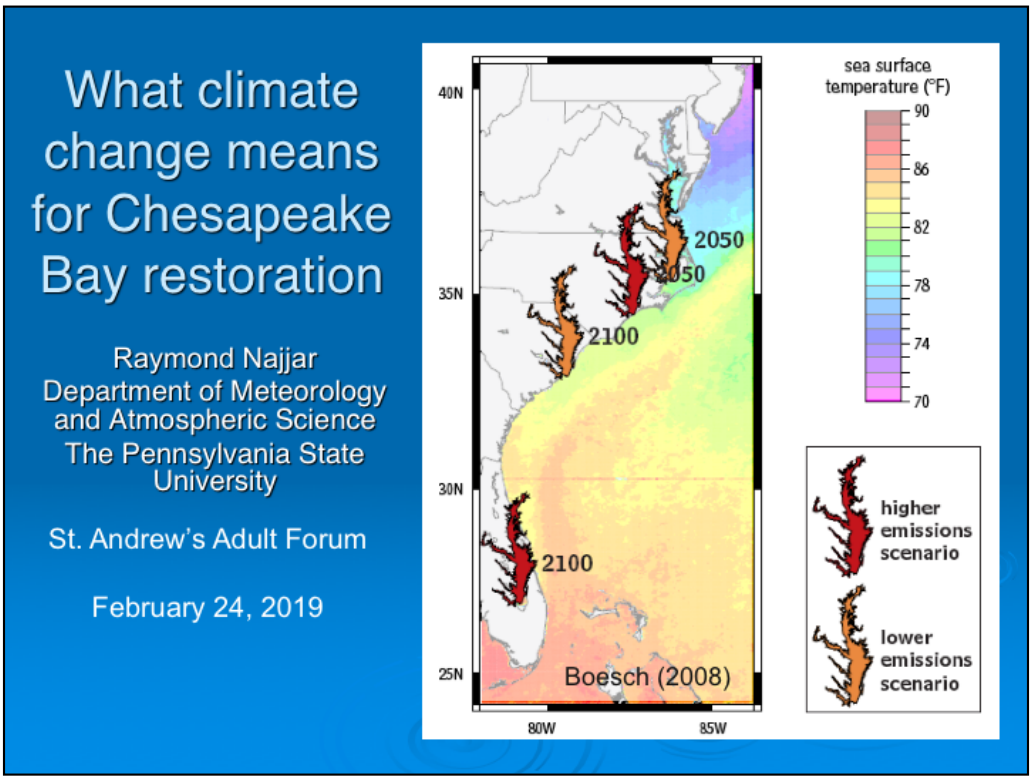
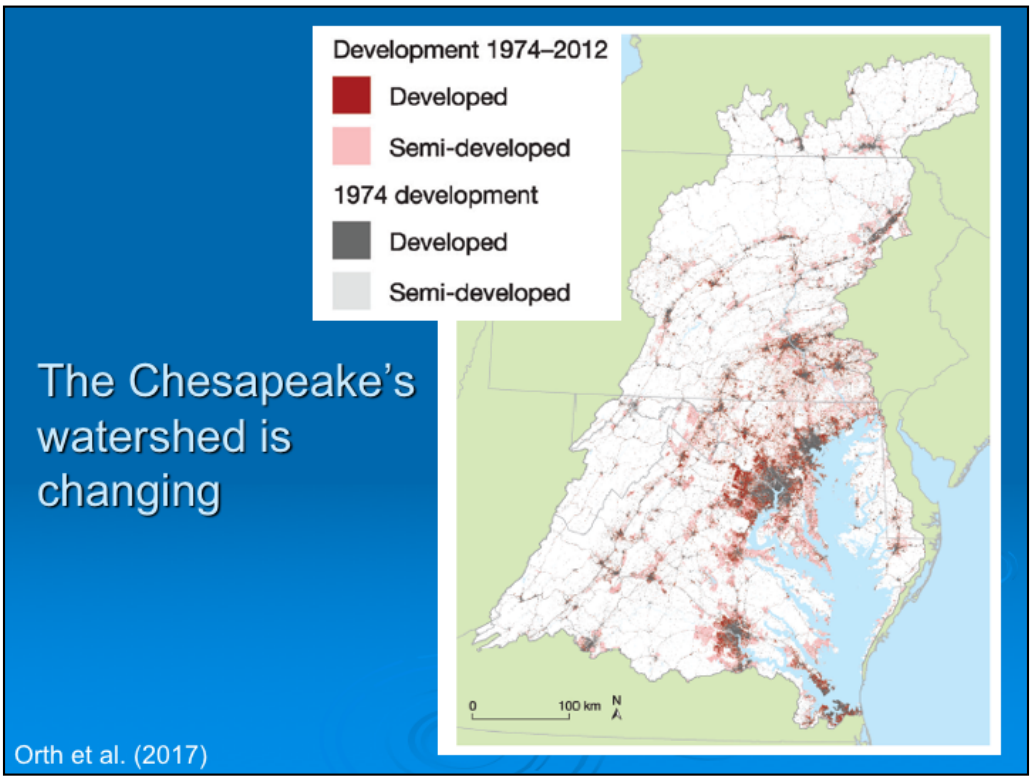


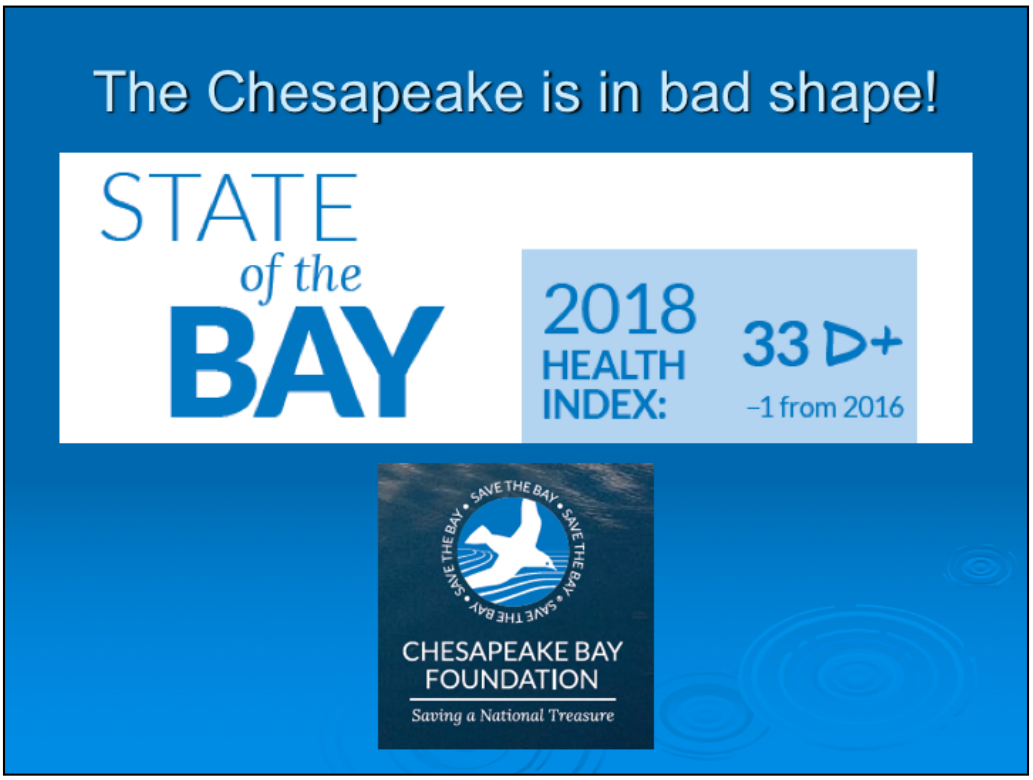
Boesch, D.F., (editor) 2008. Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland. Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change. University of Maryland Center for Environmental Science, Cambridge, Maryland.

