

Synthesis examples and principles

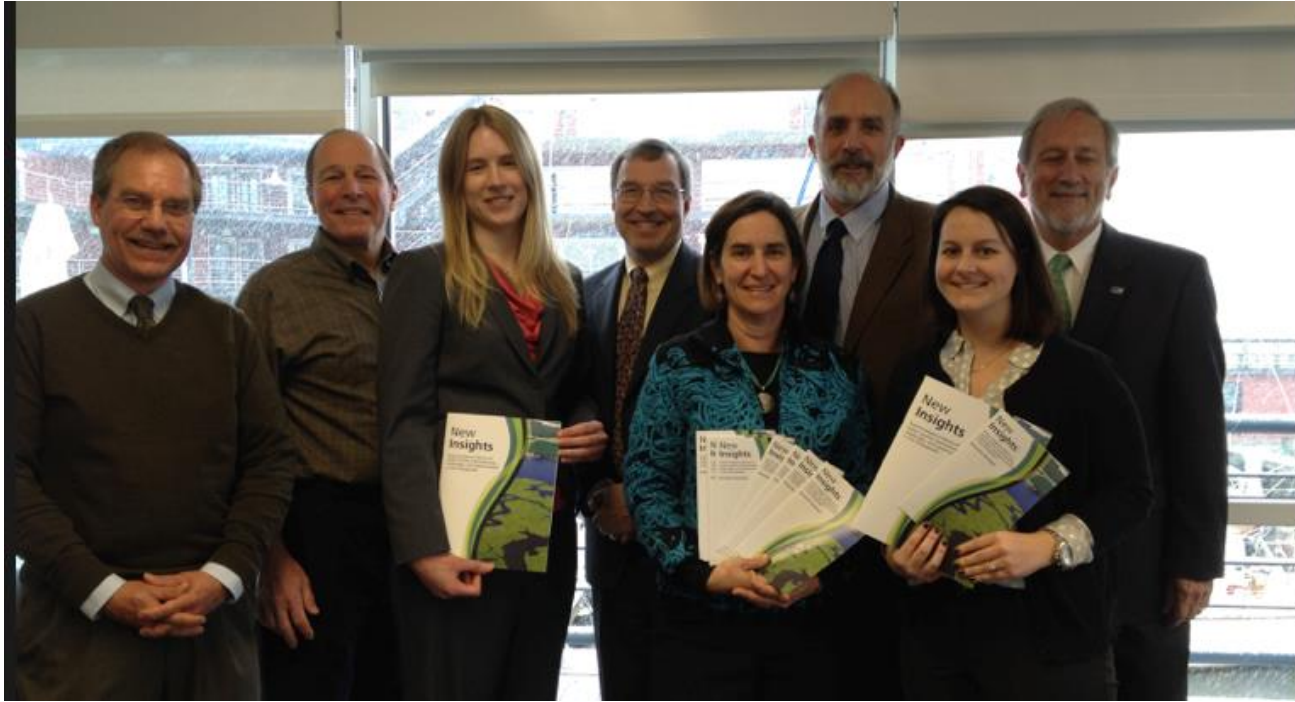
Bill Dennison

27 May 2021



University of Maryland
CENTER FOR ENVIRONMENTAL SCIENCE
INTEGRATION AND APPLICATION NETWORK

New Insights report



New Insights report

New Insights

Science-based evidence of water quality improvements, challenges, and opportunities in the Chesapeake

Synopsis

This report summarizes results from more than 40 case studies in the Chesapeake Bay watershed where water quality monitoring was conducted to detect benefits from implementation of best management practices. These benefits emerged from this data:

- Several groups of practices are proven effective;
- Certain challenges can impede water quality improvements; and
- Practices that target the impacts of intensified agriculture and rapid population growth are needed to advance progress toward improving water quality.

Each of these results of issues that managers can use in their decision-making processes, and the public to help raise awareness of and support for restoration efforts. Within each of the seven sections, several studies are highlighted to provide a detailed look at the knowledge acquired from water quality results related to BMP implementation.

What's Working



Advanced wastewater treatment facility at Washington, D.C. Photo by Chesapeake Bay Program

Three major groups of BMPs are demonstrably effective in improving water quality:

- Upgrades to wastewater treatment plants (WWTPs);
- Decreases in atmospheric nitrogen deposition; and
- Reductions in agricultural nutrient inputs.

