2015 Patuxent River Conference

18 June, 2015

Jefferson Patterson Park

W. R. Boynton, Lora Harris
and many Colleagues

Chesapeake Biological
Laboratory

Solomons, MD

I thought THRESHOLDS were in houses not the Bay

N x magic = fish

Has the River gone over too many tipping points?

All this stuff is so complicated

Can you finish these 20 TMDLs today?

You can get a ticket for crossing a tipping point?

What to say about the Patuxent River and Basin, people, history, what we know and what we don't know?

In 30 minutes or less?

A Big Challenge for Sure

- Trying to cover what's known and what's not known in the Patuxent Basin and estuary is just not possible

- I feel a bit like a "one man" band here and, like this dude, I will not be able to play all notes

- I trust through the next two days we will develop a more complete picture of the Patuxent and what to do

http://farm3.static.flickr.com/2301/2267333635_88aa0c9fe8.jpg

Conference Challenges

- What is happening in the Patuxent River?
- Why are we all in the room today? Why is this event important?
- What is the challenge ahead of us?
- How might we need to think about things differently than we have in the past?

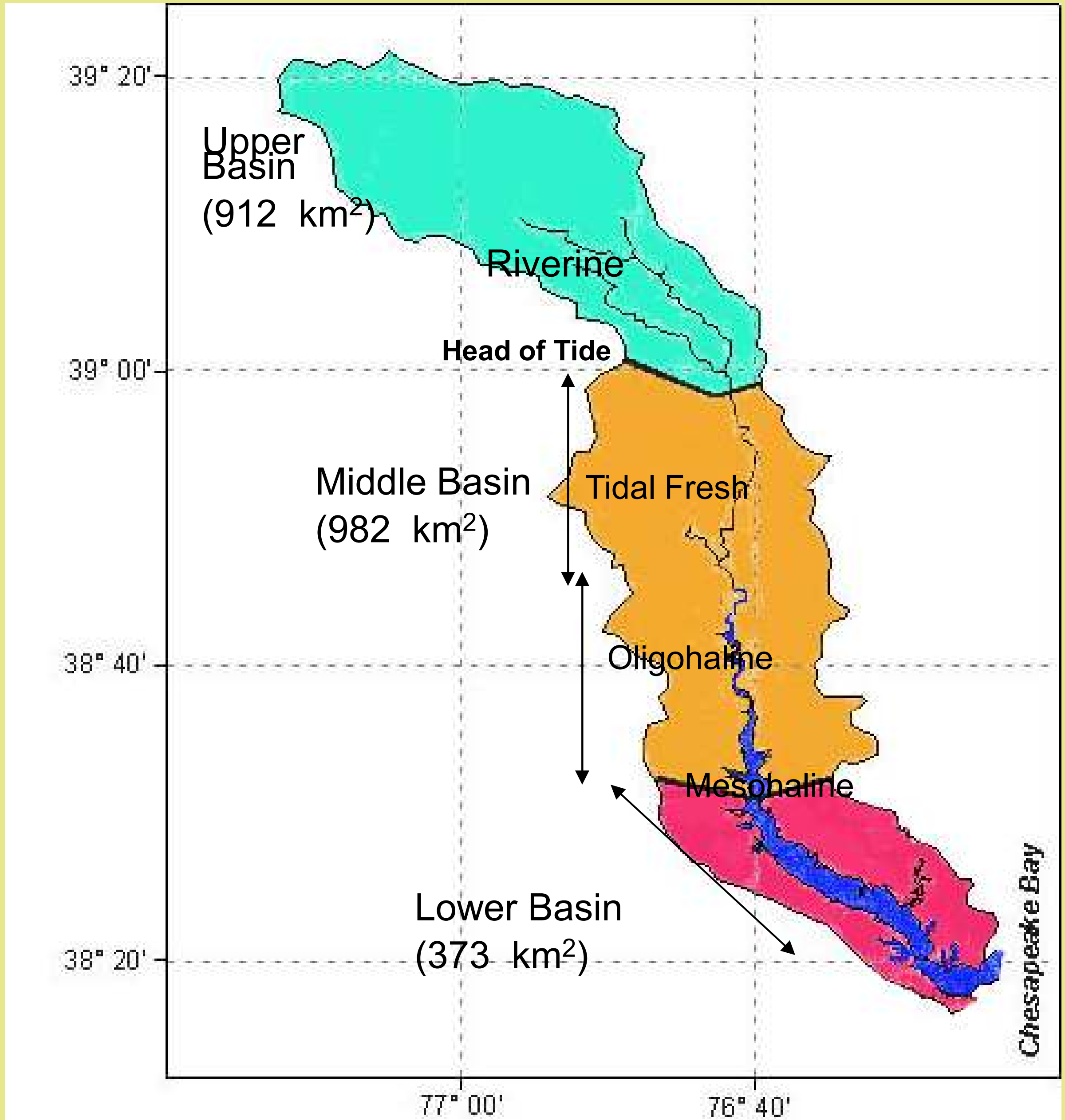
Patuxent Basin Landmarks

•River ~110 miles long…longest river in Maryland

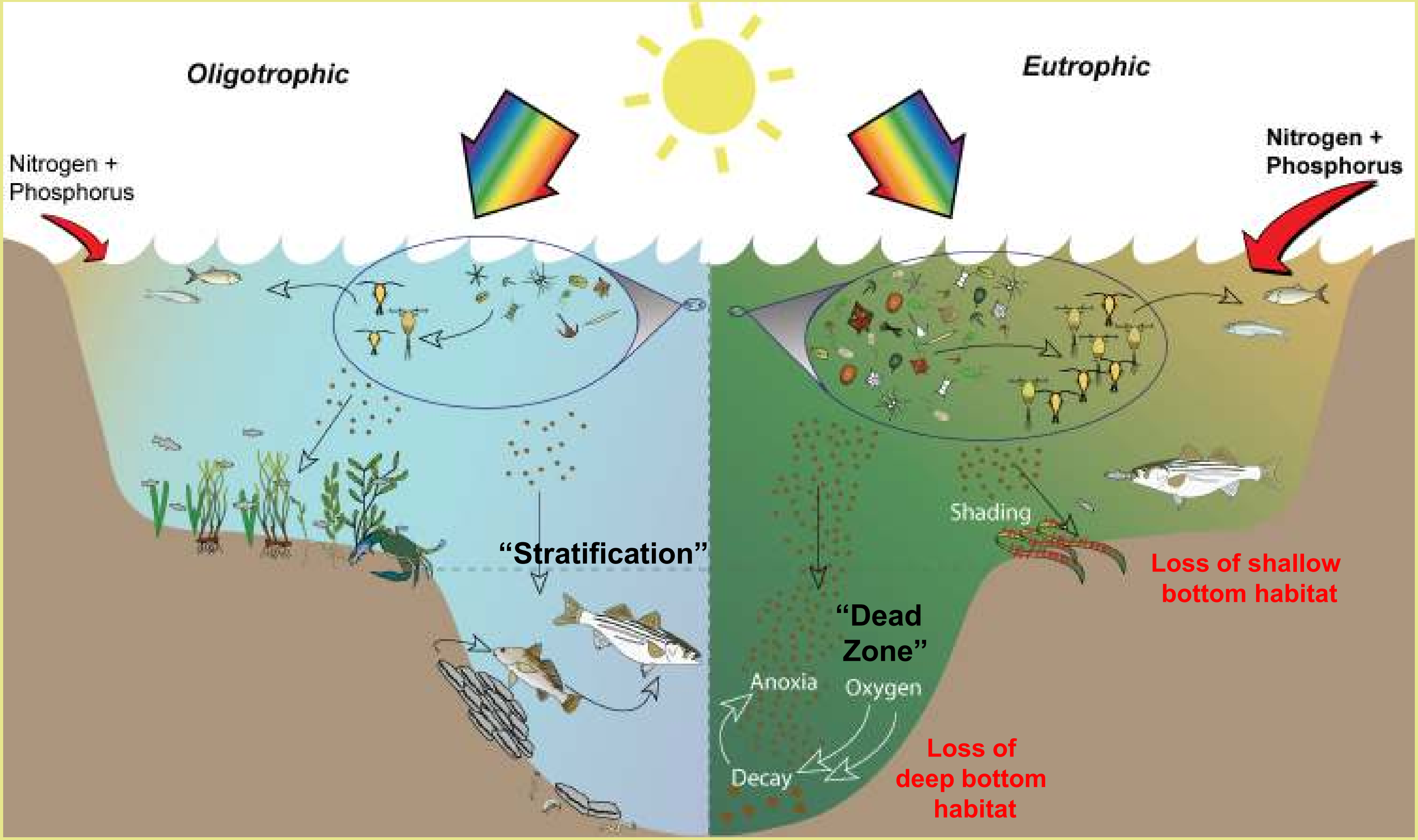
• Long history of human habitation (~9000 yrs)

• Extreme changes beginning in mid-1960s in estuary…others in the Colonial period

