

# North Carolina SAV Partners Restoration Sub-committee

Sep 9 2011 Meeting  
Joseph Luczkovich  
East Carolina University  
Greenville, NC 27858

# Charge of the subcommittee

- **ASSIGNMENT: *Develop NC SAV Restoration Action Plan***
- The SAV Action Plan should provide a framework to prioritize SAV Partners' research and restoration efforts, including 2-year and 5-year objectives to feed into APNEP and CHPP planning processes.
- Develop research objectives and restoration implementation actions.
- Meet and review the objectives and actions to see whether we have achieved them or not, and then revise as needed.

# Summary of Work So far

- GOAL #2 – To initiate and support research for restoration and protection of SAV habitat in the Albemarle-Pamlico Estuarine System (APES).
- **General Objective #1** – Develop and prioritize research questions that will allow better SAV habitat restoration.
  - **Action: develop habitat suitability matrix for SAV species in NC**
  - **Status: done**
- **General Objective #2** – Determine what water quality conditions have historically supported good SAV beds.
  - Action: complete matrix of habitat suitability and research needed for NC SAV
  - Status: ongoing review of literature
- **General Objective #3** – Provide a recent case study example (Liz Noble’s Currituck Sound and Back Bay pilot project? ) that can serve as a model.
  - **Action: case studies in Chesapeake**
  - **Status: Ongoing**
- **General Objective #4** – Develop a Research **tool** for SAV Restoration in the APES watershed.

# New Objective

- New Objective 5 was formed – create a guidance document for how to do restoration projects.
  - Kevin Hart (and Rob Breeding) understood it be more of the development of a restoration guideline that sums up actions that can be taken to restore SAV
  - See: Shafer and Bergstrom (2010). An Introduction to a Special Issue on Large-Scale Submerged Aquatic Vegetation Restoration Research in the Chesapeake Bay: 2003–2008. *Restoration Ecology*, 18(4): 481-489

# John Gallegos's notes from May meeting (edited by Joe Luczkovich)

- In May we edited General Objective 1 to read “Develop and prioritize research questions that will allow better SAV habitat protection and restoration”
- To address objective 1, Rob Breeding suggested we create a matrix of general research questions and categories at the top (habitat categories, nutrients, light, project ID, case studies, criteria, sampling methods, etc.) and species on the left.
  - We wish to fill cells of the matrix with a research findings (what's been done) or action needed
  - Creates a database of research actions that can be or have already been taken
  - This matrix can be used to determine what gaps in knowledge exist (outline for our research needs)
  - We should have both 2-year and 5-year goals in matrix (2 years is more suited to an action plan, whereas 5 years is more on a strategic level)
  - What would the time to populate this matrix be?
- This matrix need to be made and populated (not done yet)!
- **I made an attempt (on next slide)**, based on Kemp et al (2004), Habitat requirements for Submerged Aquatic Vegetation in Chesapeake Bay: water quality, light regime, and physical-chemical factors, Estuaries, 27: 363-377

# Matrix of SAV Habitat Requirements

SAV Species	Common name	Salinity regime	Max Depth Zc, m (feet)	Total Susp'd Solids (mg/L)	Light levels (PLW,%)	Light levels (PLL,%)	Plankton Chlorophyll (µg/L)	Dissolved Inorganic Nitrogen (mg/L)	Dissolved Organic Phosphorus (mg/L)
<i>Zostera marina</i>	Eel grass	Polyhaline	2 (6.5')	< 15	>22 %	>15 %	< 15	< 0.15	<0.02
<i>Halodule wrightii</i>	Shoal grass	Polyhaline	2 (6.5')	< 15	>22 %	>15 %	< 15	< 0.15	<0.02
<i>Ruppia maritima</i>	Widgeon grass	Polyhaline Oligohaline	2 (6.5')	< 15	>22 %	> 15 %	< 15	< 0.15	<0.02
<i>Valisneria americana</i>	Wild Celery	Oligohaline	4 (13')	< 15	>22 %	> 9 %	< 15	-	<0.02
<i>Potamogeton perfoliatus</i>	Red head grass	Oligohaline	4 (13')	< 15	> 22 %	> 9 %	< 15	-	<0.02
<i>Najas guadelupensis</i>	Southern naiad	Oligohaline	4 (13')	< 15	>13 %	> 9 %	< 15	-	<0.02
<i>Ceratophyllum demersum</i>	Coontail	Oligohaline	4 (13')	< 15	>13%	> 9 %	< 15	-	<0.02
<i>Myriophyllum spicatum</i>	Eurasian water-milfoil	Oligohaline	4 (13')	< 15	>13%	> 9 %	< 15	-	<0.02
<i>Zannichellia palustris</i>	Horned Pondweed	Oligohaline	4 (13')	< 15	>13%	> 9 %	< 15	-	<0.02

# Chesapeake Bay SAV Restoration Plan

- <http://archive.chesapeakebay.net/pubs/sav/index.html>
- Everyone should download and read this document, it is basically what we need here in NC
- It provides a lot of the groundwork for habitat requirements and summarizes the relevant literature.

