

# Implications of climate change for Chesapeake Bay fish and shellfish

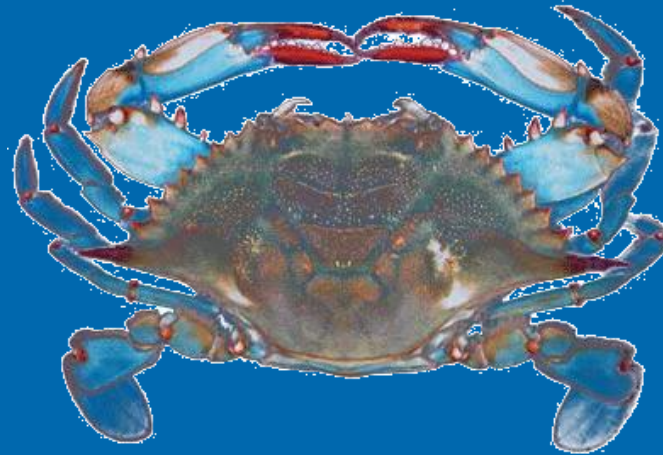
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The Pennsylvania State  
University

Fish contributions:  
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and Denise Breitberg

CEPA Forum  
April 20, 2013



Striped Bass



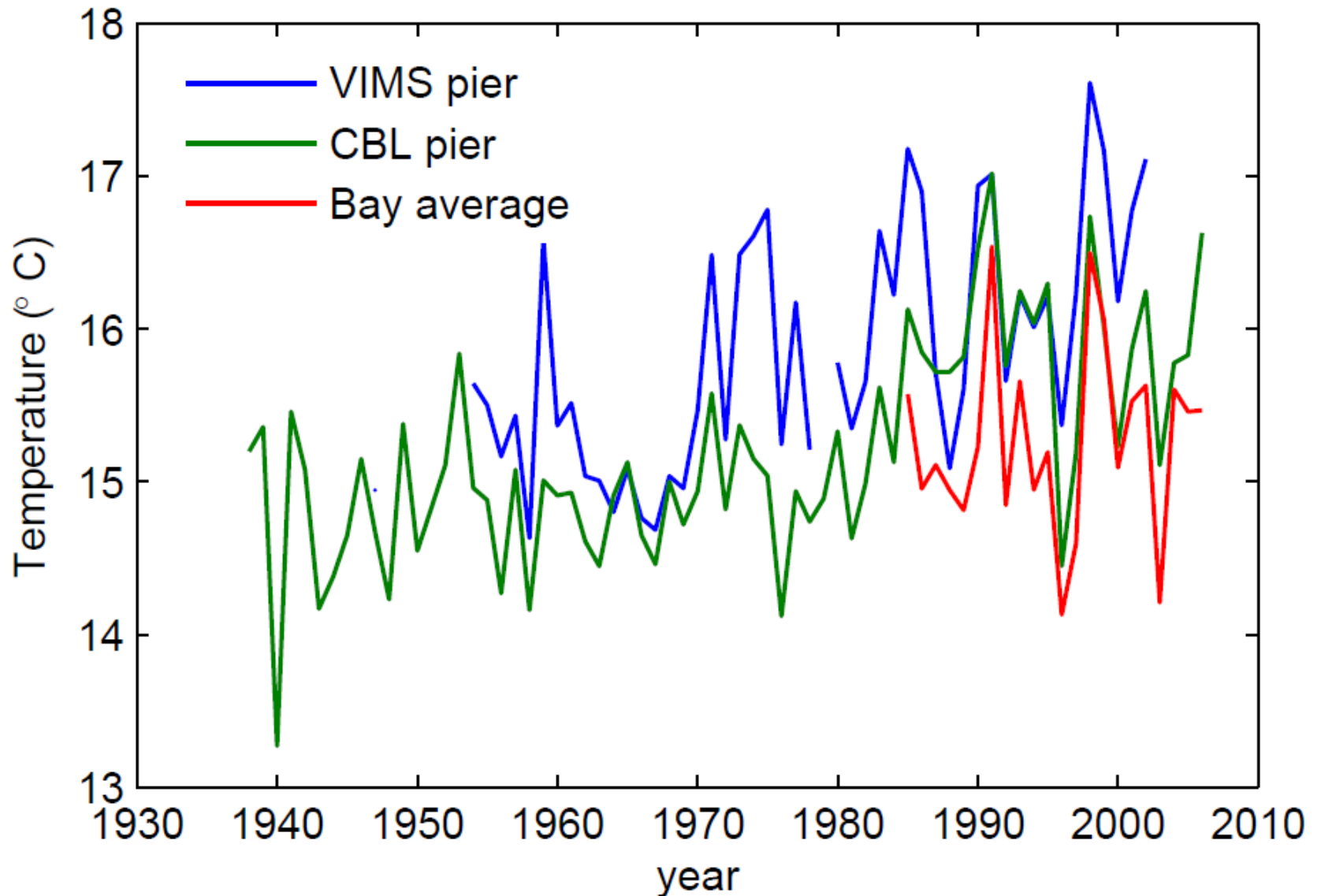
Blue  
Crab



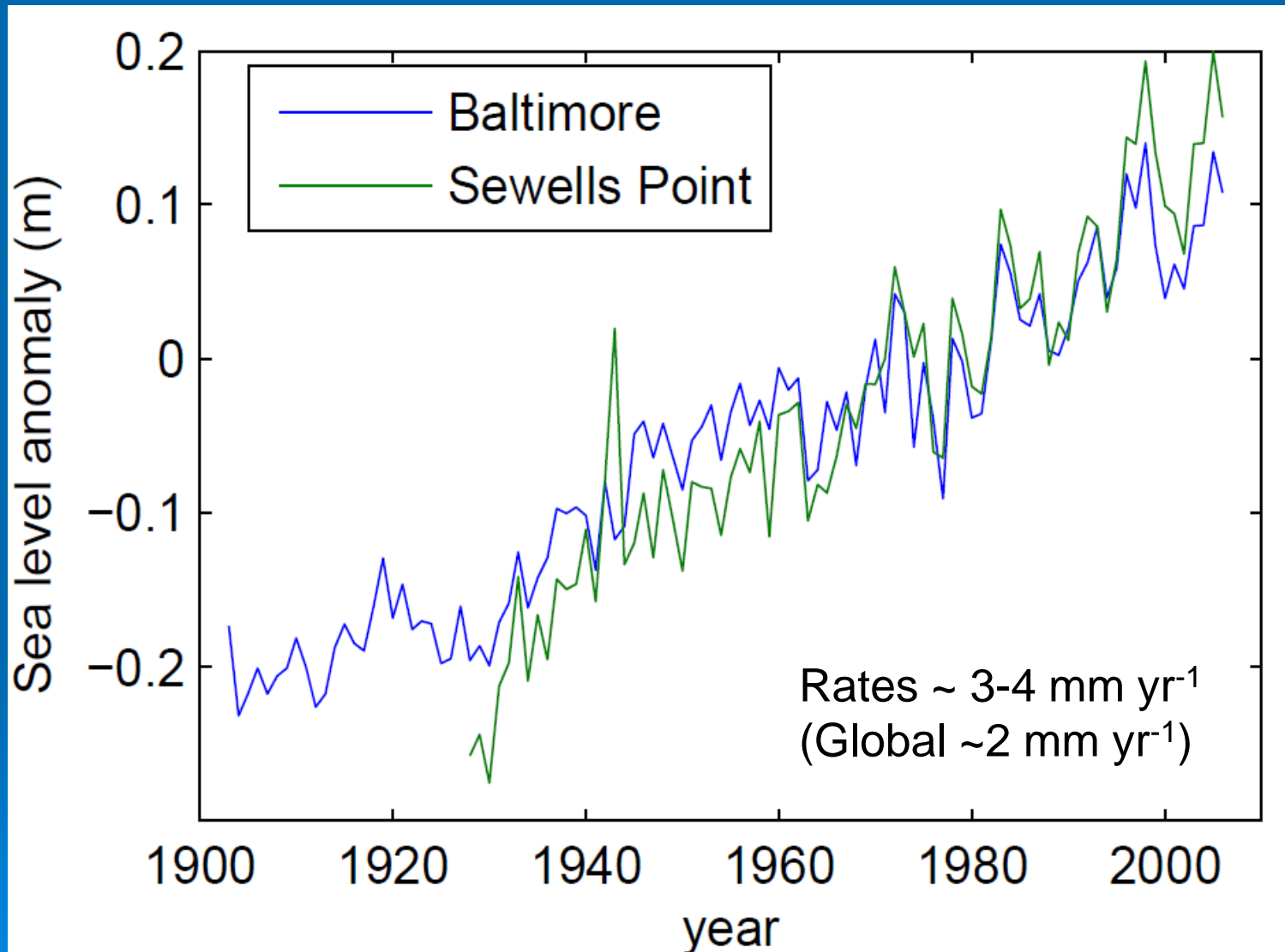
Atlantic  
Menhaden

Sources: MD and SC DNR

# Chesapeake Bay is warming ...



# ... and rising



# Projected Climate Change in the Chesapeake Region

## *Virtually certain (>99%):*

- Higher CO<sub>2</sub>
- Higher sea level

## *Very likely (90-99%):*

- Warmer
- Higher winter & spring precipitation

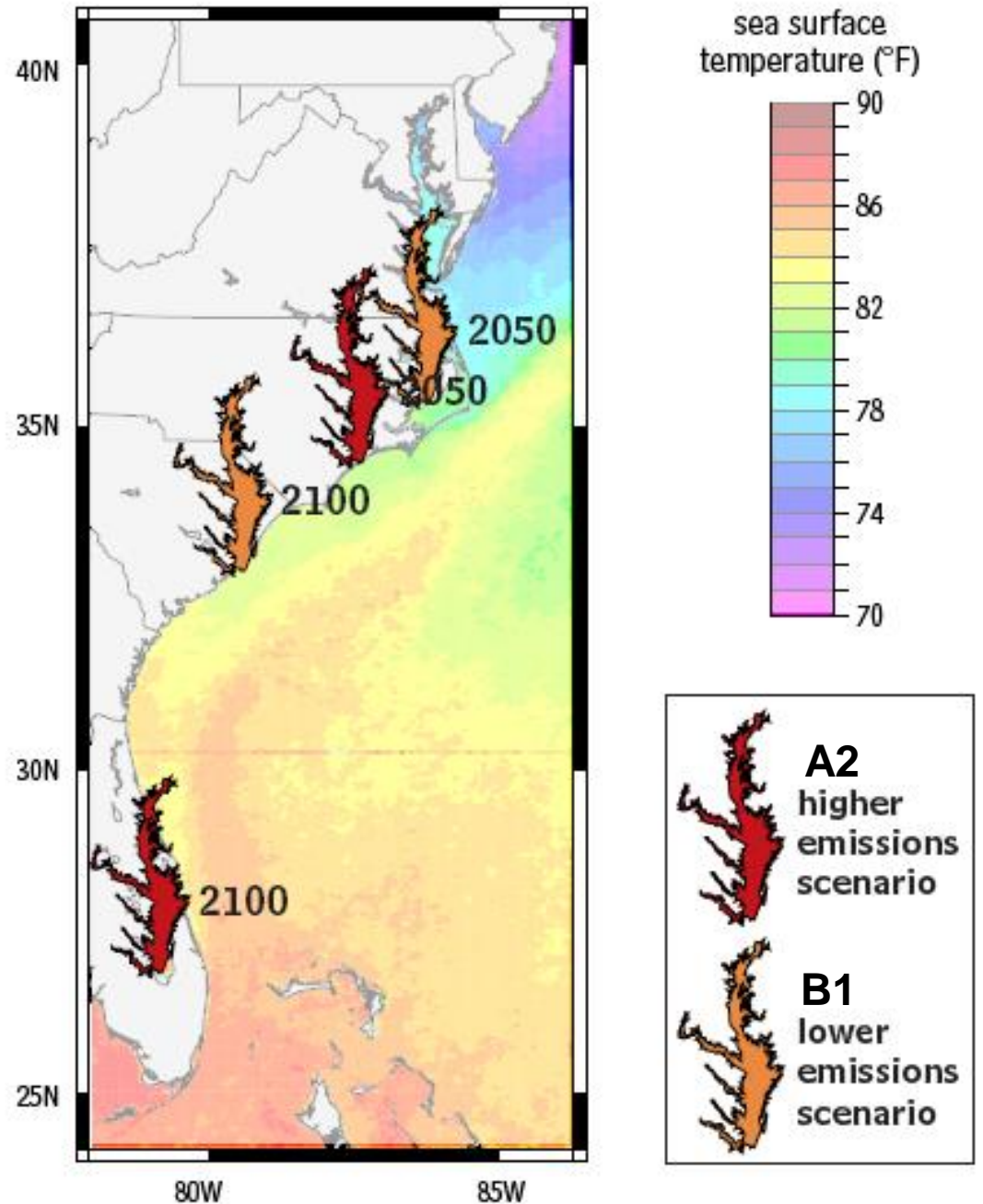
## *Likely (66-90%):*

- More intense precipitation
- Flashier streamflow
- Increased winter streamflow
- Increased storm intensity

Najjar et al. (2010), Boesch (2008)

# Moving estuary analogue: summer temperature change

Boesch (2008)





# Fish will be affected by climate change through changes in:

- Temperature
- Dissolved oxygen
- Submerged vegetation
- Acidity
- Salinity
- Circulation patterns
- Food web
- Timing of seasonal events (e.g., spring freshet)

# Northward species shift?

- Pushed out: yellow perch, *soft clam*, white perch, striped bass, black sea bass, tautog, summer and winter flounders, silver hake, and scup



- Pulled in: some shrimps, southern flounder, cobia, spadefish, *Spanish mackerel*, mullet, tarpon, black drum, red drum, weakfish, spotted sea trout, spot, and Northern and Southern kingfish



