

Use of High Frequency Water Quality Data to Scale Ecological Processes in Estuaries

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Background

And...

- **Continuous water quality monitoring technology has facilitated the acquisition of unprecedented volumes of water quality data in aquatic ecosystems**
- **Satellite imagery is another data trove for evaluating coastal water quality**
 - Florida coastal criteria (Schaeffer et al. 2013)
 - Effect of land use and climate on chlorophyll (Le et al. 2009, 2013a,b,c)
- **Monitoring programs are increasingly relying on such data sources to supplement or replace field sampling**
 - Cost effective
 - Potentially vast information content

Background (cont)

But

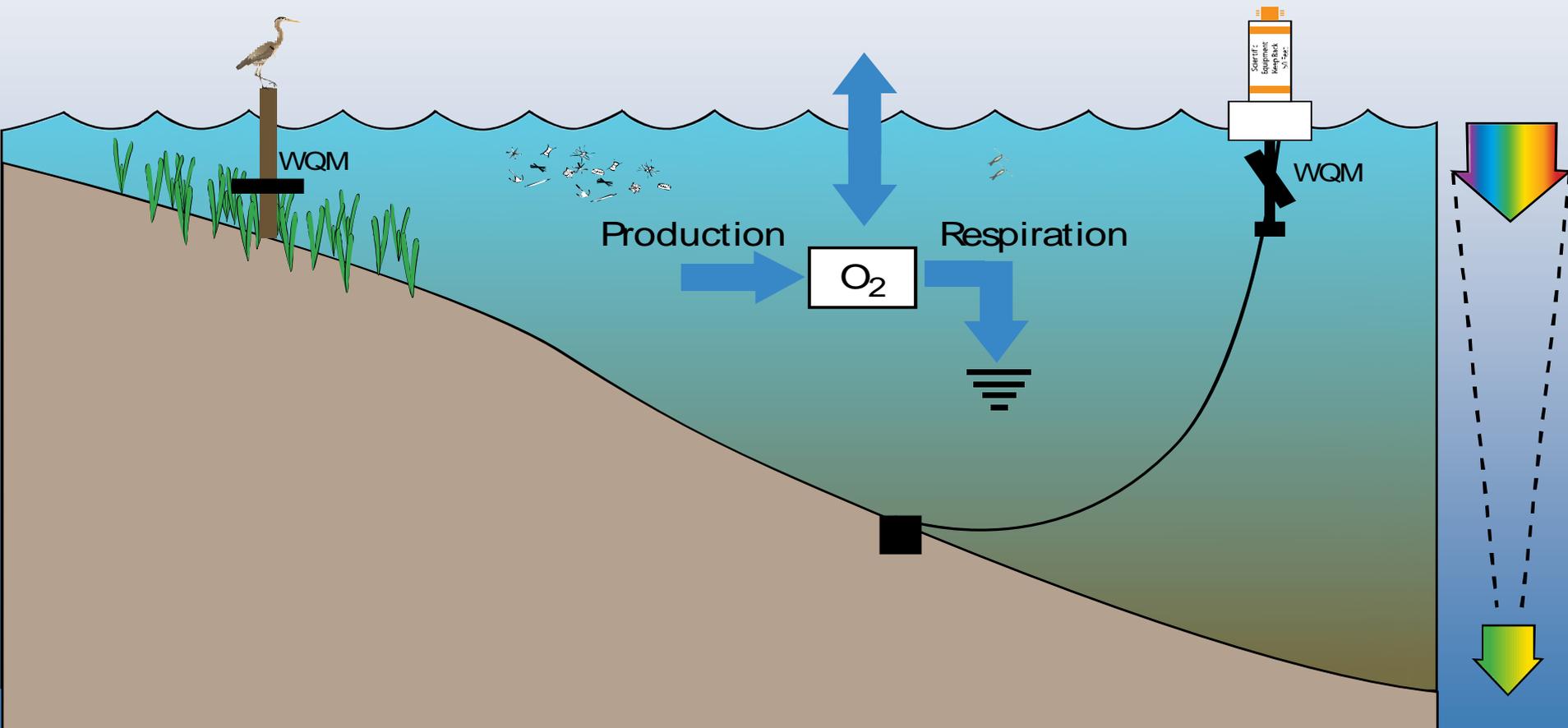
- **A question remains how and whether these high volumes of data have increased our understanding of aquatic systems**
 - Data ≠ Information
- **State variables (i.e. chlorophyll, CDOM, salinity, water clarity) are useful but do not predict ecological rate processes**
- **Process rate measurements provide an integrated way of evaluating the “health” or trophic state of an ecosystem**
 - Growth Rates, Grazing Rates, Trophic Transfer Rates, etc.
 - Labor intensive
- **Methods that estimate process rates from water quality time series are a promising “value-added” use of high frequency datasets**
 - Ecosystem Gross Production, Respiration, NEM

Purpose of Study

Therefore

- **Compare and evaluate methods of measuring ecological processes**
 - Ecosystem vs Plankton Metabolism
 - Channel vs Shoal
- **Compare and evaluate methods of measuring water optical properties**
 - Satellite vs. Point sampling
 - Channel vs Shoal

