SAV Modeling Approach

Quarterly Review (7/14-15/2026)

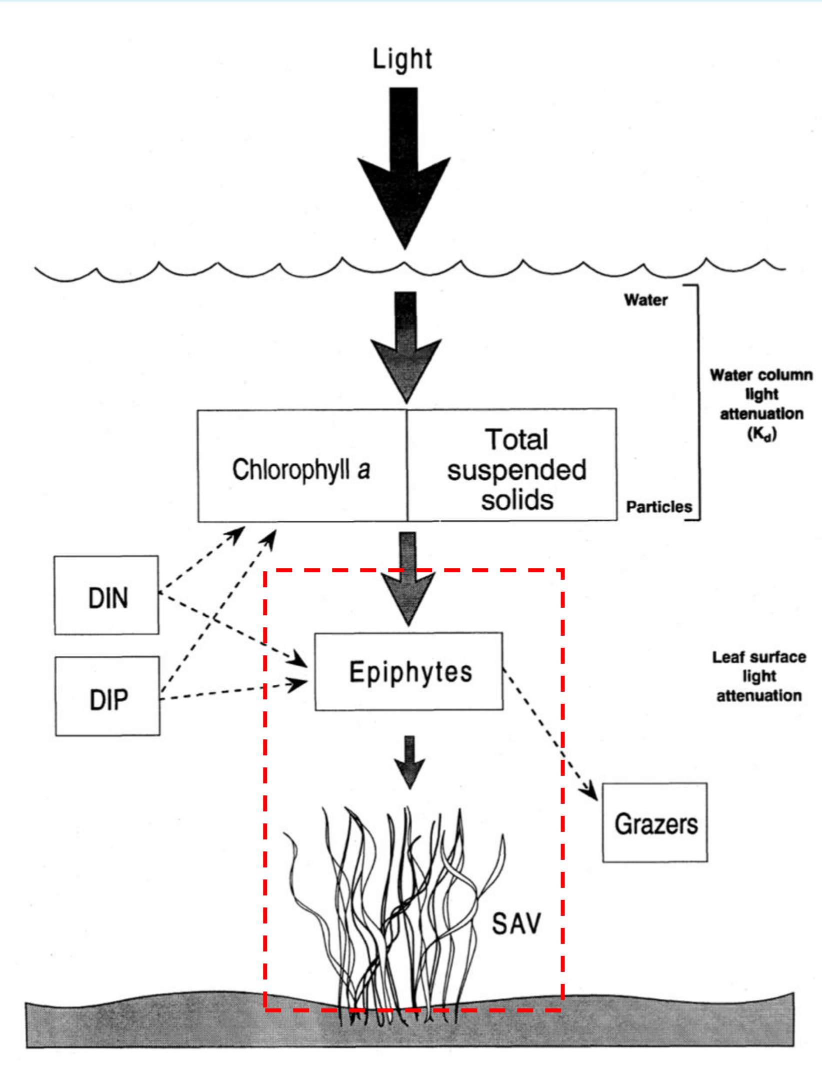
Jian Shen, Joseph Zheng, Zhengqui Wang

VIMS | William & Mary

Virginia Institute of Marine Science

SAV Model

Conceptual Model



Dennison et al., 2008

SAV Numerical Model

Leaf biomass (g C m^{-2})

Stem biomass (g C m^{-2})

Root biomass (g C m^{-2})

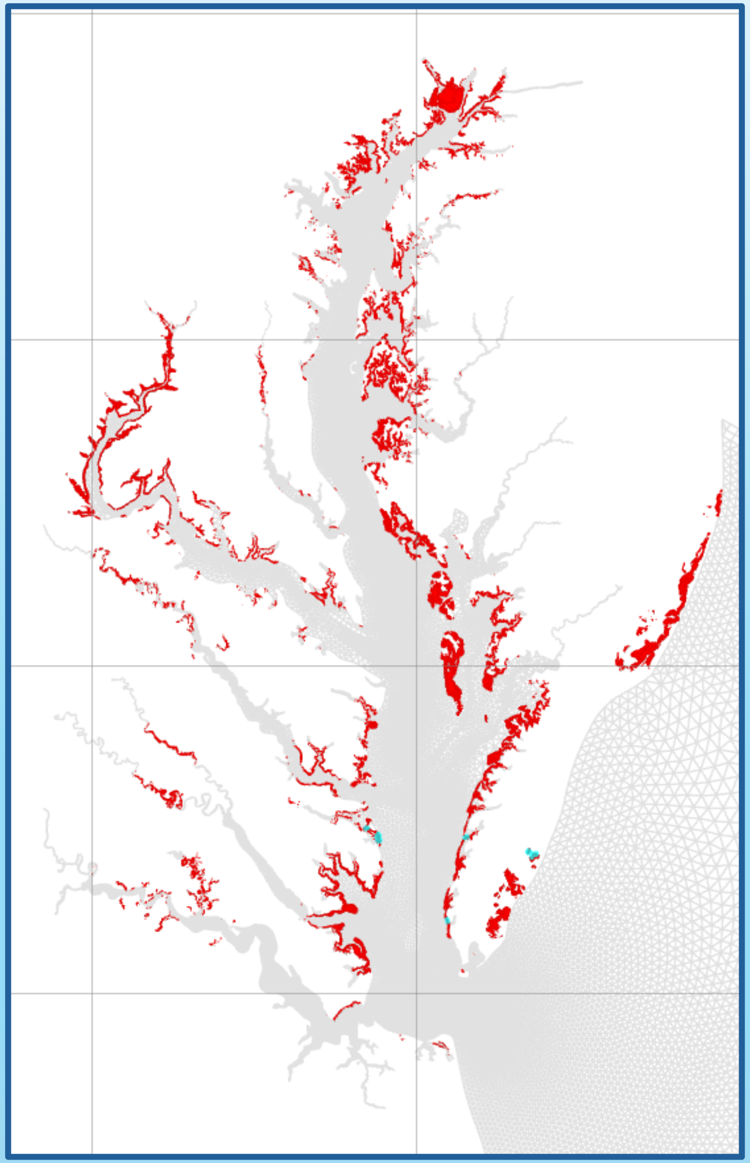
Epiphytes
(g epiphyte C m^{-2} leaf area)

Light
DIN
DIP
Temperature
TSS

Cerco et al. 2010

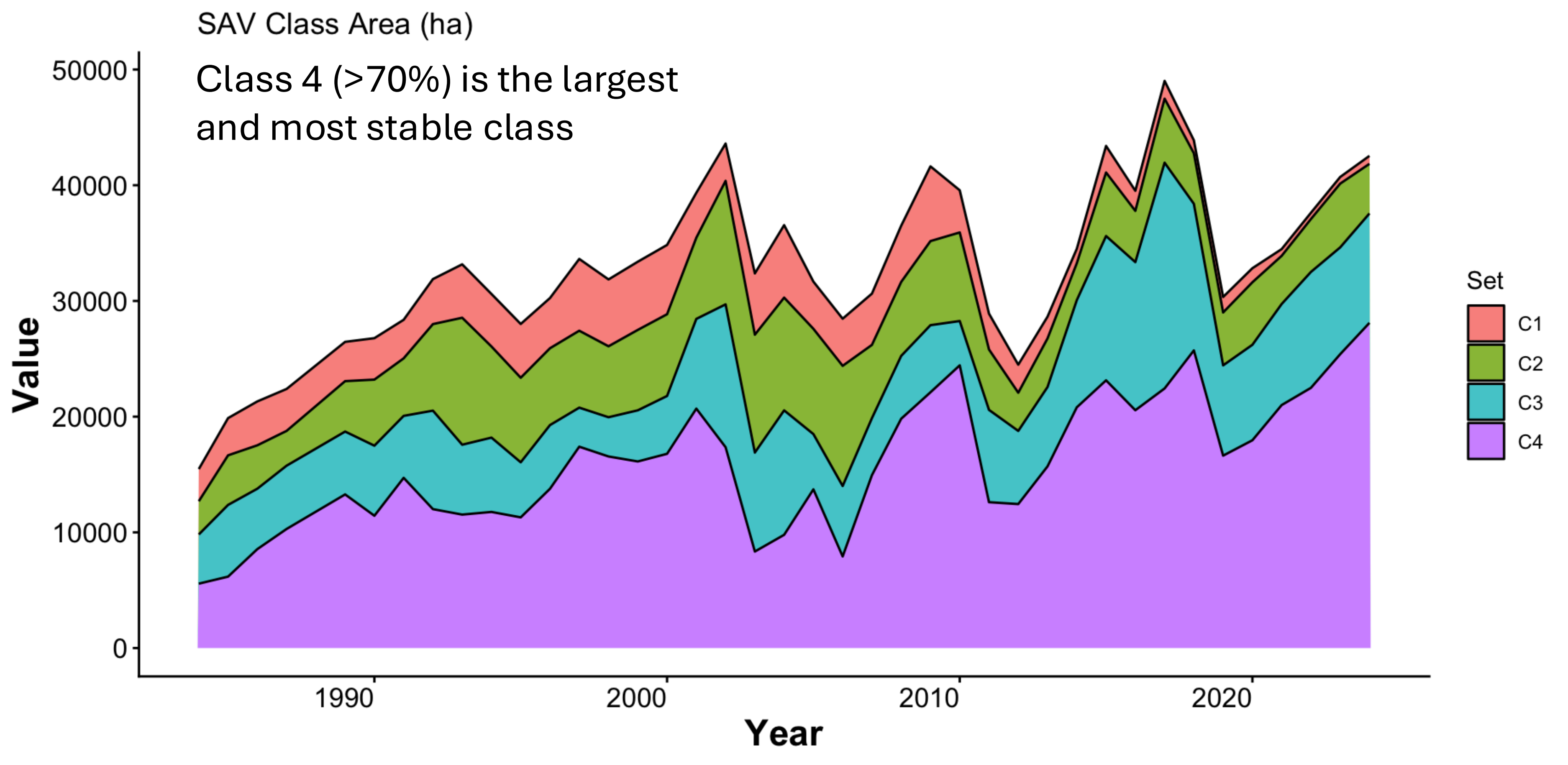
Essential Needs for Modeling SAV

- Estimate SAV biomass
- Select SAV species
- Convert biomass to area
- Set initial conditions for the model
- Model verification



