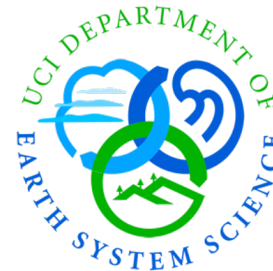
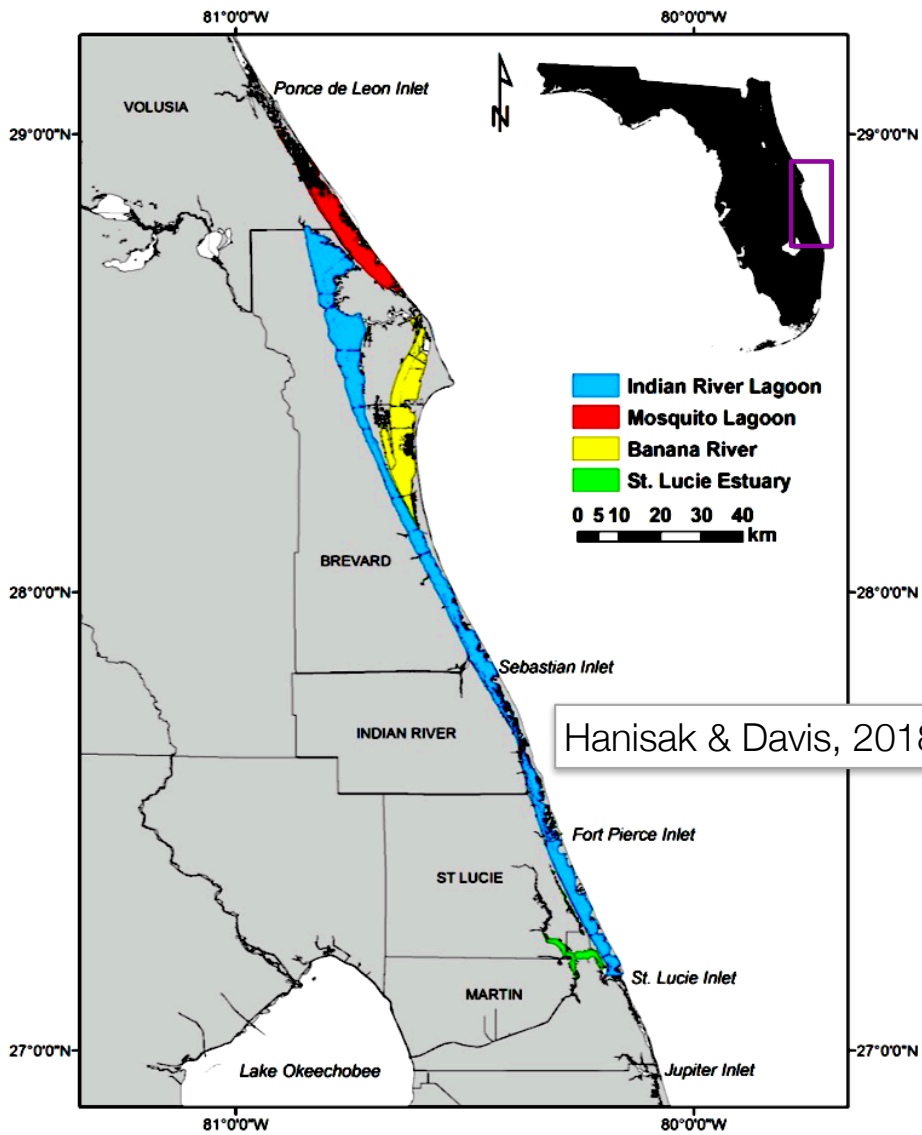


# Spectral characteristics & cyanobacteria abundance in the Indian River Lagoon

Raisha Lovindeer · Tim Moore · Mike Twardowski · Kate Mackey



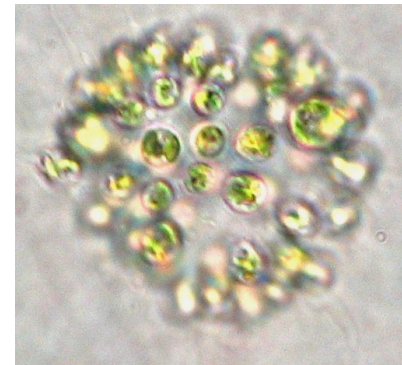
**Ridge 2 Reef**  
An NSF Research Traineeship  
in Urban Ecosystem Management