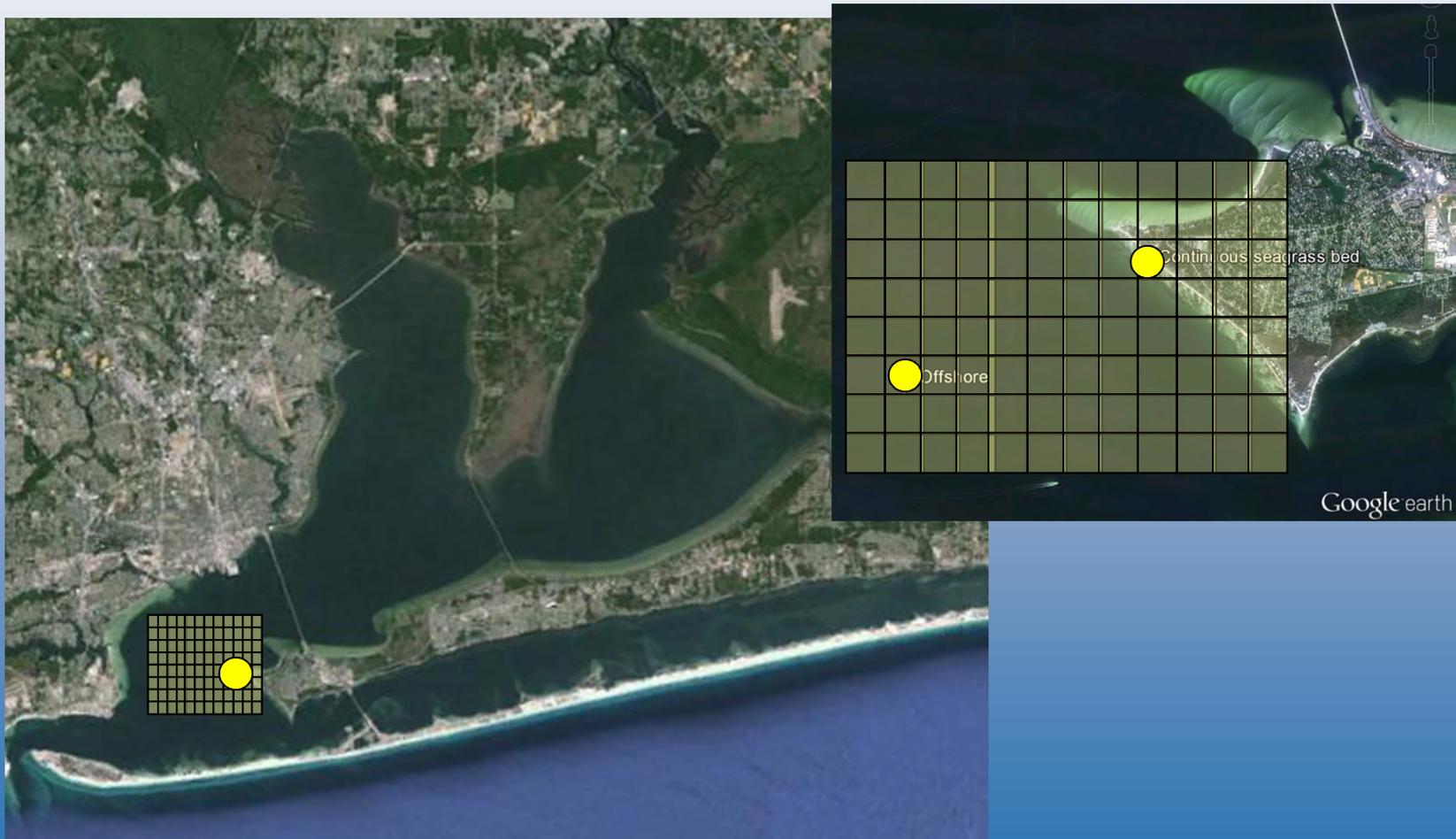
Conceptual Model



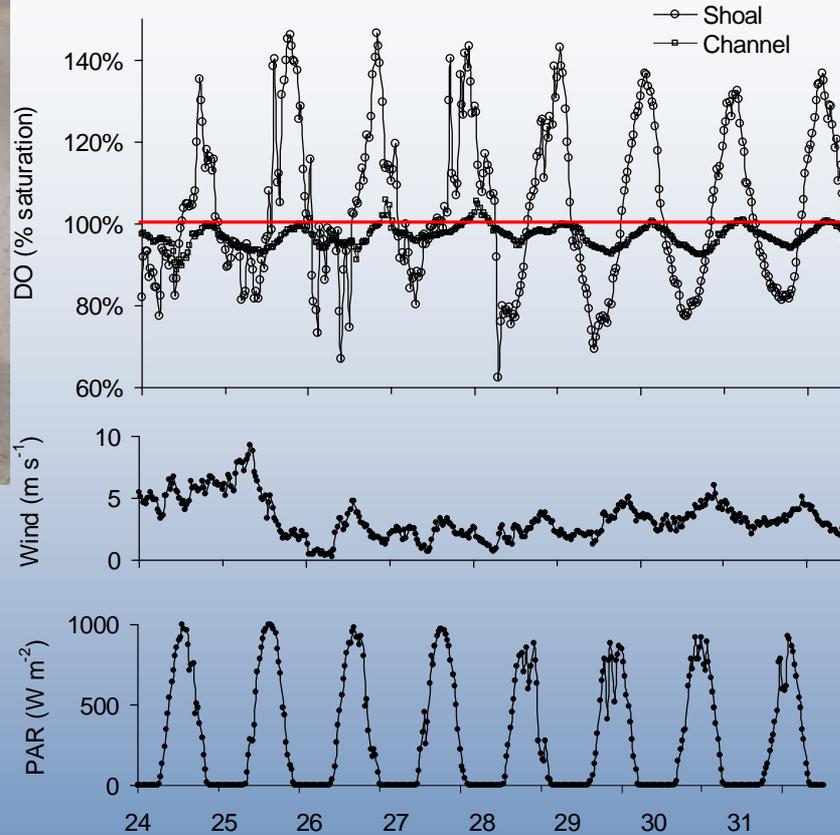
Study Design 2013

- **Satellite imagery**
 - MERIS time series (2002-2012)
 - Chlorophyll and CDOM products
- **In situ WQ instruments (Apr-Sept 2013)**
 - Shoal (seagrass) vs Channel (bare bottom)
 - Ecosystem gross production and respiration
- **Point sampling (~Weekly)**
 - CTD profiles
 - Chlorophyll, CDOM, Part Abs.
 - Plankton Primary Production, Respiration