• Diverse basin: urban, suburban, industrial, agriculture, tourism…it's all here



Nutrient Enrichment Effects: Estuarine Ecosystems

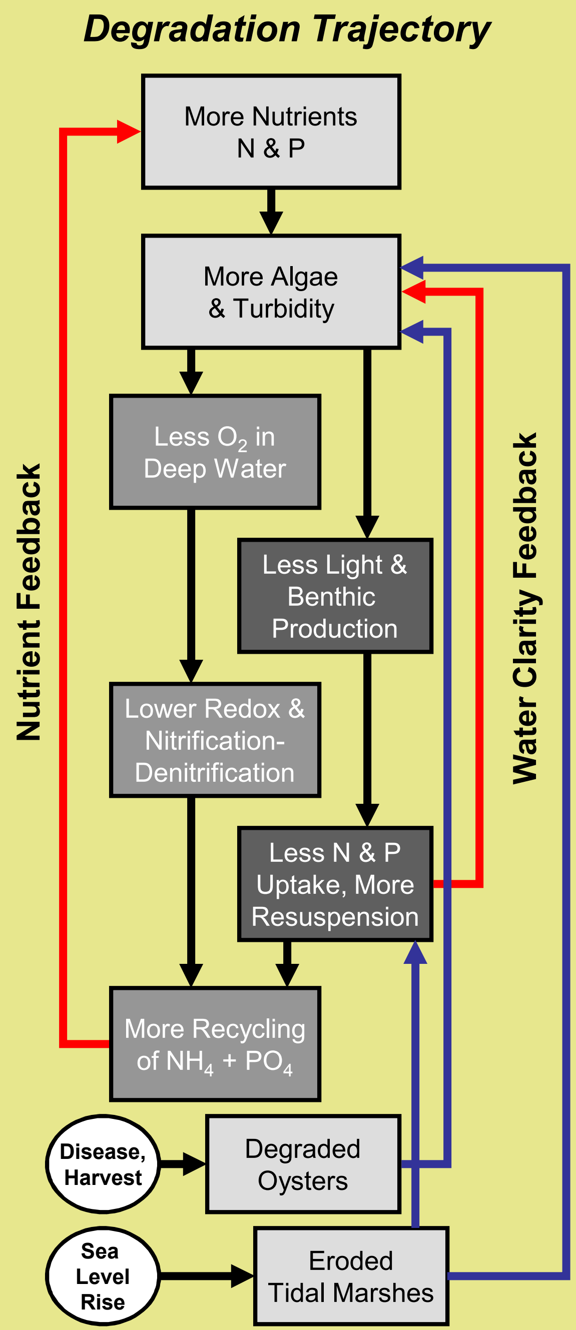


Degradation Trajectories…

where things are not so simple

- Positive & negative feedbacks
- N & P inputs affect hypoxia & light
- Hypoxia leads to more nutrients, more algae, & more hypoxia
- Turbidity leads to less SAV causing more turbidity, less SAV
- Loss of oysters & marshes tend to reinforce these feedbacks

(Kemp et al. 2005)

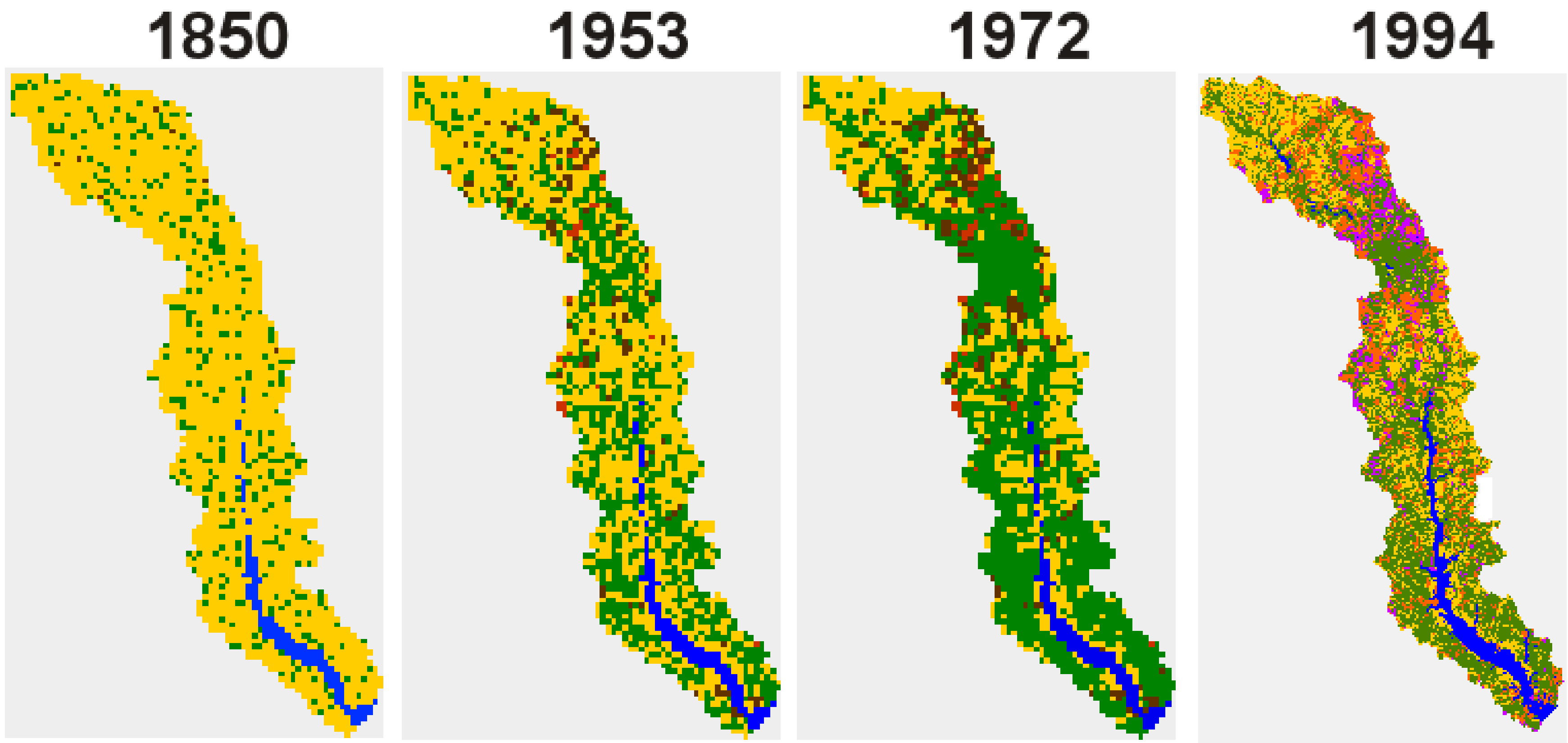


Patuxent River Estuary Circa 1832

Water Quality and Habitat Conditions can be much improved…not to the 1832 conditions…that may not be the optimal status

"So transparent are its waters that far out from shore you may see, in the openings of the sea-weed forest, on its bottom the flashing sides of the finny tribe as they glide over the pearly sands."

The Old Plantation by Hungerford (1859)



	1850	1953	1972	1994
Forest	14.3%	37.3%	57.0%	51.6%
Residential	0.3%	4.6%	8.0%	15.5%
Urban	0.0%	1.2%	2.3%	4.3%
Agro	85.5%	57.0%	32.8%	28.5%

PATUXENT RIVER WATERSHED

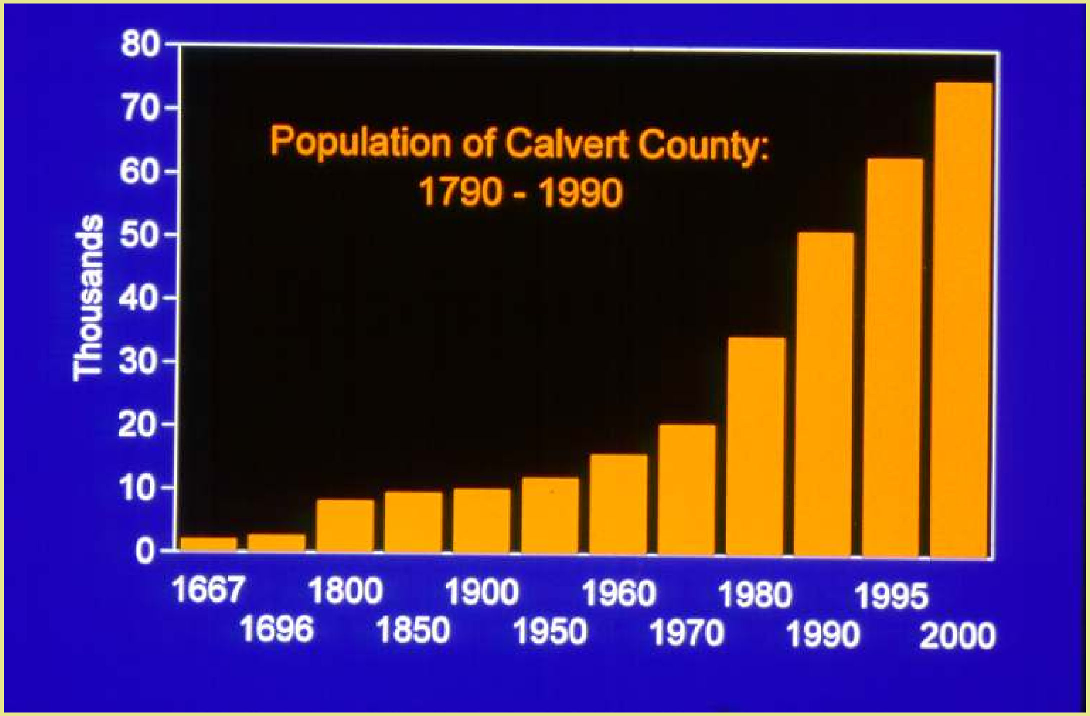
Costanza and Colleagues

Watershed population growth increased dramatically during the second half of the last century.