Available Data

- Annual Distribution of SAV for each density class



Available Data

- Percentage areas for each class are reported by VIMS for each Bay segment

Download Data Year: 2024 Zone: Tidal Fresh

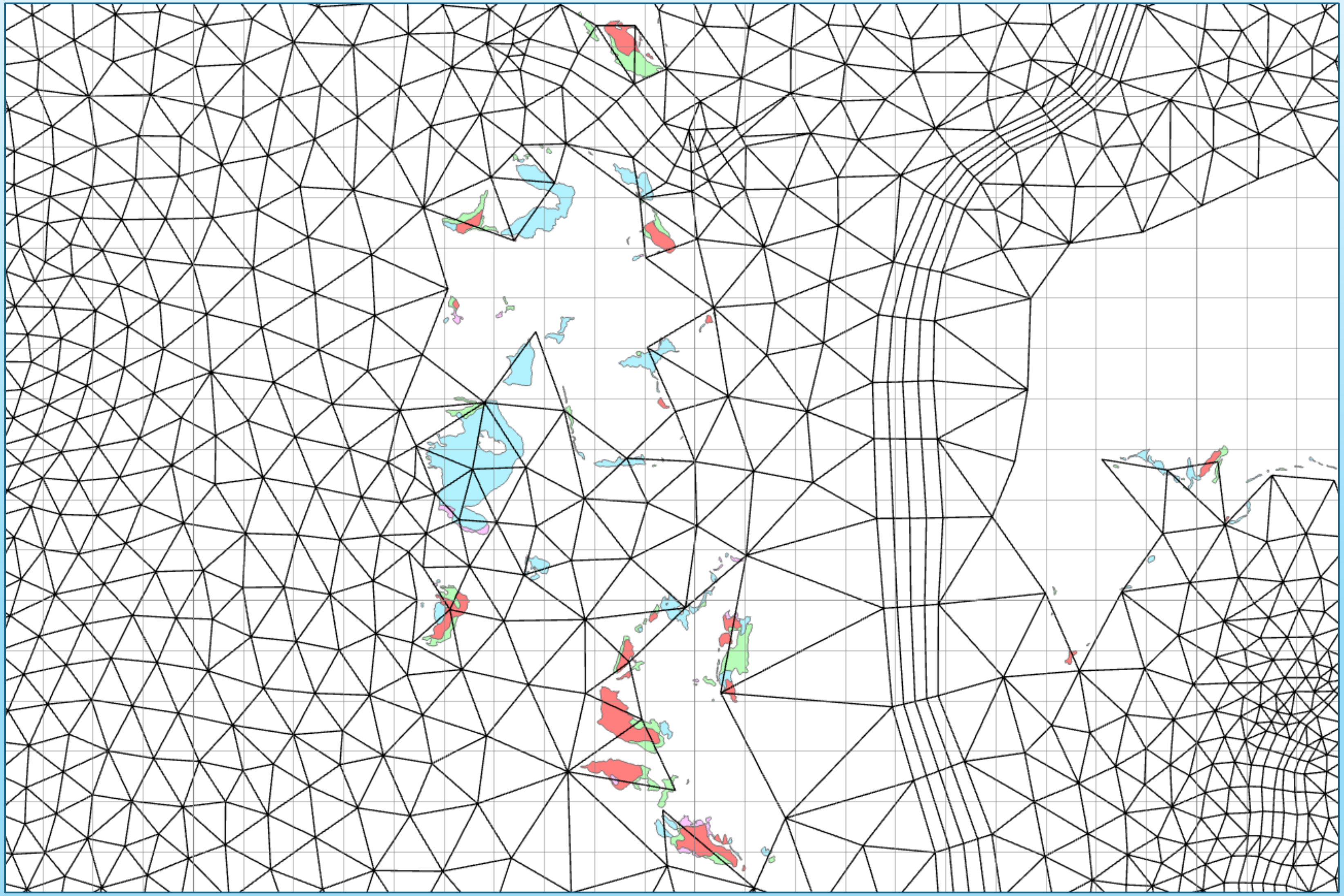
Salinity Zones Geographic Zones

Segment	Class 1	Class 2	Class 3	Class 4	Total
CB1TF1	0.72 0 %	5.92 2 %	28.48 11 %	233.67 87 %	268.79
CB1TF2	31.69 1 %	267.97 6 %	110.74 3 %	4,010.94 91 %	4,421.34
NORTF	0.61 1 %	2.59 4 %	19.25 32 %	36.99 62 %	59.44
CHSTF	0.00 0 %	0.00 0 %	0.00 0 %	1.11 100 %	1.11
CHOTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
NANTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
POCTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
PAXTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
WBRTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
POTTF	0.00 0 %	15.26 1 %	89.83 5 %	1,536.56 94 %	1,641.65
MATTF	0.00 0 %	38.26 11 %	36.14 10 %	278.54 79 %	352.94
ANATF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00
PISTF	0.00 0 %	2.92 4 %	1.19 2 %	61.16 94 %	65.27
RPPTF	0.37 0 %	19.82 2 %	73.96 9 %	699.71 88 %	793.86
MPNTF	0.00 0 %	0.00 0 %	16.92 92 %	1.52 8 %	18.44
PMKTF	6.58 2 %	15.17 4 %	65.95 17 %	302.33 78 %	390.03
JMSTF1	0.87 1 %	24.36 14 %	60.20 36 %	83.88 50 %	169.30
JMSTF2	0.00 0 %	0.98 100 %	0.00 0 %	0.00 0 %	0.98
APPTF	0.00 0 %	0.00 0 %	0.00 0 %	0.00 0 %	0.00

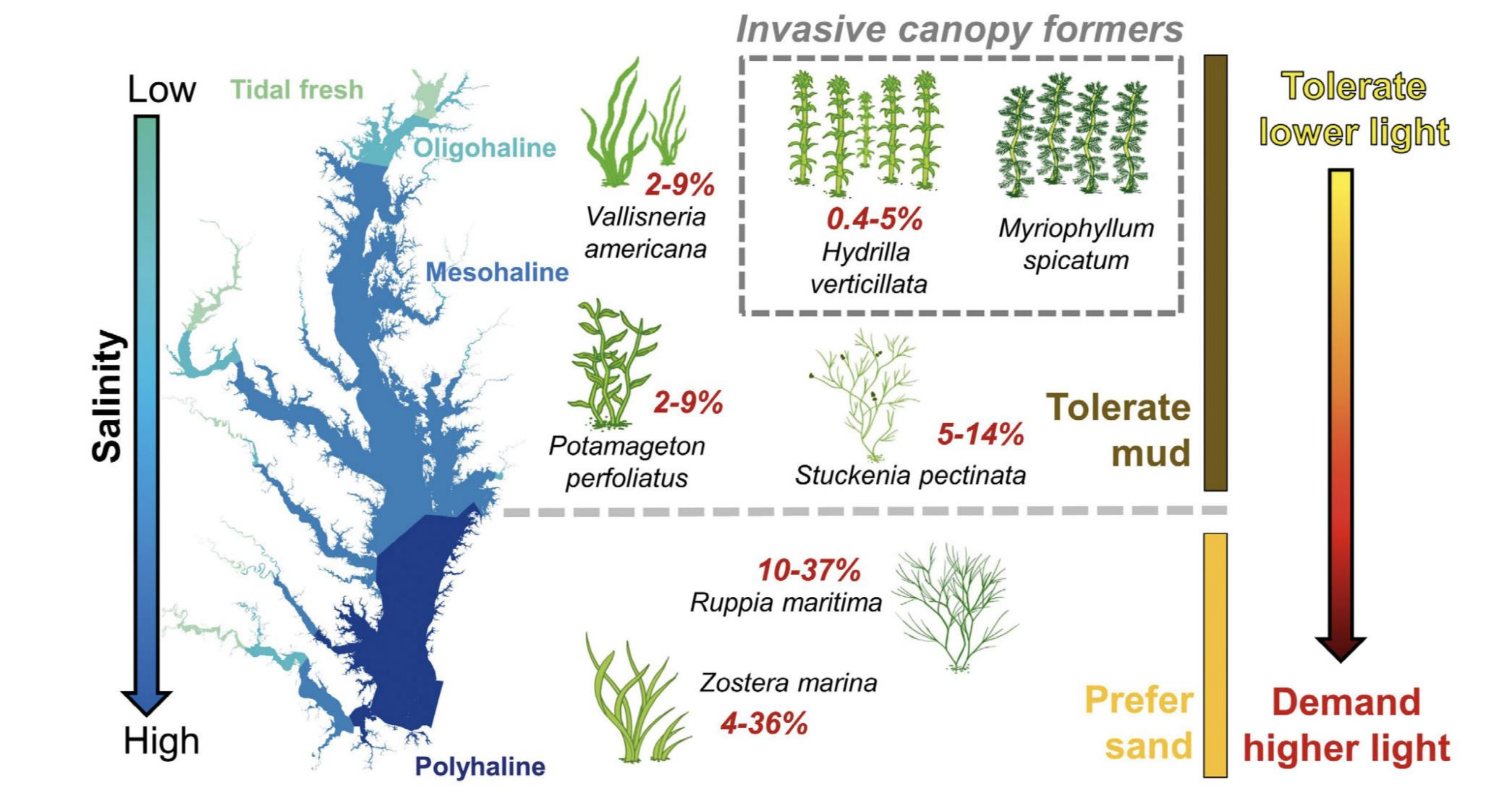
Areas in Hectares. "nd" indicates that the area was not mapped. "pd" indicates that the area was not fully mapped.