Satellite spatial resolution of Pensacola Bay



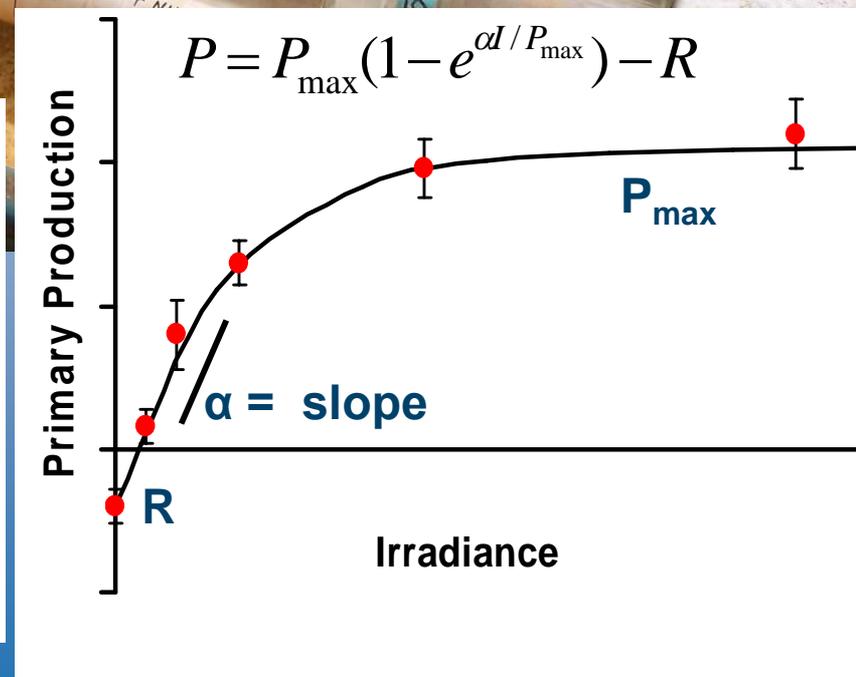
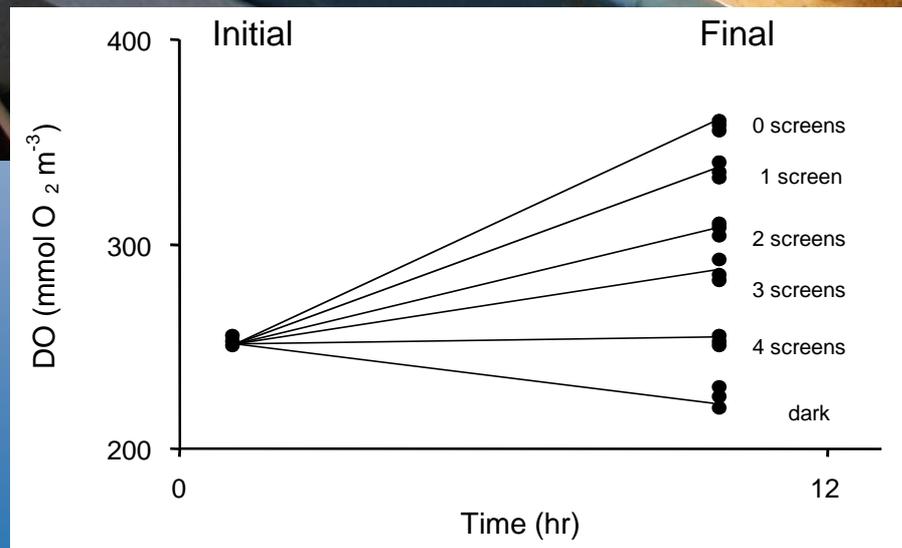
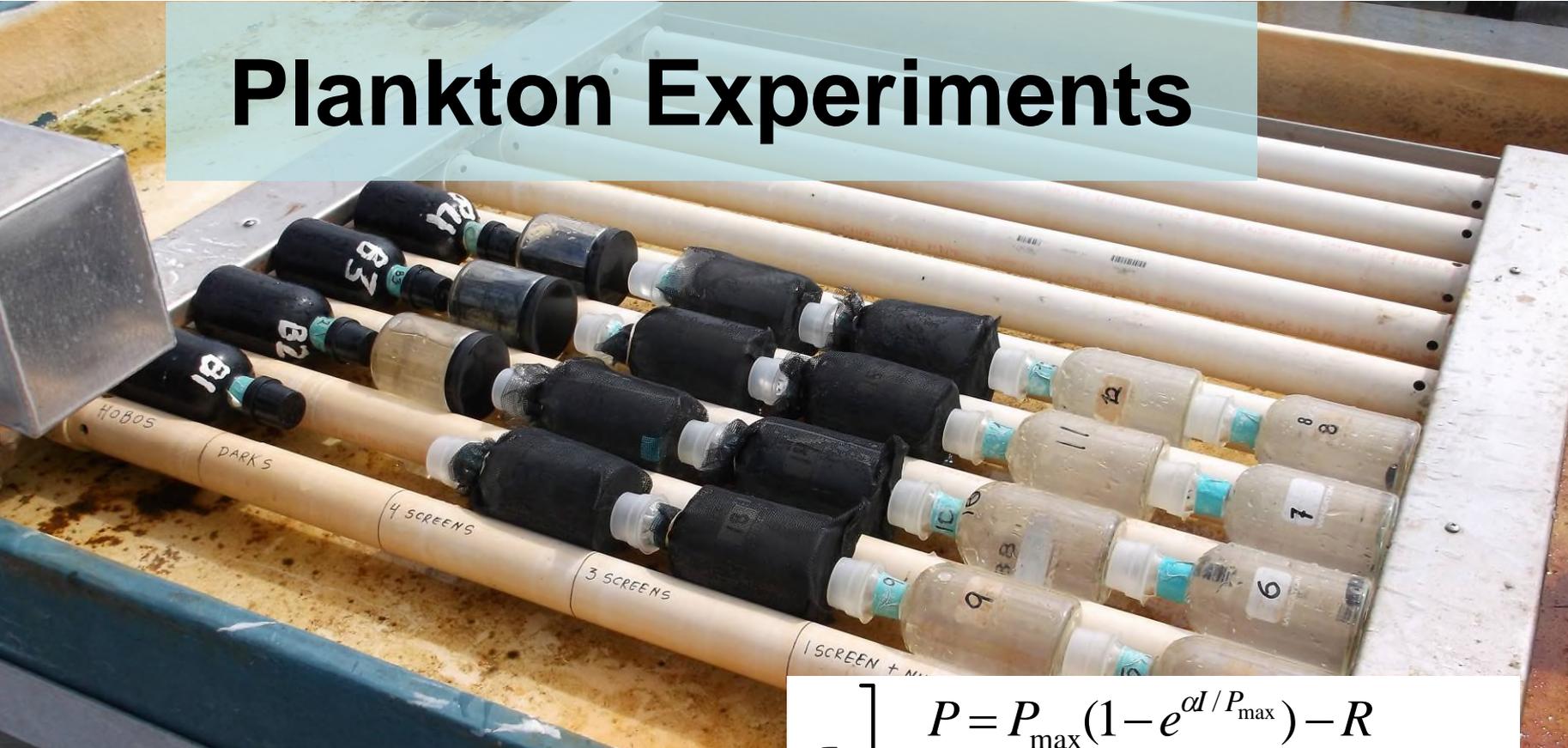
WQM's and Weather Station



