Chesapeake Bay estuary topics
11 June 2020

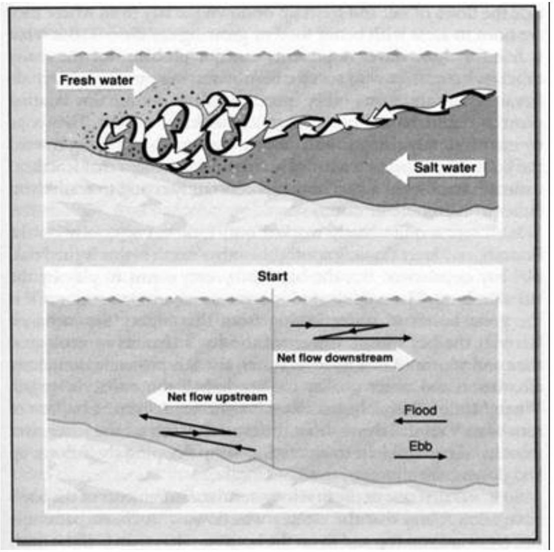
- Bill Dennison
- Bill Ball
- Brian Benham
- Kathy Boomer
- Diedre Gibson
- Carl Hershner
- Lewis Linker
- Mike Runge
- Larry Sanford
- Jeremy Testa

Key points

1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes.
2. Creating a ***collaborative integration approach*** in which diagnostic science is used to understand the underlying processes and predictive science is employed to forecast future trajectories by integrating monitoring, modeling, and research approaches.
3. Understanding the dynamics of ecosystems at the ***land-sea interface (triblets)*** in Bay restoration.
4. Investigating the impact of ***tipping points (ecological thresholds)*** in estuarine restoration dynamics.
5. Accounting for ***climate change*** in Bay restoration and expectations of restoration.
6. Using ***shallow water benthos*** as an example of an ecosystem for application of an integrative monitoring, modeling, and research approach at the land-sea interface, and particularly with regard to investigation of tipping points and climate change effects .
7. Developing a ***future vision*** of Chesapeake Bay management that better embraces and addresses decision making in the face of uncertainty by incorporating adaptive management and potential major interventions.
8. Identifying ***new tools, approaches, and personnel*** that will feature in Chesapeake Bay restoration science and analysis.

1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

Primacy of Chesapeake estuarine science



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1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

Primacy of Chesapeake estuarine science

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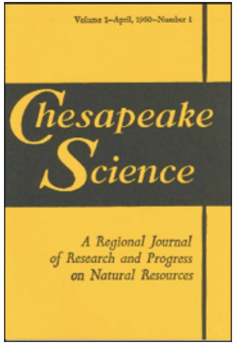
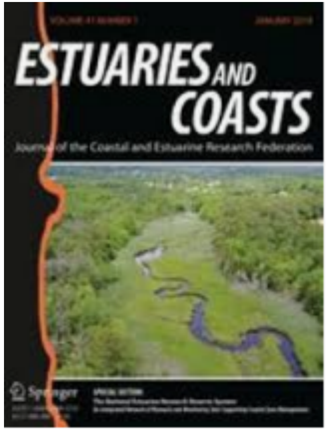
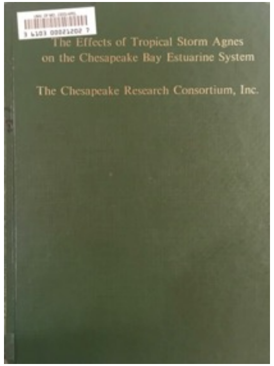




1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

Primacy of Chesapeake eutrophication science

Figure 1. The Chesapeake Bay's "Big Three." From left to right: Bill Hargis, Don Pritchard, and Gene Cronin. Photo taken at the Bi-State Conference on Chesapeake Bay 1977, Patuxent Naval Air Station, Maryland.



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FEATURE ARTICLE: REVIEW

Eutrophication of Chesapeake Bay: historical trends and ecological interactions

W. M. Kemp[1,*], W. R. Boynton[2], J. E. Adolf[3], D. F. Boesch[3], W. C. Boicourt[1], G. Brush[4], J. C. Cornwell[1], T. R. Fisher[1], P. M. Glibert[1], J. D. Hagy[5], L. W. Harding[1], E. D. Houde[2], D. G. Kimmel[1], W. D. Miller[1], R. I. E. Newell[1], M. R. Roman[1], E. M. Smith[6], J. C. Stevenson[1]

Chesapeake Bay Eutrophication: Scientific Understanding, Ecosystem Restoration, and Challenges for Agriculture

Donald F. Boesch,* Russell B. Brinsfield, and Robert E. Magnien

Assessing Water Quality with Submersed Aquatic Vegetation

Habitat requirements as barometers of Chesapeake Bay health

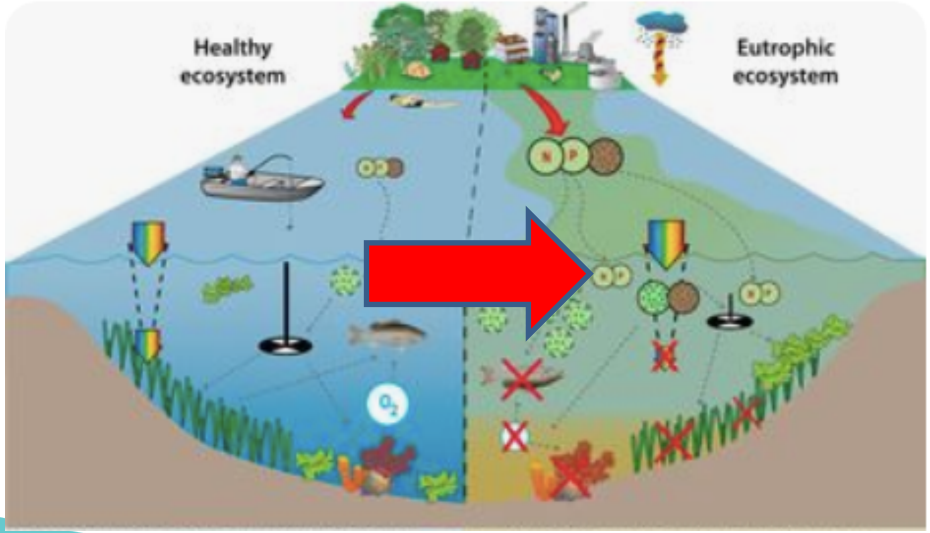
William C. Dennison, Robert J. Orth,[1] Kenneth A. Moore, J. Court Stevenson, Virginia Carter, Stan Kollar, Peter W. Bergstrom, and Richard A. Batiuk

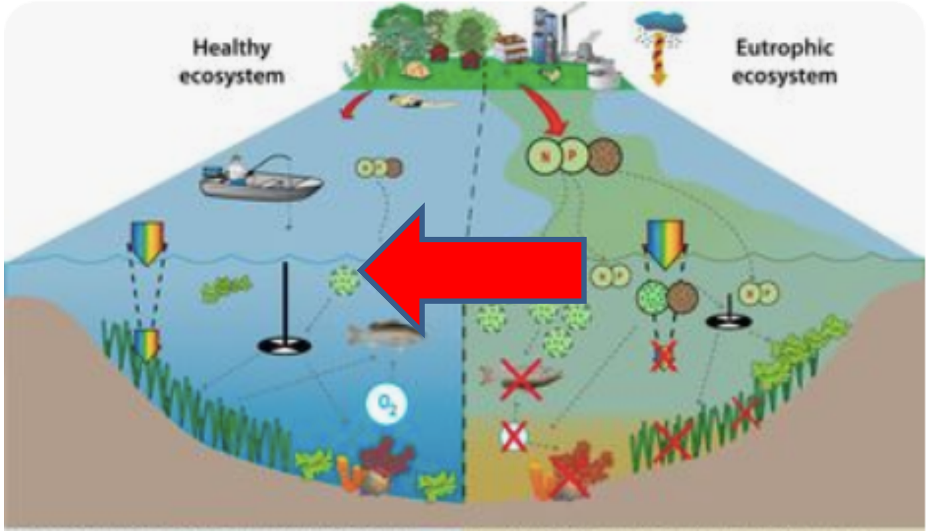
THREE-DIMENSIONAL EUTROPHICATION MODEL OF CHESAPEAKE BAY

By Carl F. Cerco,[1] Associate Member, ASCE, and Thomas Cole[2]

1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

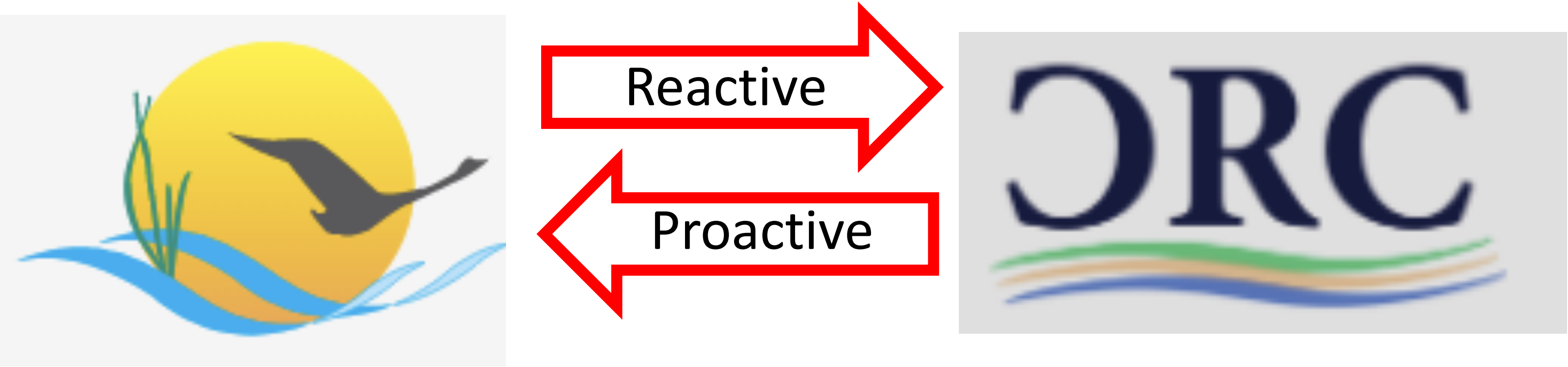
Shift from degradation to restoration science





1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

Duality of a reactive and proactive role for STAC



1. Shifting to a focus on accelerating ***restoration processes***, rather than the historical focus on slowing and preventing degradation processes

Chesapeake Bay restoration uniqueness

Chesapeake Bay Program
Science. Restoration. Partnership.

