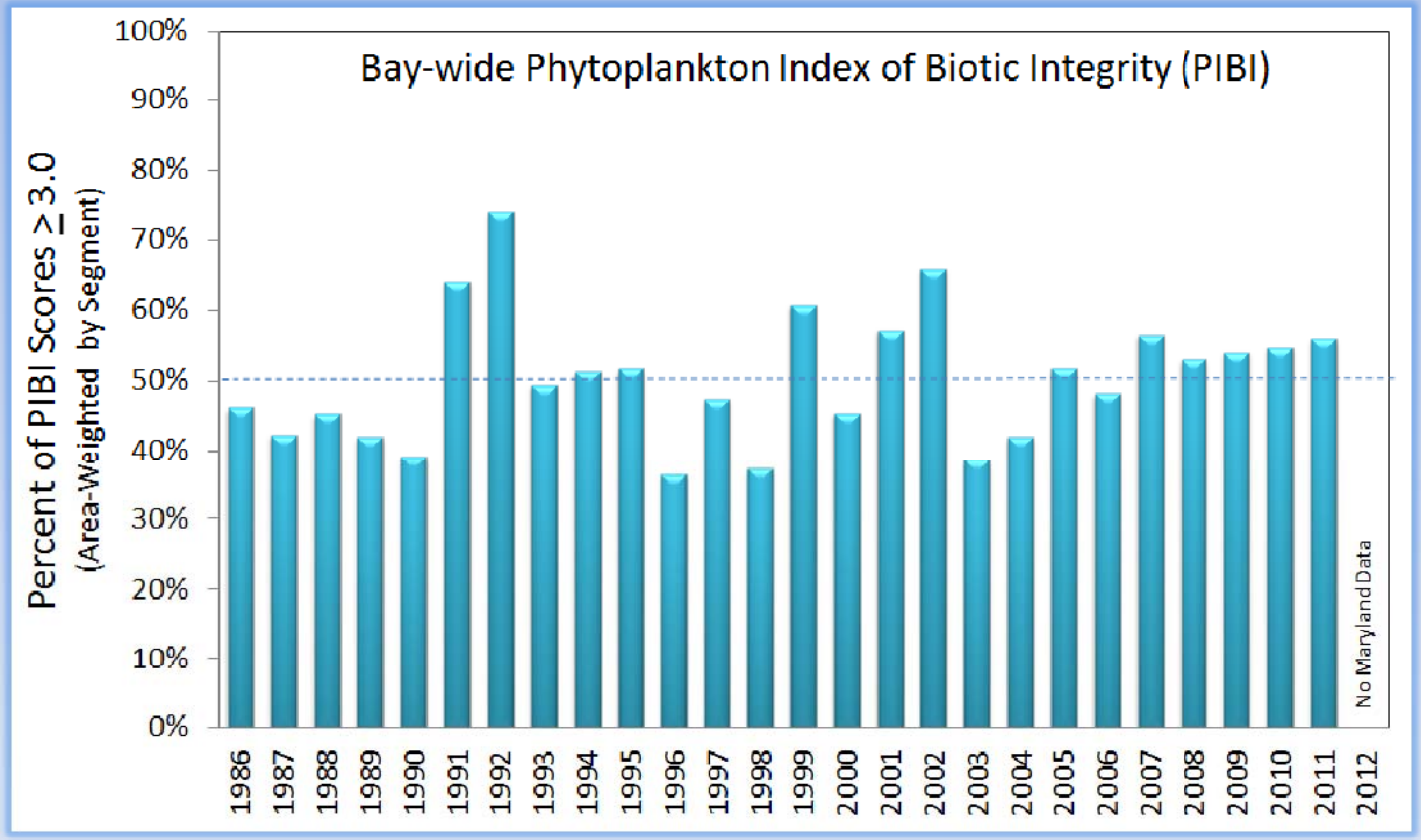
Creating a Surrogate for the Baywide PIBI



Long-term average 50.3%

Claire Buchanan

TMAW workgroup meeting, July 2013

Short History of Chesapeake Bay PIBI

- PIBI developed from phytoplankton count data; based on communities in Reference and Degraded habitats defined by DIN, PO_4, and Secchi
- Published *Estuaries* 2006; CBP goal of 3 or better on a 1-5 scale decided shortly after
- PIBI used for CBP reporting; incorporated into EcoCheck Bay index
- MRAT → phytoplankton monitoring discontinued in MD after 2010
- Revalidation of PIBI completed; manuscript submitted to *J. Environmental Management* 2013
- Currently no <u>baywide</u> biological indicator or response variable for Bay's open water habitat (chlorophyll *a* doesn't count!)
- Currently no Data Manager to manage phyto data & calculate indicators
- Close relationships between phytoplankton index and habitat categories suggest a possible water quality-based <u>surrogate</u> for the baywide PIBI.

Objective:

develop a phytoplankton habitat index that

1) strongly mimics the PIBI, and
2) is derived from water quality parameters still monitored bay-wide

Original Phytoplankton Habitat Categories

- Fisher & Gustafson (2003) bioassays ID'ed N and P concentrations that limit algal bloom formation
- Olson (2002) Relative Status Method ID'ed benchmarks of Secchi depths and extreme nutrient concentrations

"Reference" "Degraded"

8 season-salinity specific categories	Best	Better	Mixed-better light (MBL)	Mixed-poor light (MPL)	Poor	Worst
Secchi depth	Very Deep best	Deep better, best	Deep better, best	Shallow poor, worst	Shallow poor, worst	Very Shallow worst
DIN	Very Low best	Low better, best	Any	Any	High poor, worst	Very High worst
PO_4	Very Low best	Low better, best	Any	Any	High poor, worst	Very High worst