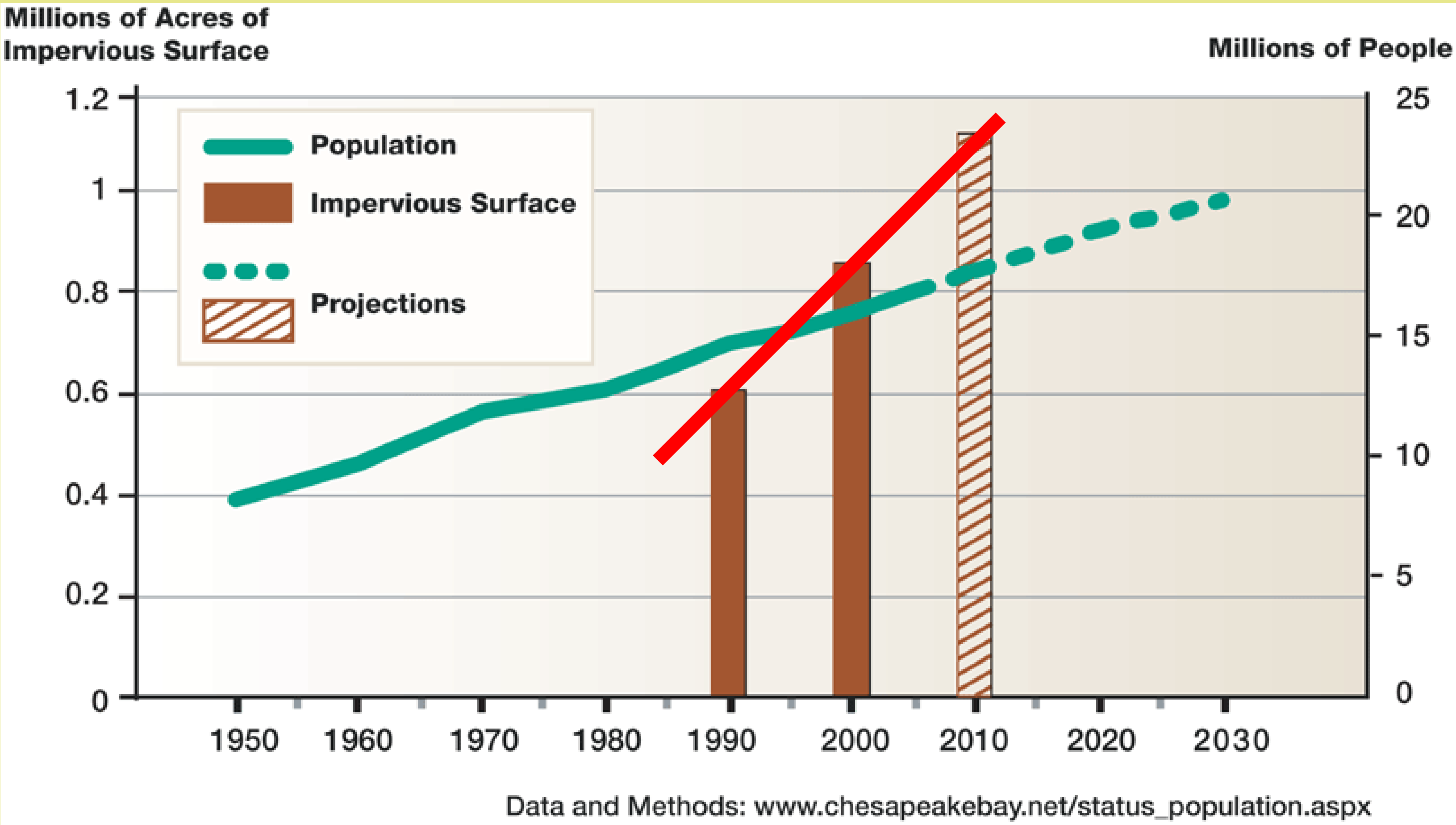
Trends in Calvert County, MD typical of other watersheds

Patuxent River Watershed Population

Year	Population
1900	28,000
1940	37,000
1970	246,000
2000	>600,000

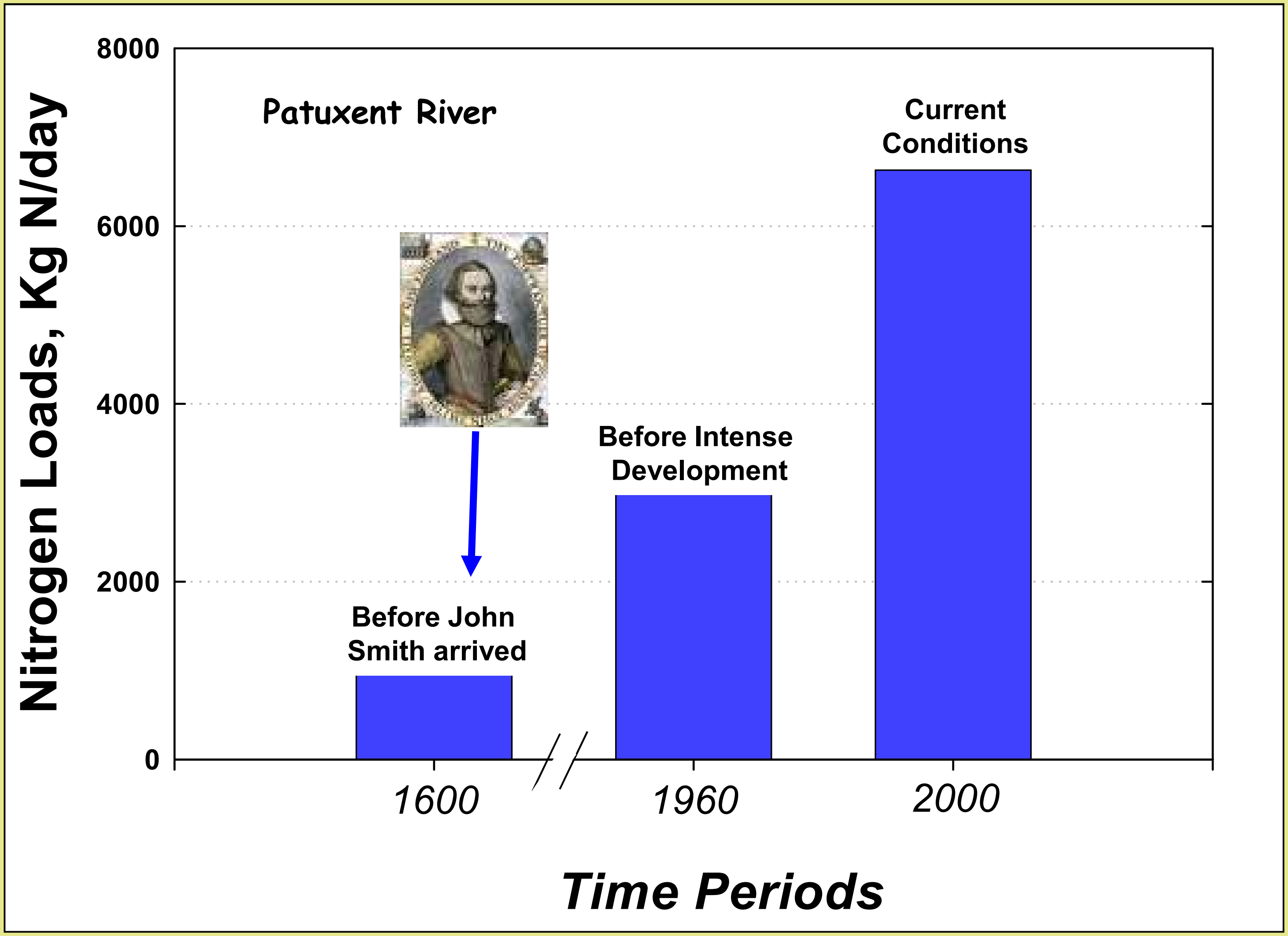


Bay Watershed Population and Impervious Surface



Conversion of land for DEVELOPMENT since 1970 has grown at double the rate of housing and triple the rate of population

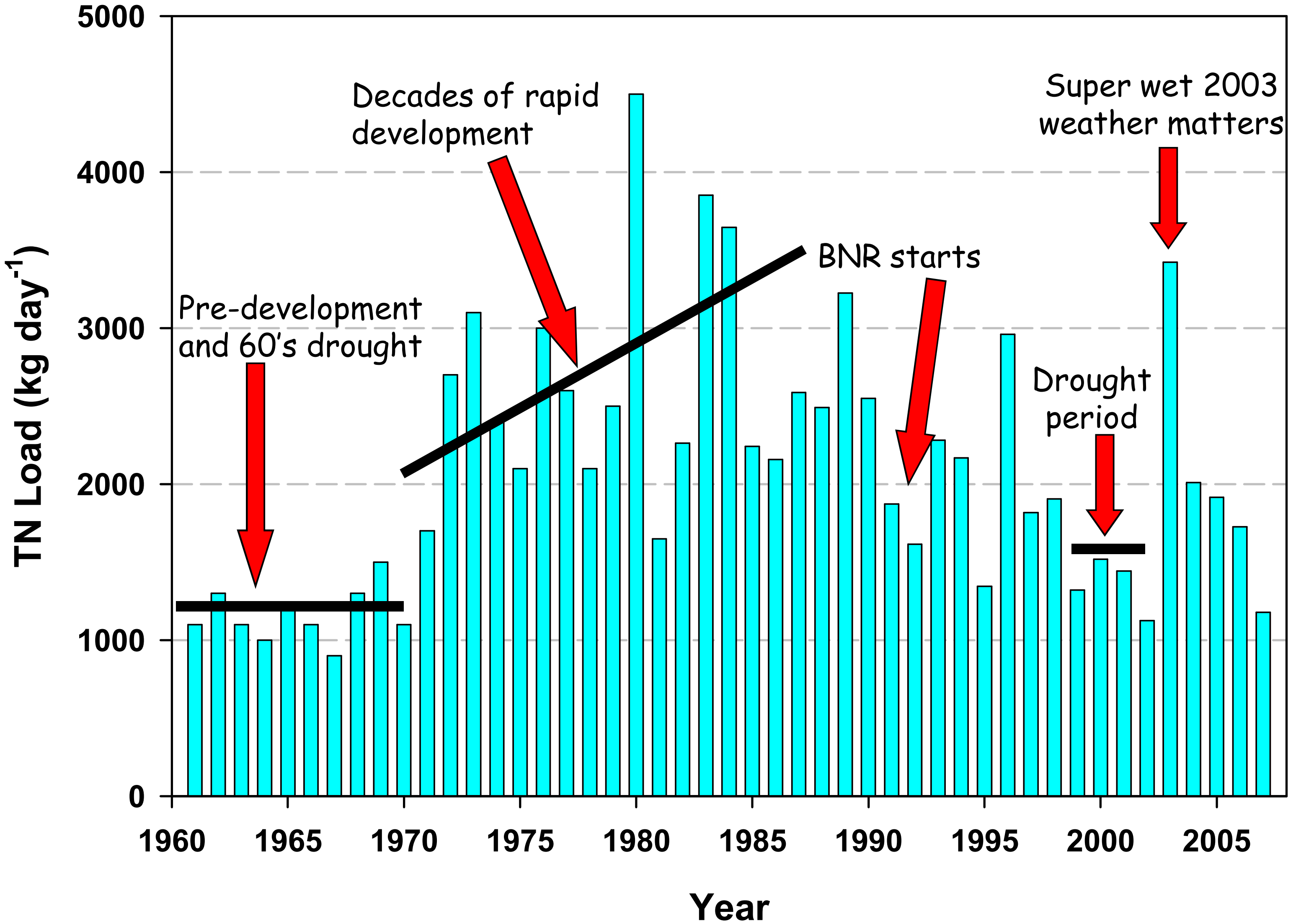
Historical Increases in Patuxent Nitrogen Loading



