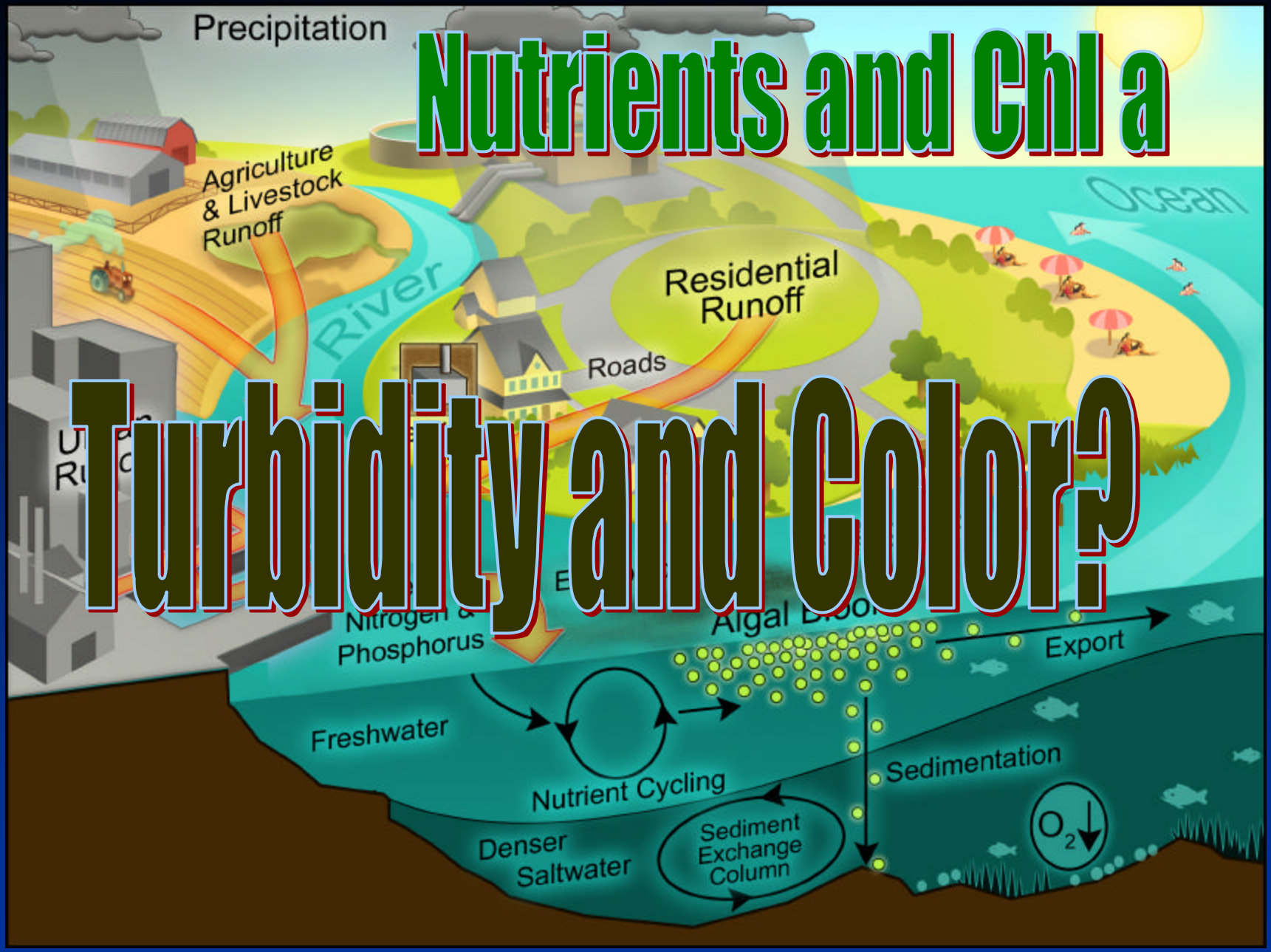
Defining Water-Quality Criteria for Seagrass Habitats Using an Optical Indicator

Patrick Biber[1], Hans Paerl[1],
Charles Gallegos[2], Jud Kenworthy[3]

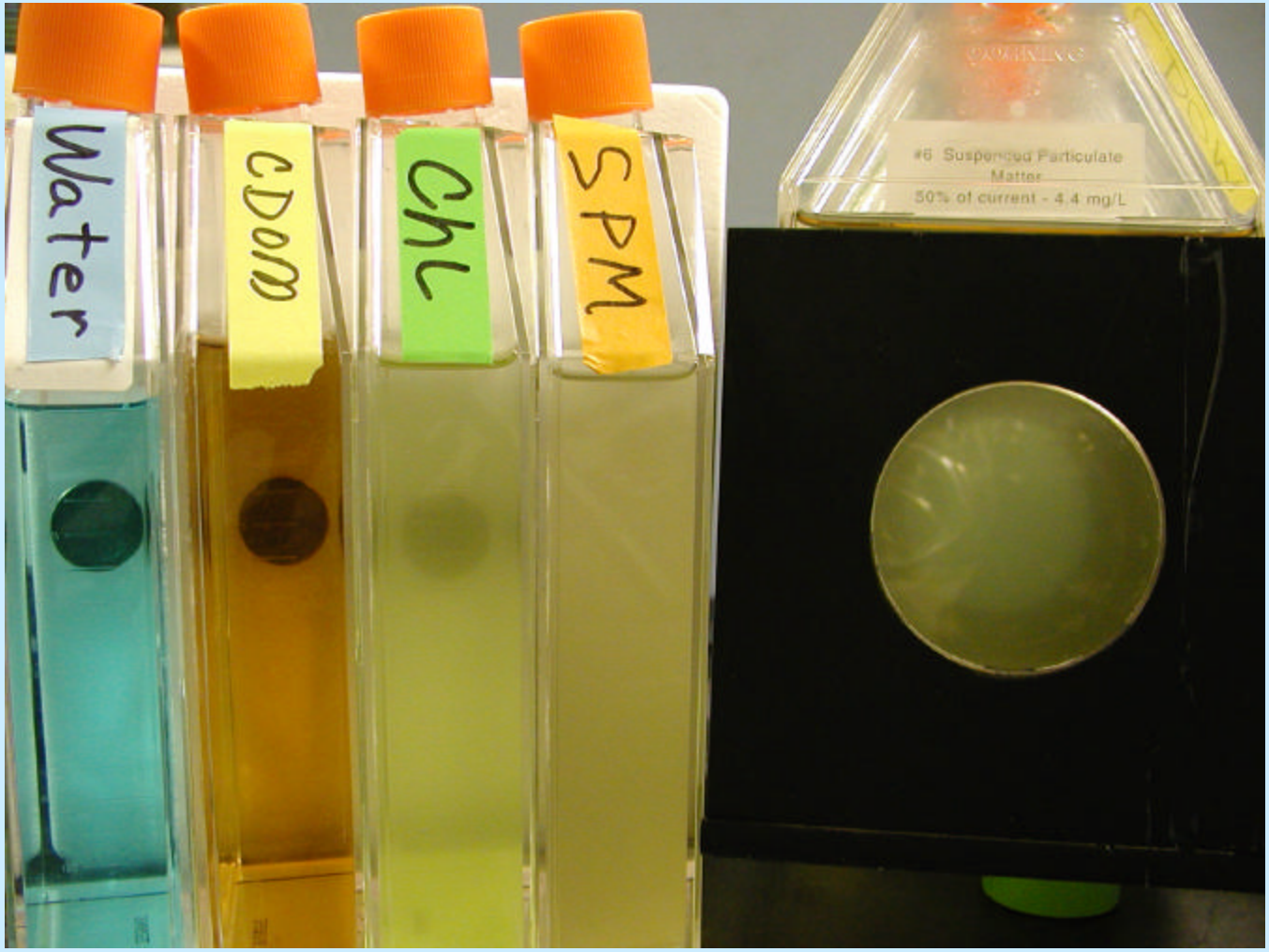
[1]UNC-Chapel Hill, Institute of Marine Sciences
[2]Smithsonian Environmental Research Center
[3]NOAA Beaufort Laboratory

