Evaluating the ecosystem service benefits & social efficiency of Chesapeake Bay restoration

Lisa A. Wainger
University of Maryland Center for Environmental Science
ACES
December 4, 2018

Cost-benefit analyses of water quality programs often show low ratios

Regulation	Study time frame	Benefit-to-cost ratio
CWA		
Freeman (6)	1985	0.19–1.23
Carson and Mitchell (7)	1990s	0.61–1.25
Lyon and Farrow (8)	1990s	0.25–1.16
US EPA (21, 61)	1990s	0.79–0.88
Keiser and Shapiro (1)	1962–2001	0.24
WOTUS		
Obama Administration	2015	1.10–2.41
Trump Administration	2017	0.11–0.30
CRP		
Hansen (47)	2000s	0.76–0.87
Effluent Guidelines		
Centralized Waste Treatment	2000	0.07–0.23
Landfills	2000	0.00
Transportation Equipment Cleaning	2000	0.11–0.33
Waste Combustors	2000	0.15–0.5
Coal Mining	2002	>1
Iron and Steel Manufacturing	2002	0.11–0.58
Concentrated Animal Feeding Operations	2003	0.61–1.06
Metal Products and Machinery	2003	0.09
Concentrated Aquatic Animal Production	2004	0.05
Meat and Poultry Products	2004	0.05

(from Keiser et al. 2018)

Are benefit-cost ratios low because…

1. We are omitting many types of benefits?
2. We are not taking full advantage of low cost pollution control methods?
3. Water quality improvements alone do not create large magnitude of benefits?

Basics: Economic valuation requires connecting restoration to outcomes that people value

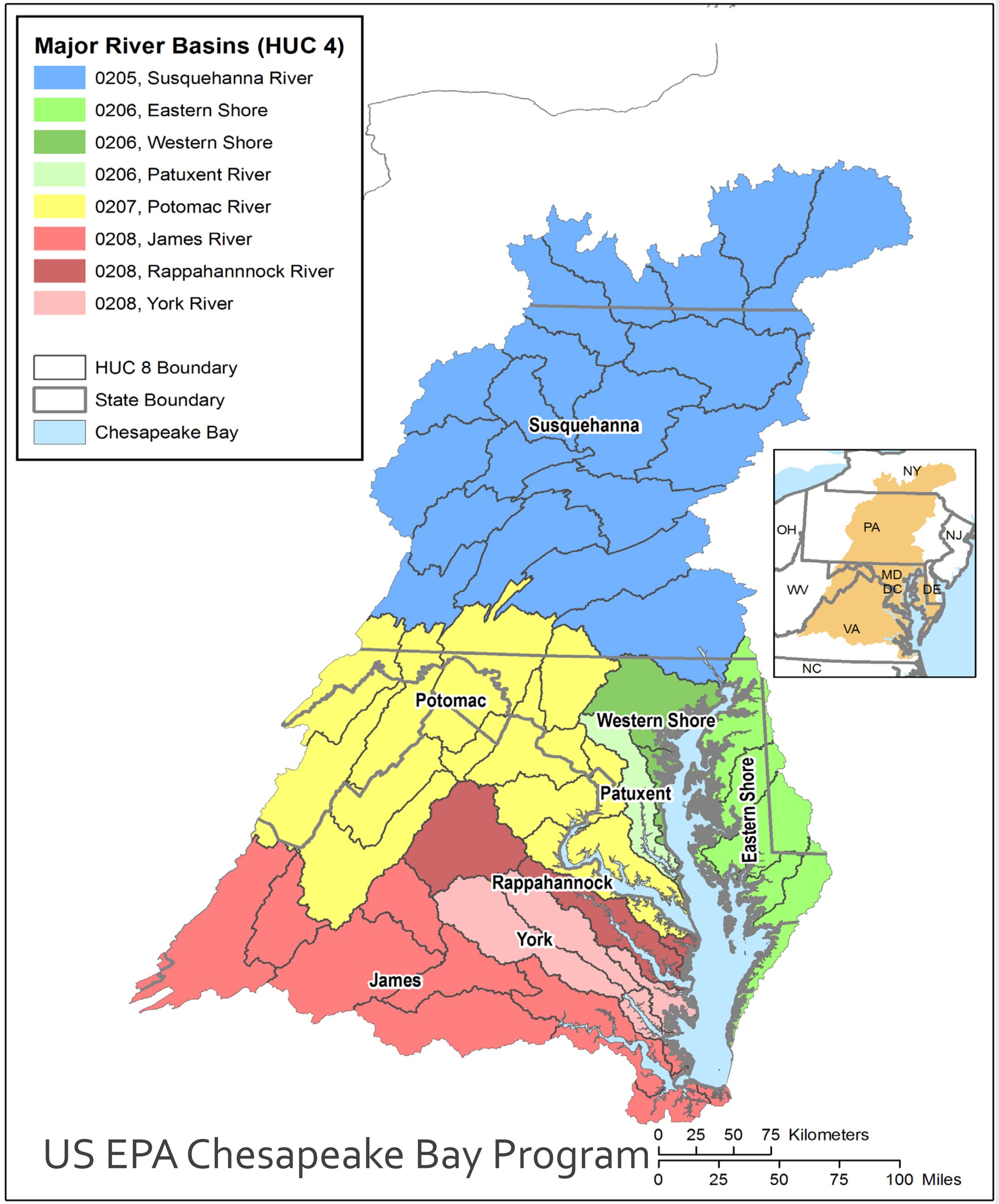
Action	Ecological Outcome	Benefit Indicator	Social Value
Identify action	Measure effectiveness of action	Relate change to human well-being	Establish value of change
Restore wetlands	Probability of toxic algal blooms	Exposure to contaminated seafood & health risk	Willingness to pay to avoid health risk

