

SAV Status & Trends

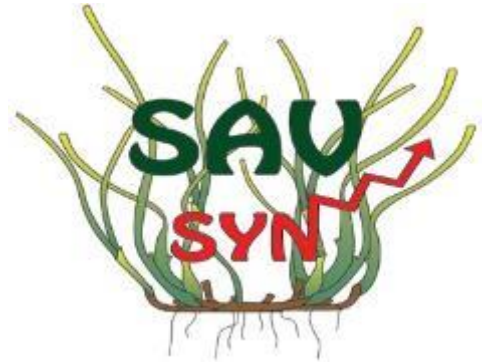
Bob Orth

Bill Dennison

Jon Lefcheck

13 Dec 2017

STAC



Why SAV Status and Trends now?

- Long term, solid data sets available
- Access to new analytical tools and expertise
- Understanding the drivers of SAV trends can have important management relevance
- Input to 2017 TMDL reassessment is timely
- Transition to new generation of scientists

Our premise is that SAV act as the 'coastal canaries' for water quality

- Integrate environmental conditions
- Responsive to perturbations
- Widespread distribution
- Ecologically important



Goals of SAV SYN workshops

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



We assembled a diverse and talented scientific team



We created an immersive environment

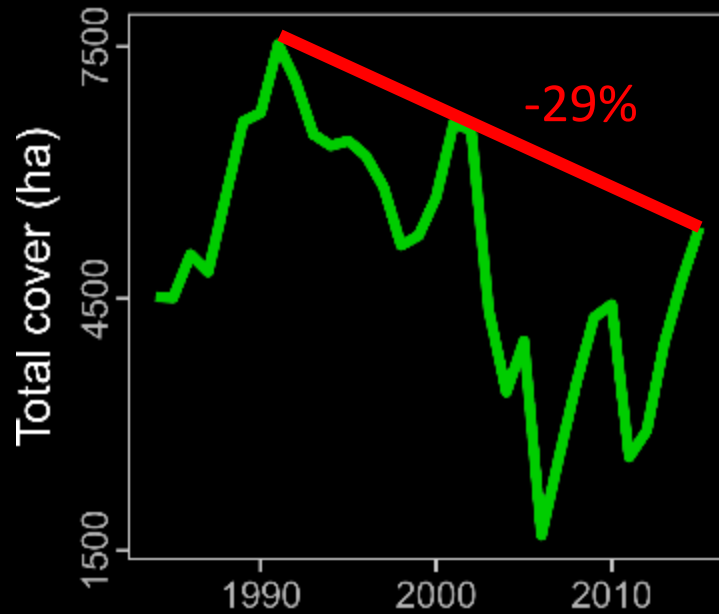
Valuable
Threatened existence
Enigmatic
Responsive
Beautiful Mysterious
Screwed
Home Unassuming Green
treasure Ripply — bane nearly
lost Mottled Buoyant Amazing
Cool plants Spatial Venerable
Slippery Complex
Dynamic Vulnerable
Widespread
Nurseries Tangling **Diverse**
Photosynthetic
Vibrant
Productive Imperiled
Important



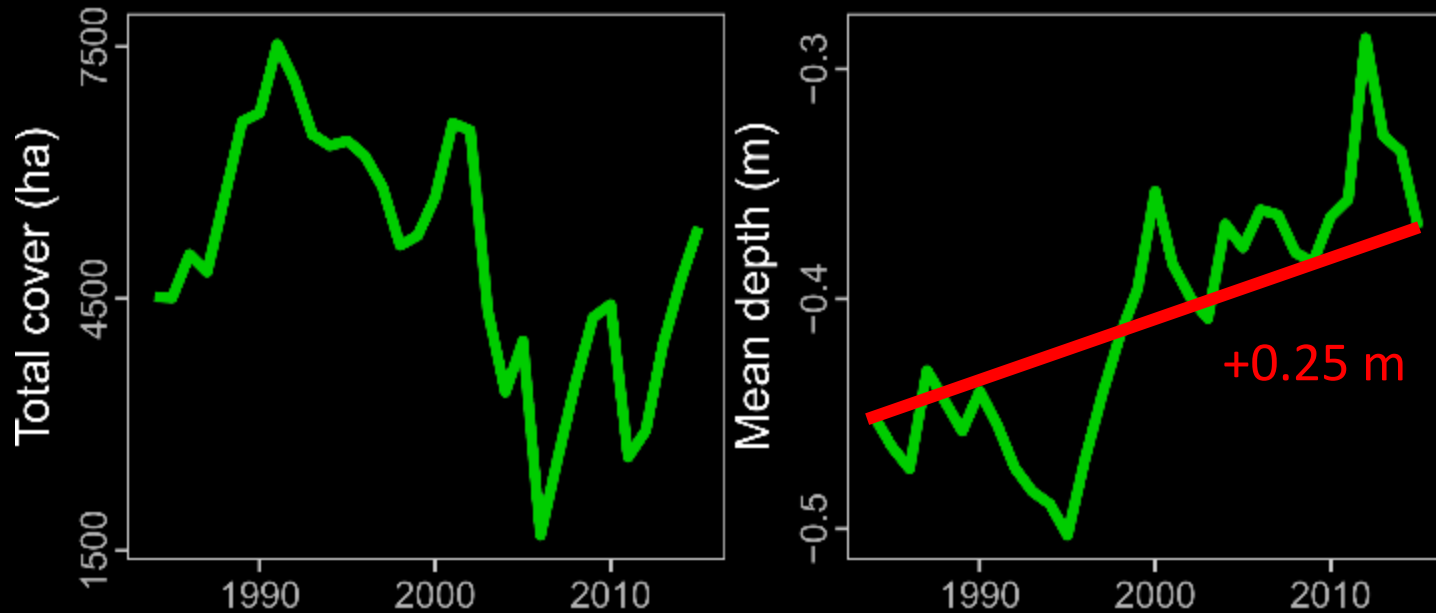
SAV SYN produced 3 papers and working on a segment analysis

1. Eelgrass declines (Global Change Biology, published)
2. SAV as sentinel species (Bioscience, published)
3. Nutrient reductions (Proc. Natl. Acad. Sci., in revision)
4. SAV segment analysis (in progress)