Advanced WWTP technology reduces excess nitrogen (N) and phosphorus (P) from wastewater prior to being discharged in waterways. Upgrades to WWTPs across the Bay and to water have decreased concentrations of total nitrogen (TN), total phosphorus (TP) and chlorophyll, and in some cases, increased oxygen levels of submerged aquatic vegetation (SAV). Research directly linked decreased N, atmospheric emissions with less surface water quality within the watershed. Decreased N was associated with greater power plant emissions controls and no visible reduction in atmospheric N deposition. It is expected that, finally, the reduction of agricultural nutrient inputs has water quality improvements. Data have demonstrated that power crops, changing fertilizer and manure applications, are feedback loops to decrease reduced nutrient concentrations, a more balanced, decreased sediment loads.

Challenges



Stormwater outfall. Photo by Chesapeake Bay Program

Two major challenges have impeded progress despite the implementation of BMPs:

- Delay between BMP implementation and demonstrable water quality improvements; and
- Counterbalancing influences of population growth and agriculture.

Delays in water quality improvements, or "lag times," are not new phenomena. Groundwater—and the nutrients that have it—move gradually—millimeters into the Bay and to tributaries. However, groundwater age range from less than a year to 100 years. As a result, it can remain in the groundwater system long periods of time, delaying water quality responses to implementation. Lag times will also result from sediment and P. Sediments will gradually release stored P, particularly under no dissolved oxygen conditions, which are common in the Bay the summer months. Despite the reduction of P load, water responses may be delayed in existing sediments in the Bay core to release P. The second challenge presents when a nutrient is not targeted by a BMP, counterbalancing any improvements that are have occurred after BMP implementation, unintended approach

(Increased use of fertilizers and greater livestock densities) and land use conversion from forests to agriculture and urban development are driving forces of declining water quality in the Chesapeake Bay watershed. Better understanding these challenges to restoring local and Bay water quality conditions leads directly to opportunities to better manage pollutant sources.

Opportunities



A small stream flows past a church in Maryland. Photo by Chesapeake Bay Program

Minimizing water quality during and after BMP implementation has exposed the challenges that impede progress and revealed practices that enhance measurable improvements in water quality and habitat availability:

- Identification of all sources of nutrients and targeting BMPs accordingly; and
- Improvements to stormwater management to accommodate the watershed's population growth.

Targeted BMPs will lead to improvements in water quality and habitat conditions. If agricultural activities are the dominant source of nutrients in a river, upgrading WWTPs alone will not produce the desired water quality outcomes. Agricultural BMPs will be required to reach water quality goals. As agricultural land uses are converted to highly-populated urban and suburban development, stormwater management becomes increasingly important to improving water quality. Stormwater BMPs that reduce sediment runoff, increase the time available for nutrient infiltration, and extend permeable surfaces will help reduce the impact of spreading development.

Implications

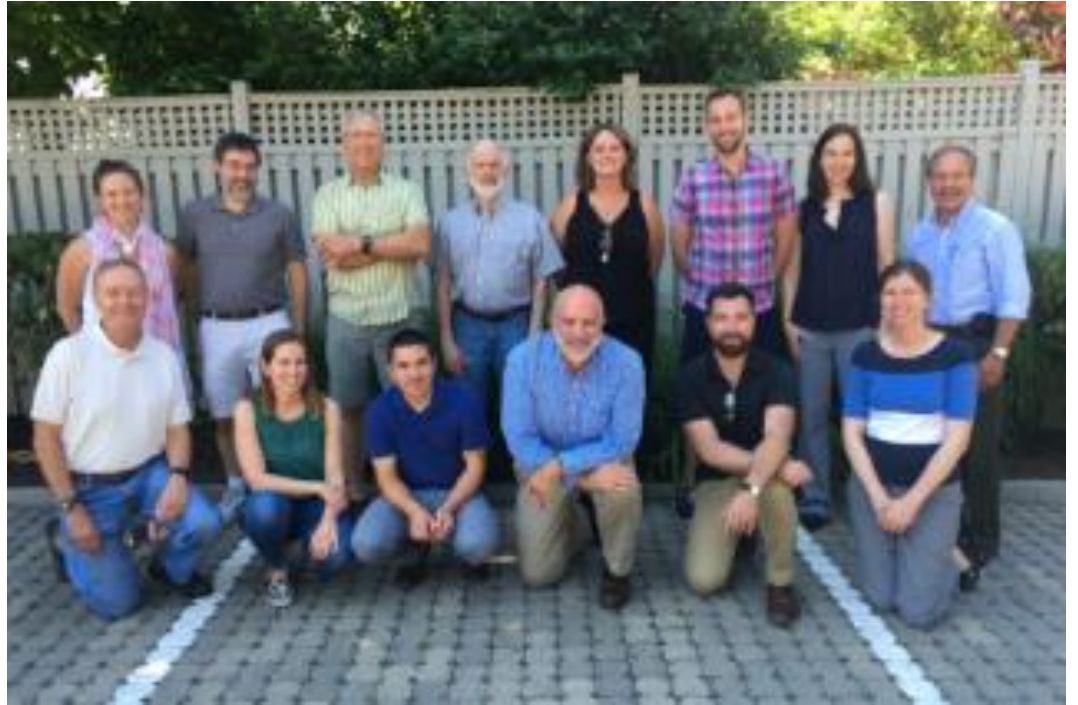
The examination of research-based on water quality monitoring data associated with BMP implementation in the Chesapeake Bay watershed reveals multiple implications for continued efforts in Bay restoration:

1. Following implementation of the Clean Water Act and the National Pollutant Discharge Elimination System permits, upgrades to WWTPs have led to many instances of improved water quality. Greater treatment in improved WWTP technology will lead to further water quality improvements and help offset the additional pressures of a growing urban and suburban population.
2. Improved air quality in the Chesapeake Bay watershed after the implementation of the Clean Air Act has decreased atmospheric nitrogen loading the land and water. As more people live in the watershed—driving more cars, further distance—greater fuel efficiency combined with continued availability of improved technology at power plants will be needed to further improve air quality and Bay health.
3. Several agriculture practices that reduced nutrient loads have led to improvements in water quality. Supporting the operation of these practices to similar extent throughout the watershed is needed to make continued progress in improving water quality and restoring Bay health.
4. Delays between implementing practices reducing activities and observing water quality improvements require patience and persistence. Long-term water quality monitoring is essential to evaluating BMP effectiveness, and to adjust management actions as new information is collected.
5. Pressure from increased fertilizer use, livestock densities, shoreline runoff, and WWTP effluent associated with greater numbers of people living in the watershed can overwhelm efforts to improve water quality. Better land-use planning and reducing both point and nonpoint sources of nutrients are needed to sustainably manage the Bay's resources.
6. The Chesapeake Bay watershed is a diverse region consisting of a variety of land uses and watershed characteristics. Targeting specific habits based on local attributes, monitoring changes in water quality, and engaging in adaptive management are needed to obtain water quality goals.
7. The number of people living in the Chesapeake Bay watershed continues to grow and more land is being converted to urban and suburban uses. Pressure and innovation practices are required to manage the resulting characteristic runoff, and testing is needed to regularly evaluate water quality benefits.

New Insights report featured in media and at Chesapeake Bay agreement meeting

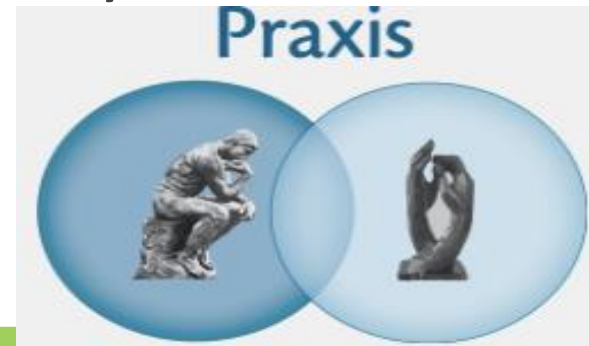


Submerged Aquatic Vegetation Synthesis (SAV SYN)



Criteria for selecting participants

- Excellent scientists
- Focus on analysis and interpretation
- Commitment to Chesapeake Bay
- Willingness to work collaboratively towards a common cause