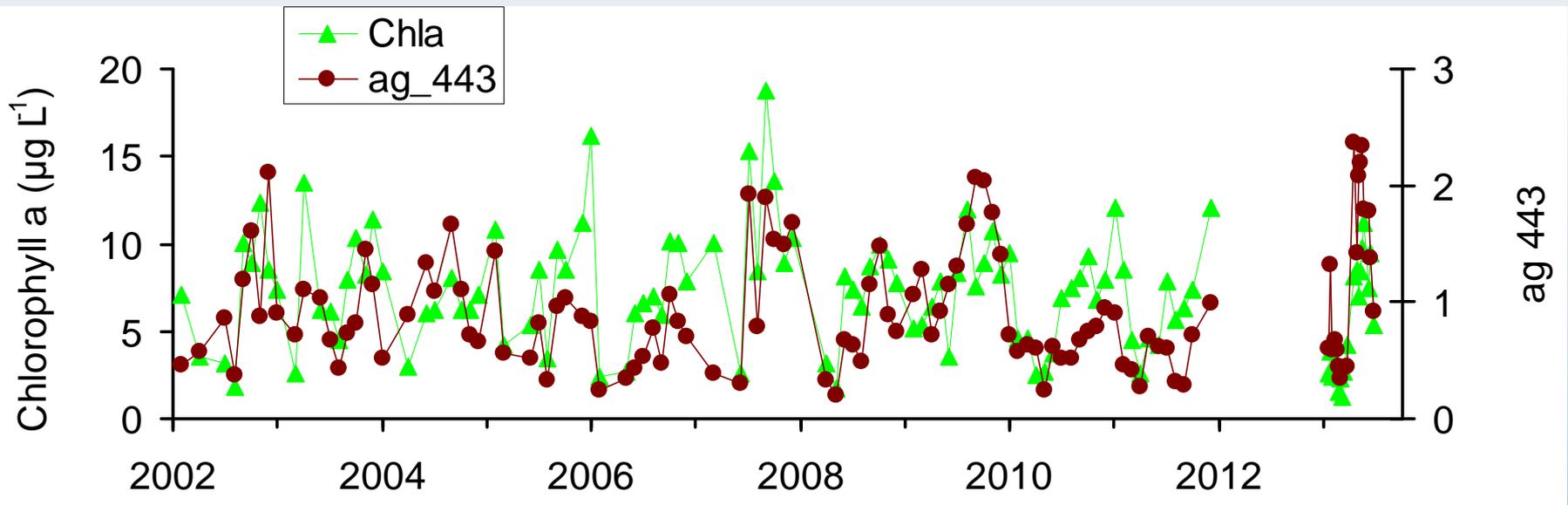
$$\frac{dC}{dt} = P - R + D$$

$$D = k_a (C_s - C)$$

Plankton Experiments



MERIS CDOM and chlorophyll products from study site show interannual variability



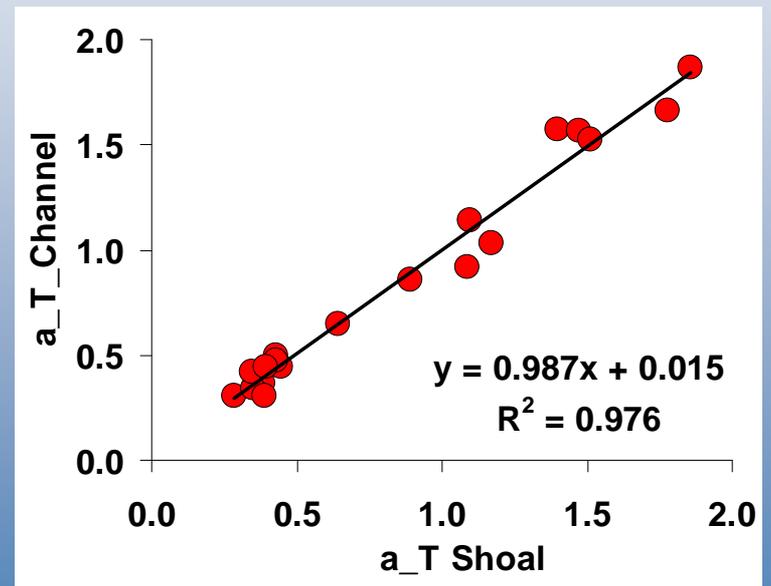
MERIS Record from Channel Site

Point Samples
from Channel Site

- MERIS died in 2012!
- Data from 2013 are similar to MERIS record

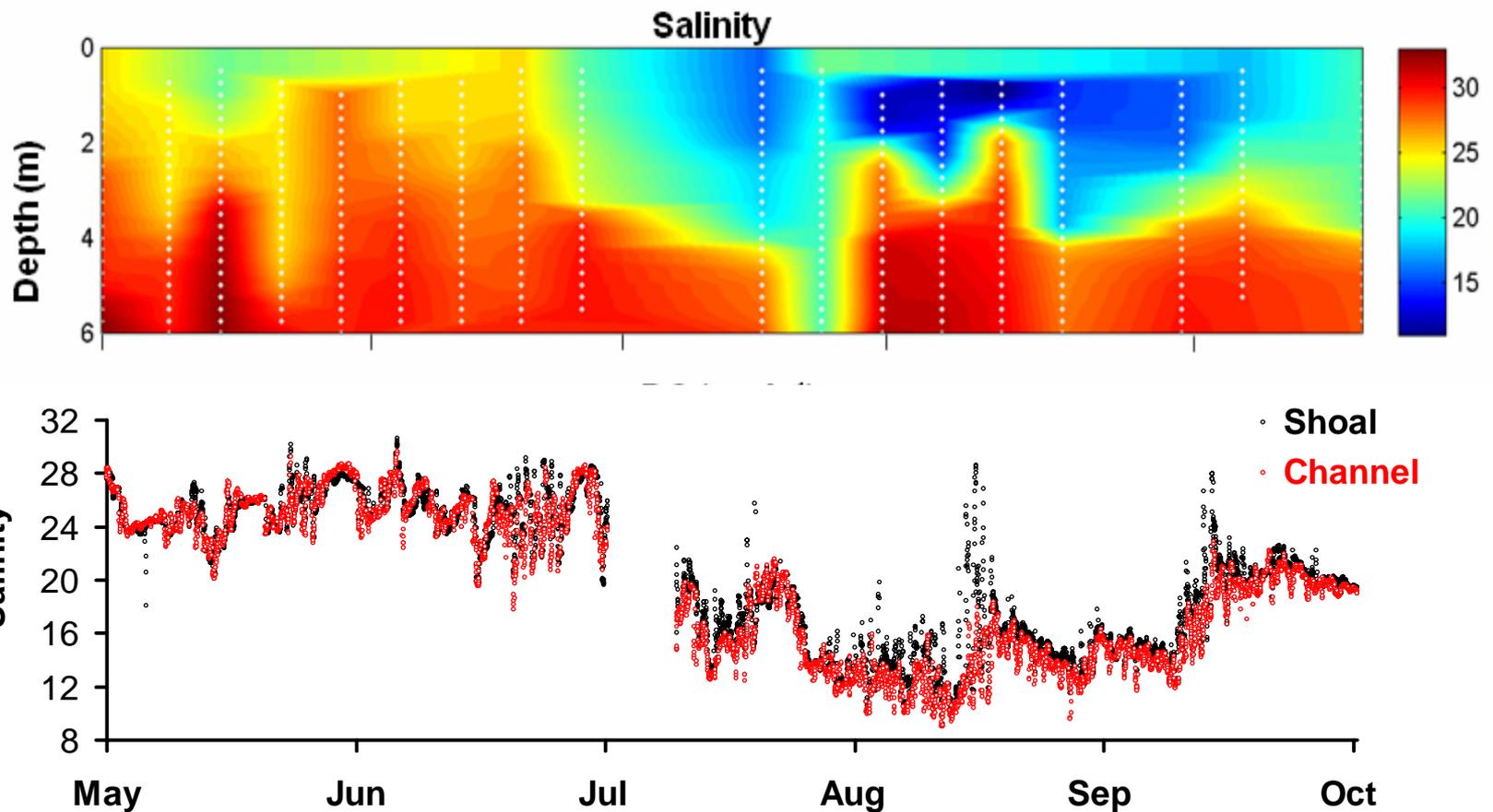
How do in situ optical properties compare between shoal and channel?