Biomass and Density Consideration

- SAV Density is divided into 5 categories
  - 1=<10%
  - 2=10-40%,
  - 3=40-70%,
  - 4=>70%,
  - -1=Unclassified
- Our grid size is larger than SAV area, it is difficult to model each density class.
- We can simulate averaged density



Species Distribution across Salinity Region



Patrick and Weller, 2015

Biomass Distribution

- Moore (2000) provided typical biomass distribution of SAV in different salinity regions

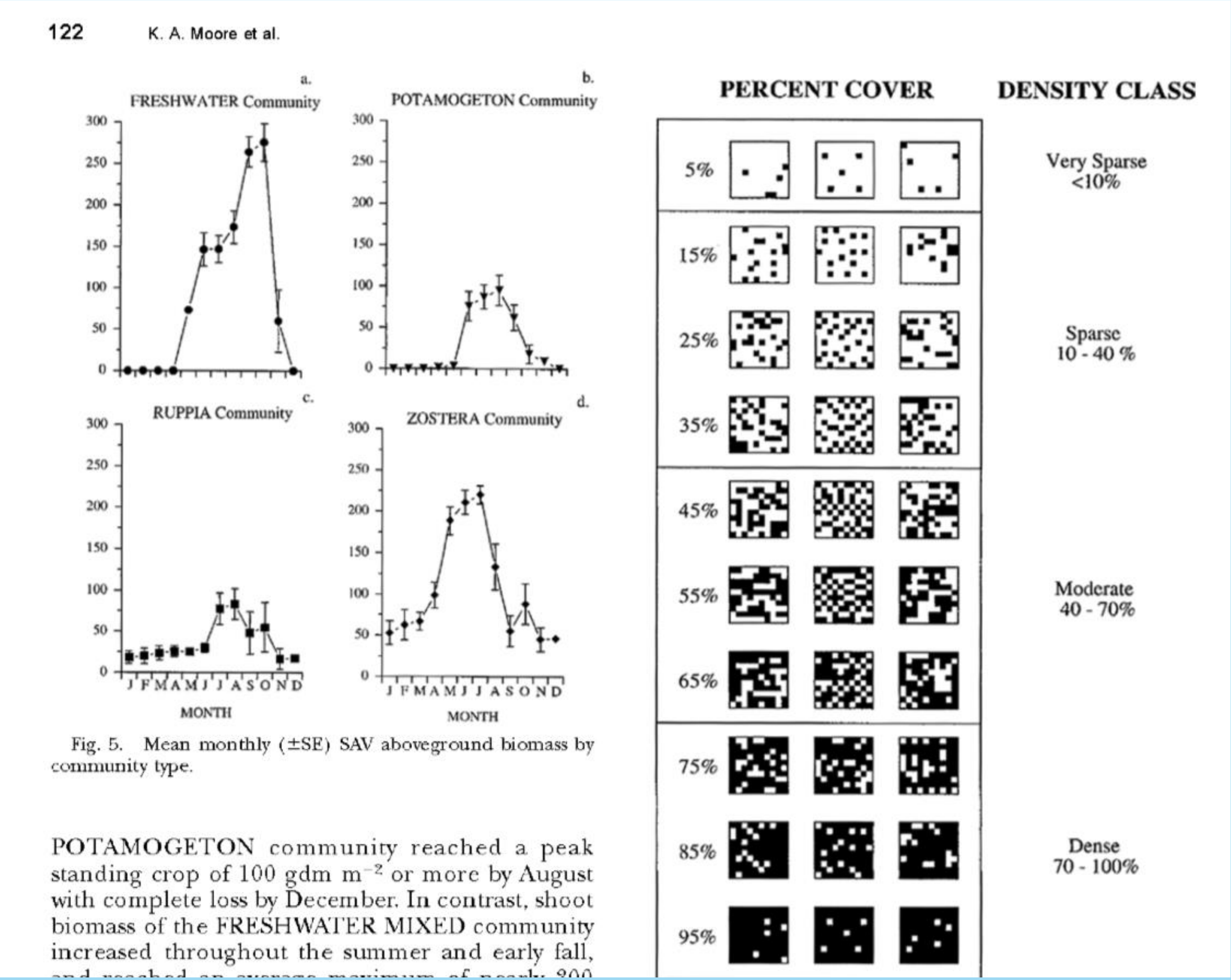


Fig. 5. Mean monthly (±SE) SAV aboveground biomass by community type.

POTAMOGETON community reached a peak standing crop of 100 gdm m^{-2} or more by August with complete loss by December. In contrast, shoot biomass of the FRESHWATER MIXED community increased throughout the summer and early fall,

Species Distribution

- Select typical 4 species for 4 salinity regions
- Key differences
  - Magnitude of peak biomass
  - Duration

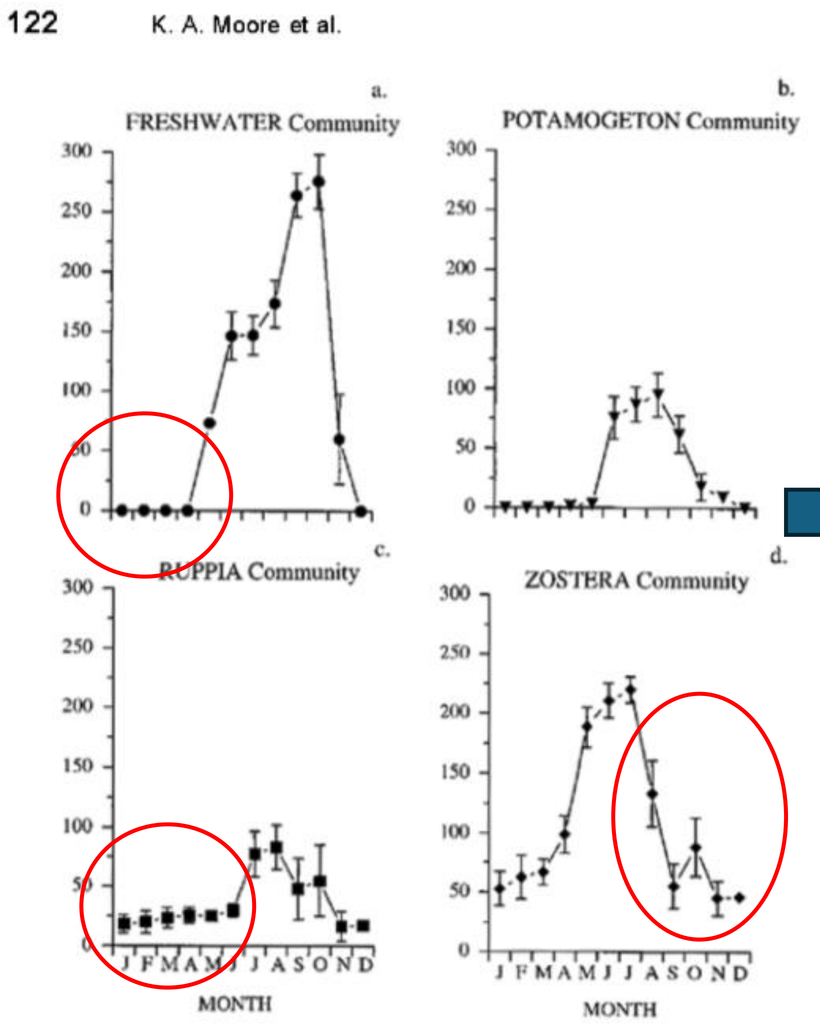


Fig. 5. Mean monthly (±SE) SAV aboveground biomass by community type.