From: Wainger et al. 2017

Chesapeake Bay TMDL in a Nutshell

- Goal: restore *aquatic habitat in estuary*

- Roughly 20-25% reduction in nitrogen, phosphorus & sediment from 2010 loads



Ecosystem Service Benefits of Chesapeake Bay Restoration

Ecosystem service increases	Spatial extent of beneficiaries	Monetary values for TMDL	Authors
Striped bass, crabs, and oysters; bay water clarity; and lake water clarity (use & nonuse)	About 80% of the total benefits accrued to non-users of the Bay	\$1.20 to \$6.49 billion / year	Moore et al. (2017)
Water clarity (capitalized in home values)	Waterfront & near-waterfront homes (CB)	\$400-\$700 million (present value)	Walsh (2017); Klemick et al. (2018)
SAV extent (capitalized in home values)	Waterfront & near-waterfront homes (CB)	\$300-\$400 million	Guignet et al. (2016)
Commercial fishing	Chesapeake Bay	\$3 - \$26 million / year	Massey et al. (2017)
Recreational fishing	Chesapeake Bay & salt water sites	\$5 - \$59 million / year	Massey et al. (2017)
Outdoor recreation (excluding fishing)	Chesapeake Bay, DE Bay & coastal sites with water access	\$105 - \$280 million / year	Massey et al. (2017)

Q1. Are we omitting benefits of restored ecosystems in benefit cost analysis?

Ecosystem Service	Quantification / Description
Pathogens	27% ⬇
HABs	4% ⬆ - 12% ⬇
West Nile Virus	⬇
Stigma / Fear of water	⬇

Wainger et al., 2017

Some neglected ecosystem service benefits

- Health
- Navigation
- Inland Flooding
- Endangered species effects
- Climate change damages avoided
- Reliability of fisheries production
- Nonuse values for resilience of ecosystem (bequest)

Measuring resilience effects of the TMDL

SPECIAL FEATURE:
WETLANDS AND GLOBAL CLIMATE AND LAND-USE CHANGE
CRITICAL REVIEW

Resilience indicators support valuation of estuarine ecosystem restoration under climate change

