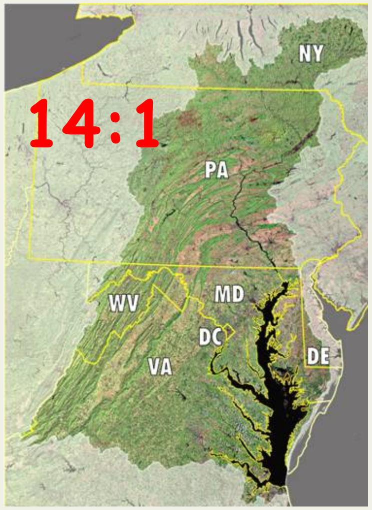
Docent Briefing

NUTRIENTS…Why all the concern and emerging success stories

April 2014

- 16 M people
- Mixed land uses
- Shallow but seasonally stratified
- Estuary "flushes" slowly (4-6 mo)
- Many rivers connect land to Bay



Large Drainage Basin

Only 0.2 acres per person for dilution of wastes

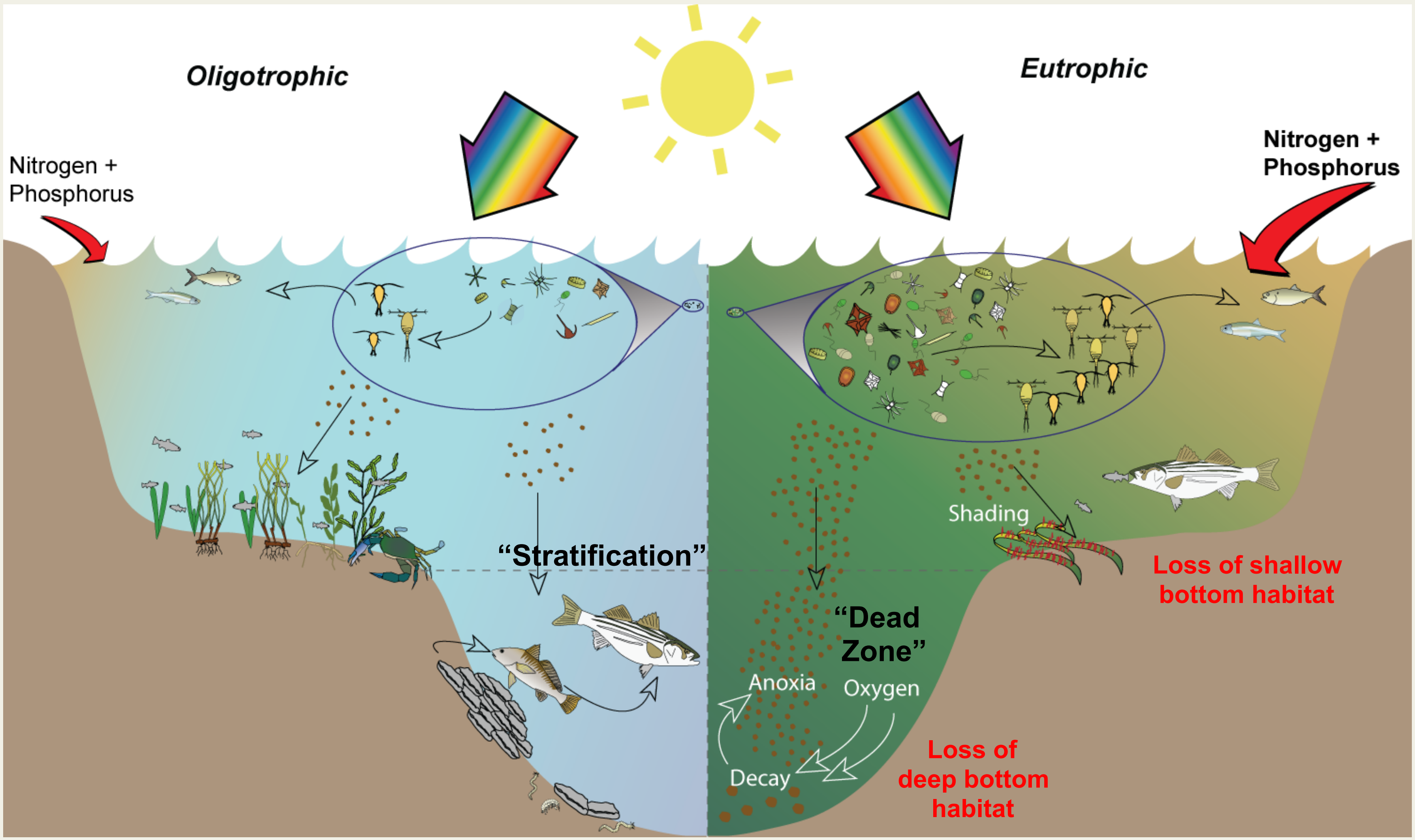
Walter Boynton
Center for Environmental Science, Univ MD

Take-Home Points

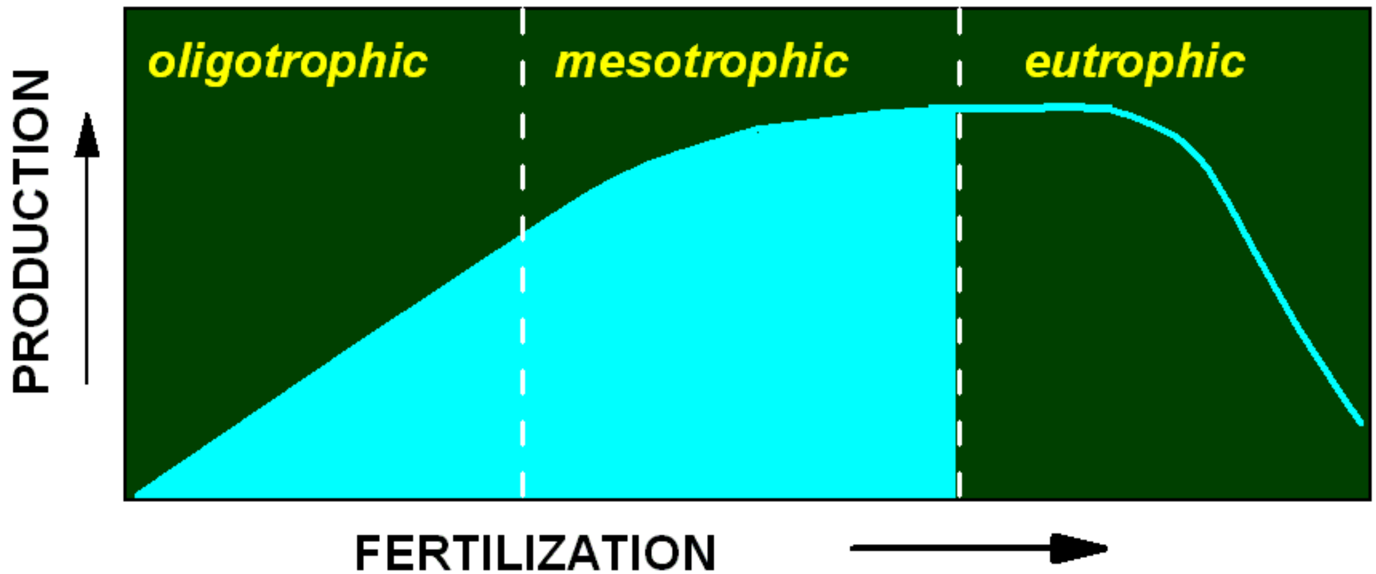
- The basic model of nutrient enrichment and restoration is solid…stay with it!
- Substantial reductions of N and P result in improved water quality and better habitat conditions
- The pathways estuaries follow towards restoration often involve time delays (lags), abrupt changes (thresholds) and things not yet fully understood
- Restoration trends (and hints of trends) have been observed in both small and large Chesapeake systems…very good signs!

Nutrient Enrichment Effects on Coastal Ecosystems

"Nutrient Obesity of an Ecosystem"