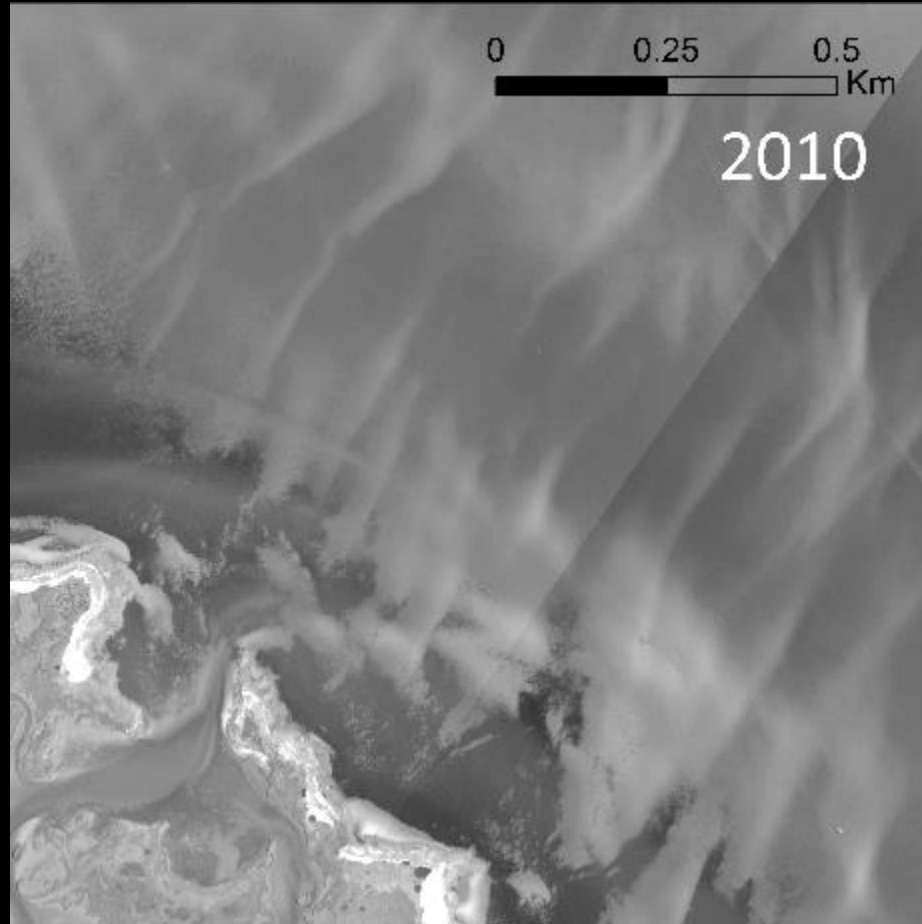
> 29% decline since 1991



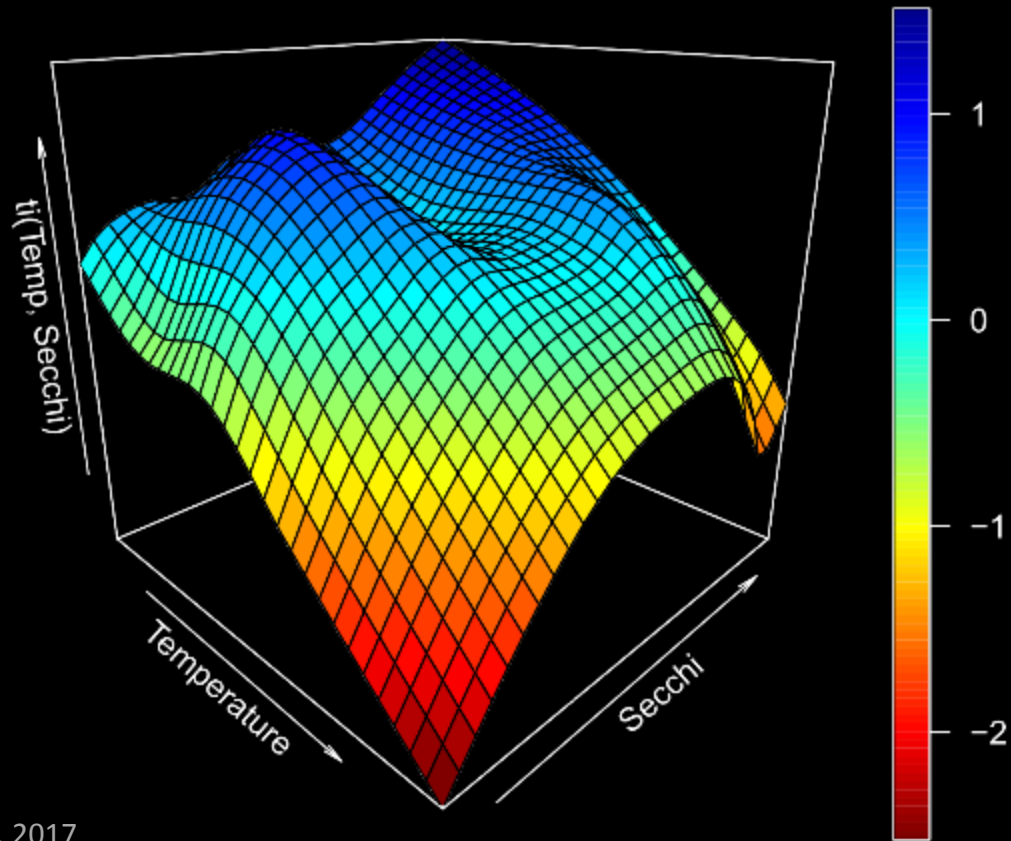
> 29% decline since 1991



> Loss of beds deeper than 0.5 m



> Interactive effects



> 16 species of SAV in the Bay

Seagrasses

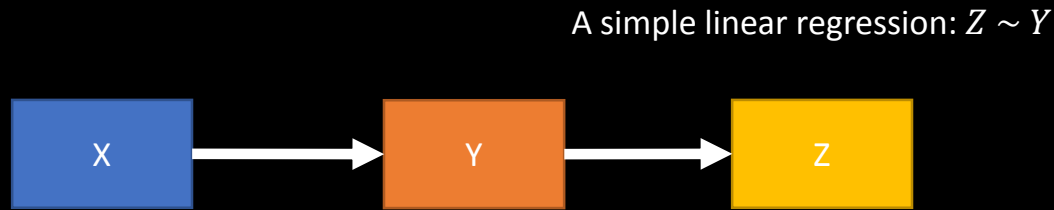


*Freshwater
grasses*



> Structural equation modeling