Smithsonian Environmental Research Center

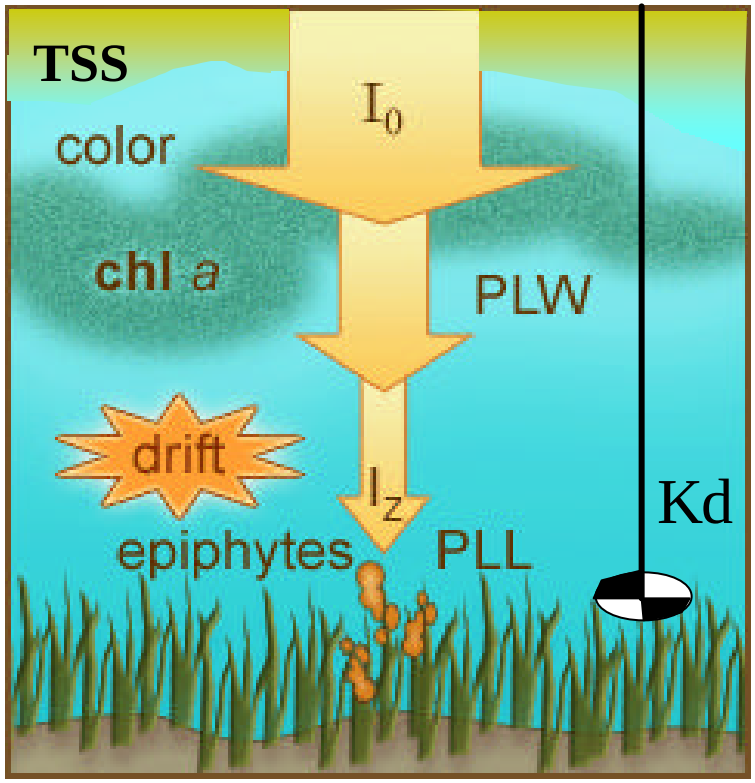
National Oceanic and Atmospheric Administration

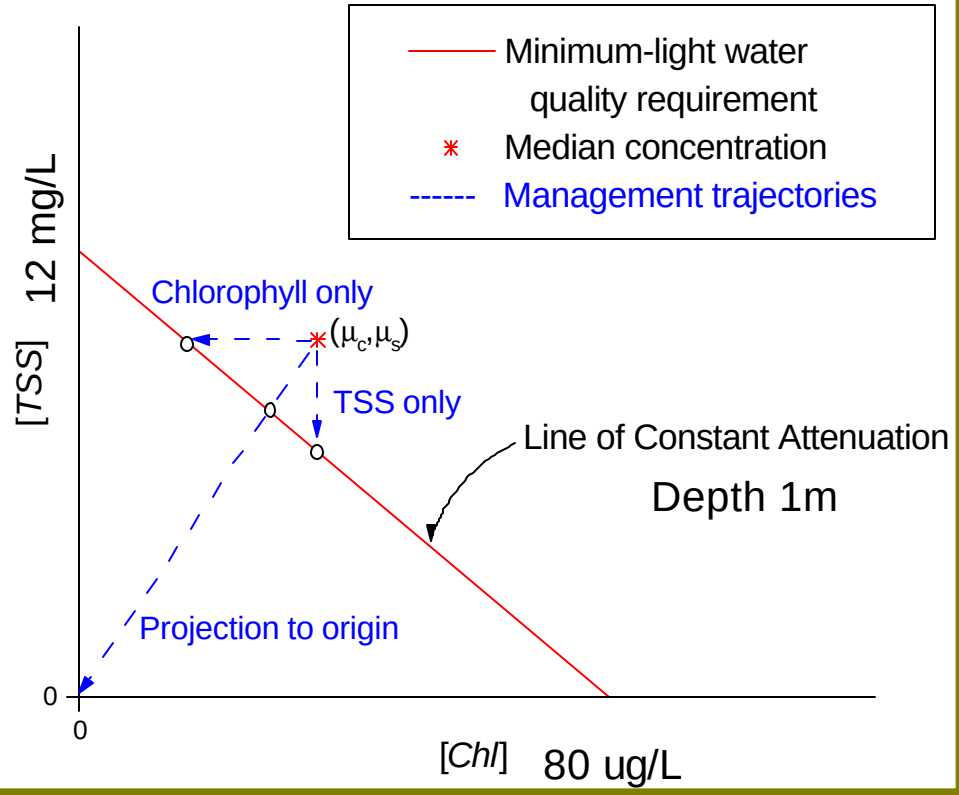

Nutrients and Chl a
Turbidity and Color?
Precipitation
Agriculture & Livestock Runoff
River
Residential Runoff
Roads
Ocean
Nitrogen & Phosphorus
Algal Bloom
Export
Freshwater
Nutrient Cycling
Sedimentation
Denser Saltwater
Sediment Exchange Column
O2

Optical Components of Water Quality



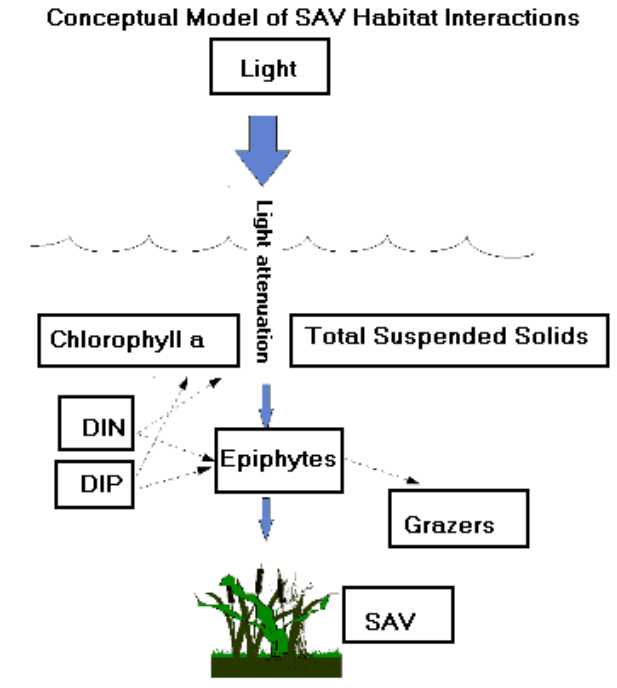
Hypothesis: Seagrass losses are due to poor water quality. This can be managed!





Scientific Basis: Light is the Principal Determinant of SAV Distribution

(or loss of water clarity is the principal cause of SAV declines)



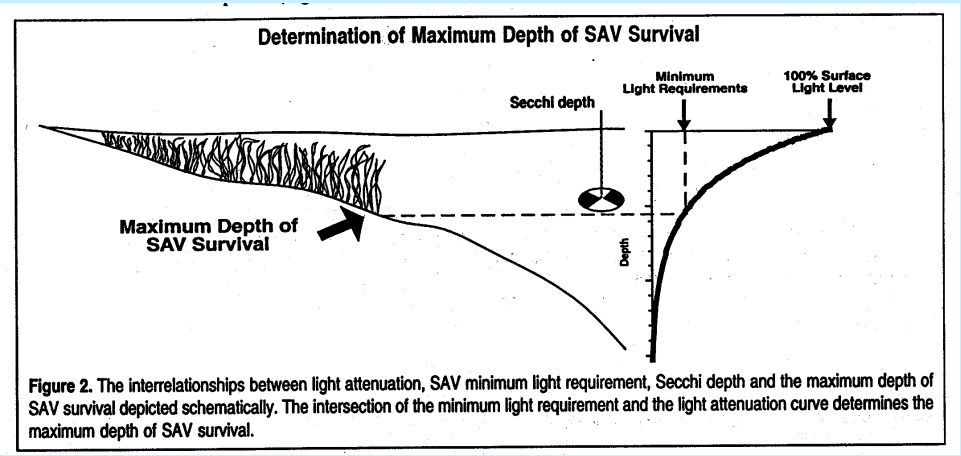
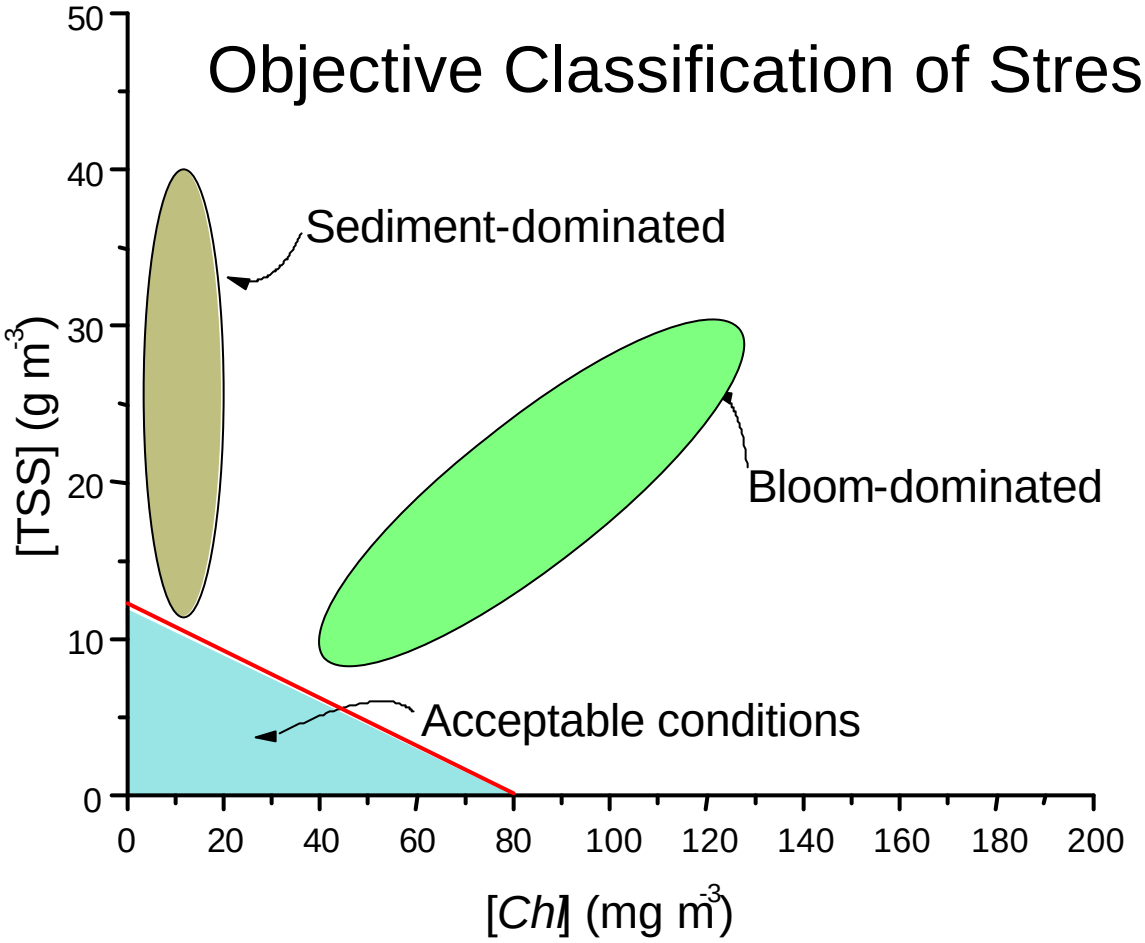