Chesapeake Bay

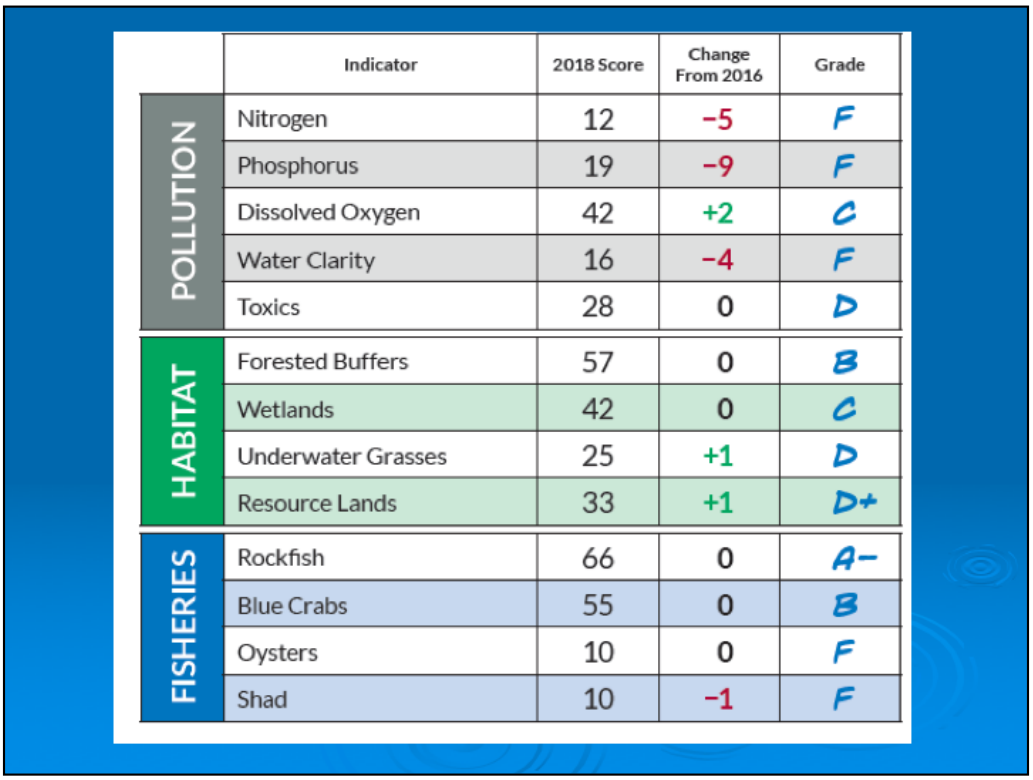
- Chesapeake = Algonquin for “land along the big river”
- Large and productive
- Submerged vegetation alone = $3 billion per year
- 1607: 14,000 indigenous people on its shores
- Today: 18 million people in its watershed



Orth, R.J., Dennison, W.C., Lefcheck, J.S., Gurbisz, C., Hannam, M., Keisman, J., Landry, J.B., Moore, K.A., Murphy, R.R., Patrick, C.J., 2017. Submersed aquatic vegetation in Chesapeake Bay: sentinel species in a changing world. Bioscience 67, 698-712.

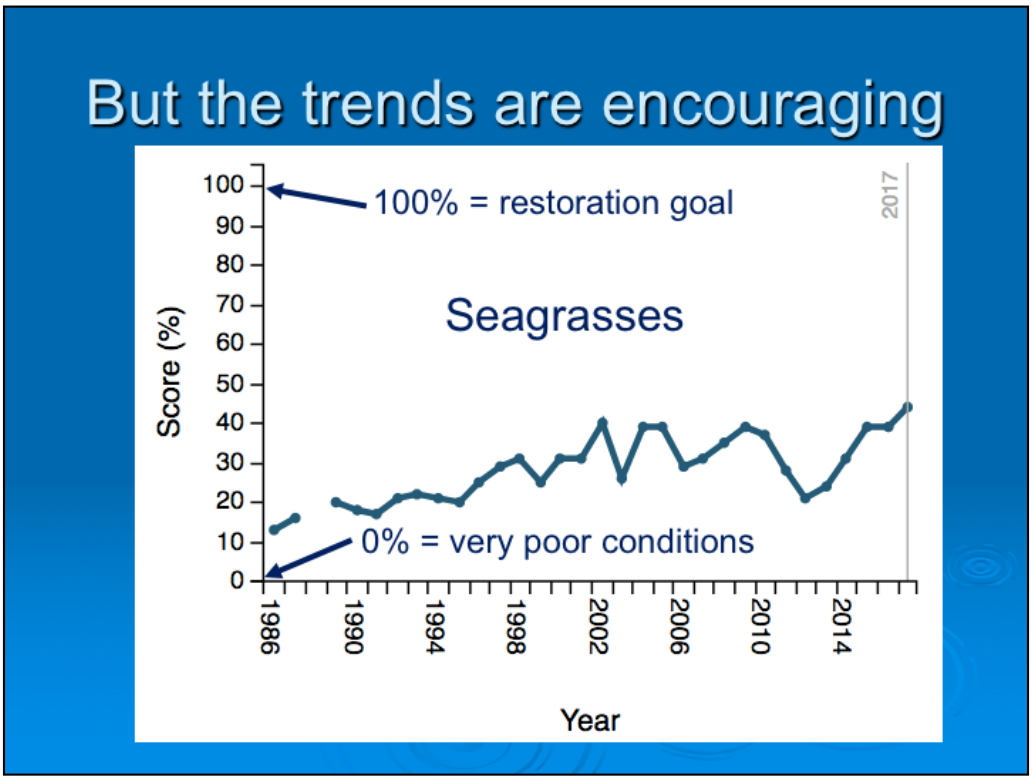


Chesapeake Bay Foundation, 2019. State of the Bay 2018, Annapolis, MD, 13 pp.

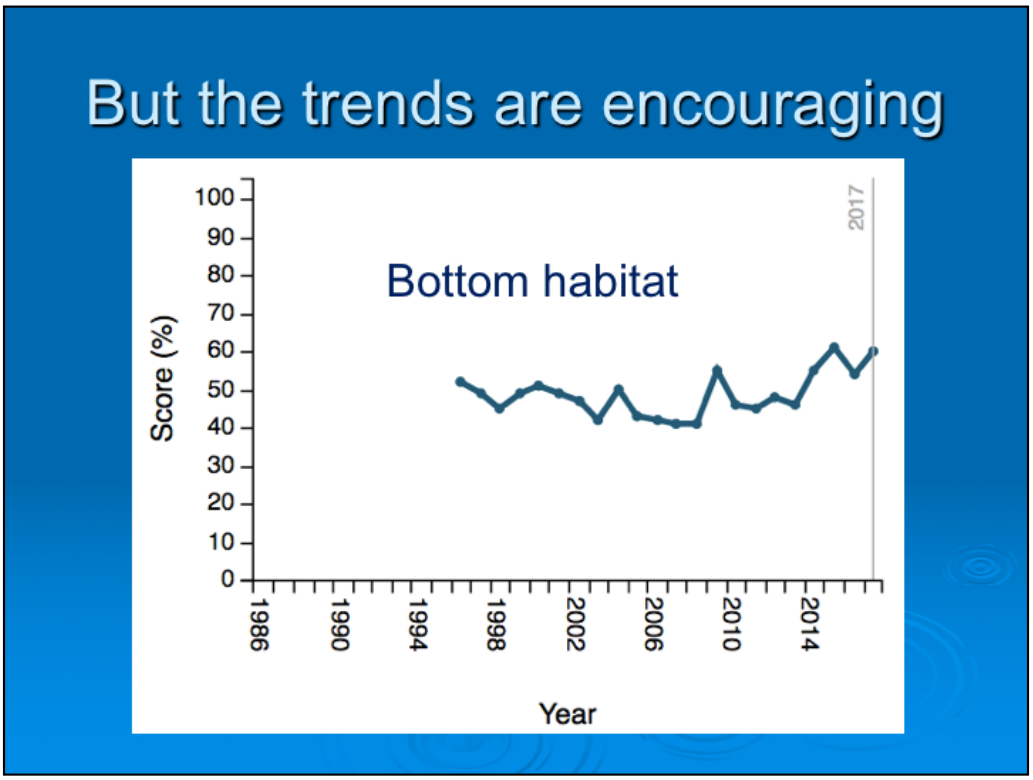


	Indicator	2018 Score	Change From 2016	Grade
POLLUTION	Nitrogen	12	−5	F
	Phosphorus	19	−9	F
	Dissolved Oxygen	42	+2	C
	Water Clarity	16	−4	F
	Toxics	28	0	D
HABITAT	Forested Buffers	57	0	B
	Wetlands	42	0	C
	Underwater Grasses	25	+1	D
	Resource Lands	33	+1	D+
FISHERIES	Rockfish	66	0	A−
	Blue Crabs	55	0	B
	Oysters	10	0	F
	Shad	10	−1	F

Chesapeake Bay Foundation, 2019. State of the Bay 2018, Annapolis, MD, 13 pp.