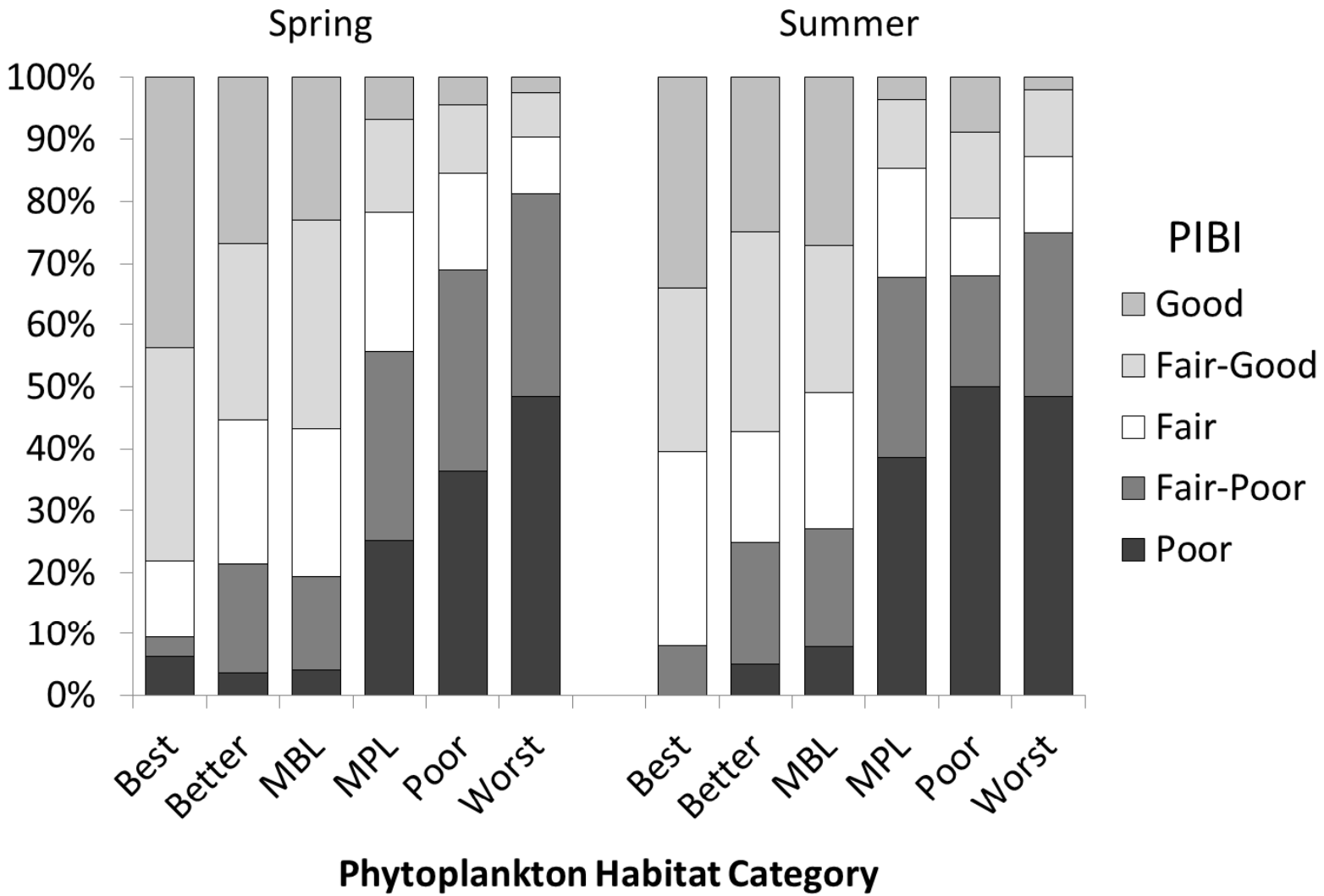
Phytoplankton

no blooms or busts
low cell content of Chl a
little cell lysis
low % blue greens
low or no #'s HABs

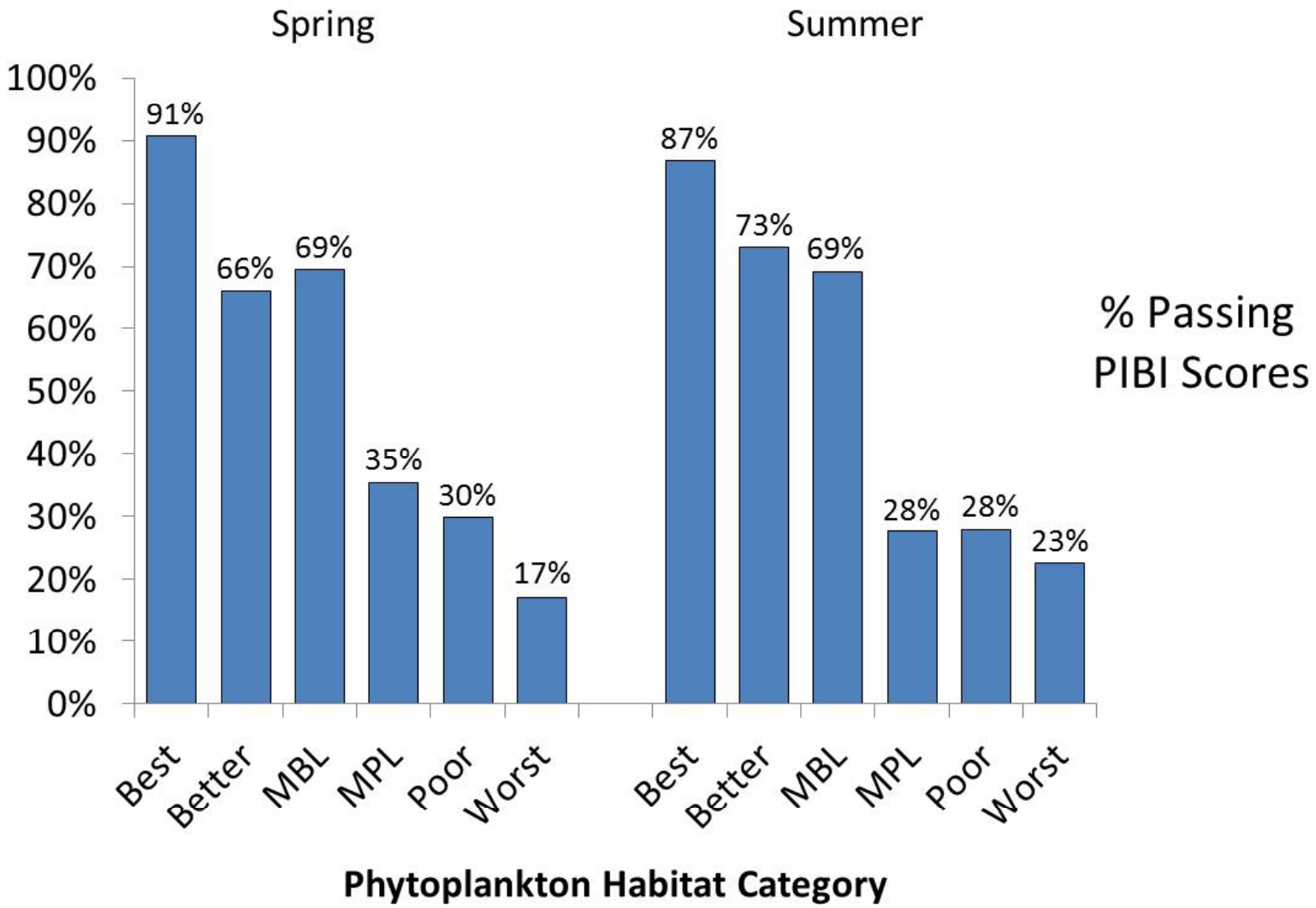
PIBI Classification Efficiency for REF and DEG = 75%