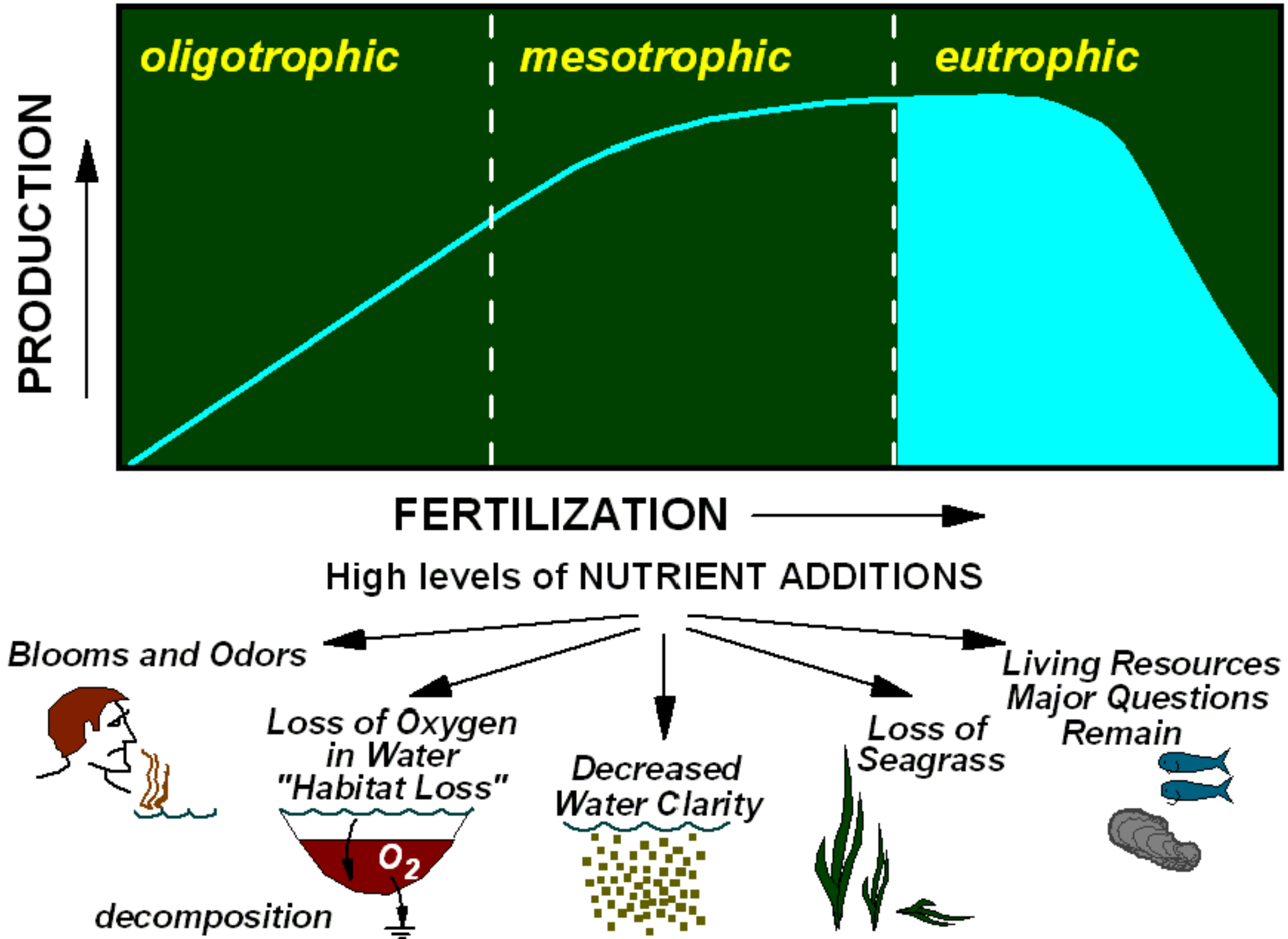


POSITIVE EFFECTS



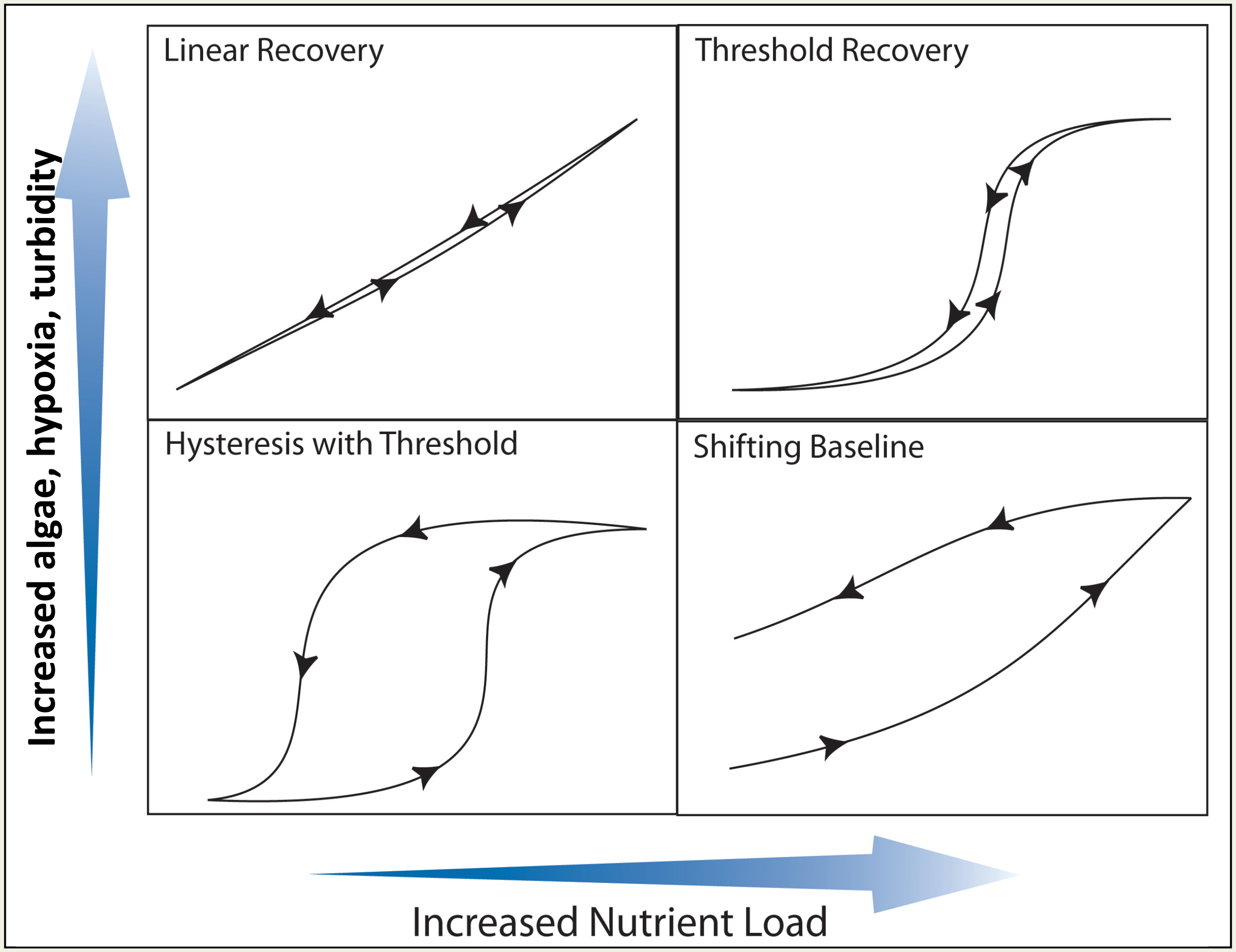
- Essential for plant growth. In most estuaries and the open ocean microscopic plants provide the basic food supply.
- Within limits, increased fertilization increases food supply and production of other organisms.

NEGATIVE EFFECTS



Ecosystem Responses to Nutrient Degradation and Remediation

we need to keep these things in mind

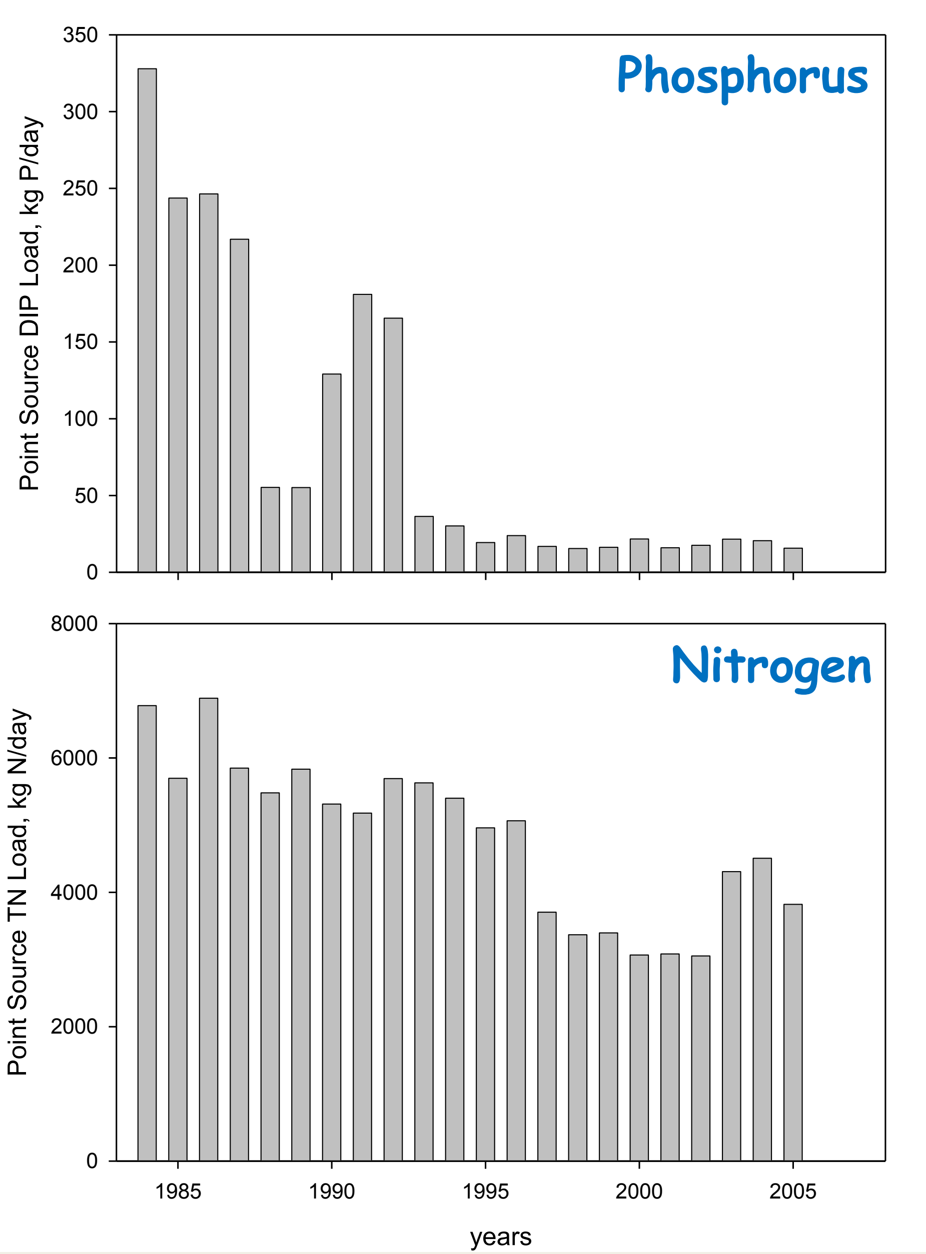


Back River Stats

Pop density	5.3/acre	dense
Land use	80% urban	intense
Impervious	41%	high
Basin/estuary	5	low
Nitrogen loads	~100 g N m^{-2} yr^{-1}	huge
SAV coverage	el zippo	none

- N and P loads very high compared to other estuaries
- Management efforts clear with N and P load reductions evident
- Corn fertilization rates = 140 lbs/acre/yr
- Back River fertilization = 900 lbs/acre/yr