https://ecoreportcard.org/report-cards/chesapeake-bay/health/



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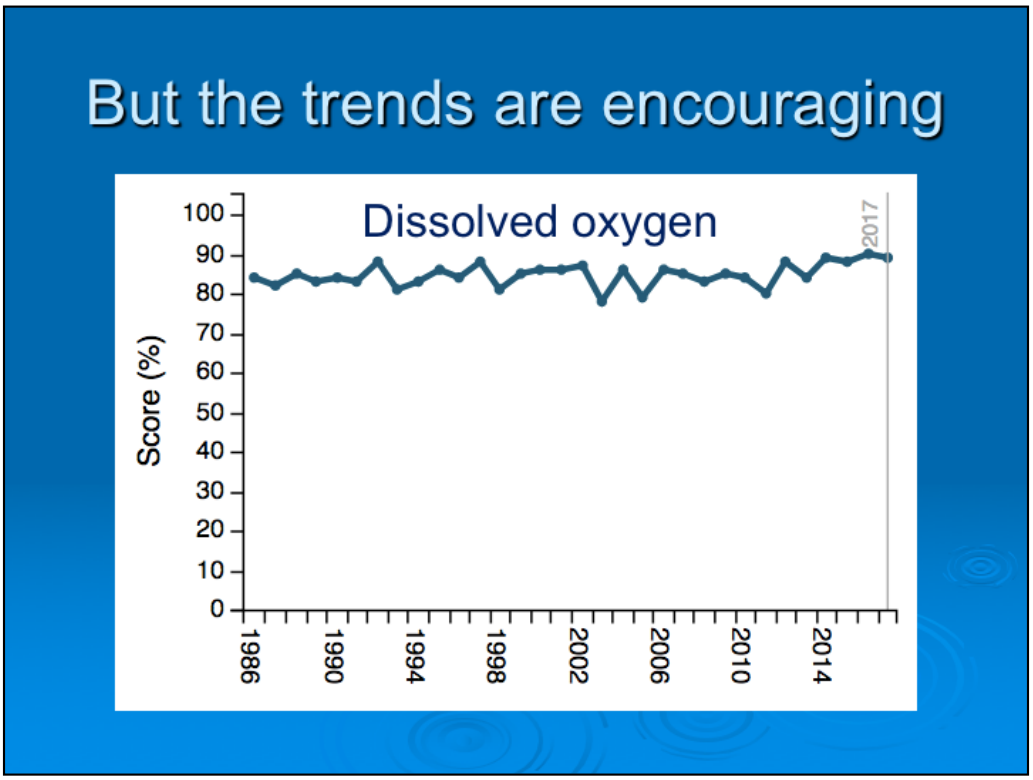

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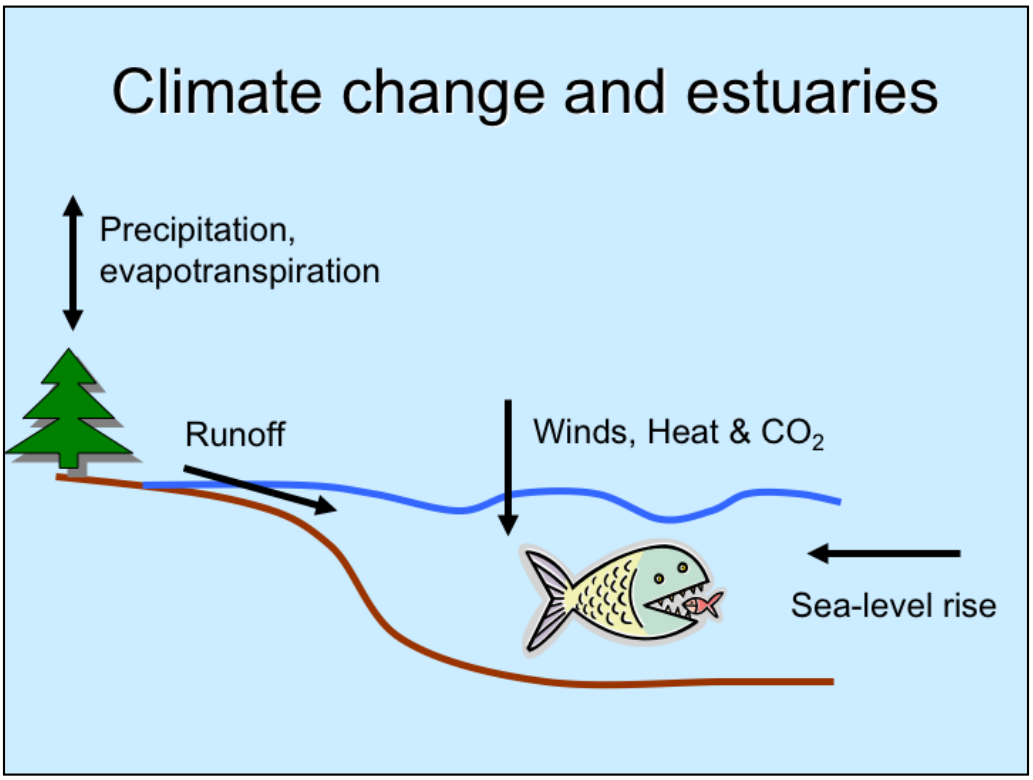
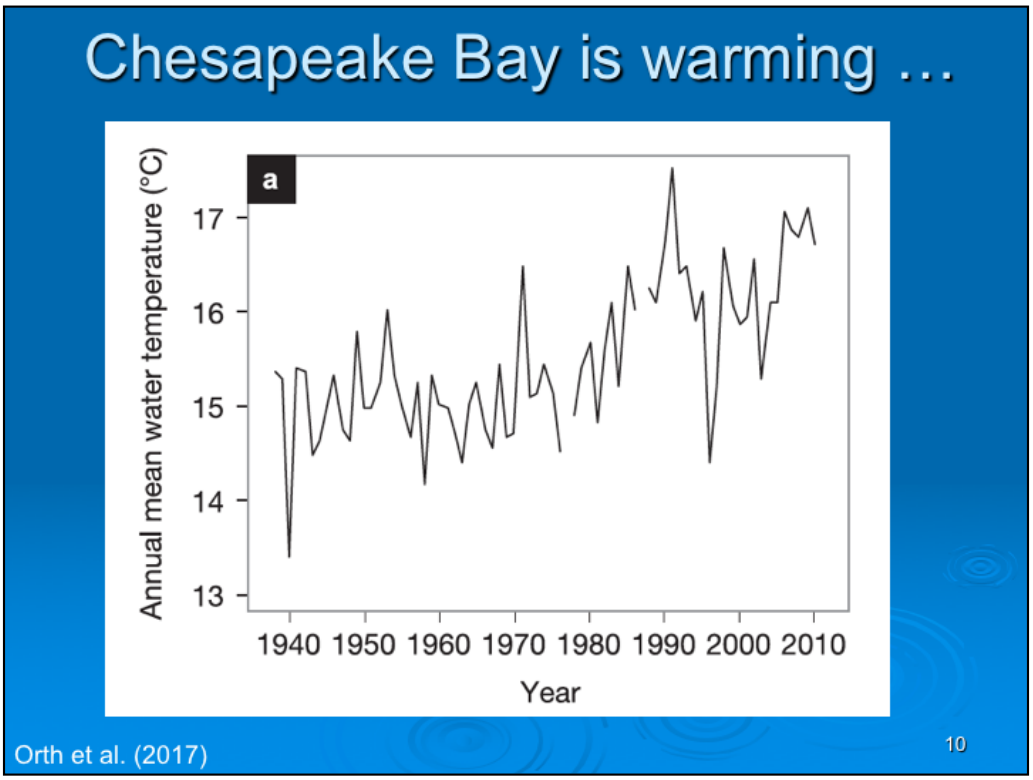
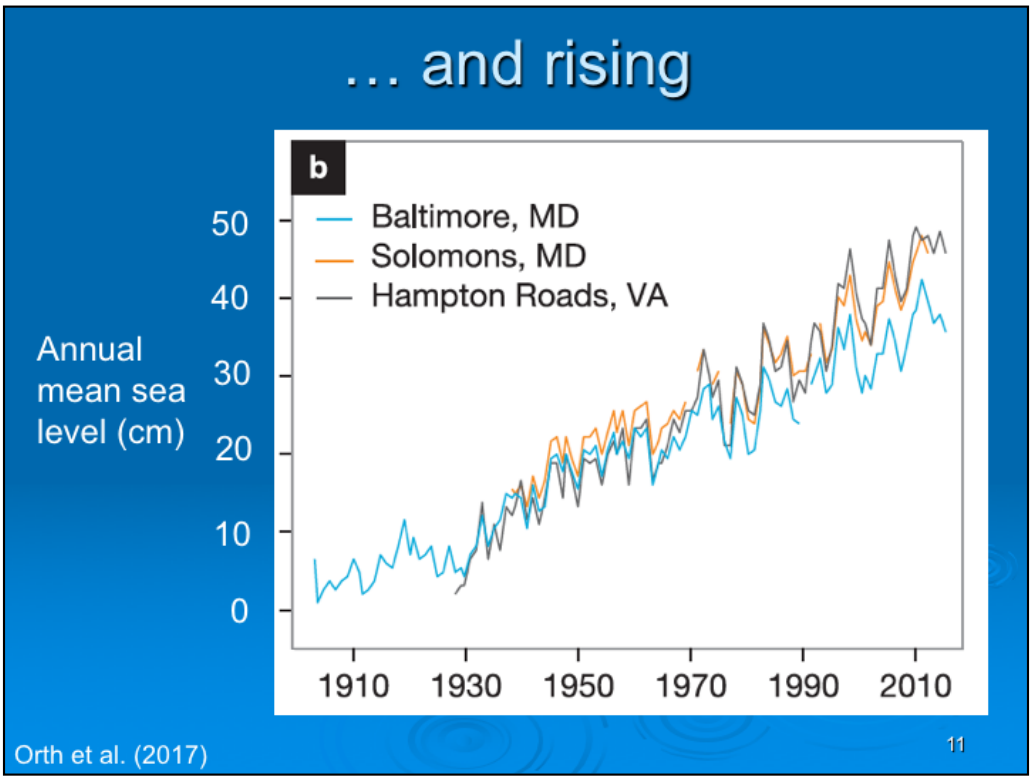
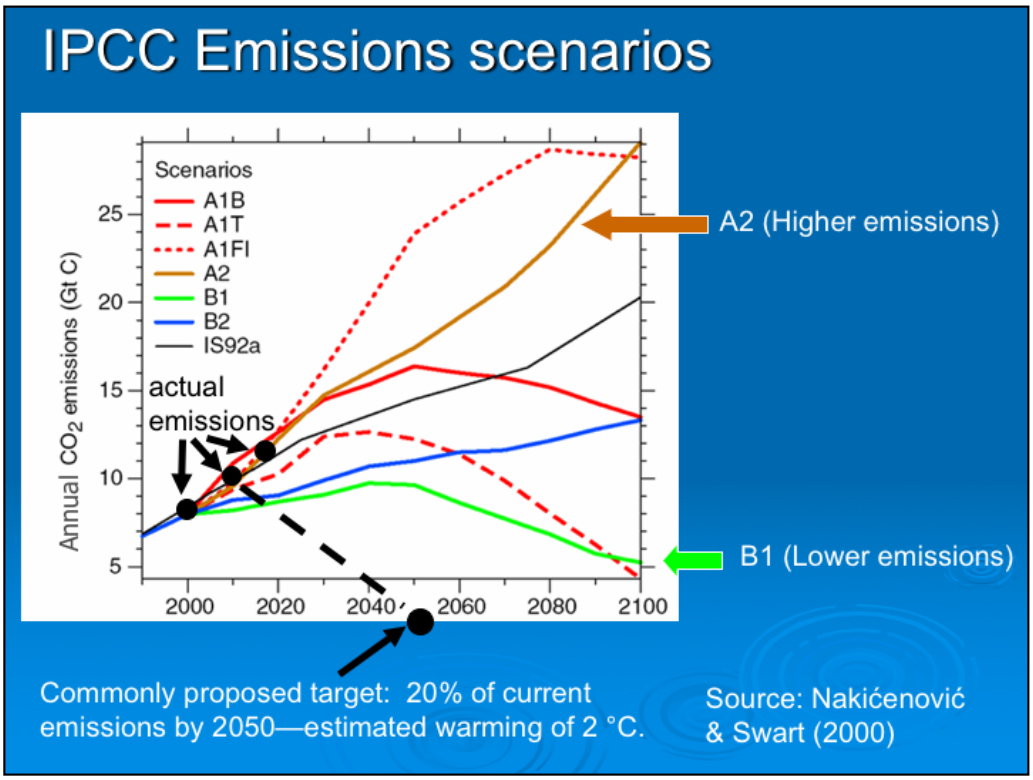