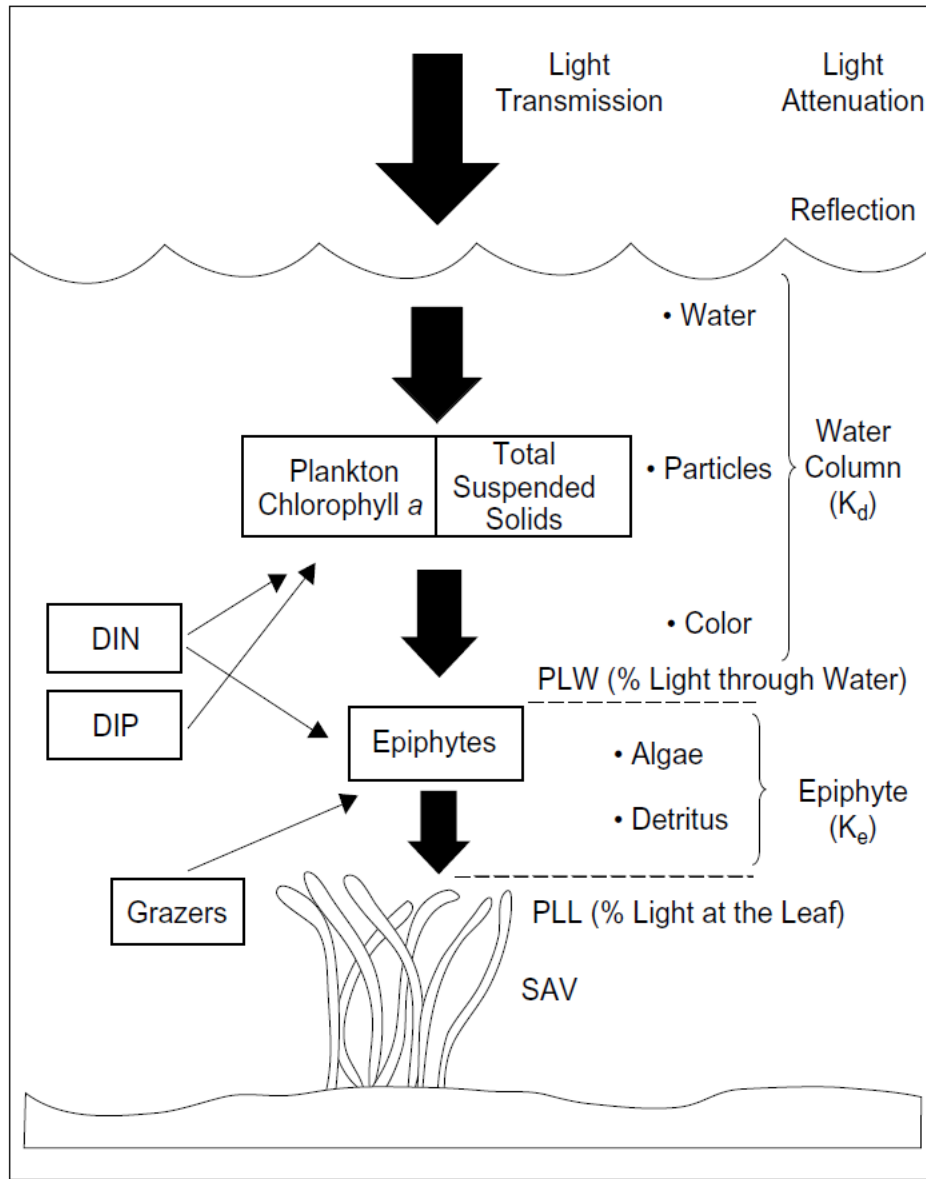
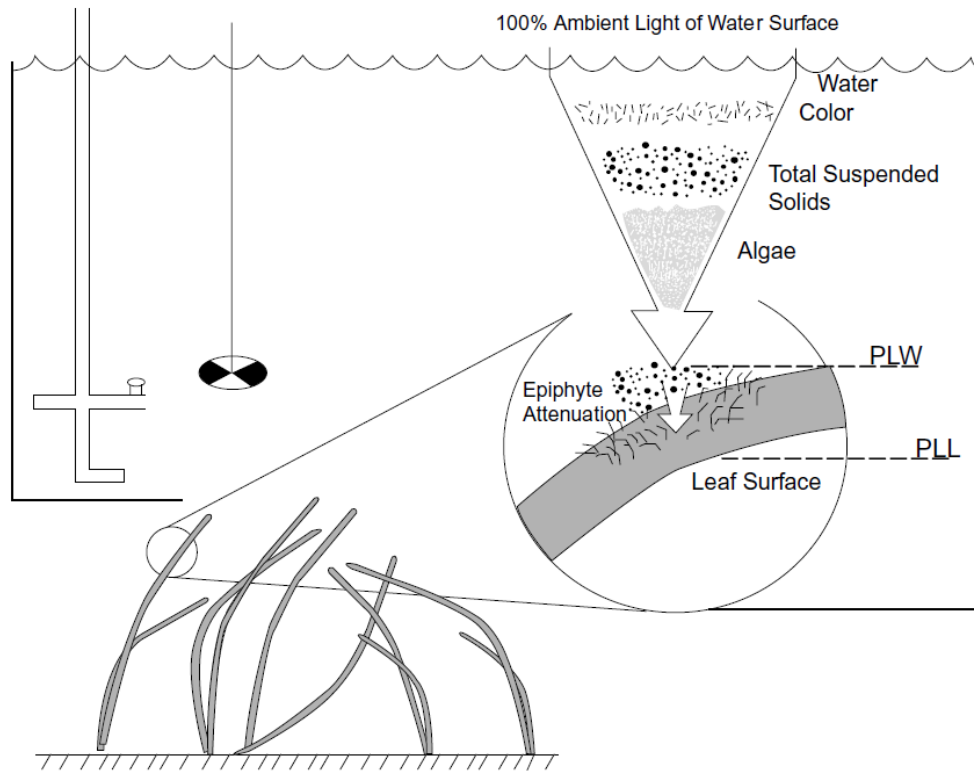