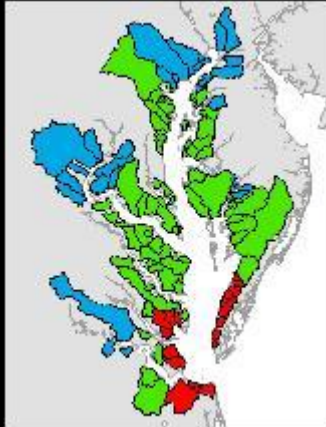
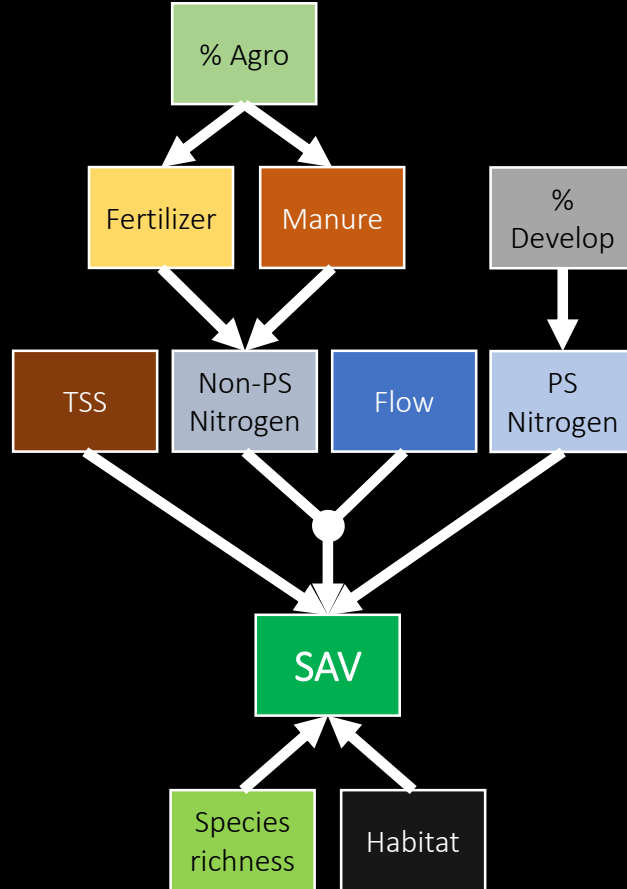
- Unites variables in a single causal network
- Ideal for testing cascading or indirect effects
- Traditional linear regression under the hood



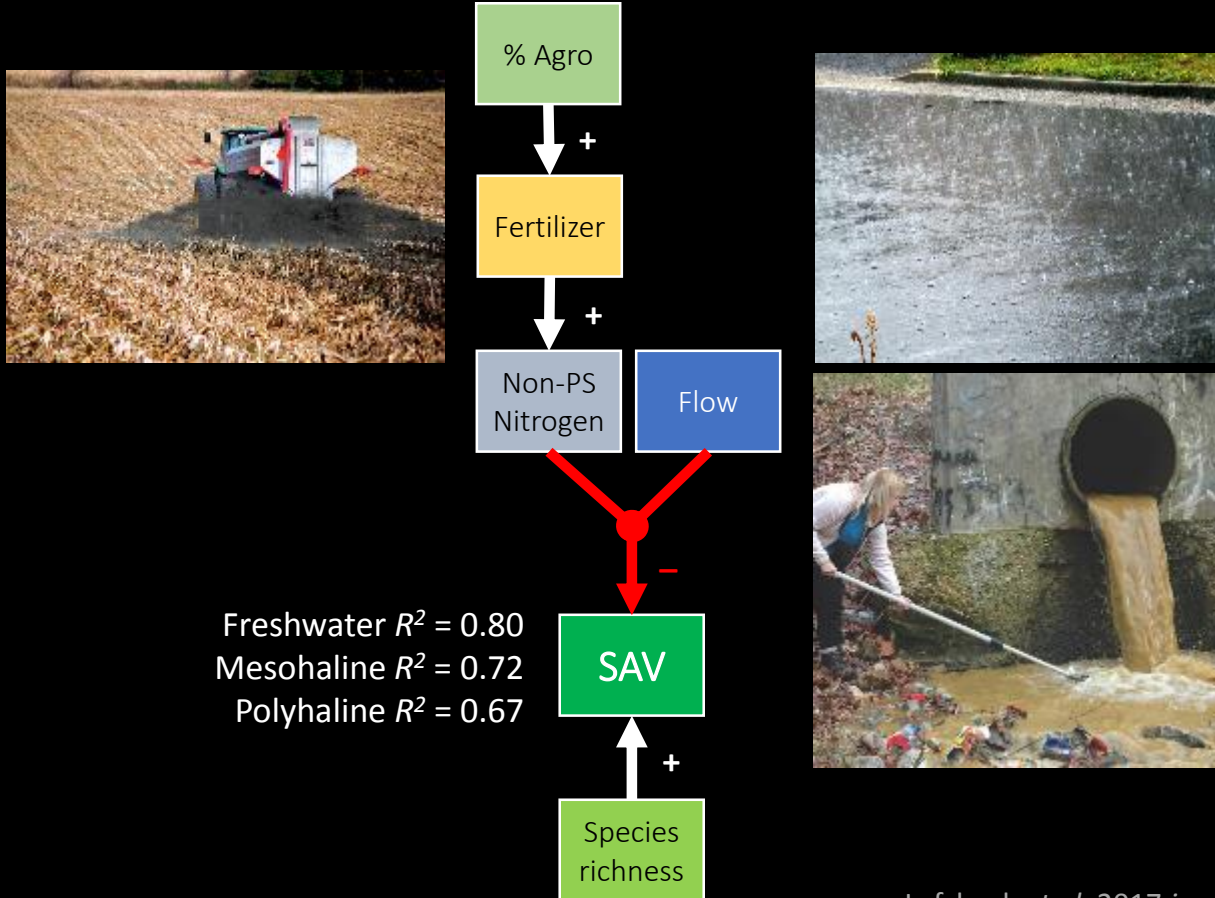
A simple linear regression: $Y \sim X$

A single causal model (SEM)

