	0	0	0
↓	4.0				50	124	354	74	304	2.5	7.1
	4.5				150	247	709	97	559	1.6	4.7
Future	5.0	34,357	16,168	32%	449	371	1,063	-78	614	0.8	2.4

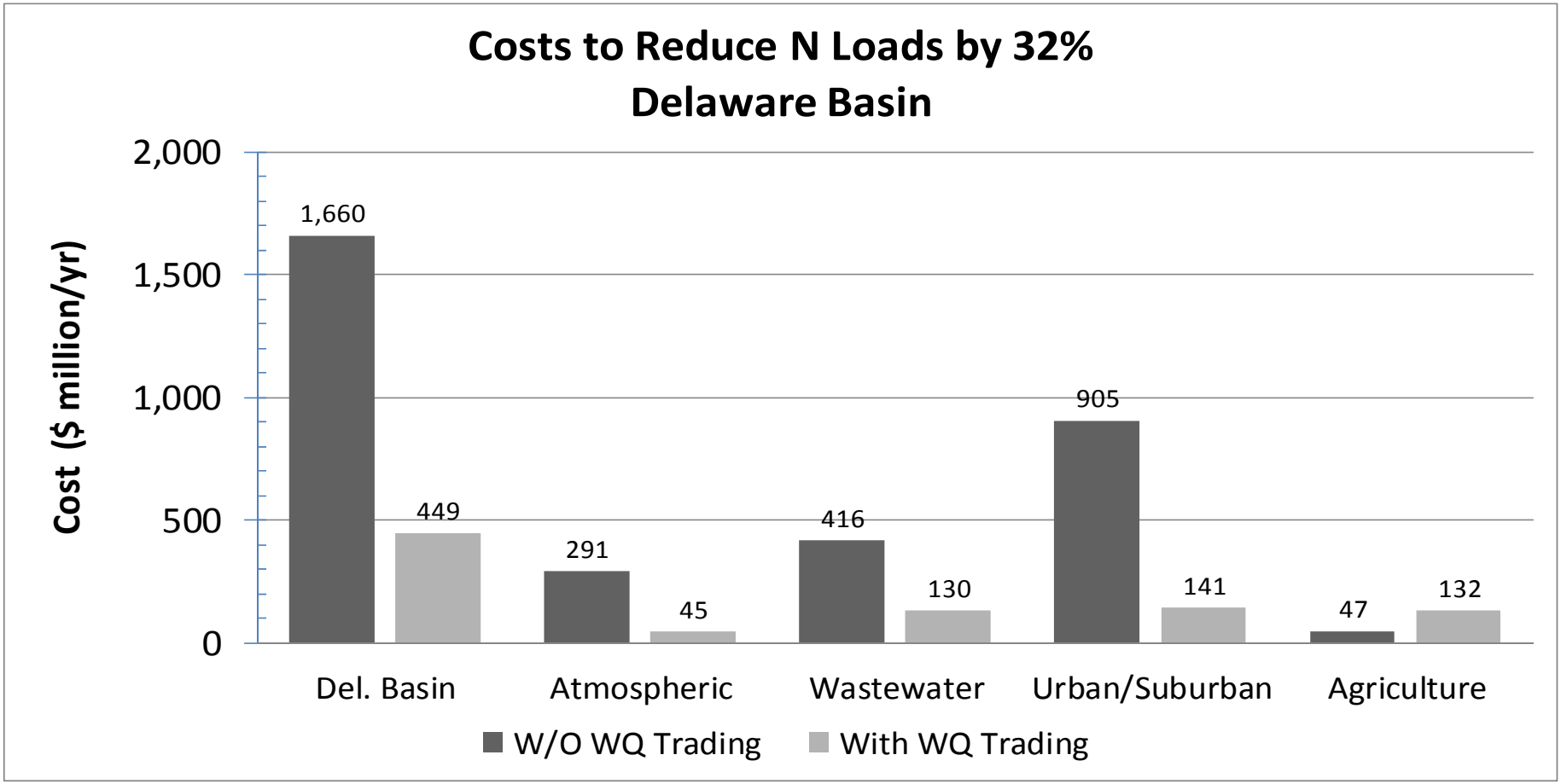



Optimal Water Quality
in the Delaware River
$ million/yr
1,200
1,000
800
600
400
200
0
MB (High)
MB (Low)
MC (High)
MC (Low)
3.0
3.5
4.0
4.5
5.0
5.5
6.0
DO (mg/l)
Marginal Cost (Low) Median 32% N Reduction
Marginal Cost (High) 75th Percentile
Marginal Benefits (Low)
Marginal Benefits (High)

A new business model is needed as Federal/state water resources appropriations are declining