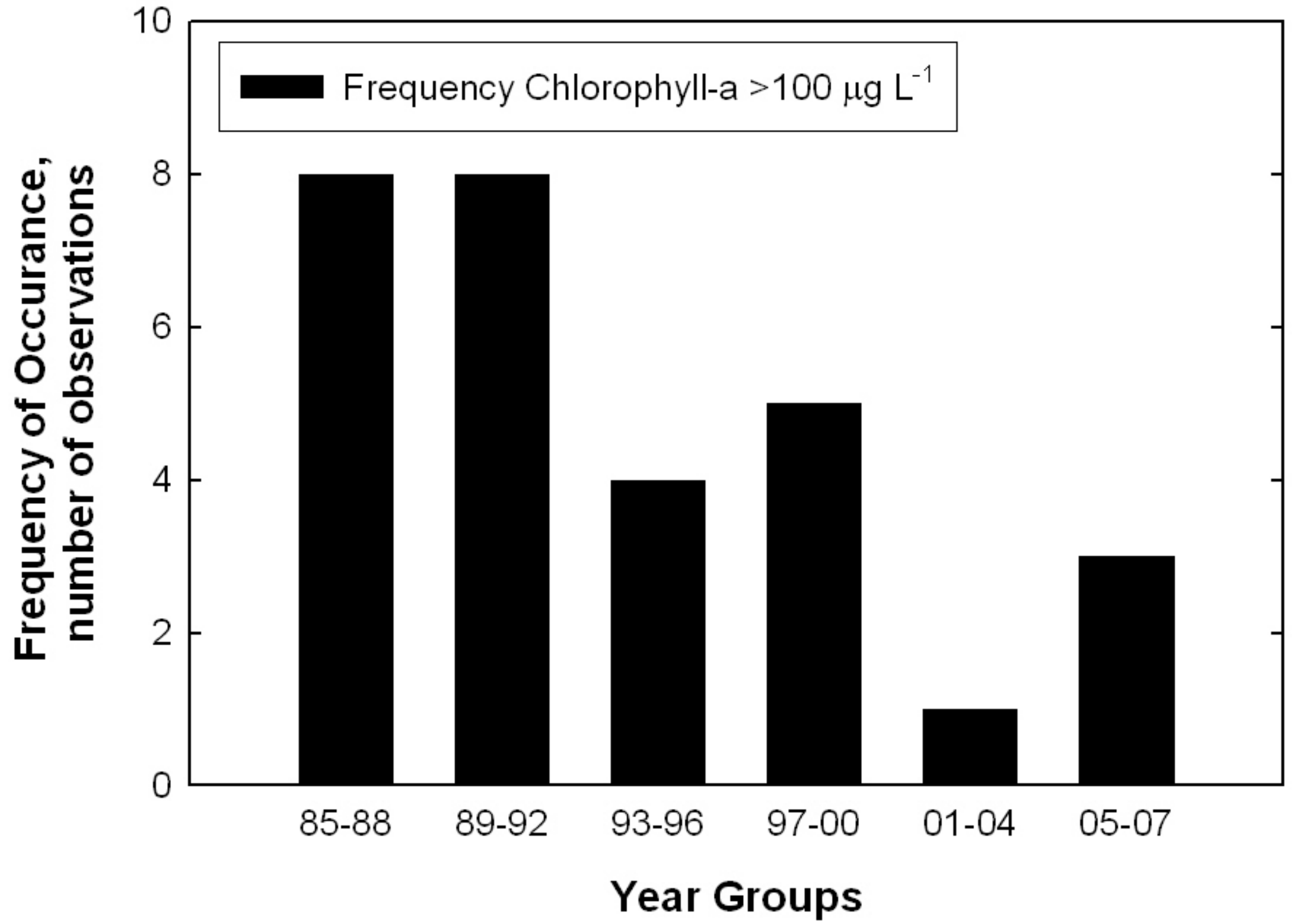
Back River WWTP Load Reductions



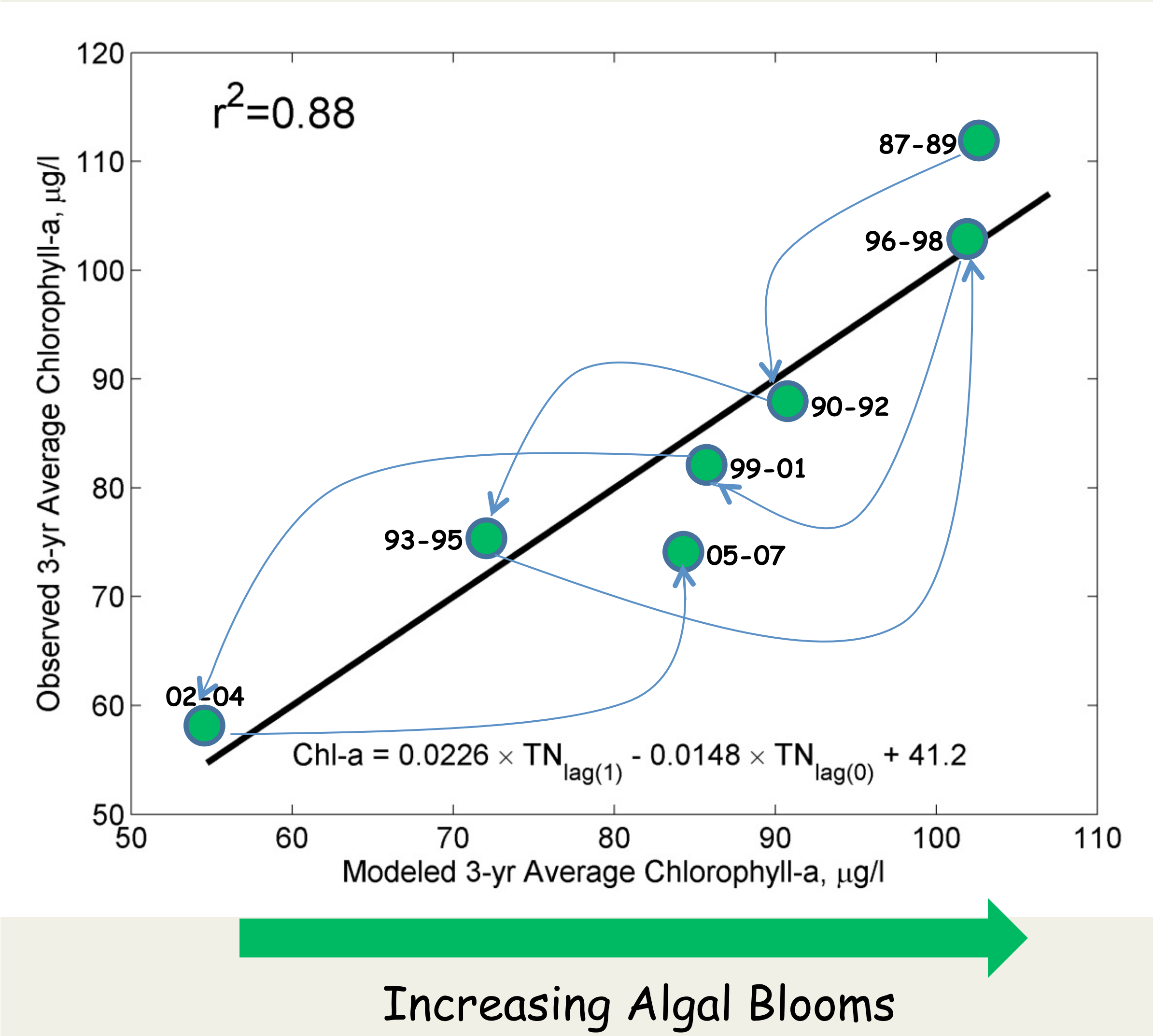
- Good engineering works!
- P loads dramatically reduced
- N loads substantially reduced

Severe Algal Blooms Decreasing

- Algal bloom frequency decreased after N load reductions
- When N loads increased again (05-07) rapid response in increased bloom frequency

