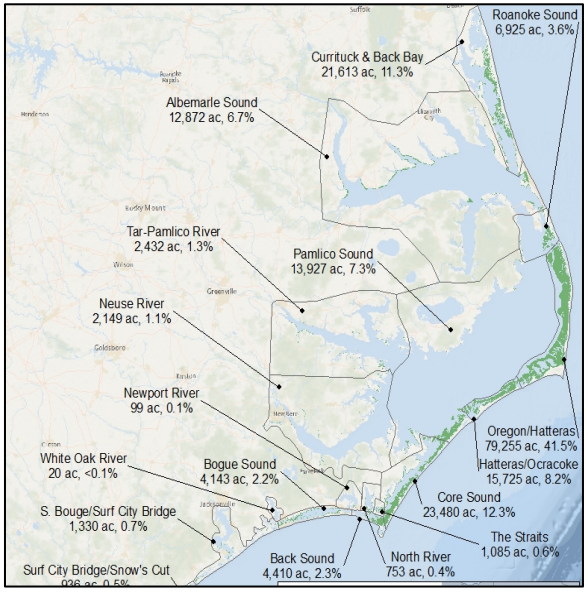
Progress Update: Development of scientifically defensible chlorophyll *a* standards for protection of submerged aquatic vegetation in the Albemarle-Pamlico Estuarine System



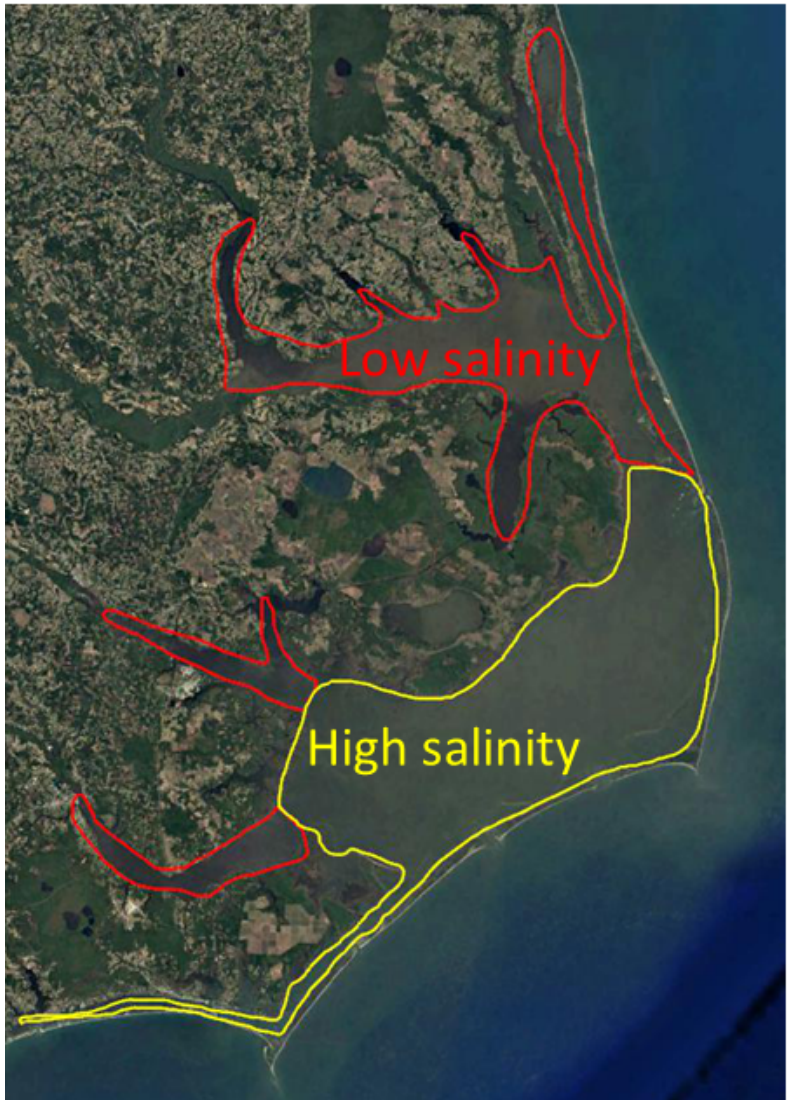
Funded by Albemarle Pamlico National Estuary Partnership