L. A. Wainger,[1,4,5] D. H. Secor,[1] C. Gurbisz,[2,3] W. M. Kemp,[2] P. M. Glibert,[2] E. D. Houde,[1] J. Richkus,[3] and M. C. Barber[3]

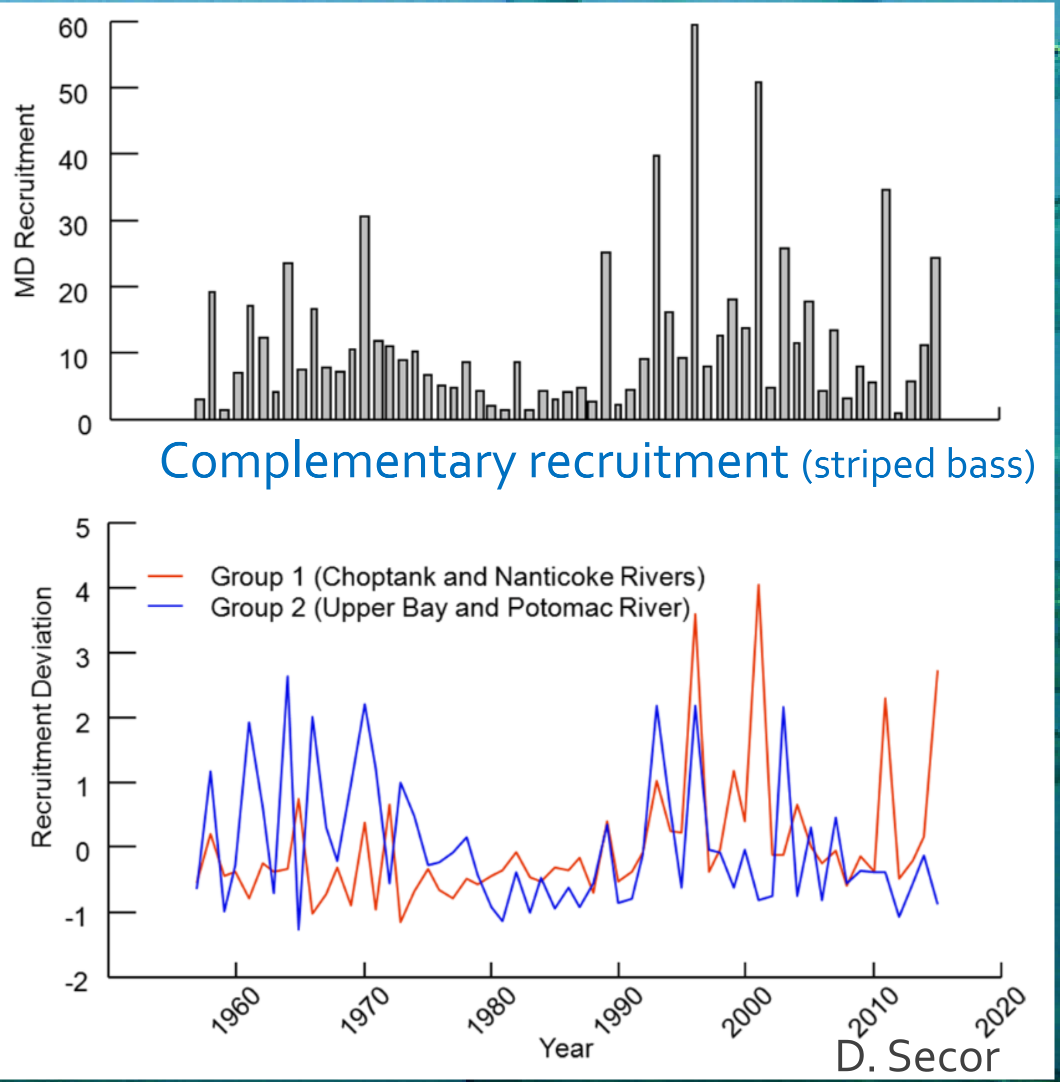
[1]Chesapeake Biological Laboratory, University of Maryland Center for Environmental Science, P.O. Box 38, Solomons, Maryland 20688 USA
[2]Horn Point Laboratory, University of Maryland Center for Environmental Science, P.O. Box 775, Cambridge, Maryland 21613 USA
[3]National Socio-Environmental Synthesis Center, 1 Park Place, Suite 300, Annapolis, MD 21401 USA
[4]RTI International, 701 13th St. NW, Suite 750, Washington, D.C. 20005 USA