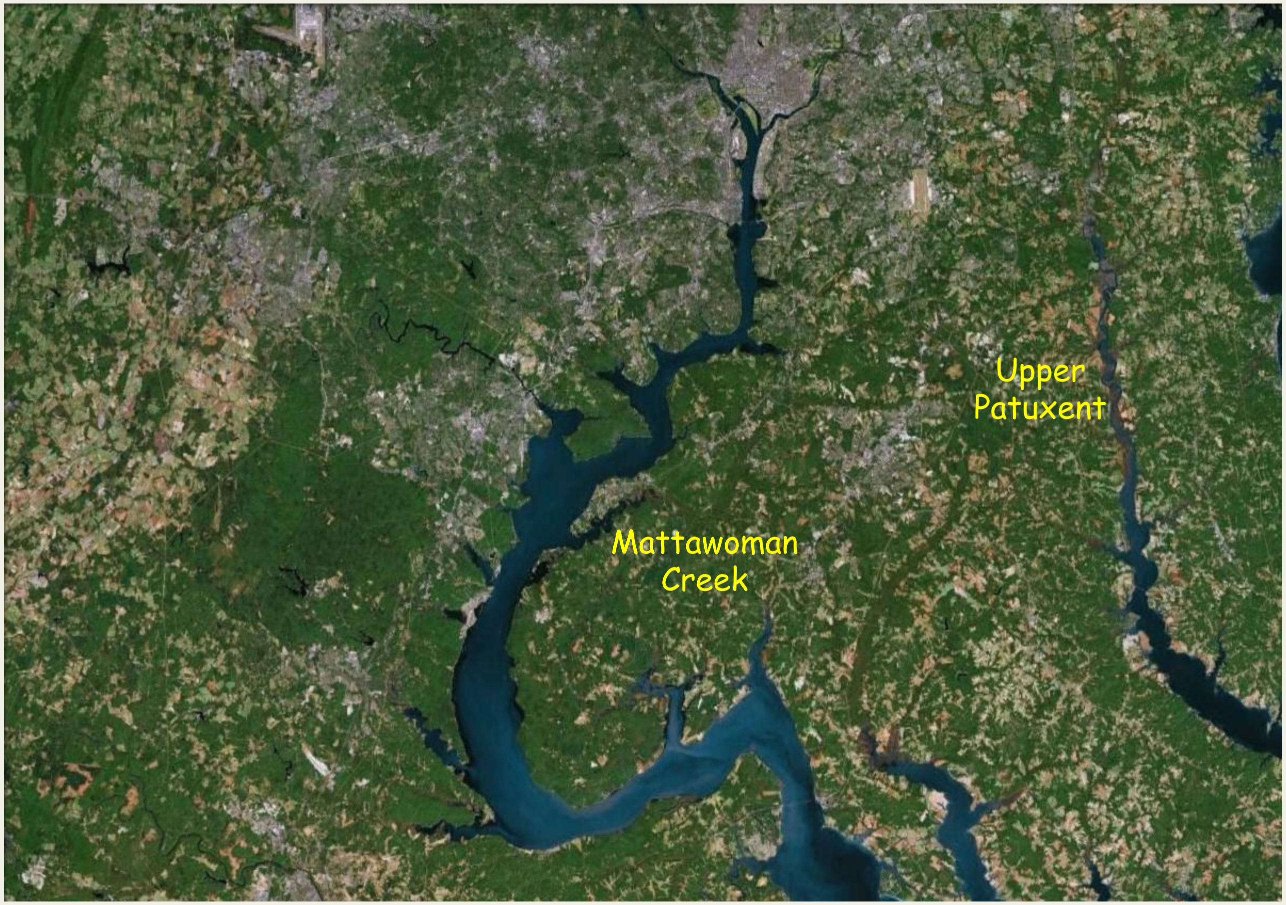


Algal Bloom – Nutrient Relationships



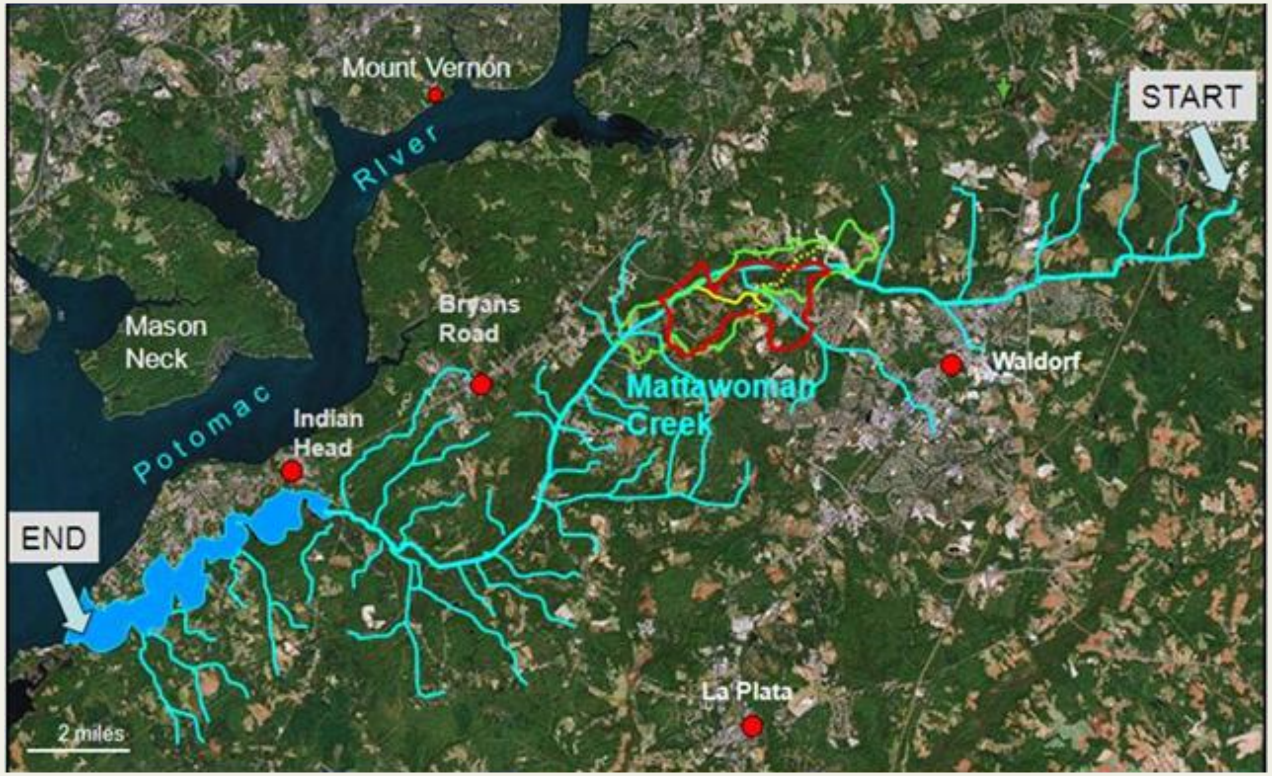
- Strong relationship between NITROGEN loads and algal blooms
- Time lags between management action and response were important… there appears to be a nutrient memory (~3 years)
- Significant algal bloom reduction was achieved (~50%)

Three Seagrass Restoration Examples



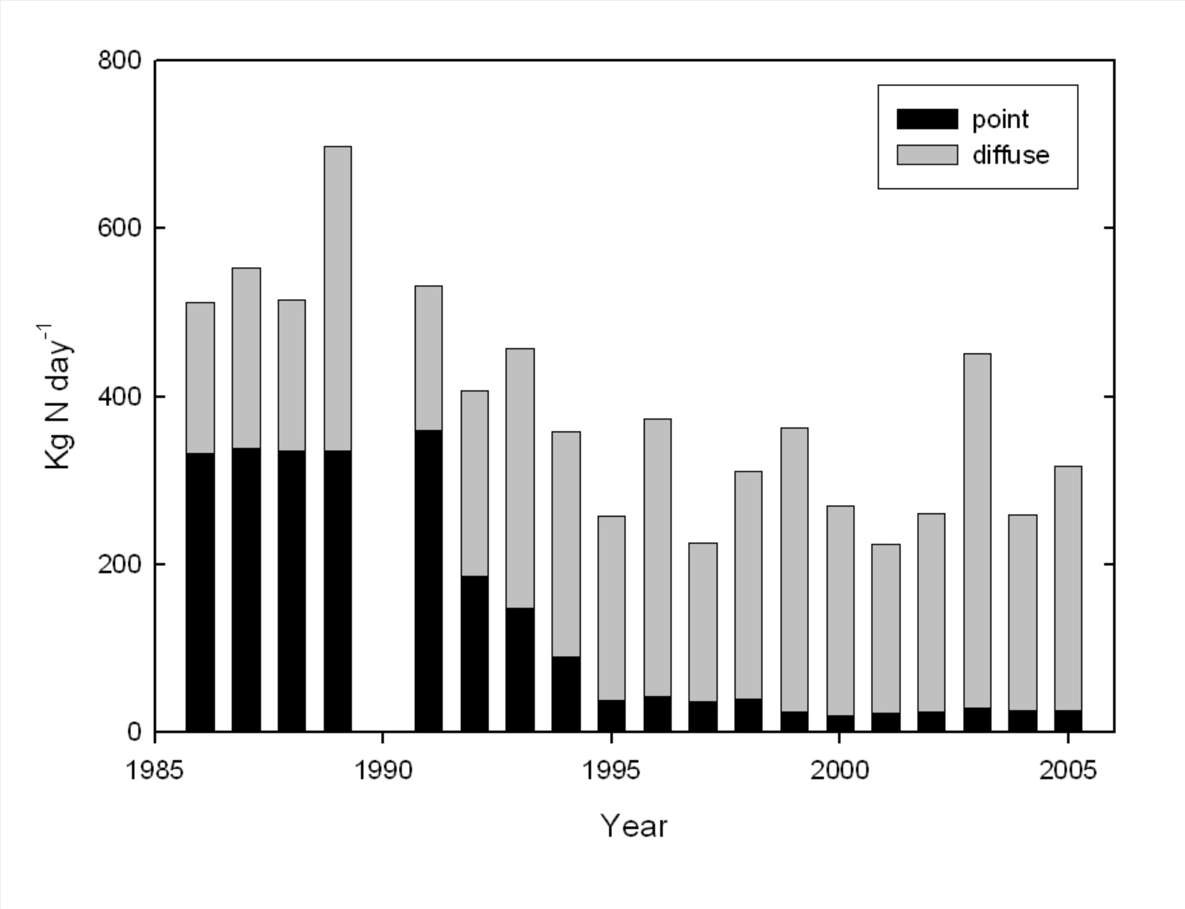
- All involved natural re-invasion of SAV
- All associated with WWTP upgrades
- All have been persistent
- This is very good news!

Mattawoman Creek, MD



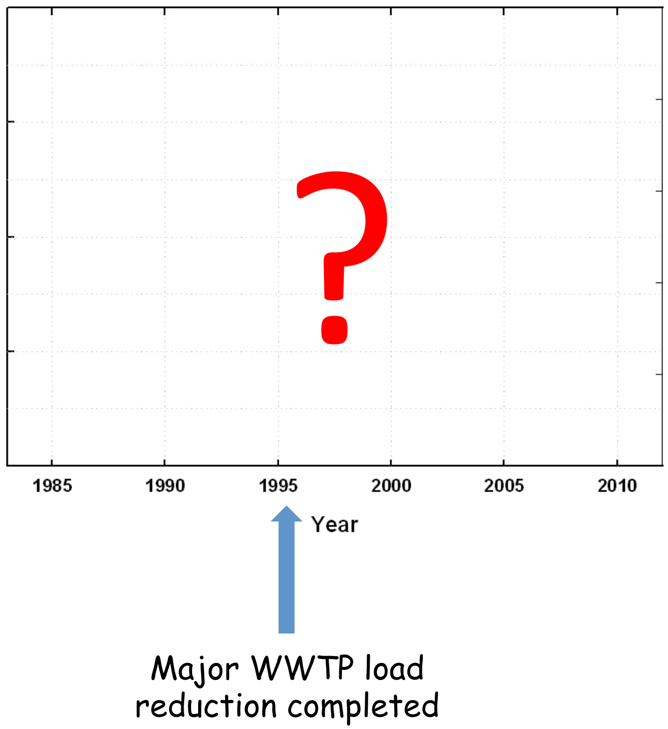
http://mattawomanwatershedsociety.org/default.aspx

Time-series of Point and Diffuse Nitrogen Loads: 1986 - 2005

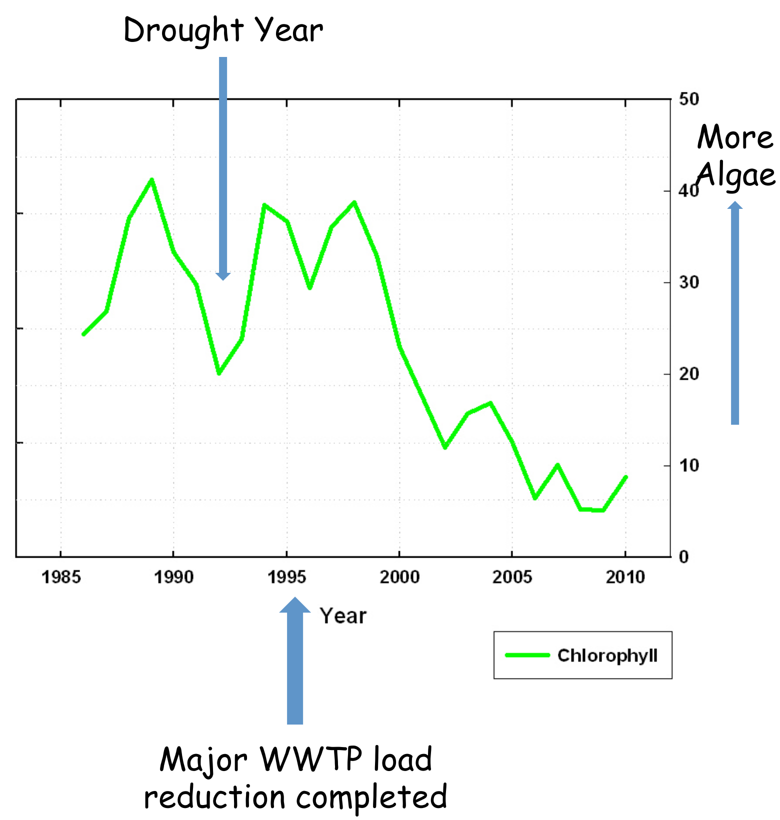


- Reductions related to point sources
- Diffuse loads weather dependent
- N-loads decreased from ~ 30 to 12 g N m^{-2} yr^{-1}
- P-loads also decreased

What Were the Responses to Load Reductions in Mattawoman Creek?