Nathan S. Hall

APNEP Science and Technical Advisory Committee

1 December 2020

Water Clarity Targets for Low & High Salinity SAV Zones



High salinity: 22% PAR to 1.7 m

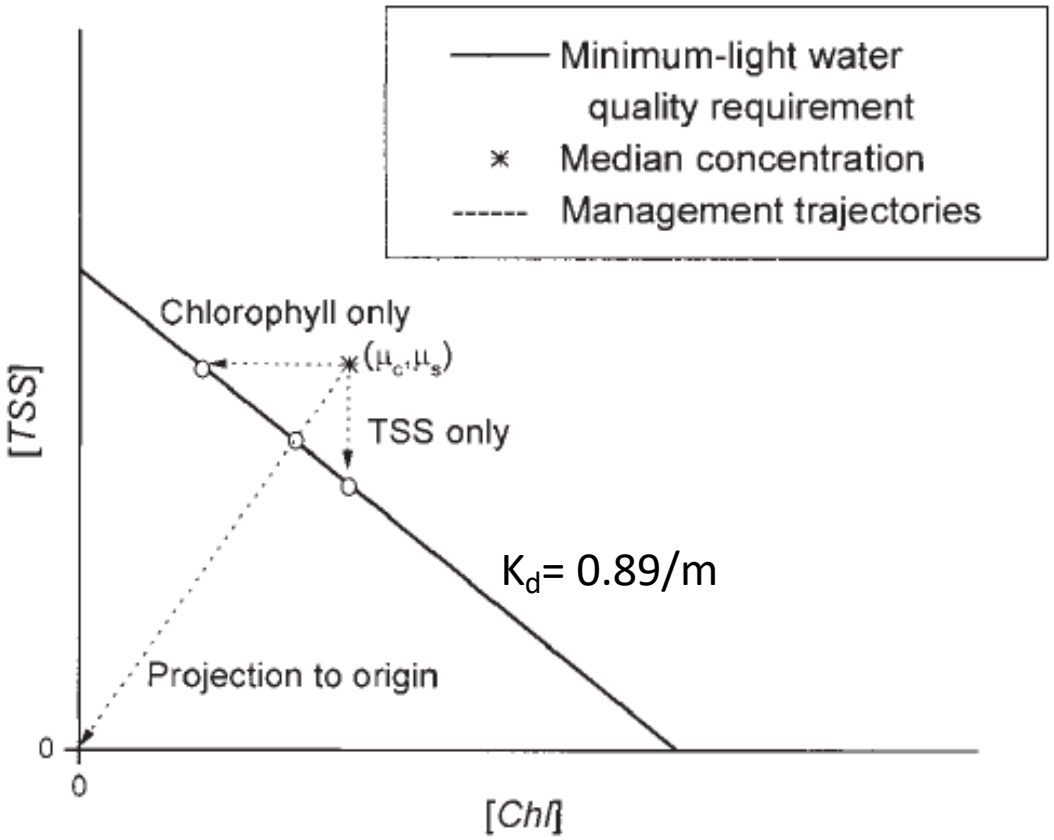
K = *ln*(0.22)/1.7 m = 0.89/m

Low salinity: 13% PAR to 1.5 m

K = *ln*(0.13)/1.5 m = 1.36/m

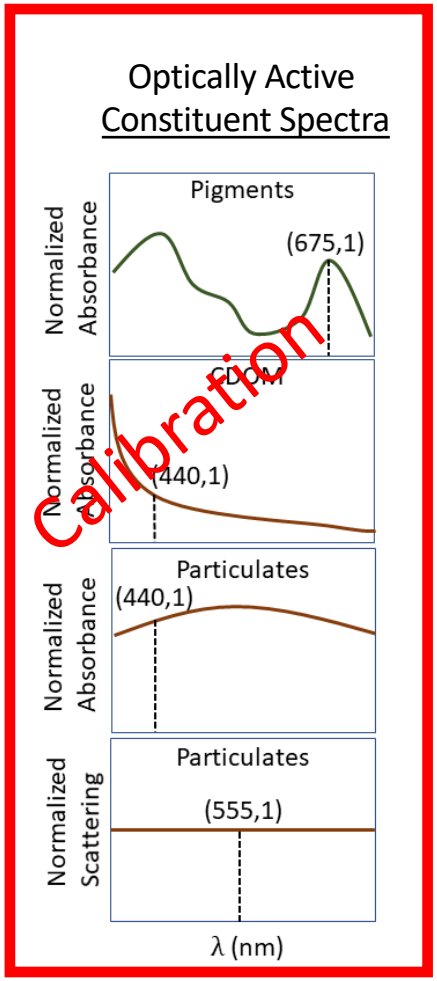
Goals of this Optical Modeling Project

1) Determine benthic area (km^2) where current water clarity meets/does not meet high/ low salinity clarity targets
2) Determine if current NC WQ standards protect high/low salinity clarity targets
3) If necessary, recommend changes to WQ standards



Assumes an average background CDOM

How the Bio-Optical Model Works



WQ Indicators

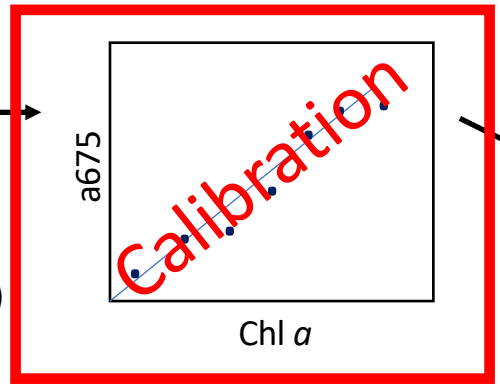
Chl *a* (µg/L)

CDOM (PCU,QSE)

Turbidity (NTU) or TSS (mg/L)

Turbidity (NTU) or TSS (mg/L)

Scale Factors



Additivity Assumption

Total Absorption

$a_{total} = a_{pig} + a_{CDOM} + a_{part} + a_{H2O}$

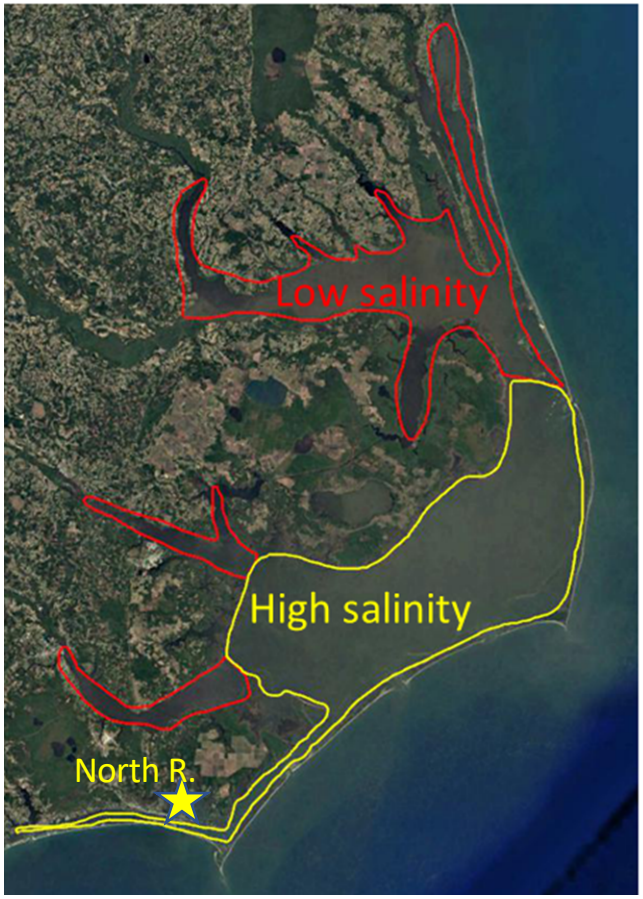
Total Scattering

$b_{total} = b_{part} + b_{H2O}$

Empirical model of K_d based on a_{total}, b_{total}, and solar angle

$K_d = (a_{total}^2 + G\, a_{total} b_{total})^{0.5} / \mu_0$

We already have a model calibrated for an NC estuary



Calibration of a Bio-optical Model in the North River, North Carolina (Albemarle–Pamlico Sound): A Tool to Evaluate Water Quality Impacts on Seagrasses