Hanisak & Davis, 2018

## Indian River Lagoon System (IRL)

# Cyanobacteria

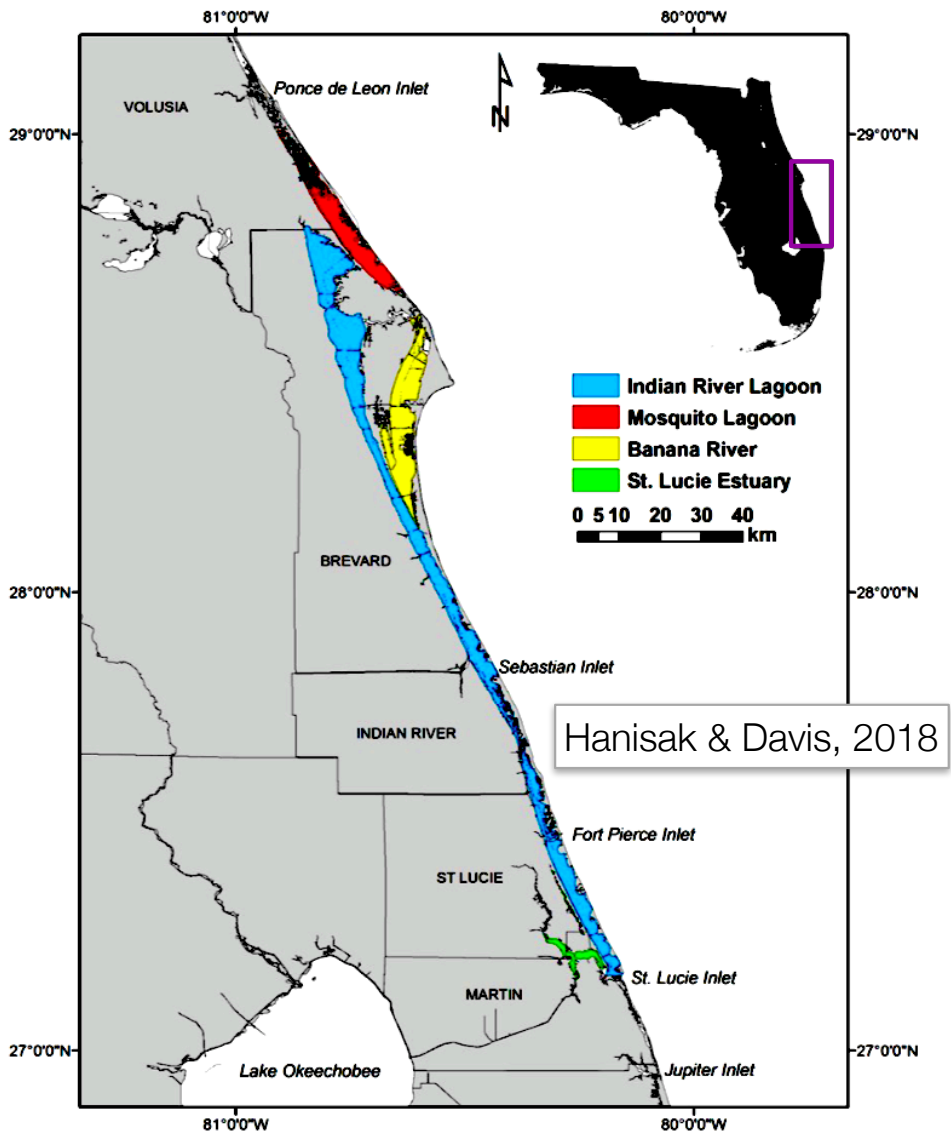


*Microcystis aeruginosa*, by Kristian Peters

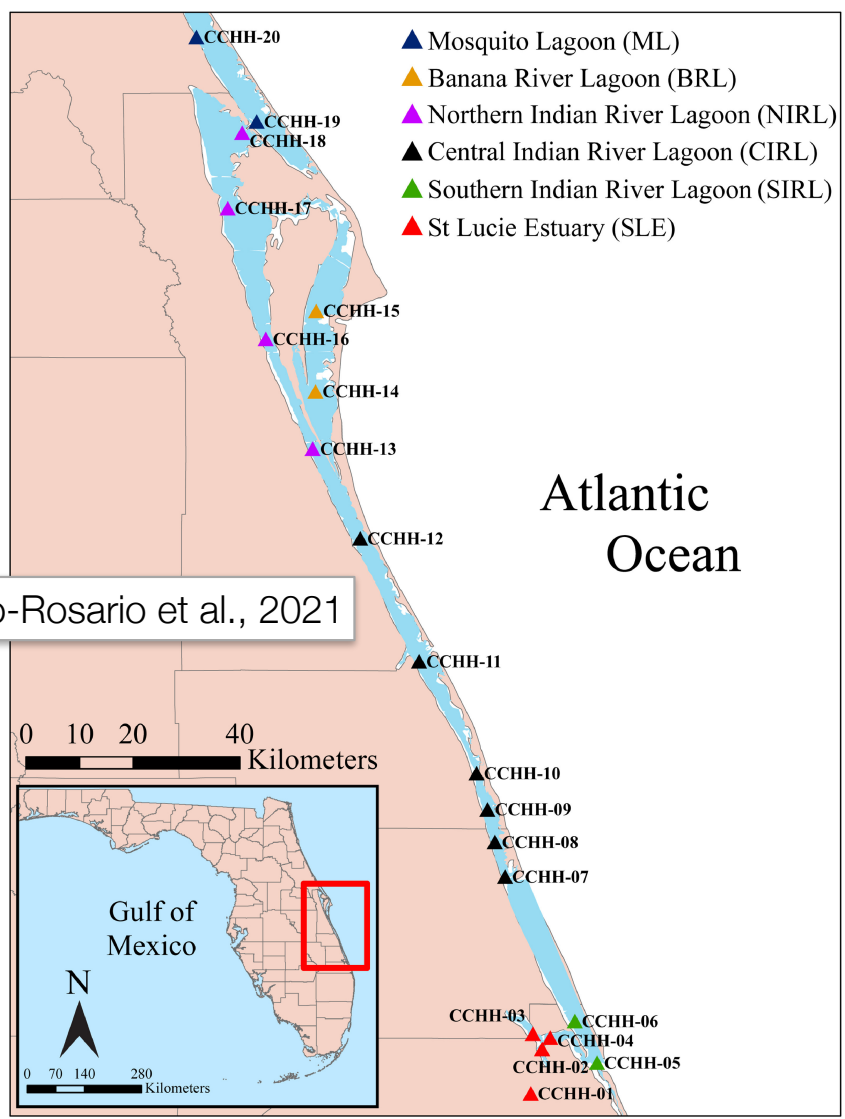
Phlips et al, 2020