Why the TMDL will increase SAV extent in Chesapeake Bay & elsewhere

- SAV extent suggests that distance to tipping point of bed collapse (lower precariousness)
  - Large restored beds have been resistant to major storm events
- Future - Enhanced eelgrass resilience in the Bay
  - Water quality improvements increase capacity to resist temperature increases

Why fish habitat distribution is an indicator of resilience

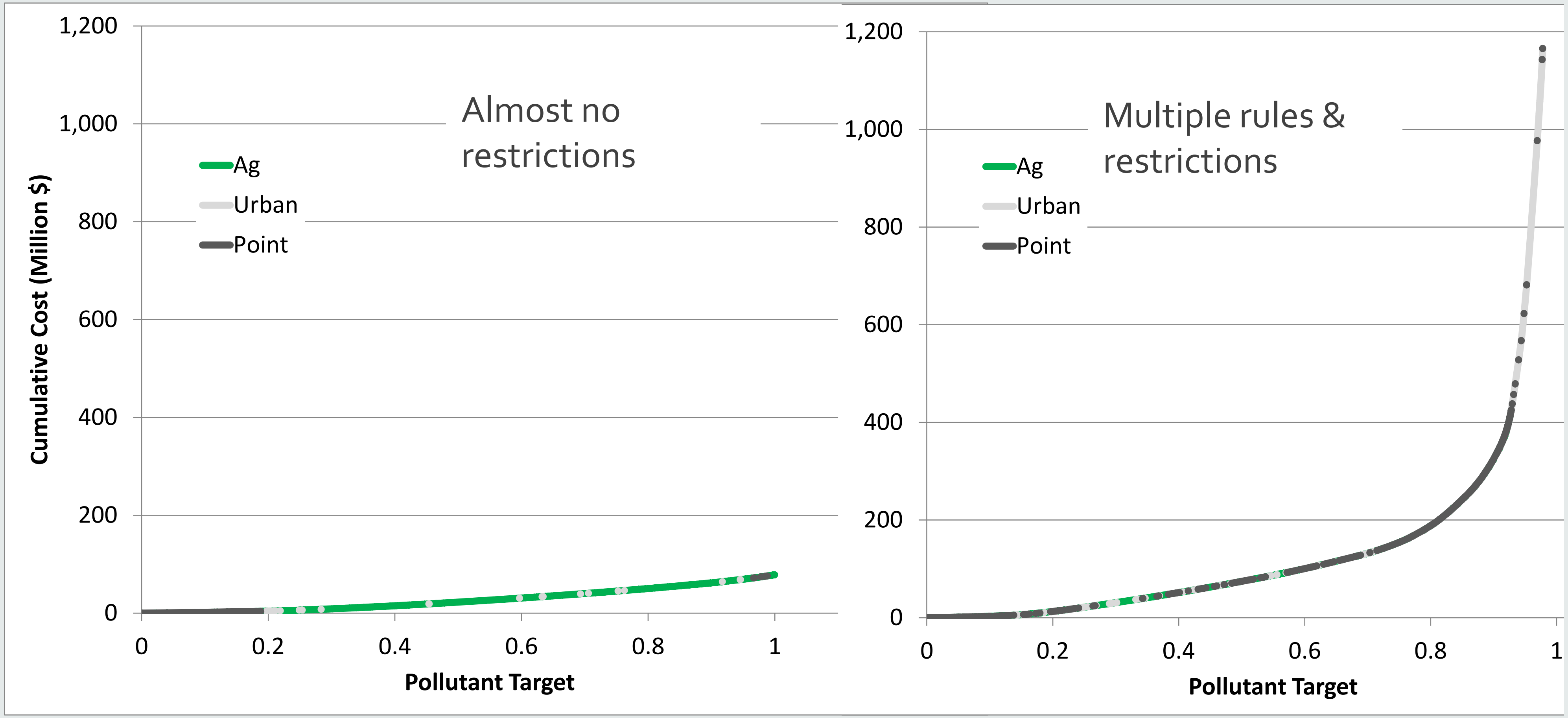
- Evenly spread and redundant habitat promotes *response diversity*
- Response diversity manages risk by providing opportunities for uncorrelated responses to stressors