Figure 2. The interrelationships between light attenuation, SAV minimum light requirement, Secchi depth and the maximum depth of SAV survival depicted schematically. The intersection of the minimum light requirement and the light attenuation curve determines the maximum depth of SAV survival.

- **K_d(PAR) quantifies light penetration**
- **K_d(PAR) depends on inherent optical properties (IOP's)**
- **IOP's depend on water quality**
- **Radiative transfer modeling provides the link between water quality and SAV light requirements**

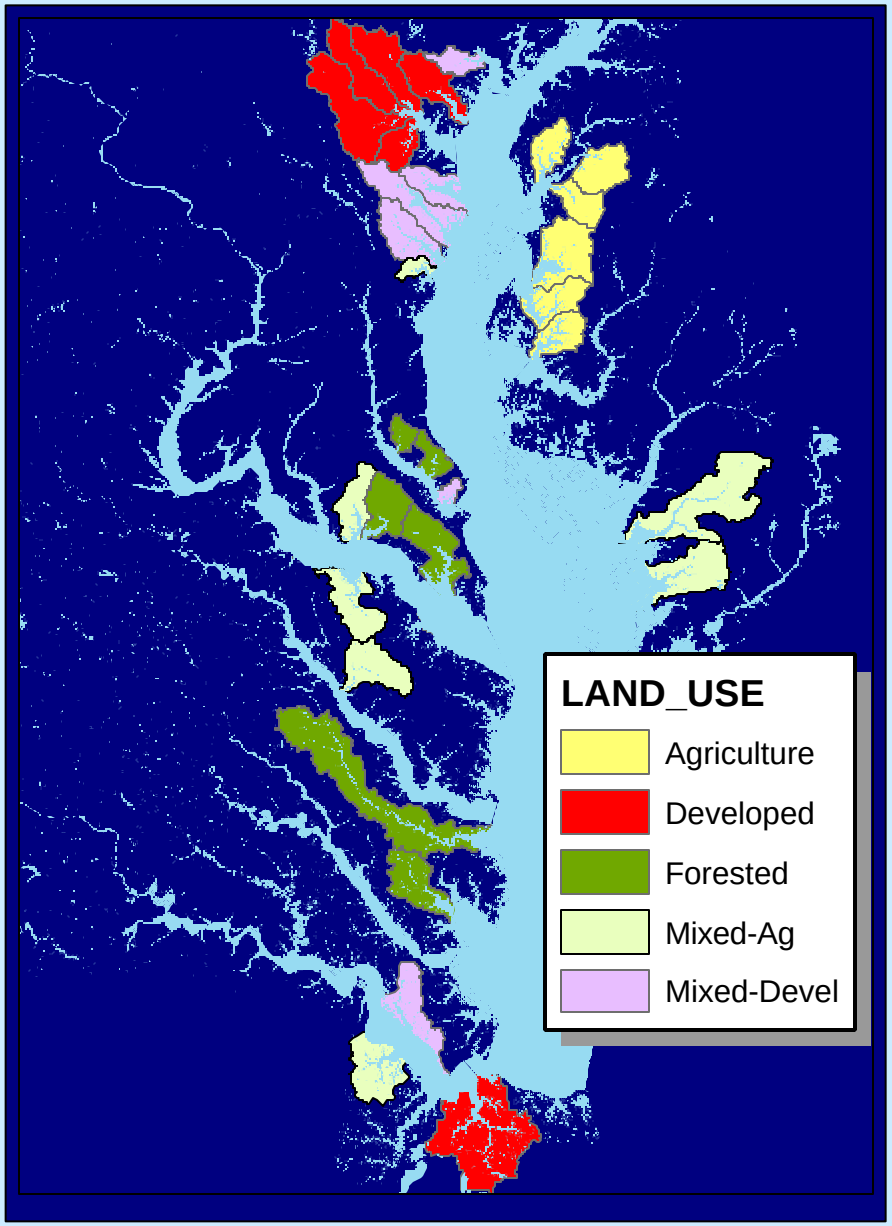
Seagrass Indicators
1. Bio-optical Model – Gallegos



Link to Land-use

- **Mesoscale features**
- **Defined by morphology (depth, location) and general salinity regime**
- **Consist of coastal watershed (min. 4th order stream), fresh and saltwater wetlands, subtidal (vegetated & unvegetated) benthos, and open water habitats**
- **Vary in land use, overall size (within limits)**
- **Control for salinity (mesohaline)**