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Discover the Chesapeake | Learn the Issues | State of the Chesapeake | Take Action | In the News | Who We Are | What We Do

IN THE NEWS > RECENT NEWS > EIGHT REASONS THE CHESAPEAKE BAY IS AN EXCEPTIONAL ESTUARY

Eight reasons the Chesapeake Bay is an exceptional estuary

1. Size, 2. Shorelines, 3. Geology, 4. Wetlands,
5. Forests, 6. Waterfowl, 7. Seafood, 8. People

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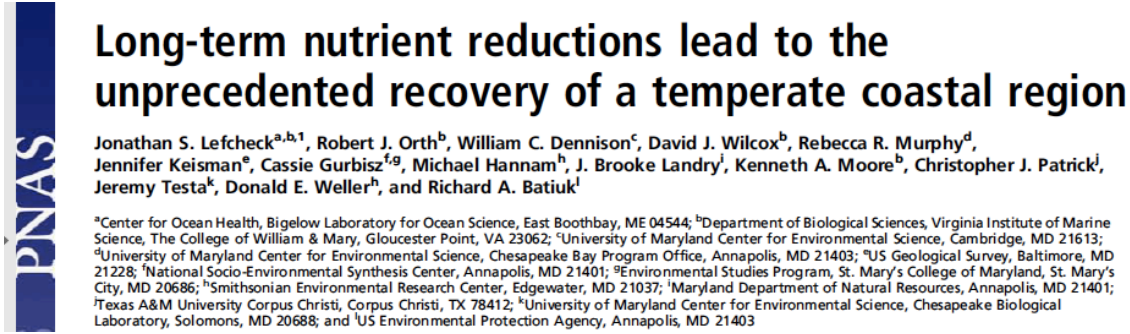
Chesapeake Bay restoration uniqueness


PNAS

Long-term nutrient reductions lead to the unprecedented recovery of a temperate coastal region

Jonathan S. Lefcheck[a,b,1], Robert J. Orth[b], William C. Dennison[c], David J. Wilcox[b], Rebecca R. Murphy[d], Jennifer Keisman[e], Cassie Gurbisz[f,g], Michael Hannam[h], J. Brooke Landry[i], Kenneth A. Moore[b], Christopher J. Patrick[j], Jeremy Testa[k], Donald E. Weller[h], and Richard A. Batiuk[l]

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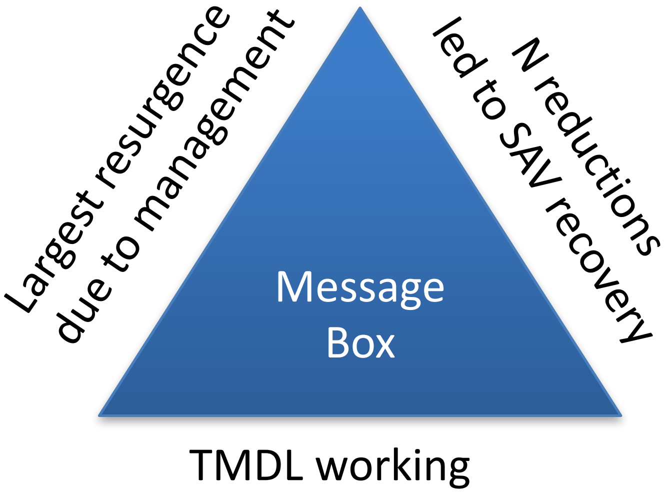

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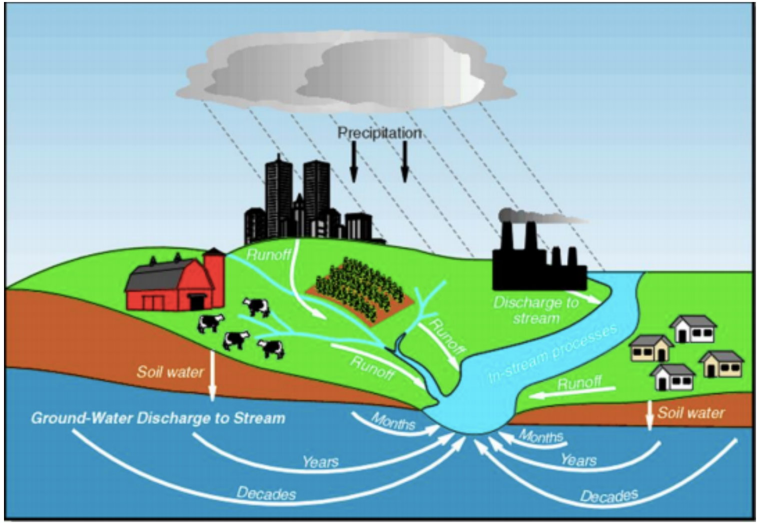
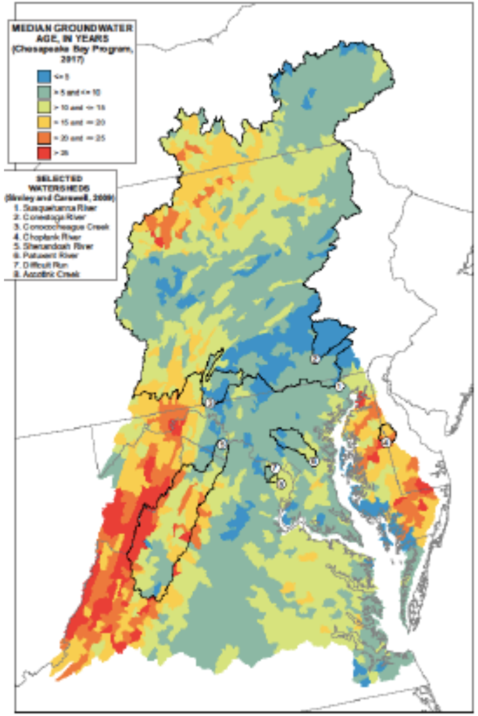
Lag times





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Managing for resilience

2. Creating a ***collaborative integration approach*** in which diagnostic science is used to understand the underlying processes and predictive science is employed to forecast future trajectories by integrating monitoring, modeling, and research approaches

Collaborative integration approach

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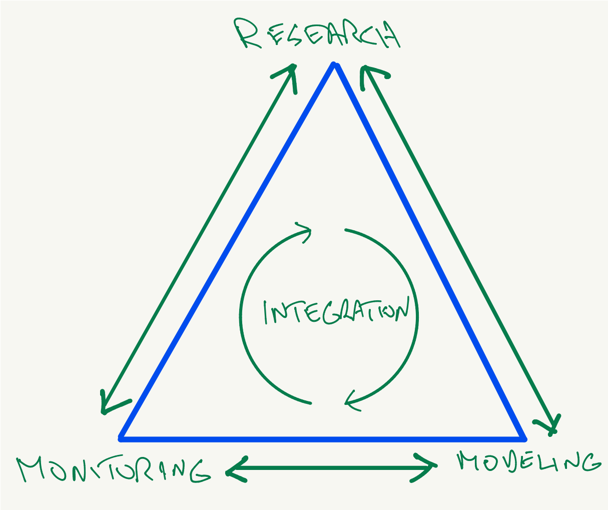
Connections between modeling, monitoring, and research