Climate change and estuaries
Precipitation,
evapotranspiration
Runoff
Winds, Heat & CO_2
Sea-level rise



Orth, R.J., Dennison, W.C., Lefcheck, J.S., Gurbisz, C., Hannam, M., Keisman, J., Landry, J.B., Moore, K.A., Murphy, R.R., Patrick, C.J., 2017. Submersed aquatic vegetation in Chesapeake Bay: sentinel species in a changing world. Bioscience 67, 698-712.

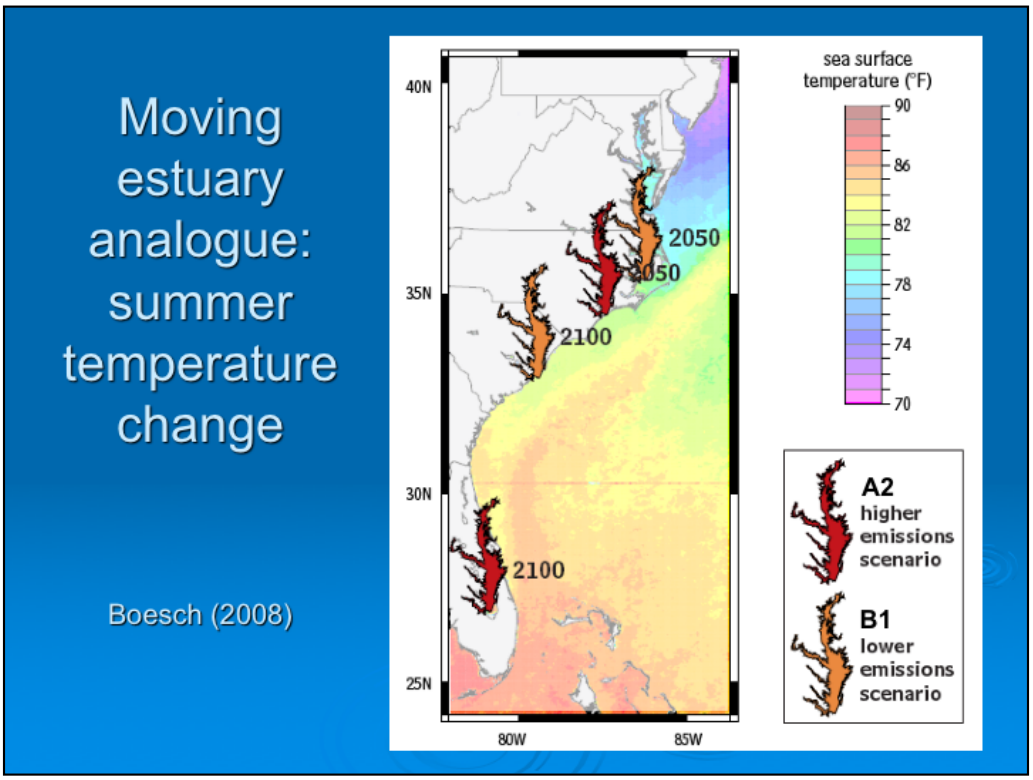


Orth, R.J., Dennison, W.C., Lefcheck, J.S., Gurbisz, C., Hannam, M., Keisman, J., Landry, J.B., Moore, K.A., Murphy, R.R., Patrick, C.J., 2017. Submersed aquatic vegetation in Chesapeake Bay: sentinel species in a changing world. Bioscience 67, 698-712.

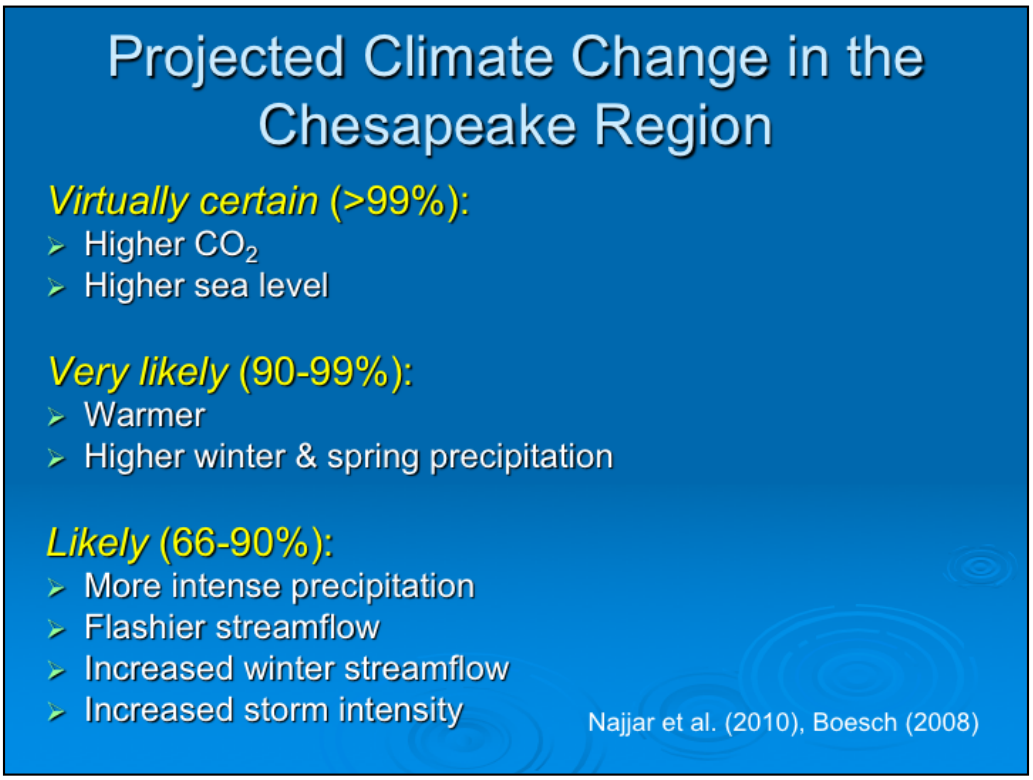


2000, 2010, and 2018 black dots are total emissions (fossil fuel, cement, and land use) from the Global Carbon Project.