many blooms and busts
high cell content of Chl a
much cell lysis
high % blue greens
high #'s HABs

Good PIBI ~ Habitat Relationship

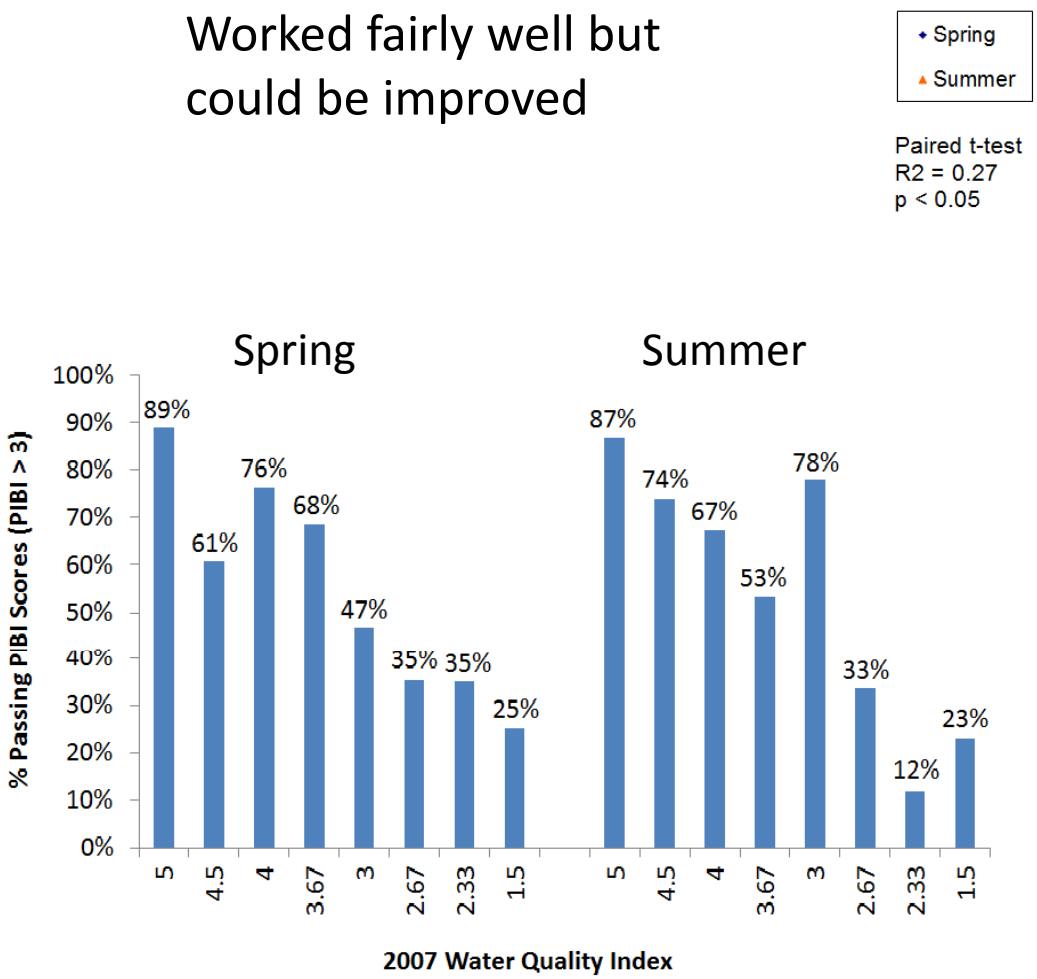


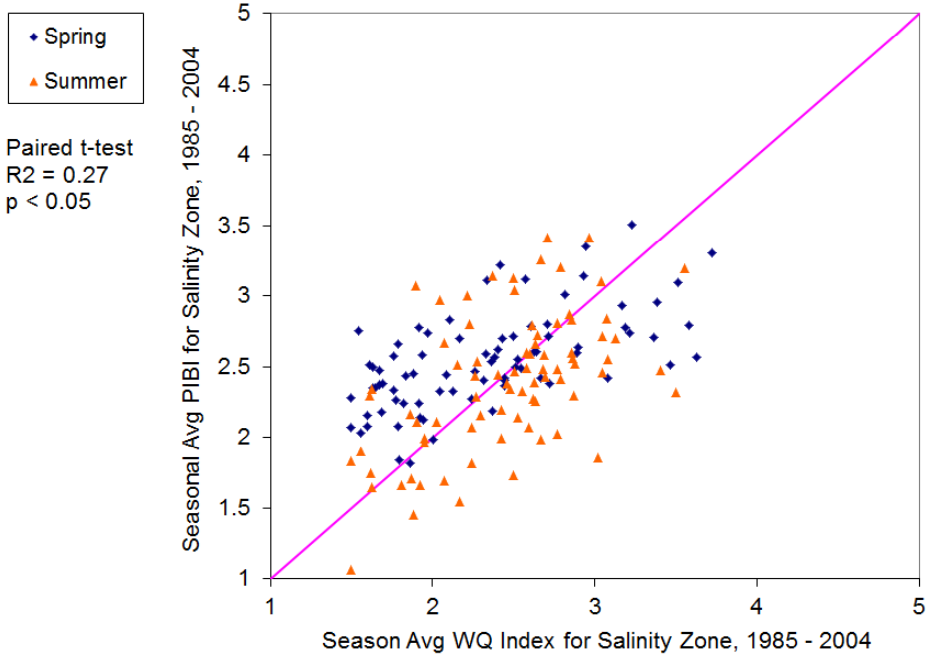
Good % Goal Attainment ~ Habitat Relationship



Tried to put phytoplankton habitat categories on a numeric 1-5 scale (2007)

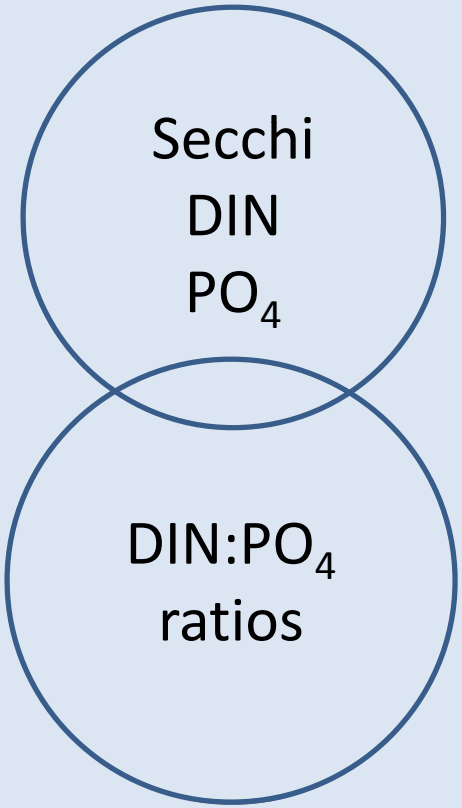
Worked fairly well but could be improved





Loss of MD Phytoplankton Program Forces Action

"Phytoplankton Habitat Index" or "Open Water Habitat Index"



PIBI

C:Chl a
Picoplankton
Diatom biomass
Microcystis aeruginosa
Prorocentrum minimum
Total nano-micro biomass
% Cryptophyte biomass
Dinoflagellate biomass
Cyanophyte biomass

Pheophytin
DOC
Chl a

Indicators of Resource Limitation

Fisher & Gustafson (2003) bioassays identified indicators of resource limitation

Contributions by Elgin Perry, Renee Karrh, Larry Haas, and Dave Jasinski

P limitation

- PO_4 <0.007 mg/liter (threshold used in original habitat categories)
- DIN/PO_4 >300:1
-

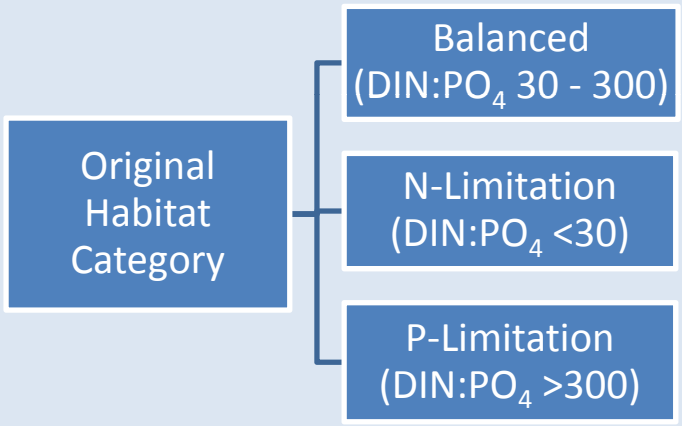
N limitation

- DIN <0.070 mg/liter (threshold used in original habitat categories)
- DIN/PO_4 <30:1
-