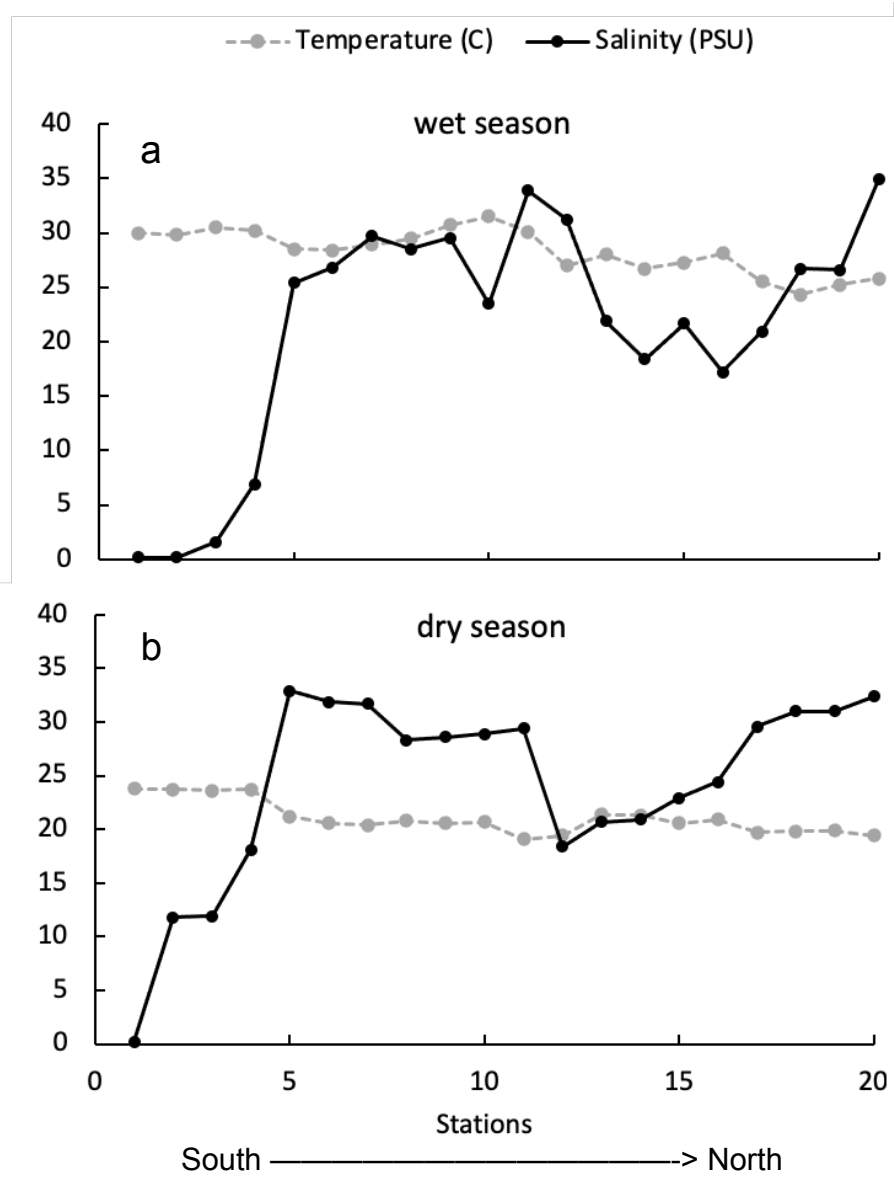


*Microcystis* bloom St. Lucie Estuary, 2016

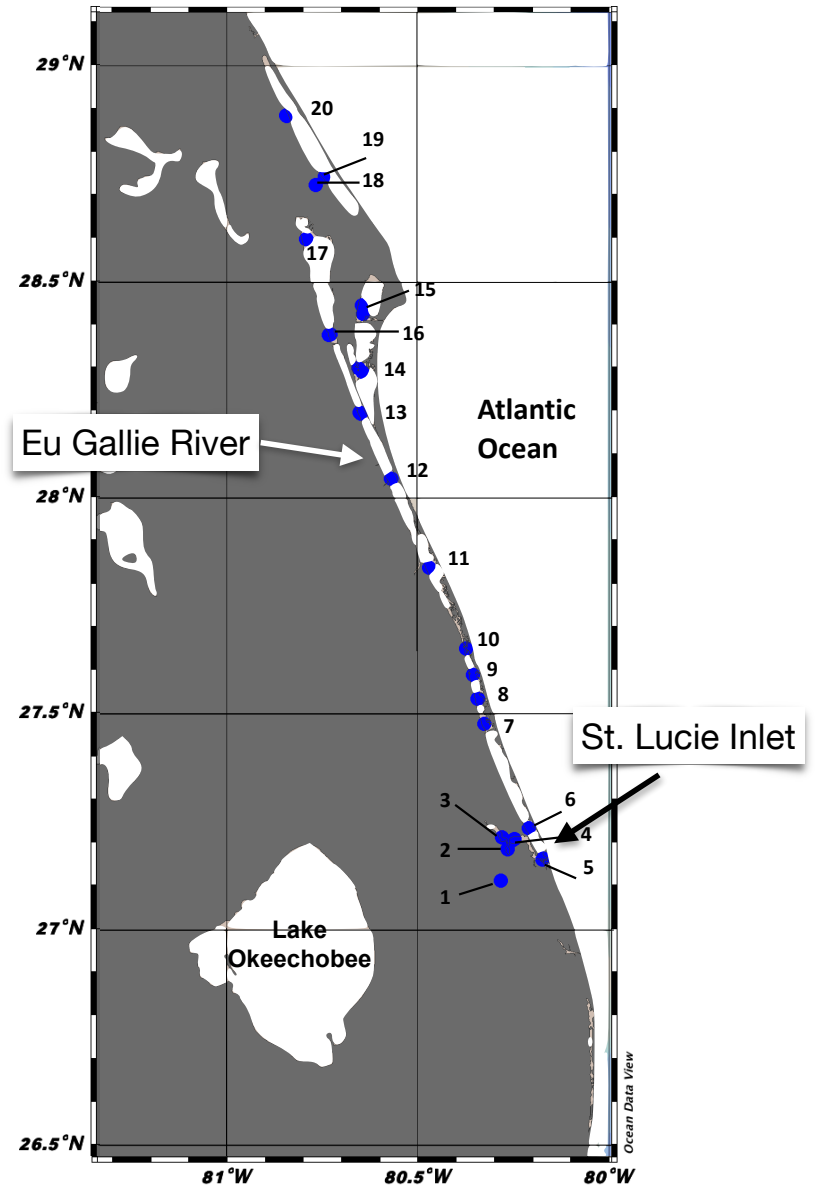


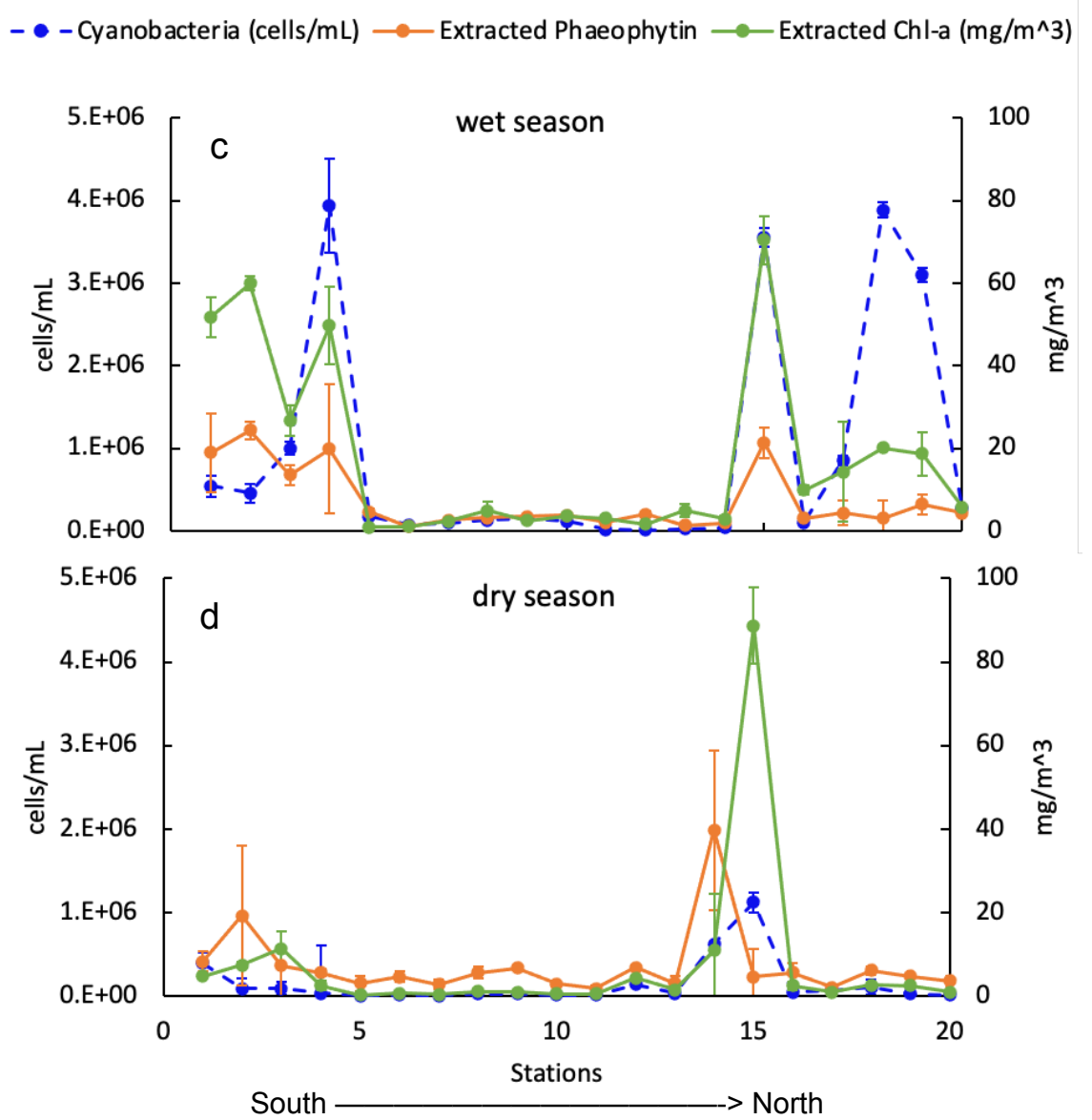
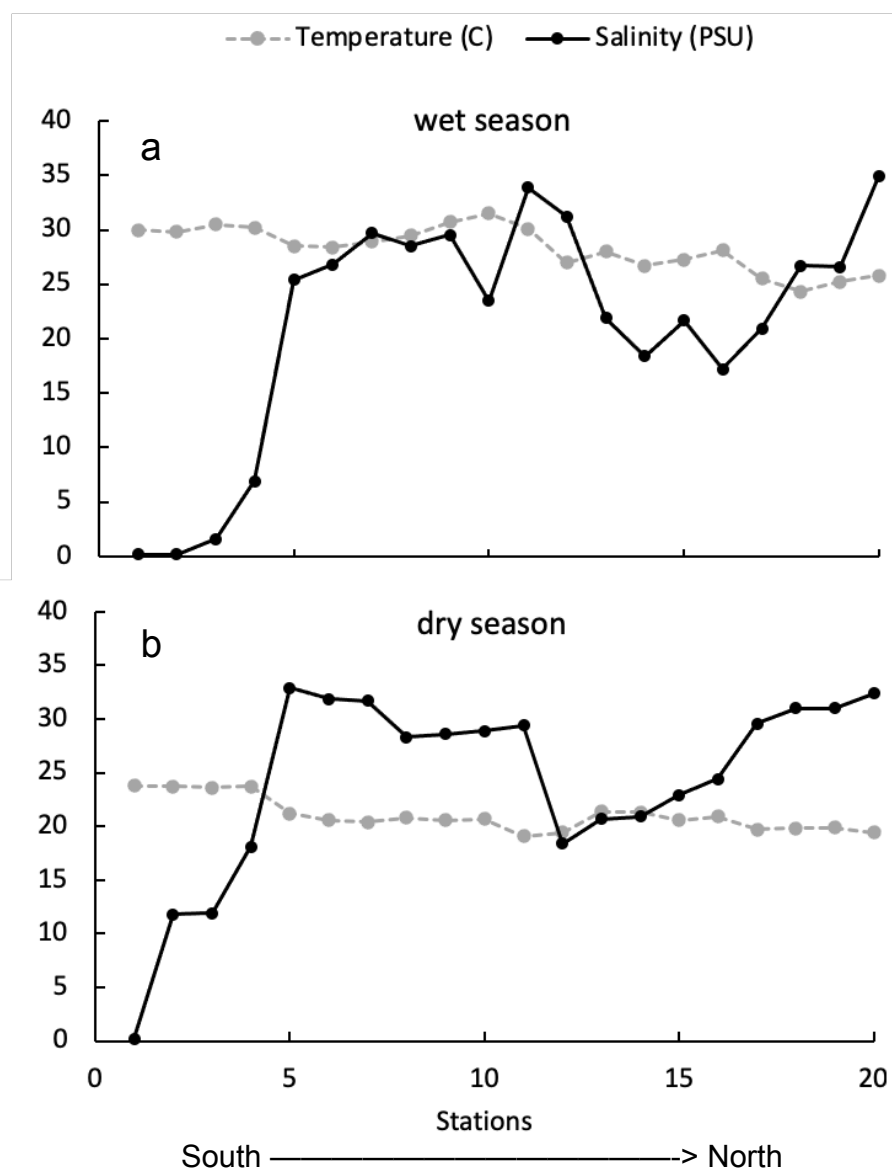
# Indian River Lagoon System (IRL)