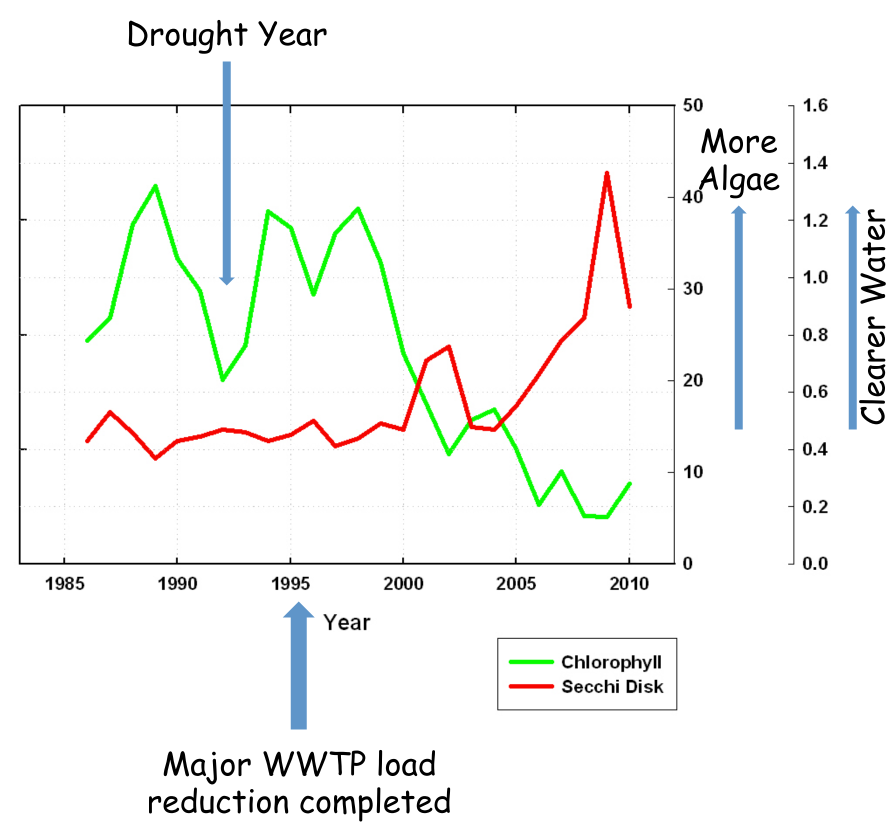


Algal Biomass Decreased…with Substantial Lag Time



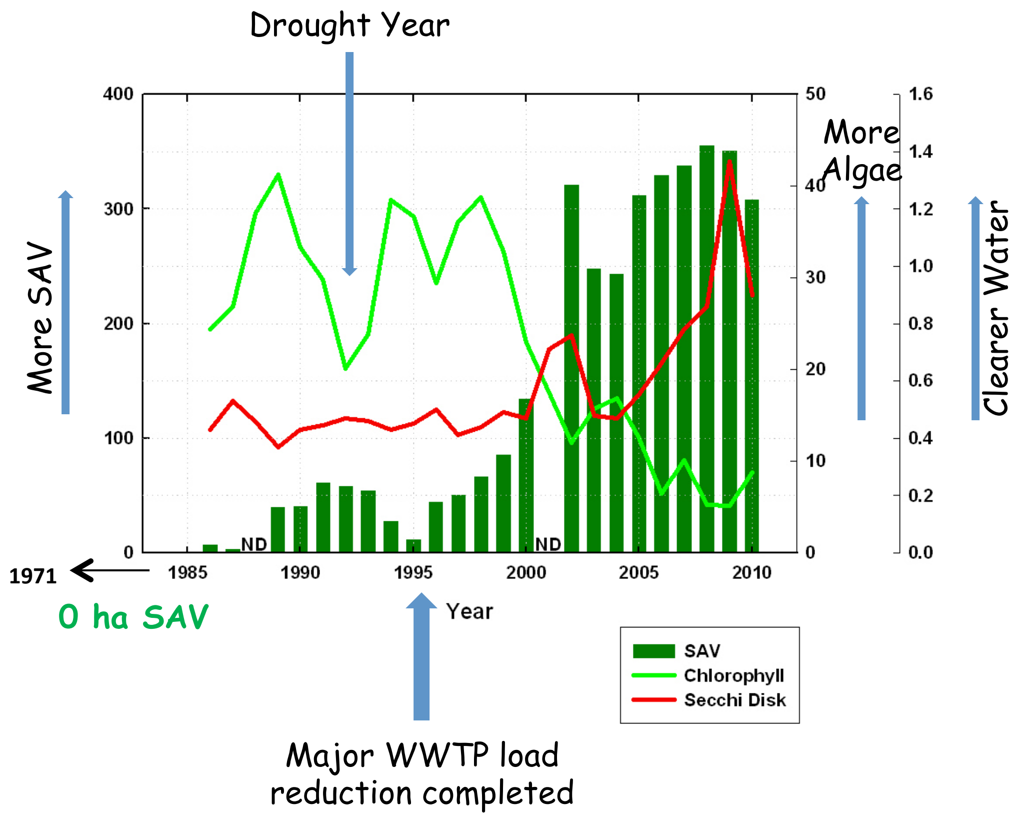
- No clear response for about 4 years followed by sharp decline in Chloro-a
- After 2005 low levels of Chloro-a persisted
- Total lag time from completed load reduction to new condition ~ 10 years

Water Clarity Increased…also with Substantial Lag Time



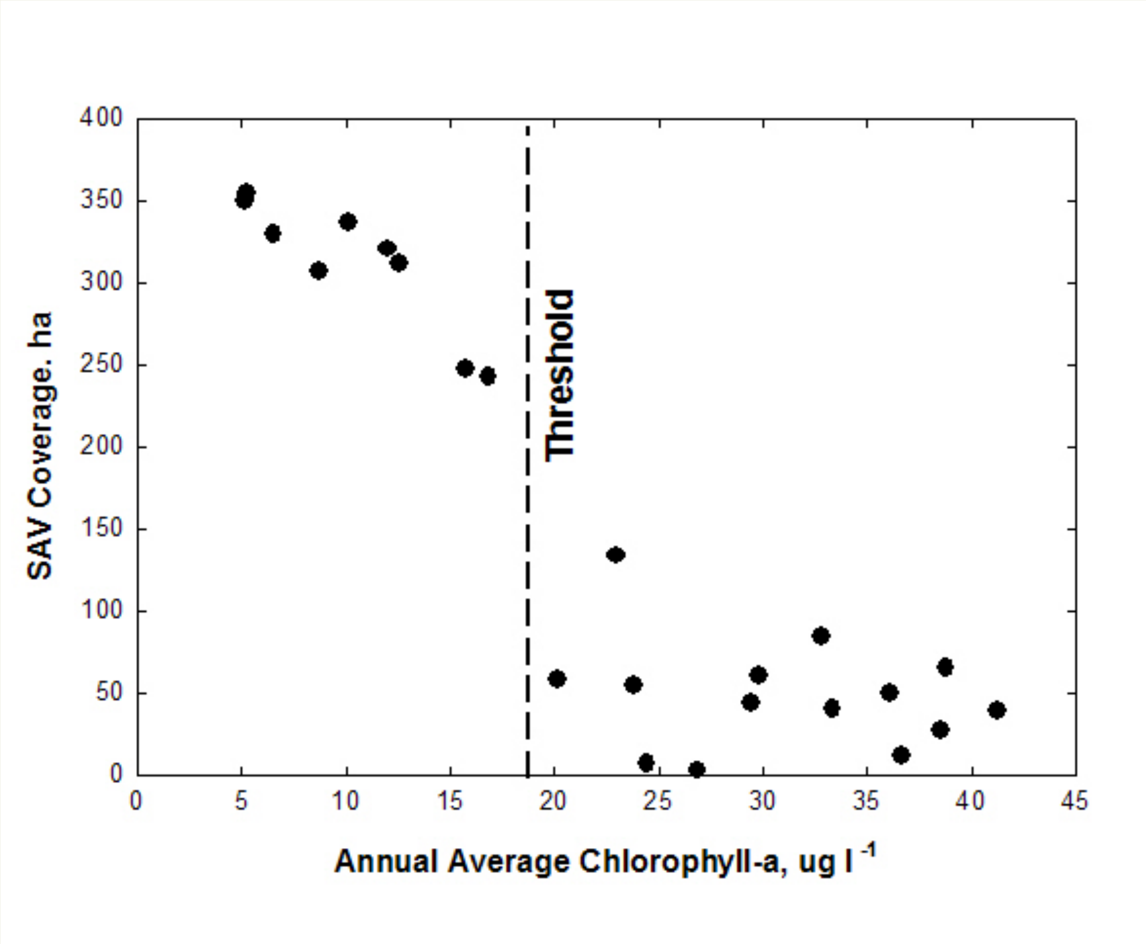
- No clear increase for about 8 years followed by sharp increase in clarity
- Water clarity and Chloro-a highly correlated in this and other shallow Chesapeake Bay systems
- Total lag time from completed load reduction to new condition ~ 13 years