FIGURE II-1. Conceptual Model of Light/Nutrient Effects on SAV Habitat. Availability of light for SAV is influenced by water column and at the leaf surface light attenuation processes. DIN = dissolved inorganic nitrogen and DIP = dissolved inorganic phosphorus.



## Percent Light through Water (PLW)

## Percent Light at the Leaf (PLL)



### Inputs

- $K_d$  measured directly or
- $K_d$  calculated from Secchi depth

### Inputs

- $K_d$
- Total suspended solids
- Dissolved inorganic nitrogen
- Dissolved inorganic phosphorus

### Calculation

$$PLW = e^{-(K_d)(Z)} \cdot 100$$

### Calculation

$$PLL = [e^{-(K_d)(Z)}][e^{-(K_e)(B_e)}] \cdot 100$$

- $K_e$  = Epiphyte attenuation
- $B_e$  = Epiphyte biomass

### Evaluation

PLW vs. Water-Column Light Requirement

### Evaluation

PLL vs. Minimum Light Requirement

Approach followed when only Secchi depth/direct light attenuation data are available

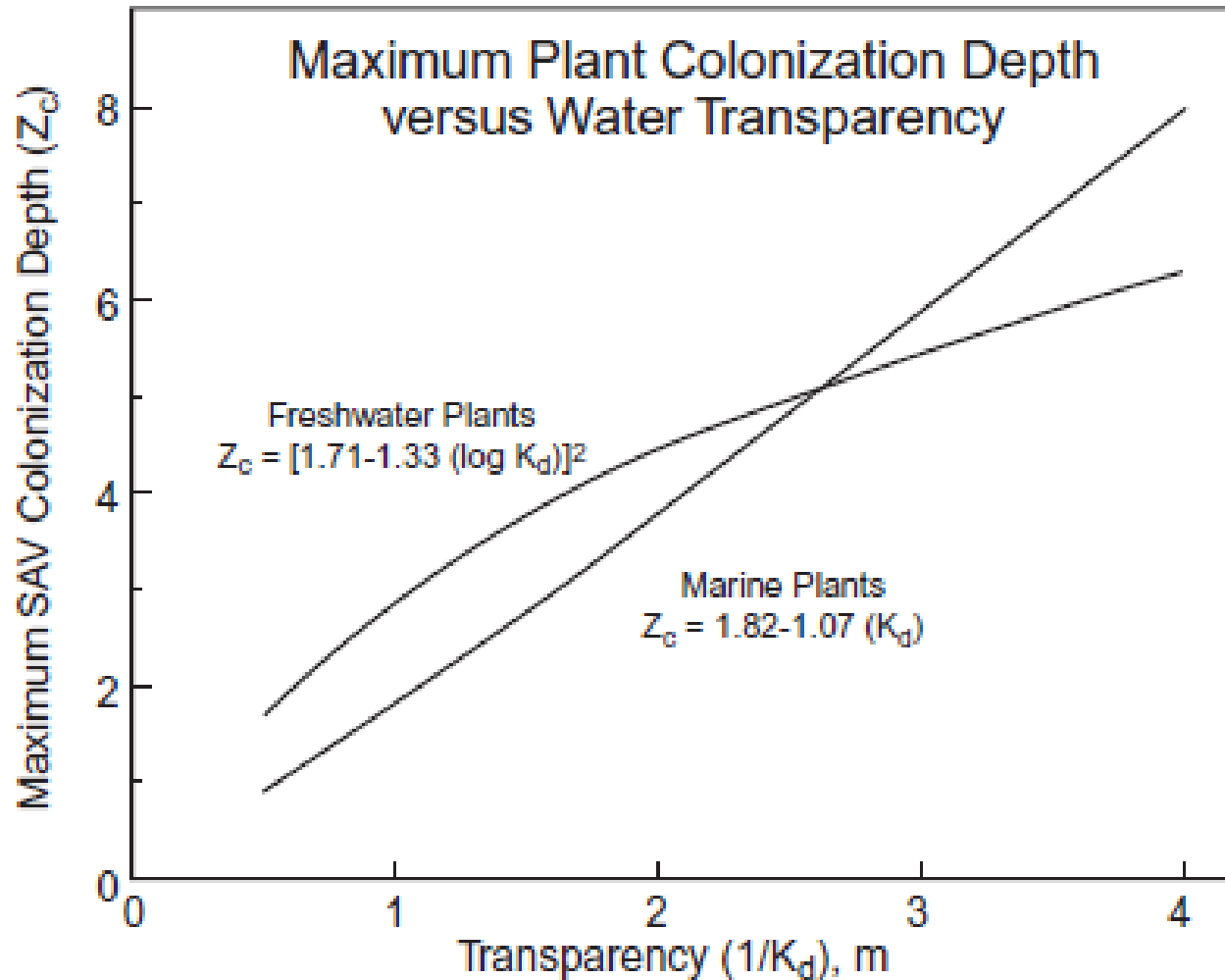
Recommended approach for best determination of the amount of light reaching SAV leaves