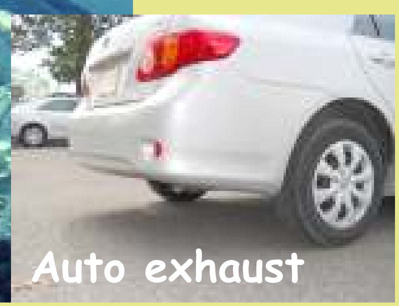
- 7-Fold Increase since John Smith's arrival to Bay Area
- 50% Increase during first 360 yrs & 50% increase in last 55 yrs

Patuxent River Nitrogen Inputs

1960 - 2007



Major Bay and River Nutrient Sources



Summary

- All have increased during last 50 yrs
- Importance varies widely with location
- Most reductions with point sources

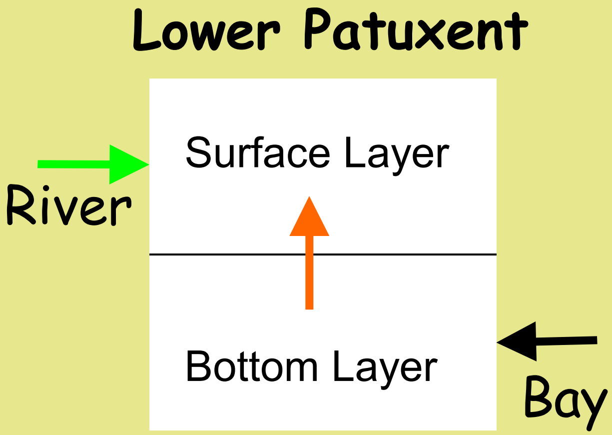
Importance of Croplands

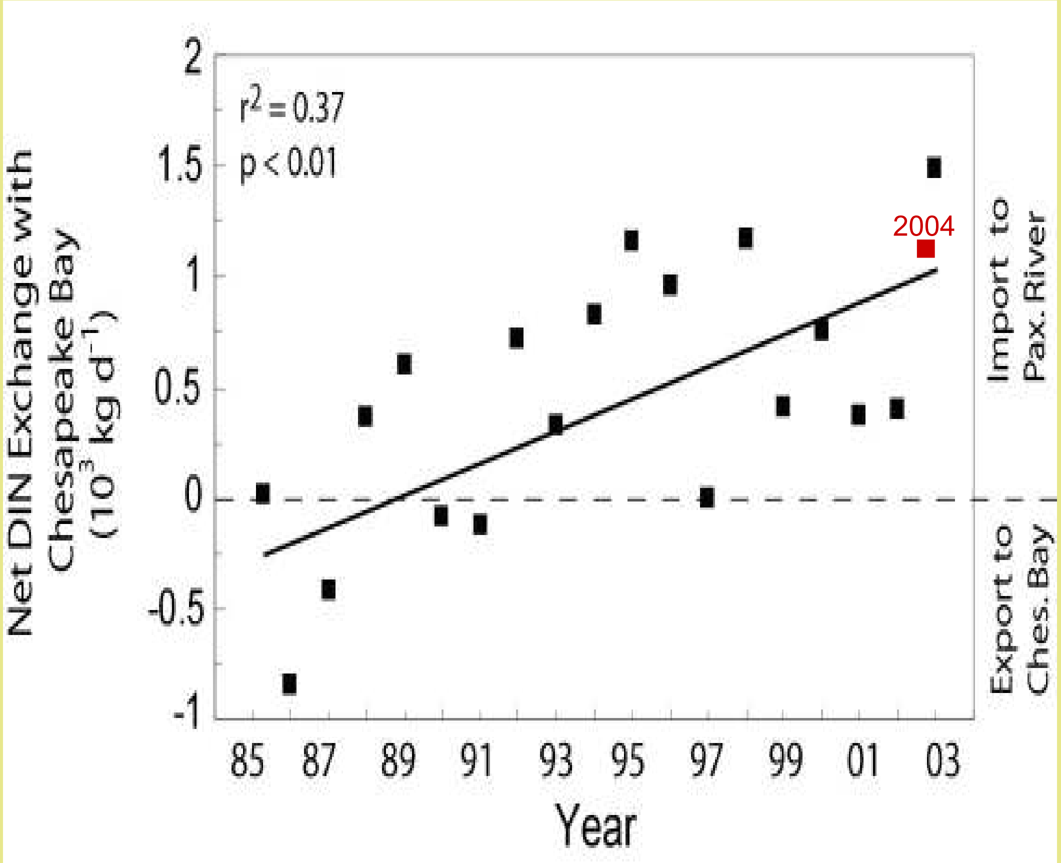
- Cropland is the most important non-point source of N and P inputs to the Patuxent, although cropland covers only 10% of the watershed and developed land covers 12% of the watershed.

- Croplands in the Piedmont release about twice as much N per unit area as do croplands in the Coastal Plain.

Jordan et al. SERC

Increasing DIN Input from Bay to Patuxent

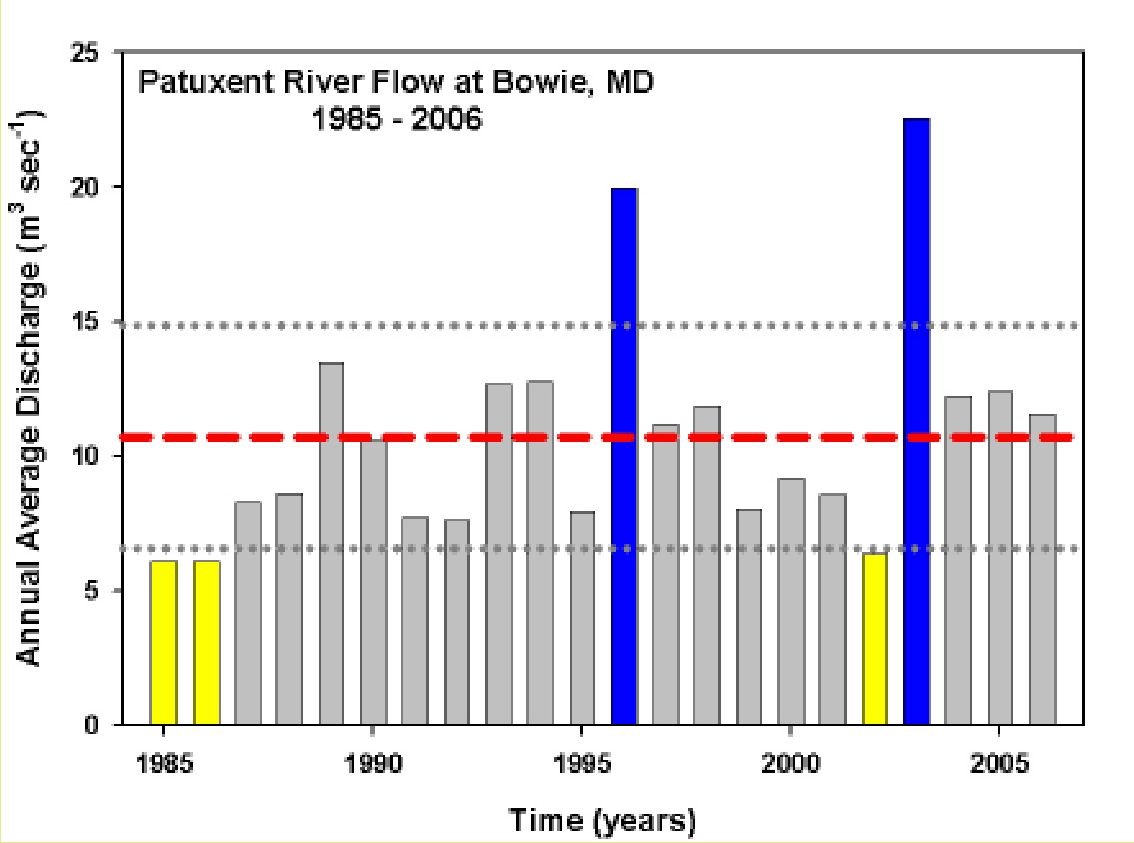




- Upwelling a significant DIN source to lower estuary surface layer
- Cause of trend unclear