Patrick D. Biber · Charles L. Gallegos · W. Judson Kenworthy

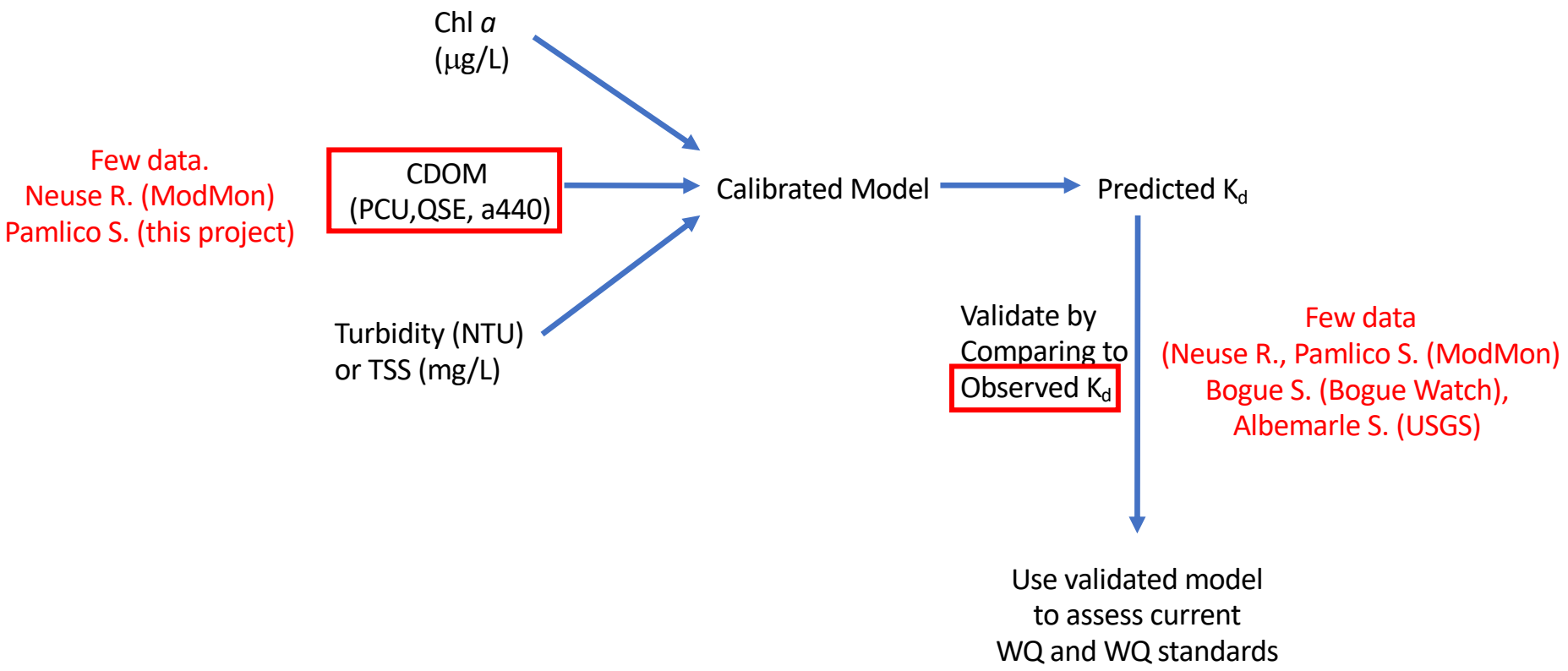
Project Objectives:

1) Validate model for other high/low salinity areas

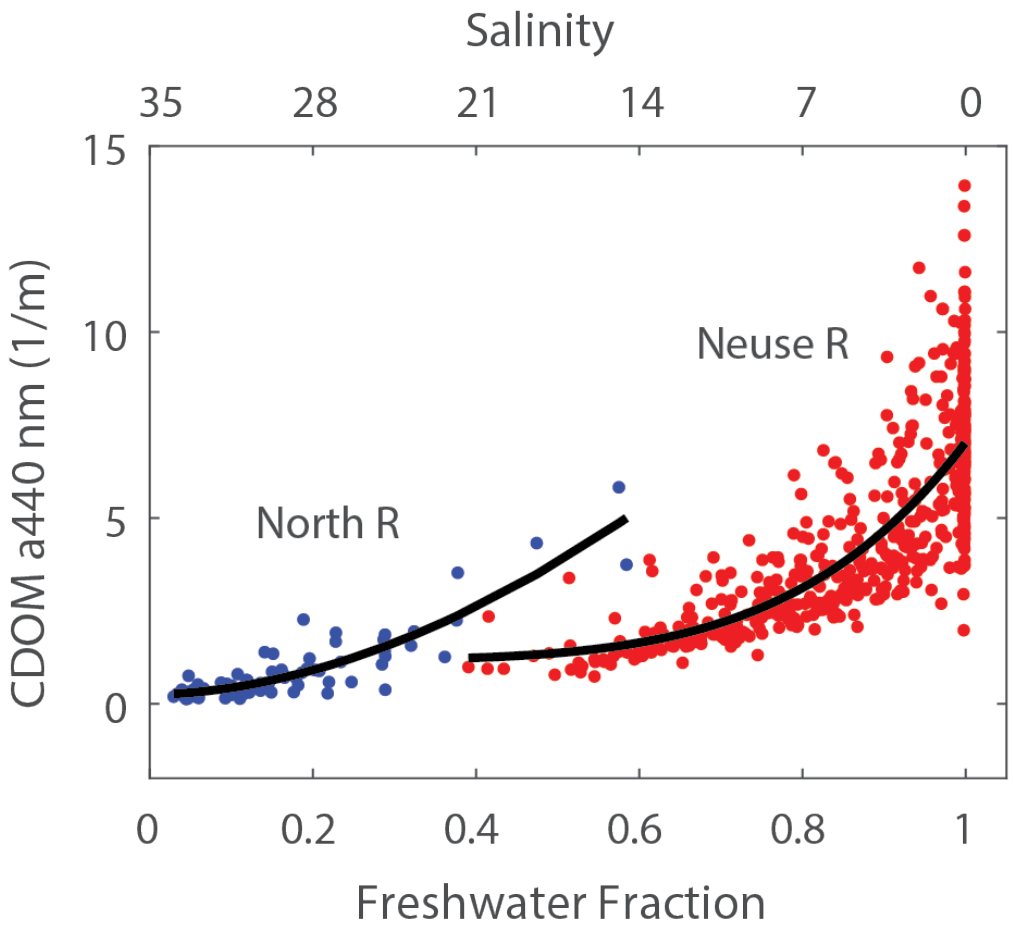
2) Use model to predict K_d, and to figure out chl *a* and turbidity thresholds that meet clarity targets