- Migrations tough for low-salinity shellfish: *Dark false mussel*



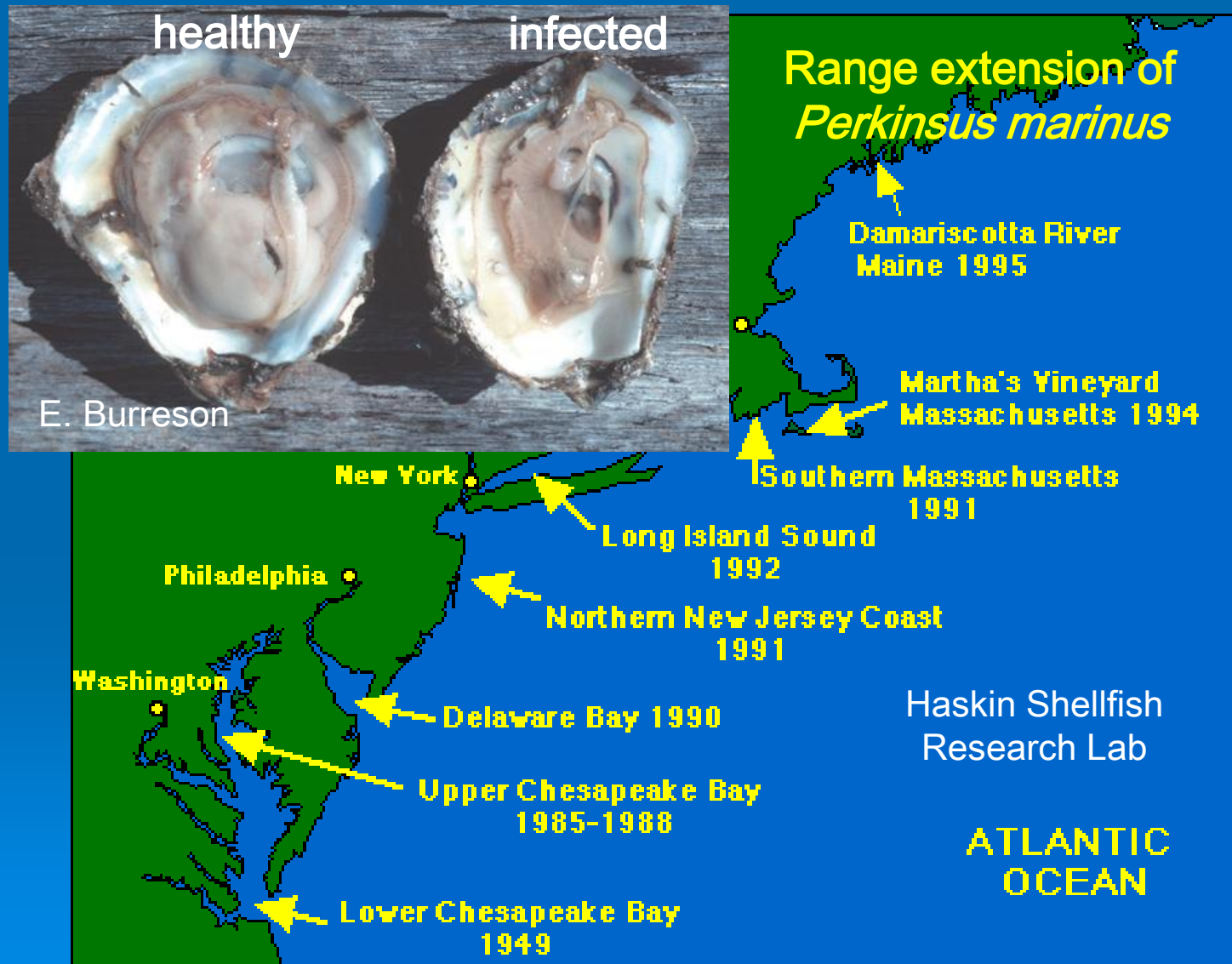
# Warming may have benefits

- Longer growing season for oysters, blue crab, eels, white perch, striped bass
- Reduced shoreline freezing
- Improved overwintering of blue crab





# But ... oyster disease has spread in response to winter warming

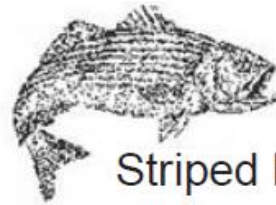


# Fish need oxygen

O<sub>2</sub> concentration (mg/l)