SAV workshop goals

Productive

Workshop summary produced, bookmarks event, document progress

Interactive

Activities & breakouts lead to input & exchange

Condensed

Workshops limited to necessary contact hours

Participatory

Multiple opportunities for input

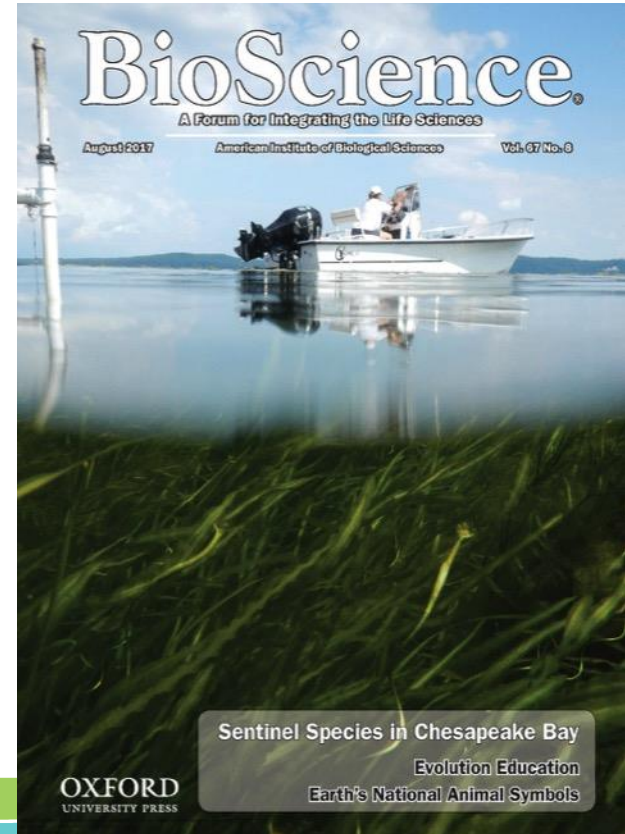
Fun



Initial qualitative paper: Bioscience

Submersed Aquatic Vegetation in Chesapeake Bay: Sentinel Species in a Changing World

ROBERT J. ORTH, WILLIAM C. DENNISON, JONATHAN S. LEFCHECK, CASSIE GURBISZ, MICHAEL HANNAM, JENNIFER KEISMAN, J. BROOKE LANDRY, KENNETH A. MOORE, REBECCA R. MURPHY, CHRISTOPHER J. PATRICK, JEREMY TESTA, DONALD E. WELLER, AND DAVID J. WILCOX



Case study: Eelgrass decline due to climate change



Global Change Biology (2017) **23**, 3474–3483, doi: 10.1111/gcb.13623

Multiple stressors threaten the imperiled coastal foundation species eelgrass (*Zostera marina*) in Chesapeake Bay, USA

JONATHAN S. LEFCHECK¹ , DAVID J. WILCOX¹, REBECCA R. MURPHY², SCOTT R. MARION³ and ROBERT J. ORTH¹

¹Virginia Institute of Marine Science, The College of William & Mary, Gloucester Point, VA 23062, USA, ²University of Maryland Center for Environmental Science, Chesapeake Bay Program, Annapolis, MD 21403, USA, ³Oregon Department of Fish & Wildlife, Marine Resources Program, Newport, OR 97365, USA

Abstract

Proc. Natl. Acad. Sci.

Nutrient reductions lead to unprecedented recovery of a temperate coastal ecosystem

Jonathan S. Lefcheck^{1,2*}, Robert J. Orth², William C. Dennison³, David J. Wilcox², Rebecca R. Murphy⁴, Jennifer Keisman⁵, Cassie Gurbisz^{6,7}, Michael Hannam^{8,9}, J. Brooke Landry¹⁰, Kenneth A. Moore², Christopher J. Patrick¹¹, Jeremy Testa¹², Donald E. Weller⁸, Richard A. Batuik¹³



Large media coverage

Energy and Environment

The Chesapeake's 'secret garden' is thriving again, but Trump could end that

By Darryl Fears March 5 [Email the author](#)



Eelgrass in the Chesapeake Bay in summer 2017. (Photo by Jon Lefcheck)