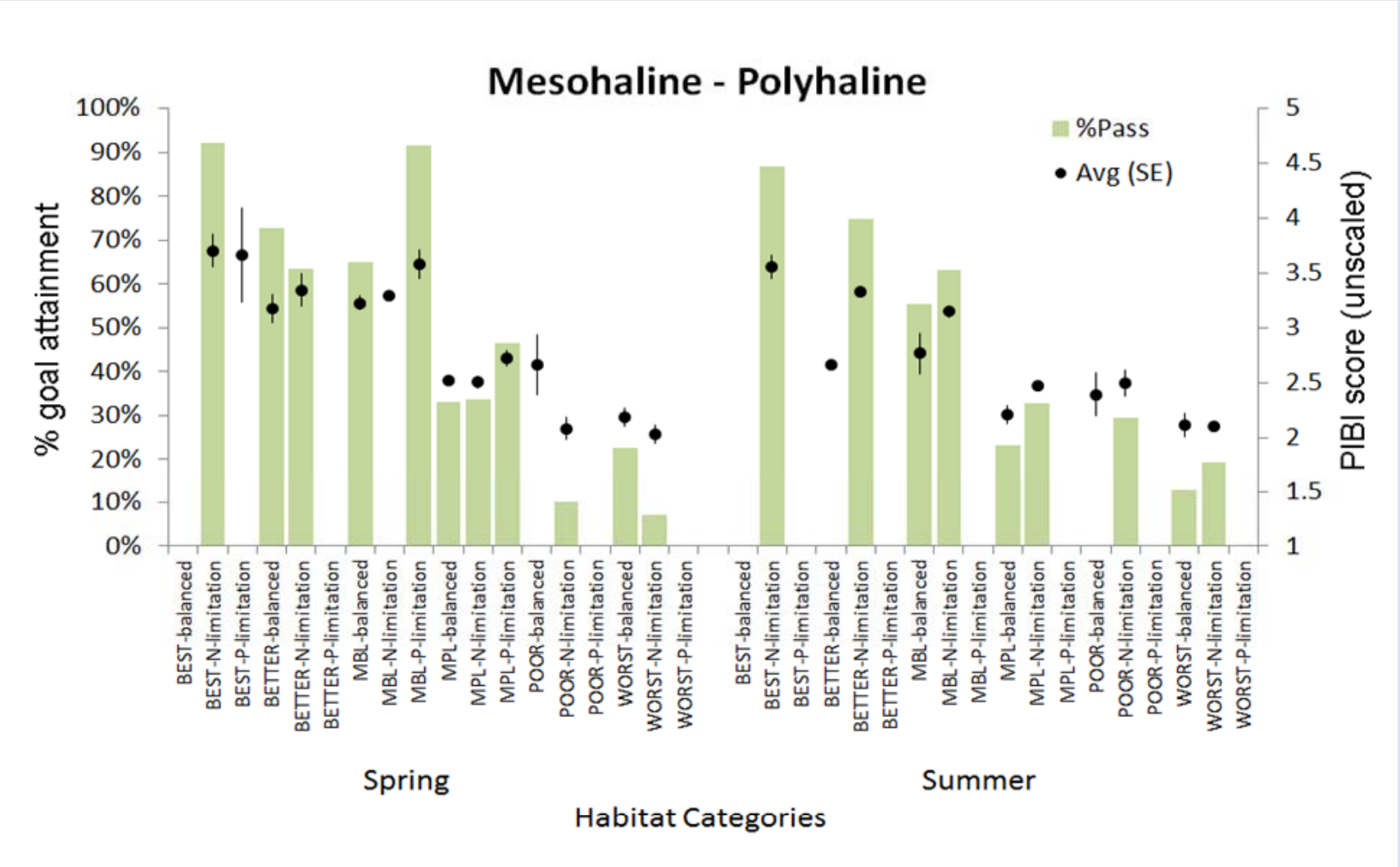
DIN:PO_4 Ratios:
- in **Poor** and **Worst** habitats indicate the *future* limiting nutrient
- in **Mixed** habitats indicate if the nutrient ratios are close to being "balanced"
- in **Better** and **Best** habitats ratios >300 and <30 could indicate nutrient deficiency?

DIN:PO_4 Ratio Incorporated into Habitat Categories

- Each of the six original habitat categories gets “balanced,” “N-limitation,” and “P-limitation” subcategories