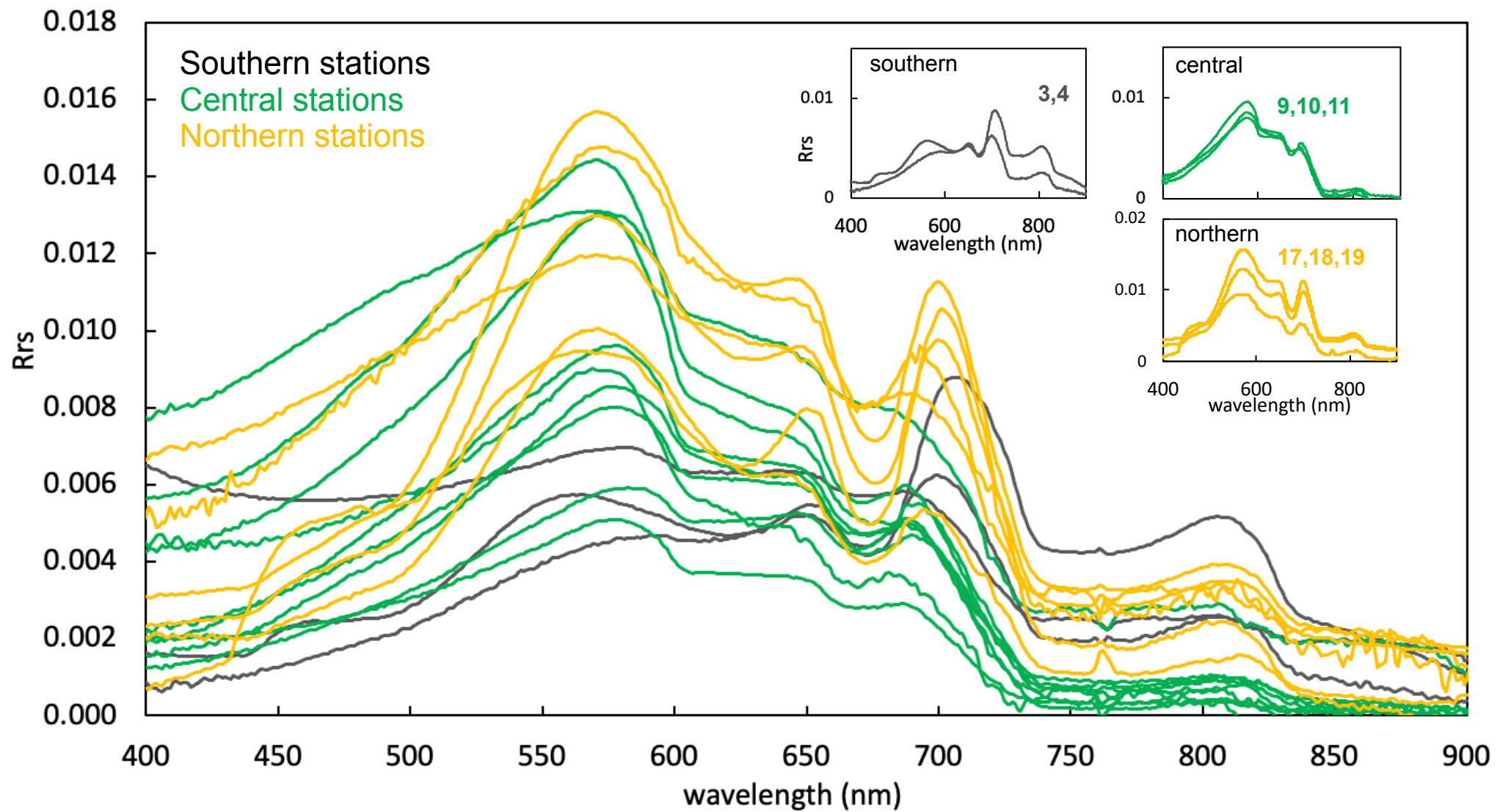




# Indian River Lagoon System (IRL)

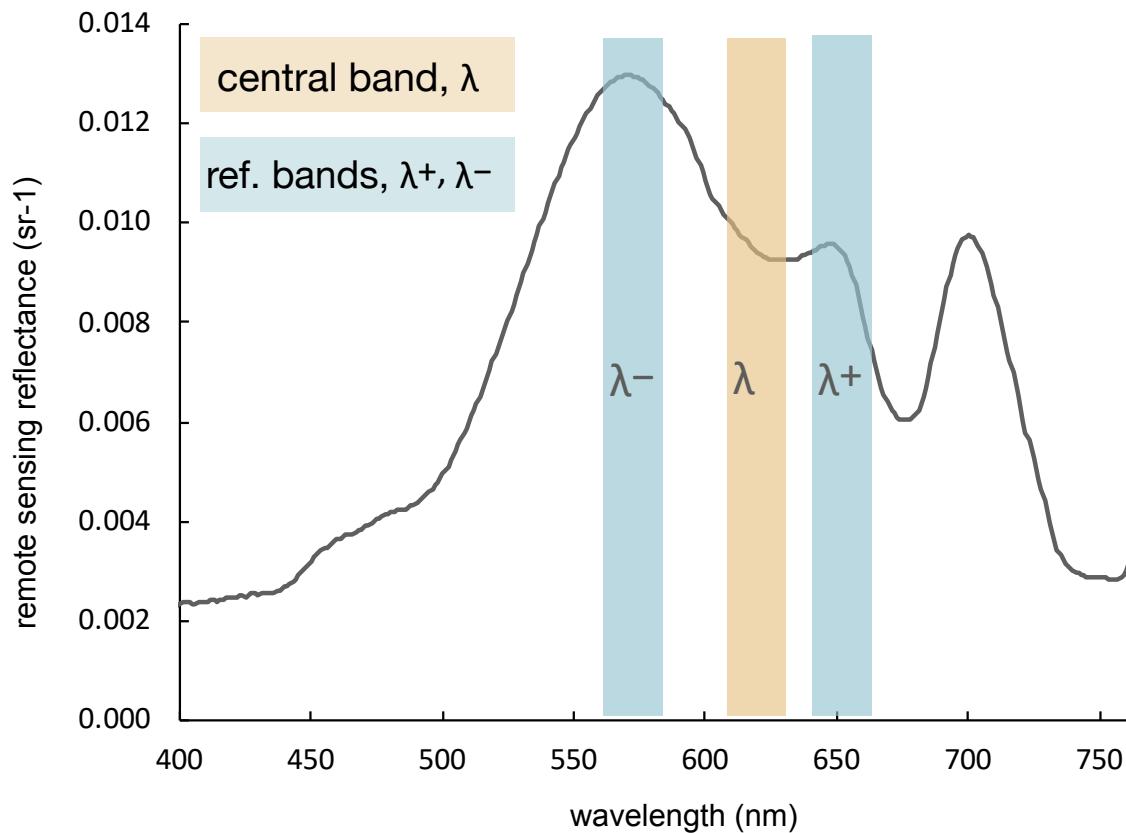






# Algorithms tested for cyanobacteria detection in the IRLS

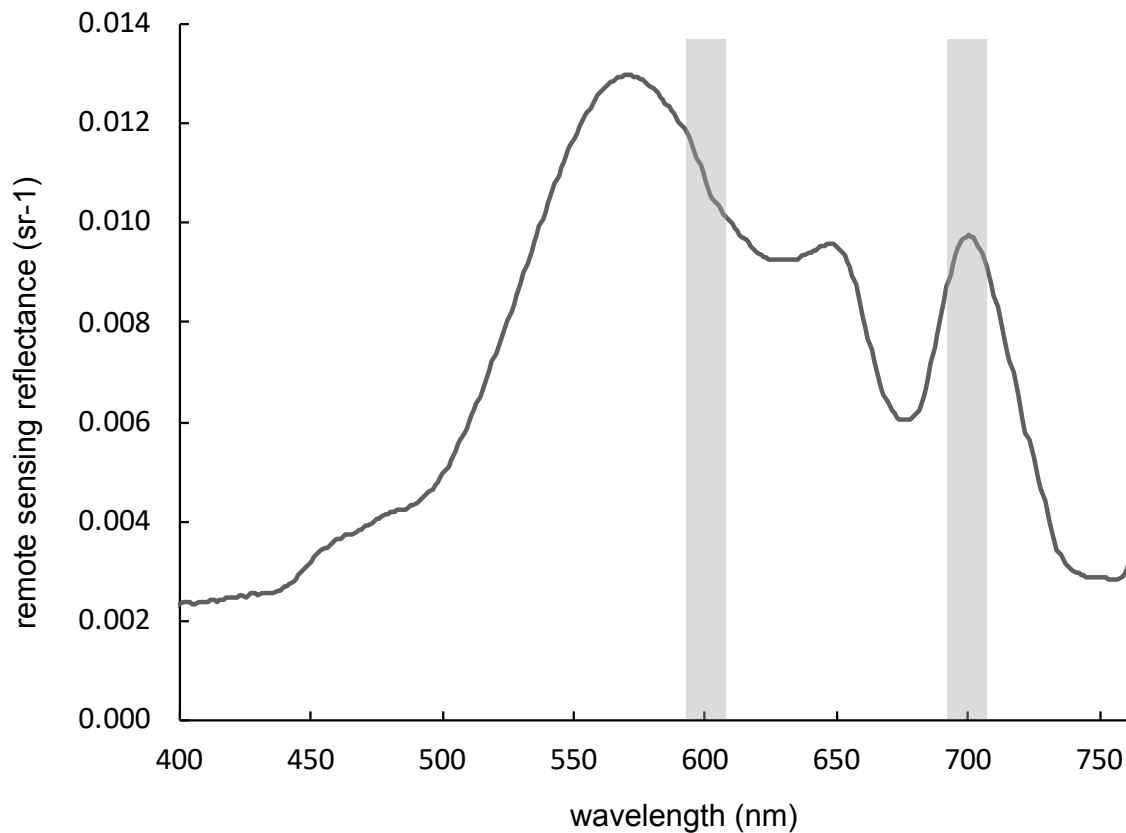
## Spectral Shape (SS) Algorithms



1. **Phycocyanin Index (PCI) - 620 nm**  
Baseline: 560, 665 nm Qi et al. 2014
2. **Cyanobacteria Index (CI) - 680 nm**  
Baseline: 665, 709 nm Wynne et al. 2008
3. **Maximum Peak Height (MPH2) - 709 nm**  
Baseline: 665, 885 nm Matthews et al. 2012

# Algorithms tested for cyanobacteria detection in the IRL

Band Ratio (BR) Algorithm