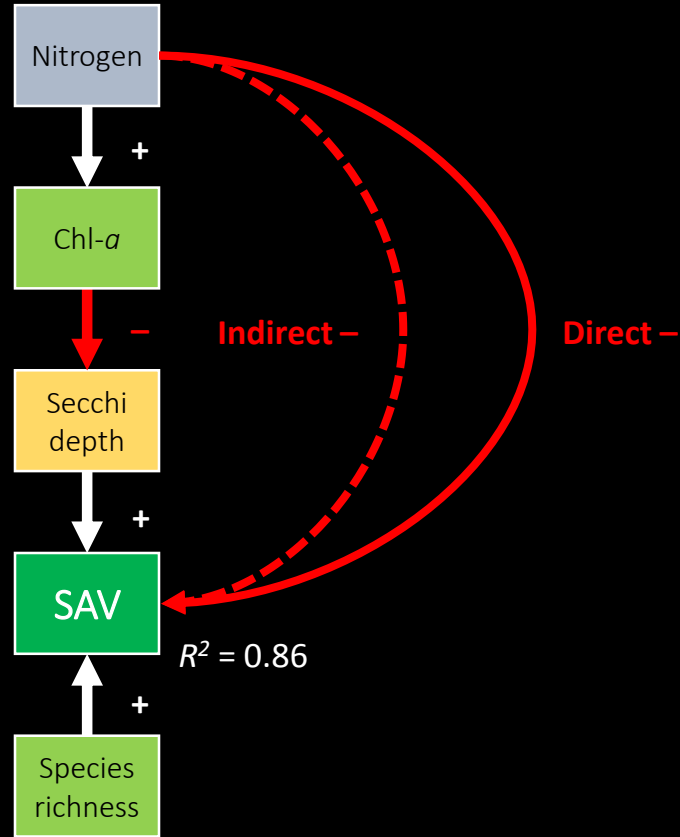
> Hypothesized SEM



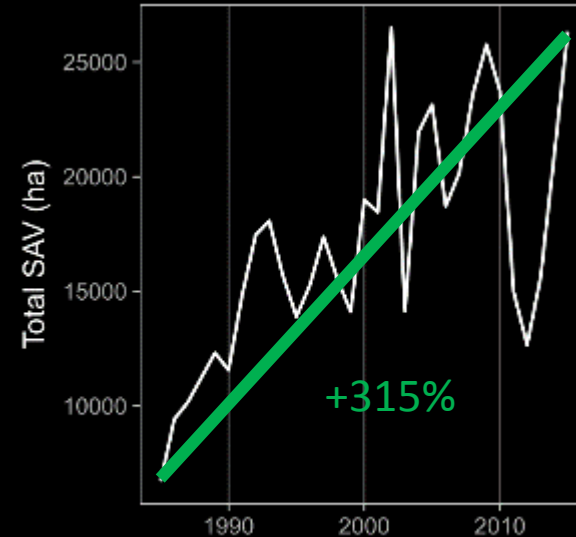
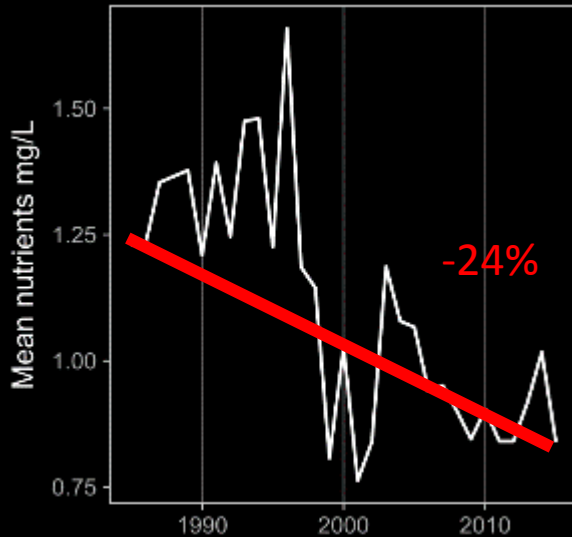
> What's happening in the watershed?



> What's happening in the water column?