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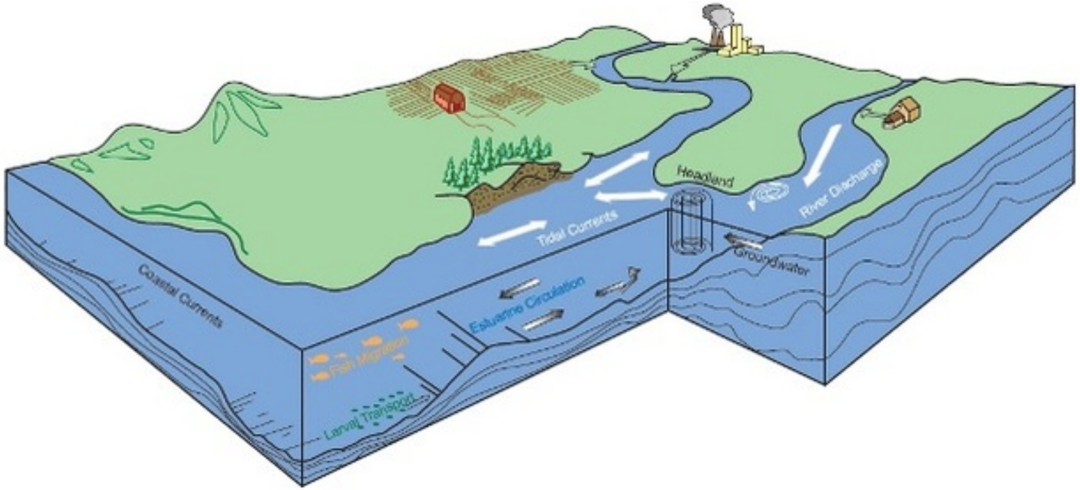
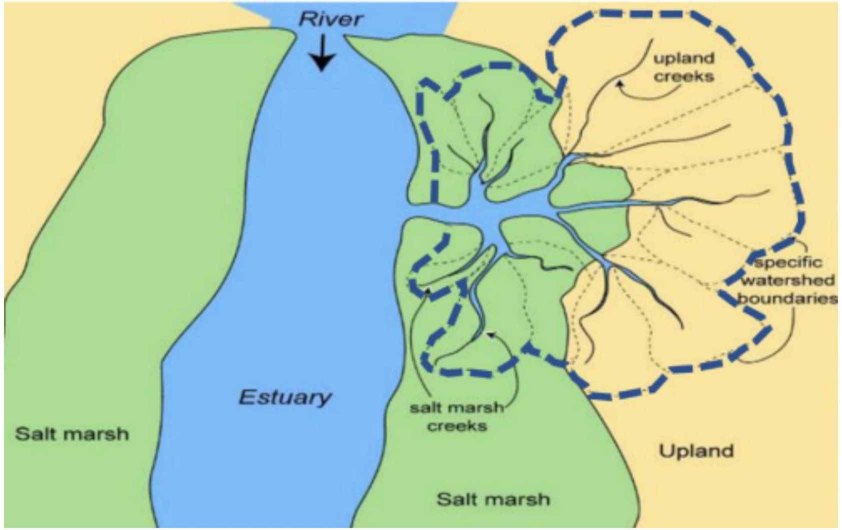
Integrating with watershed and living resources



3. Understanding the dynamics within the ***Terrestrial-Estuarine Transition Zone (T-zone)*** and the important role of ***triblets*** in Bay restoration

T-zone is a critical landscape area connecting watersheds and coastal waters



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Focused restoration efforts and research in T-zones

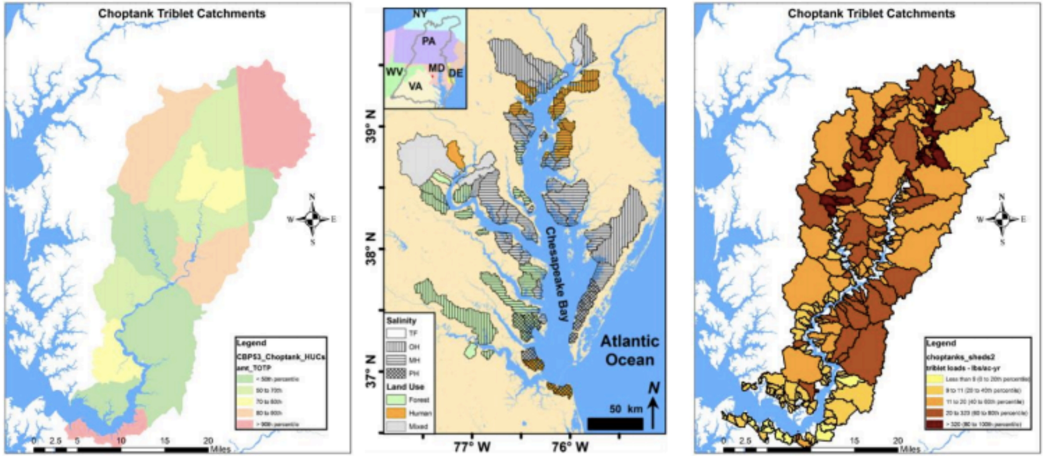
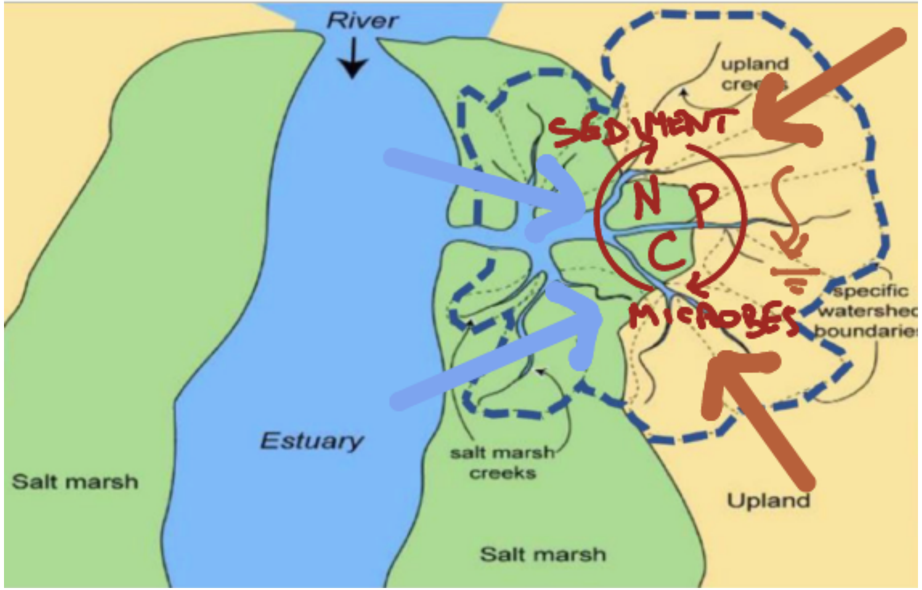


***Figure 3:** Current Chesapeake Bay Program's land-river model segments of the Choptank River in contrast to potential triblet-based model segmentation strategies, including land areas draining to small estuaries (middle) or based on channelized waterways connecting uplands to the estuary (right). Note the middle figure maps examples of triblet catchments across the Chesapeake Bay watershed (Weller and Jordan), in addition to the Choptank River subsystems (left and right panels).*

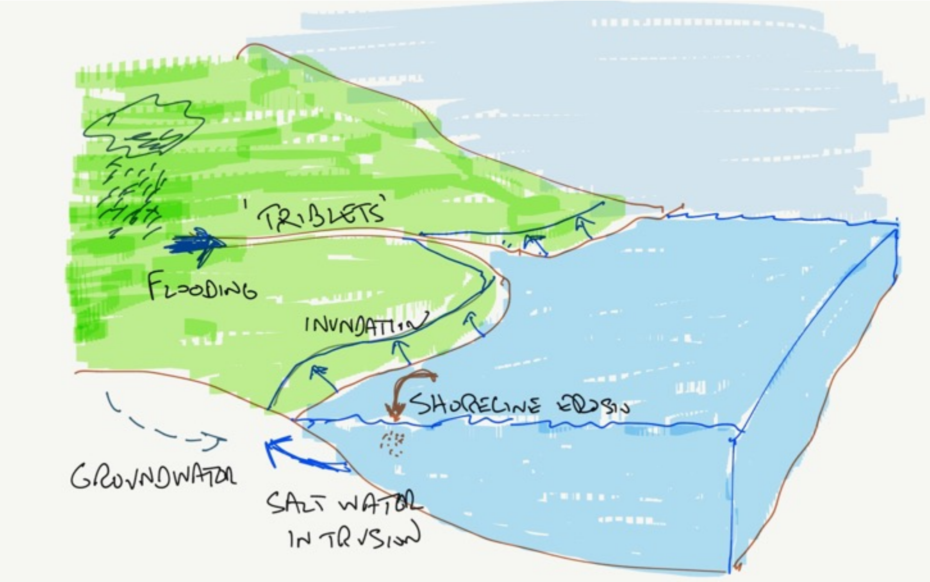
3. Understanding the dynamics within the ***Terrestrial-Estuarine Transition Zone (T-zone)*** and the important role of ***triblets*** in Bay restoration

T-zones function as complex bioreactors



3. Understanding the dynamics within the ***Terrestrial-Estuarine Transition Zone (T-zone)*** and the important role of ***triblets*** in Bay restoration

T-zone hydrodynamics need to be characterized



3. Understanding the dynamics within the ***Terrestrial-Estuarine Transition Zone (T-zone)*** and the important role of ***triblets*** in Bay restoration

Scientific response to triblets

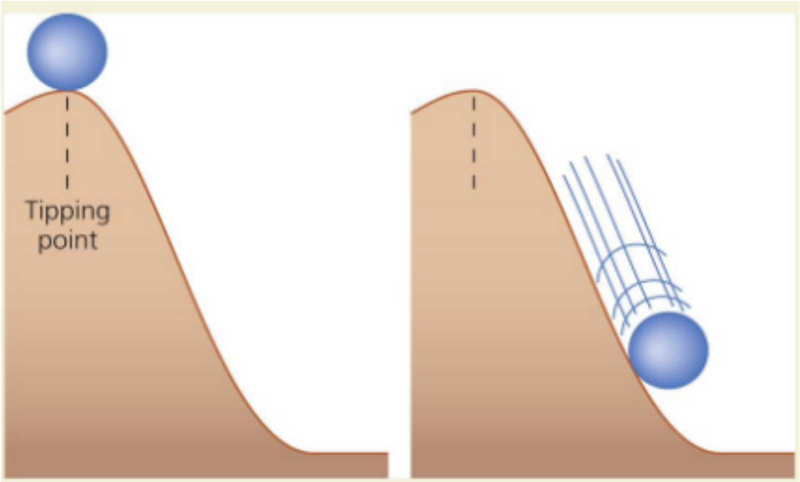
Research: Use low cost continuous sensors, remote sensing and emerging technologies to assess the intense biogeochemical processes in triblets