Nakićenović, N., Swart, R., 2000. Special Report on Emissions Scenarios. A Special Report of Working Group III of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 599 pp.

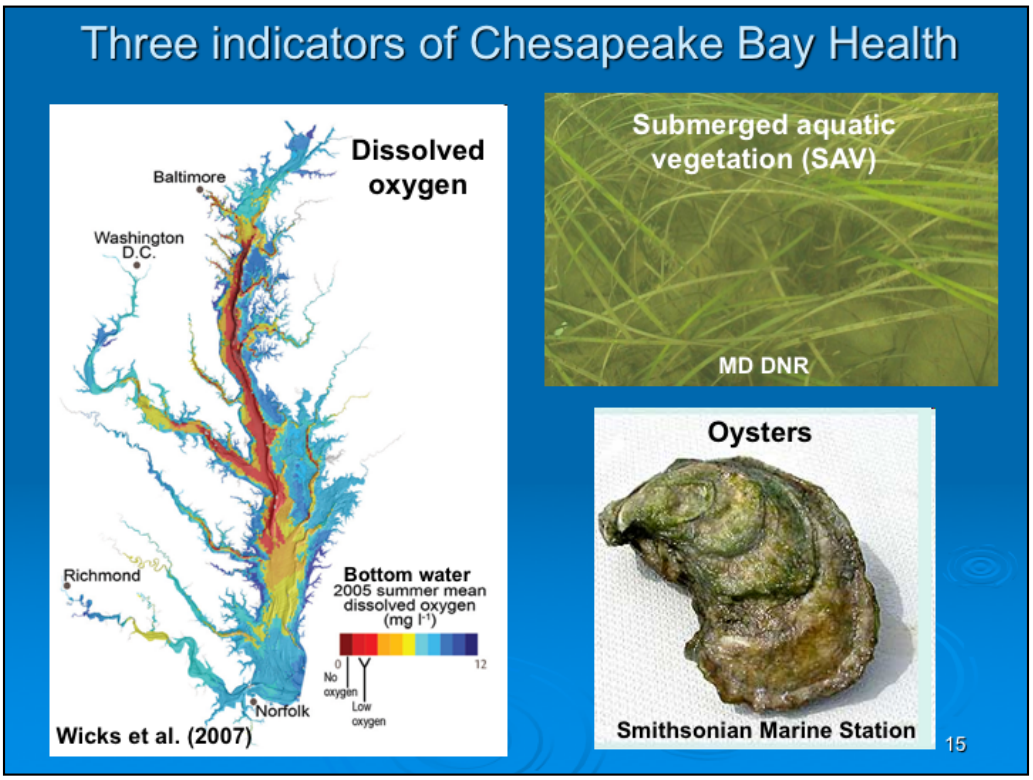


Boesch, D.F., (editor) 2008. Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland. Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change. University of Maryland Center for Environmental Science, Cambridge, Maryland.



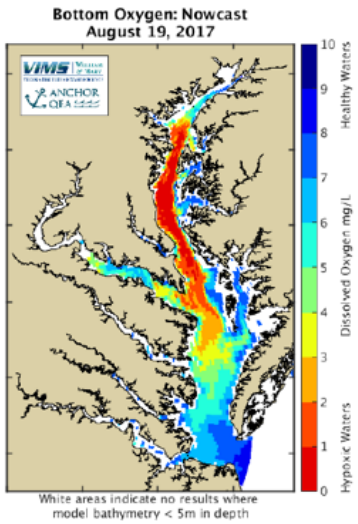
Najjar, R.G., Pyke, C.R., Adams, M.B., Breitburg, D., Hershner, C., Kemp, M., Howarth, R., Mulholland, M., Paolisso, M., Secor, D., Sellner, K., Wardrop, D., Wood, R., 2010. Potential climate-change impacts on the Chesapeake Bay. Estuarine, Coastal and Shelf Science 86, 1-20.

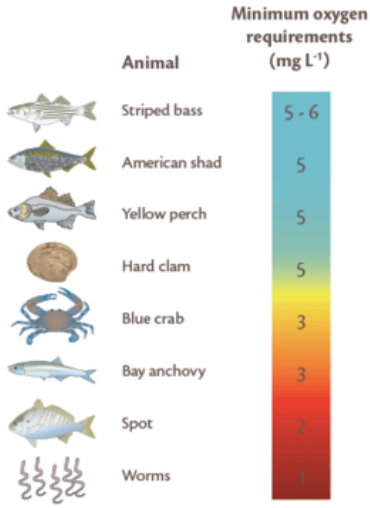
Boesch, D.F., (editor) 2008. Global Warming and the Free State: Comprehensive Assessment of Climate Change Impacts in Maryland. Report of the Scientific and Technical Working Group of the Maryland Commission on Climate Change. University of Maryland Center for Environmental Science, Cambridge, Maryland.



Wicks, C., D. Jasinski, and B. Longstaff. Breath of Life: Dissolved Oxygen in Chesapeake Bay. Oxford, MD: EcoCheck, 2007.

Low dissolved oxygen (hypoxia) is a serious problem in Chesapeake Bay

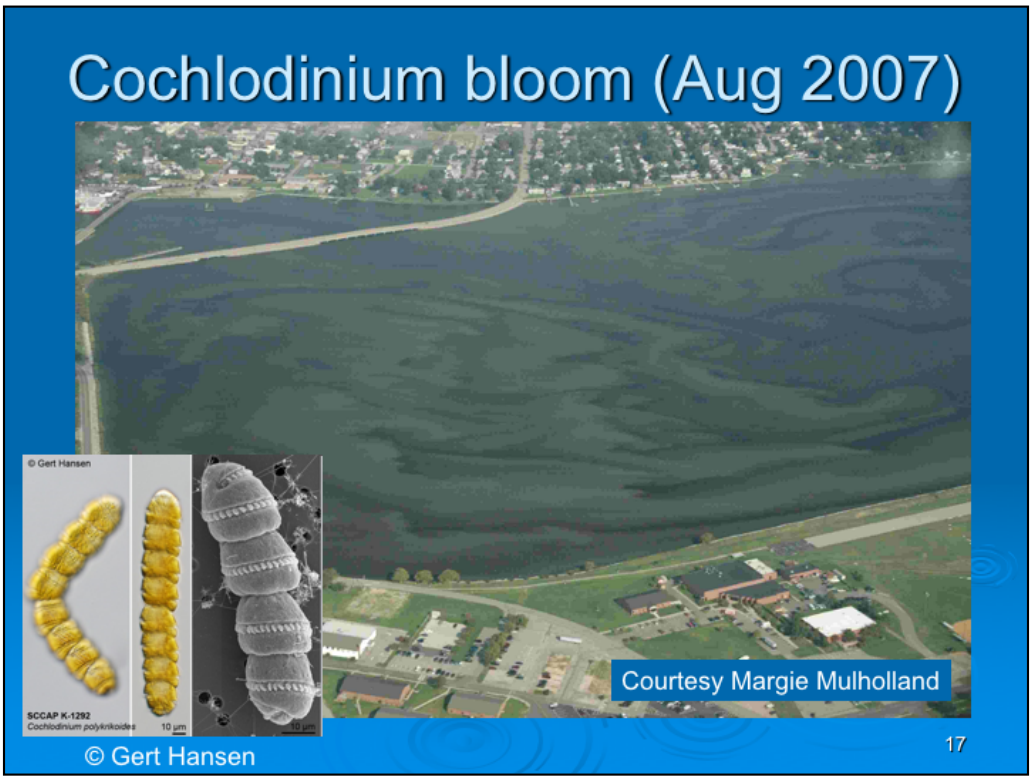




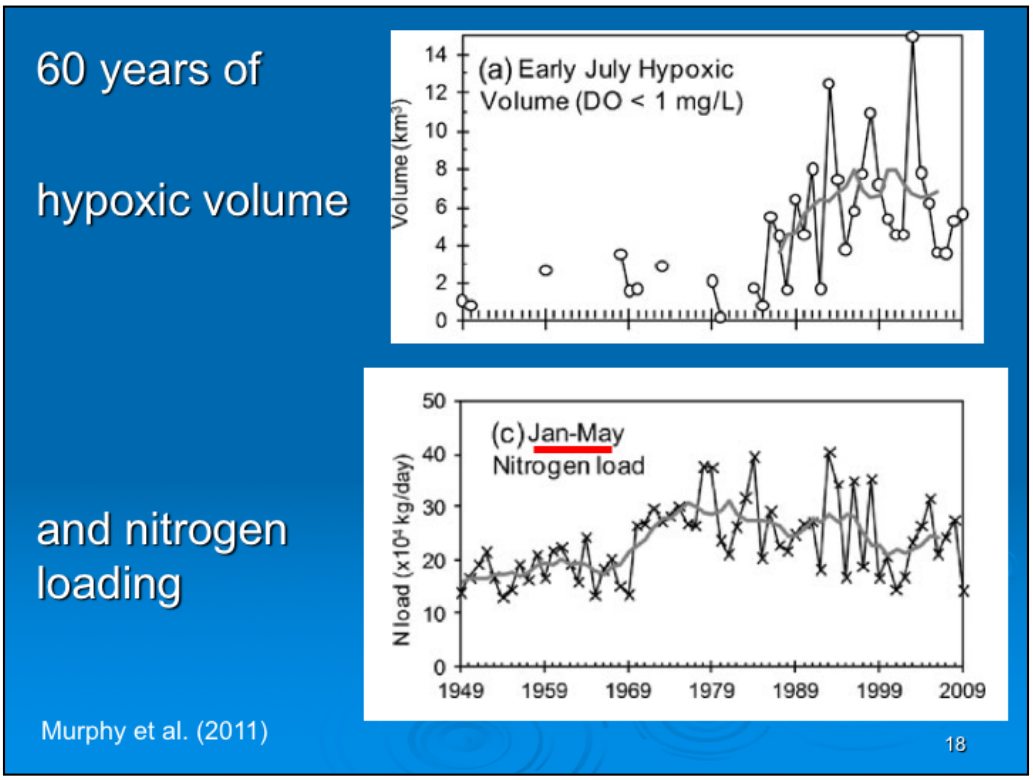
Minimum dissolved oxygen requirements for key organisms in Chesapeake Bay