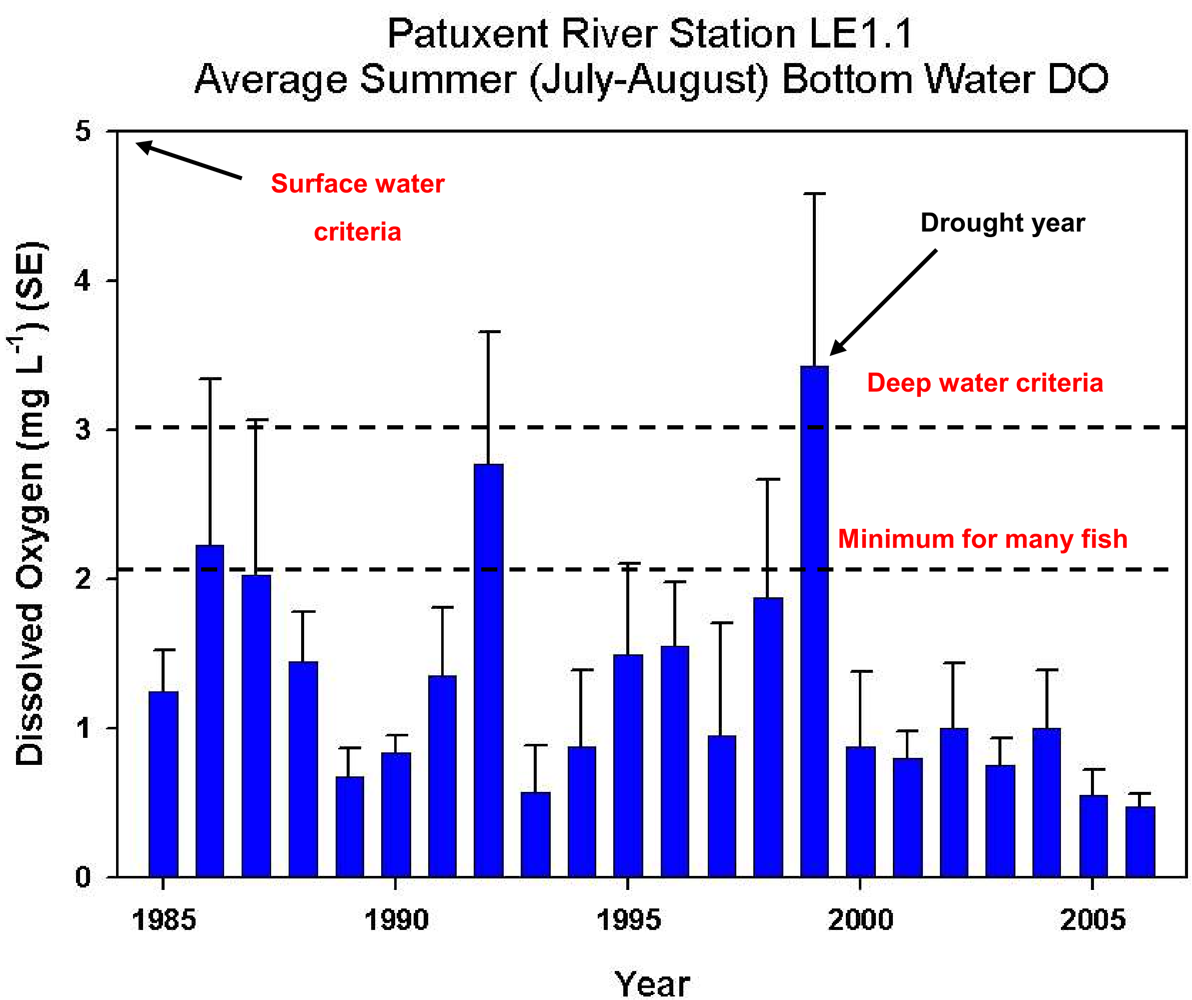
Testa et al. 2012

River flow matters and is quite variable



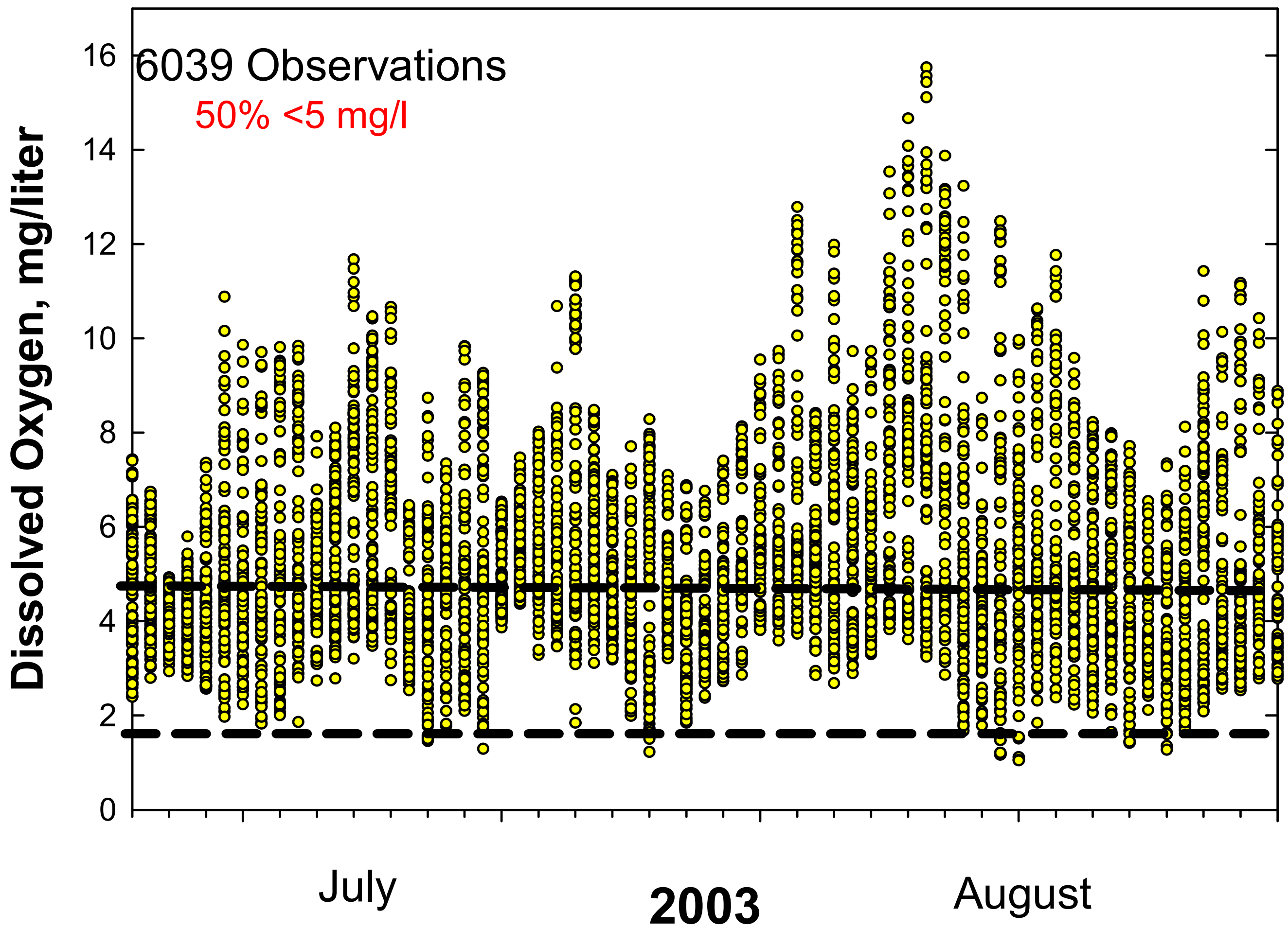
A time series of annual river flows at the fall line (Bowie, MD) of the Patuxent River. The red dashed line is the 22 year average flow and grey dotted lines represent one standard deviation of the mean. Yellow bars indicate very dry years and blue bars very wet years. Data from USGS (2007).