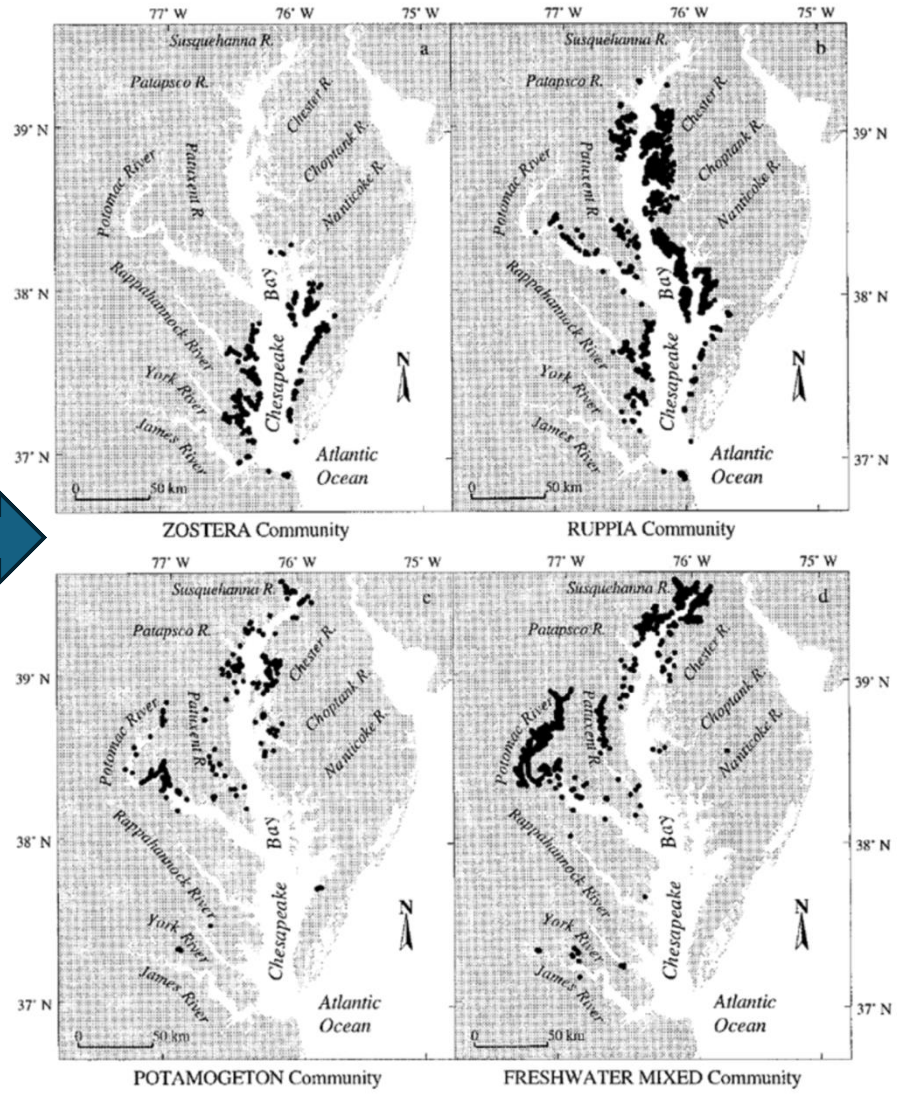
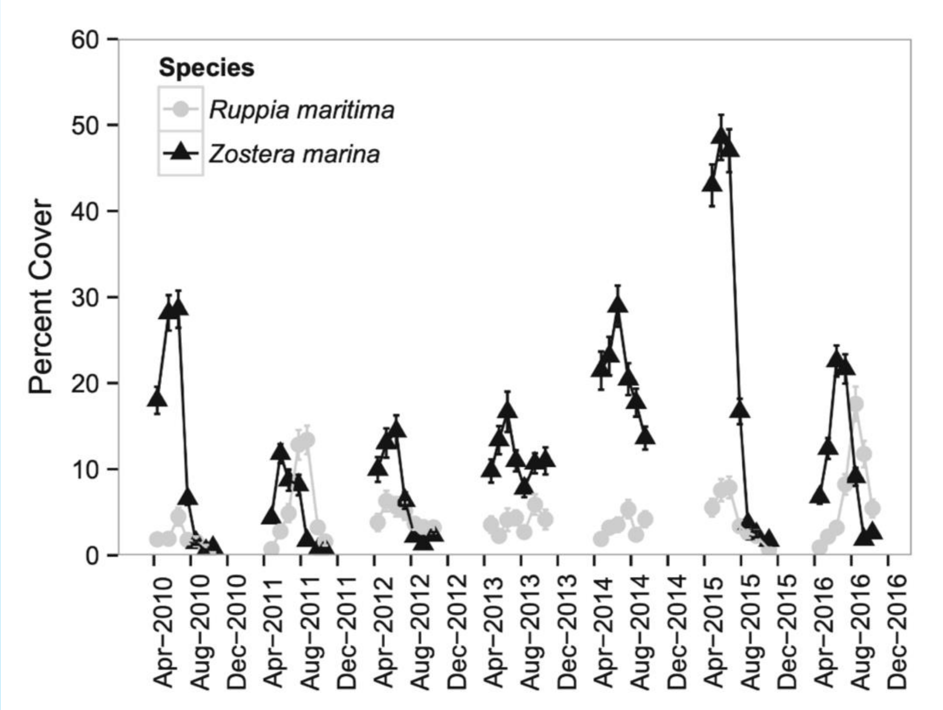
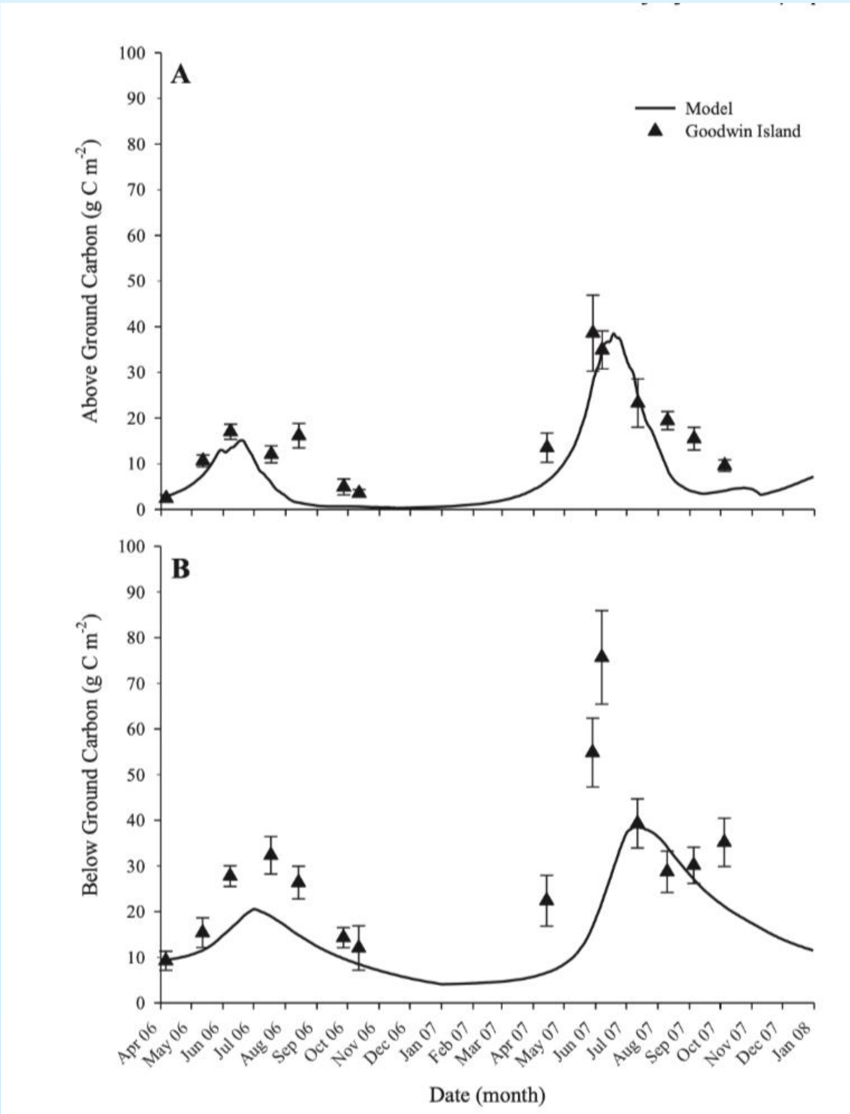


Fig. 3. Ground survey observations of SAV after assignment to community type, 1985–1996.