Project Tasks

& Challenges

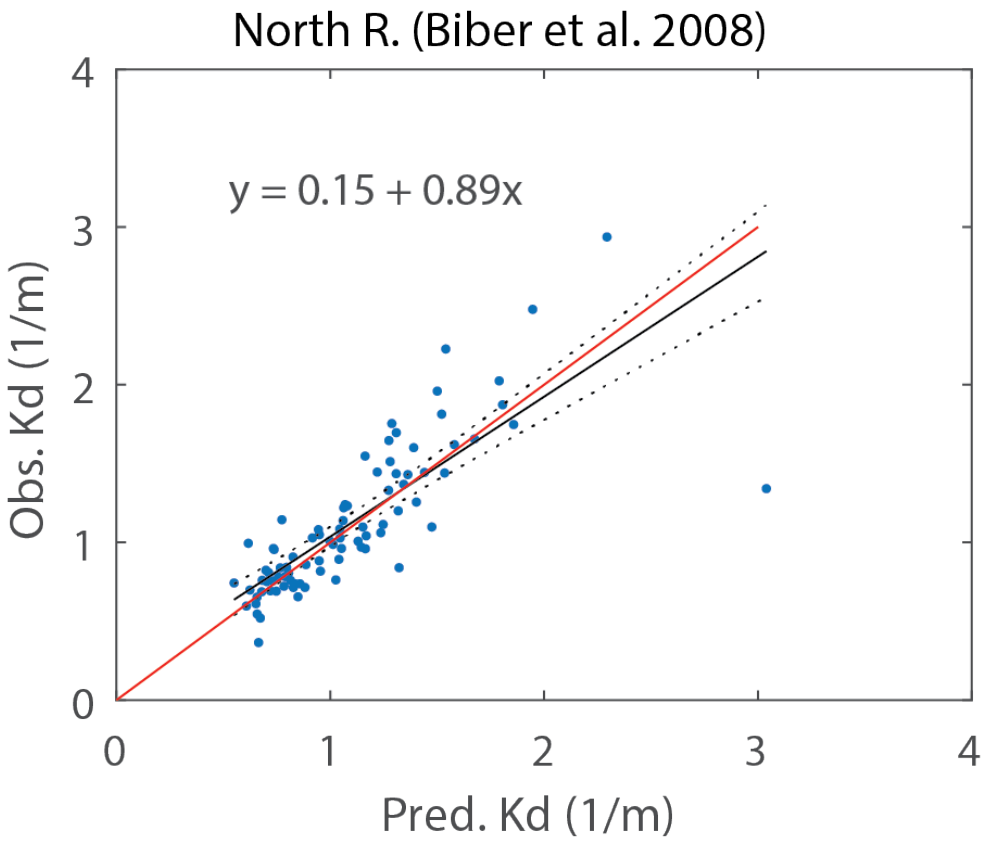


Empirical relationships to derive CDOM from salinity



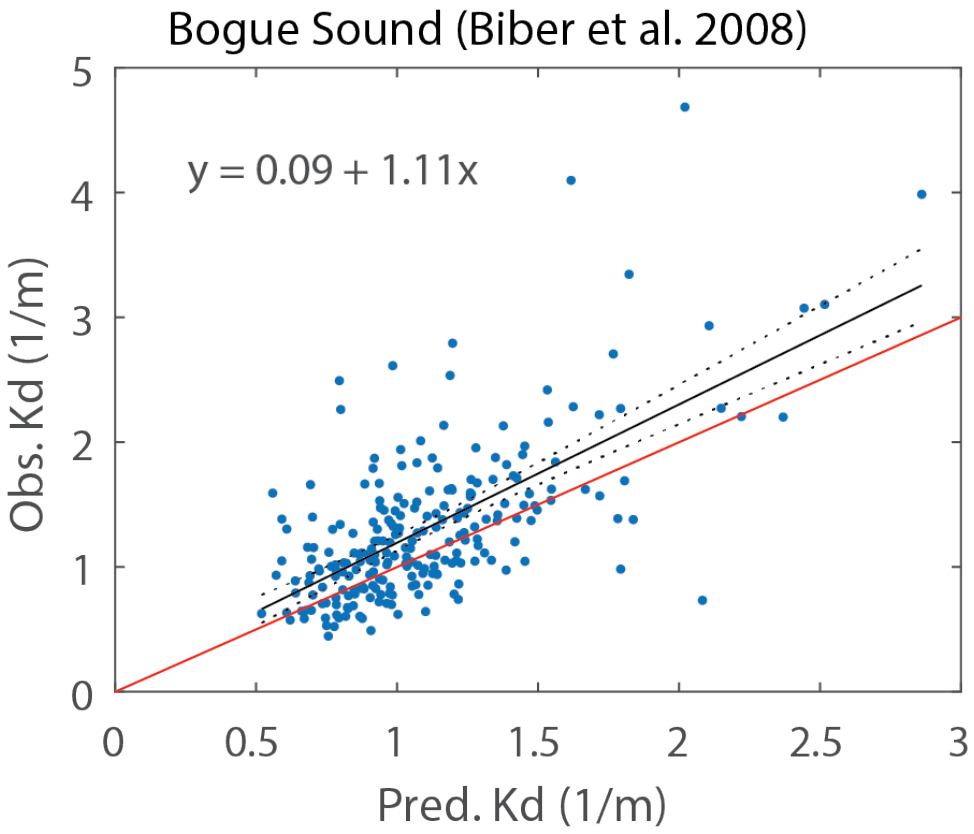
High scatter at low salinity. Relationships are river specific.