Q2. Are we taking full advantage of low cost pollution control methods?

Chesapeake Bay
Total Maximum Daily Load Cost-Effectiveness Analysis

Total costs depend on policies



Wainger et al. 2013

Q3. Do we need to add complementary actions to increase benefits of water quality improvements ?

Oyster Futures

Elizabeth North, Jeff Blair, Jeffrey Cornwell, Troy Hartley, Raleigh Hood, Robert Jones, Lisa Wainger, Rasika Gawde, Chris Hayes, Melanie Jackson, Taylor Goelz, Matthew Damiano, Dylan Taillie, Emily Nastase

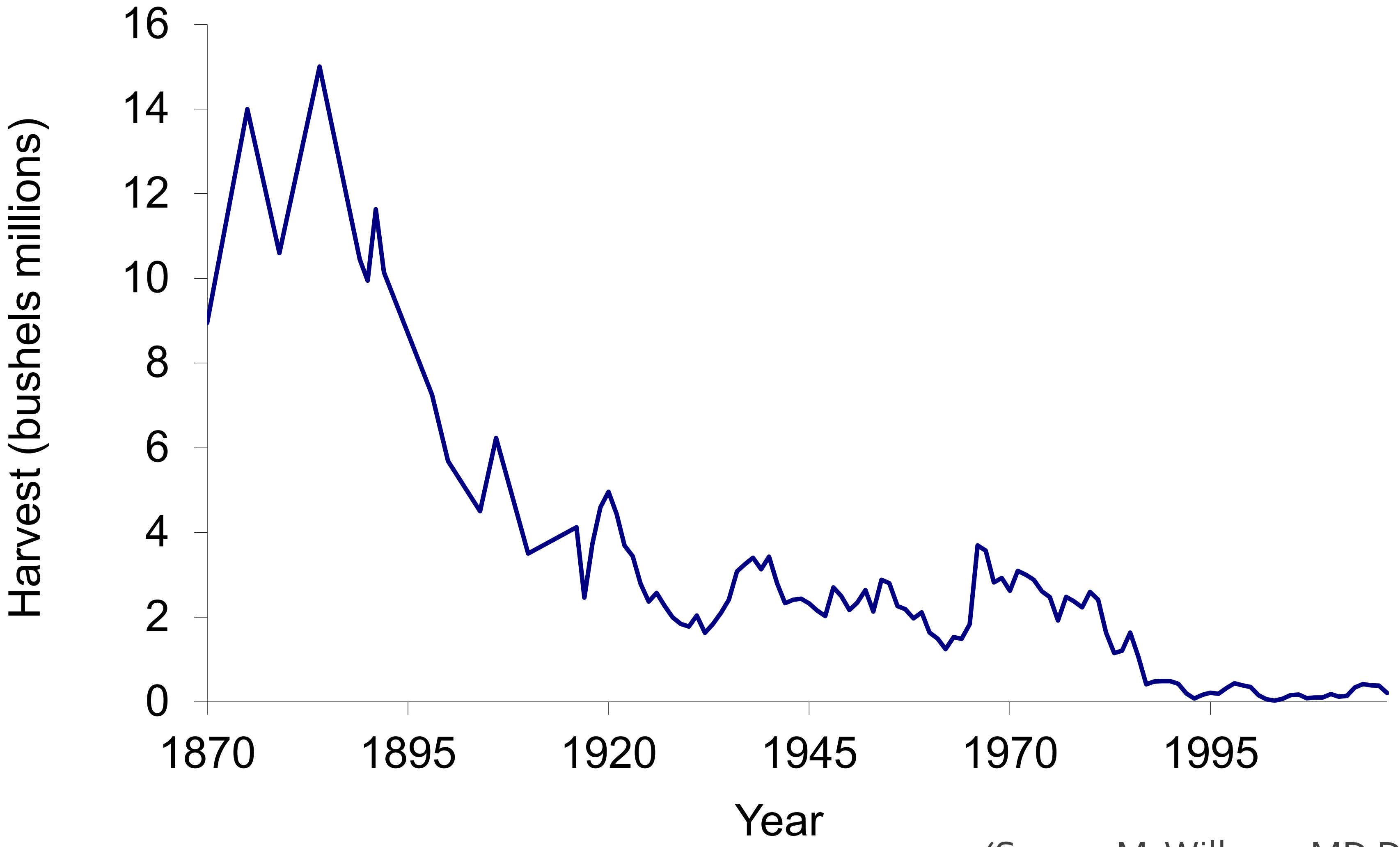
VIMS WILLIAM & MARY VIRGINIA INSTITUTE OF MARINE SCIENCE

University of Maryland CENTER FOR ENVIRONMENTAL SCIENCE

FCRC CONSENSUS CENTER

NSF

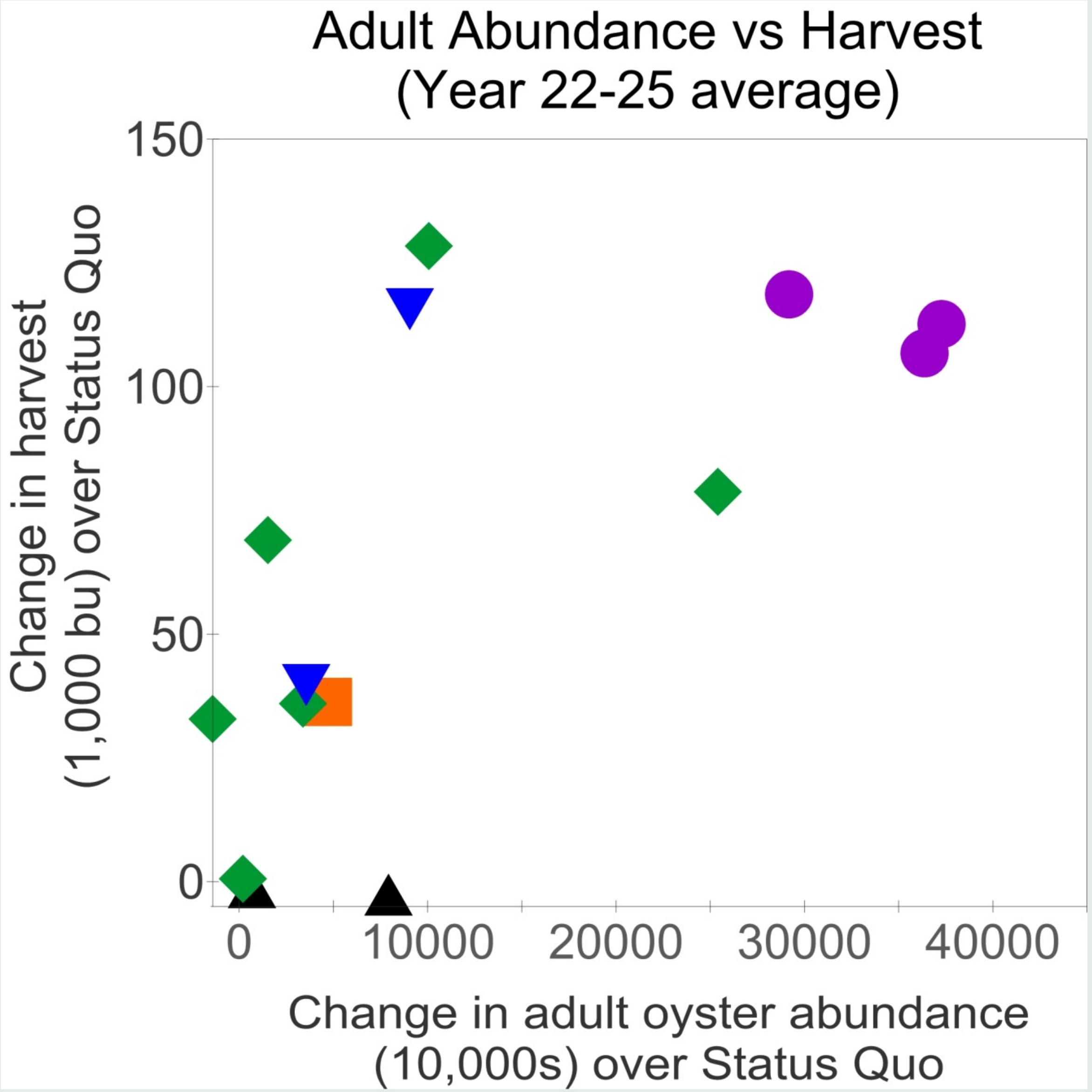
Maryland Oyster Harvest



(Source M. Wilberg, MD DNR)

Goal: Help a diverse group of stakeholders develop recommendations for oyster restoration and management that meet the needs of industry, citizen, and government stakeholders