Examples of Seasonal Variation



Shields et al., 2019



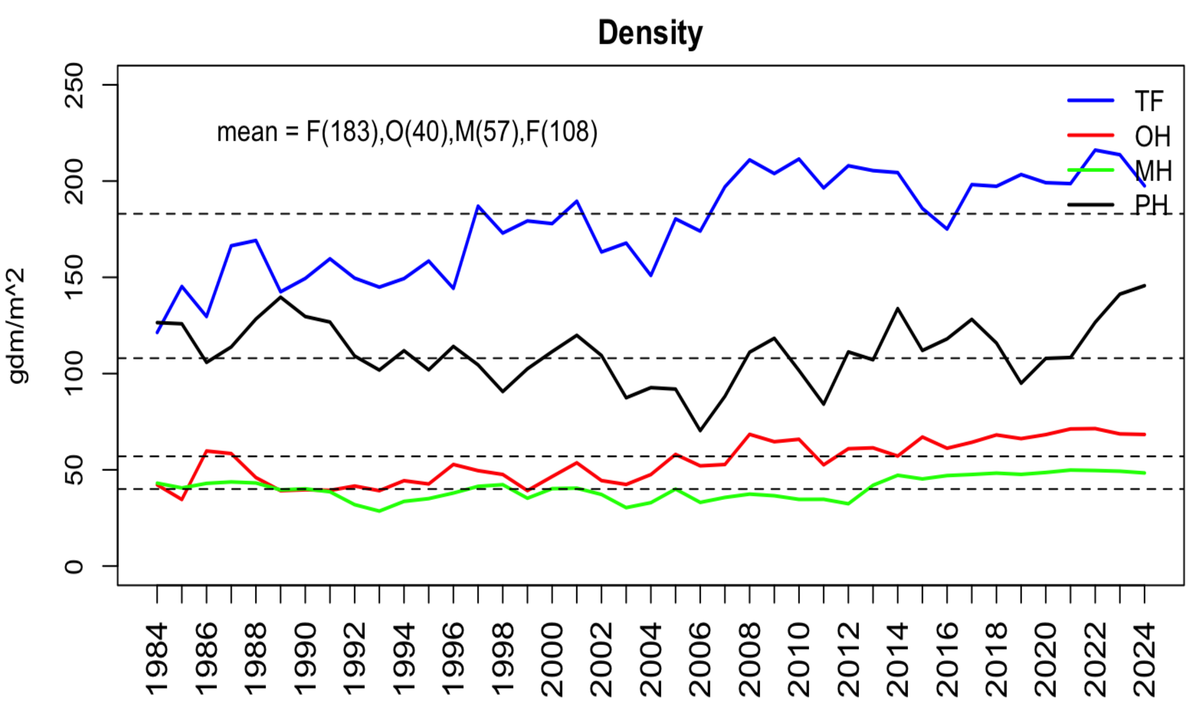
Jessie et al., 2014

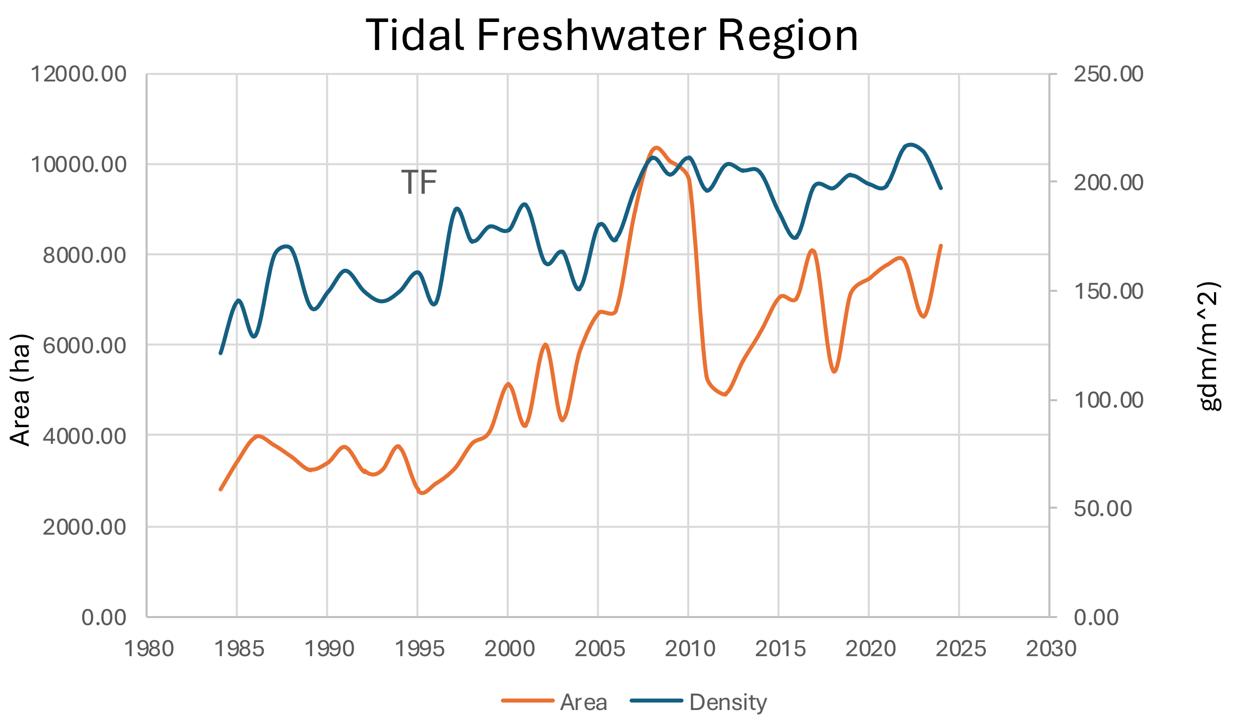
Estimate of Typical Mean Biomass

- Use maximum biomass as the baseline biomass for each salinity regions (TF ~ 275 (gdm/m^2), OH ~ 100, MH ~ 80, PH ~ 220)
- Biomass density ρ x % of each SAV class to estimate biomass for each SAV class
- Mean density is estimated as area weighted mean:

  Density (ρ) = Sum(Density (i)x area(i))/Sum of total area

Distribution of Biomass

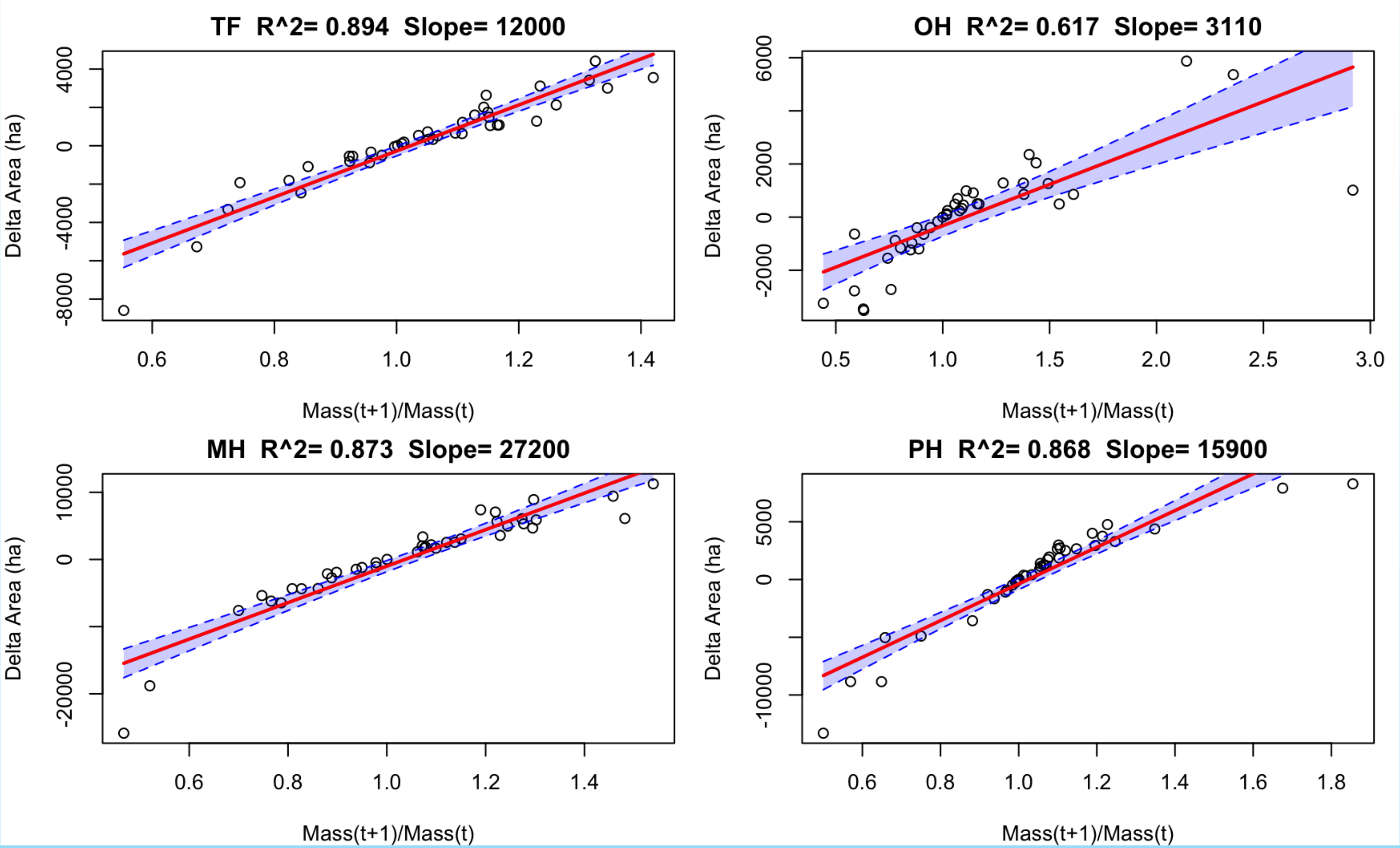




- Area has larger variation than density
- The difference can be partially attributed to the precondition