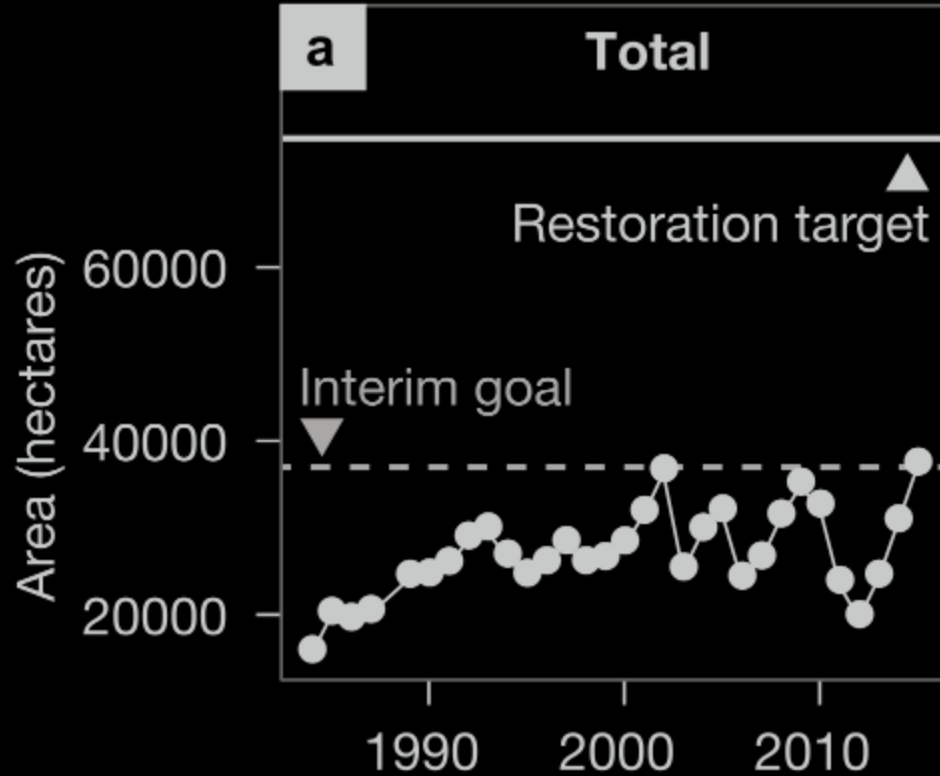


> Nutrient reductions leads to more SAV



*Active management can reverse human impacts
and restore coastal systems!*

> SAV Restoration on track

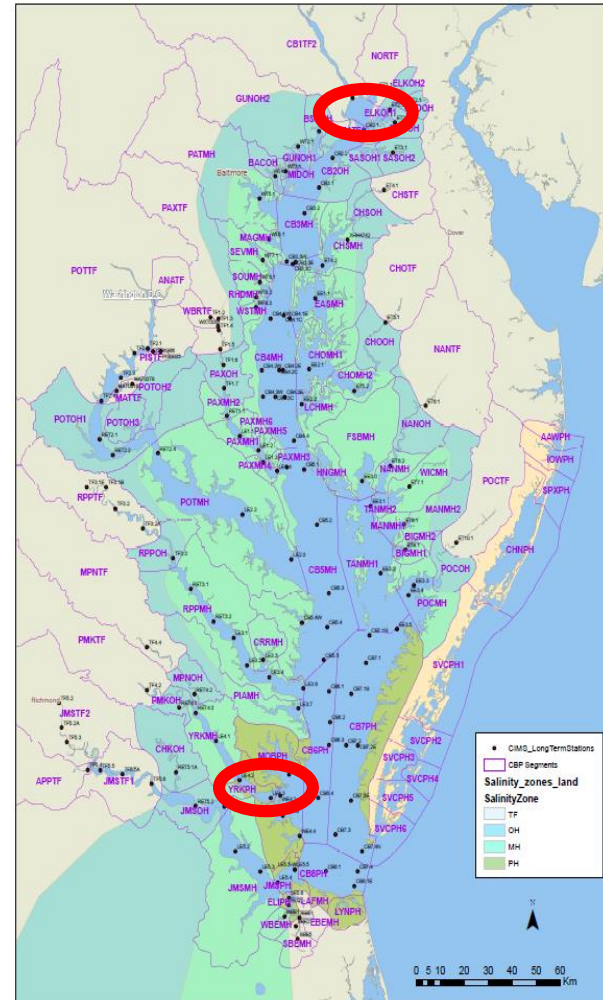


4. SAV segment analysis challenges

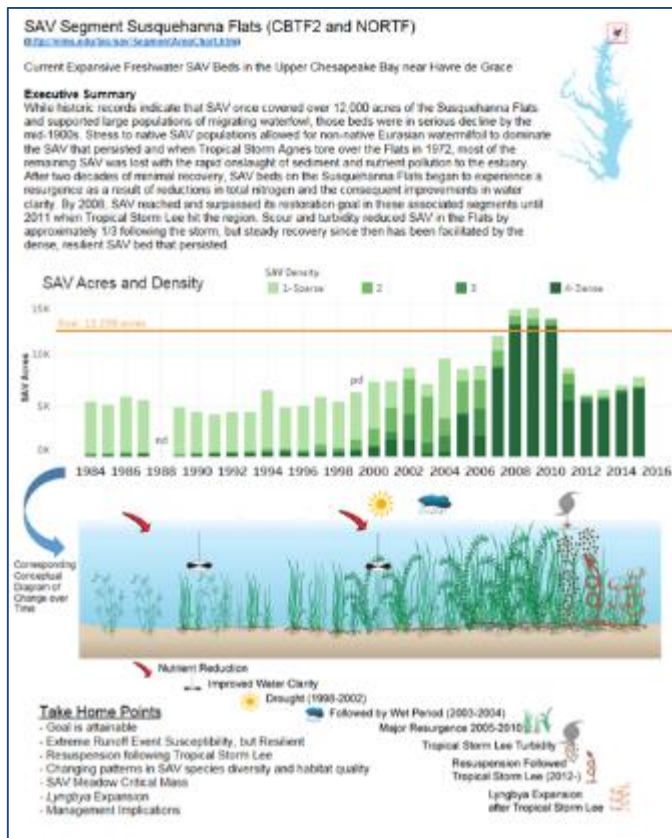
- Water quality stations vs. SAV locations
- Inside vs. outside SAV
- Temporal integration water quality vs. SAV
- Event impacts (e.g., storms, thermal)
- Inter-annual variability vs. long term trends
- Shoreline, seedbanks, land use influence on local SAV

Segment analysis

- 97 segments
- Some segments combined for analysis
- Two examples have been developed
Susquehanna flats
York River polyhaline



Susquehanna Flats



Footnotes:

Susquehanna Flats (Synthesis of 2 segments - CBTF2 and NORTF)
<http://www.umces.edu/bio/sav/segmentAreaChart.html>

Goal is attainable.

The goal is 12,257 acres. This goal was achieved from 2008-2010, following a decade of increasing of improving water quality, reduction in total nitrogen, and expanding SAV. In September 2011, Tropical Storm Lee led to the second highest flow amount recorded from the Susquehanna River at the Conowingo dam, resulting in high turbidity in the upper bay, resulting in the [decline of SAV](#) primarily at the deeper sections of the SAV beds.

Extreme runoff event susceptibility but resilient.

SAV that had been recovering following the loss of milfoil in the 1960s which had outcompeted native species in the late 1960 through the early 1960s were decimated by Tropical Storm Agnes in 1972, leading to a two decade period without appreciable SAV presence. Following the resurgence of SAV in the region through 2011, Tropical Storm Lee in Sept., 2011 (http://lan.umces.edu/eoccheck/watrrmr-review/chesapeake-bay/2011/indications-influencing_factors/)

led to a dramatic decline of SAV because of prolonged turbidity. However, the large dense beds protected the interior of the meadow from the river-borne turbidity, with losses primarily in the deeper, south and east ends of the Flats. But these beds proved to be resilient in that unlike Tropical Storm Agnes, large and dense grass beds persisted, facilitating a steady recovery in the years following Lee.

Resuspension following Tropical Storm Lee

The fine grain sediments that overlapped the Conowingo Dam were resuspended and persisted for years following their deposition. This shows the resuspension following storm events and fine grain sediment deposition can have lingering long term effects in water clarity and SAV abundance, influencing the trajectory of the recovery.

Changing patterns in SAV species diversity and habitat quality

This region historically supported a dense, diverse SAV assemblage which provided habitat for a myriad of migratory waterfowl. The Susquehanna Flats was the premier wintering waterfowl habitat of the mid-atlantic coast. The appearance of milfoil in the late 1950s dramatically altered the presence of native species. The disappearance of milfoil beginning in the late 1960s allowed some native species to return but in 1972, the passage of Agnes was the coup de gras for the native SAV species. Over the next two decades, some recovery of native species occurred on the flanks of the Susquehanna Flats, but little recovery on the main flats. Over the last two decades, the flats have become colonized by a dense and diverse SAV community of up to 15 species.

Lyngbya Expansion

Expansion of invasive bluegreen cyanobacteria shades SAV from light. Lyngbya thrives in warm, clear water. Lyngbya can also fix nitrogen and produce toxins. It forms dense floating mats, and loosely attaches to SAV in other regions of the world. Lyngbya has been known to decrease SAV density. Lyngbya can be very ephemeral, disappearing quickly due to viral lysis.