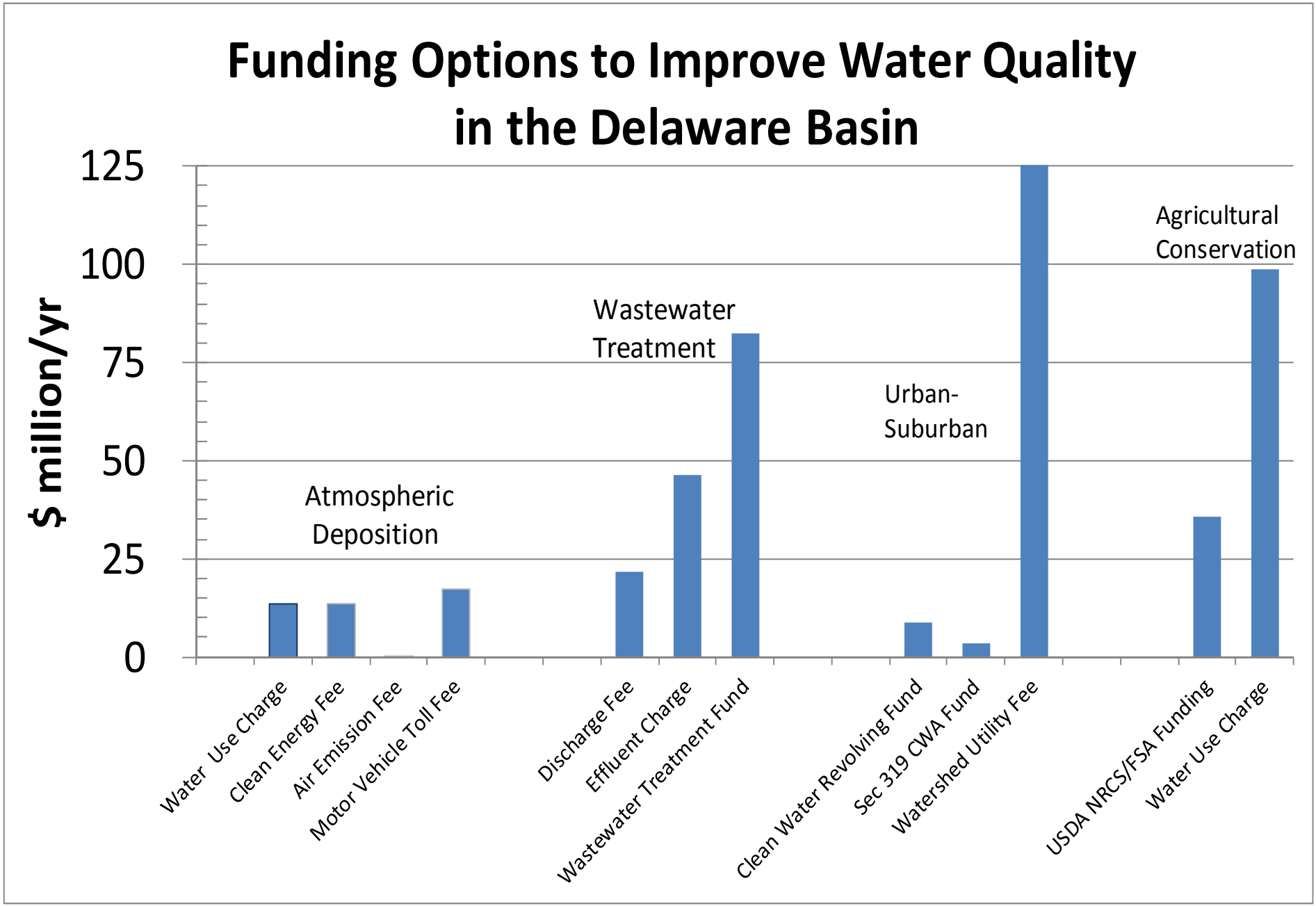


Nitrogen reduction costs with/without water quality trading in the Delaware Basin



Funding programs to improve water quality in the Delaware Basin

Funding Program	DE ($mil)	NJ ($mil	NY ($mil)	PA ($mil)	Del. Basin ($mil)
Atmospheric NOX Reduction	**2.2**	**24.2**	**0.0**	**18.0**	**44.5**
Water Use Charge ($0.14/1000 gal0	0.0	9.8	0.0	3.8	13.6
Clean Energy Fee ($10/kW)	1.1	4.8	0.0	7.5	13.4
Air Emission Fee (($39.48/ton N)	0.0	0.0	0.0	0.1	0.2
Motor Vehicle Toll Fee ($0.03/toll)	1.1	9.6	0.0	6.6	17.3
Wastewater Treatment	**9.5**	**34.5**	**1.6**	**104.4**	**150.6**
Discharge Fee ($0.50/1000 gal)	1.9	4.0	0.1	15.5	21.5
Effluent Charge ($1.00/lb N)	1.1	11.0	0.2	33.6	46.5
Wastewater Treatment Fund ($25/hh/yr)	6.4	19.5	1.2	55.3	82.6
Urban/Suburban Runoff	**9.4**	**35.1**	**2.9**	**89.9**	**137.4**
Clean Water Revolving Fund (20% Green)	1.0	2.5	0.2	4.8	8.6
Sec 319 CWA Fund	0.9	0.6	0.0	2.1	3.6
Watershed Utility Fee ($0.008/ft^2 imperv.)	7.5	32.0	2.7	83.0	125.2
Agriculture Conservation	**12.5**	**31.3**	**45.2**	**44.3**	**134.3**
USDA NRCS/FSA Funding (Farm Bill)	10.3	15.8	1.4	7.1	35.6
Water Use Charge ($0.15/1000 gal)	2.2	15.5	43.8	37.2	98.7
Total	**33.7**	**125.2**	**49.8**	**256.6**	**466.8**


Funding Options to Improve Water Quality in the Delaware Basin
$ million/yr
125
100
75
50
25
0
Atmospheric Deposition
Wastewater Treatment
Urban-Suburban
Agricultural Conservation
Water Use Charge
Clean Energy Fee
Air Emission Fee
Motor Vehicle Toll Fee
Discharge Fee
Effluent Charge
Wastewater Treatment Fund
Clean Water Revolving Fund
Sec 319 CWA Fund
Watershed Utility Fee
USDA NRCS/FSA Funding
Water Use Charge

Discussion