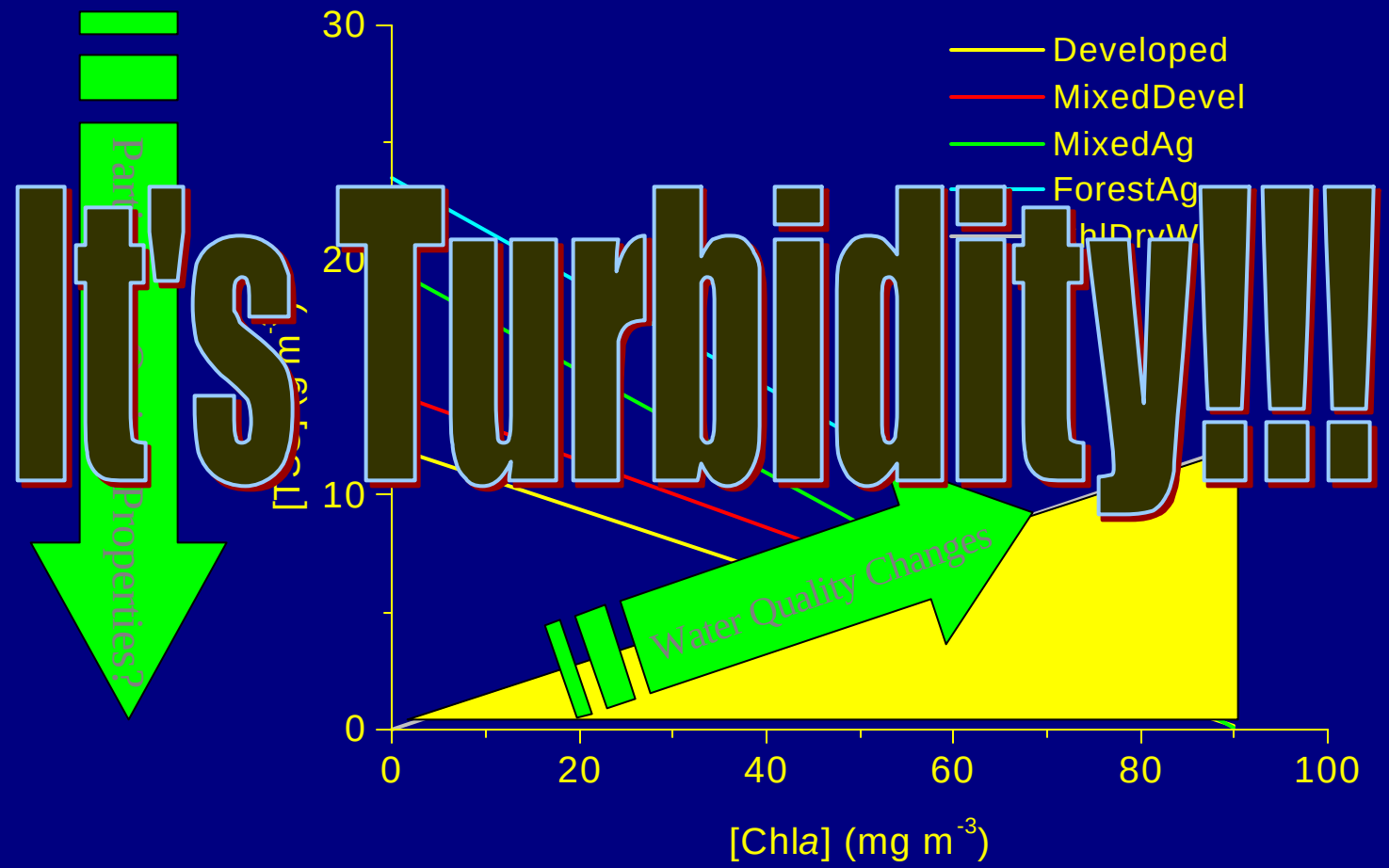
Chesapeake Region



North River, NC

Middle Marsh *Zostera* and *Halodule* beds

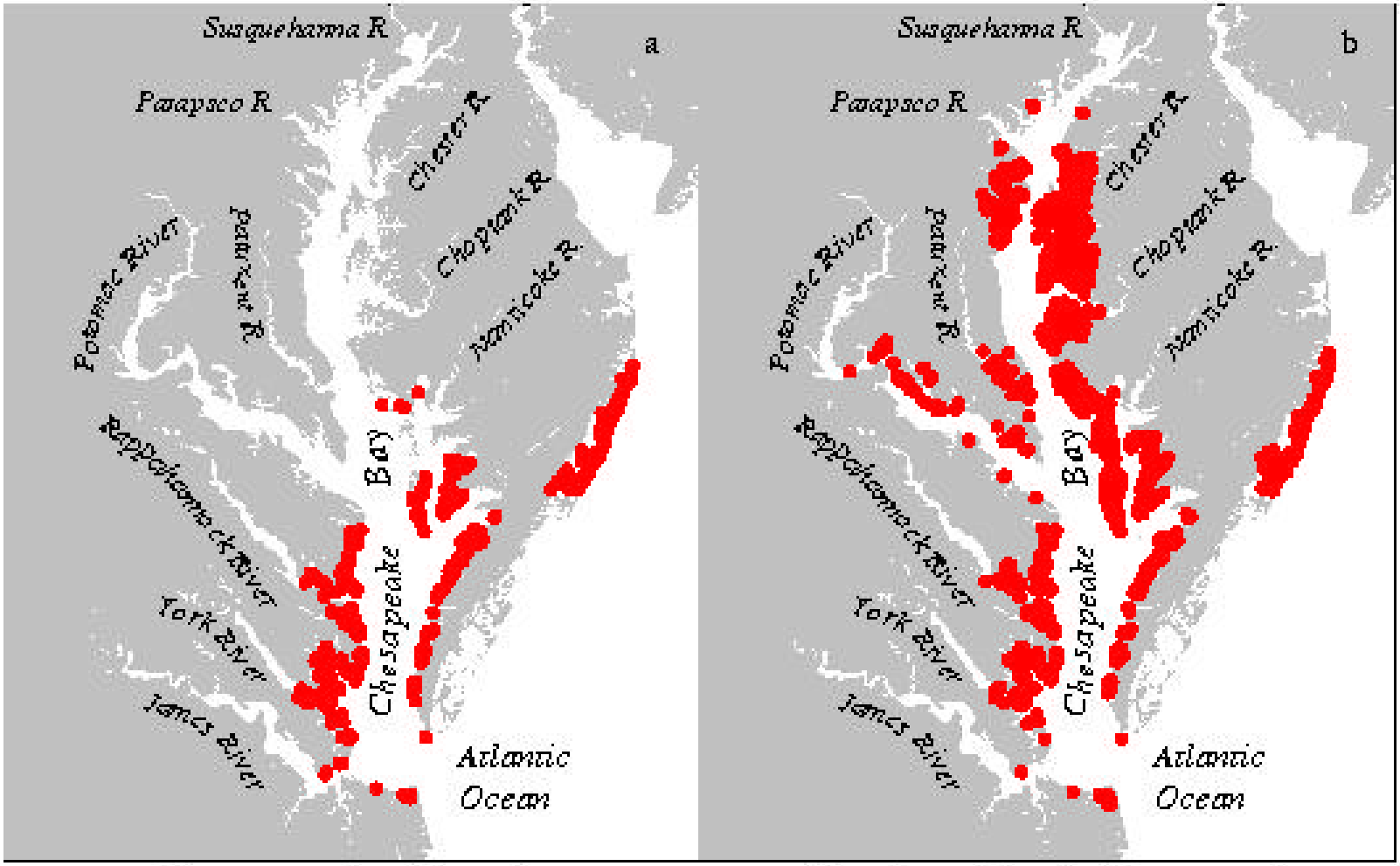
Potential Linkages between Eutrophication and Particulate Optical Properties



And is the process reversible?

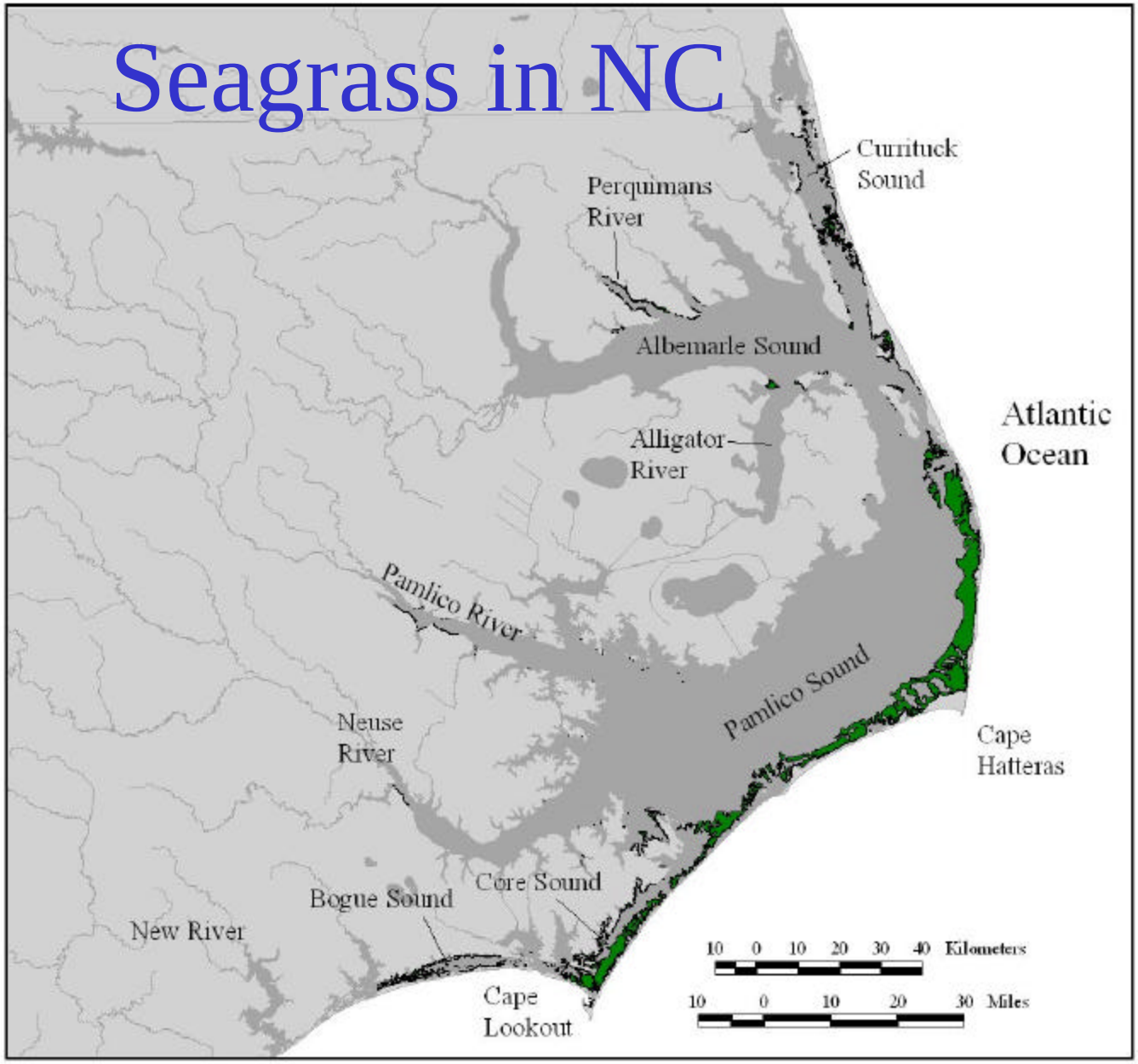
Moore et al. 1998: http://www.vims.edu/bio/sav/biomass/