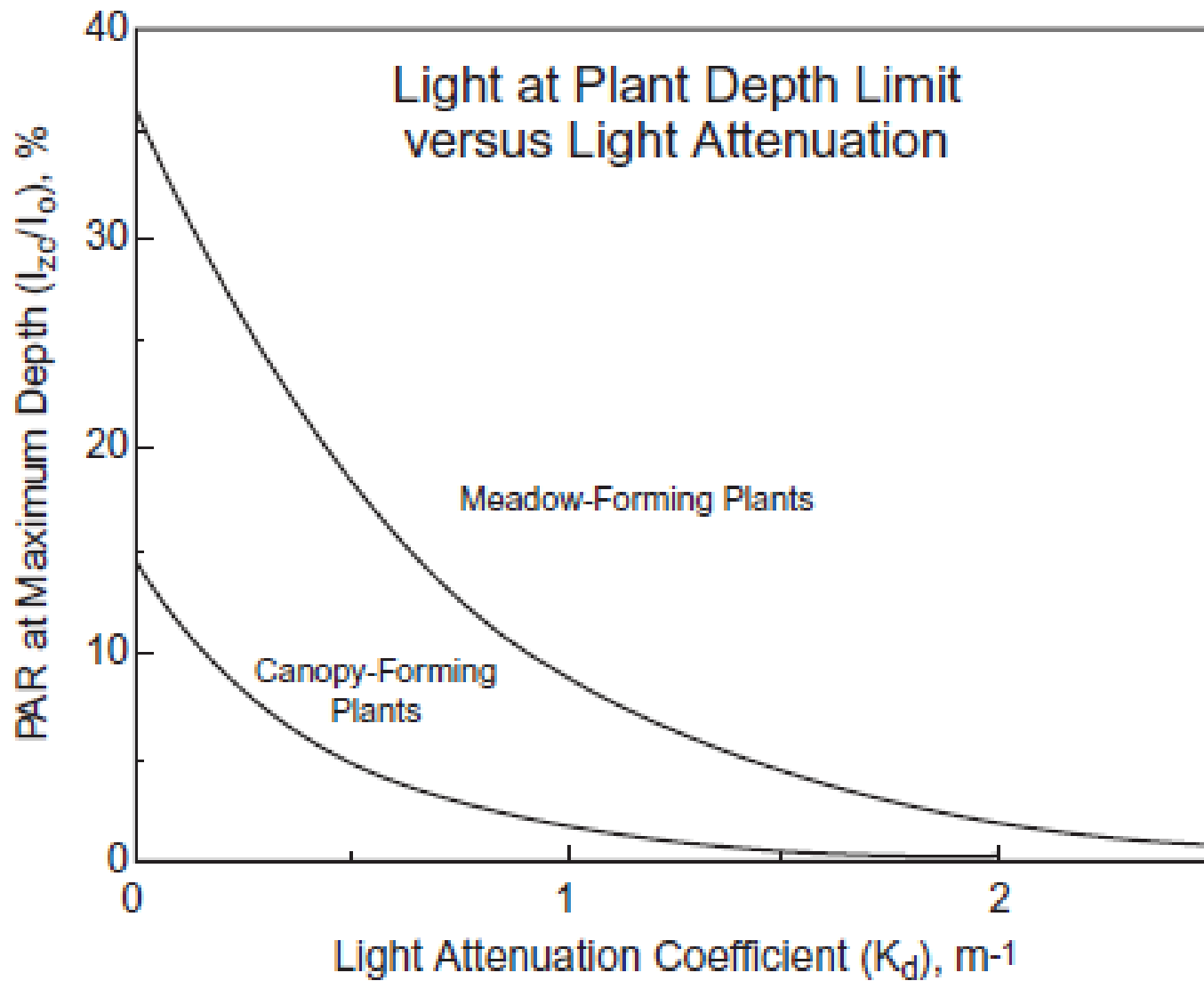
**FIGURE 2. Calculation of PLW and PLL and Comparisons with their Respective Light Requirements.** Illustration of the inputs, calculation and evaluation of the two percent light parameters: percent light through