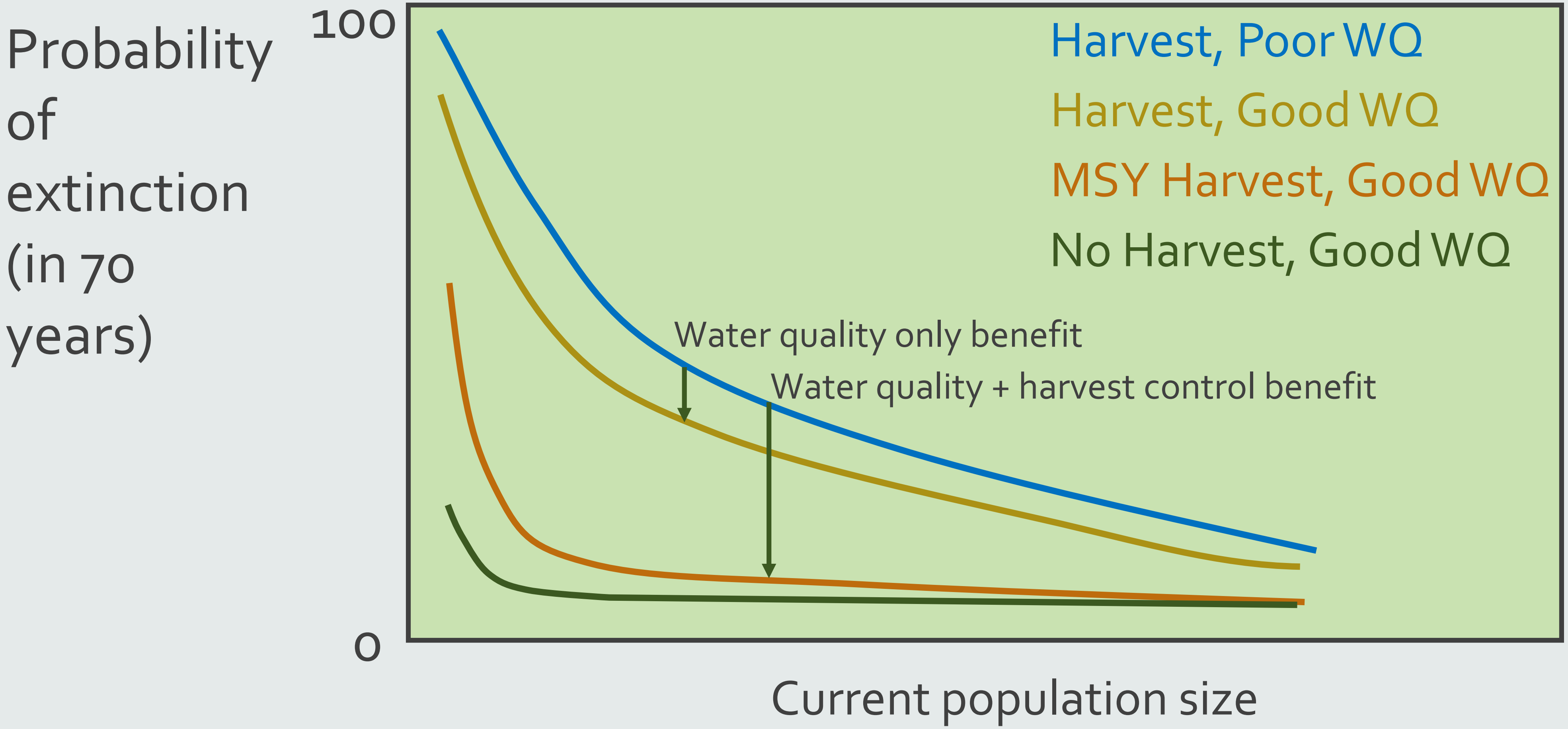
Win-win options found



- High population abundance
- High harvest/profits
- High environmental benefits

Wilberg 2018

Q3. Is water quality improvement enough to create benefits?



Conclusions about why benefit cost ratios for water quality programs tend to be low

1. Many benefits are not captured in current valuation
   - Missing resilience effects (future damages avoided)
   - Including terrestrial benefits from hunting, aesthetics, carbon sequestration
2. Lowest cost restoration options are not widely used
   - Policies/incentives could provide more flexibility to offset expensive practices with low-cost options
3. Complementary policies may needed to generate some values
   - Harvest management + water quality improvements
4. Mismatch between policy-maker rationale and measurable benefits raises questions
   - Social efficiency of water policies
   - CBA capacity to represent social well-being

References

- Guignet, D., Griffiths, C., Klemick, H., Walsh, P.J., 2016. The Implicit Price of Aquatic Grasses. Marine Resource Economics 32, 21–41. https://doi.org/10.1086/689201
- Keiser, David A., Catherine L. Kling, and Joseph S. Shapiro. 2018. The low but uncertain measured benefits of US water quality policy. www.pnas.org/cgi/doi/10.1073/pnas.1802870115