Chesapeake Bay Seagrasses



Zostera marina (eelgrass) *Ruppia maritima* (widgeon grass)

Seagrass in NC

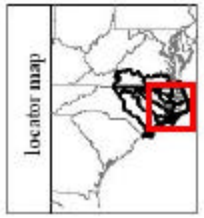


LEGEND

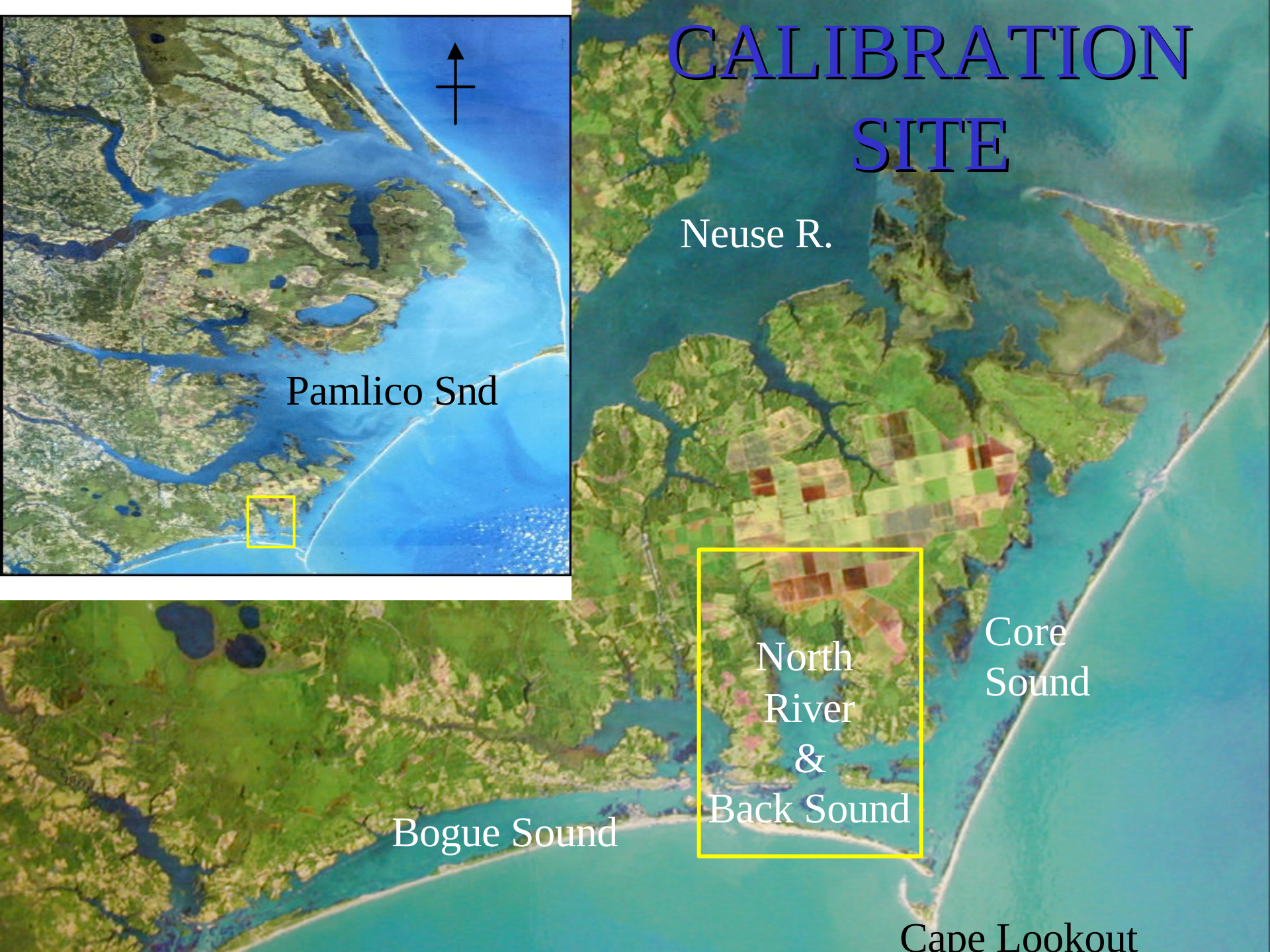
- SAV beds (1983-1990)
- Rivers
- Water Bodies
- CHPP Management Units