water and percent light at the leaf.

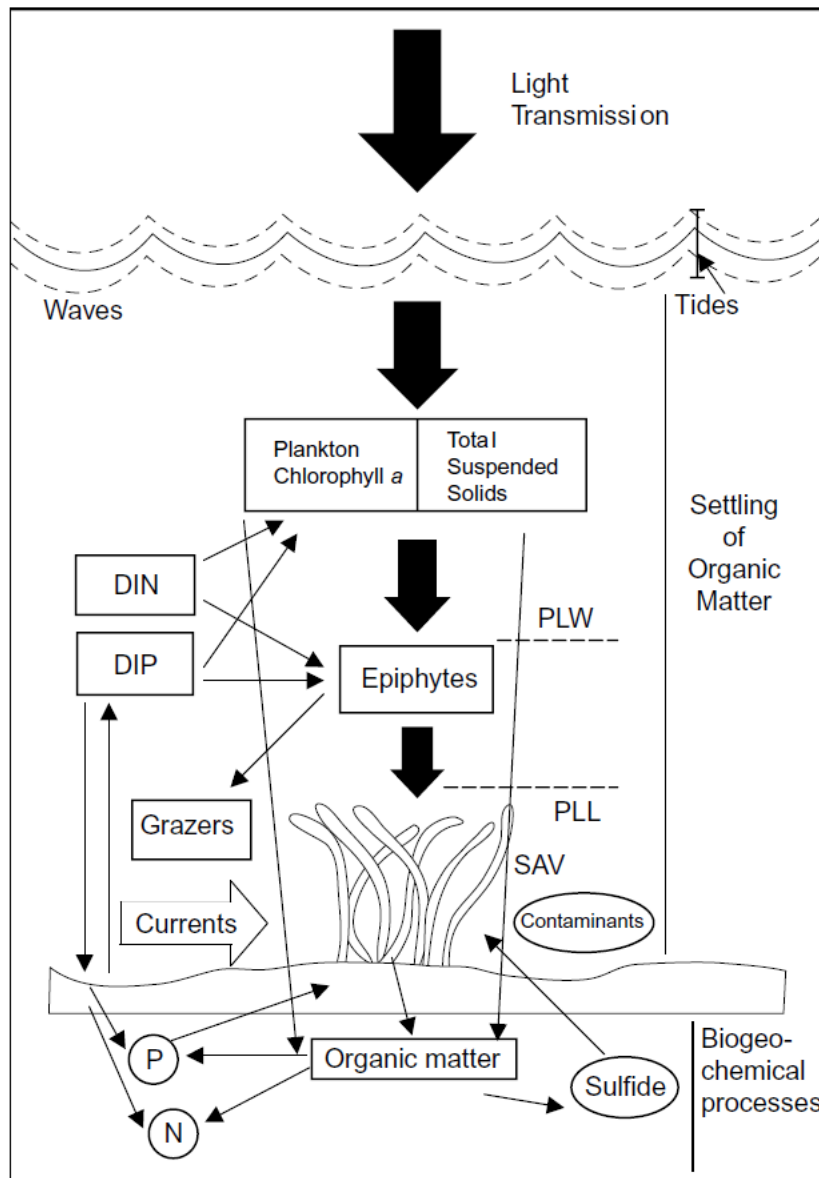
TABLE II-1. Comparison of SAV Habitat Requirements with median levels of water quality variables among SAV growth categories within salinity regimes in Chesapeake Bay.