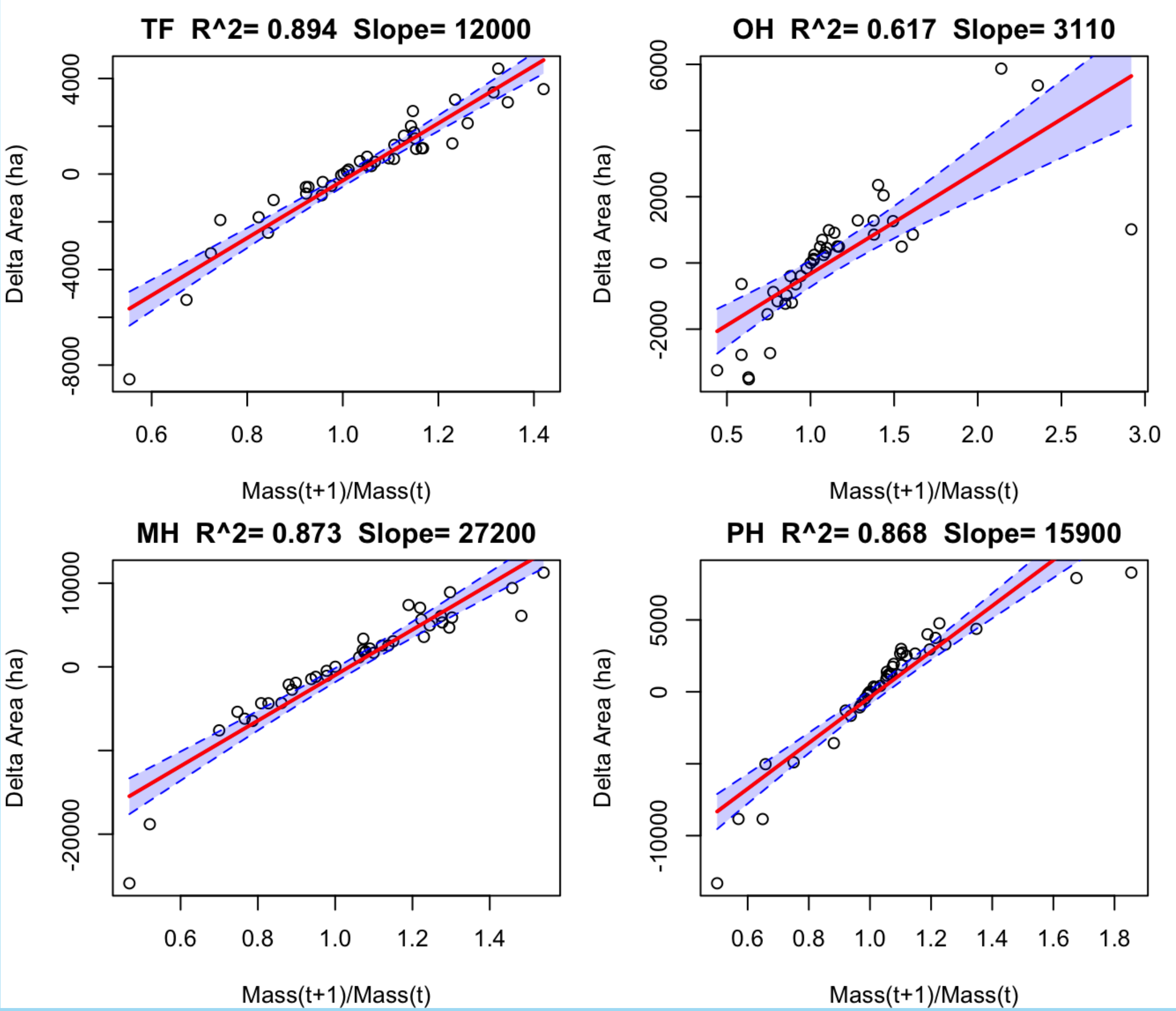
Estimated Biomass Ratio vs. Delta Area

- Assume average ρ does not change dramatically, ratio of of biomass r = $\rho * A(t)/ \rho * A(t\text{-}1)$ can quantify the changes in biomass
- $\rho(t)/\rho(t - 1$ ranges form 0.77-1.72
- On average, r ~ (A(t+1)-A(t)) has a good linear correlation
- It suggests that we can use this relationship to Conver biomass to area and match the mean condition in each salinity region