1. **Phycocyanin Index (PCI) - 620 nm**  
Baseline: 560, 665 nm Qi et al. 2014
2. **Cyanobacteria Index (CI) - 680 nm**  
Baseline: 665, 709 nm Wynne et al. 2008
3. **Maximum Peak Height (MPH2) - 709 nm**  
Baseline: 665, 885 nm Matthews et al. 2012
4. **Band ratio (BR)**  
 $\log_e(R_{rs700}/R_{rs600})$  Mishra et al. 2009



Derivative equation for **spectral shape** algorithms

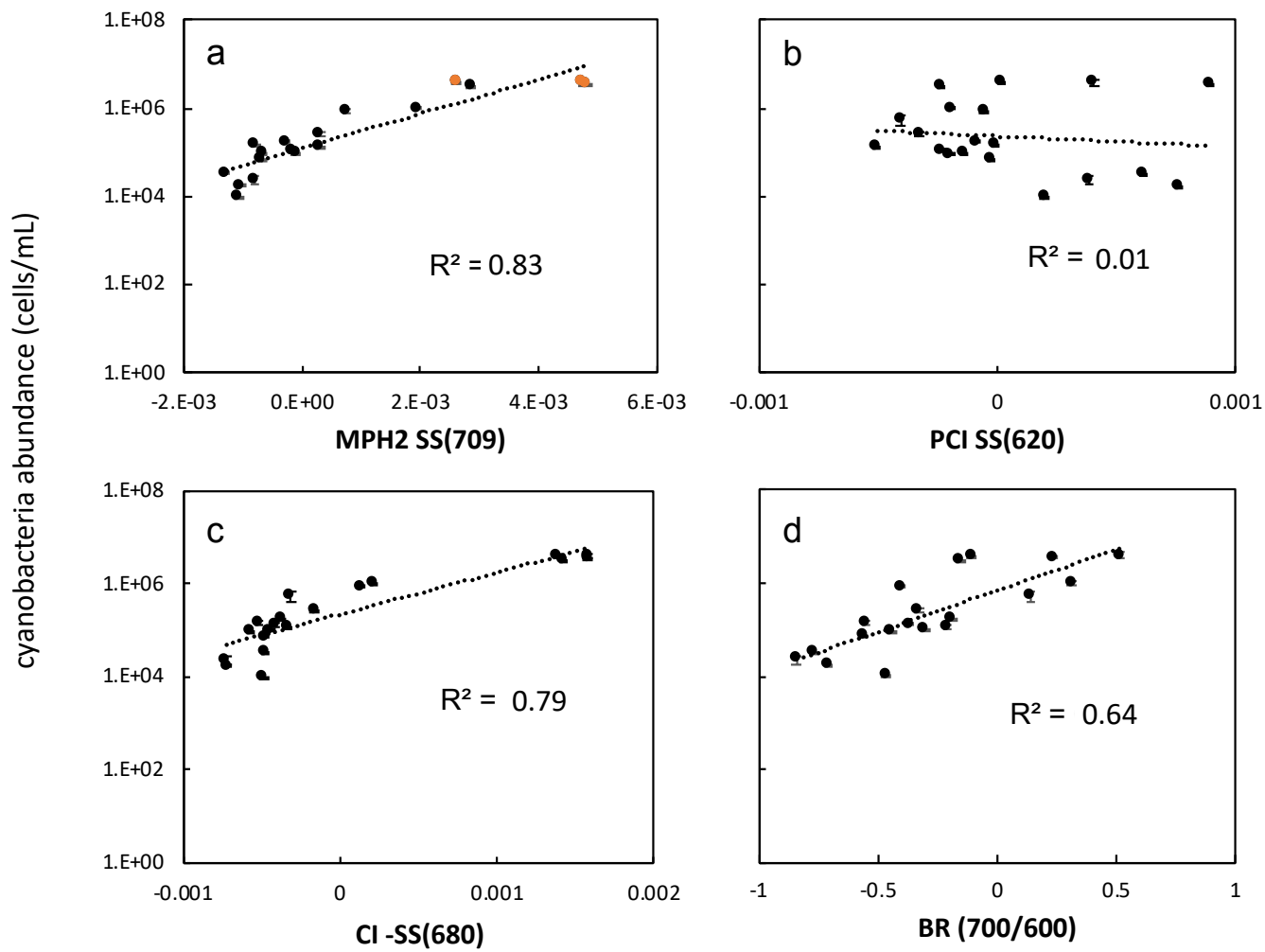
$$SS(\lambda) = Rrs_{\lambda} - Rrs_{\lambda^-} - (Rrs_{\lambda^-} + Rrs_{\lambda^+}) * (\lambda - \lambda^-) / (\lambda^+ + \lambda^-)$$