The Post's View • Opinion

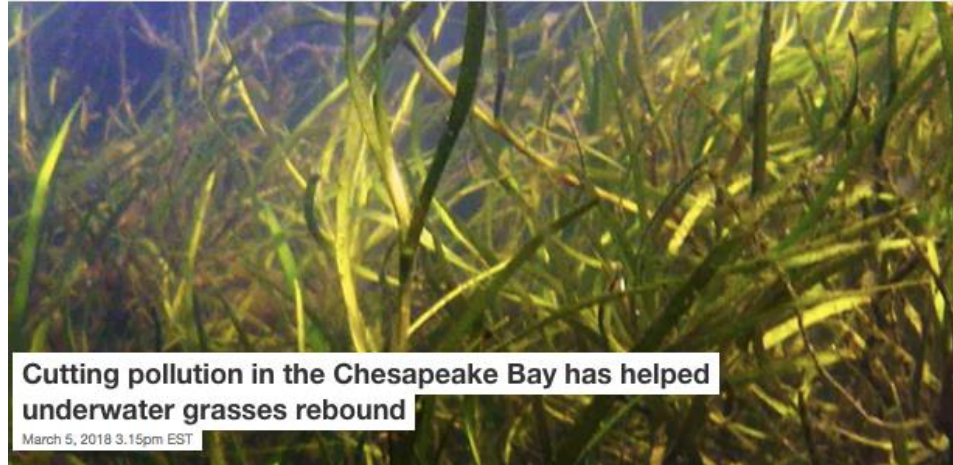
Why the Chesapeake Bay is the best in the world

THE CONVERSATION

Academic rigor, journalistic flair

Search analytics

Arts + Culture Economy + Business Education **Environment + Energy** Ethics + Religion Health + Medicine Politics + Society
Science + Technology