Deep Water Dissolved Oxygen



Shallow Water DO

Patuxent River at Benedict, MD

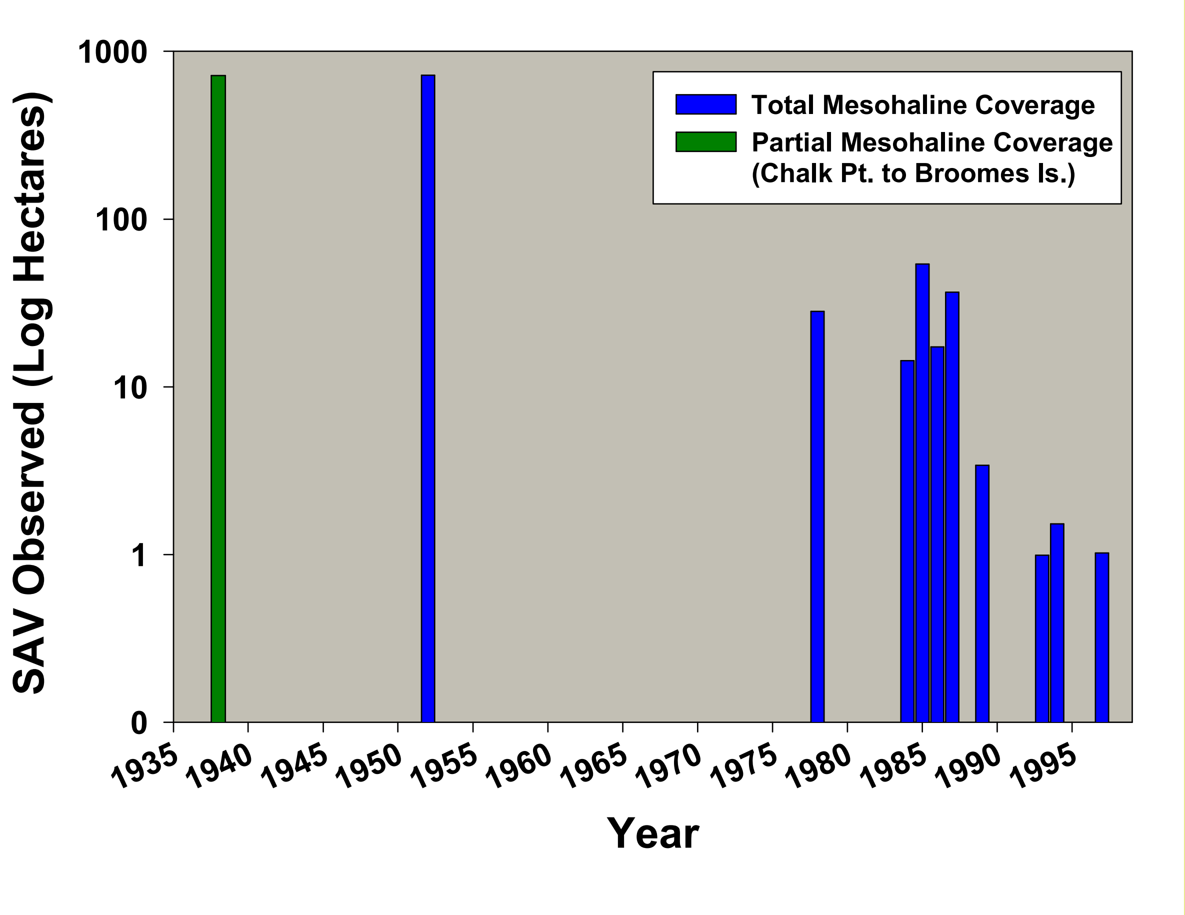


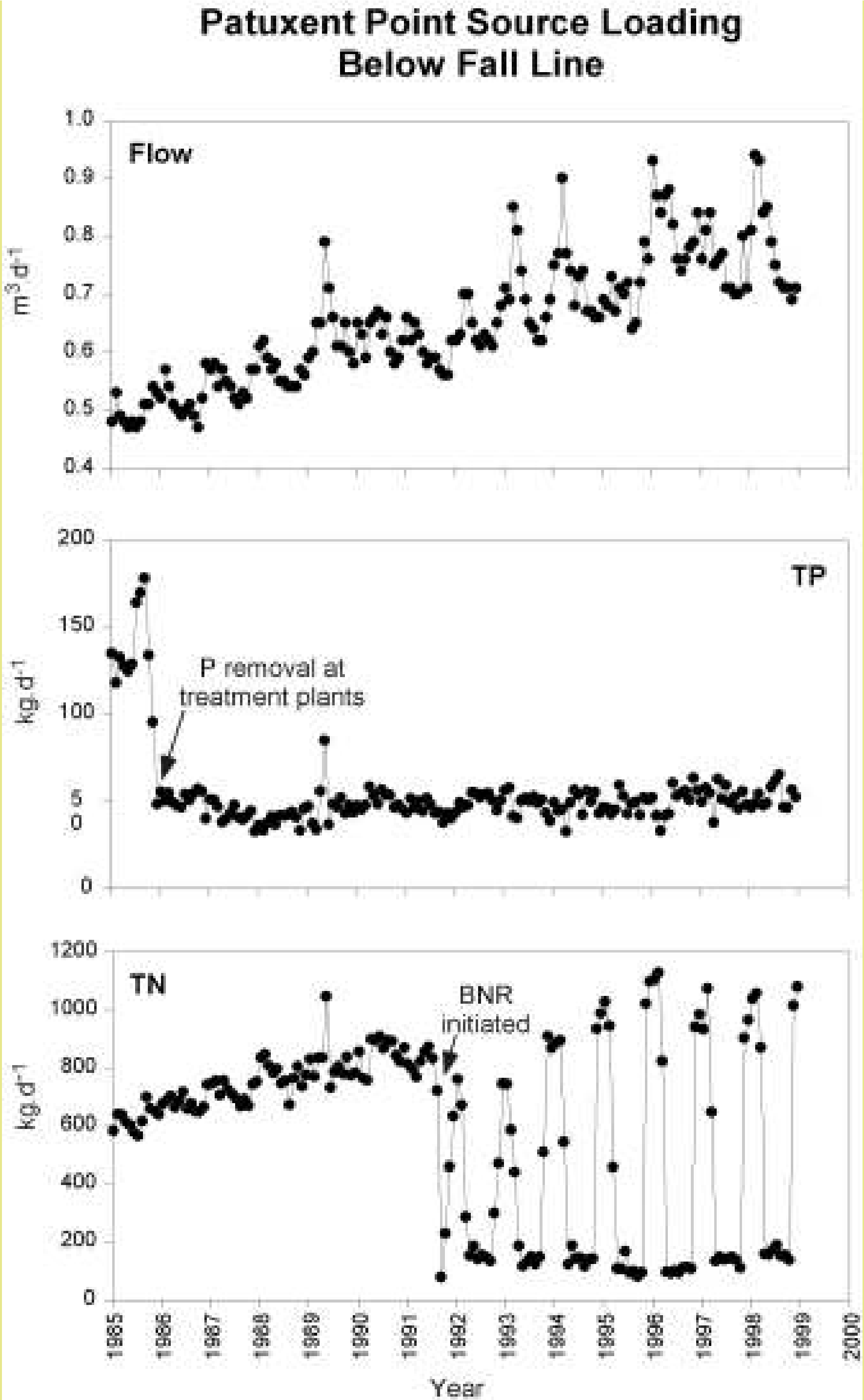
MD-DNR ConMon Program

Patuxent Estuary

Mesohaline SAV Coverage

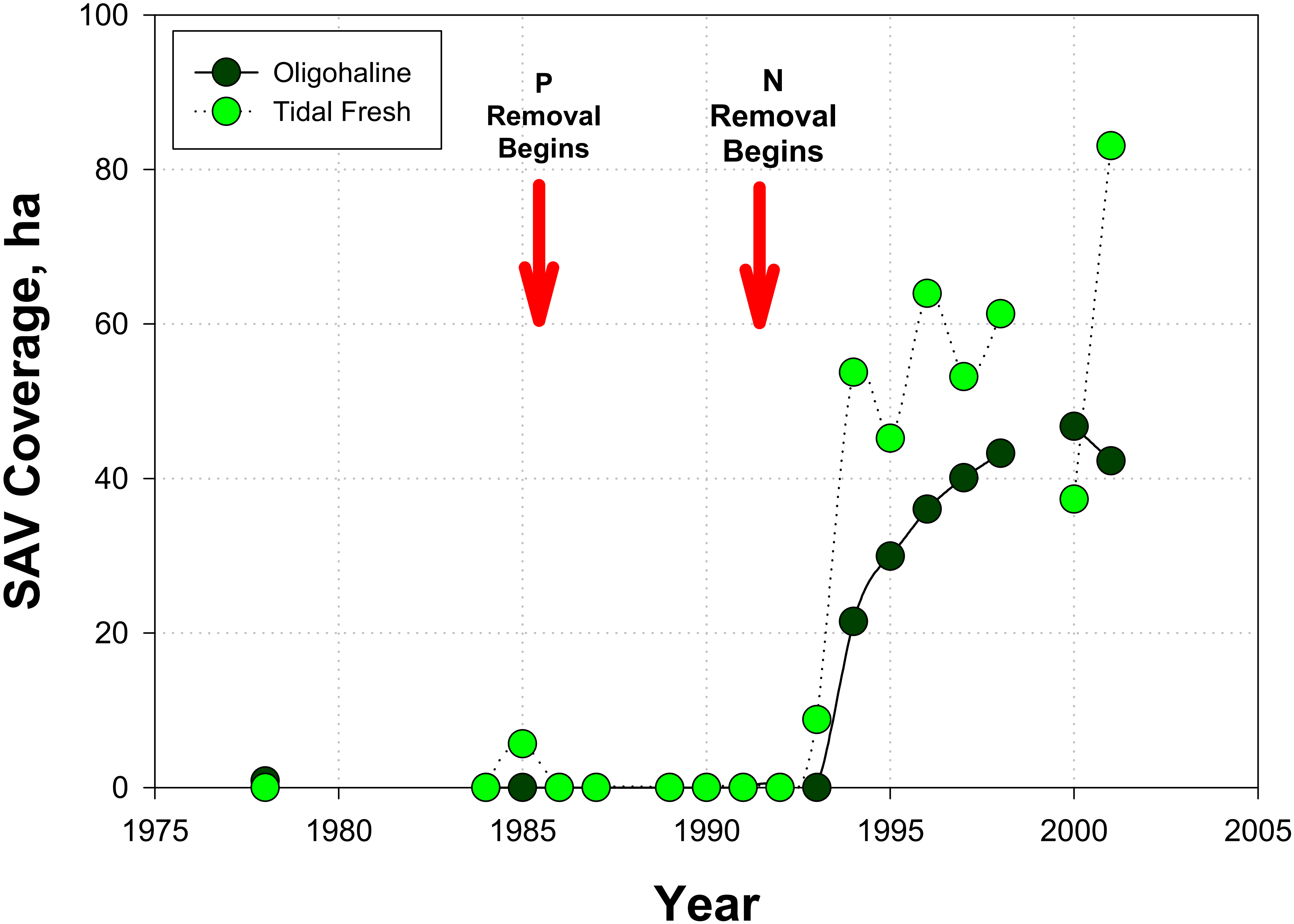
- NOTE: Log scale
- In early 1960s SAV extended 300 m from shore at Benedict
- Large decline occurred during the late 1960s
- All this decline pre-dated Tropical Storm Agnes