central band,  $\lambda$     reference bands,  $\lambda^+$ ,  $\lambda^-$

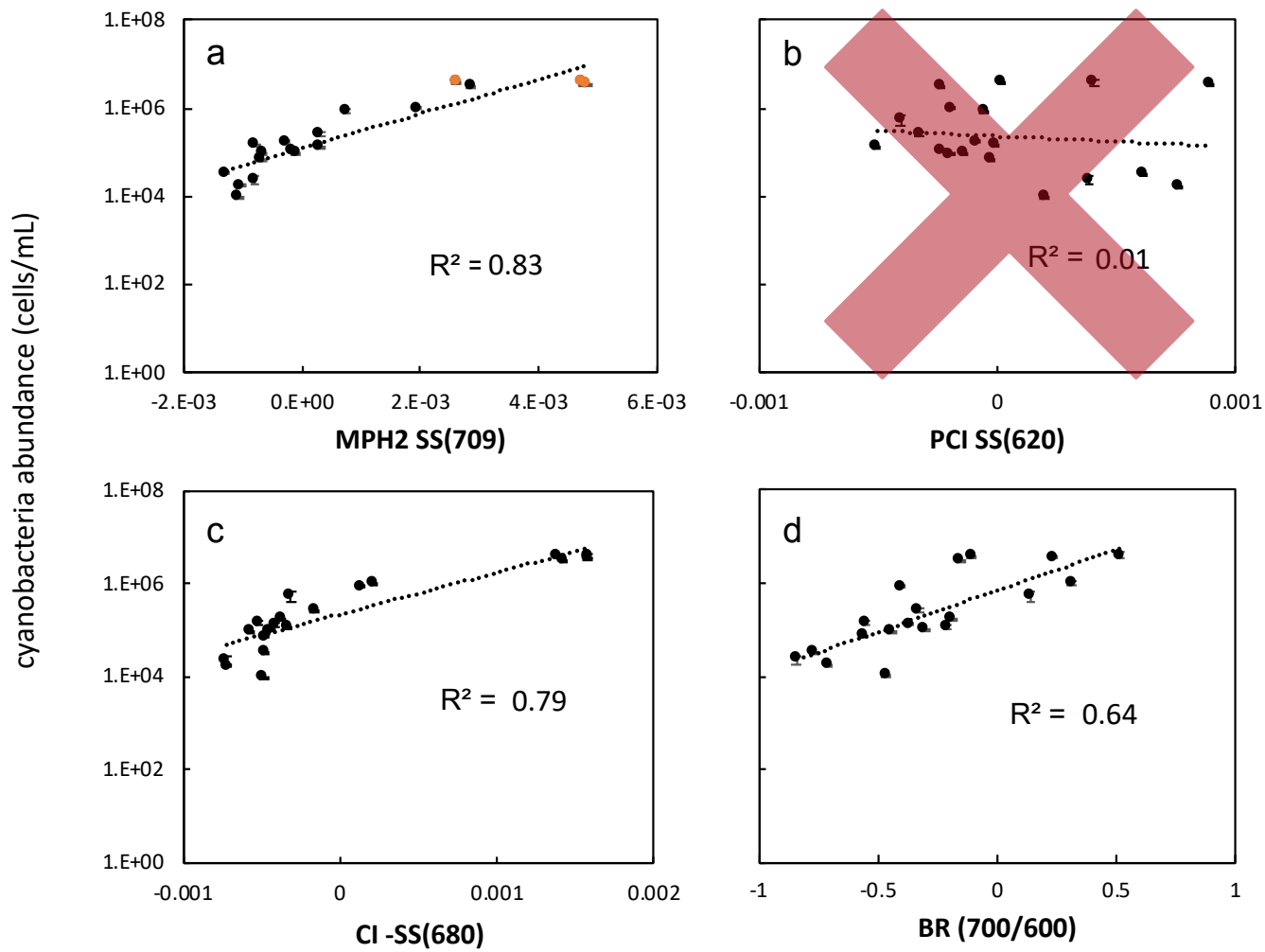
Equation for **band ratio** algorithms

$$BR = LN (Rrs_{700} / Rrs_{600})$$

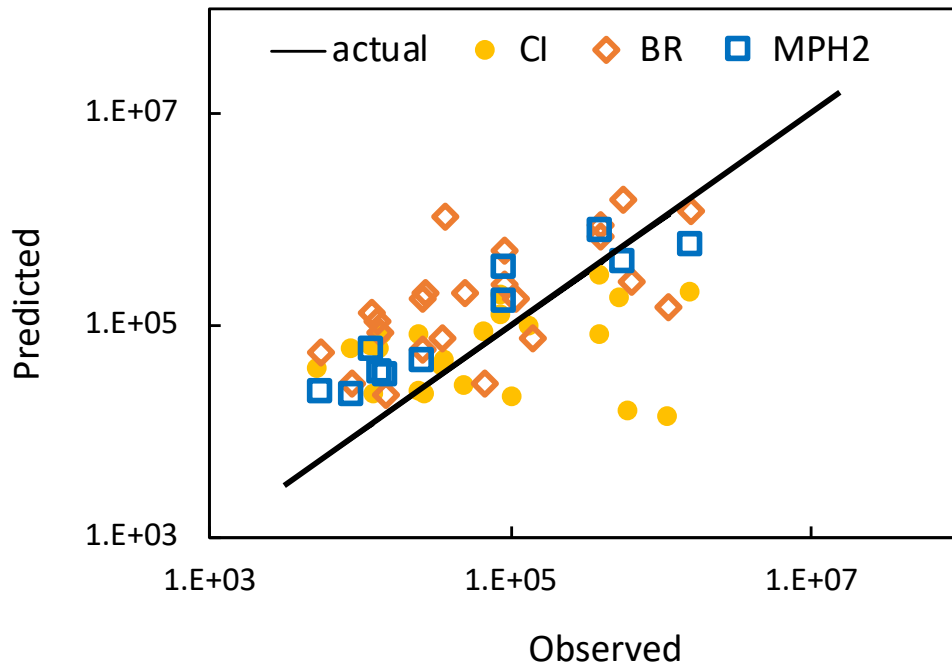
# model development



# model development



# model predictions across IRL & Lake Okeechobee



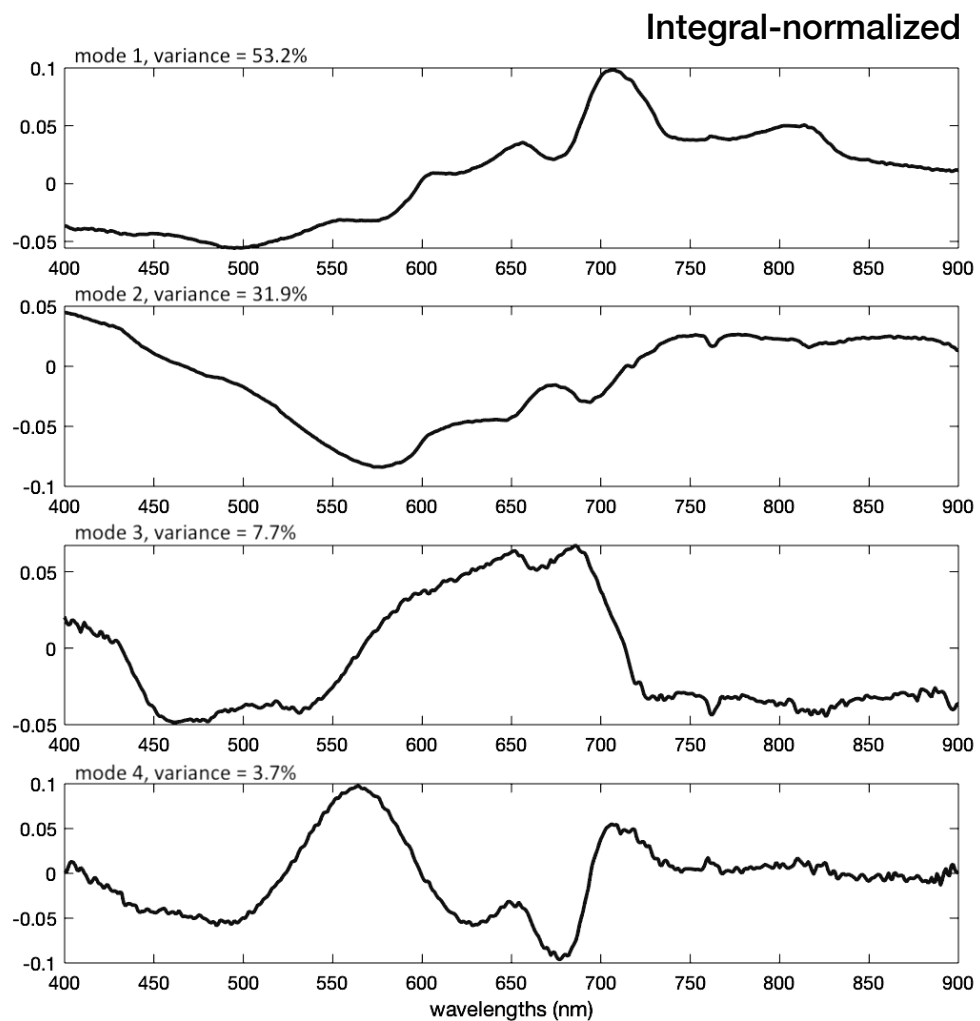
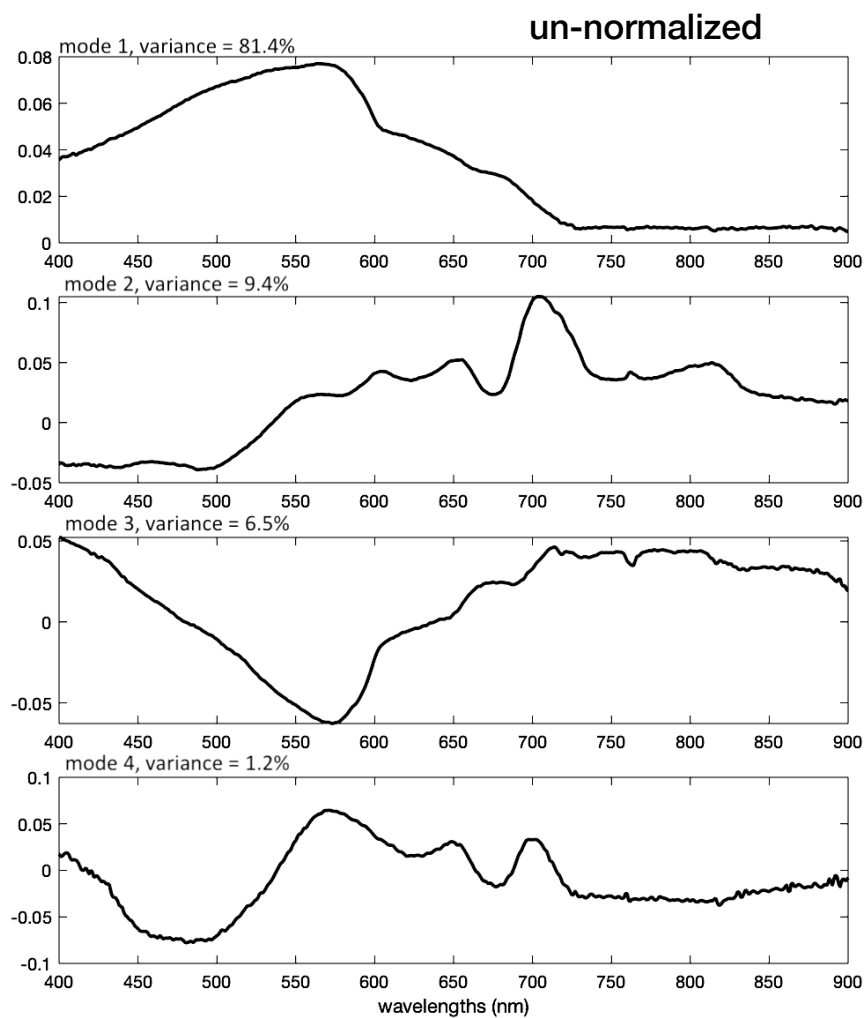