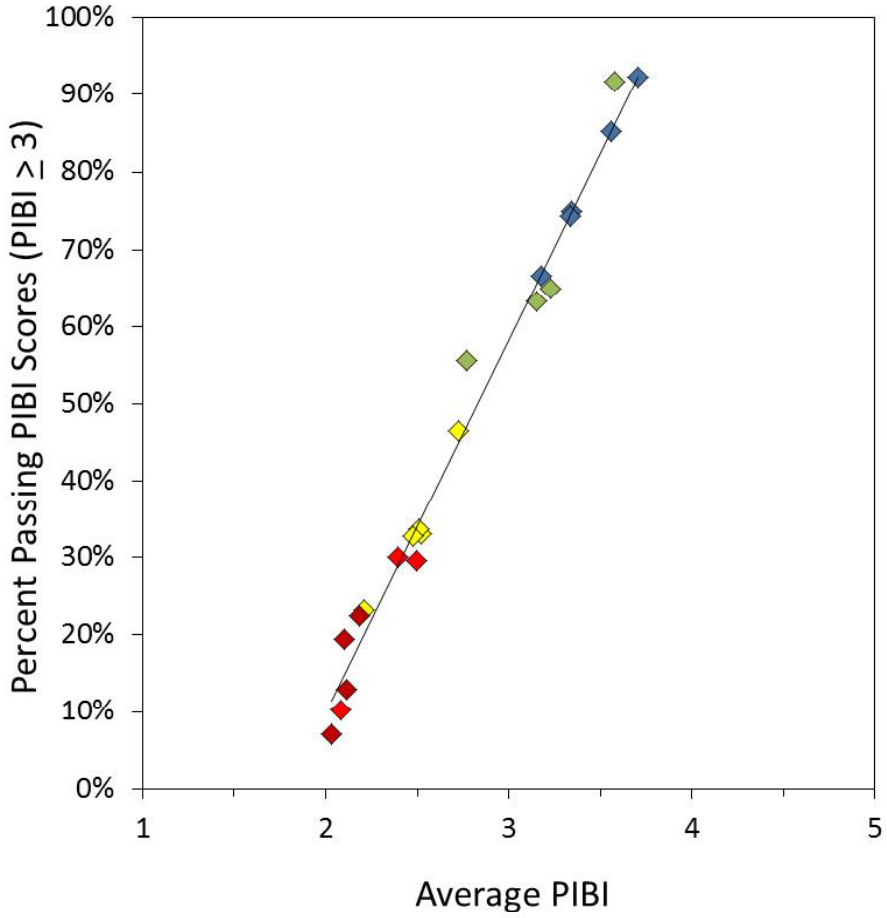


Greater Resolution and Complexity of Categories



Useful Index Properties Enhanced

Mesohaline + Polyhaline



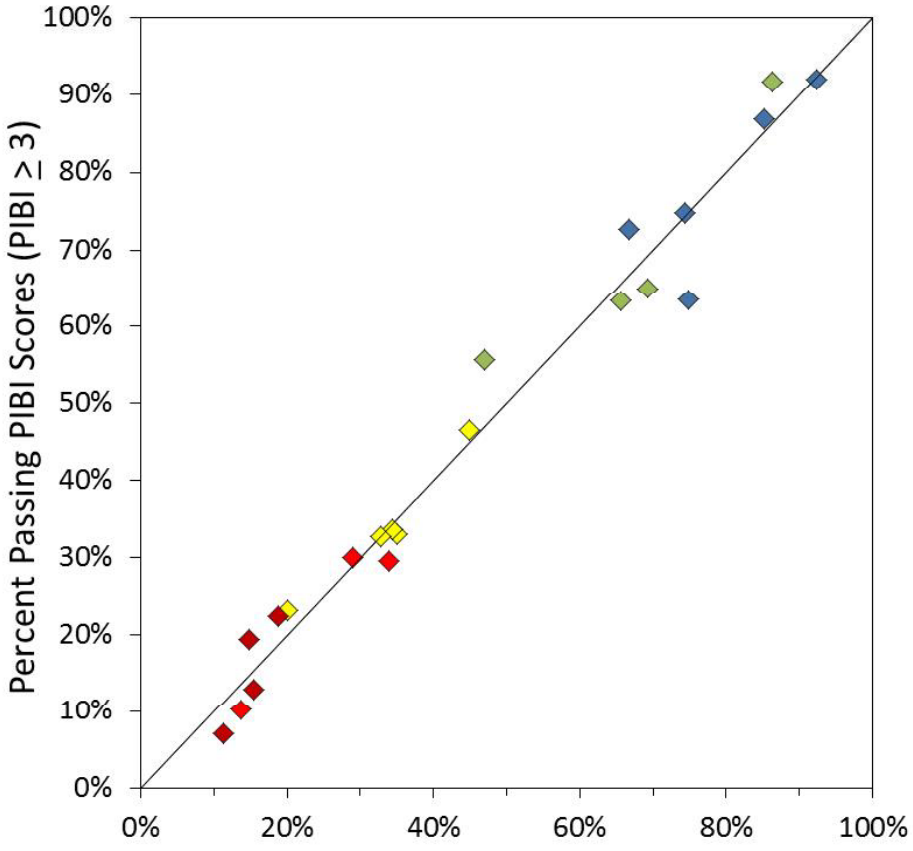
18 Habitat Categories/2 Seasons

BEST-balanced	no data
BEST-N-limitation	♦
BEST-P-limitation	♦
BETTER-balanced	♦
BETTER-N-limitation	♦
BETTER-P-limitation	no data
MBL-balanced	♦
MBL-N-limitation	♦
MBL-P-limitation	♦
MPL-balanced	♦
MPL-N-limitation	♦
MPL-P-limitation	♦
POOR-balanced	♦
POOR-N-limitation	♦
POOR-P-limitation	no data