source: ian.umces.edu

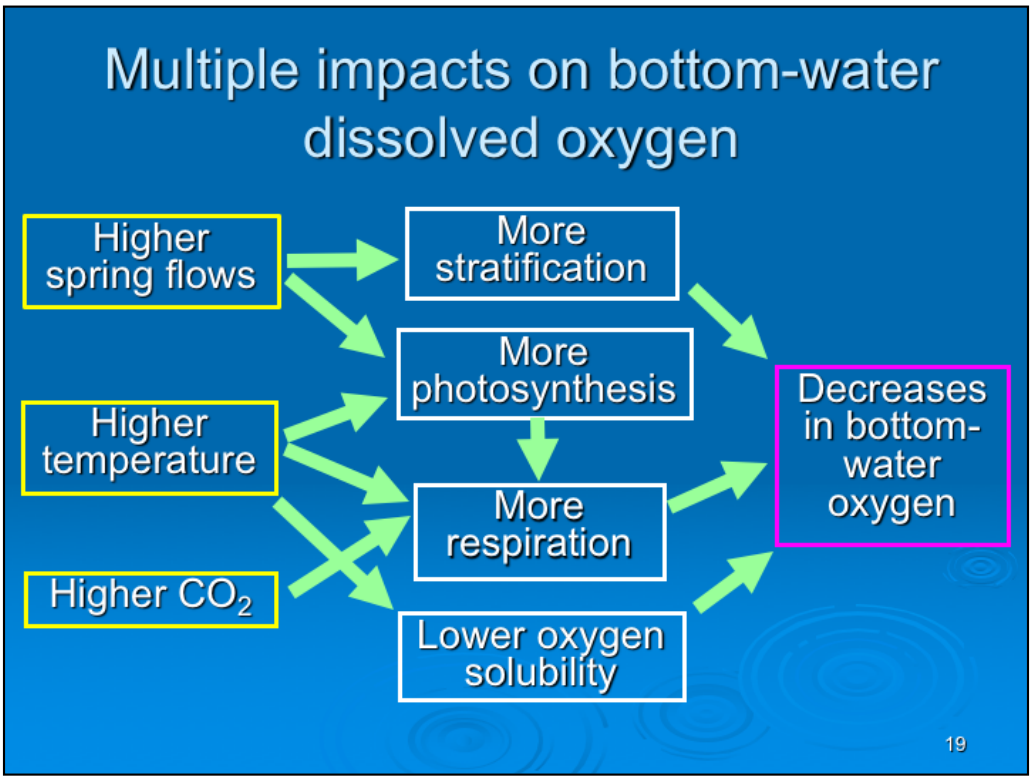
VIMS: http://www.vims.edu/research/topics/dead_zones/forecasts/cbay



Cochlodinium is a harmful marine dinoflagellate



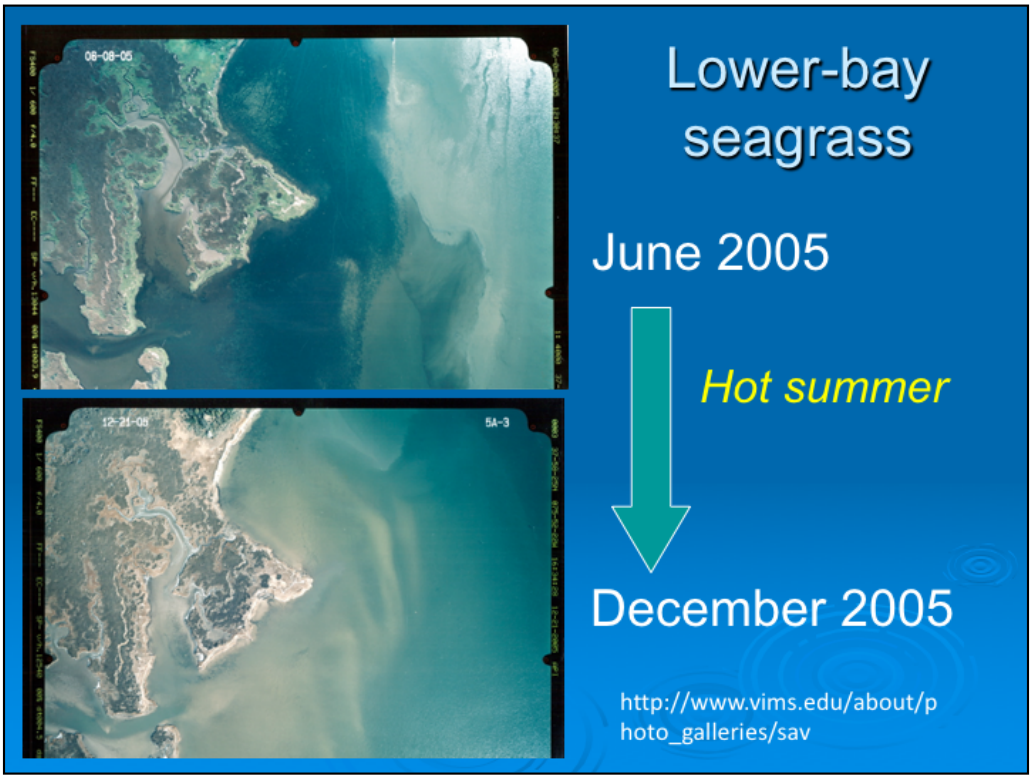
Murphy, R.R., Kemp, W.M., Ball, W.P., 2011. Long-term trends in Chesapeake Bay seasonal hypoxia, stratification, and nutrient loading. Estuaries and Coasts 34, 1293–1309.

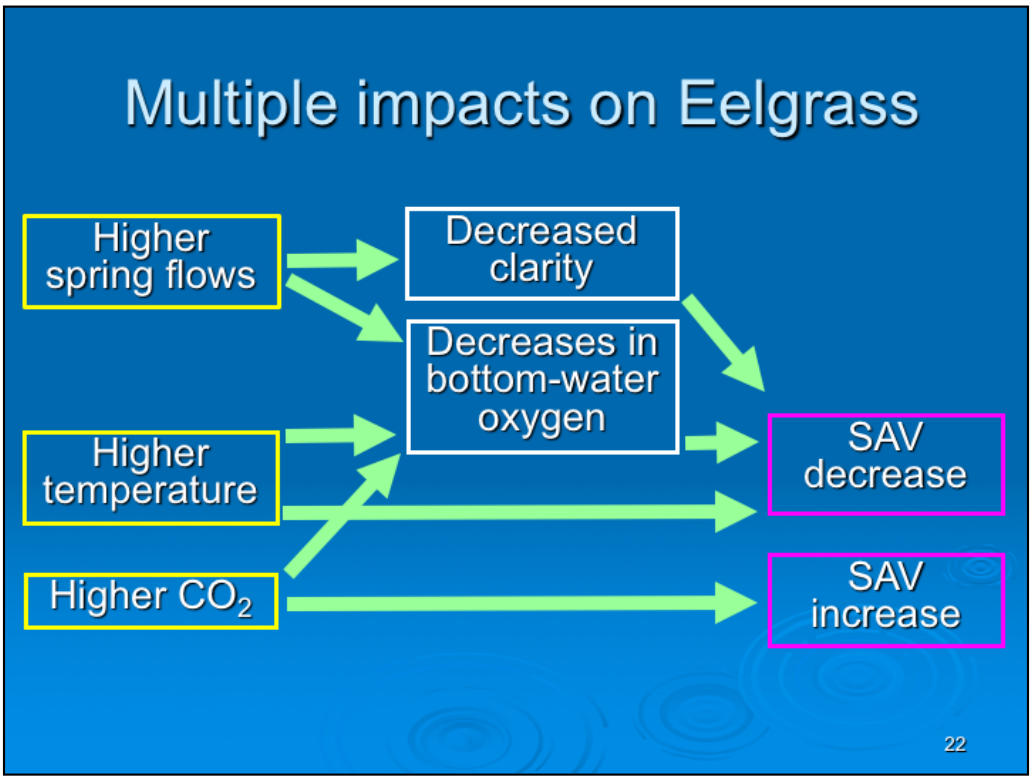

Multiple impacts on bottom-water dissolved oxygen
Higher spring flows
Higher temperature
Higher CO_2
More stratification
More photosynthesis
More respiration
Lower oxygen solubility
Decreases in bottom-water oxygen
19