SAV Increased…with Shorter Lag Time and Possible Threshold Response

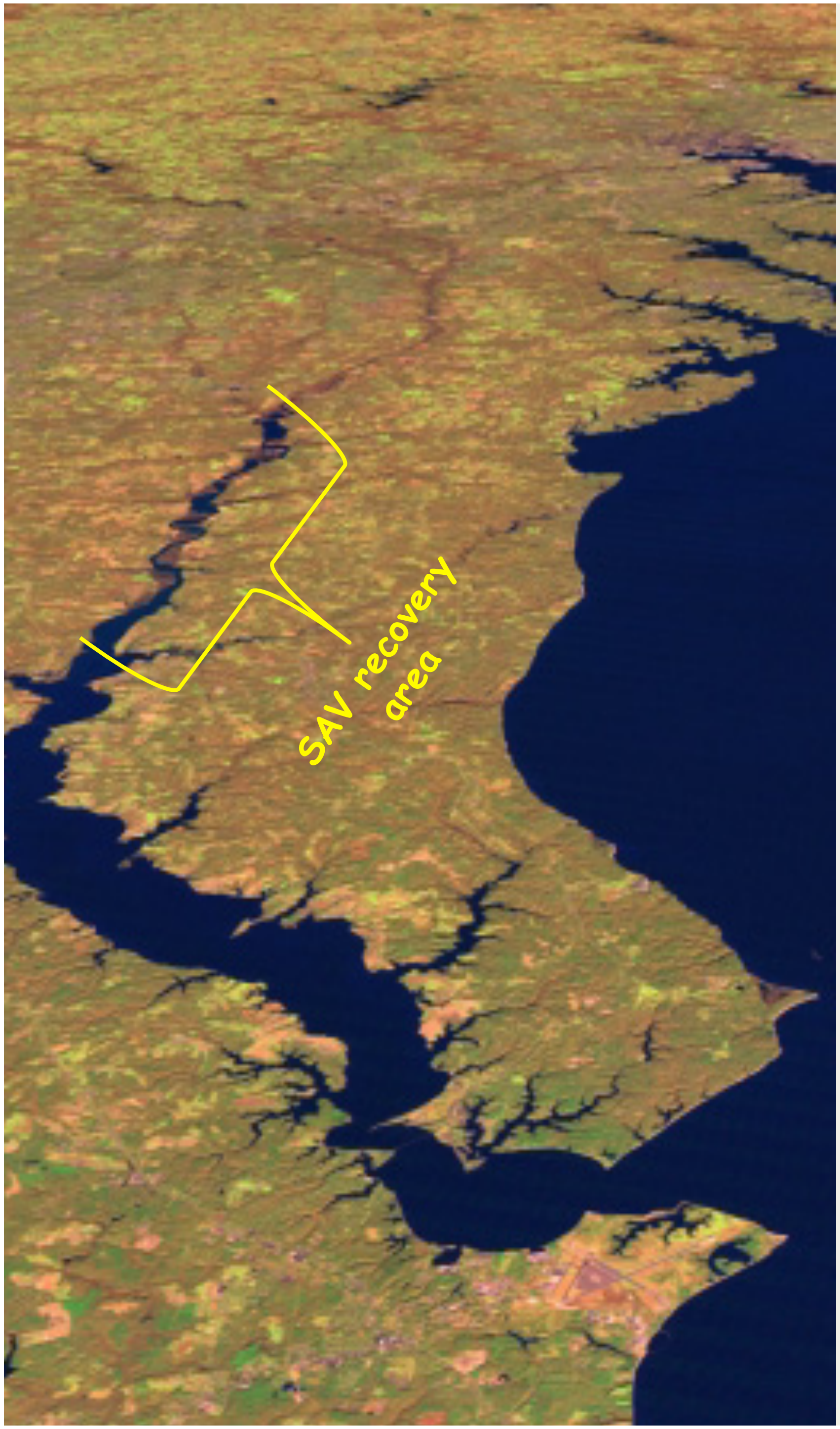


- Low levels of SAV were present prior to WWTP modifications
- Major expansion of SAV in 2002, a severe drought year
- SAV relatively stable post 2002; lag in SAV relatively short

Possible SAV Threshold Related to Chlorophyll-a and Water Clarity



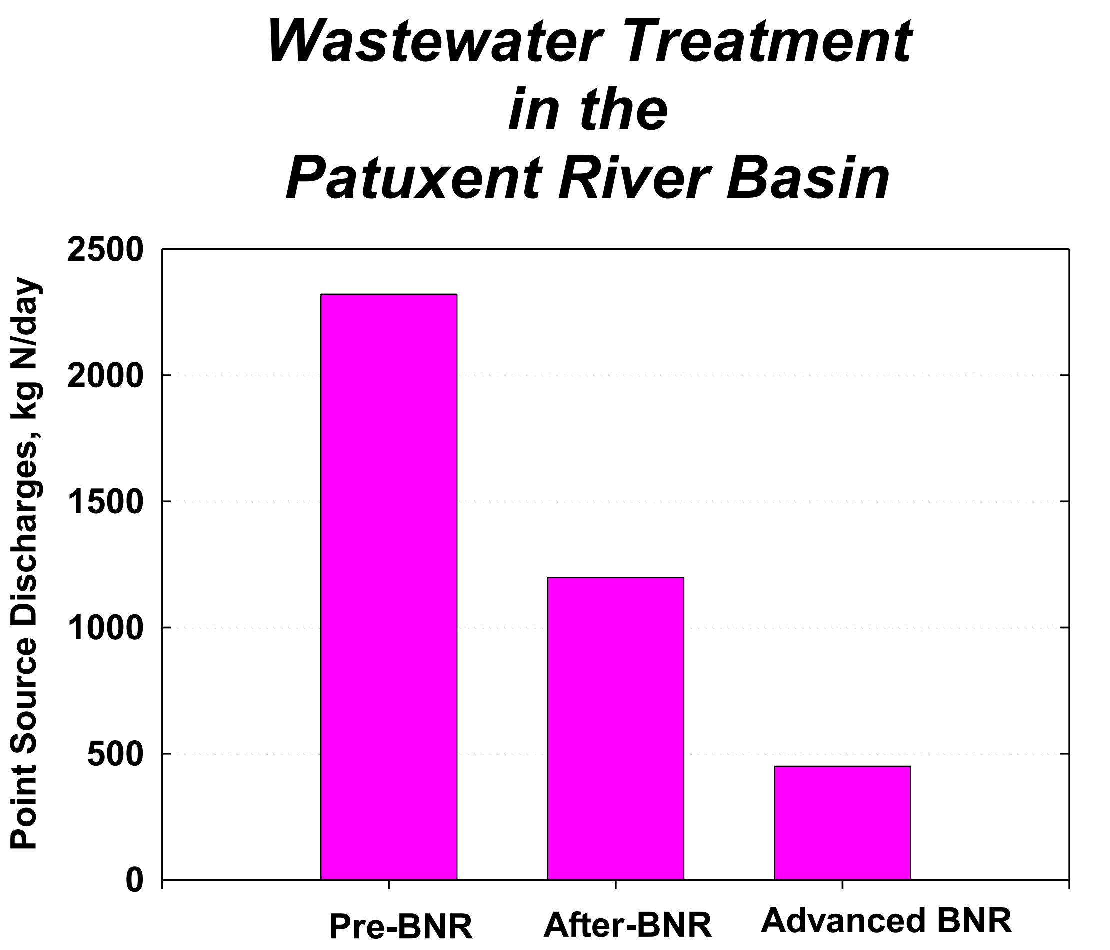
- A large increase in SAV coverage (and density) associated with Chloro-a concentration < 18 ug L^{-1}
- SAV expansion in this creek occurred at N-loading rates only slightly higher than those observed in other coastal systems



SAV in the Upper Patuxent River Estuary

- SAV gone by 1970 in upper estuary
- P removal at WWTP in 1986…no SAV response…could not see any WQ response
- Seasonal N removal at WWTP 1992-1993
- Dramatic SAV response by 1994 and sustained to the present day
- Appears to be a response to N load reduction with almost no lag time

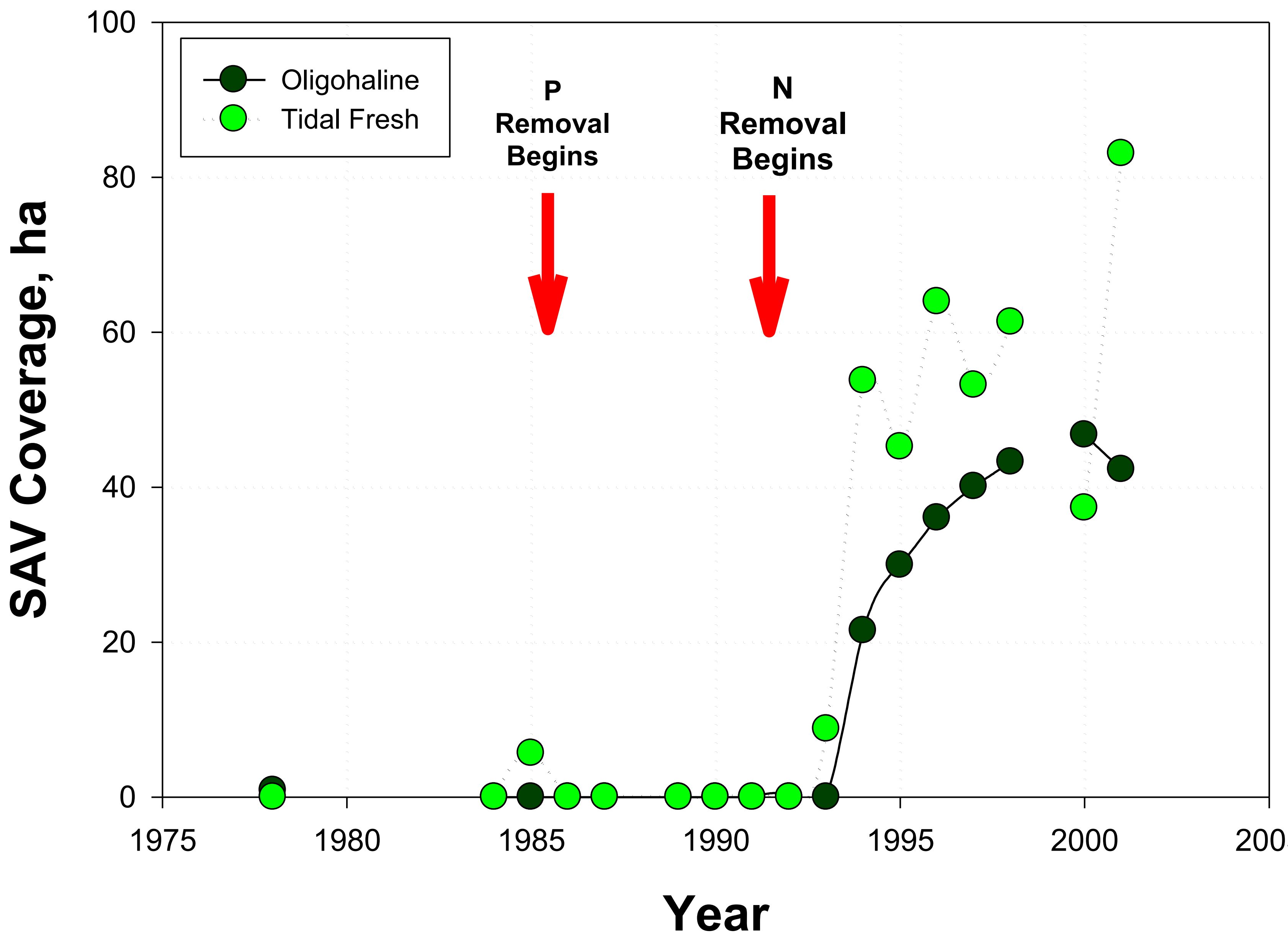
Major Reductions in WWTP Discharges of N and P in the Patuxent