Migratory Spawning and  
Nursery Habitats

6



Striped Bass: 5-6



American Shad: 5

Shallow-Water and  
Open-Water Habitats

5



White Perch: 5



Yellow Perch: 5

4



Hard Clams: 5



Alewife: 3.6

Deep-Water Habitats

3



Crabs: 3



Bay Anchovy: 3

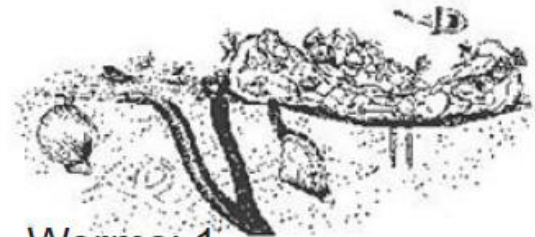
2

Deep-Channel Habitats

1



Spot: 2



Worms: 1

0

# Cochlodinium bloom (Aug 2007)

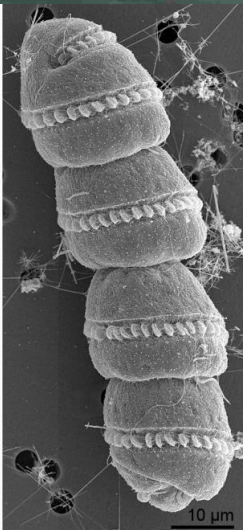


© Gert Hansen



SCCAP K-1292  
*Cochlodinium polykrikoides*

10 µm

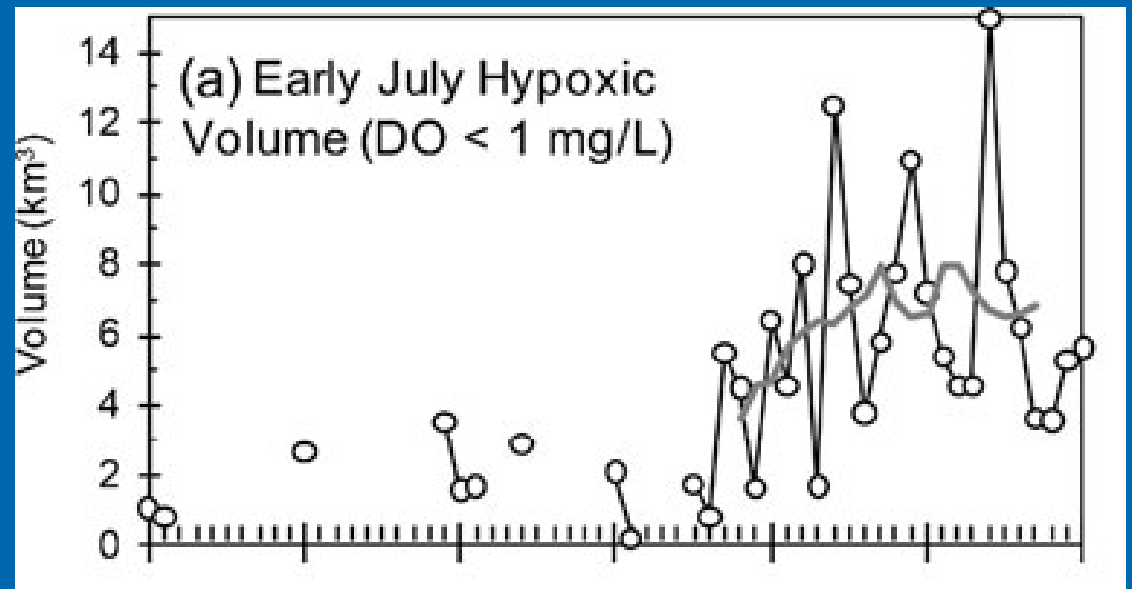


10 µm

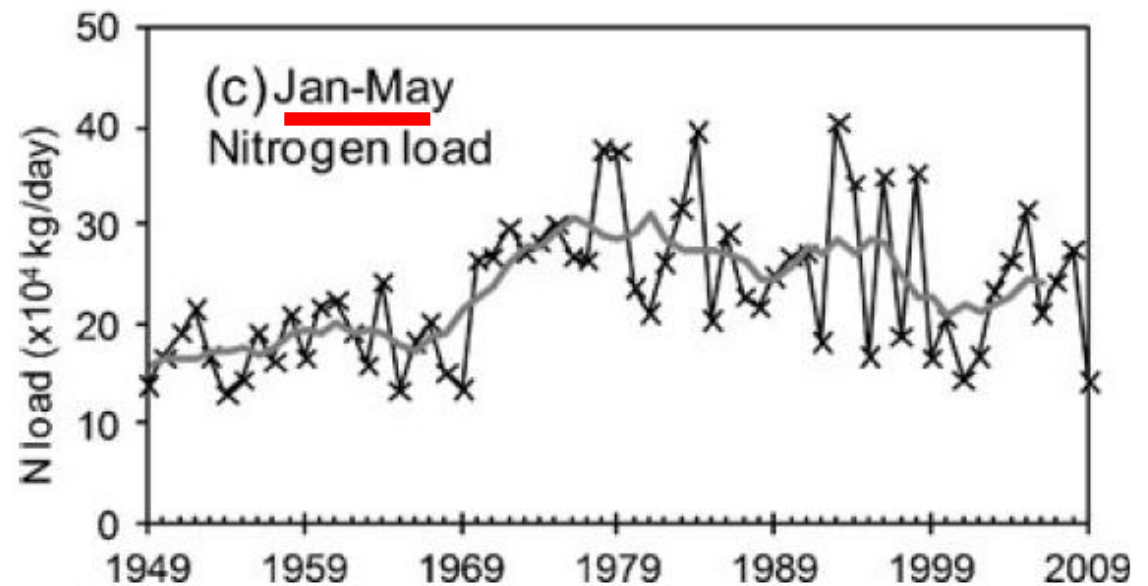
© Gert Hansen



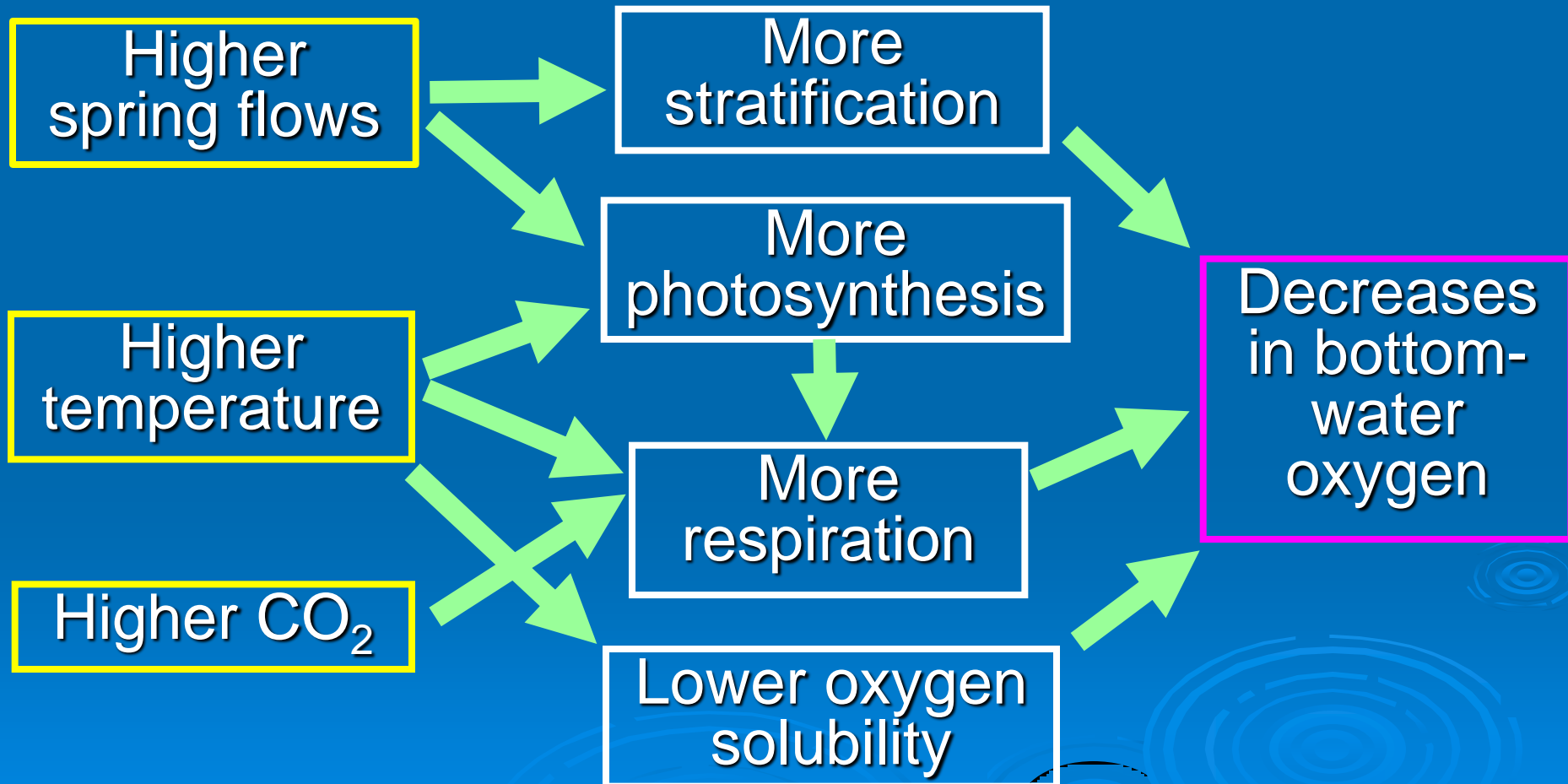
60 years of  
hypoxic volume



and nitrogen  
loading



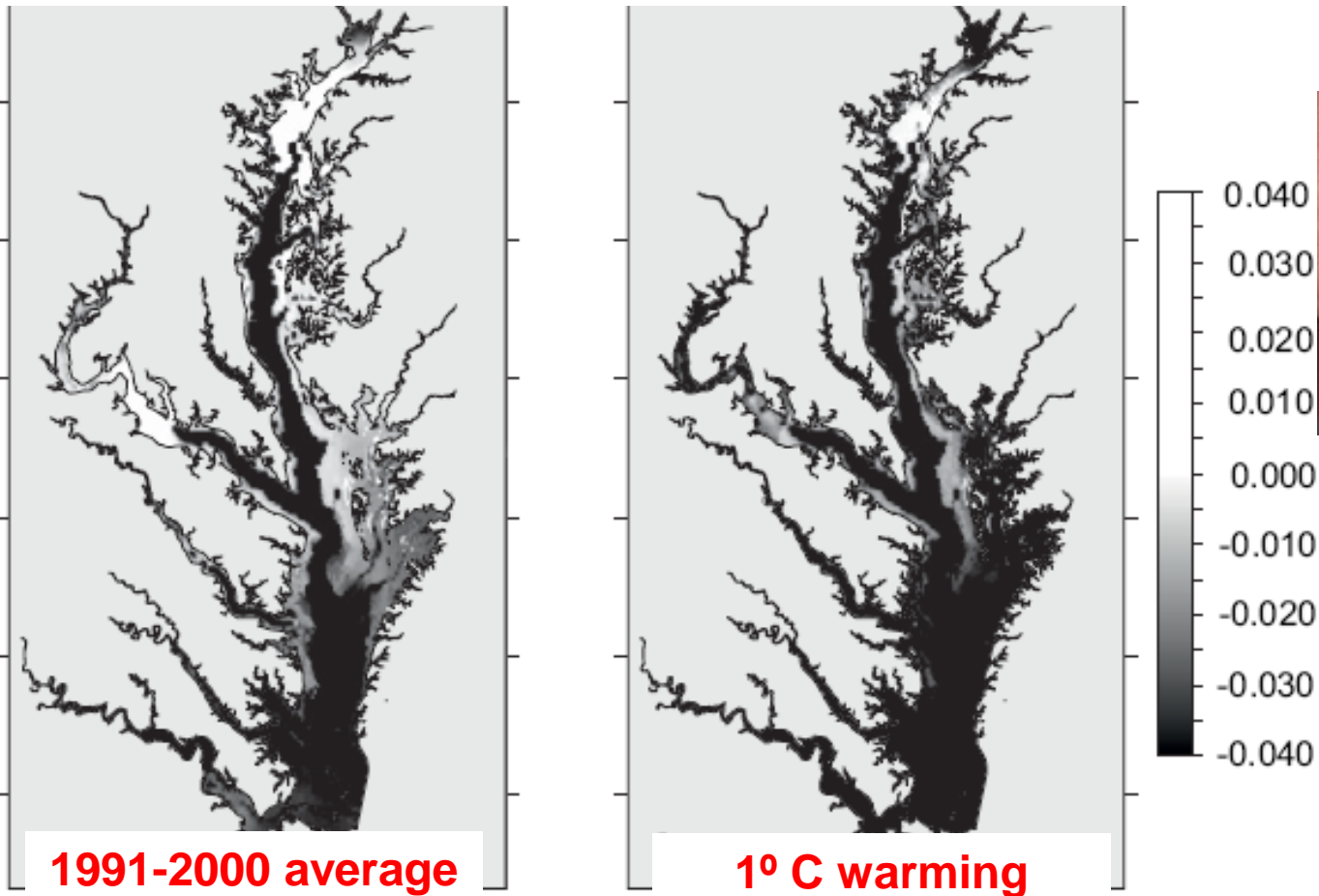
# Multiple impacts on bottom-water dissolved oxygen