Monitoring: Develop a practical way to monitor in difficult land sea interfaces; Simple, targeted monitoring of representative triblets is recommended

Modeling: Develop simple estuarine characterizations, good triblet models will require extensive expertise and time; Use existing shallow water and watershed models to identify vulnerable triblets; Target triblets for explicit modeling efforts

4. Investigating the impact of ***tipping points (ecological thresholds)*** in estuarine restoration dynamics

Tipping points are when small changes in environmental conditions lead to large shifts in ecological status



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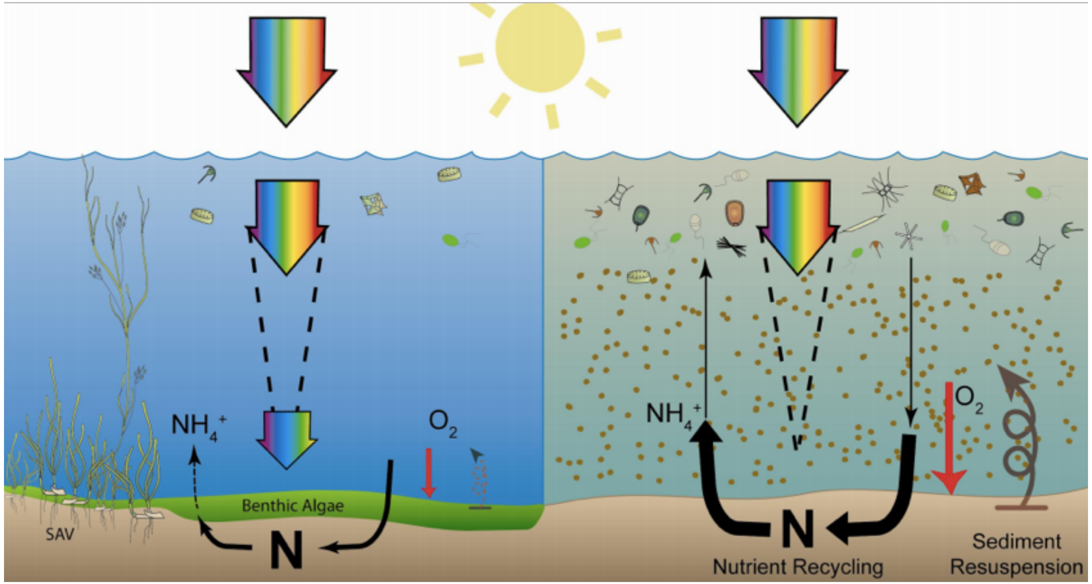
Water clarity tipping point



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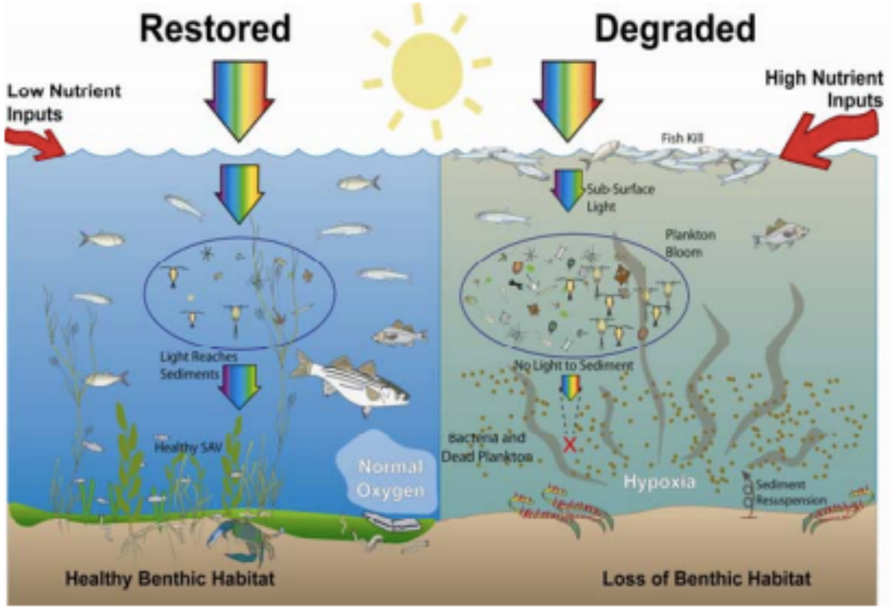
Dissolved oxygen tipping point



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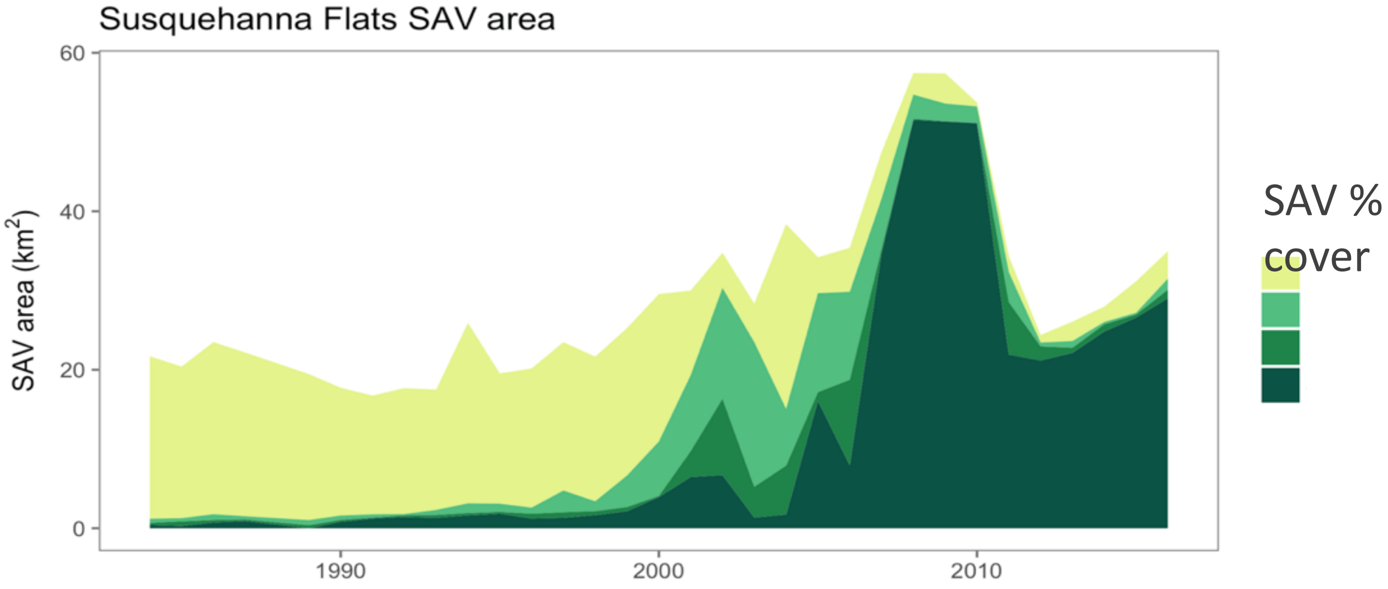
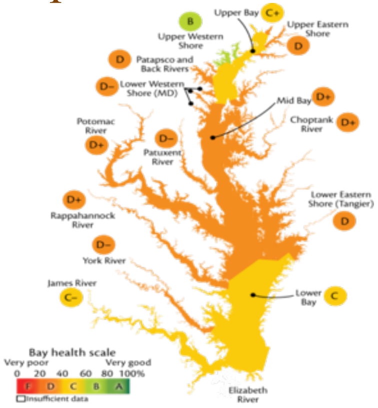
Submerged Aquatic Vegetation tipping point

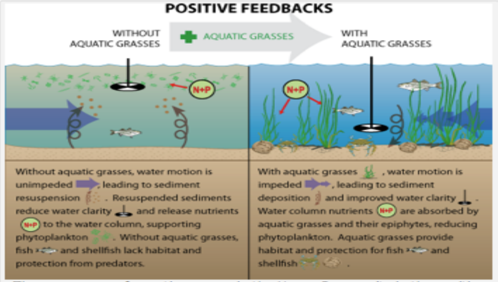


4. Investigating the impact of ***tipping points (ecological thresholds)*** in estuarine restoration dynamics

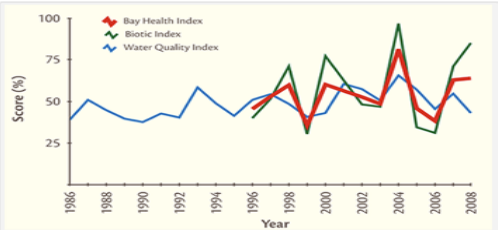
Tipping points affecting Bay health metrics

Chesapeake Bay report card

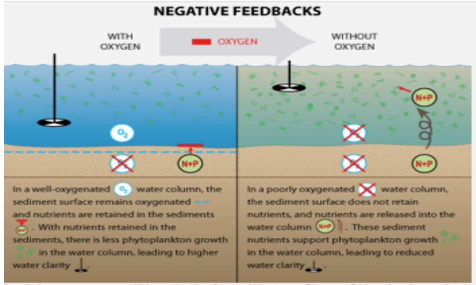




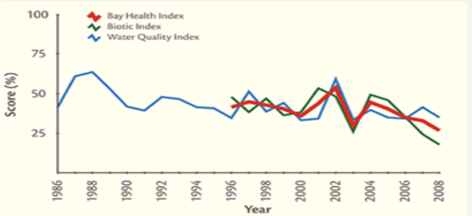
The resurgence of aquatic grasses in the Upper Bay results in the positive feedbacks to water quality.