Management Implications

The two major issues that will influence the continued abundance and diversity of SAV in this region will be additional sediments that will be released from behind the Susquehanna Dam now that it is full, and nitrogen loads coming into the river. While we have shown the resiliency of this vast expanse of SAV following Tropical Storm Lee, the persistent release of sediments have the potential of altering the dynamics of SAV, either by the shoaling of the Flats, or the smothering of SAV by the sediments.

References - Gurbuz et al 2016, Bailey 78 et al, Orth et al 2010, Demerson 1999 et. al, Kemp et al 2005, <http://web.umces.edu/bio/sav/biogeography/Biogeography.html?>

SAV acres & density graphs

Susquehanna Flats

SAV Acres and Density

SAV Density



1-Sparse



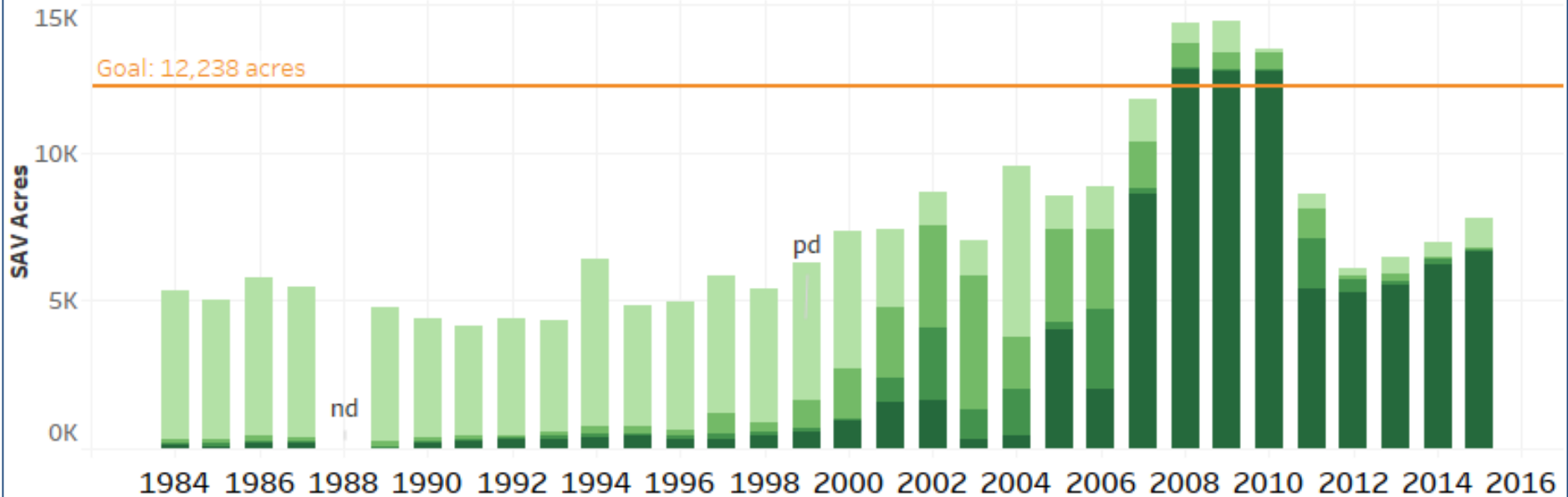
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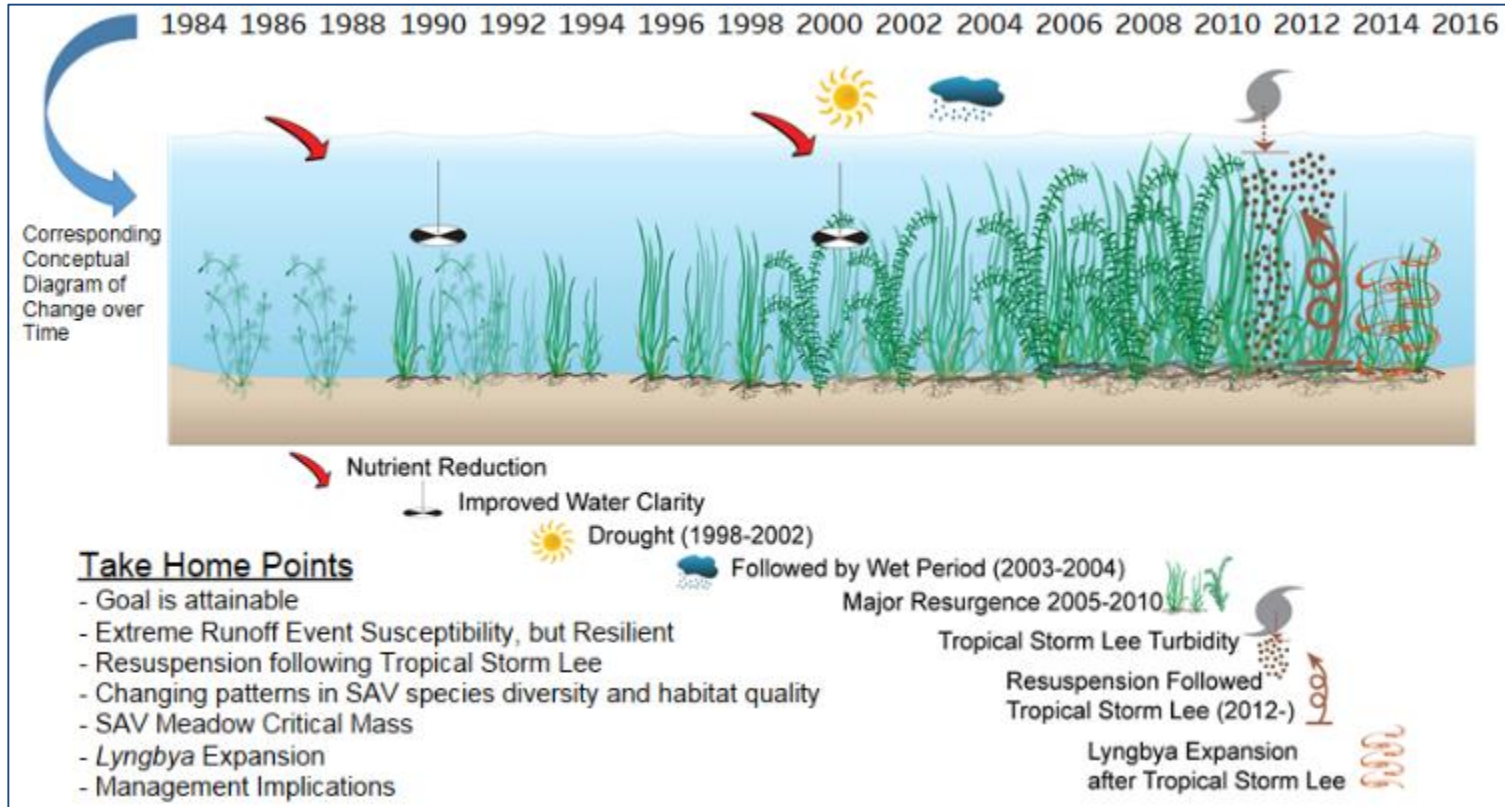
3