- Massey, D.M., Moore, C., Newbold, S.C., Ihde, T., Townsend, H., 2017. Commercial fishing and outdoor recreation benefits of water quality improvements in the Chesapeake Bay (No. 201702), NCEE Working Paper Series. National Center for Environmental Economics, U.S. Environmental Protection Agency.
- Moore, C., Guignet, D., Dockins, C., Maguire, K.B., Simon, N.B., 2017. Valuing Ecological Improvements in the Chesapeake Bay and the Importance of Ancillary Benefits. Journal of Benefit-Cost Analysis 1–26. https://doi.org/10.1017/bca.2017.9
- Wainger, L.A., Van Houtven, G., Loomis, R., Messer, J., Beach, R., Deerhake, M., 2013. Tradeoffs among Ecosystem Services, Performance Certainty, and Cost-efficiency in Implementation of the Chesapeake Bay Total Maximum Daily Load. Agricultural and Resource Economics Review 42, 196–224.
- Wainger, L.A., Secor, D., Gurbisz, C., Kemp, M., Glibert, P.M., Richkus, J., Barber, M., 2017. Resilience indicators support valuation of estuarine ecosystem restoration under climate change. Ecosystem Health and Sustainability 3, e01268.
- Walsh, P., Griffiths, C., Guignet, D., Klemick, H., 2017. Modeling the Property Price Impact of Water Quality in 14 Chesapeake Bay Counties. Ecological Economics 135, 103–113. https://doi.org/10.1016/j.ecolecon.2016.12.014
- Wilberg, Michael, 2018. Personal Communcation. University of Maryland Center for Environmental Science. Chesapeake Biological Lab. See also oysterfutures.wordpress.com