Model Validation



Same Result as Biber et al. 2008-Model Coded Properly

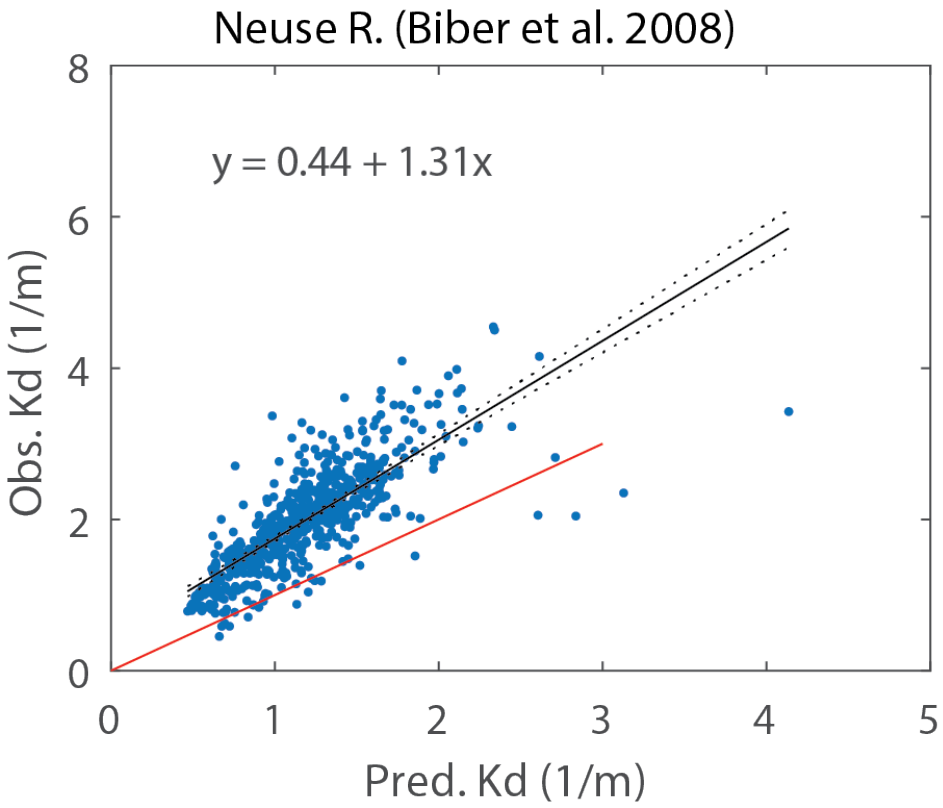
Model Validation



CDOM estimated based on Neuse CDOM vs. salinity

Lots of Scatter but Minimal Bias in Intercept or Slope

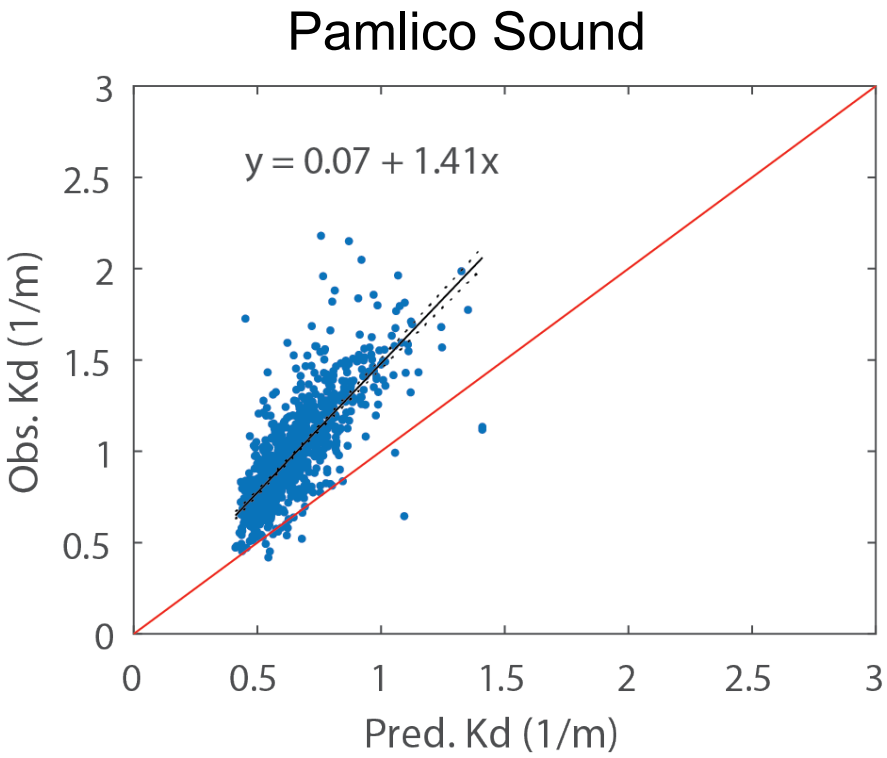
Model Validation



CDOM measured

Strong relationship but model underestimates K_d

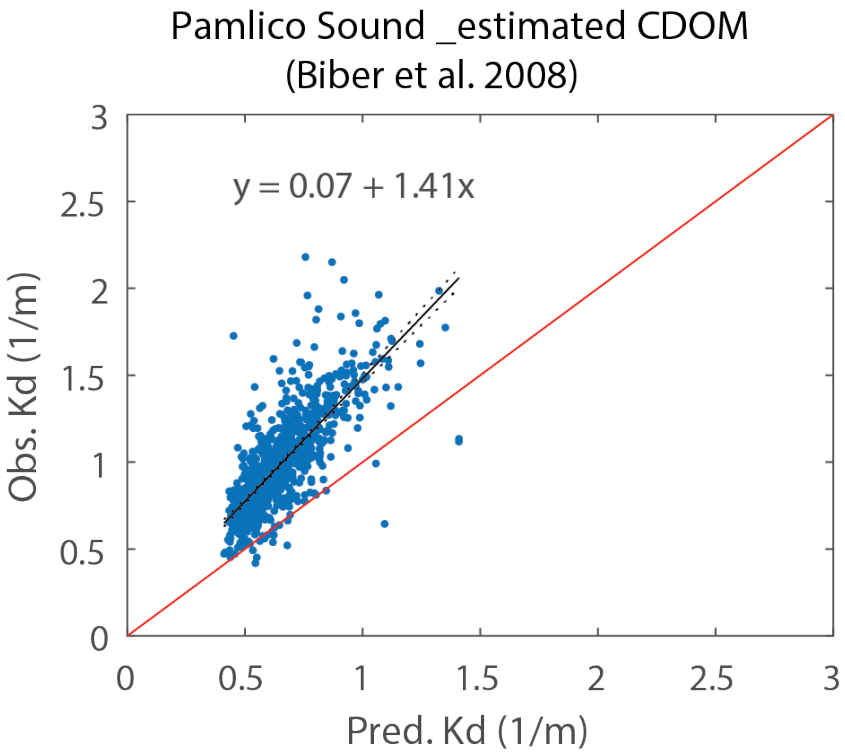