SAV Habitat Requirements						
Salinity Regime*	SAV Growth Category In Segment	Primary	Secondary			
		Percent Light at Leaf, 0.5 m (PLL, %)	Total Suspended Solids (mg/l)	Plankton Chlorophyll-a (ug/l)	Dissolved Inorganic Nitrogen (mg/l)	Dissolved Inorganic Phosphorus (mg/l)
<i>Tidal Fresh</i>	<b>Requirement</b>	>9	<15	<15	none	<0.02
	Always Abundant	18	10.0	8.8	0.94	0.006
	Sometimes None	5.6*	20.0*	23.8*	0.66	0.015
	Usually None	1.3	24.0	19.4	1.17	0.033
	Always None	6.6	17.0	7.7**	0.37	0.020
<i>Oligohaline</i>	<b>Requirement</b>	>9	<15	<15	none	<0.02
	Always Abundant	8.5*	17.0*	4.7	0.86	0.047*
	Always Some	7.1*	18.5*	8.7	0.64	0.014
	Sometimes None	4.3*	25.0*	28.7*	0.12	0.005
	Usually None	3.8	27.3	17.4	0.15	0.023
	Always None	2.2	32.8	13.0**	0.23	0.020
<i>Mesohaline</i>	<b>Requirement</b>	>15	<15	<15	<0.15	<0.01
	Always Abundant	41	8.0	8.1	0.08	0.004
	Always Some	33	10.5	9.2	0.11	0.007
	Sometimes None	28	11.0	10.0	0.08	0.005
	Usually None	19**	15.0	15.2	0.09**	0.010
	Always None	5.3	27.0	11.9**	0.18	0.015
<i>Polyhaline</i>	<b>Requirement</b>	>15	<15	<15	<0.15	<0.02
	Always Abundant	40	10.0	6.3	0.05	0.003
	Always Some	22	9.8	5.9	0.12	0.010
	Sometimes None	22	11.1	7.1	0.14	0.015
	Usually None					
	Always None	15	11.5**	6.0**	0.21	0.025