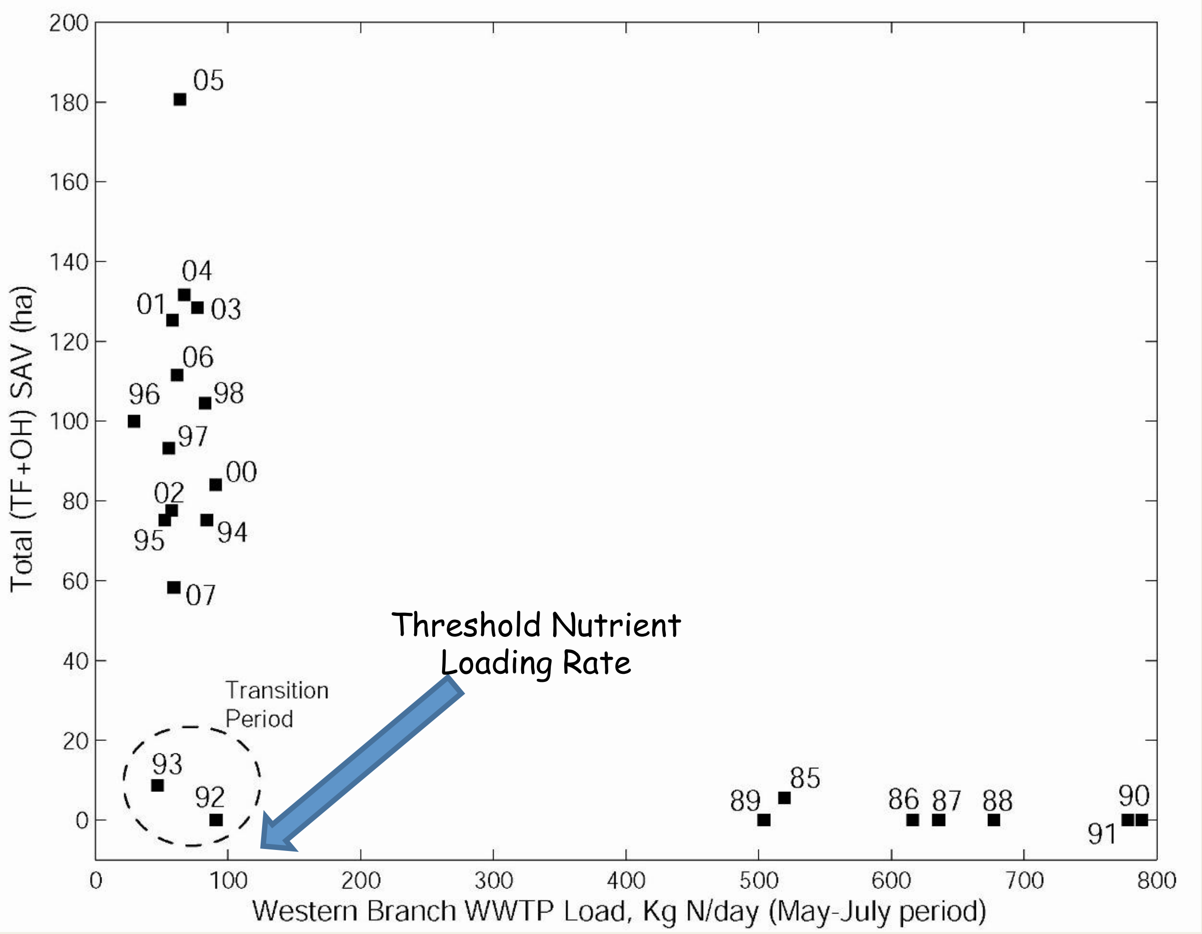
Patuxent WWTP Story

- 9 major WWTP in the basin
- Among the first to remove P
- N removal began 1992-93
- Plans call for further reductions
- When reductions completed, WWTP discharges will be a small part of the Patuxent nutrient problem

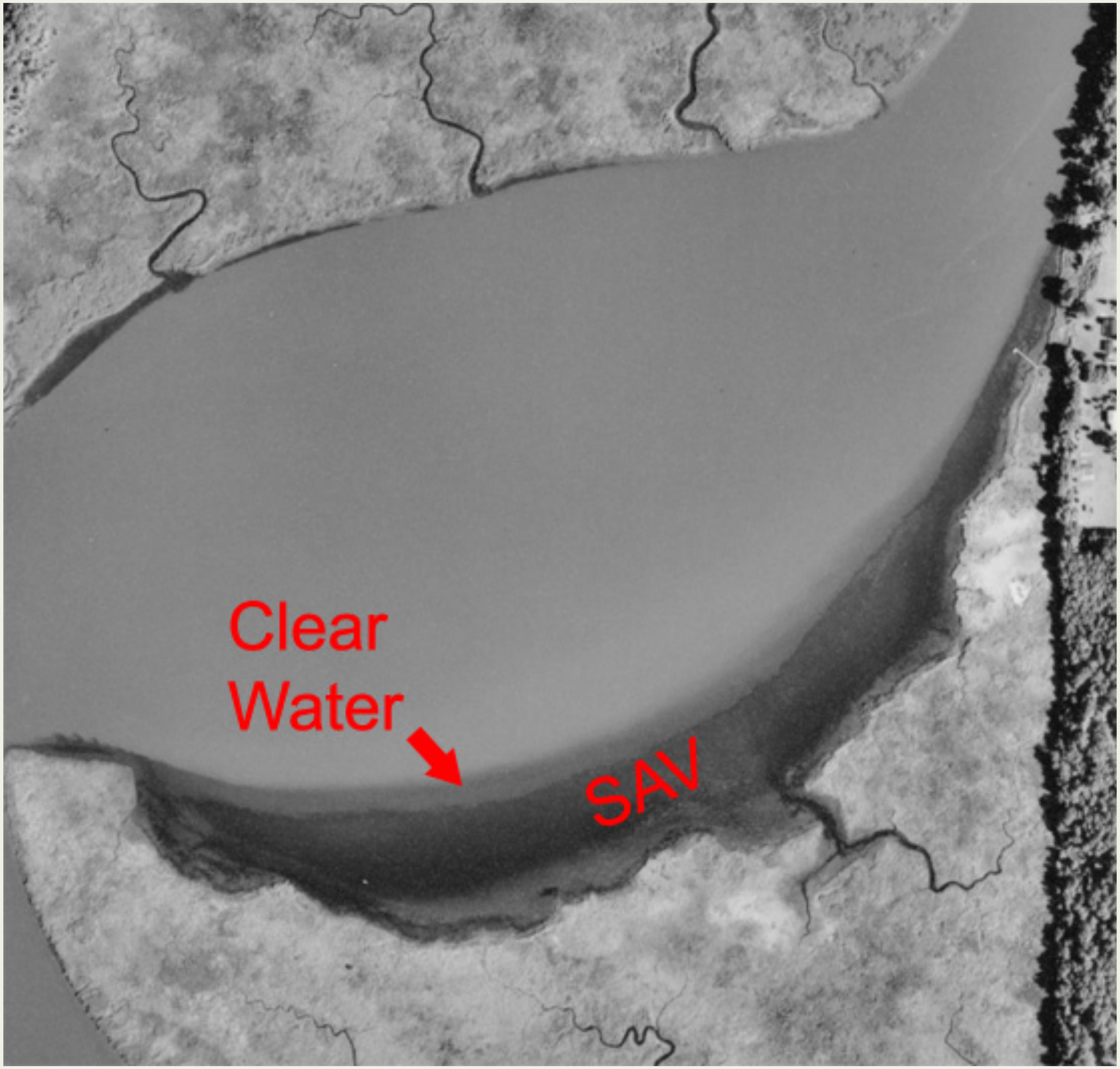
A rapid SAV response to BIG CHANGES in nutrient loads