# Temperature-O<sub>2</sub> synergistic impact (oxygen squeeze)

Instantaneous potential production  
for young-of-the-year Atlantic Sturgeon, July bottom water



Coastal Fisheries  
Reform Group



Dave Conover

Niklitschek &  
Secor (2005)

Submerged  
vegetation:  
an important  
habitat



Snails on  
seagrass

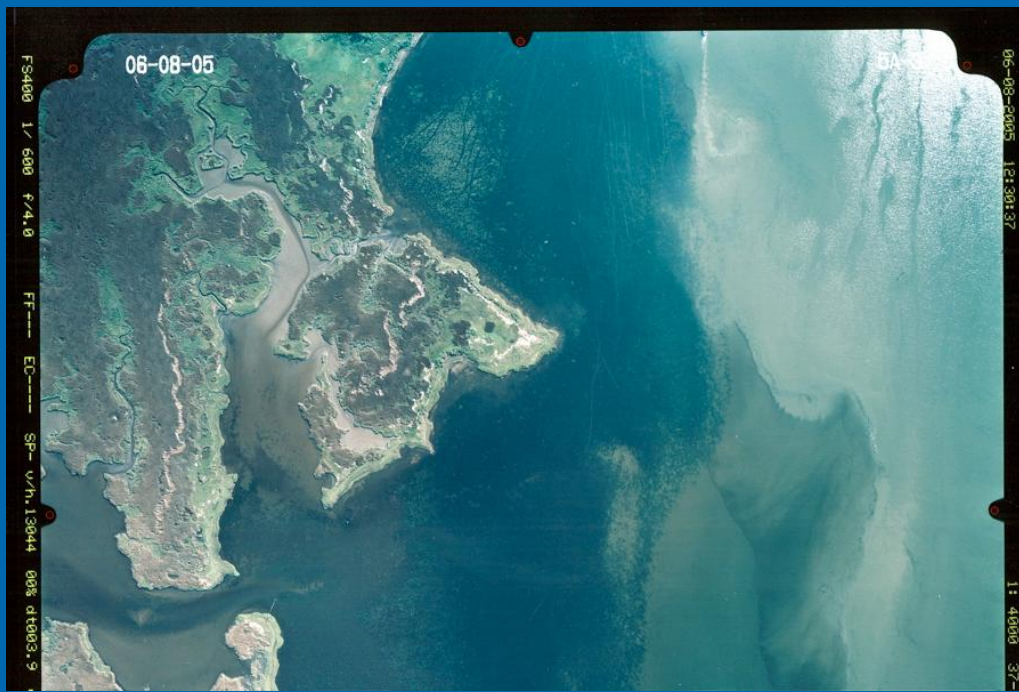


Blue crab caught in SAV bed

[http://www.vims.edu/about/  
photo\\_galleries/sav](http://www.vims.edu/about/photo_galleries/sav)

NOAA

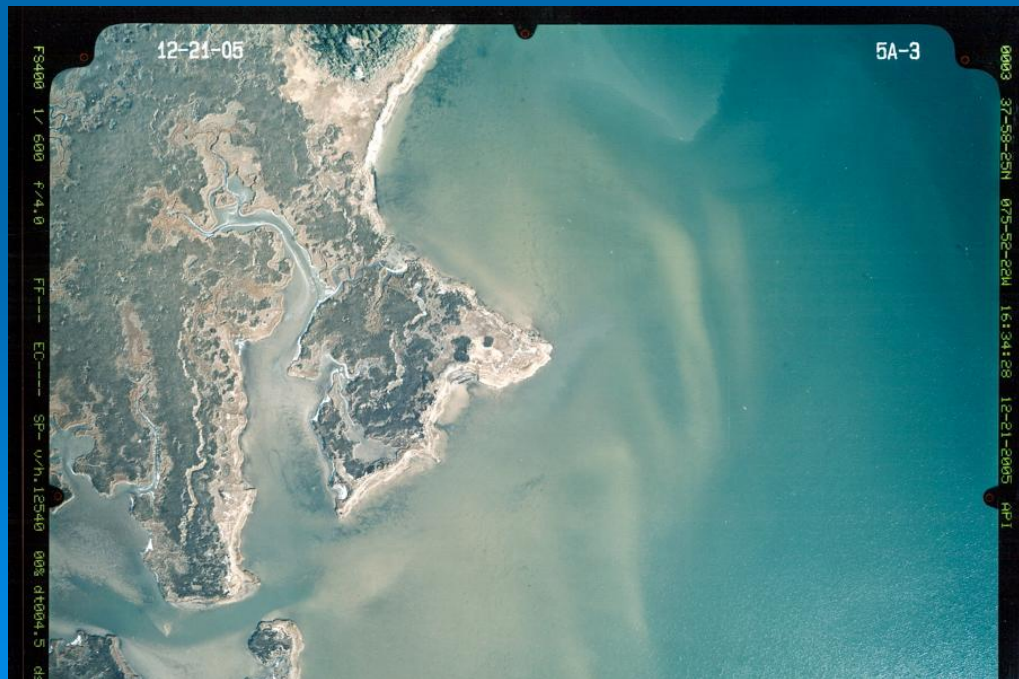
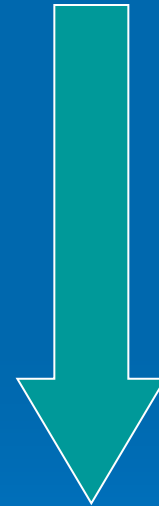