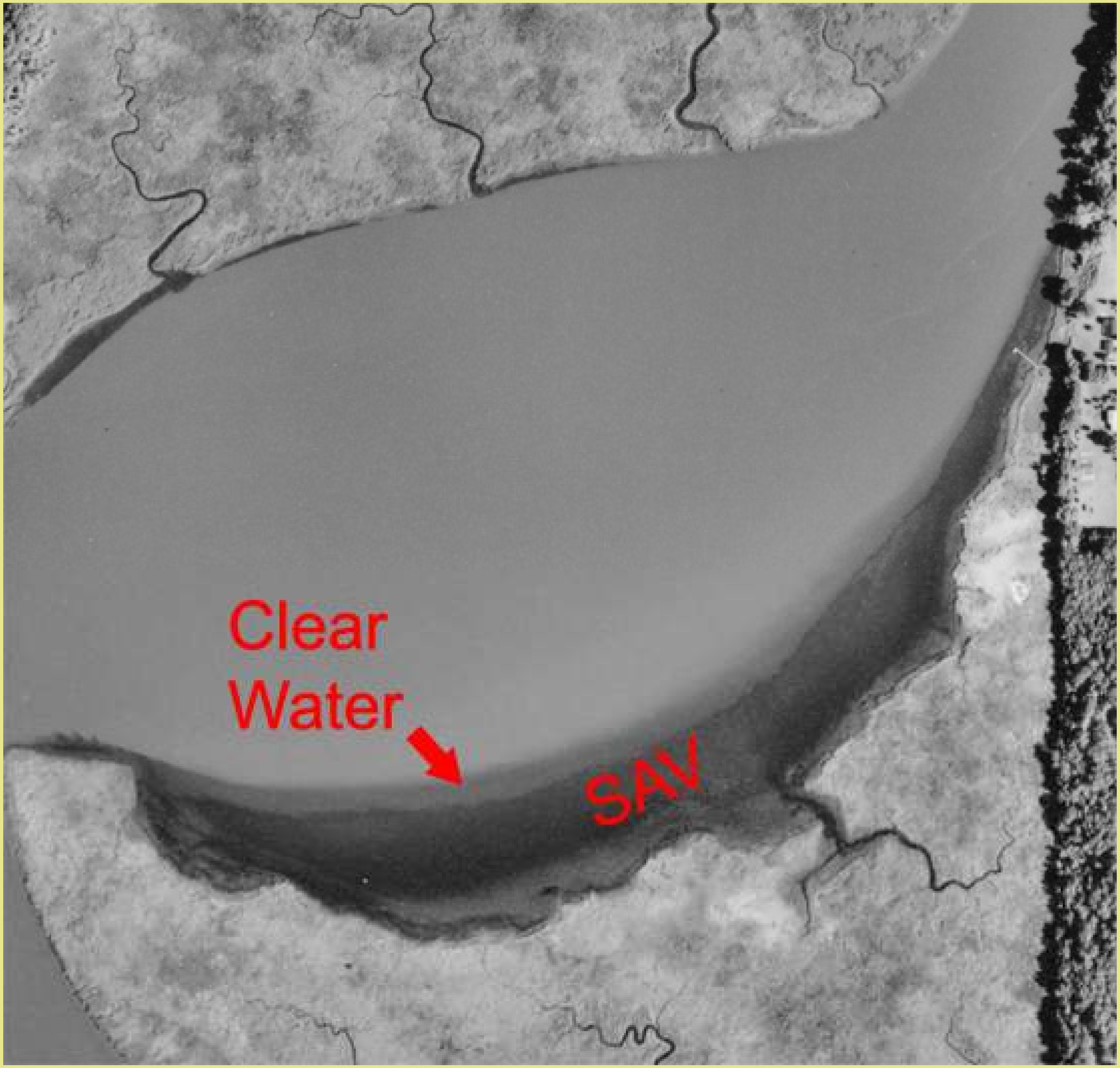




- Sewage flow rates have steadily increased with human populations.
- P removal has greatly reduced point source P inputs (3x), despite increasing flows.
- N removal via BNR has seasonally reduced point source N inputs (2x). Further N reductions from point sources will occur soon