Submerged vegetation: an important habitat

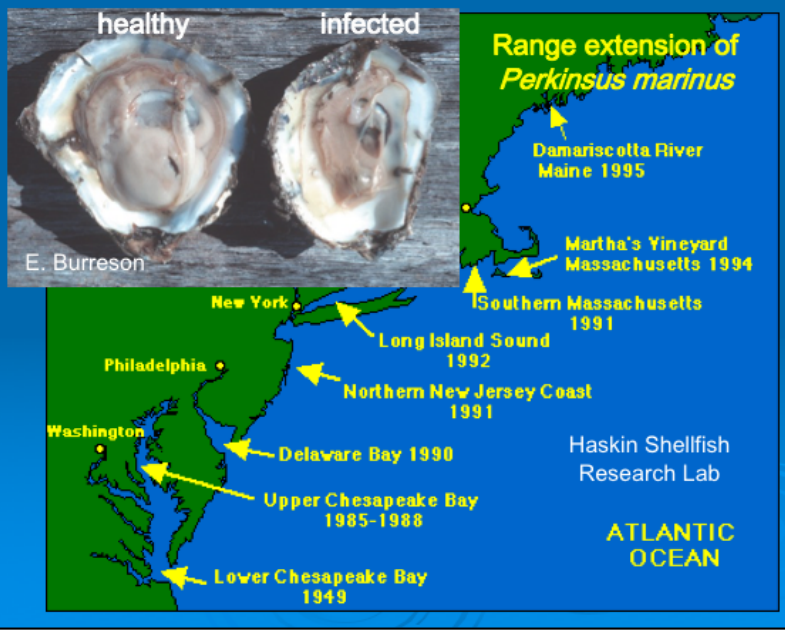
http://www.vims.edu/about/photo_galleries/sav

NOAA

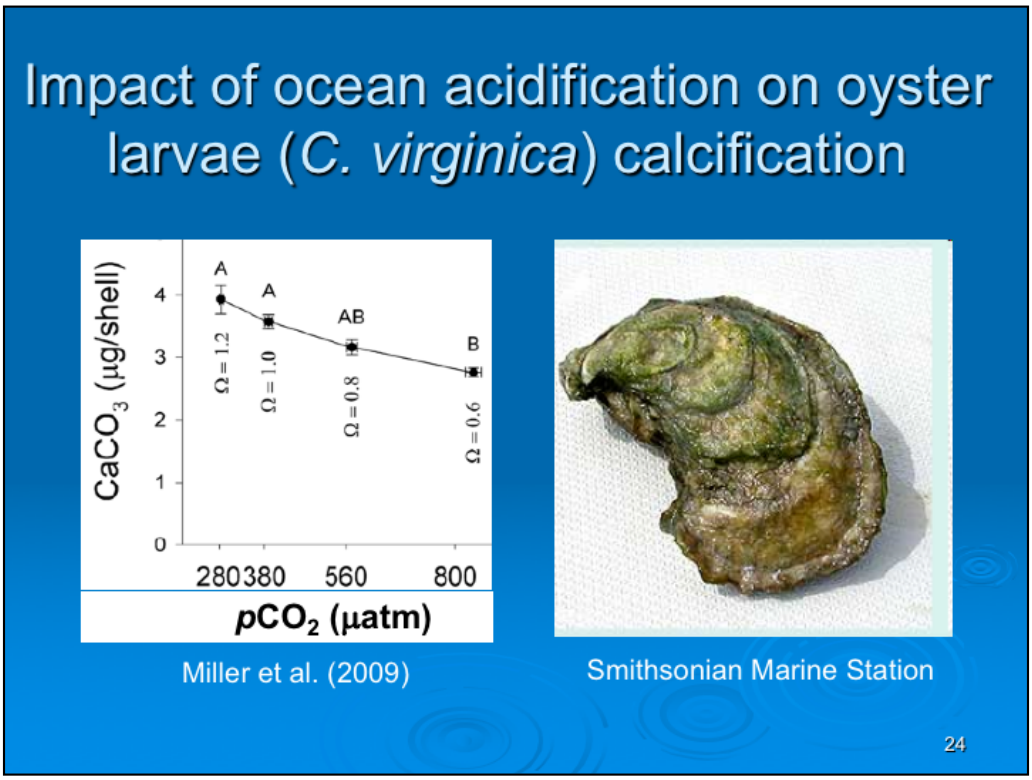

Lower-bay seagrass
June 2005
Hot summer
December 2005
http://www.vims.edu/about/photo_galleries/sav


Multiple impacts on Eelgrass
Higher spring flows
Decreased clarity
Decreases in bottom-water oxygen
Higher temperature
SAV decrease
Higher CO_2
SAV increase
22

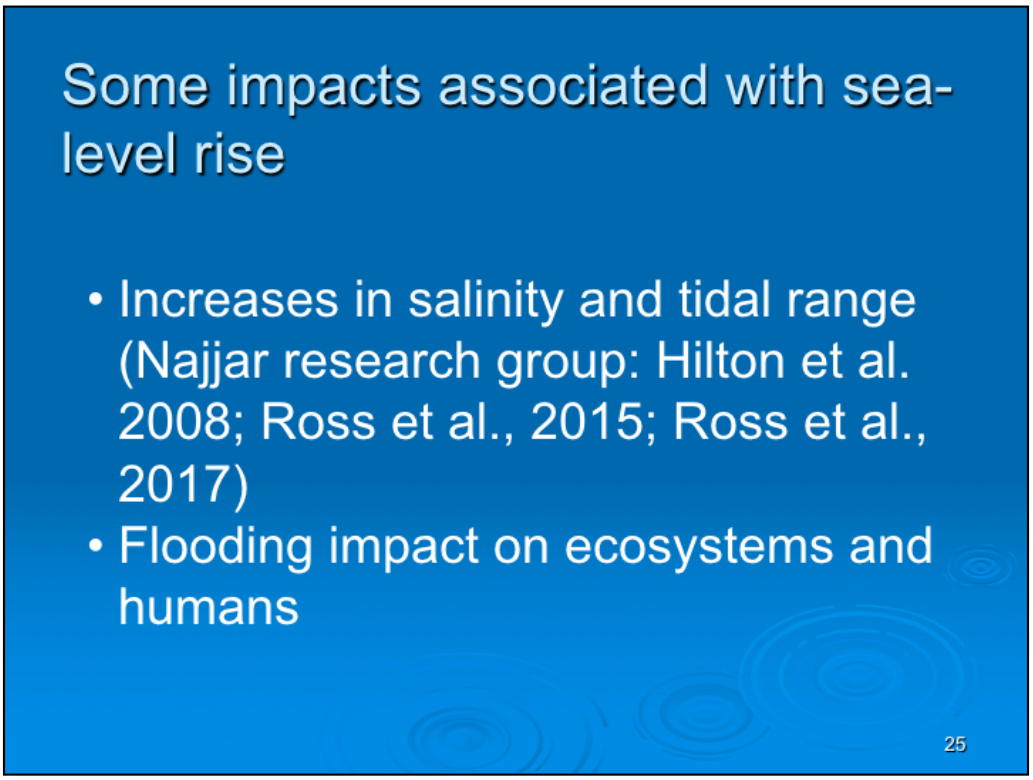
Oyster disease has spread in response to winter warming