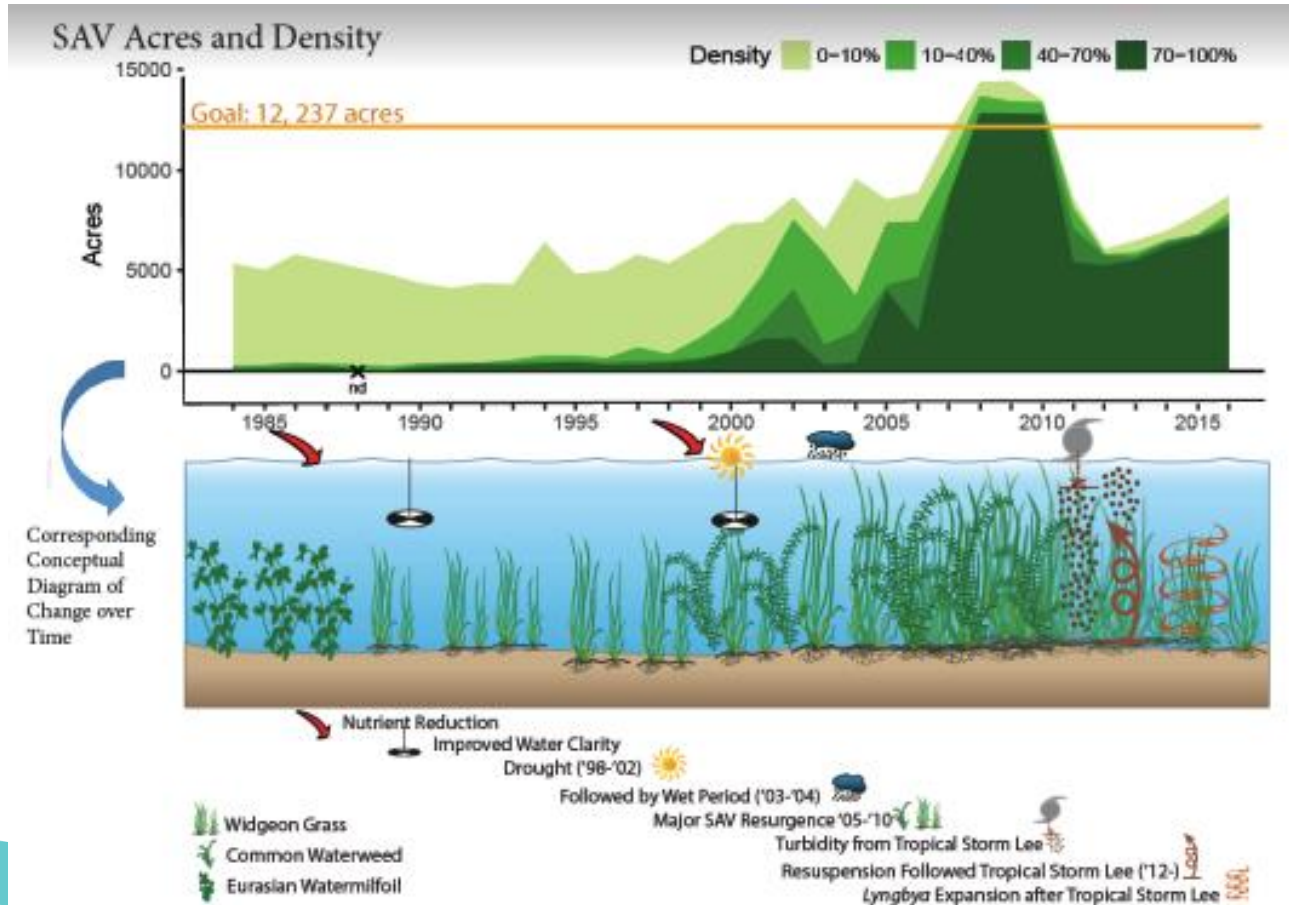


Cutting pollution in the Chesapeake Bay has helped underwater grasses rebound

March 5, 2018 3:15pm EST

Washington Post editorial supporting Chesapeake Bay Program
56 M people exposed to story via traditional and social media

Fact sheets produced for resource managers



Two key questions answered:

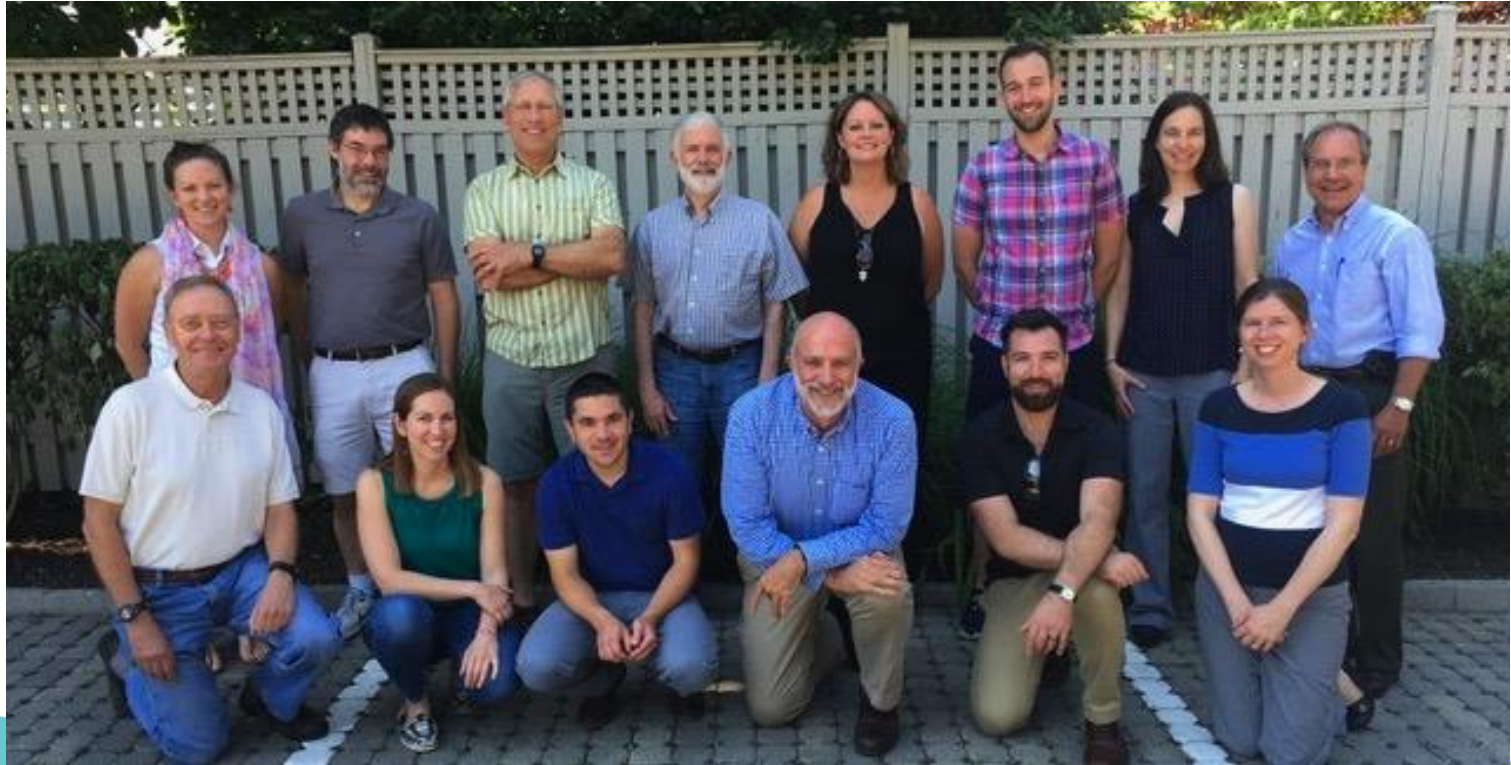
1. What are the long term SAV trends in Chesapeake Bay?