# Light determines Max Depth ( $Z_c$ )







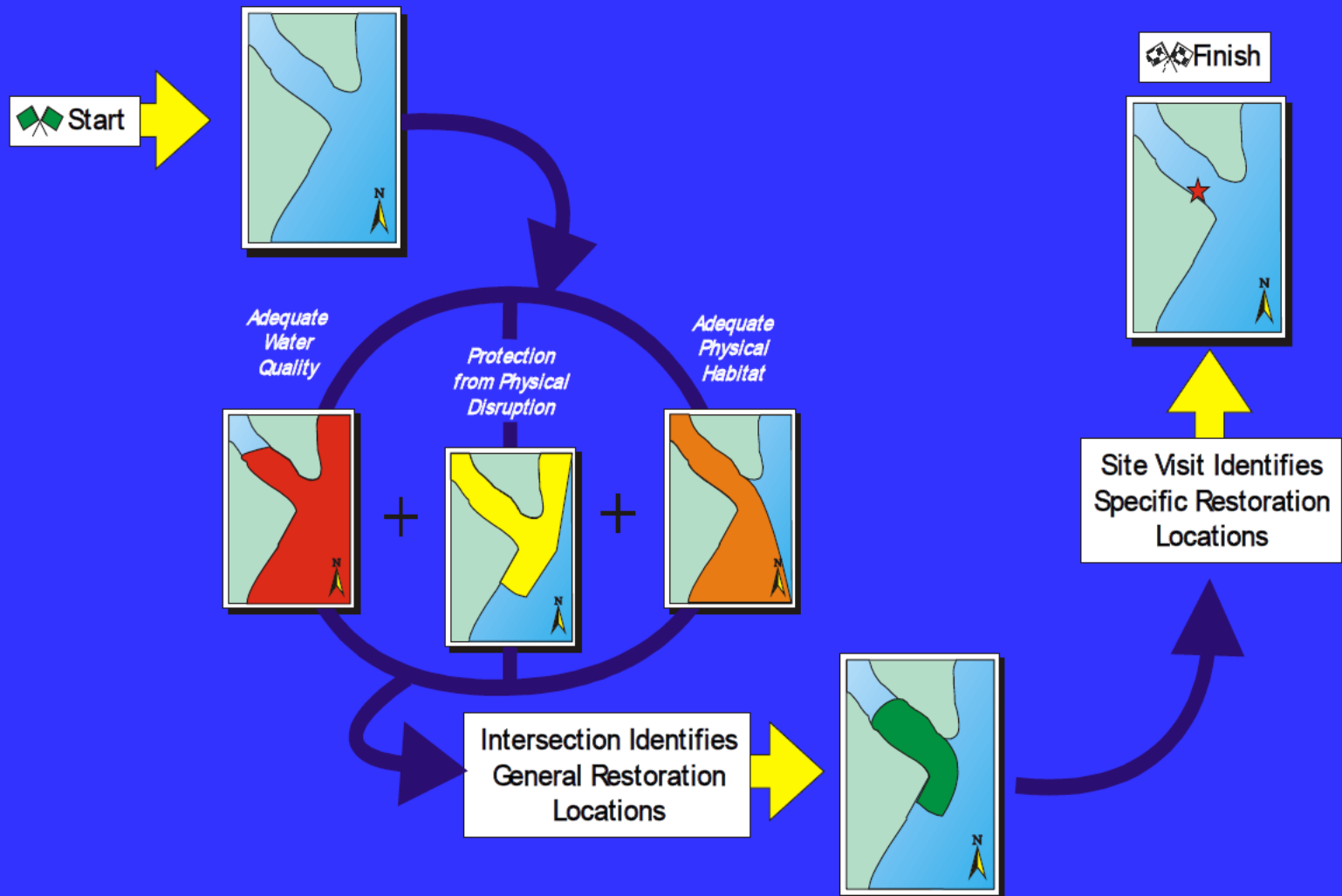
**FIGURE II-3. Interaction between Light-Based, Physical, Geological and Chemical SAV Habitat Requirements.** Interaction between previously established SAV habitat requirements, such as light attenuation, dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), chlorophyll a, total suspended solids (TSS) and other physical/chemical parameters discussed in this chapter (waves, currents, tides, sediment organic matter, biogeochemical processes). P = phosphorus; N = nitrogen; PLW = percent light through water; PLL = percent light at the leaf.