N
W E
S

NAD83
NC State Plane
January 2002

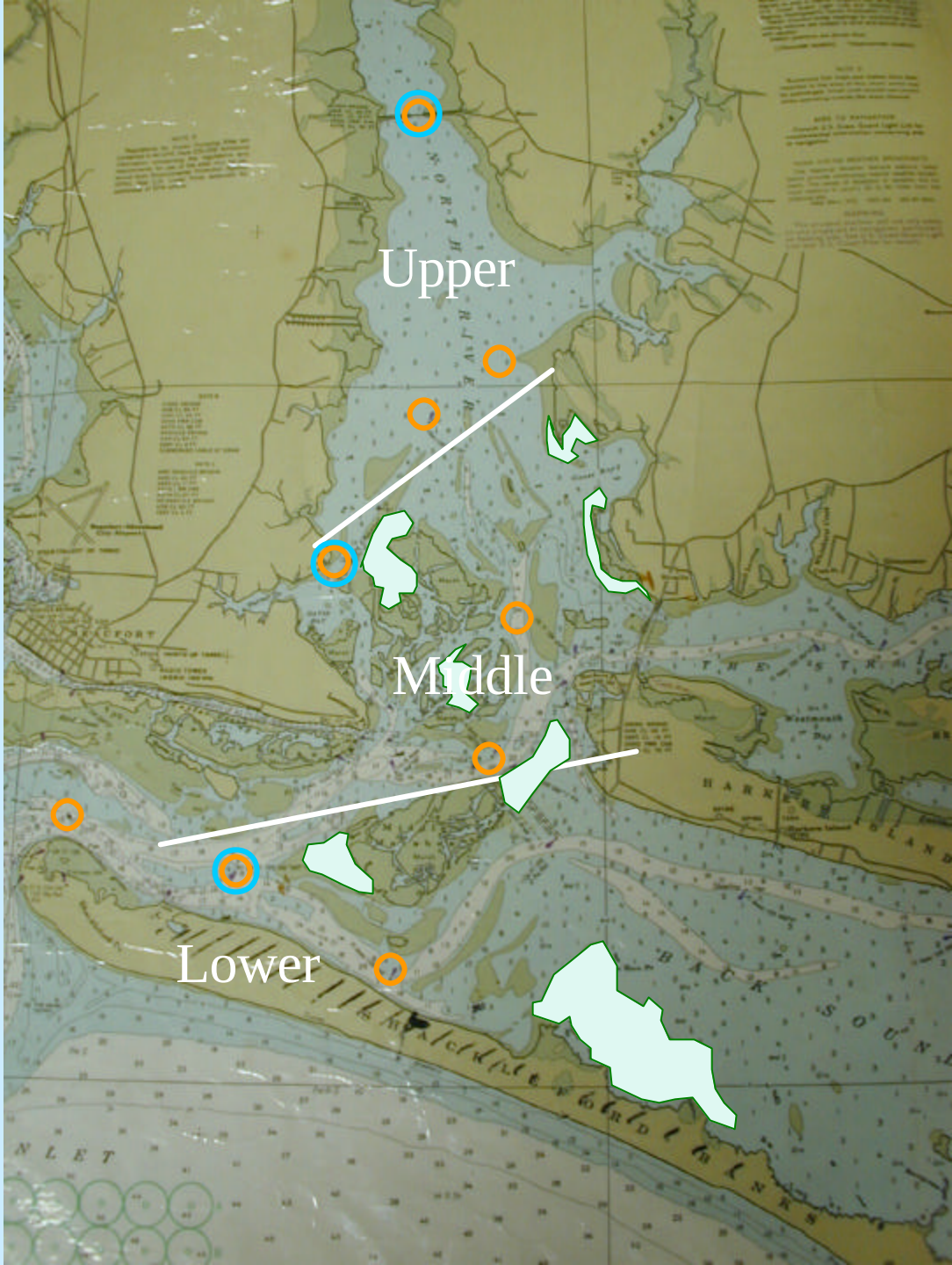


NCDENR

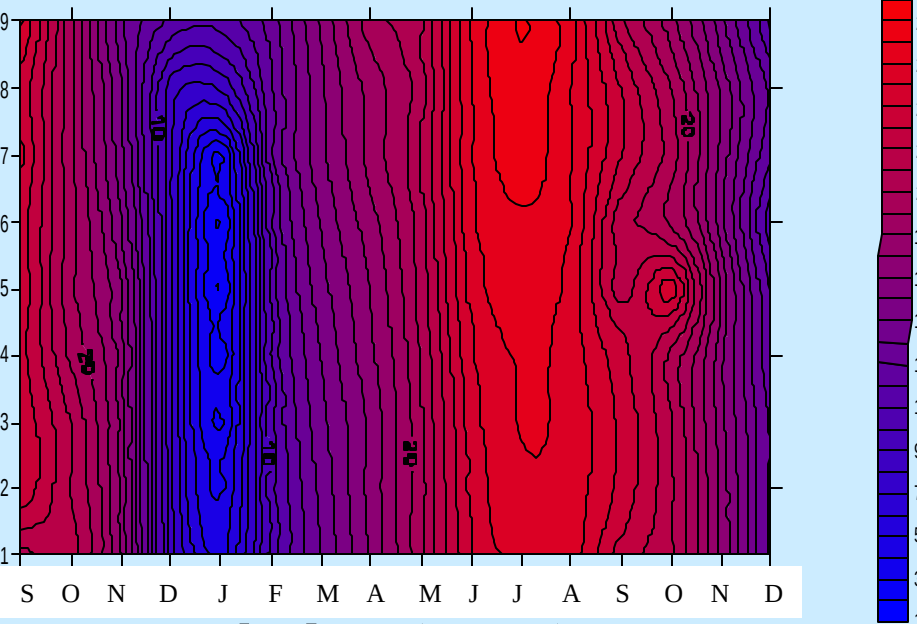

CALIBRATION SITE
Neuse R.
Pamlico Snd
North River & Back Sound
Core Sound
Bogue Sound
Cape Lookout

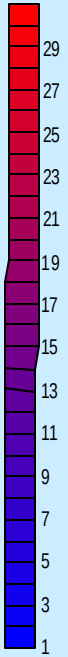
Monitoring

- Turbidity/Color gradient
- 3 regions along gradient
  Middle region has seagrass
- 3 Stns per region
  Sampled 1 day/mo.
  Water - chl a/TSS/C-DOM
  LiCor+YSI profile (0.5m inc.)
  Secchi depth
- 1 “Permanent” Stn per region
  Sample each quarter for a month
  Mar., Jun., Sept, Dec 2003.
  LiCor (5min) and YSI (30min) @ 1m depth.

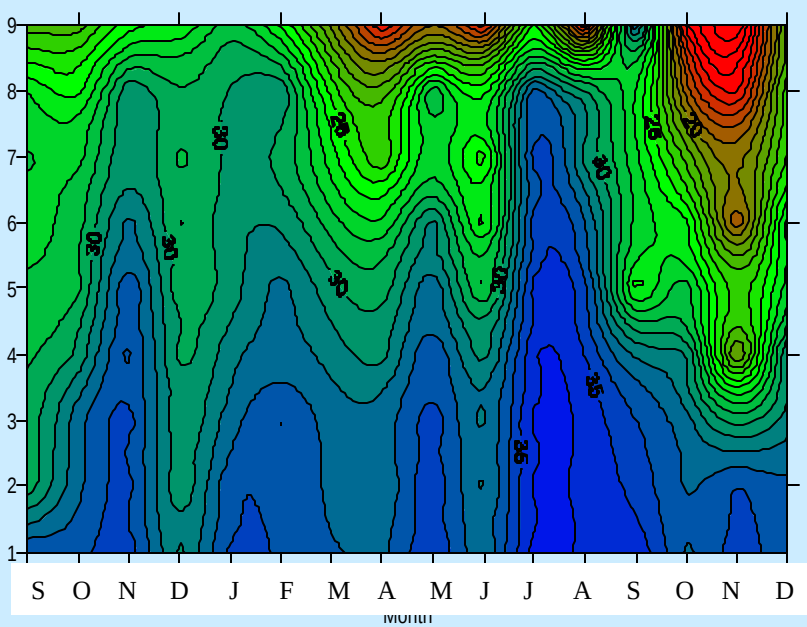


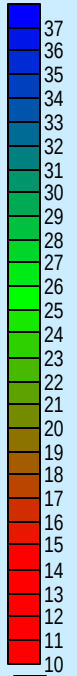
TEMPERATURE (C)



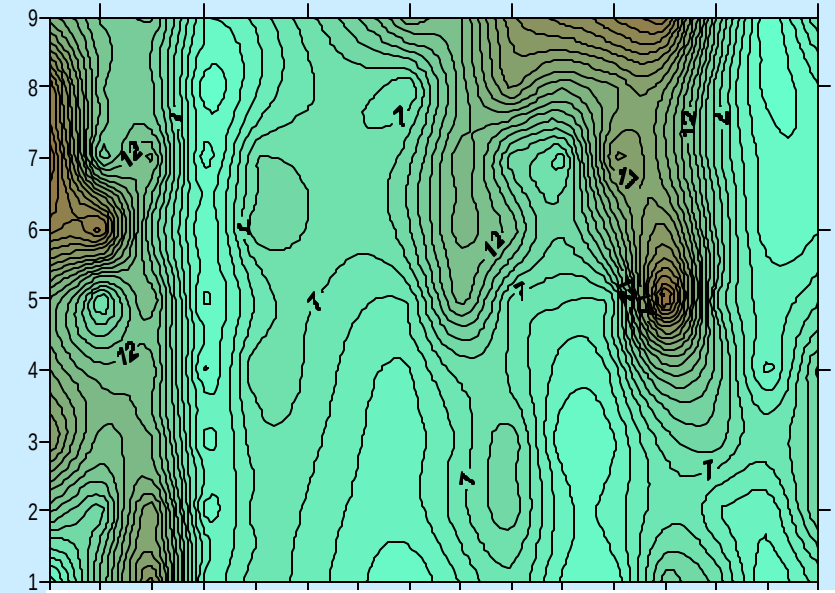


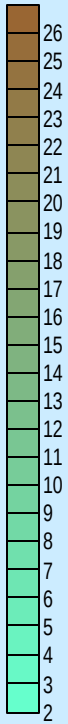
SALINITY (ppt)



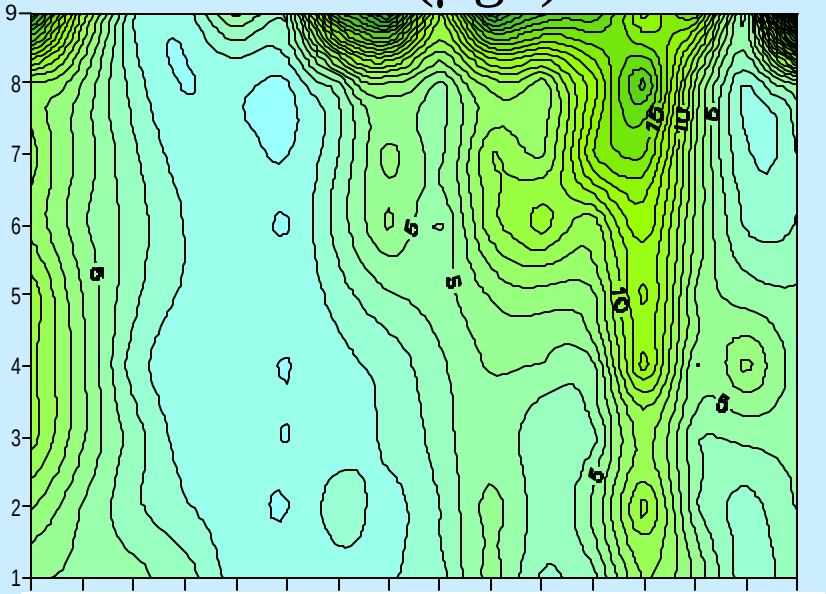


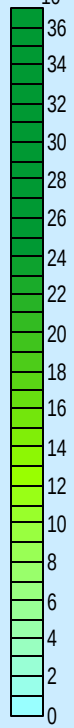
Turbidity (NTU)