MODEL	n	R <sup>2</sup>	p value	RMSE (log <sub>10</sub> )
MPH2	11	0.89	< 0.01	0.29
BR	23	0.41	< 0.01	0.56
CI	23	0.06	0.28	0.71

## Discussion

- 700 nm reflectance is a dominant optical feature in the IRL

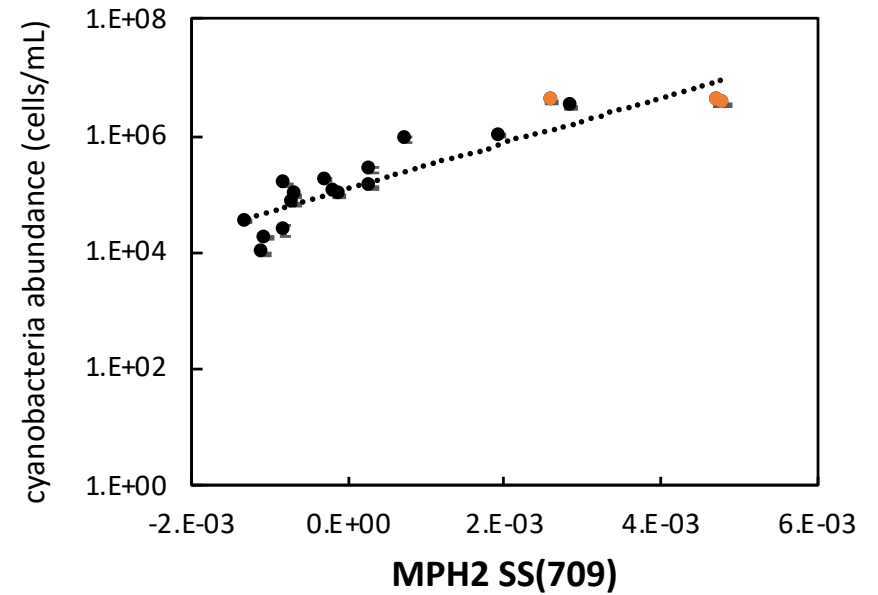
# Discussion

Method by Craig et al., (2012)



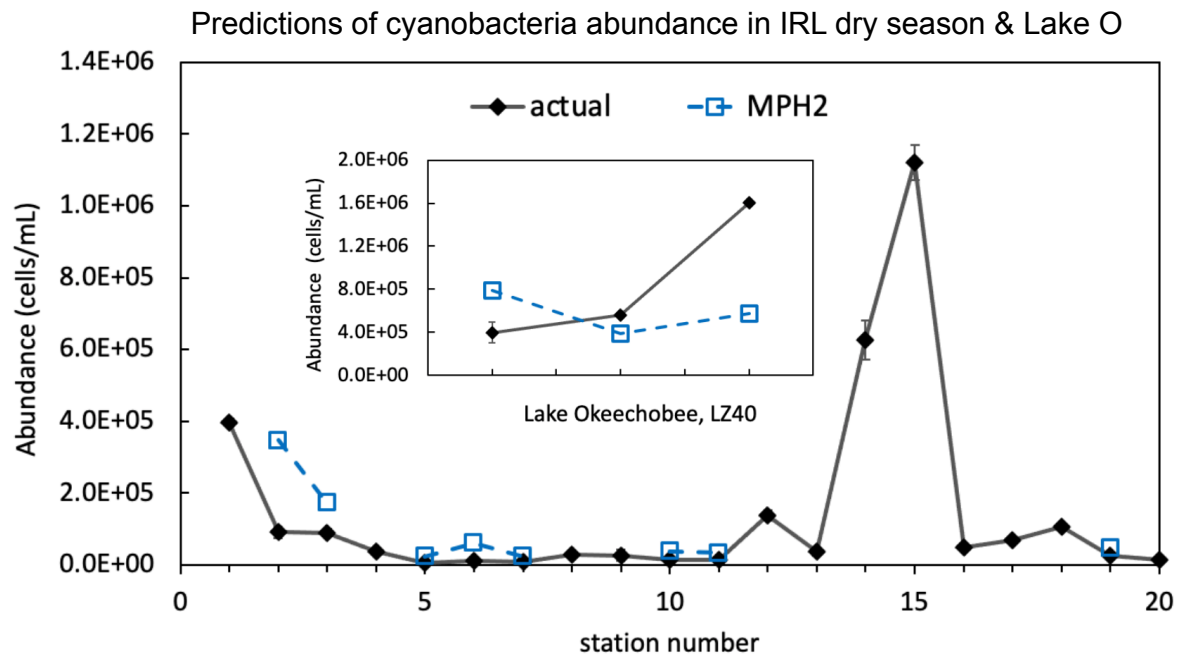
# Discussion

- 700 nm reflectance is a dominant optical feature in the IRL
- Ability to identify cyanobacteria not well developed