- $a(T) = a(g) + a(d) + a(ph)$
- Shoal and Channel sites have virtually identical absorption properties based on weekly point samples
- Extrapolating RS products to shallow waters (i.e. seagrass habitat) is supported

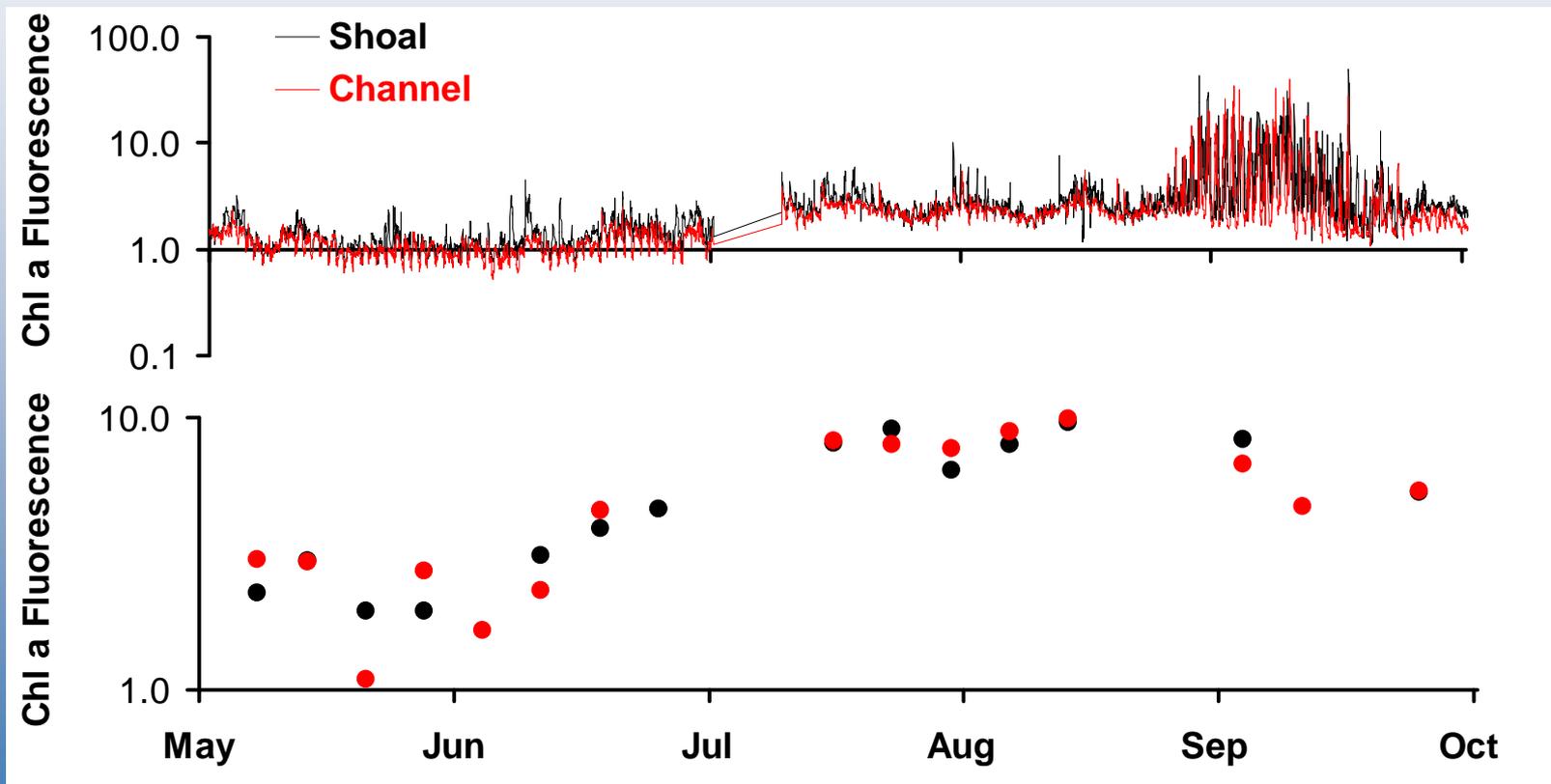


What 'happened' during 2013 study?

Time series show low salinity water intrusion in July

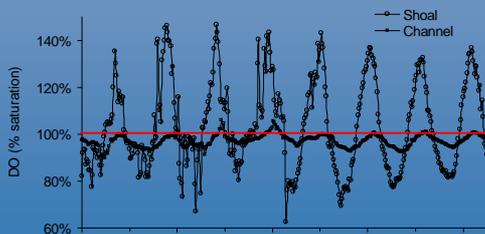
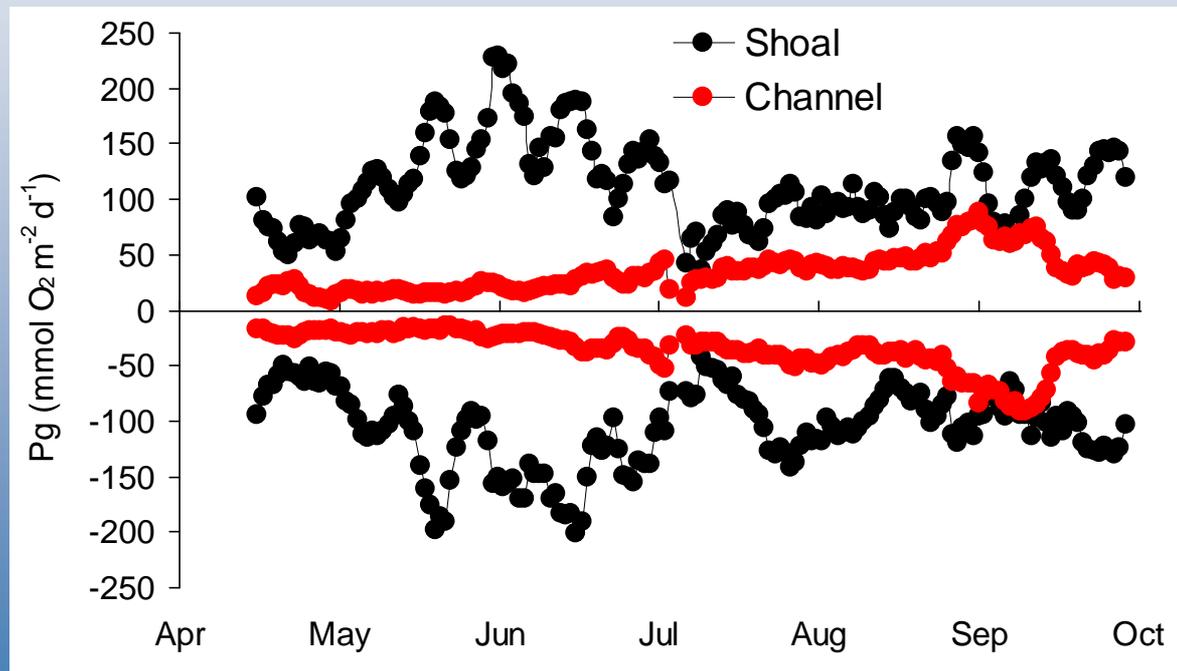