A rapid response to a BIG CHANGE in Nutrient Loads





Orth et al. VIMS SAV Monitoring Program

Chesapeake Tidal Marshes:
A couple of examples

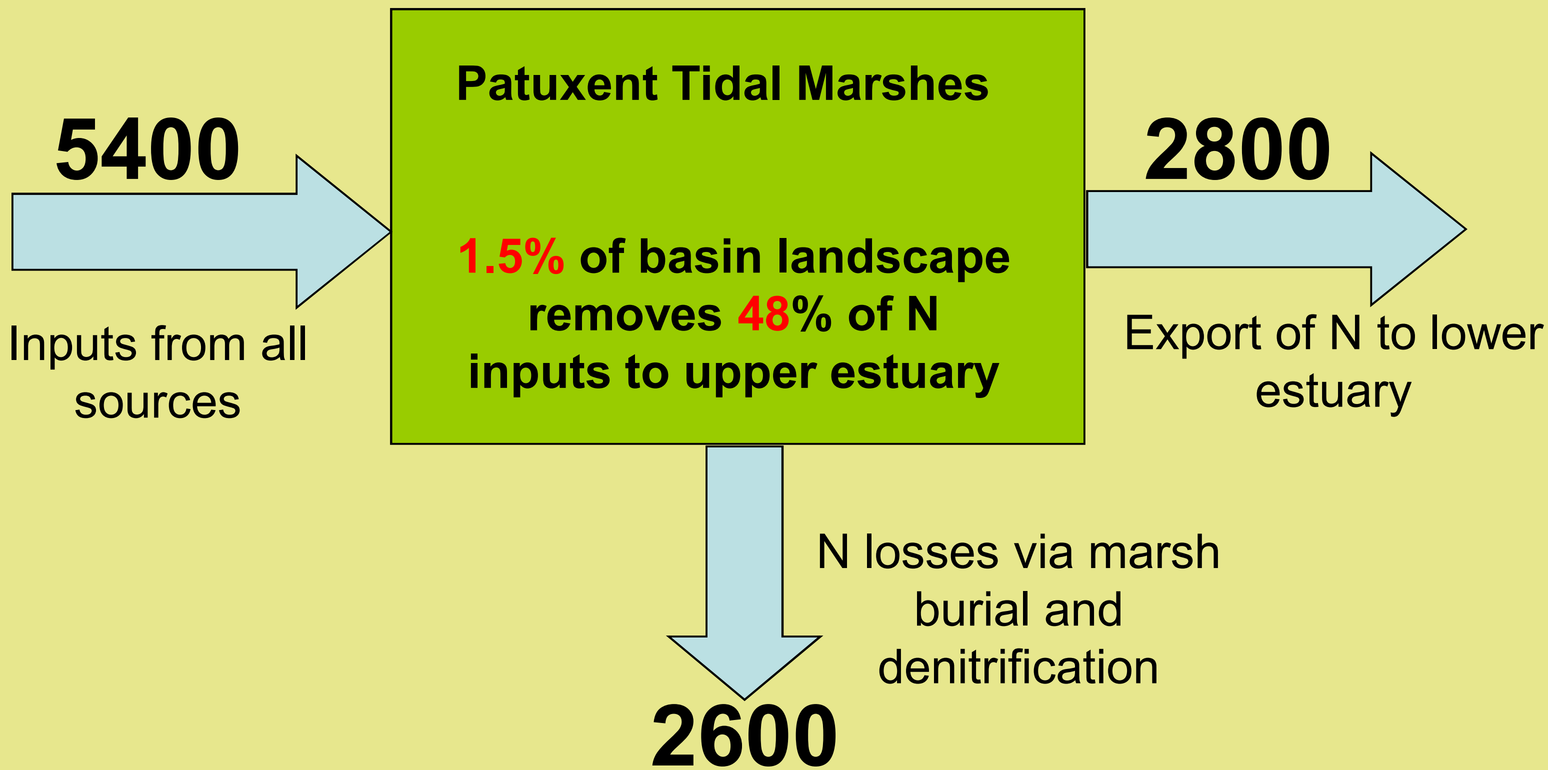
Upper Patuxent Estuary

Parkers Creek

- These wetlands are the Kidneys between the land and water

- See paper by Grace Brush on the value of wetlands…a great read

Tidal Marshes: *Hotspot* in the Landscape



Units = Kg N/day

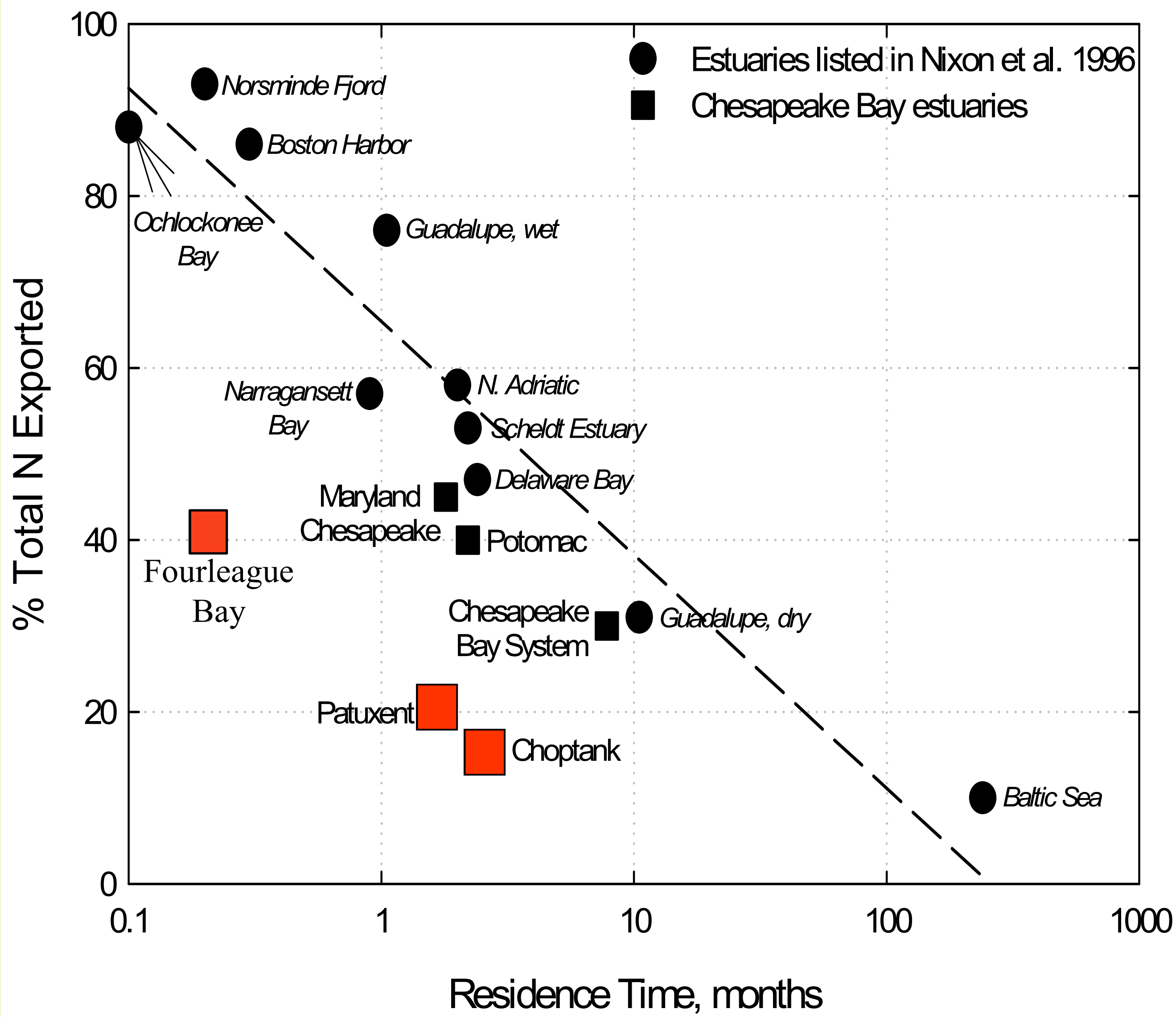
Boynton et al. 2008

Estuarine Nitrogen Export

- Strong inverse relationship between N export and water residence times

- Those that have substantial wetlands near the head of tide export far less N

- Suggests these wetlands are effective N sinks and thus promote water quality

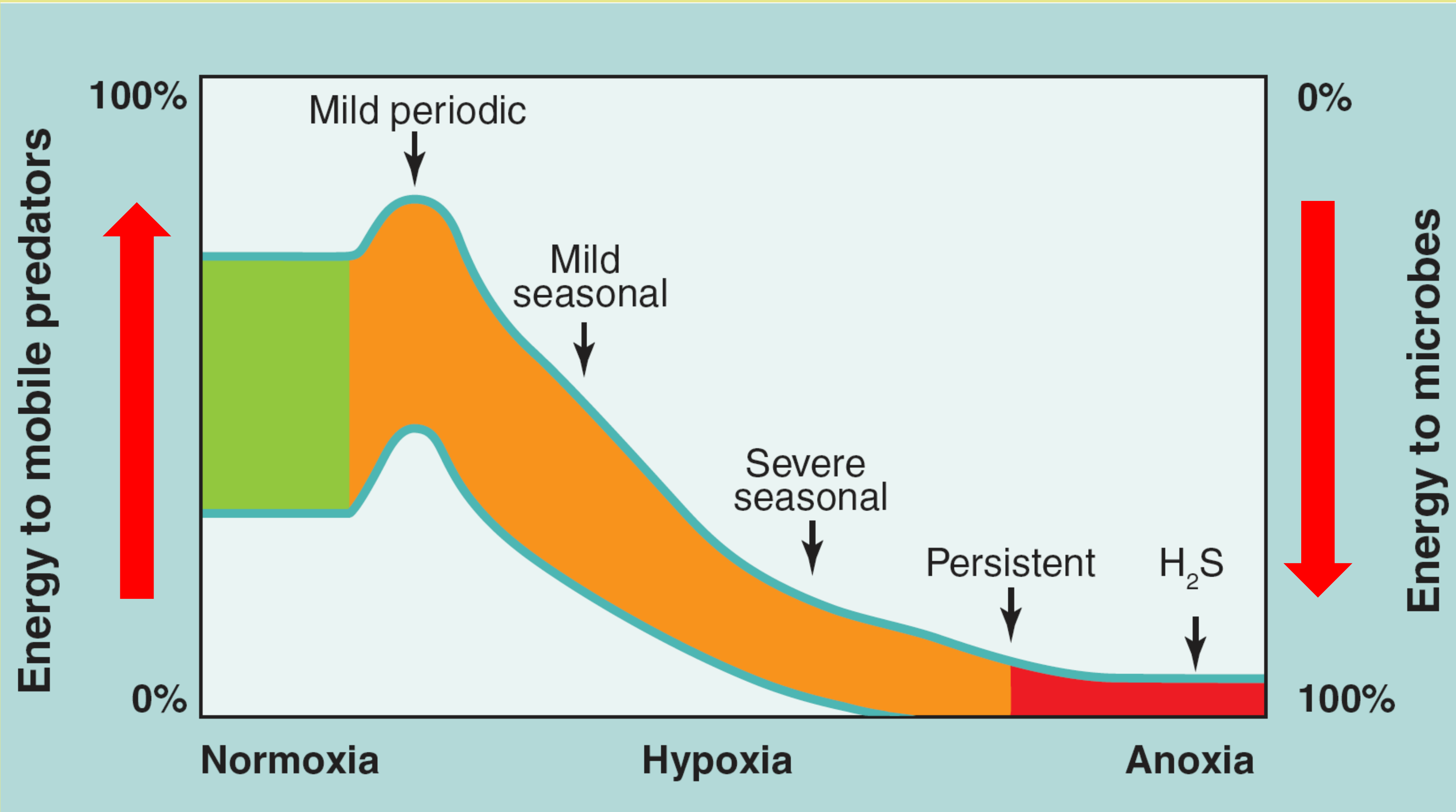


Nixon et al. 1996

A Few Words About Living Resources....the things many people value the most

- hypoxia and microbes
- benthic communities
- fisheries yields

Growing Big versus Very Small Critters Along DO Gradients



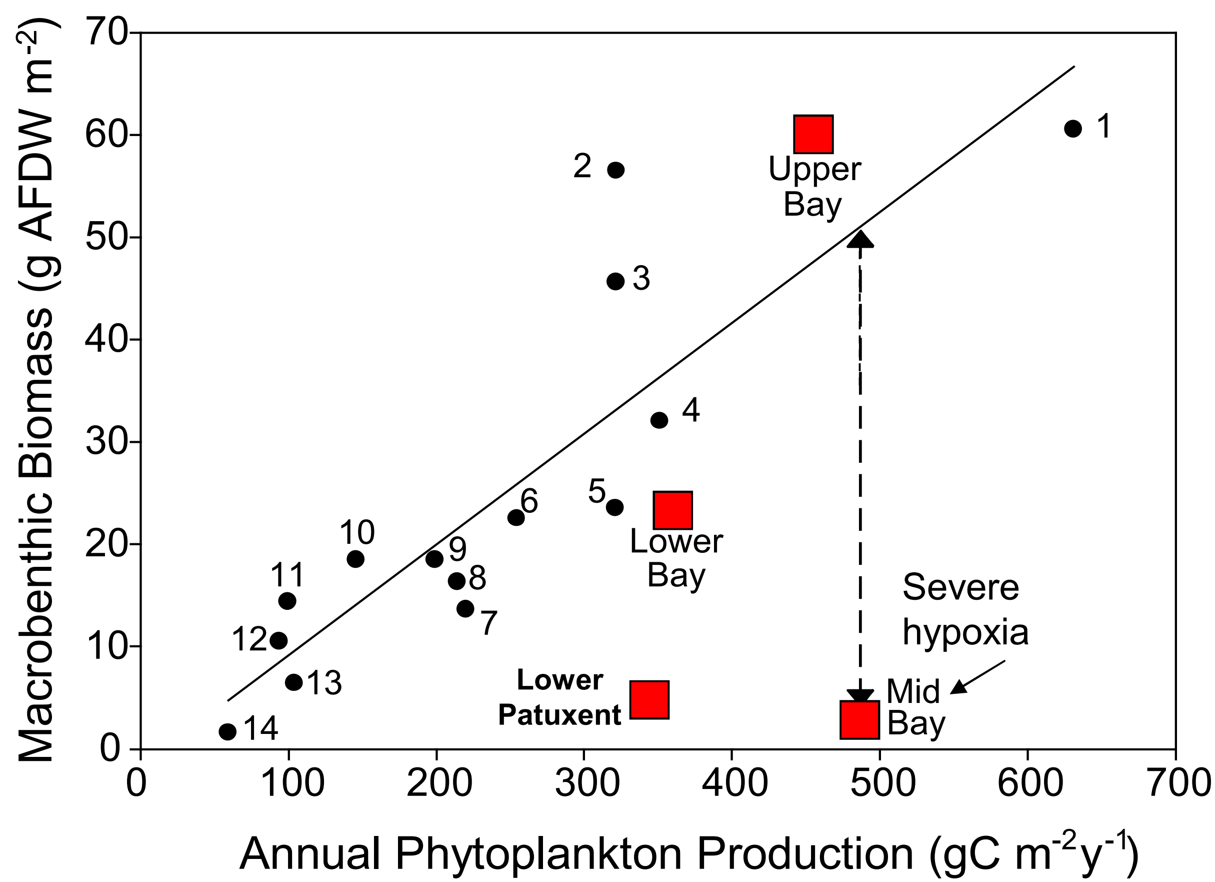
(From Diaz and Rosenberg 2008)

Degraded Bottom Habitats Lead to Loss of Benthic Invertebrate Populations in Hypoxic Regions

- Comparing estuaries worldwide (#1-14), benthic animal abundance tends to be proportional to algal food produced in water

- Upper and lower Bay generally follow this trend, but hypoxic areas have lower animal biomass

- Loss of bottom habitat may cause loss of fish and other animals

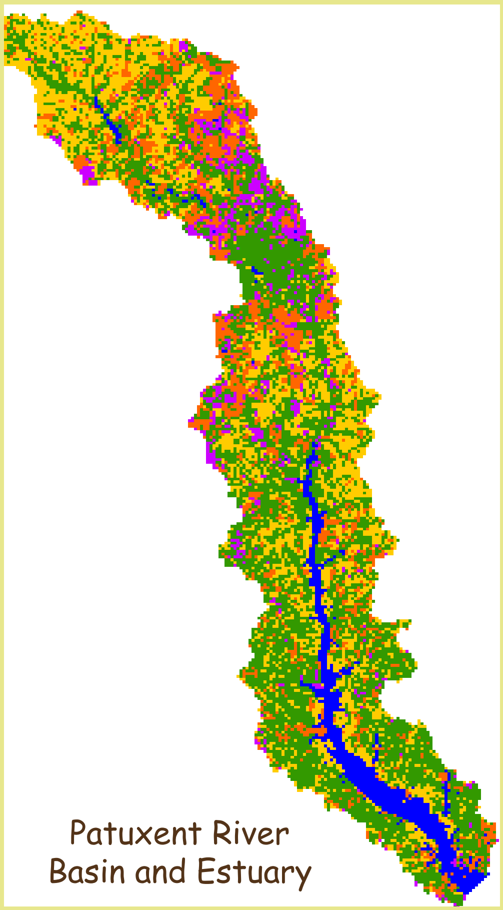


(Hagy 2002, Herman et al. 1999)

Recent vs Historical Catches, since 1960

Bottom Dwellers	Recent Catches as Percent Of Highest Catch
Oysters	<1
Spot	6
Croaker	32
Eels	49
Crabs	66
Catfish	100
Water Column Dwellers	
Bluefish	4
River Herring	18
StripedBass	20
Menhaden	54
Seatrout Gray	68
White Perch	84
Yellow Perch	100

System-Scale Insights



• Nutrient Source and Fate data much improved…helps with understanding

• Estuaries do not all respond in the same way to nutrient inputs

• Wetlands, SAV and vibrant benthic communities are all key ecosystem components…and the Pax has lost 2 of these.

• Advances in coupling physics to biology and chemistry of estuaries…models are continuing to improve

• These ecosystems characterized by "strong feedback" effects. Progress on understanding degradation and restoration trajectories

• Activities in the basin are key to the future of Water and Habitat quality in the Patuxent


Thank You for Listening!

Nutrient Loads to Many Estuaries