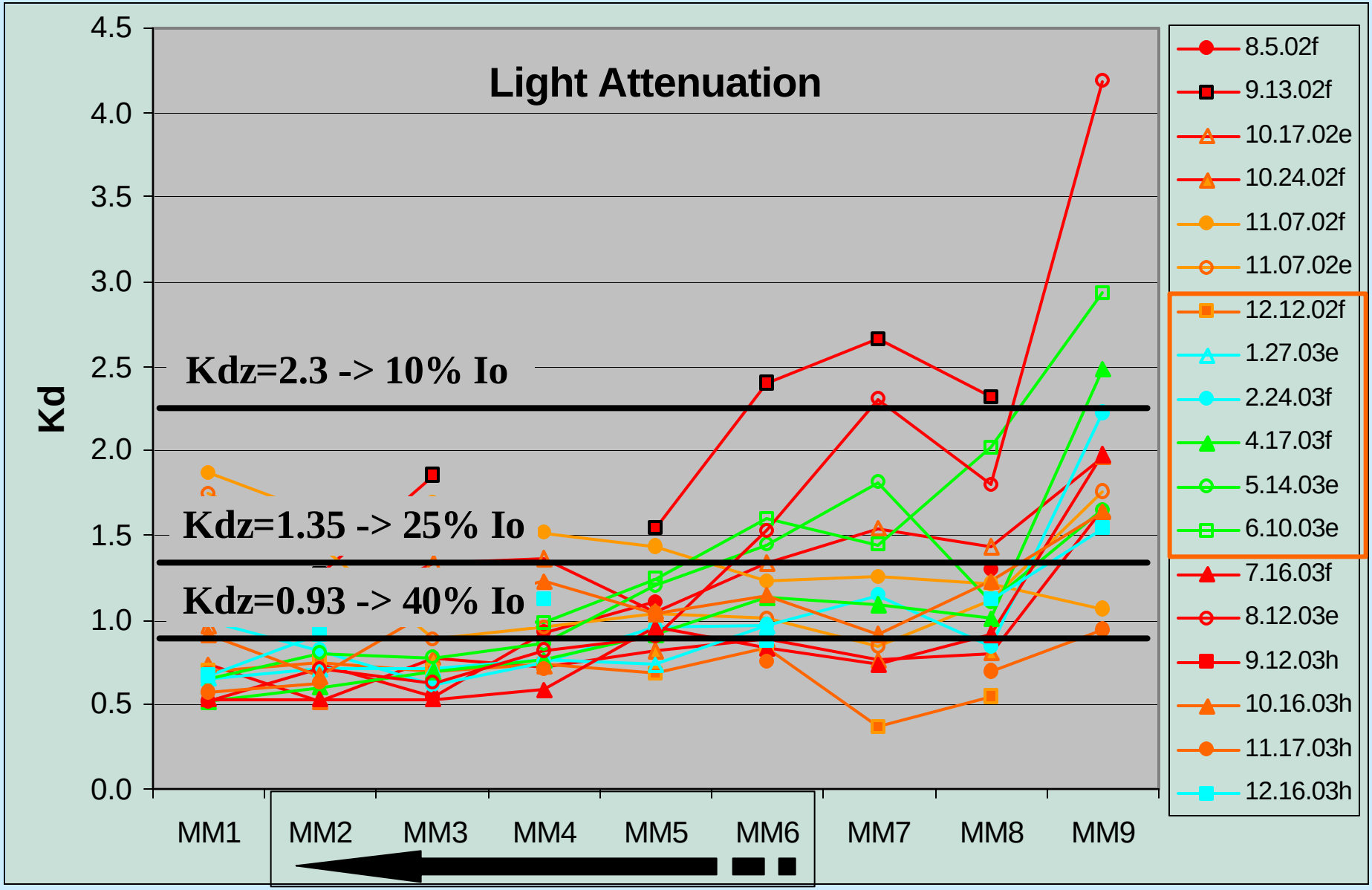


Chl *a* (µg/l)