Chlorophyll increased after low salinity water intrusion



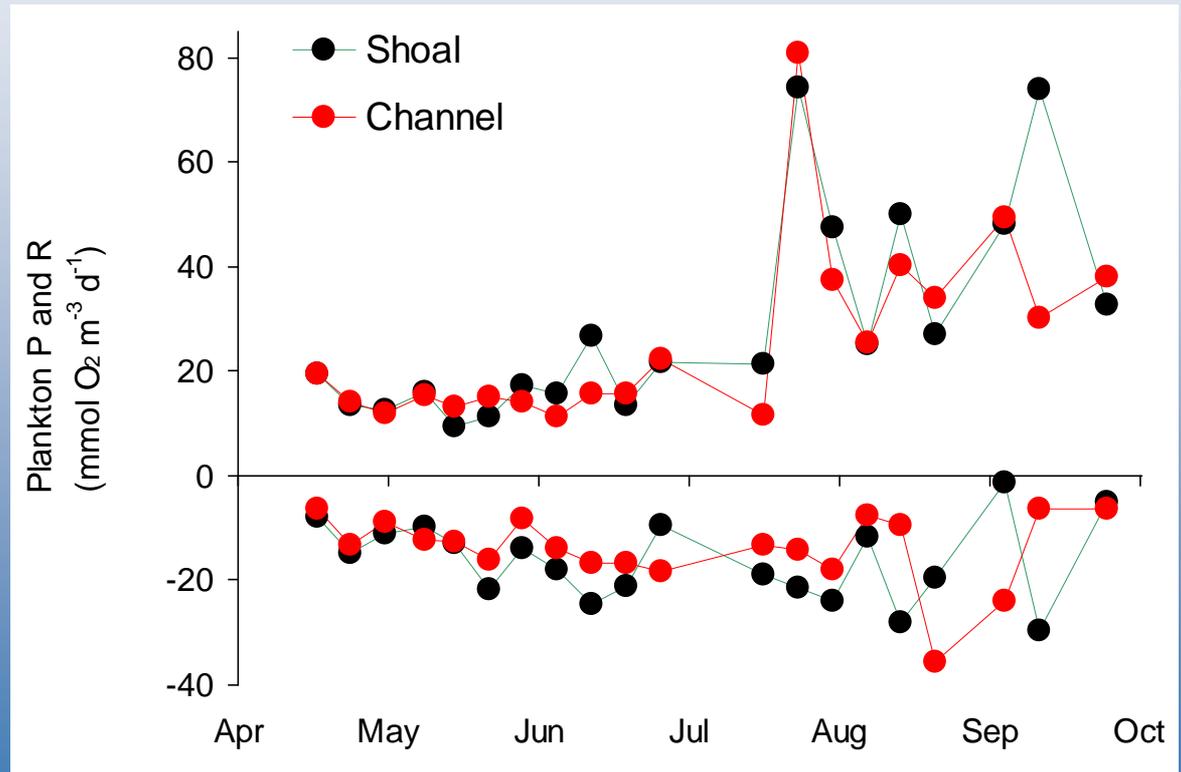
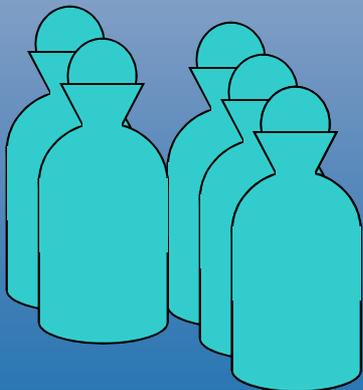
Open water metabolism shows influence of low salinity intrusion

- Shoal >> Channel
- Shoal
 - High > Decrease
- Channel
 - Low > Increase



Plankton metabolism also influenced by low salinity intrusion

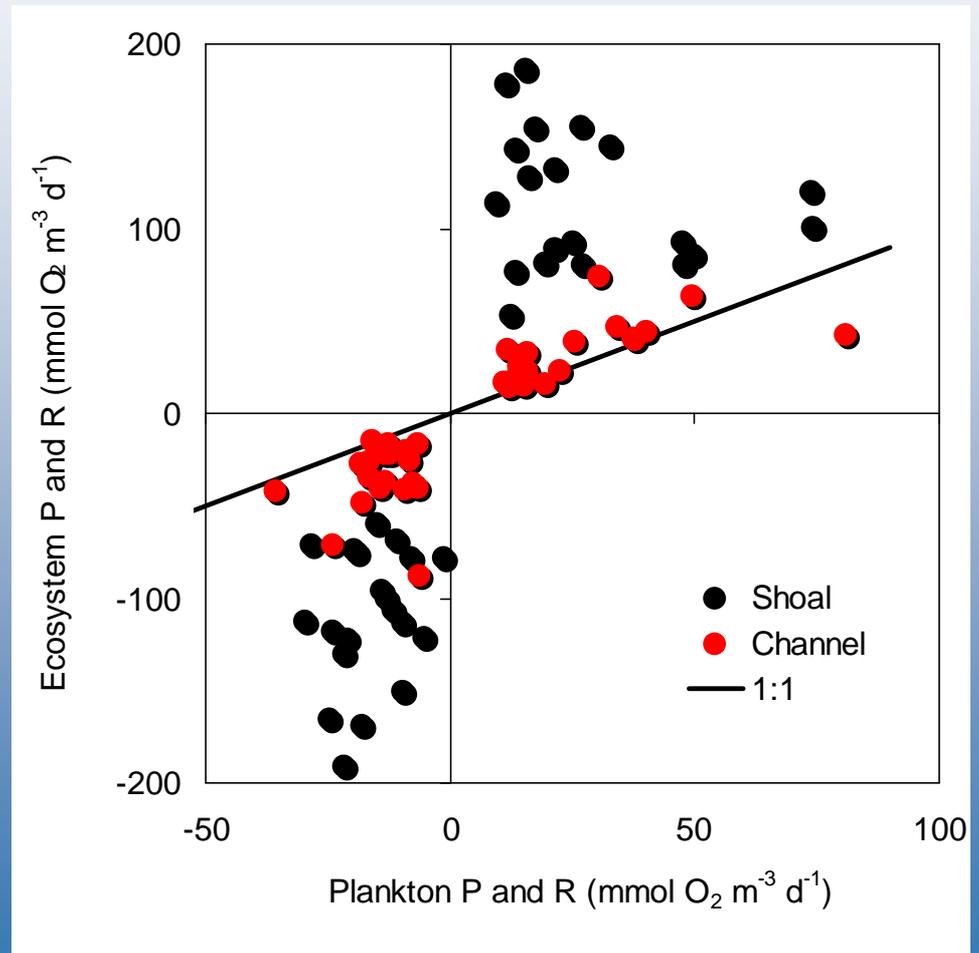
- Shoal and Channel sites similar response
- Low > Increase