4-Dense



Time course conceptual diagram & take home points



Extensive footnotes

- Goal is attainable
- Extreme runoff event susceptibility but resilient
- Resuspension following Tropical Storm Lee
- Changing patterns in SAV species diversity and habitat quality
- *Lyngbya* expansion
- Management implications
- References

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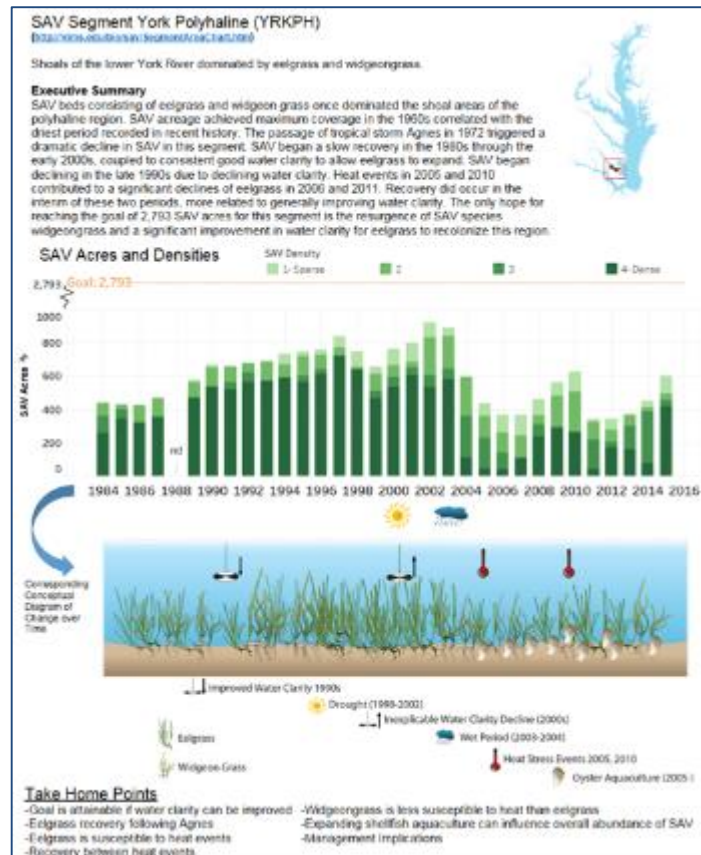
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York River polyhaline



Footnotes

York Polyhaline (YRKPH) <http://vims.edu/ter/ter/segment/AgnesChart.htm>

Goal is attainable if water clarity can be improved.

Improving water quality and clarity results in increases of eelgrass. This indicates that some of the thermal stress on eelgrass from heat events could be mitigated by improved water quality and clarity. The goal is attainable but probably not with eelgrass, but more likely with widgeongrass.

Eelgrass recovery following Agnes

There was a precipitous decline of eelgrass following tropical storm Agnes. Recovery was recorded through early 2000s, reaching a peak in 2003. This was related to long term, consistent improving water clarity. This recovery was slowed by inexplicable declining water clarity prior to heat events.

Eelgrass is susceptible to heat events

Eelgrass is a temperate seagrass species in the Chesapeake Bay near the southern distributional boundary of the mid-Atlantic. Shallow water summertime extreme temperatures led to mass mortality of eelgrass. Mortality of the meristematic tissue caused the plants to dislodge and float away. Small remnant populations persisted. High turbidity exacerbates high temperature stress. This occurred in Aug 2005 and June 2010. The SAV surveys do not fully assess this loss until the following year.

Recovery between heat events

The majority of eelgrass recovery was by seedlings and remnant rhizomes. The years following the heat events were cooler, with seedlings able to survive and grow. Because of the nature of eelgrass flowering and lack of a seedbank, two successive years of heat events could be devastating for eelgrass populations.

Widgeongrass is less susceptible to heat than Eelgrass

Widgeongrass is much more tolerant than eelgrass of temperature extremes. Widgeongrass has a broader global distribution and wider salinity tolerance. Widgeongrass populations can be highly variable on an annual basis.

Expanding shellfish aquaculture can influence overall abundance of SAV

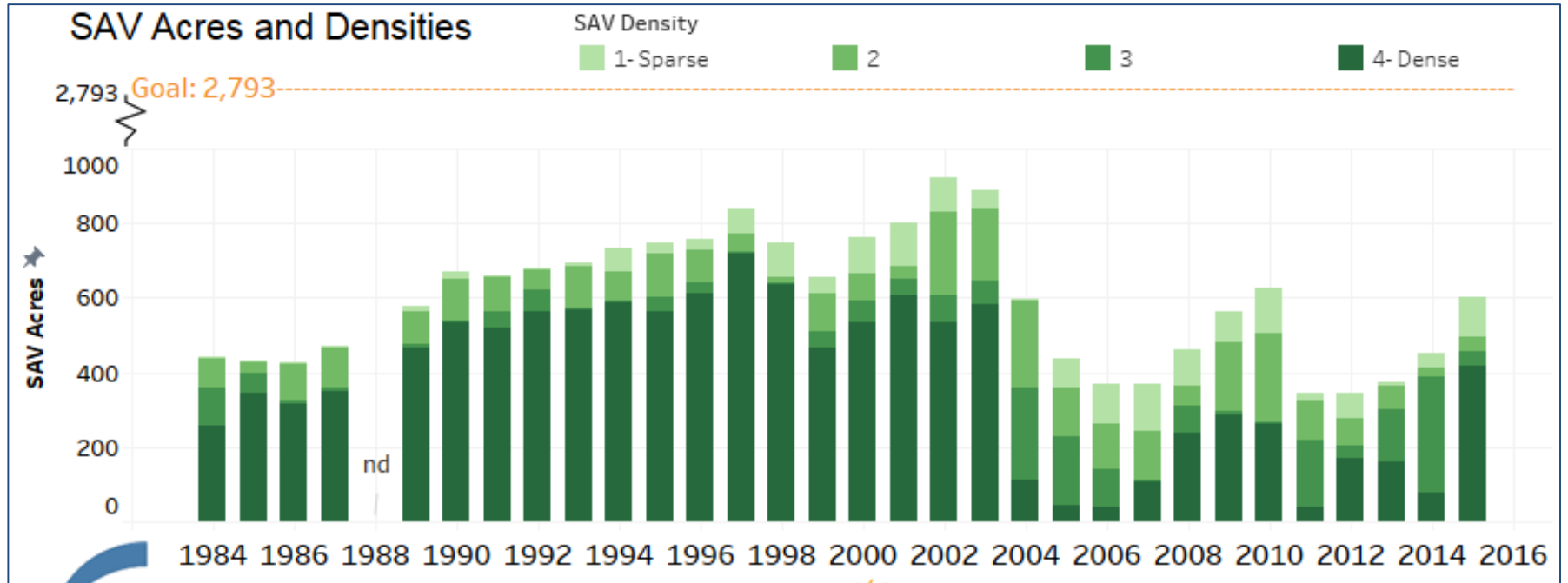
Shellfish aquaculture could provide a boost to local economy, help replace declining wild stocks, and lead to water clarity improvements due to biofiltration. Shellfish aquaculture, clams and oysters, that use up shallow water habitat, potential SAV habitat, limit the recovery of SAV into those regions if water clarity improvements lead to a resurgence.