# Lower-bay seagrass

June 2005

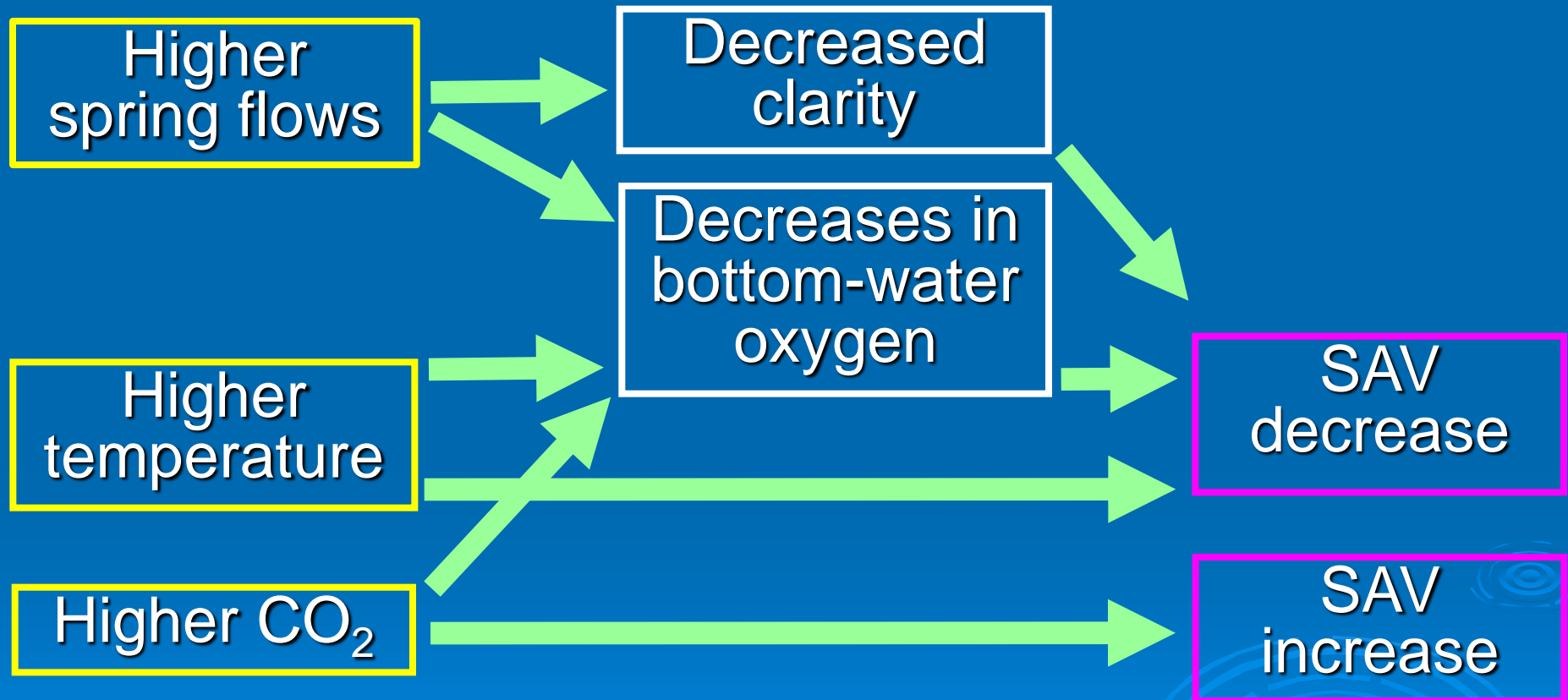
*Hot summer*



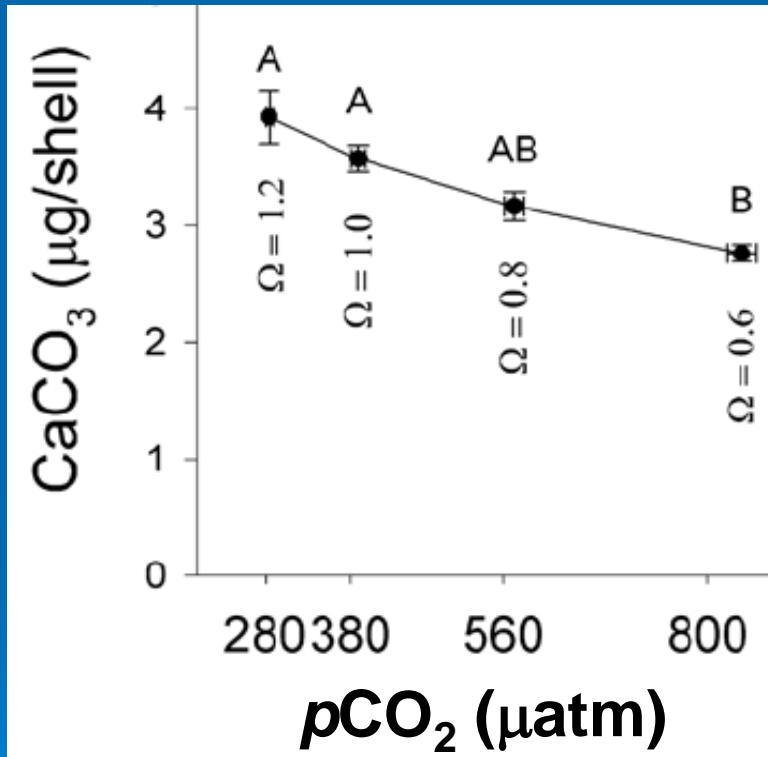
December 2005

[http://www.vims.edu/about/photo\\_galleries/sav](http://www.vims.edu/about/photo_galleries/sav)

# Multiple impacts on Eelgrass



# Impact of ocean acidification on oyster larvae (*C. virginica*) calcification



Miller et al. (2009)



Smithsonian Marine Station



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
- Long-term: *Avoid the unmanageable* → reduce emissions

# What you can do for the Bay

- Reduce N into water and CO<sub>2</sub> into air
- Most suggestions do both and save \$