Nutrient reductions have led to SAV recovery since the 1980s



2. How are the trends related to human activities?

Nutrient pollution reduces SAV; species enrichment enhances SAV

Limited size



Regular communication

Bill Dennison	Fwd: Bay Journal article on our PNAS paper - Robert J Orth CC: Jonathan Lefcheck , Bill Dennison (dennison@umc	Apr 3
Bill Dennison	Fwd: Bay Journal article on our PNAS paper - Robert J Orth CC: Jonathan Lefcheck , Bill Dennison (dennison@umc	Apr 3
Robert J Orth	RE: [EXTERNAL] Segment conference call Wed. - Robert J Orth; Bill Dennison (dennison@umces.edu); I	Apr 3
Brooke Landry -DNR-	Re: [EXTERNAL] Segment conference call Wed. - Robert J Orth wrote: >>> >>>> Is supposed to be an upda	Apr 3
Keisman, Jennifer	Re: [EXTERNAL] Segment conference call Wed. - Robert J Orth wrote: >> >>> Is supposed to be an updi	Apr 3
Brooke Landry -DNR-	Re: [EXTERNAL] Segment conference call Wed. - Robert J Orth wrote: > >> Is supposed to be an update	Apr 3
Keisman, Jennifer	Re: [EXTERNAL] Segment conference call Wed. - Robert J Orth wrote: > Is supposed to be an update on	Apr 3
Robert J Orth	RE: Responses! the segment work - full speed ahead - Robert J Orth; Brooke Landry; Bill Dennison (den	Apr 3
Melissa Merritt	RE: Responses! the segment work - full speed ahead - Robert J Orth; Brooke Landry; Bill Dennison (den	Apr 3
Robert J Orth	Robert J Orth conf line for tomorrow - Melissa: Can you set up a conf line for all of us to call in to review the segment wor	Apr 3
Jonathan Lefcheck	RE: Responses! the segment work - full speed ahead - Robert J Orth; Brooke Landry; Bill Dennison (den	Apr 3
David J Wilcox	RE: Responses! the segment work - full speed ahead - Robert J Orth; Brooke Landry; Bill Dennison (den	Apr 3
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Melissa Merritt	conf line for tomorro	Apr 3
Melissa Merritt	RE: conf line for to	Apr 3
Keisman, Jennifer	Re: [EXTERNAL] Segment conference call Wed. - @usgs.gov 443-498-5565 On Mon, Apr 2, 2018 at 9:41	Apr 3
Brooke Landry -DNR-	Re: Double-checking which SAV goal we are using for the segment summaries - Robert J Orth wrote: : 	Apr 3
Robert J Orth	RE: Double-checking which SAV goal we are using for the segment summaries - Robert J Orth; Jonathan Le	Apr 3
Robert J Orth	RE: Responses! the segment work - full speed ahead - Robert J Orth; Melissa Merritt Cc: Brooke Landry	Apr 3
Jonathan Lefcheck	RE: Responses! the segment work - full speed ahead - Robert J Orth; Melissa Merritt Cc: Brooke Landry; Bill 	Apr 3
David J Wilcox	RE: Responses! the segment work - full speed ahead - Robert J Orth ; Melissa Merritt Cc: Brooke Landry	Apr 3
Jonathan Lefcheck	RE: Responses! the segment work - full speed ahead - Robert J Orth; Melissa Merritt Cc: Brooke Landry	Apr 3
David J Wilcox	RE: Responses! the segment work - full speed ahead - Robert J Orth ; Melissa Merritt Cc: Brooke Landry	Apr 3
Jonathan Lefcheck	RE: Responses! the segment work - full speed ahead - Robert J Orth; Melissa Merritt Cc: Brooke Landry	Apr 3
David J Wilcox	RE: Responses! the segment work - full speed ahead - Robert J Orth Sent: Tuesday, April 03, 2018 8:57	Apr 3