Management Implications

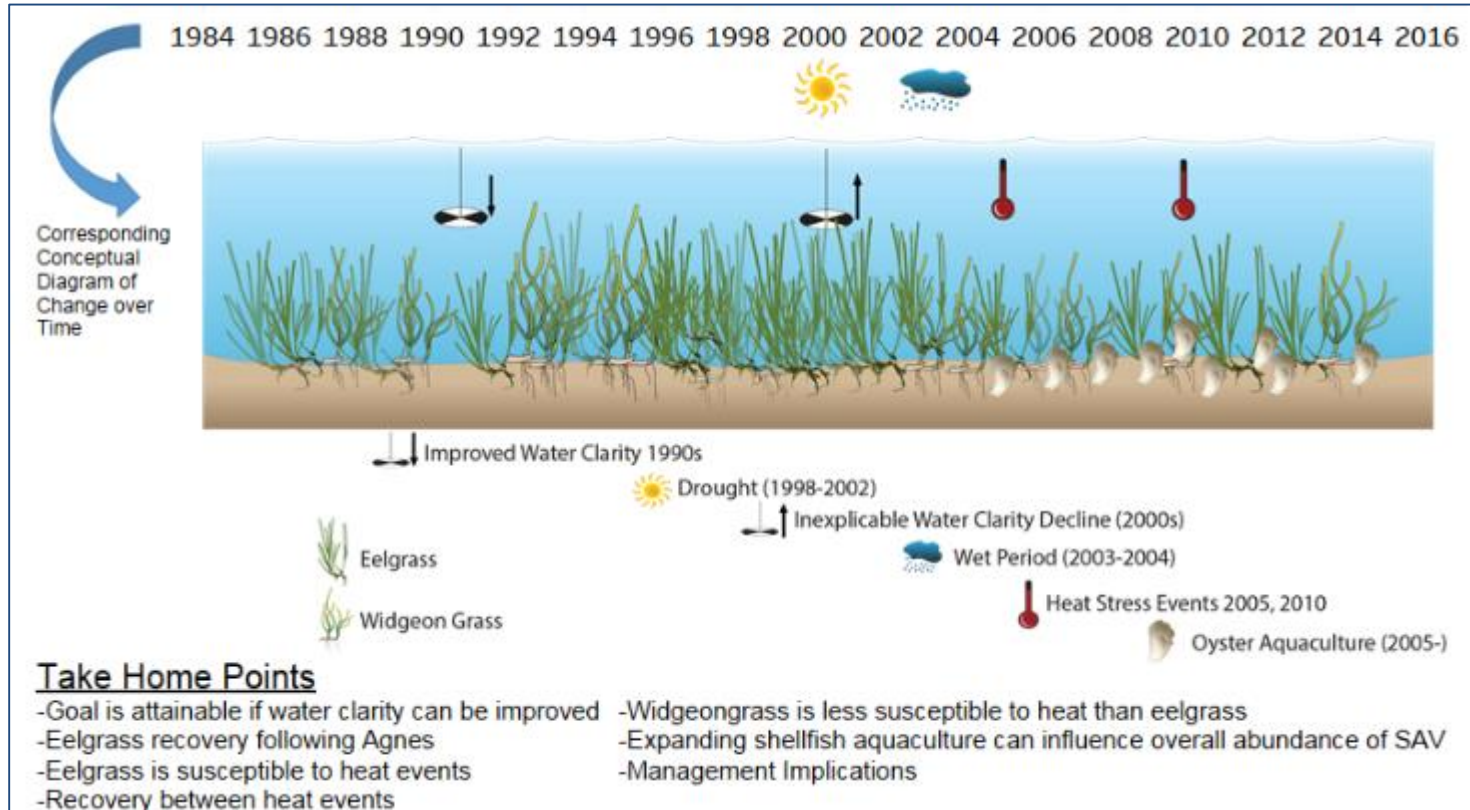
Managers will need to focus on improving water clarity by both reducing sediments and nutrients. Managers will be unable to do much about temperature as this is a more global issue. However, by improving water clarity, plants may be able to tolerate periods of warmer water when clarity allows plants to photosynthesize. In addition, if and when water clarity improves, managers will have to deal with aquaculture requests, as well as existing leases where SAV may begin colonizing once unvegetated areas.

References- Orth et al 2010, Moore et al 2014, Lefcheck et al. 2017

SAV acres & density graphs



Time course conceptual diagram & take home points



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- Recovery between heat events
- Widgeongrass is less susceptible to heat than eelgrass
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- Management implications
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Footnotes

York Polyhaline (YRKP1) | <http://vims.edu/loisavo/ScenerAreaChart.htm>

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Quote from a senior top level manager to lower level manager

Hey Rich – just wanted to give you some feedback on the SAV gurus and their proposed approach – **I found those two page segment approaches very approachable and really gave a lot of info.** So from your legal non-science civilian perspective, I say good job **(much better than the charts with the R squared figures)!** Please pass on my regards to the team – seems like really good building block science happening.

SAV SYN