*On the road:* Bike and walk more, drive less

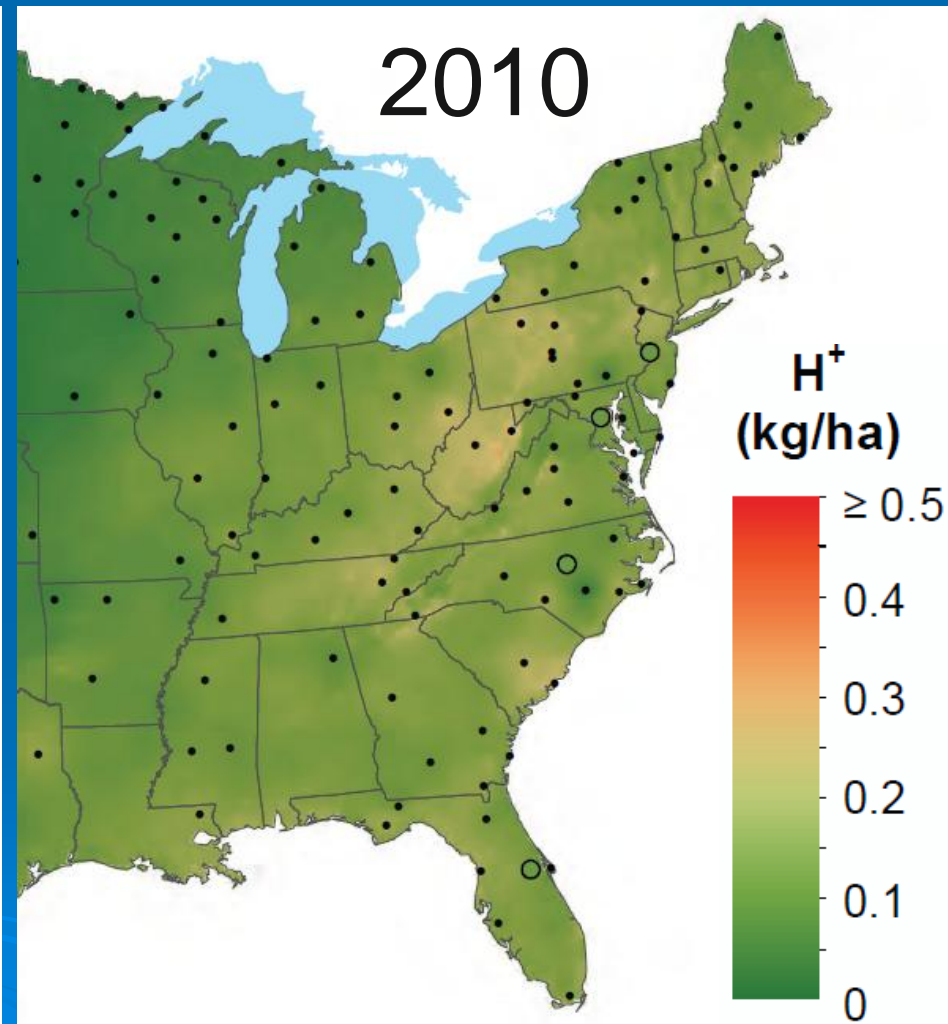
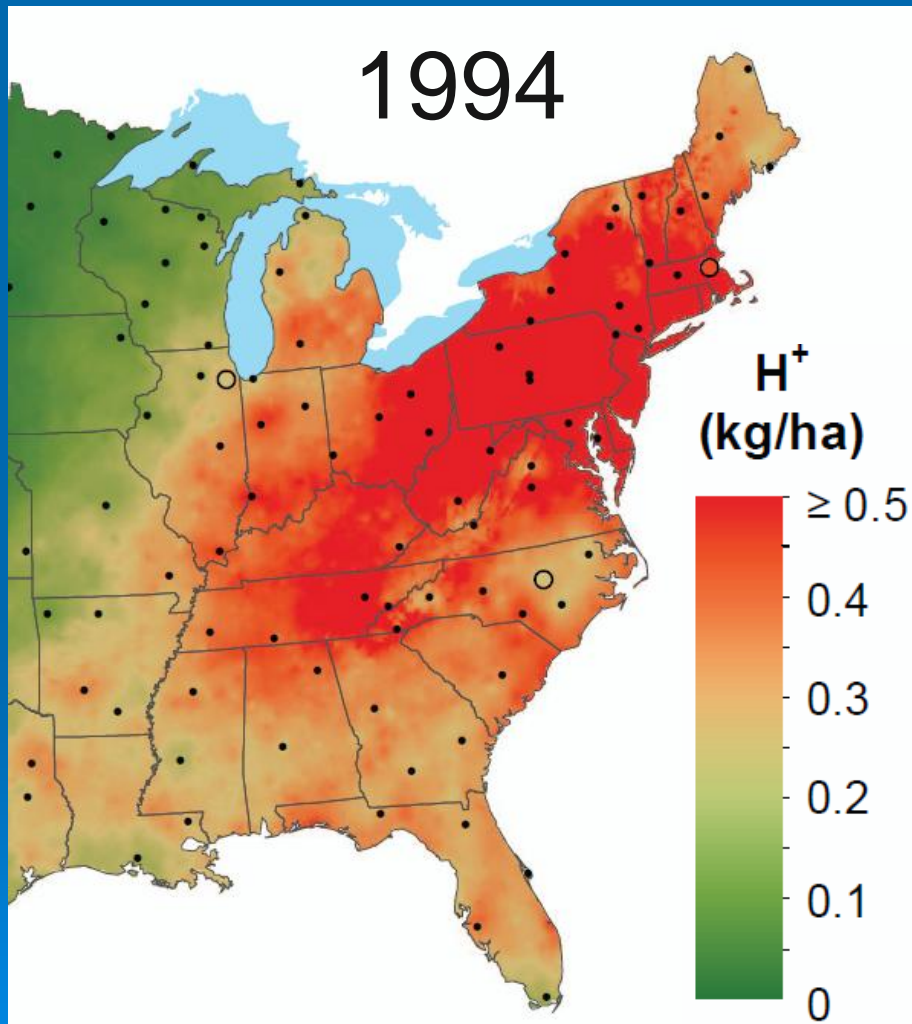
*At the table:* Eat more veggies, less meat

*At home:* Insulate and seal; shade in summer

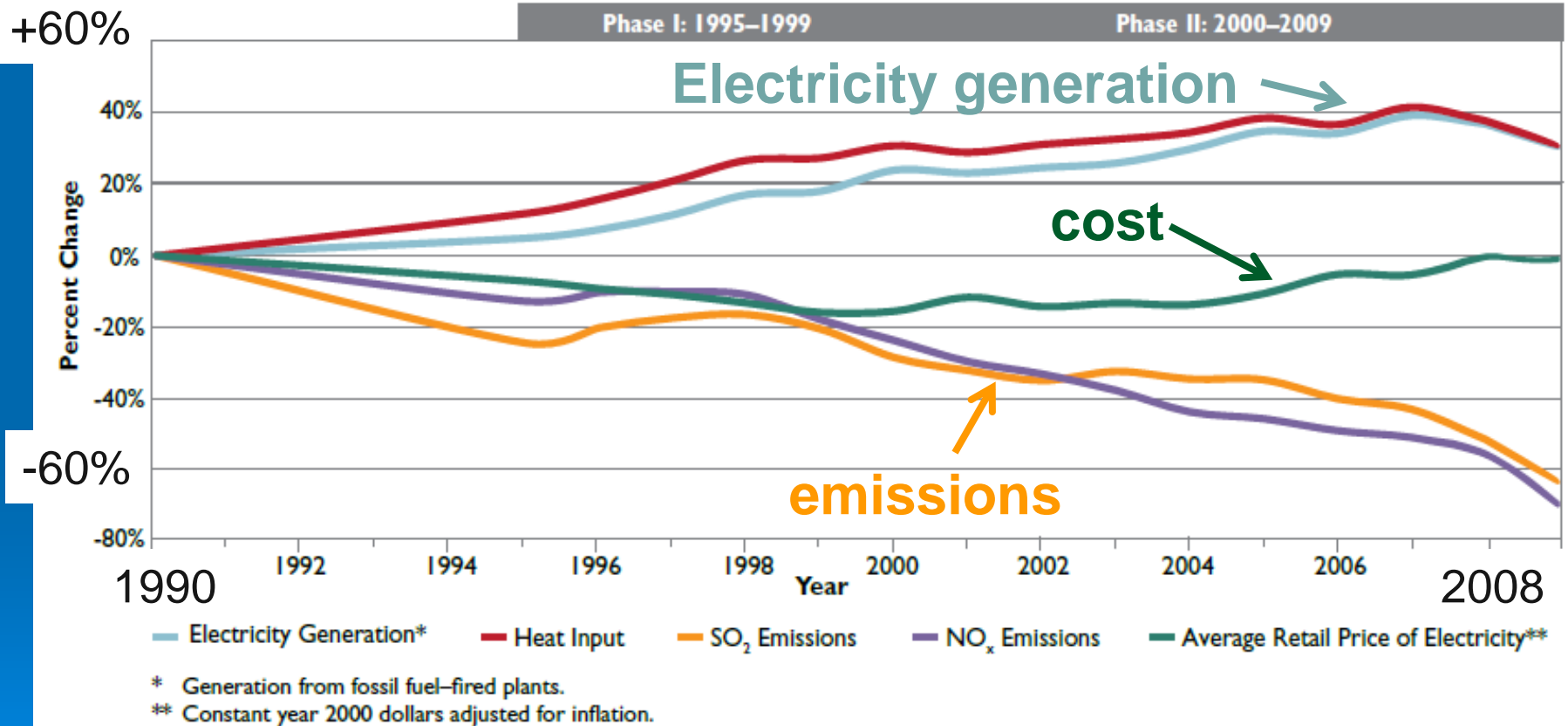
*In the public sphere:* What you're doing now!

- Support legislation for clean air and water—it works!