WORST-balanced	♦
WORST-N-limitation	♦
WORST-P-limitation	no data

Tight relationship between average PIBI and % passing PIBI ($r^2 = 0.97$)

Useful Index Properties Enhanced

Mesohaline + Polyhaline



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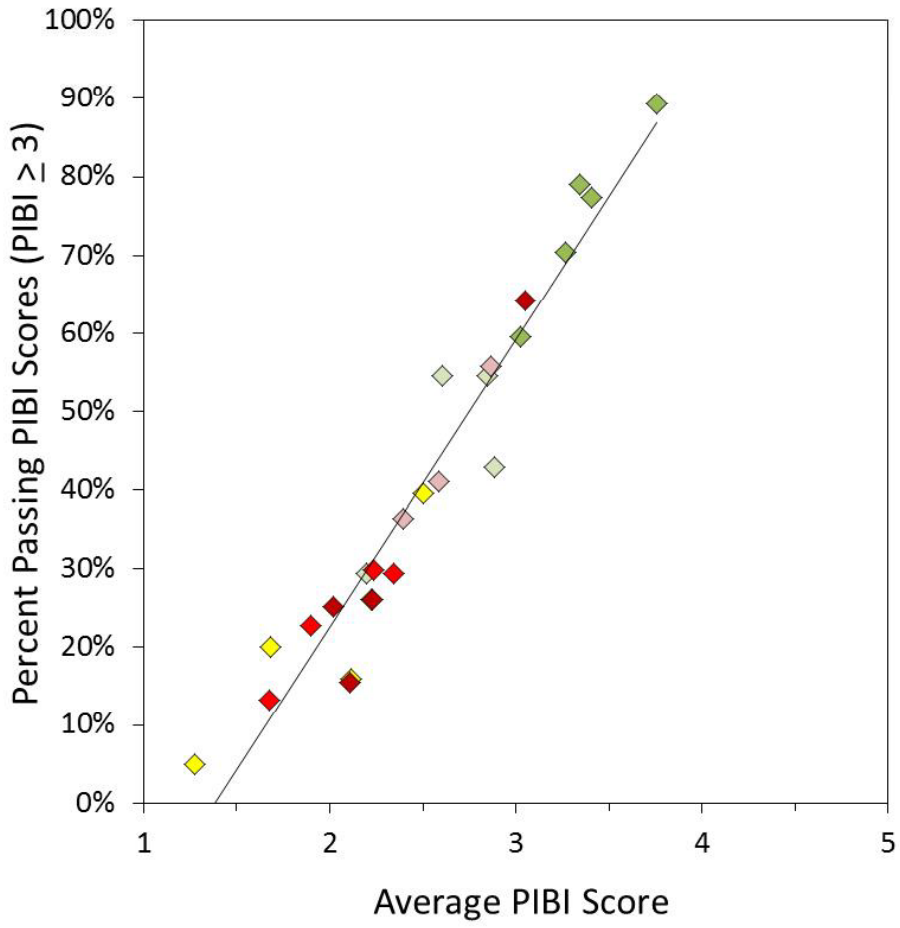
MBL-balanced	♦
MBL-N-limitation	♦
MBL-P-limitation	♦
MPL-balanced	♦
MPL-N-limitation	♦
MPL-P-limitation	♦
POOR-balanced	♦
POOR-N-limitation	♦
POOR-P-limitation	no data
WORST-balanced	♦
WORST-N-limitation	♦
WORST-P-limitation	no data