Positive ecological feedbacks resulting in improving water quality trajectories.



Declining oxygen conditions in the lower Western Shore of Maryland results in degrading water quality.



Negative ecological feedbacks resulting in degrading water quality trajectories.

4. Investigating the impact of ***tipping points (ecological thresholds)*** in estuarine restoration dynamics

Scientific response to tipping points

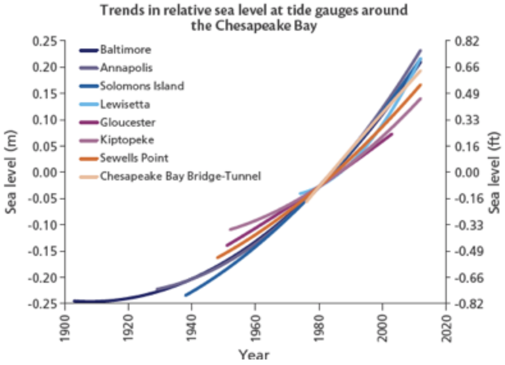
Research: Develop methodology to establish high priority triblets for management interventions; Field research to determine responses of triblets to management (natural science) and stakeholder perceptions (social science) Investigate feedback mechanisms; Test out tipping points in different salinity regimes, Spatial variability of nitrification/denitrification

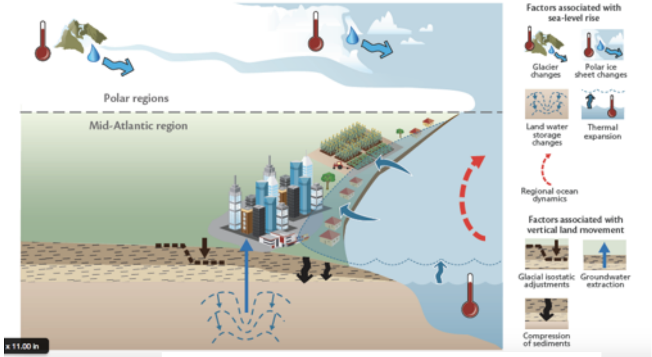
Monitoring: Careful observations to establish tipping points for both degradation and restoration trajectories, Frequent water clarity measurements, Continued bottom water dissolved oxygen levels and annual SAV surveys

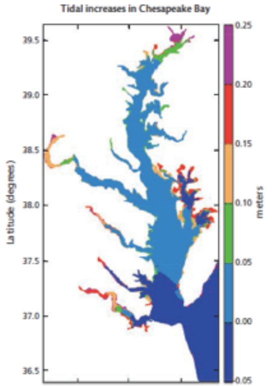
Modeling: Incorporate ecological feedbacks into models, Extrapolate specific site measurements to Bay-wide forecasting, model continued nutrient reductions needed to reverse degradation or enhance restoration

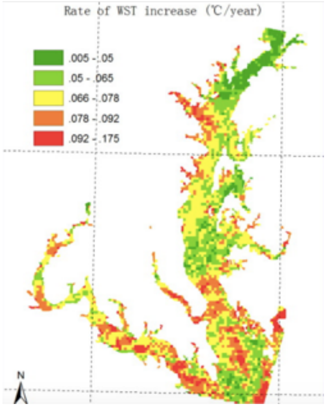
5. Accounting for *climate change* in Bay restoration

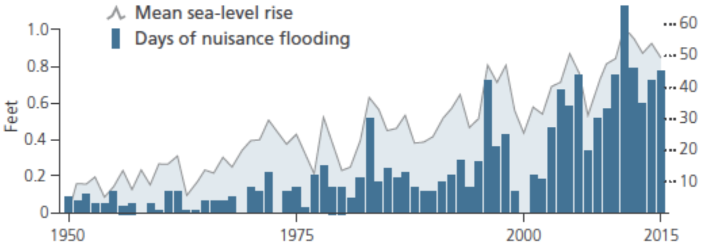
Observed changes: Sea level rise, increased temperature and salinity

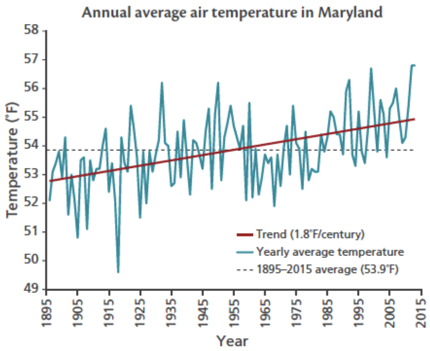


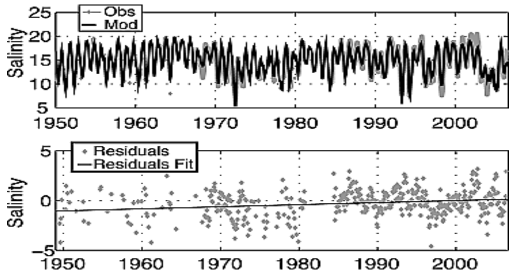






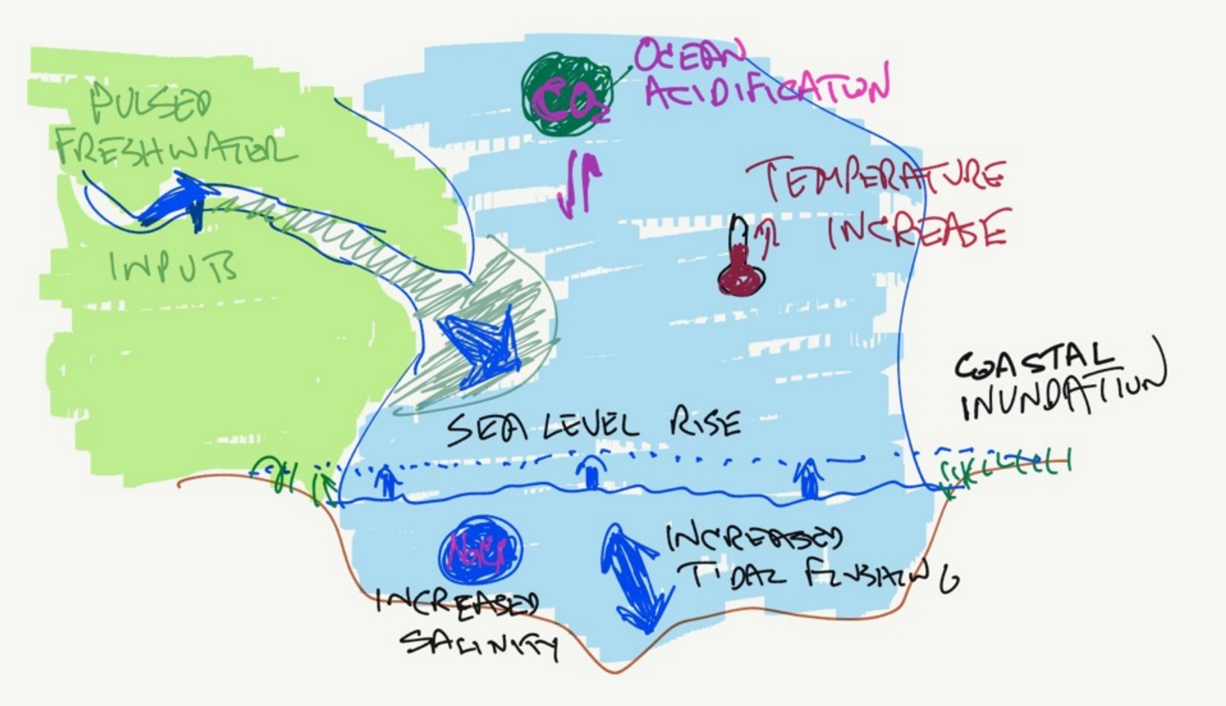






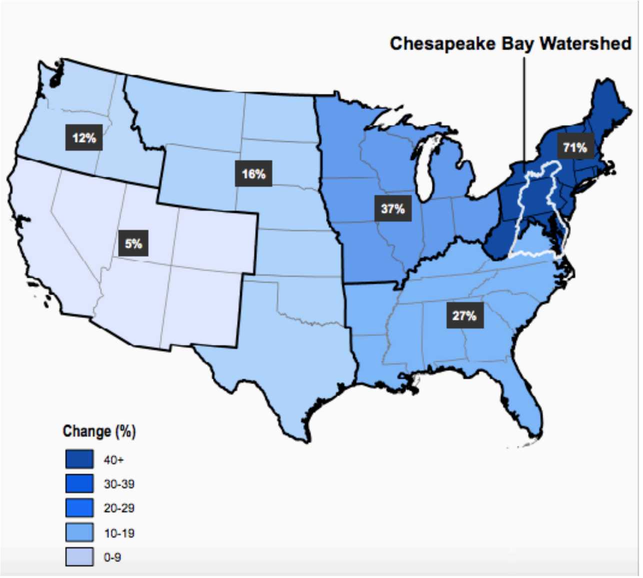
5. Accounting for ***climate change*** in Bay restoration