Model Validation

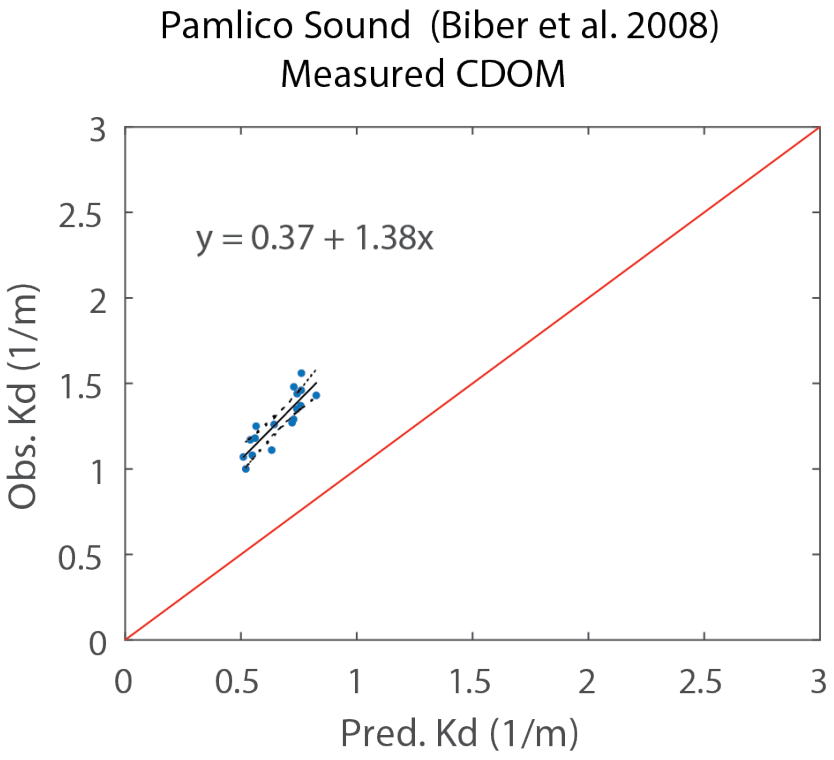


CDOM estimated based on Neuse CDOM vs. salinity

Strong relationship but model underestimates K_d

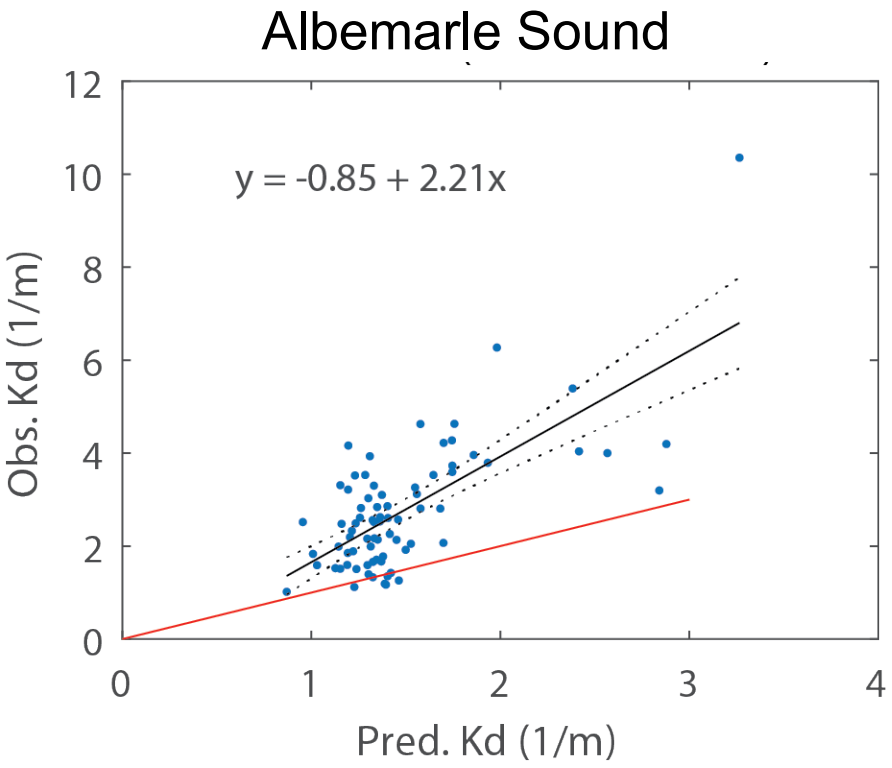
Model Validation





Underestimate of K_d in Pamlico Sound is not driven by biased CDOM estimation

Model Validation



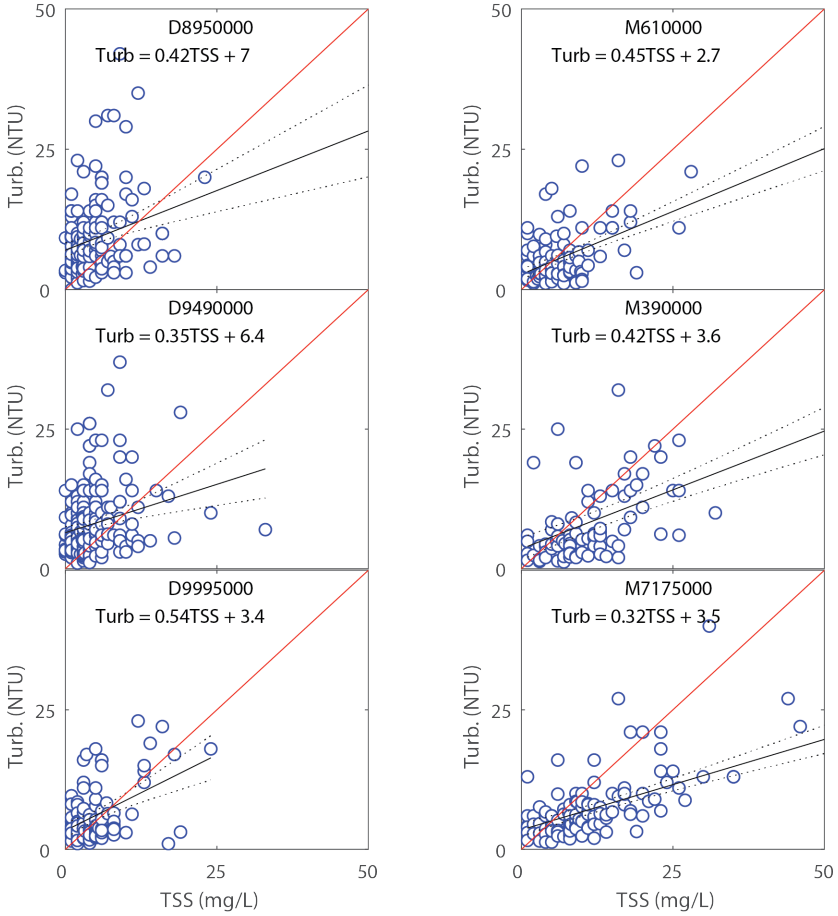
CDOM estimated based on Neuse CDOM vs. salinity