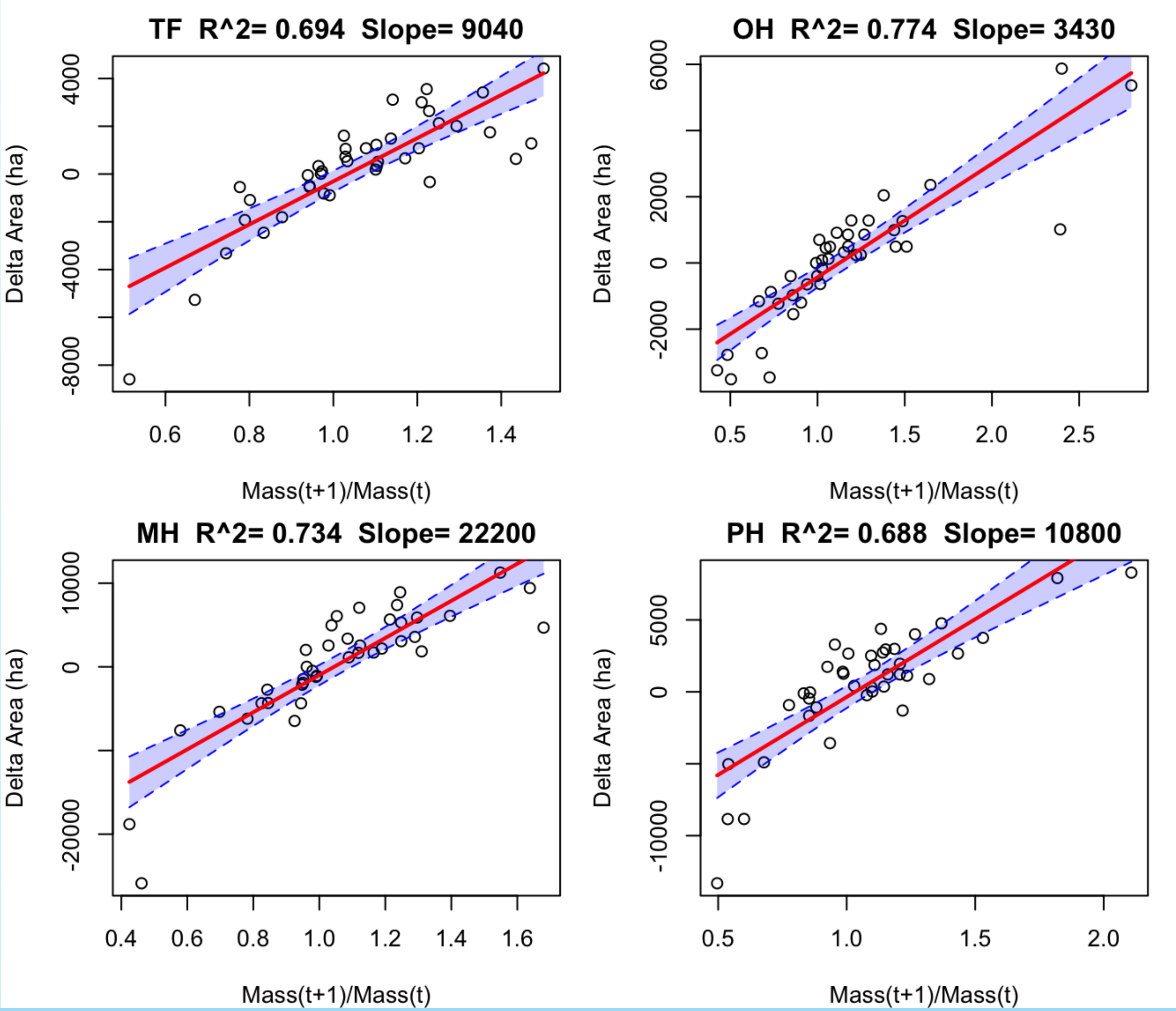


Compare using Constant and Varying Density

Constant density

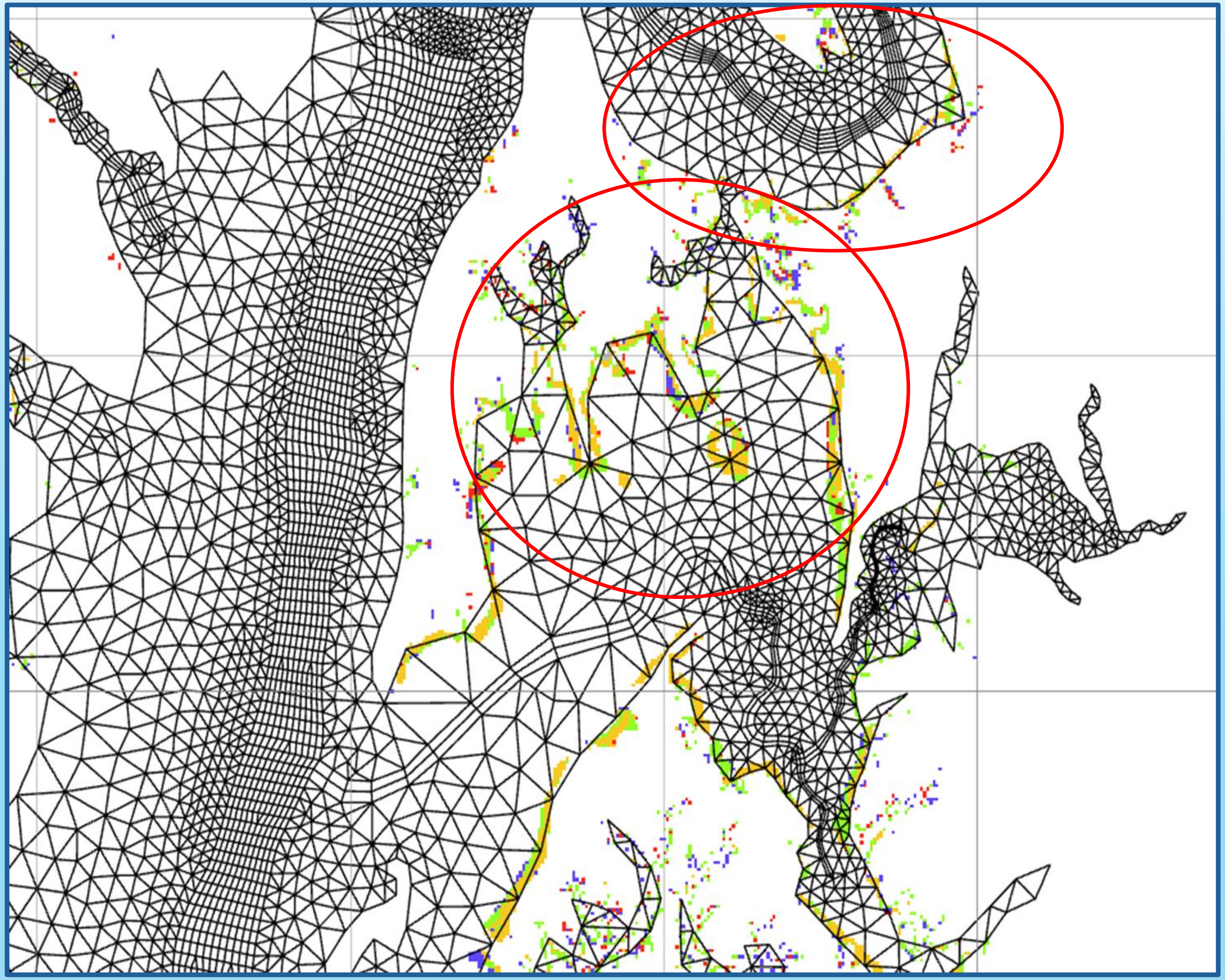


Varying density

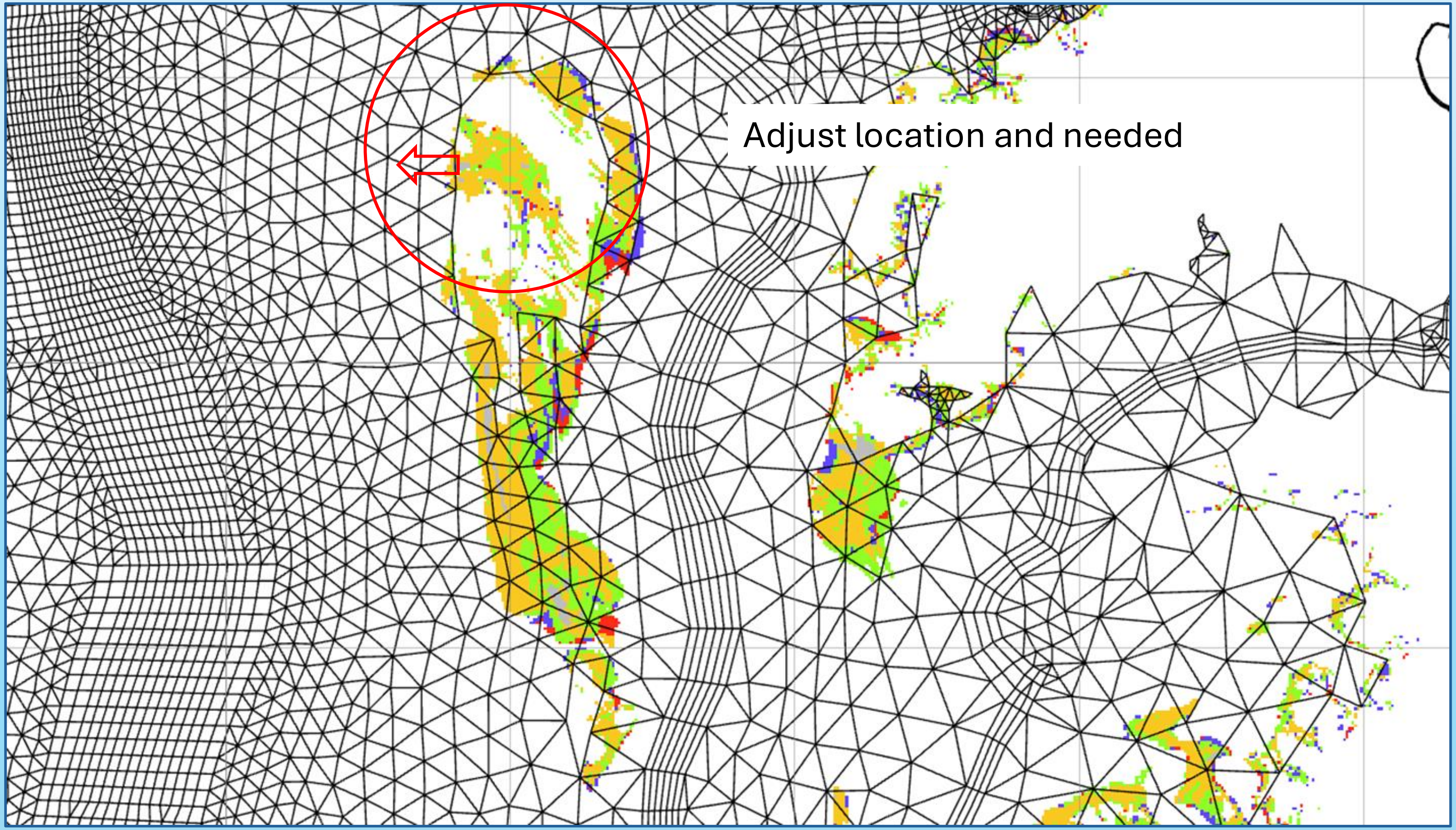


Initial Condition of SAV

- Convert observed SAV area to 100 x100 m grid
- Set criteria to include all the SAV outside of the model grid to the nearest model grid.
- Estimate total area in each grid (count 100x100 grids)
- Use typical mean density to estimate the initial condition