With scaling, an average PIBI score can be directly equated to a % passing PIBI score ($r^2 = 0.97$)

Useful Index Properties Enhanced

Tidal Fresh + Oligohaline



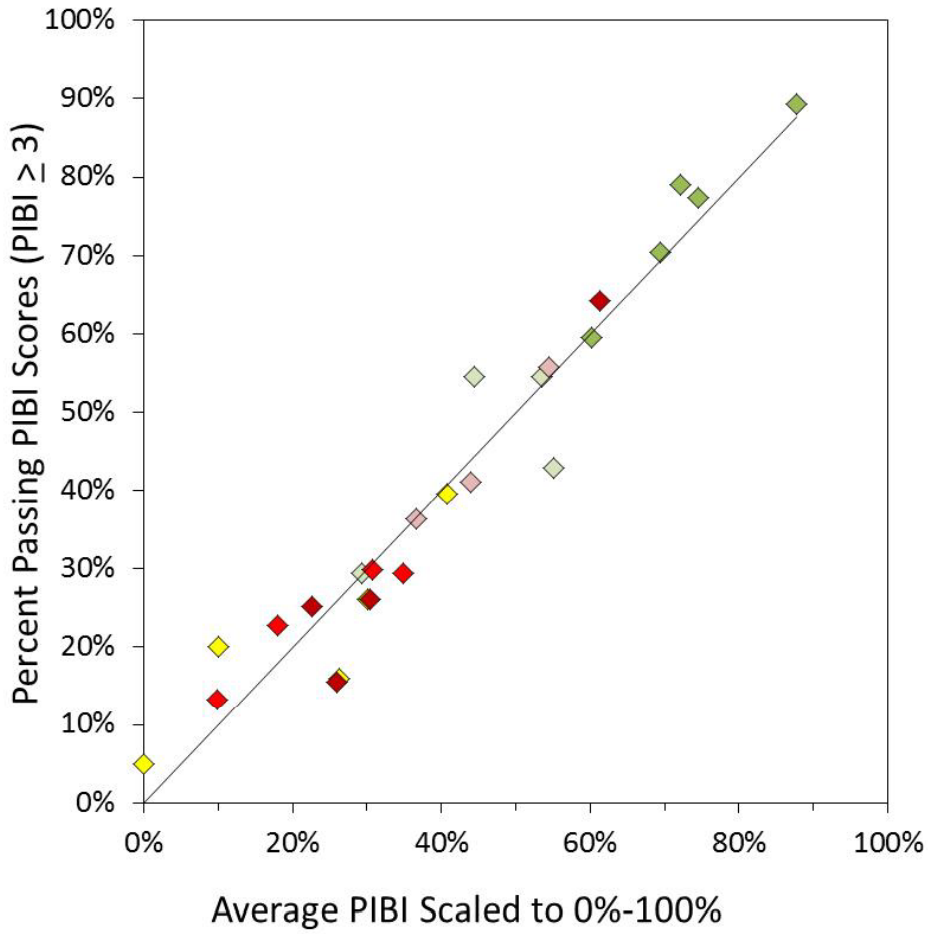
24 Habitat Categories/Spr & Sum Seasons

BEST-balanced	no data
BEST-N-limitation	no data
BEST-P-limitation	no data
BETTER-balanced	few data
BETTER-N-limitation	few data
BETTER-P-limitation	no data
MBL-balanced	♦
MBL-N-limitation	♦
MBL-P-limitation	♦
Mixed_FairLight-balanced	♦
Mixed_FairLight-N-limitation	♦
Mixed_FairLight-P-limitation	♦
Poor_FairLight-balanced	♦
Poor_FairLight-N-limitation	♦
Poor_FairLight-P-limitation	no data
MPL-balanced	♦
MPL-N-limitation	♦
MPL-P-limitation	♦
POOR-balanced	♦
POOR-N-limitation	♦
POOR-P-limitation	few data
WORST-balanced	♦
WORST-N-limitation	♦
WORST-P-limitation	no data

In TF-OH, relationship even stronger when a “Fair” light class is added ($r^2 = 0.93$).