Anticipated changes



5. Accounting for ***climate change*** in Bay restoration

Anticipated changes: Precipitation patterns



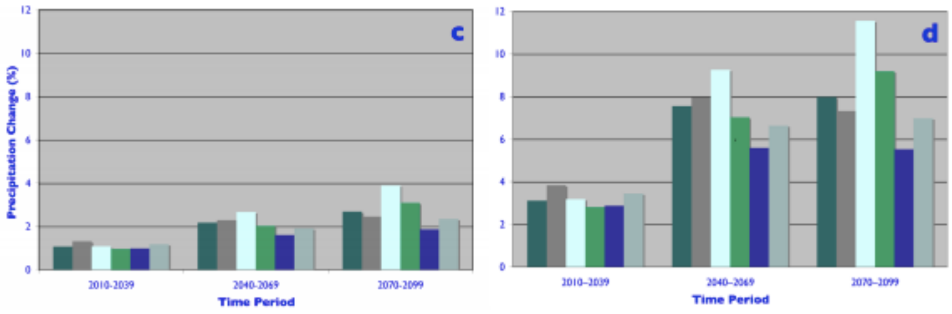
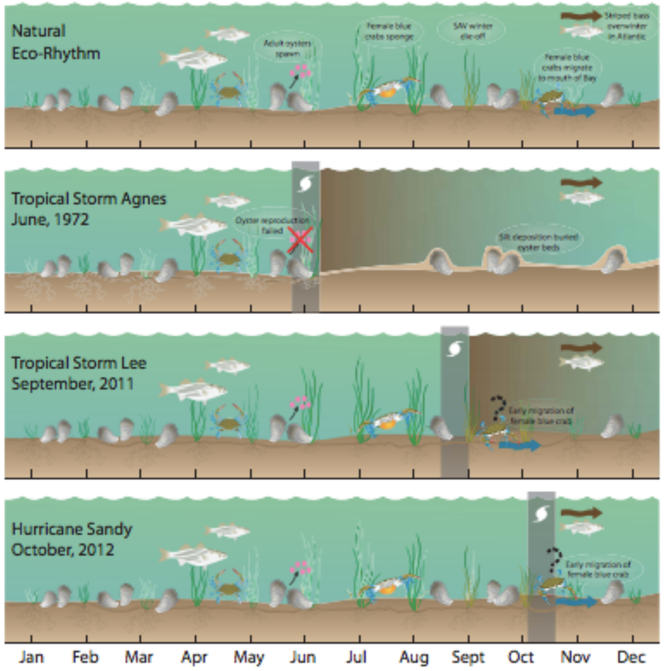


Figure 4. *Projected change in the annual mean temperature (a and b) and precipitation (c and d) of the Chesapeake Bay watershed for six IPCC scenarios (see Figure 1) averaged over seven climate models (a and c) and the four highest ranked (b and d). From Najjar et al. [2008].*

5. Accounting for ***climate change*** in Bay restoration

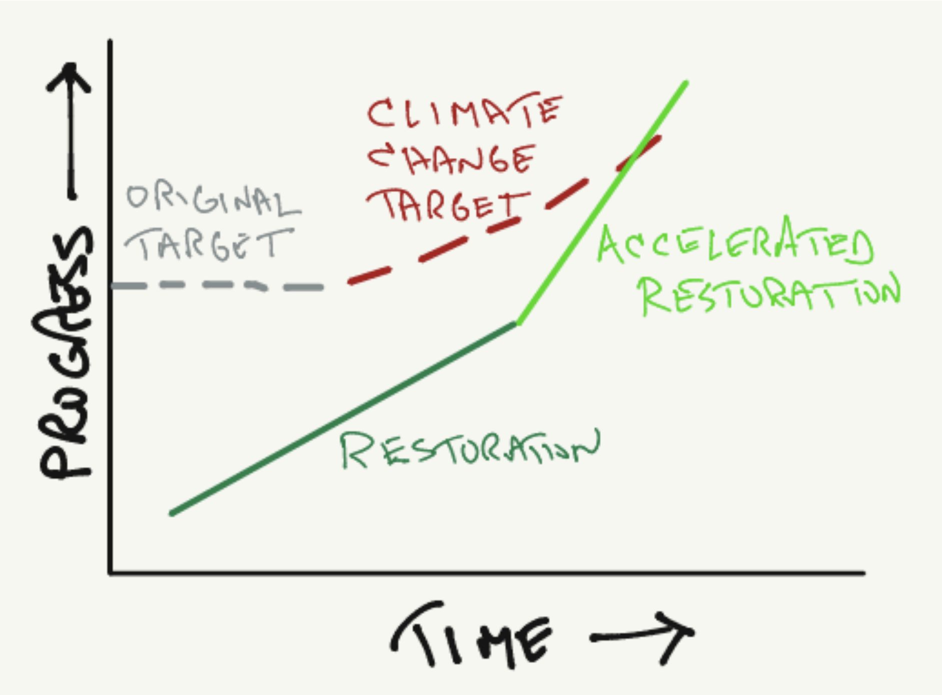
Anticipated changes: Storm intensity and frequency

Tropical Storm Lee



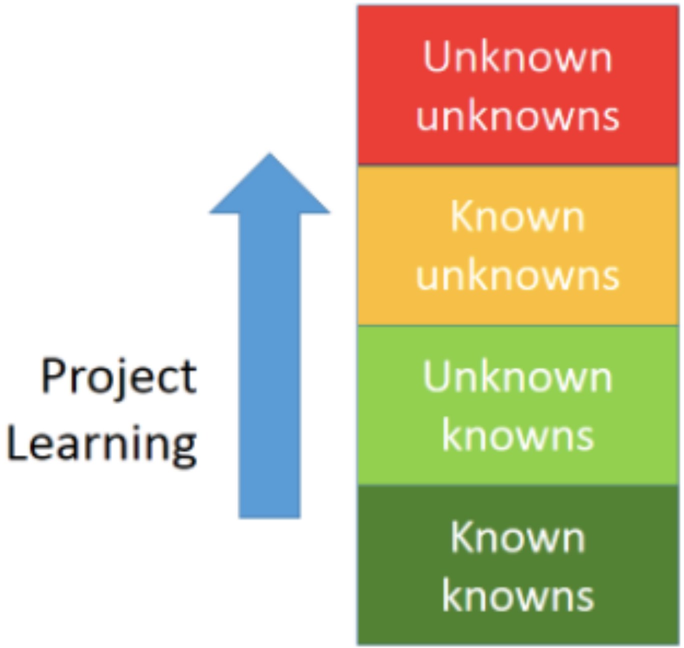
5. Accounting for ***climate change*** in Bay restoration

Progress in face of climate change



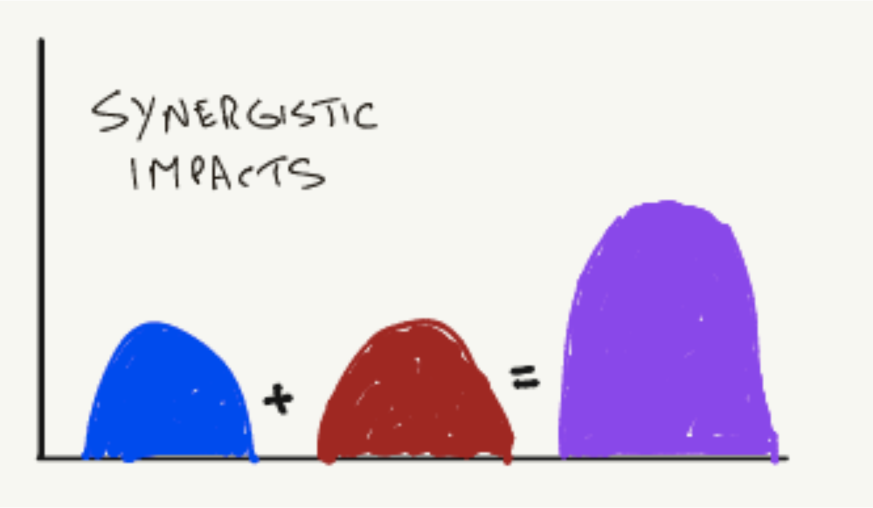
5. Accounting for ***climate change*** in Bay restoration