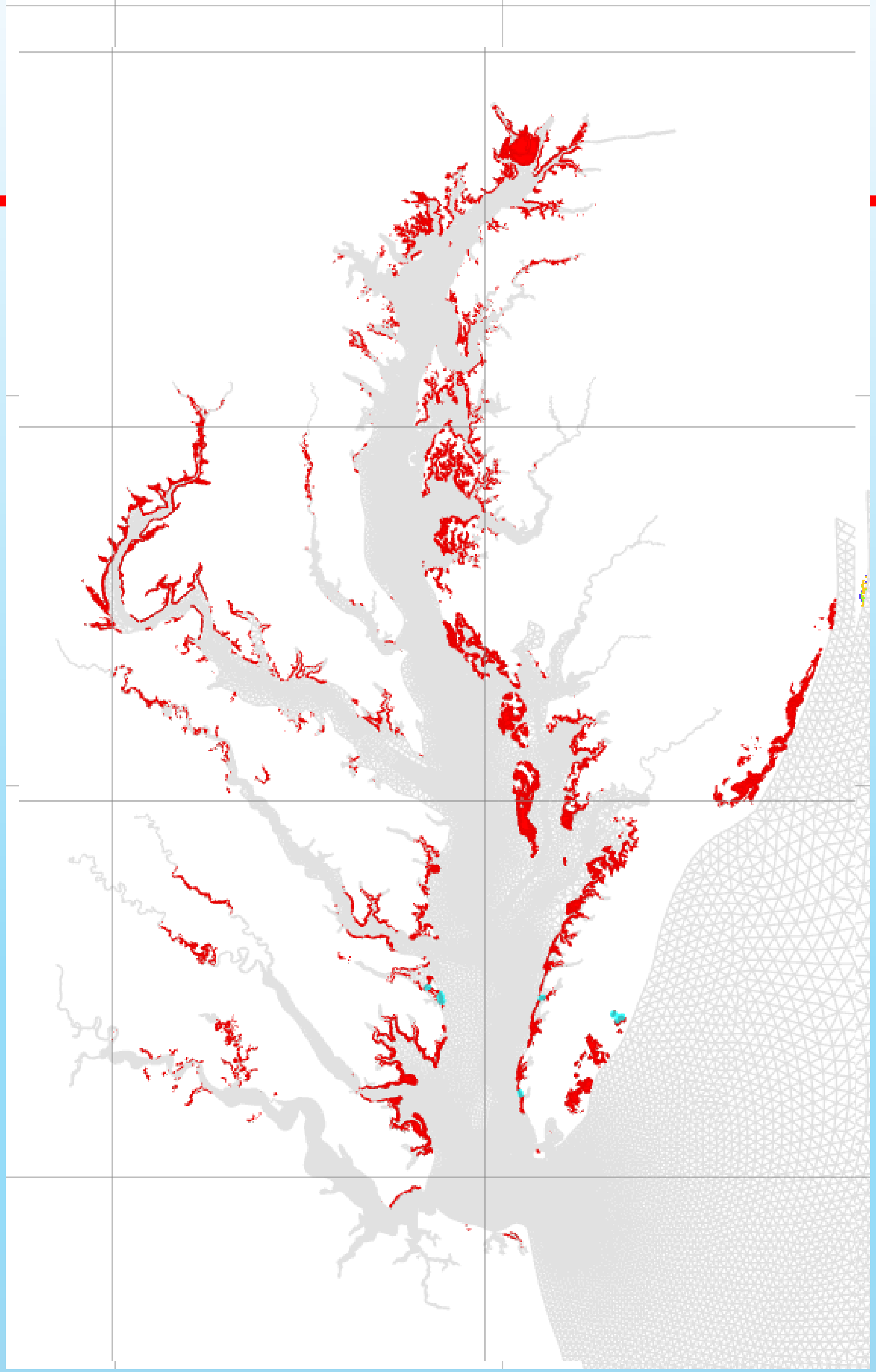


Add SAV to Model Grid

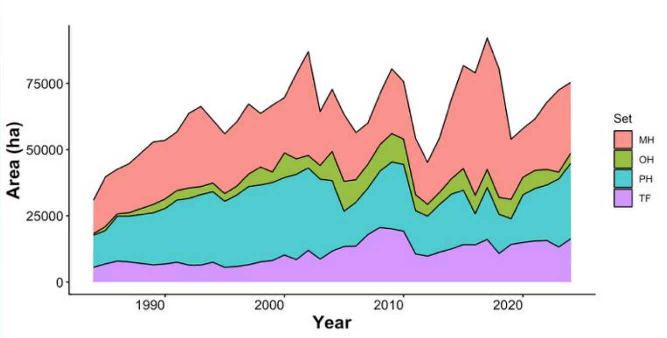


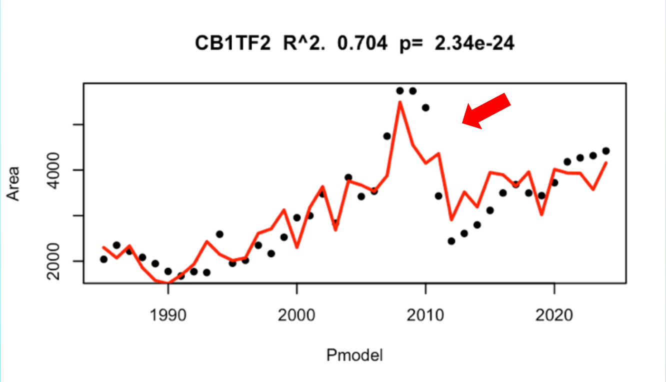
Designate Area for SAV

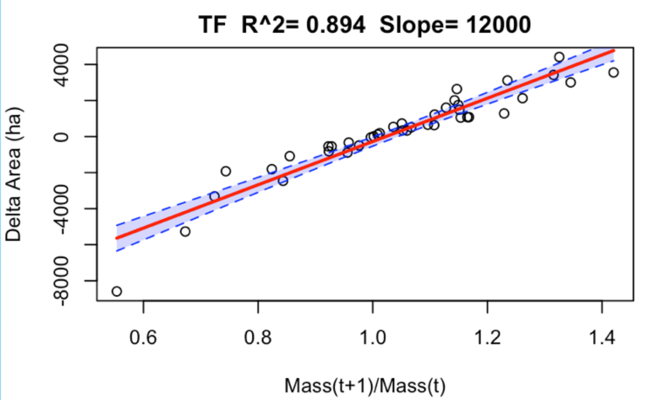
- Not all shallow water have SAV
- We plan to include the largest area (1990-2020) to set SAV and corresponding biomass
- We will do sensitivity test to see if SAV will survivor in the region that currently no SAV
- Because model does not consider the bed condition, SAV will likely to growth if salinity, temperature, and light are favorable
    - Under which bed condition preventing SAV growth?



Model Calibration and Verification







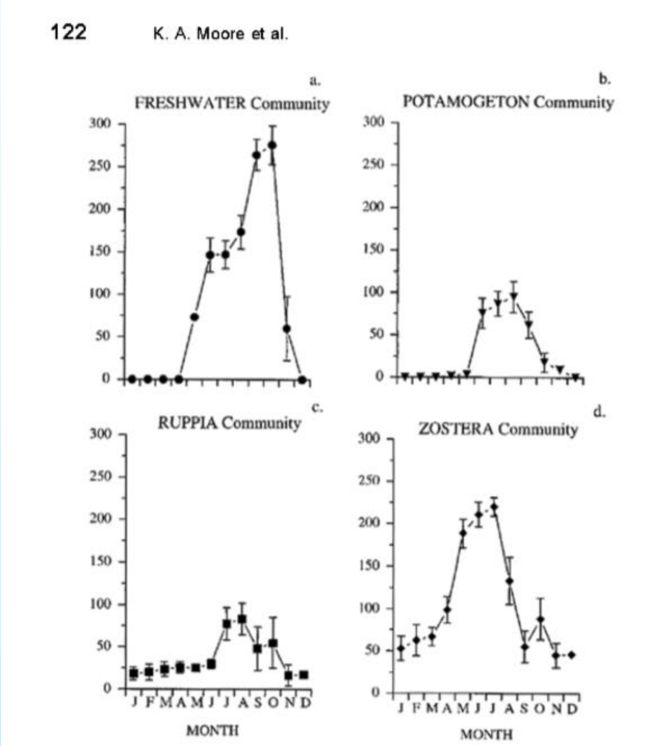
Set initial SAV in different salinity region with typical species

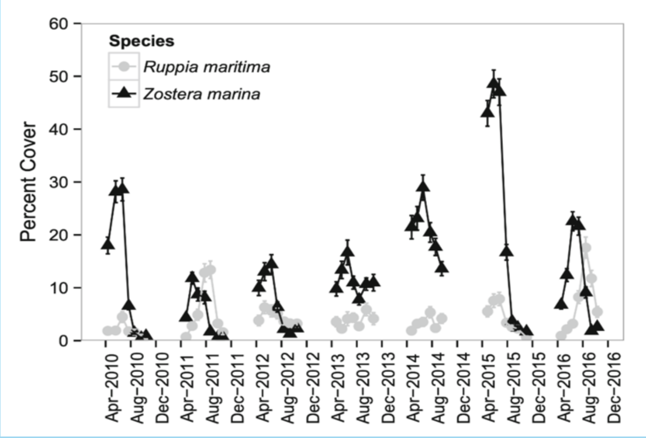
Select a typical year (e.g., average temperature condition)

Calibrate model to match typical SAV in different salinity regions

Use ratio ~ delta area to convert biomass to area

Compare observations. Focuses on key events of changes in SAV area





Summary Modeling Approach

- Select 4 species for 4 salinity regions (tidal fresh, oligohaline, mesohaline, polydalin)
- Use observations to obtain weighted biomass (gdm/m^2)
- Conver SAV area to 100m x 100m grid
- Use defined criteria to include SAV outside of the model grid into the model grid
- Count the area and biomass in each grid
- Calibrate SVA in four regions in average year (mean flow and temperature)
- Use varying parameters to account for species variations
- Convert model biomass to area (using typical linear relationship)
- Compare model results to SAV area for salinity region (or Bay segment)