Useful Index Properties Enhanced

Tidal Fresh + Oligohaline



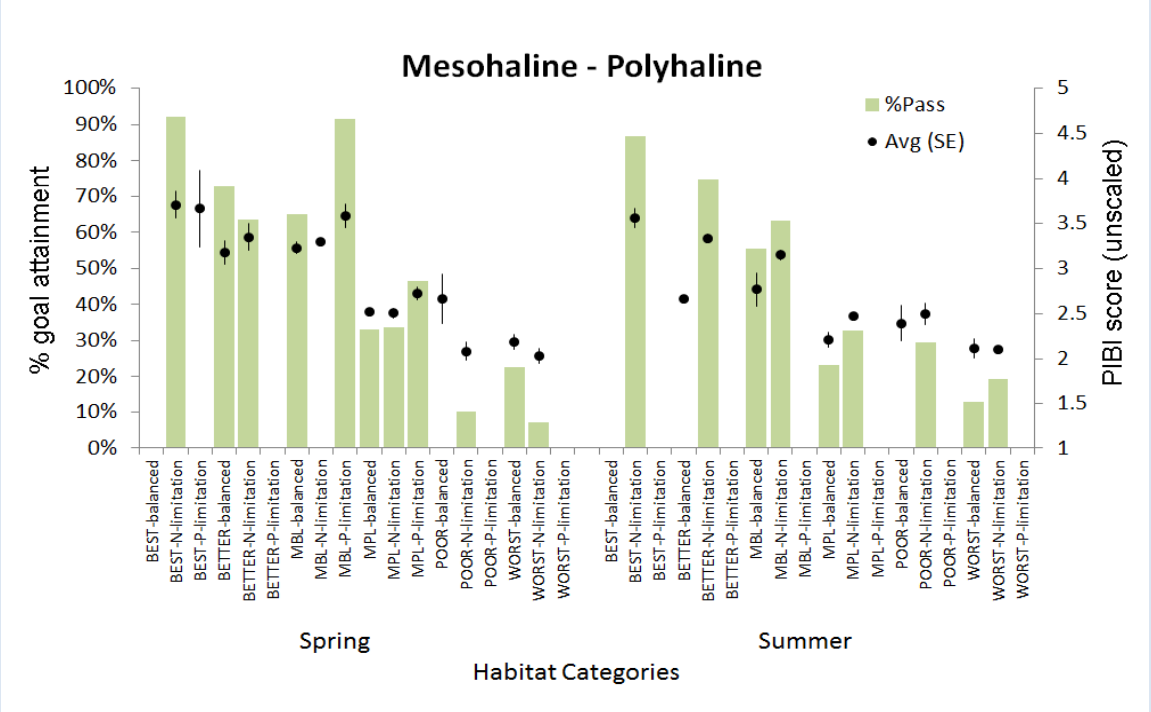
24 Habitat Categories/Spr & Sum Seasons	
BEST-balanced	no data
BEST-N-limitation	no data
BEST-P-limitation	no data
BETTER-balanced	few data
BETTER-N-limitation	few data
BETTER-P-limitation	no data
MBL-balanced	♦
MBL-N-limitation	♦
MBL-P-limitation	♦
Mixed_FairLight-balanced	♦
Mixed_FairLight-N-limitation	♦
Mixed_FairLight-P-limitation	♦
Poor_FairLight-balanced	♦
Poor_FairLight-N-limitation	♦
Poor_FairLight-P-limitation	no data
MPL-balanced	♦
MPL-N-limitation	♦
MPL-P-limitation	♦
POOR-balanced	♦
POOR-N-limitation	♦
POOR-P-limitation	few data
WORST-balanced	♦
WORST-N-limitation	♦
WORST-P-limitation	no data

With scaling, an average PIBI score can be directly equated to a % passing PIBI score ($r^2 = 0.94$)

Remaining Challenge

Put <u>numeric</u> values on the habitat categories…

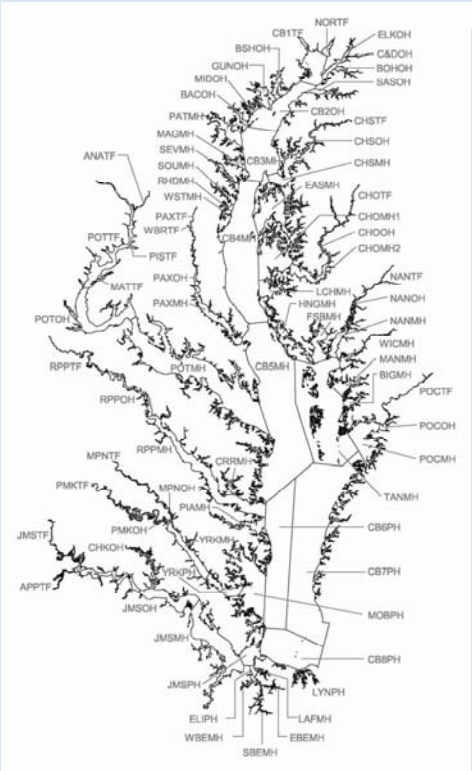
… so that PIBI status and % attainment of PIBI goal can be projected anywhere that DIN, PO_4 and Secchi are measured



<u>Propose</u>:

Score each phytoplankton habitat category with its corresponding 1984-2010 'historic' values for PIBI goal attainment (%) <u>and</u> PIBI average score

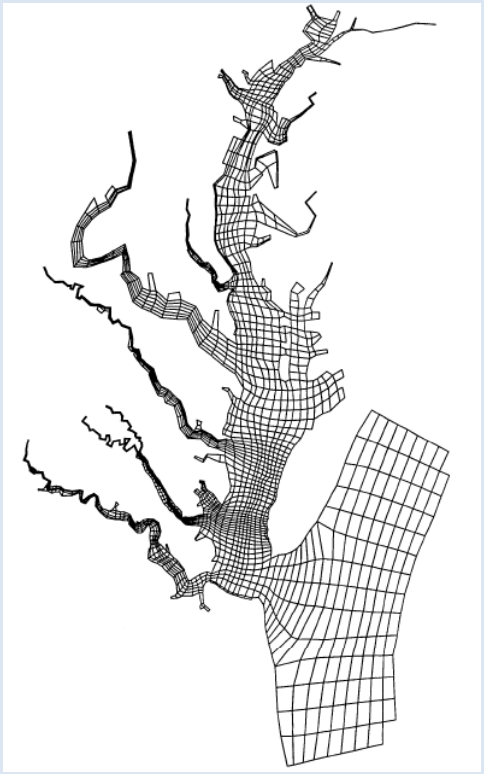
Possible Applications of PIBI Surrogate, or "Phytoplankton Habitat Index"



Illustrate probable phytoplankton community status (Good-Fair-Poor) baywide

Show probable % attainment of goal baywide

Incorporate PHI into composite Bay Health indicators



Assess likely phytoplankton community responses to model scenario output

Phytoplankton Habitat Index (PHI)

Benefits: - provides a PIBI surrogate stronger than Chl a

- is an integrated, open water index of nutrient and light conditions important to phytoplankton

- maintains a few phytoplankton-related parameters as biological response metrics (Chl a, pheophytin, DOC)

- can be verified in the future with Virginia phytoplankton PIBI values, to detect any shifts in habitat category characteristics

- has broader spatial & temporal coverage than original PIBI

- can be folded into composite indexes of Bay Health

Next step: - produce 2011 and 2012 maps of PHI showing probable % PIBI goal attainment in all CBP segments

QUESTIONS FOR TMAW

- Is this PHI index a convincing PIBI surrogate?
- Would a PHI index be useful to incorporate into the (dwindling) suite of CBP indicators as a PIBI surrogate?

Thank you Renee Karrh and Peter Tango