# Discussion

- Larger dataset with Rrs spectra at 885nm is needed to test MPH2

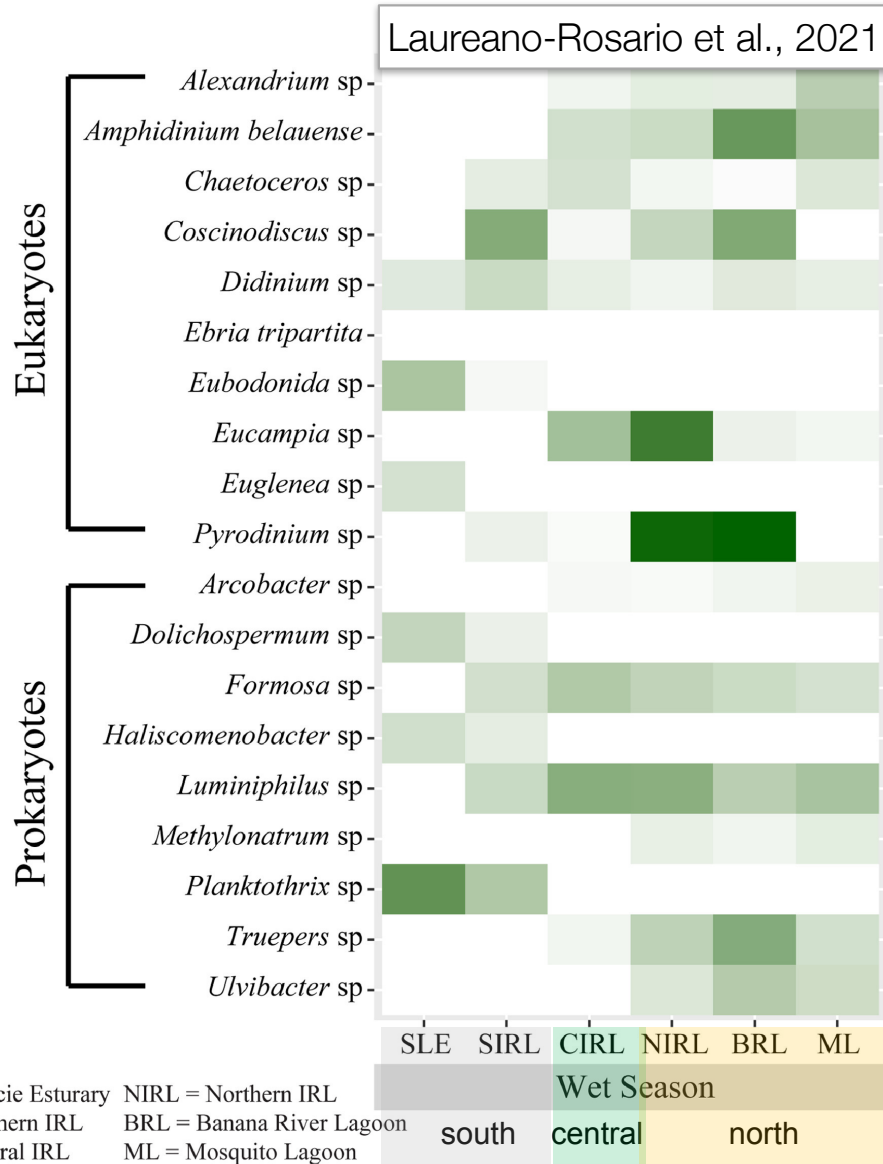
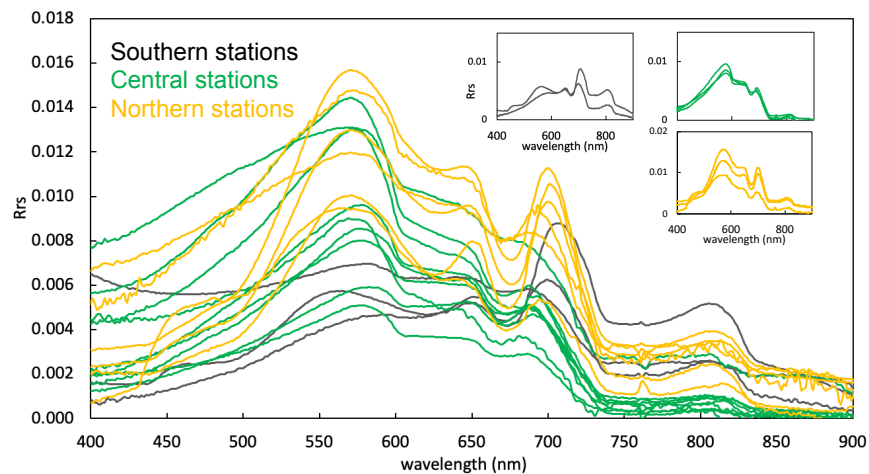
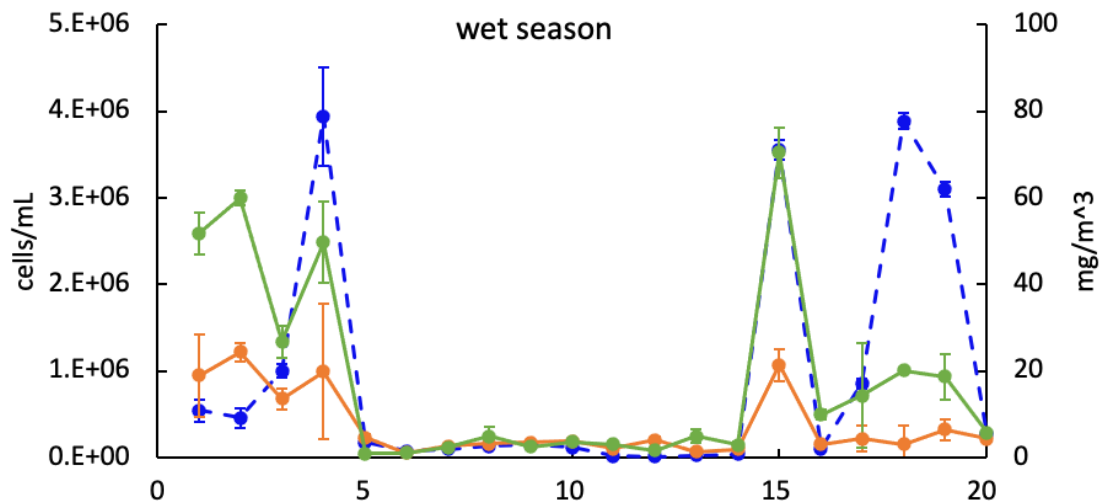




## Discussion

- Phycocyanin signature likely has high interference from Chl-*a* absorption and fluorescence

—●— Cyanobacteria (cells/mL) —●— Extracted Phaeophytin —●— Extracted Chl-a (mg/m<sup>3</sup>)



# Summary

Mean Peak Height (for turbid waters)

- is viable in the IRL
- can be more robust with larger dataset
- requires wavebands in the far-red range of 885 nm
- model output likely influenced by other phytoplankton and not just cyanobacteria - likely beneficial in the IRL

# Thanks

Alberto Tonizzo · Processing & providing field optical data

Malcolm McFarland · Providing other field & flow cytometry data

Twardowski lab at HBOI · Sampling & data collection