23



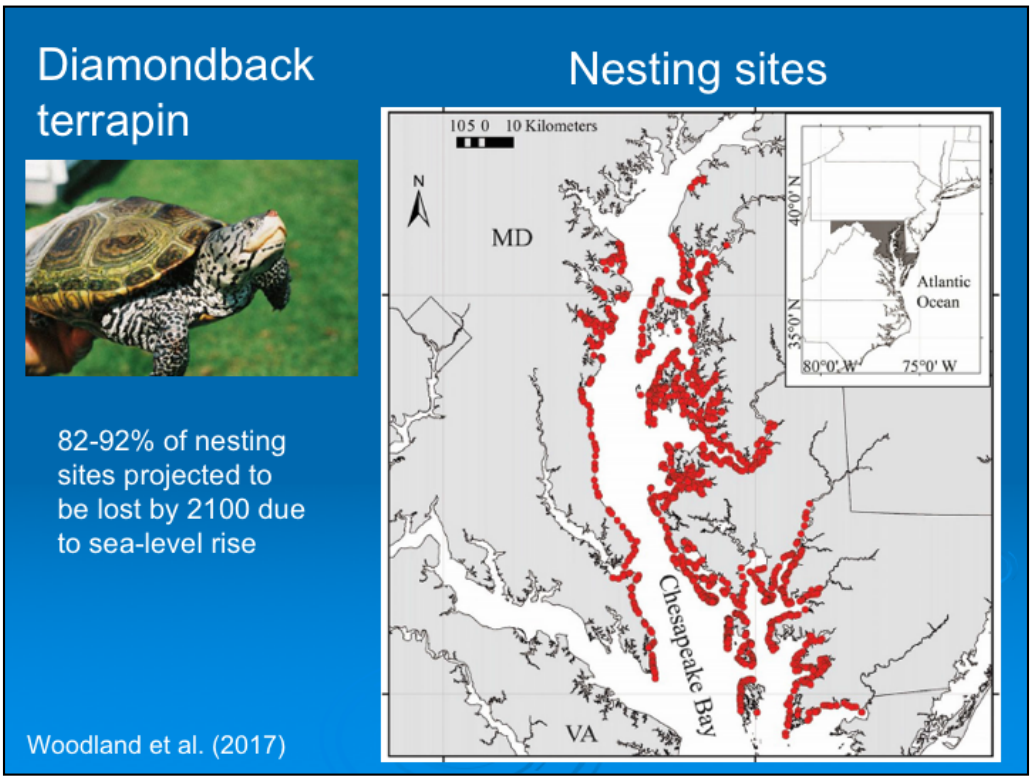
Miller, A.W., Reynolds, A.C., Sobrino, C., Riedel, G.F., 2009. Shellfish face uncertain future in high CO2 world: Influence of acidification on oyster larvae calcification and growth in estuaries. PLoS ONE 4, 1-8.



Hilton, T.W., Najjar, R.G., Zhong, L., Li, M., 2008. Is there a signal of sea-level rise in Chesapeake Bay salinity? Journal of Geophysical Research 113, C09002, doi:10.1029/2007JC004247.

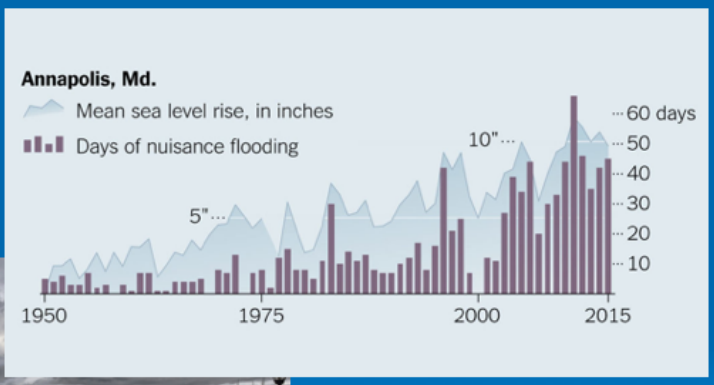
Ross, A.C., Najjar, R.G., Li, M., Mann, M.E., Ford, S.E., Katz, B., 2015. Sea-level rise and other influences on decadal-scale variations of salinity in a coastal plain estuary. Estuarine Coastal and Shelf Science 157, 79-92.

Ross, A.C., Najjar, R.G., Li, M., Lee, S.B., Zhang, F., Liu, W., 2017. Fingerprints of sea-level rise on changing tides in the Chesapeake and Delaware Bays. Journal of Geophysical Research: Oceans 122, 8102–8125.



Woodland, R.J., Rowe, C.L., Henry, P.F.P., 2017. Changes in habitat availability for multiple life stages of diamondback terrapins (Malaclemys terrapin) in Chesapeake Bay in response to sea level rise. Estuaries and Coasts 40, 1502–1515.

Nuisance flooding in Annapolis



New York Times

Climate Central

Bottom line: Climate change will significantly impact the Bay and present additional challenges to Bay restoration and fisheries management

Recommendations

- Short-term:

  Manage the unavoidable → adapt

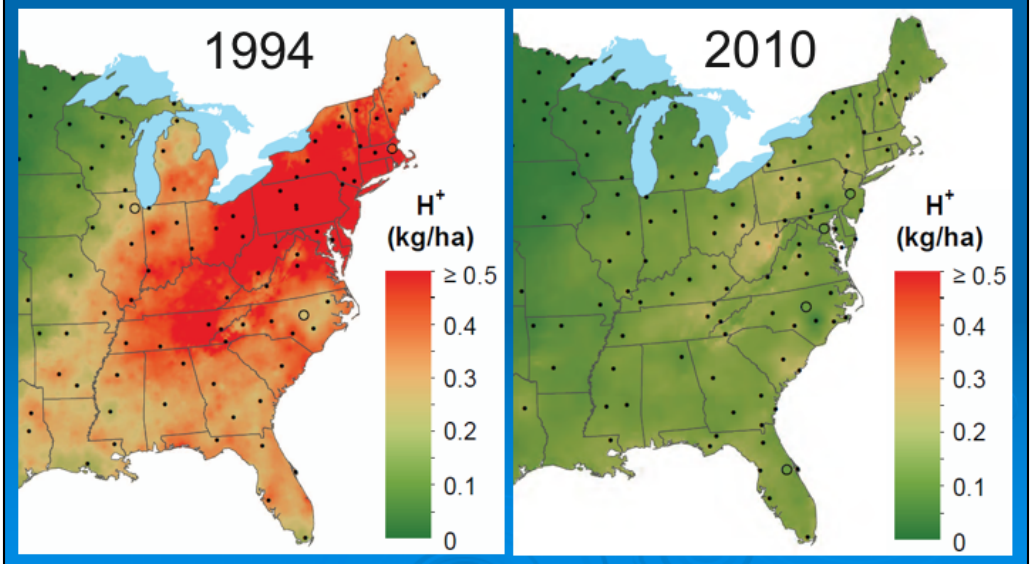
  account for climate change in restoration efforts

- Long-term:

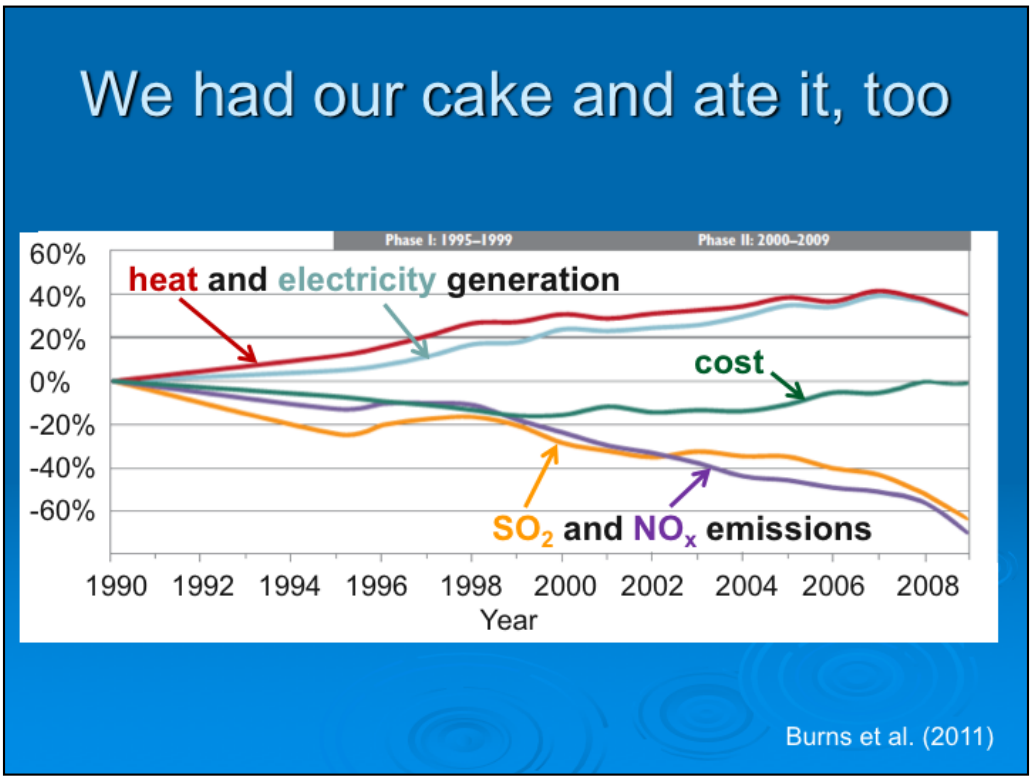
  Avoid the unmanageable → reduce emissions

  make the Chesapeake and other ecosystems examples of the benefits of reducing emissions

We did it before: acid rain



National Atmospheric Deposition Program



Burns, D.A., Baron, J.S., Cosby, B.J., Fenn, M.E., Lynch, J.A., 2011. National Acid Precipitation Assessment Program Report to Congress 2011: An Integrated Assessment. National Science and Technology Council, United States Government, Washington, D.C., 114 pp.

Source: Weather Underground