Plankton vs. Ecosystem Metabolism

Channel vs Shoal Environment

| | P | R |
|-------------------|-----|-----|
| Ecosystem | | |
| Shoal | 114 | 110 |
| Channel | 33 | 36 |
| Plankton | | |
| Shoal | 29 | 16 |
| Channel | 26 | 13 |
| % Plankton | | |
| Shoal | 28% | 16% |
| Channel | 83% | 47% |



Summary

- Both remote sensing and continuous WQ data provide unique perspectives on ecosystem dynamics
- Allows for ‘scaling up’ and extrapolation of limited point samples
- Shows HF features ‘missed’ by point samples, expands temporal scale
- Channel and Shoal comparison
 - Identical optical properties
 - Vastly different process rates

Thank You!



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Future Directions

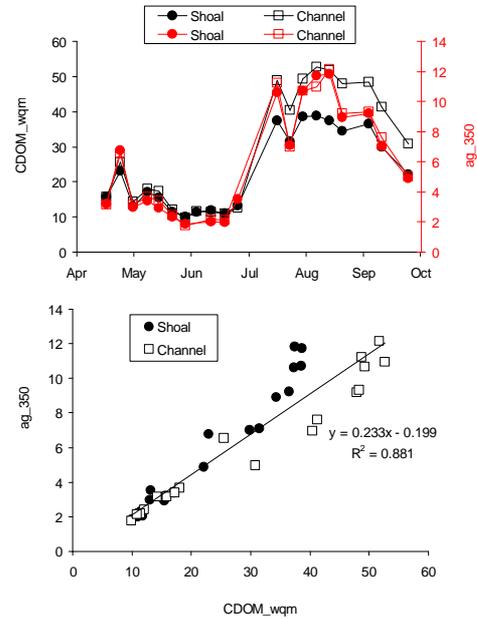
Open Water Metabolism

- **Odum 1956**

- Diel changes in dissolved oxygen used to infer rates of daytime apparent net production and night-time respiration
- Air-sea exchange estimated using wind speed and departures from saturation
- Daily integration yields estimates of gross production and respiration