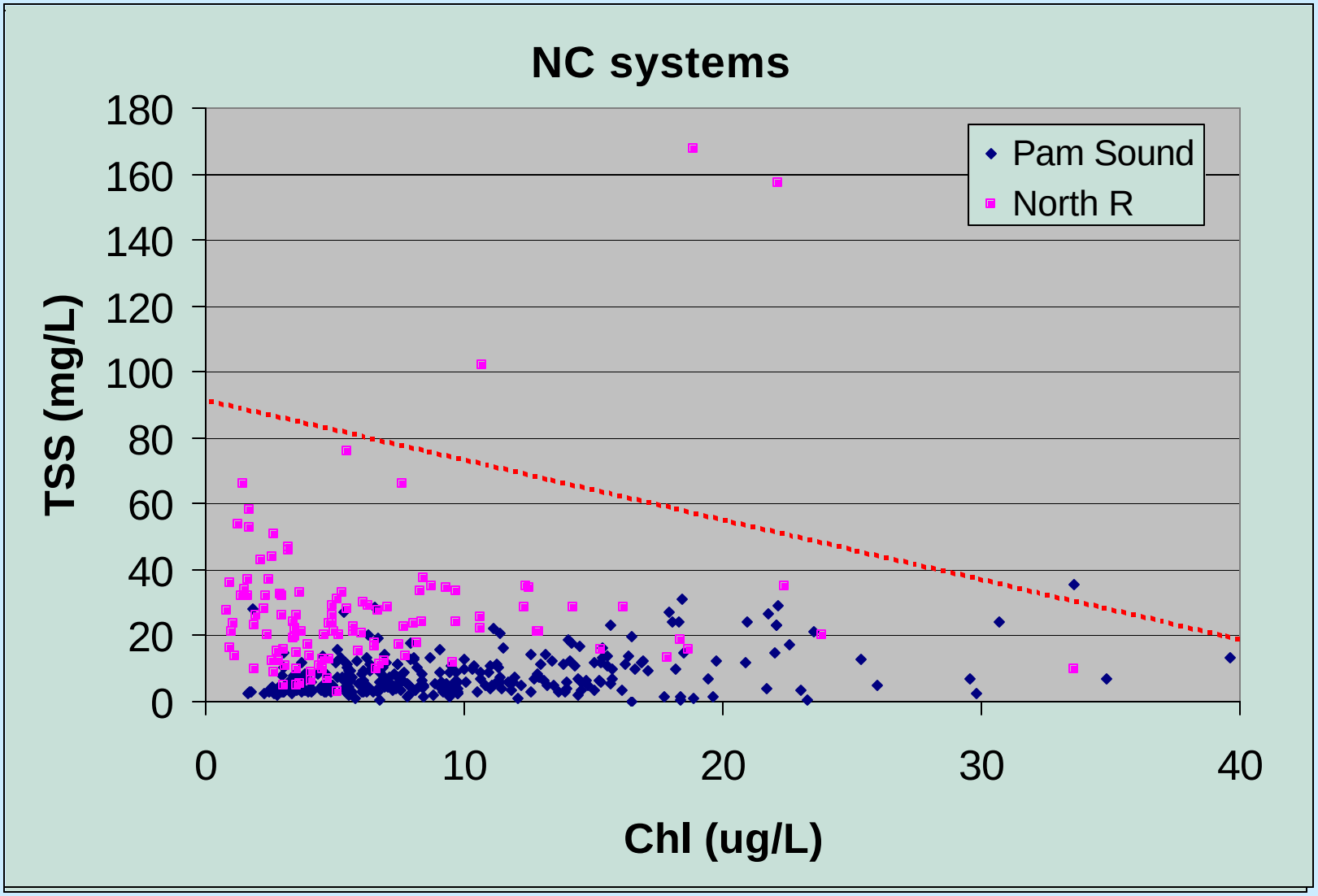




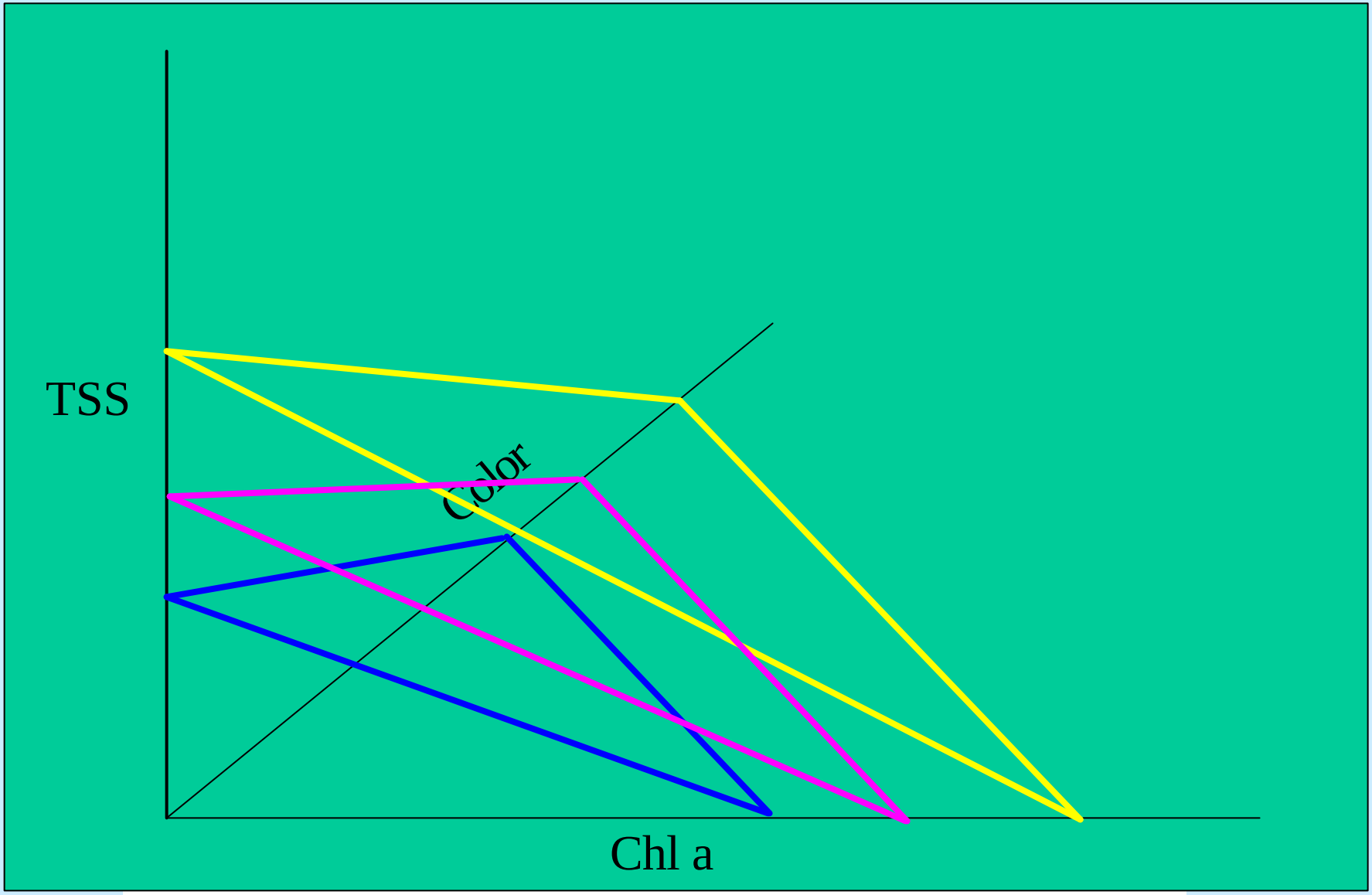
Water Clarity: Sept 02-Dec 03



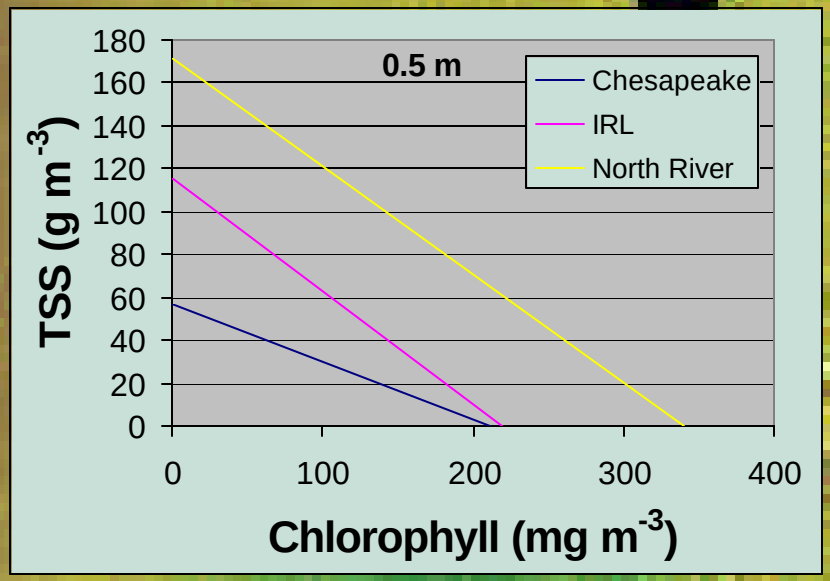
1. Bio-optical Model Applied

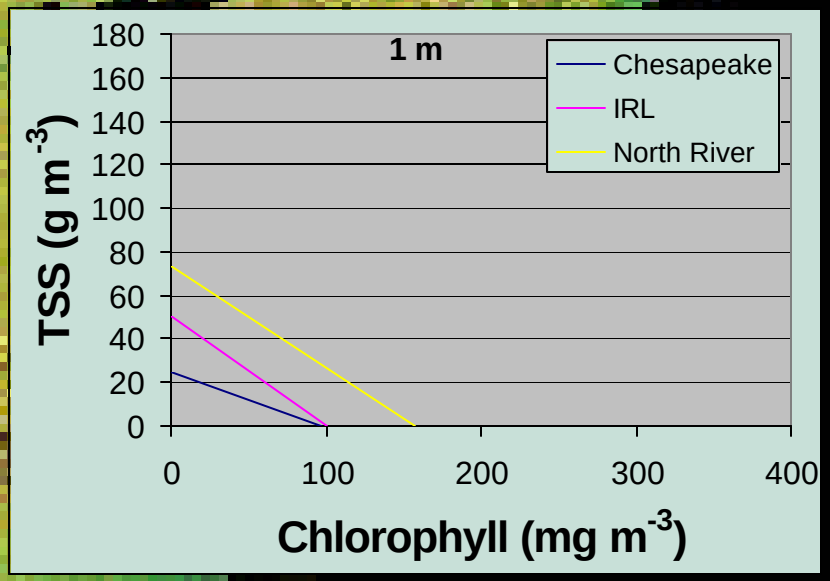


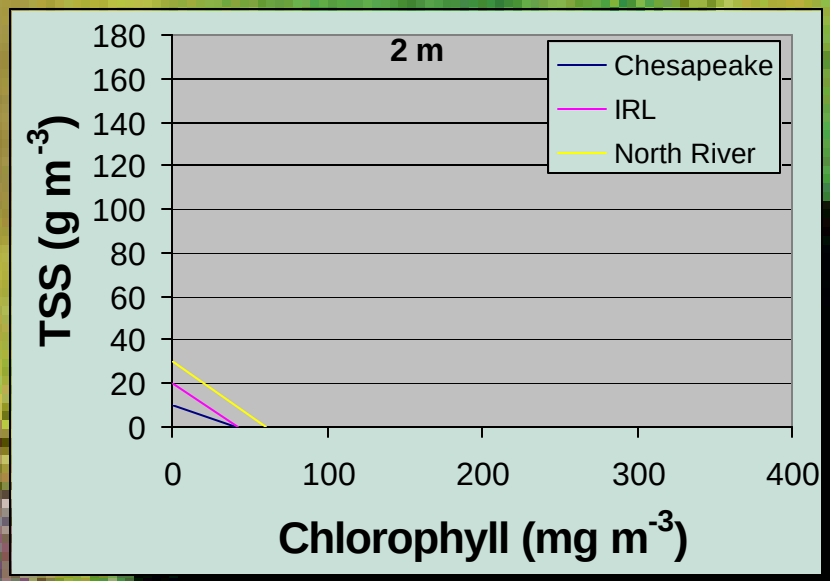
More Theory, add Color!



Three Region Comparison







Turbidity Criteria – time for a re-evaluation by EPA?

Region	State	% losses	Time Period	%/decade	AVG regional
NE	Connecticut				
NE	Delaware	no SAV			
NE	Maine				
NE	Massachussetts	42.5	?-2003	10.6	
NE	New Hampshire	-23	1986-1996	-23.0	
NE	Rhode Island	41	1974-1992	22.8	3.5
CEN	Maryland	-45	1985-2000	-30.0	
CEN	New Jersey	67	1968-1998	22.3	
CEN	New York				
CEN	Virginia	-45	1985-2000	-30.0	-12.6
SE	Florida	30	1950-1995	6.7	
SE	Georgia	no SAV			
SE	North Carolina	6	1985-1988	20.0 ?	
SE	South Carolina	no SAV			13.3
GOM	Alabama	50	1940-1995	20.0	
GOM	Louisiana	21	1978-1989	10.0	
GOM	Mississippi	85	1969-1992	37.0	
GOM	Texas	70	1956-1987	23.3	22.6
PAC	Alaska				
PAC	California				
PAC	Oregon				
PAC	Washington	48	1974-2002	17.1	17.1
HA	Hawaii				

SUMMARY

Bio-optical model provides explicit target water quality criteria for management. Is pro-active indicator -> before seagrasses are lost.

Indicator diagnoses causes of light attenuation, coupled with existing long-term monitoring data can identify anthropogenic trends that caused water quality decline, and quantify the improvement needed to return to a desired target.

Seagrasses are critical habitat (EFH) and require high quality water. Mainly turbidity is cause of light limitation. NO existing federal guidelines on turbidity – this should be addressed!

National Oceanic and Atmospheric Administration

www.aceinc.org

Acknowledgements

This research has been supported by a grant from the US Environmental Protection Agency's Science to Achieve Results (STAR) Estuarine and Great Lakes (EaGLe) Coastal Initiative through funding to the ACE-INC Project, US EPA Agreement *EPA/R82-867701*

EPA

EaGLe