Flexibility

**SAV Status and Trends
Agenda Feb. 1 and 2, 2018
IAN Conference Room, Annapolis, MD**

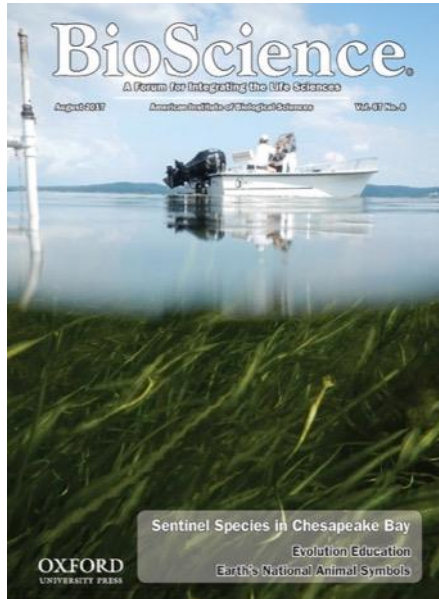
Thursday	9:00-9:30	Review PNAS Media Strategy
	9:30-10:30	Review, revise, and finalize segments recently completed
	10:30-11:00	COFFEE BREAK
	11:00-12:30	Identify next set of segments for analysis and begin process of developing the SAV storyline for them
	12:30-1:30	LUNCH
	1:30-3:00	Continue analysis
	3:00-3:30	COFFEE BREAK
	3:30-5:30	Continue analysis

Friday	8:30-10:30	Summary first day – Continue segment analysis
	10:30-11:00	COFFEE BREAK
	11:00-12:00	Continue segment analysis
	12:00-1:00	LUNCH
	1:00-2:30	Review Progress and set date for next segment meeting

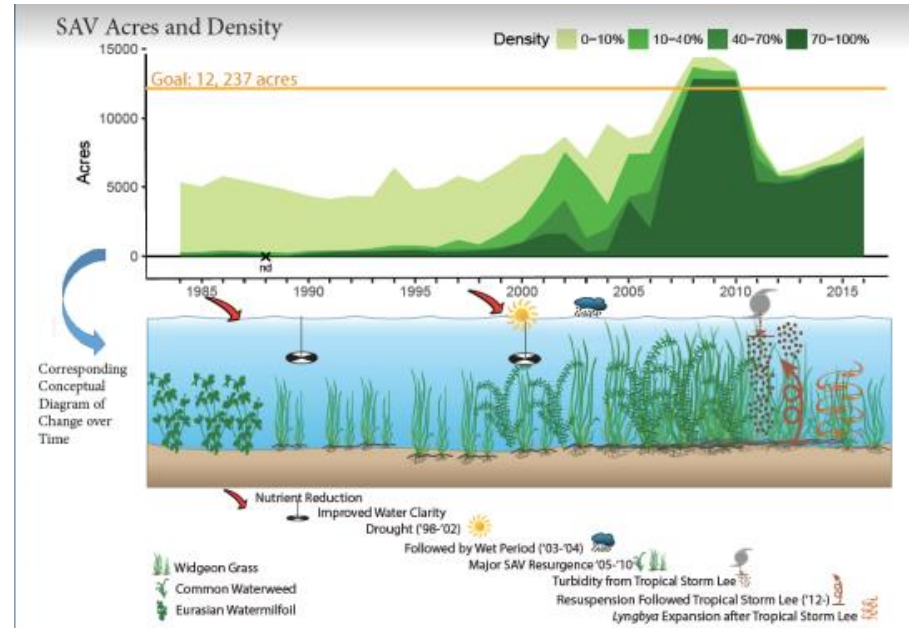


Product focus

Peer review papers



Segment analysis



Conductive location

Walk-able restaurants, coffee shops, bars & hotels



Fun



The Chesapeake Sentinels

27 Jan 2017
William C. Dennison

Submerged aquatic vegetation are an important mainstay

They provide homes to many of the little critters

So if we lost the sentinels, the critters would get the jitters.



Defending against erosion and protecting the coastline

These aquatic grasses are not at all benign

They suck up nutrients, and cause sediments to drop out

Cleaning the water in the Bay beyond any doubt.

Indicators for water quality, acting as a coastal canary

Declining when water gets too warm or too cloudy

They are sensitive to subtle changes in nature

So we can recognize signs of imminent danger.



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