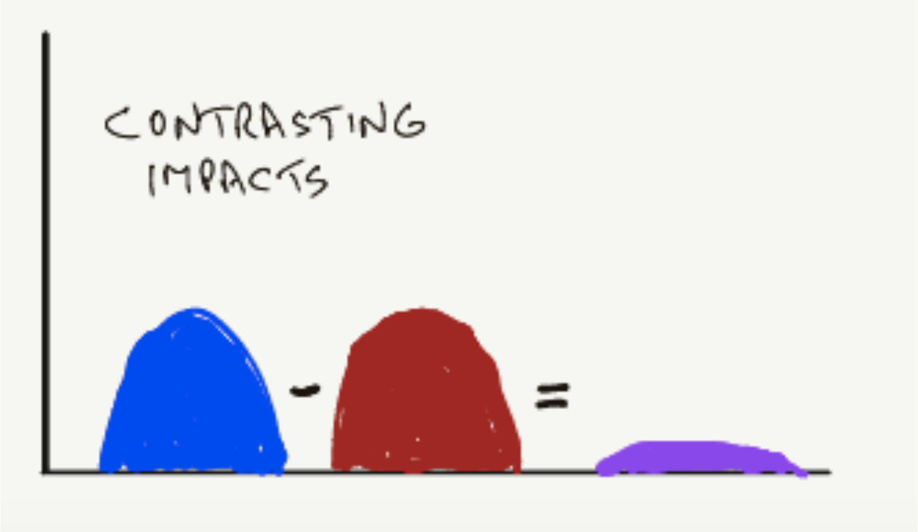
Future unknowns



5. Accounting for ***climate change*** in Bay restoration

Synergistic and contrasting impacts





5. Accounting for ***climate change*** in Bay restoration

Scientific response to climate change

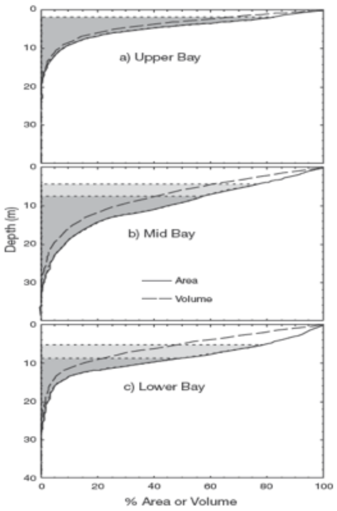
Research: The combined impacts of climate change will need to be investigated; Large scale experimental simulation facilities will aid climate change research (e.g., mesocosms)

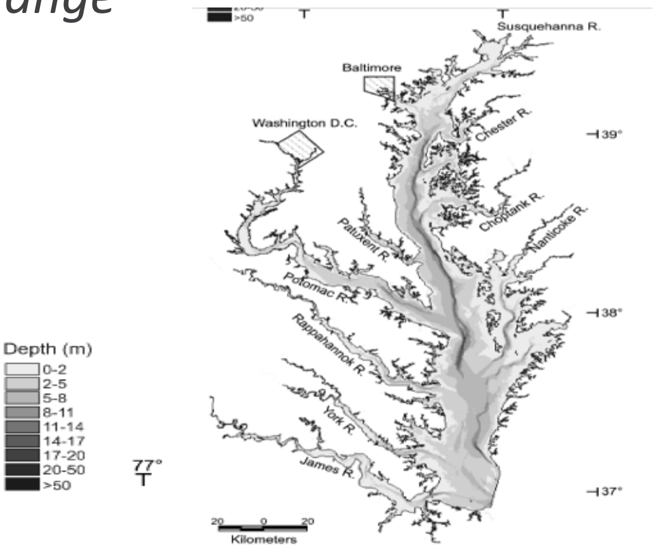
Monitoring: Maintain and expand long term monitoring that detects climate change; Maintain annual SAV surveys and develop salt marsh monitoring capacity; Develop capacity to monitor dissolved inorganic carbon

Modeling: Model synergistic effects of climate change; Use models to discern climate impacts from development impacts

6. Using ***shallow water benthos*** as an exemplar of integrating the land-sea interface, tipping points and climate change using monitoring, modeling and research approaches

Shallow water habitats as a testbed for studies on the land-sea interface, tipping points and climate change

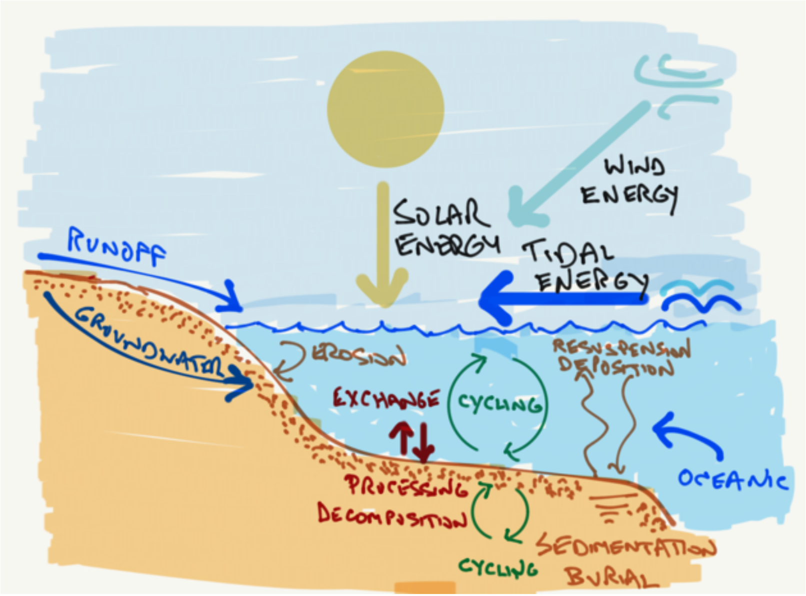




Kemp et al., 2005

6. Using ***shallow water benthos*** as an exemplar of integrating the land-sea interface, tipping points and climate change using monitoring, modeling and research approaches

Dominant role of benthic processes in shallow water



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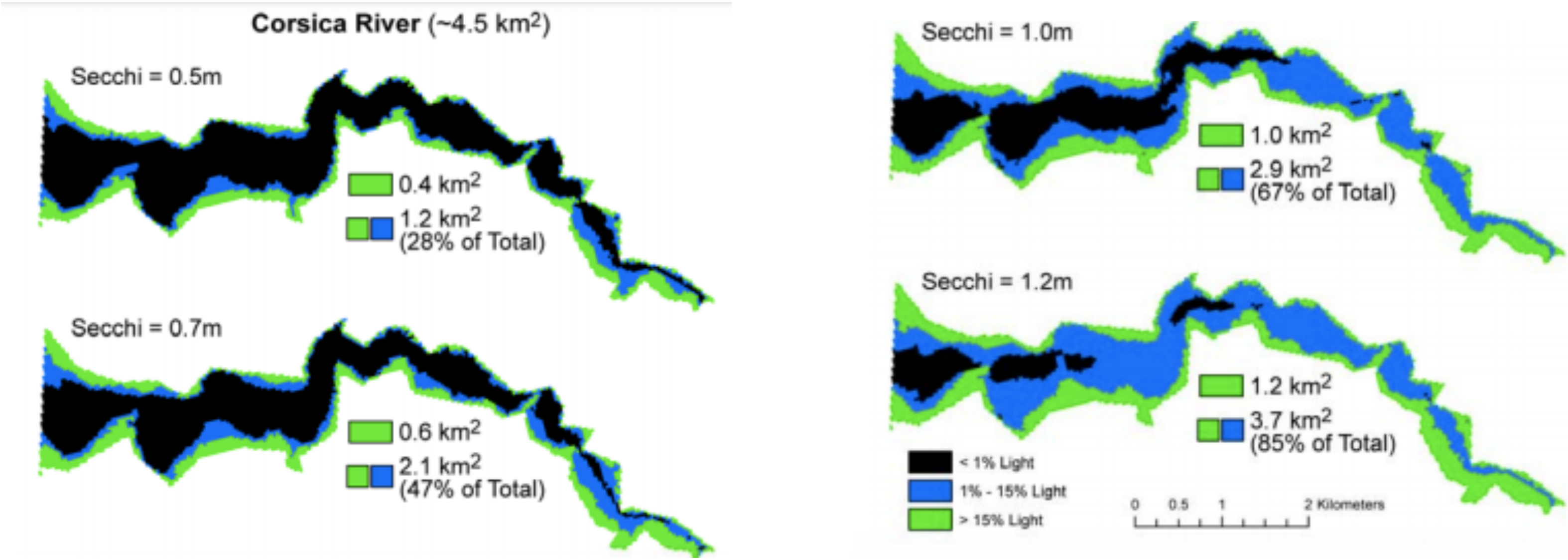
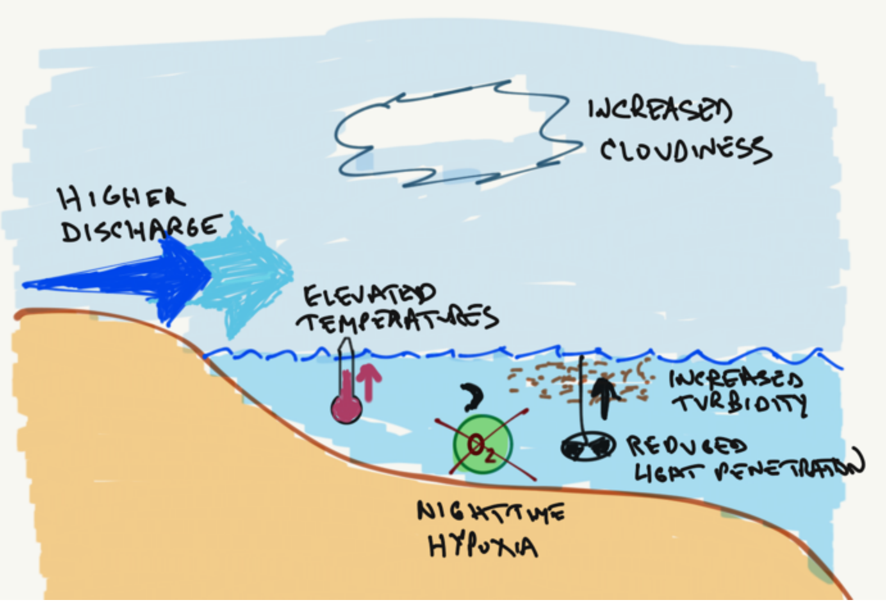
Light sensitivity of shallow water benthic processes