Turbidity estimated based on TSS from DEQ's TSS & Turbidity data

Weak relationship and model underestimates K_d

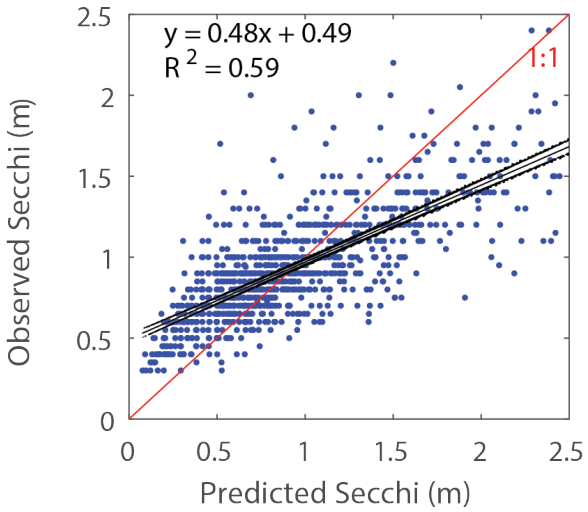
TSS is a poor predictor of turbidity in Albemarle Sound

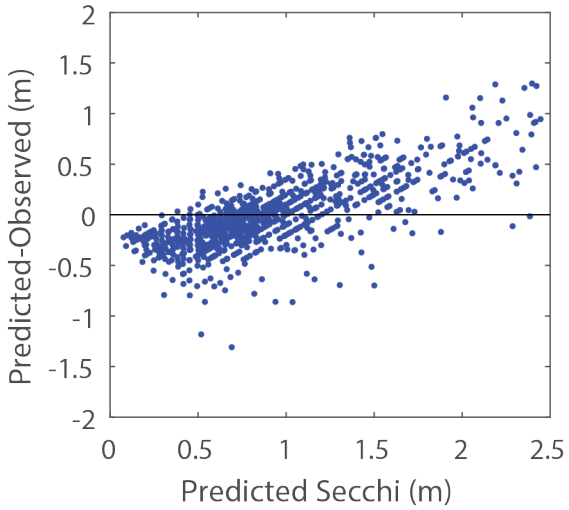
Turb = 0.34*TSS +5.33



Model Validation

DEQ AMS Albemarle Sound & Pamlico River



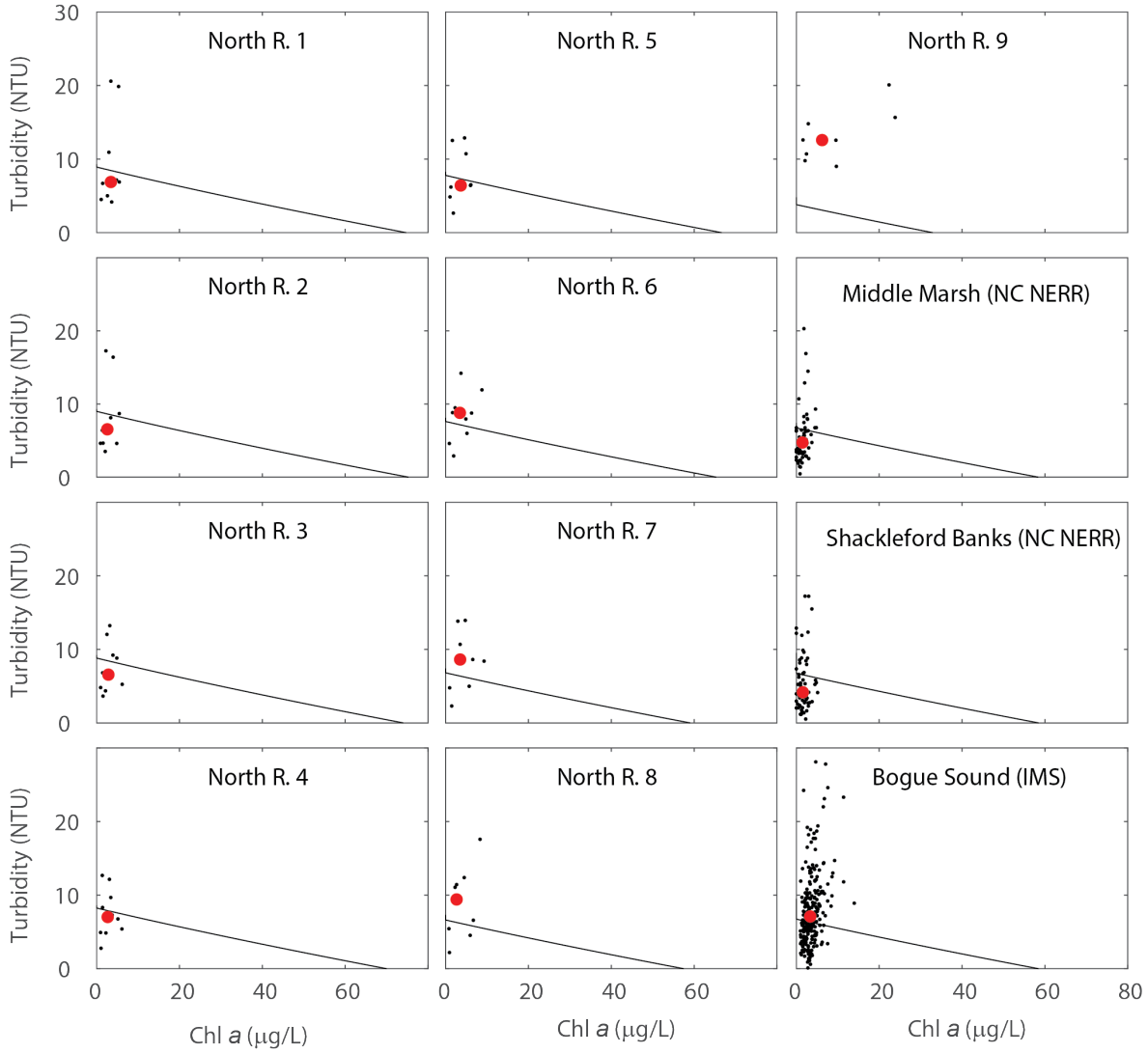


CDOM estimated based on Neuse CDOM vs. salinity

Chl a and turbidity measured by NC DEQ

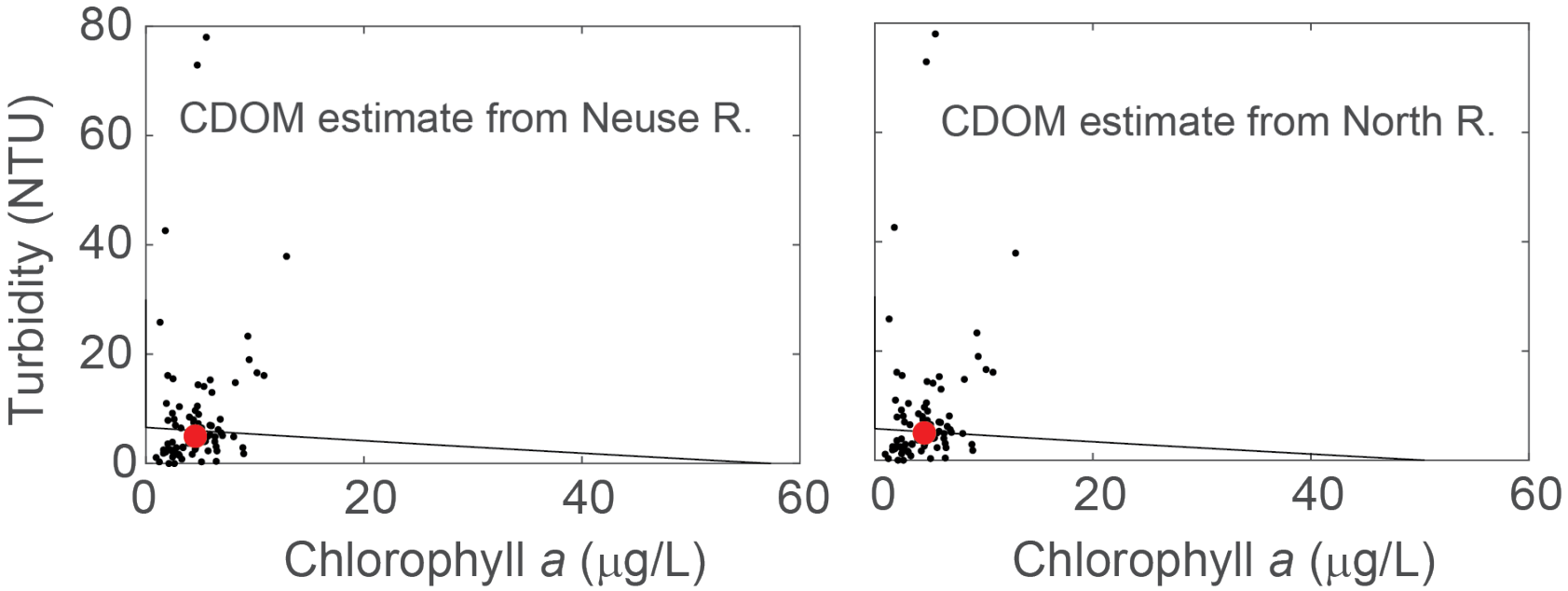
Better relationship but model still has significant biases

Turbidity and Chlorophyll *a* Thresholds for High Salinity Waters



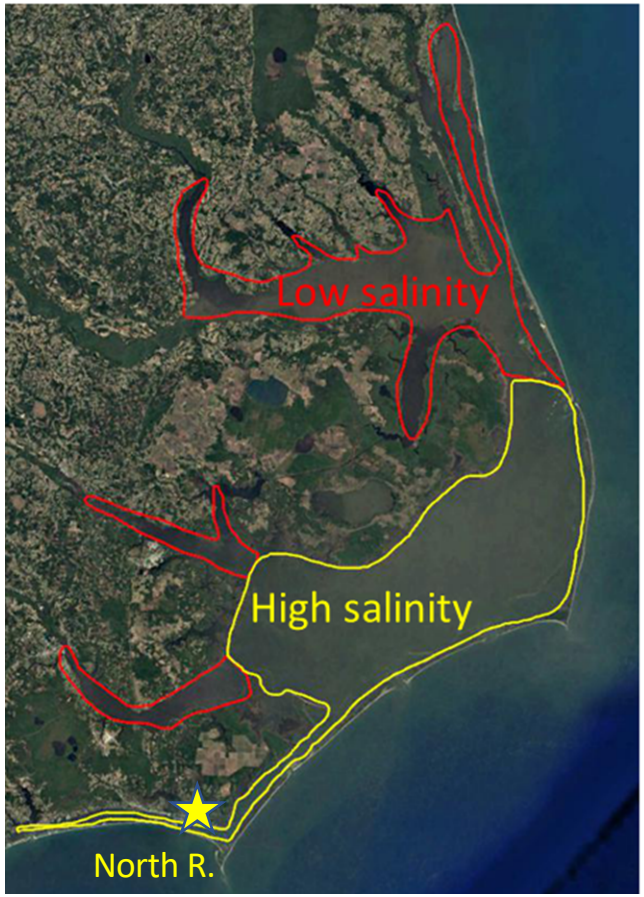
Clarity is near threshold and turbidity dominates attenuation

Sensitivity of turbidity and chlorophyll *a* thresholds to CDOM estimation at Silver Lake, Ocracoke Island



Effect of CDOM error is not severe for high salinity waters where CDOM is low.
Not sure of model bias effect for the areas behind the Outer Banks

Conclusions



1) Model works well for high salinity waters near where it was calibrated

2) Model will require recalibration for low salinity waters

3) Poor CDOM estimation is not the only cause of bias but CDOM data is badly needed

4) High salinity areas examined were near clarity thresholds but Chl *a* was a minor component of attenuation

5) Current chlorophyll *a* levels and WQ standard (40 μg/L) are protective of clarity targets for high salinity SAV.