# Summary of Chesapeake Restoration Efforts (Karrh and Orth, 2011)

source: <http://www.chesapeake.org/OldStac/savrestreview.html>

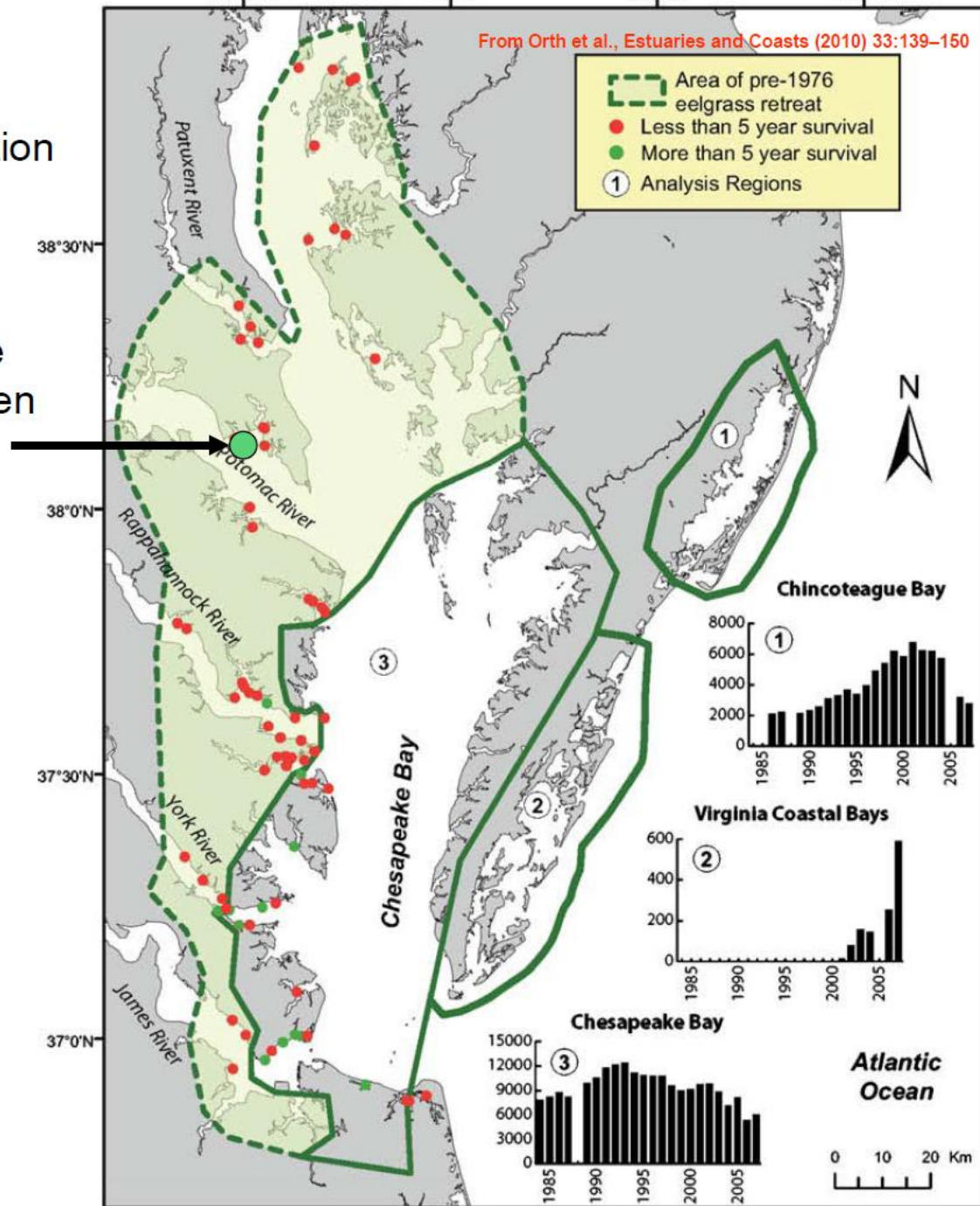
- Seeds used to plant *Zostera*; No attempt to restore freshwater species. Goal: 1,000 acres direct restoration; 185,00 acres via improved WQ
- Mass seed production, followed by large-scale planting in targeted restoration sites and monitoring of survival (this entailed huge costs).
- Failures in many cases (59 sites, No SAV after 5 years), some successes (11 sites w/ SAV, 5 year later, 16% success); went large-scale, too soon.
- Water quality conditions were bad in some places during restoration years, caused summer die-off.

# MD Restoration Targeting System (Parham and Karrh, 1998)



These are mostly small-scale restoration projects

This site would have had a green dot if the paper had been written one year later







## Stressors

There is column for "competition", are you referring to invasive species?

Under the species column, you have both exotic and invasive listed, should only invasive be listed. Eurasian Milfoil is listed, which is a non-native but has not been invasive in Back Bay so far.

The following affect SAV production as well:

- climate change
- parameters that affect water quality (suspended solids, chlorophyll a, nitrogen, and phosphorous)
- parameters that affect light attenuation (such as % cover of epiphytes on SAV)

## **Restoration Research**

You have plant production; also include research on seeding establishment (collection, storage, transplant, dispersal method, and best season to plant). In reading the articles, they mention due to low germination success, the SAV didn't grow.

Monitoring and management were together, should these be separate. Monitoring results of restoration efforts versus management protocols.

Include Temperature Range (minimum and maximum)

## **Project ID**

Under site location, include acreage, also water depth of SAV planted. Compare results if SAV is planted at different water depths of different restoration sites.

In Restoration Research and Project Id and Priorization, you have the column for "Criteria", criteria regarding what aspects?

## **Historical Occurrence**

Habitat Quality is a general term but specifically what qualifications are you looking for? Under **Life History**, several factors are listed that could describe habitat, so habitat quality under Historical Occurrence could be deleted.

For objectives 4 (research plan) and Objective 5 (implementation plan), keep them separate. Researching could involve several categories, whereas implementation plan is like the conclusion of research findings to determine which actual management and restoration efforts to use. Thank you for the opportunity to participate,