Boynton et al., 2009

6. Using ***shallow water benthos*** as an exemplar of integrating the land-sea interface, tipping points and climate change using monitoring, modeling and research approaches

Climate sensitivity of shallow water benthic processes



6. Using ***shallow water benthos*** as an exemplar of integrating the land-sea interface, tipping points and climate change using monitoring, modeling and research approaches

Scientific response to shallow water habitats

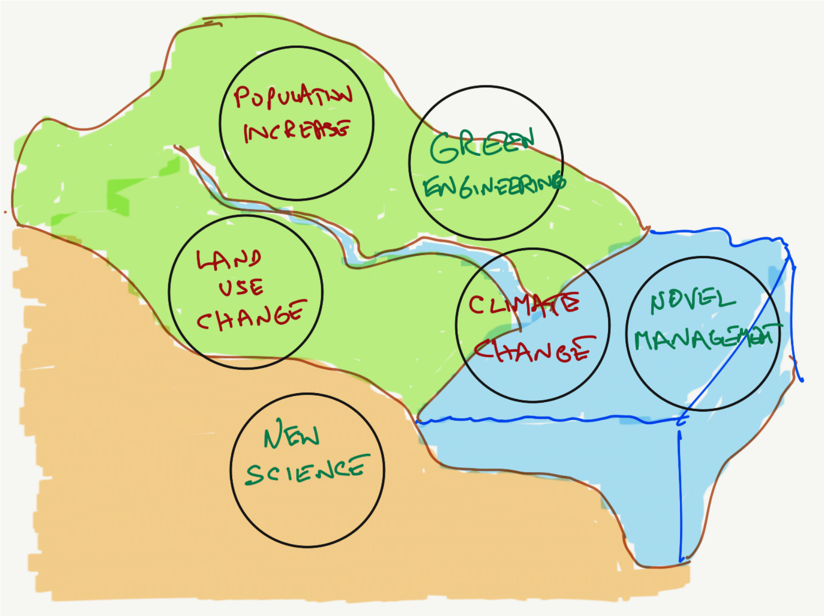
Research: Elucidate biogeochemical processes in shallow benthos habitats, Identify tipping points and feedbacks in shallow water

Monitoring: Use emerging technology (drones, AUVs) or more targeted, spatially extensive sensor deployments to advance our understanding of the shallow-water benthos.

Modeling: Capitalize on improvements in computing power, gridding schemes and model sophistication to address ecological processes in shallow waters, including diel cycling hypoxia, microphytobenthic production, and sediment-water interactions.

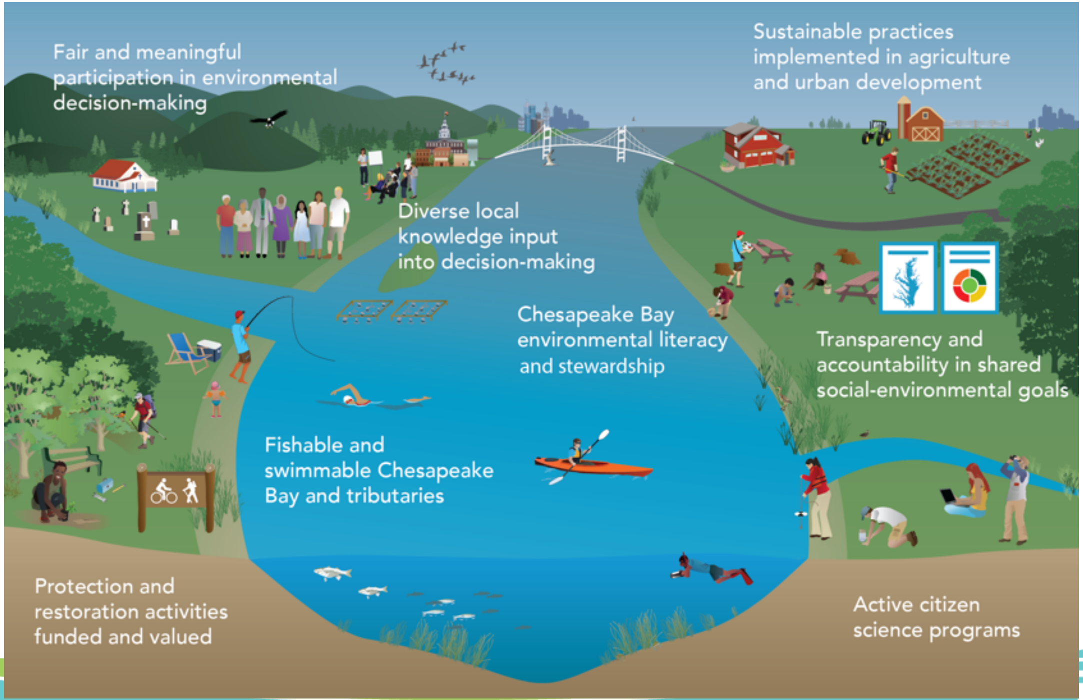
7. Developing a ***future vision*** of Chesapeake Bay that incorporates adaptive management and potential major interventions

Scale of future vision



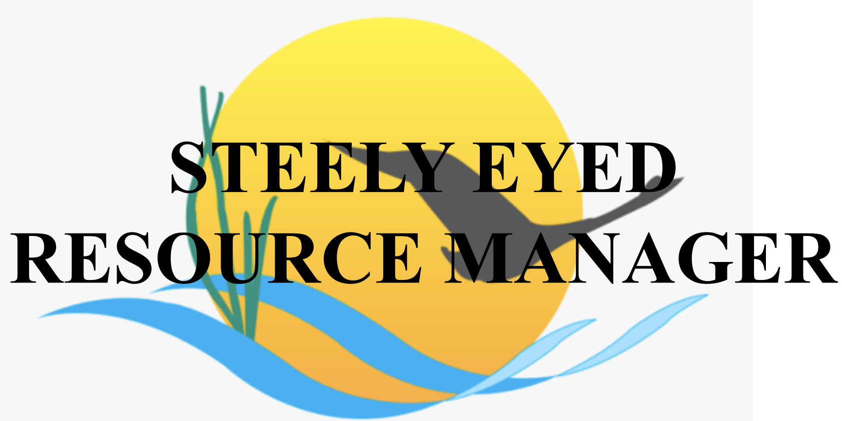
7. Developing a ***future vision*** of Chesapeake Bay that incorporates adaptive management and potential major interventions

Future vision of research and management interactions



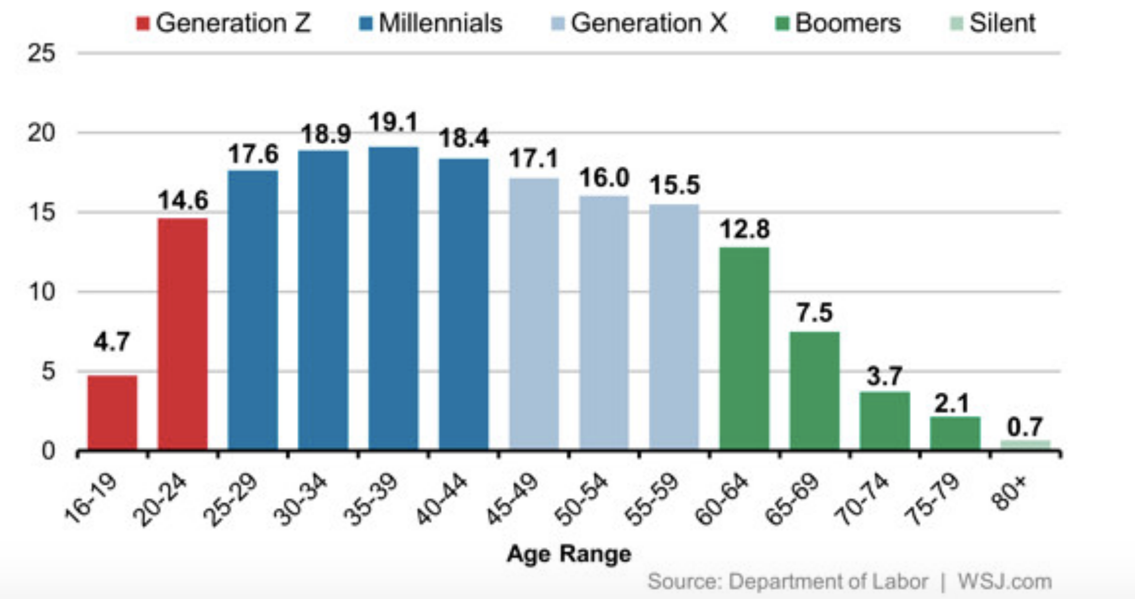
7. Developing a ***future vision*** of Chesapeake Bay that incorporates adaptive management and potential major interventions

Coupled research and management



8. Identifying ***new tools, approaches and personnel*** that will feature in Chesapeake Bay restoration

Turnover in human resources



8. Identifying ***new tools, approaches and personnel*** that will feature in Chesapeake Bay restoration

Enhancement of environmental intelligence