# We did it before: acid rain



# We had our cake and ate it, too



# Thank you





# References

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# Extra slides

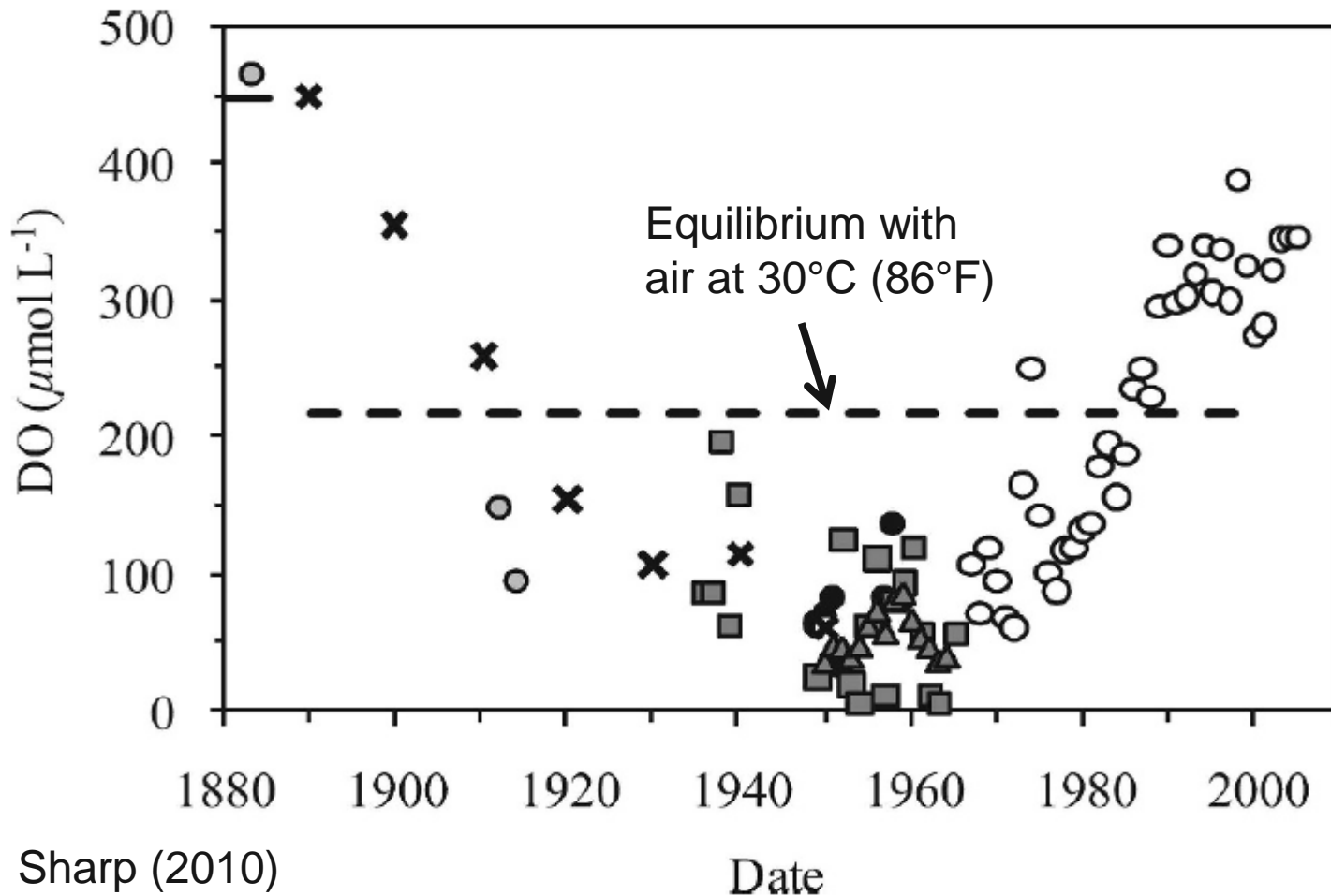


# Hypoxia

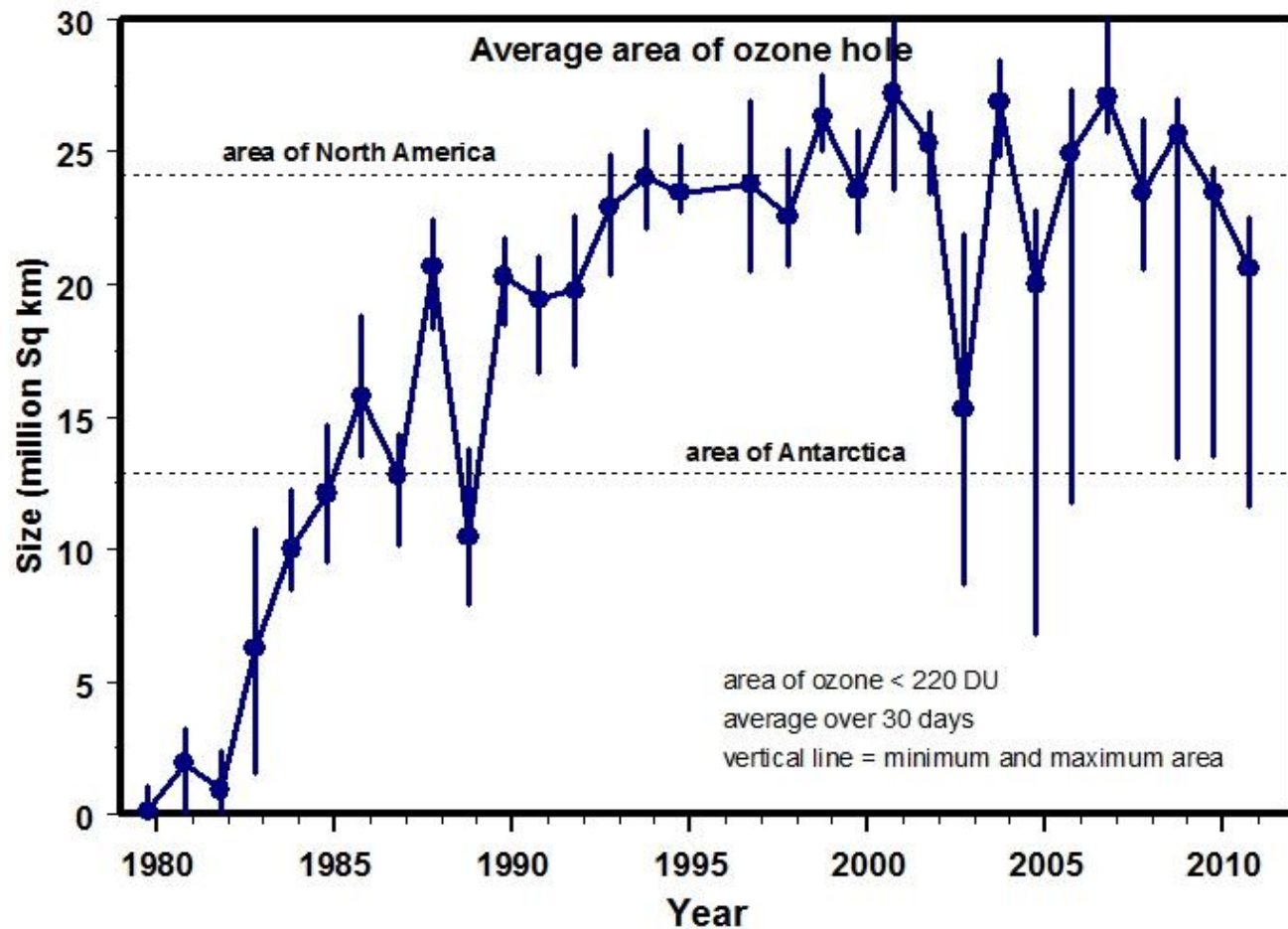
- Increases benthic mortality
- Alters behavior: oxygen squeeze on striped bass and Atlantic sturgeon
- Affects prey (zooplankton), making some more susceptible to predation while providing refuge for others
- Decreases growth rates (oysters)
- Warming increases oxygen demand

# We did it before: Delaware Bay

Summer dissolved oxygen concentration in the Delaware River near Philadelphia



# We did it before: the ozone hole





# Climate impacts on fish may be complex



CO<sub>2</sub>



Temperature  
& precipitation



Stream-  
flow



Nutrients



Phytoplankton



Bacteria &  
Zooplankton



Dissolved  
oxygen