A Threshold Response in the Upper Patuxent



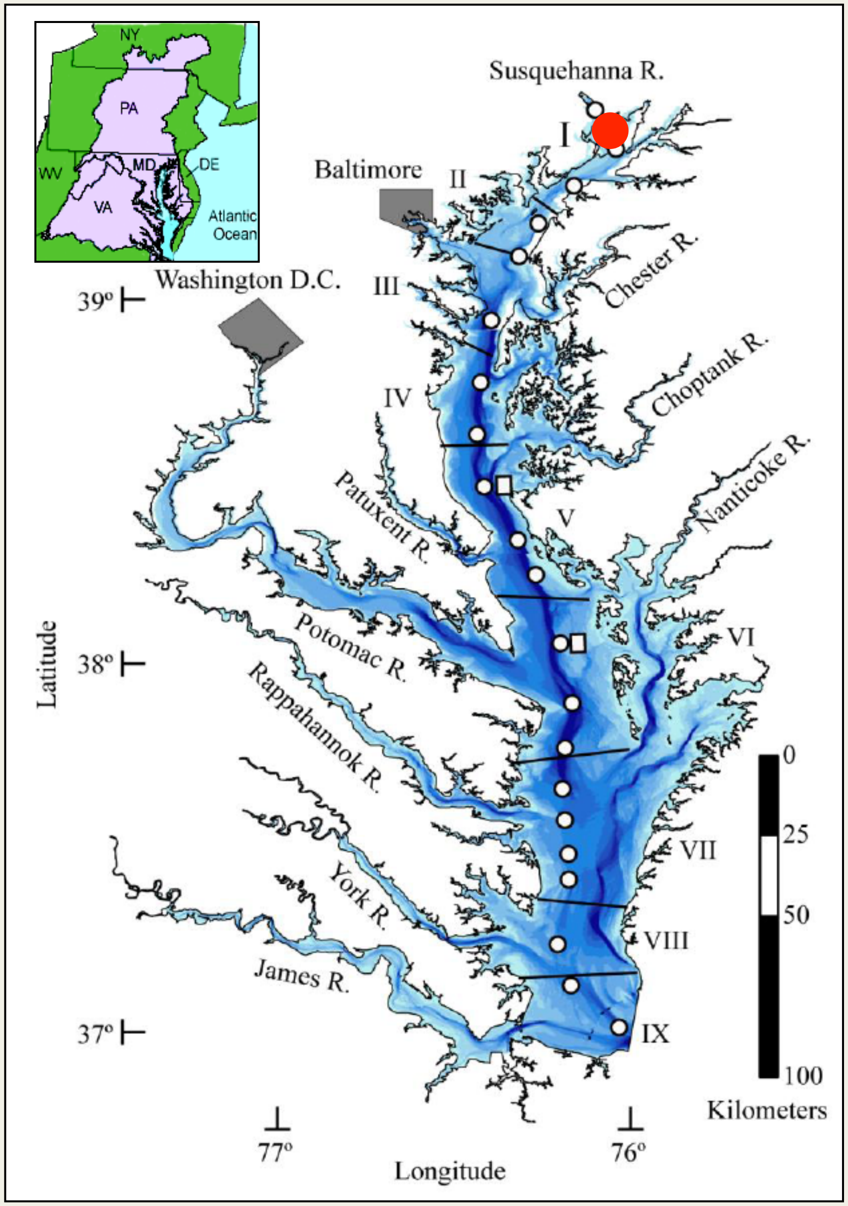
- No SAV at WWTP loads greater than ~100 kg N/day
- Very short transition period
- SAV exploded post 1993
- Post-1993 inter-annual variability not related to small variations in N load



- A typical summer situation in the upper Patuxent
- SAV dominated shoal water and associated fringe quite clear
- Channel water very turbid

- photo from R. Orth and colleagues (VIMS)

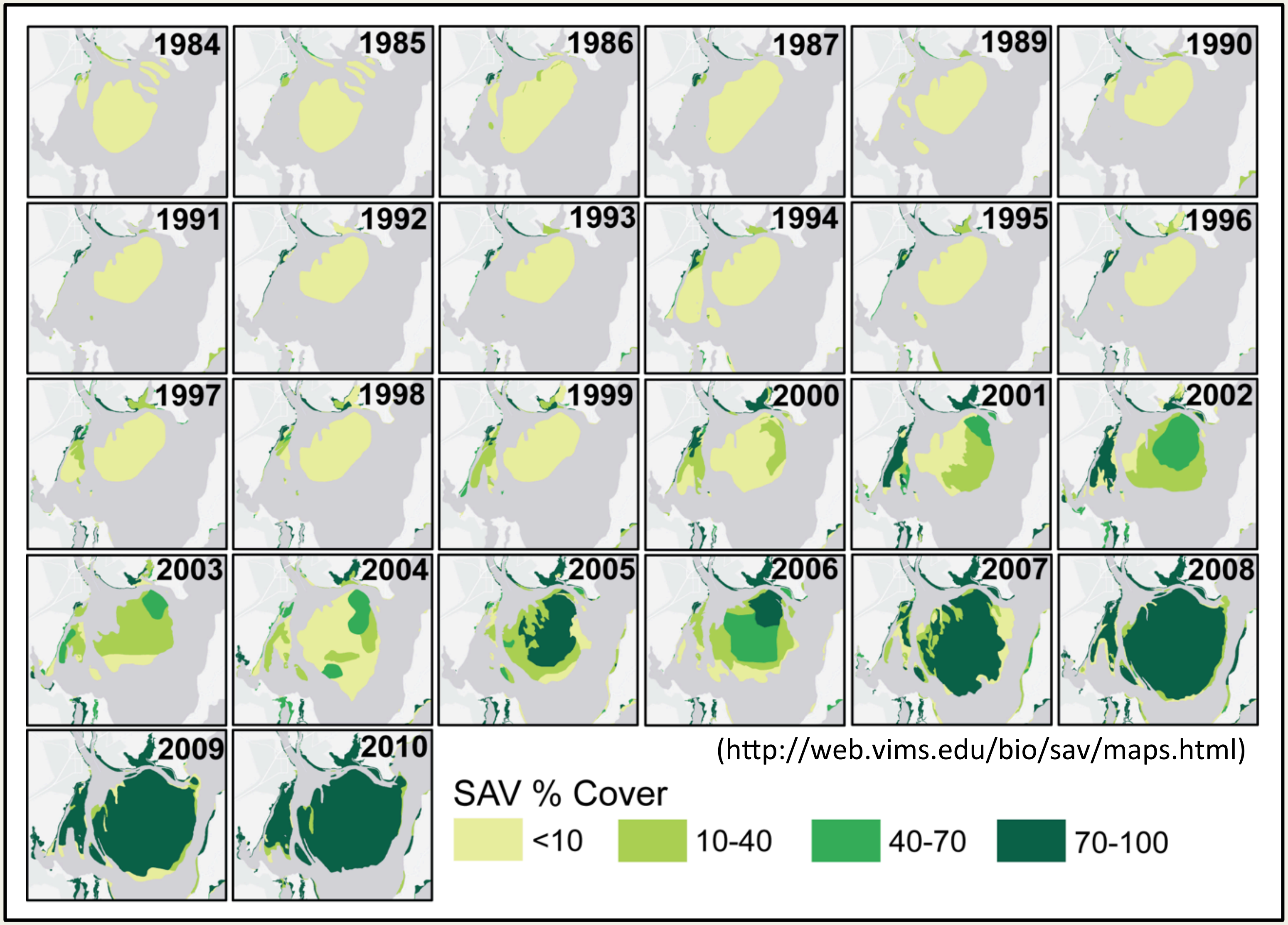
Susquehanna Flats SAV at the Head of the Bay



- Quite the unexpected piece of very good news
- A super-clear example of why long-term monitoring is so valuable for both trends and explanations
- This example also reminds us that once these habitats start to " get better" strong positive feedbacks can accelerate the restoration process

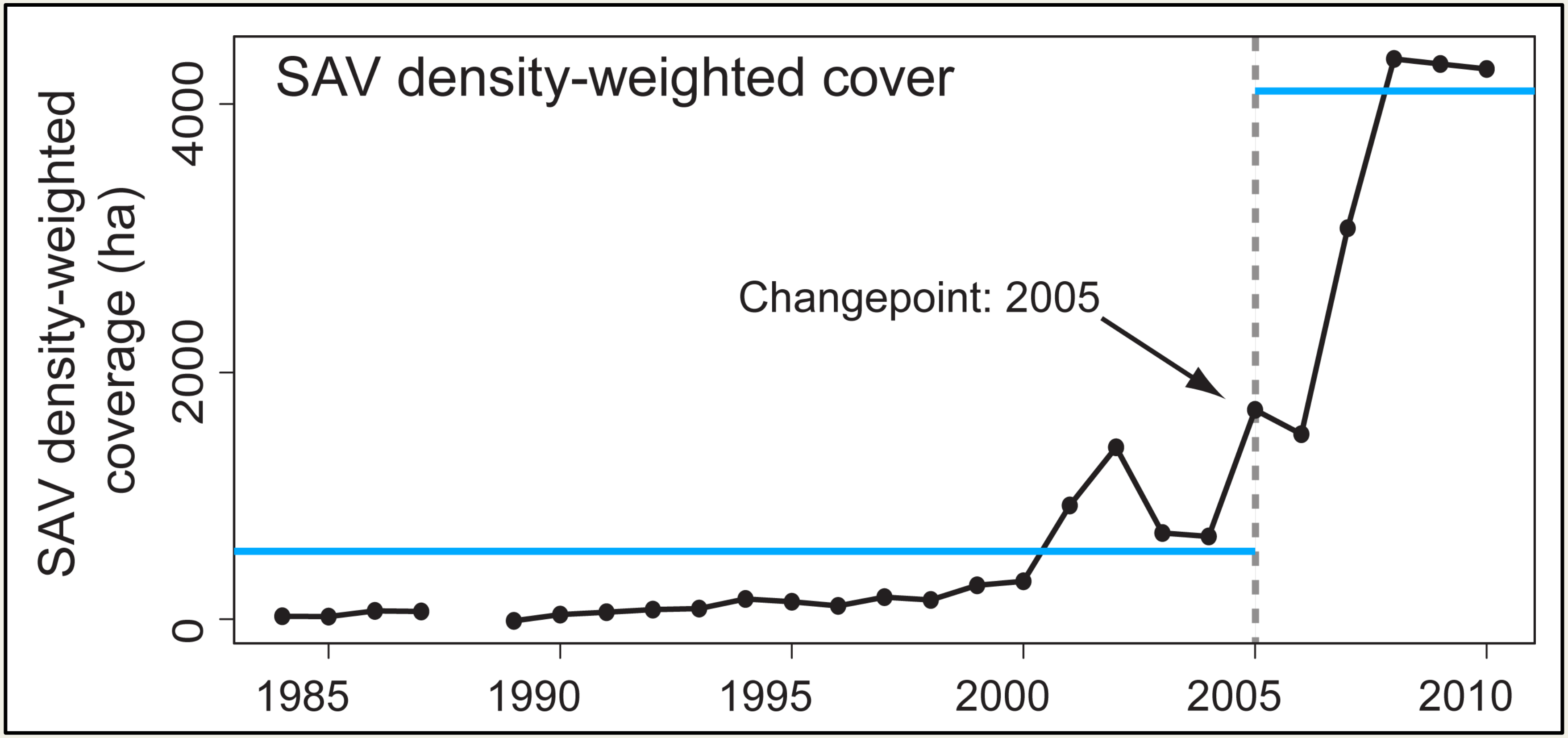
Adapted from Gurbisz and Kemp 2014

Time Series Maps of SAV Cover and Density



(Gurbisz & Kemp 2011)

Change-Point in SAV Density-weighted Cover



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Thank You and Question?