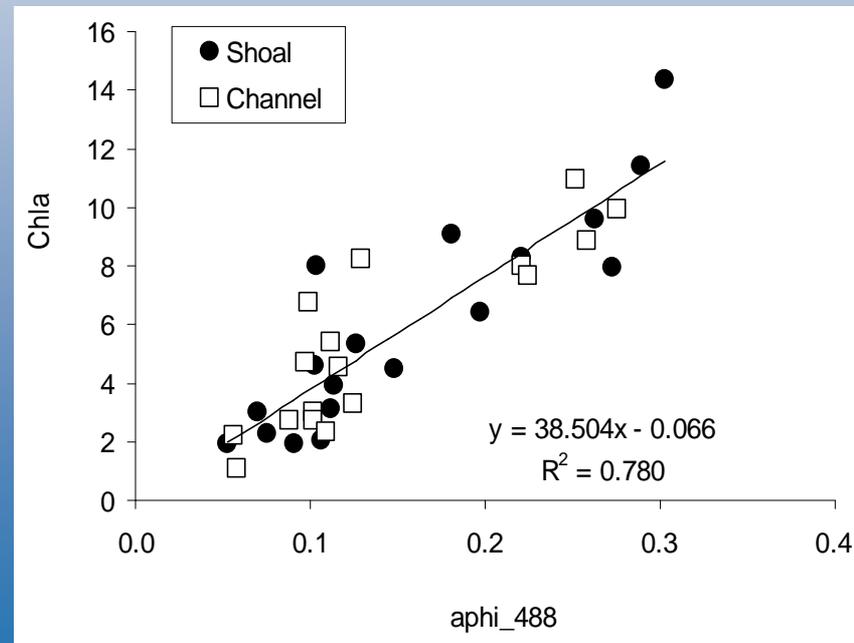
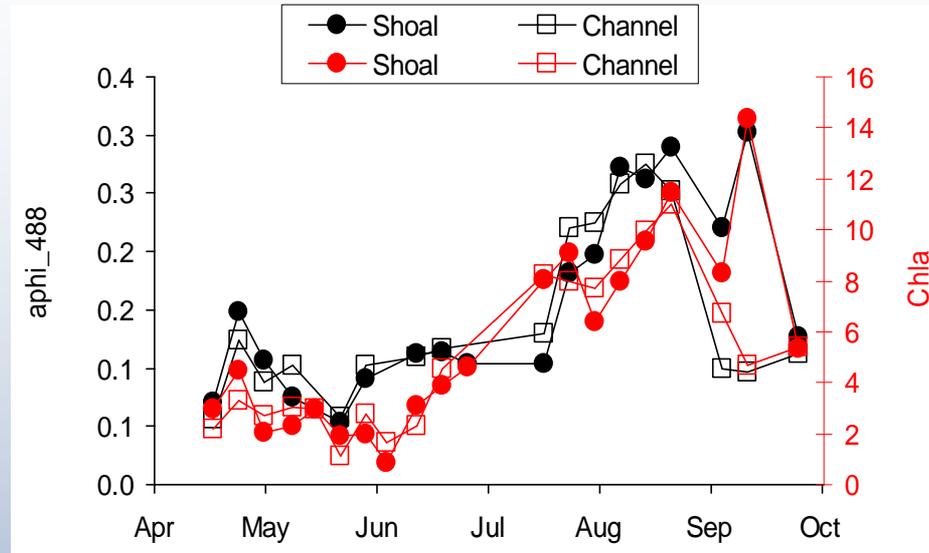
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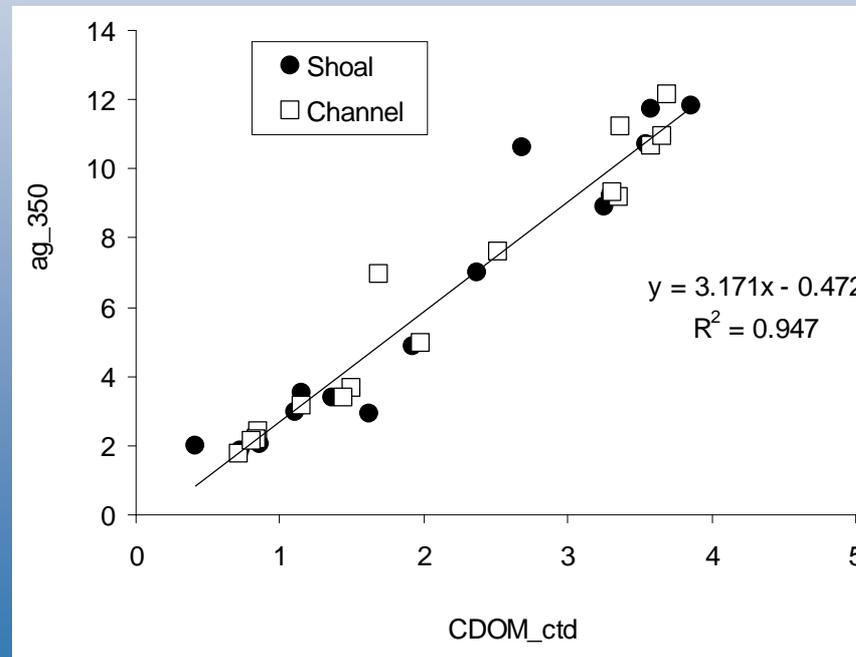
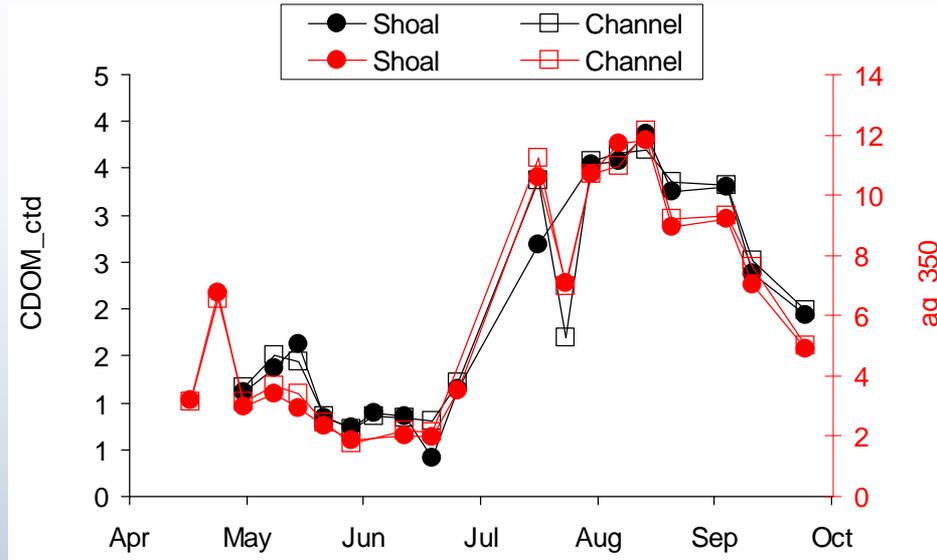
$$D = k_a (C_s - C)$$



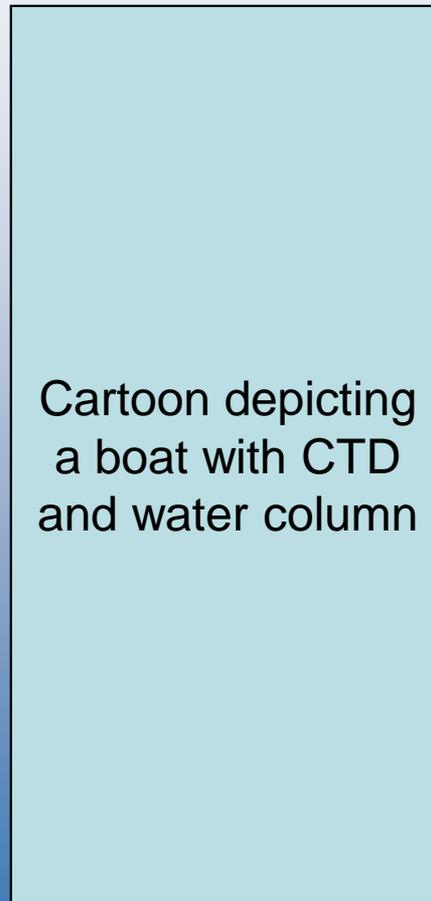
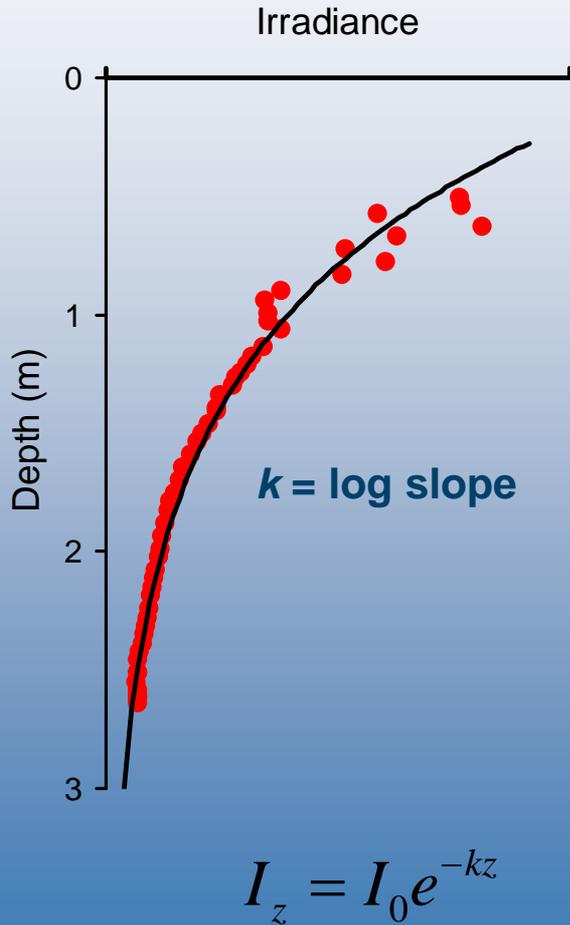
CDOM fluorescence (from WQM, daily average) and ag_350

CDOM fluorescence (from W

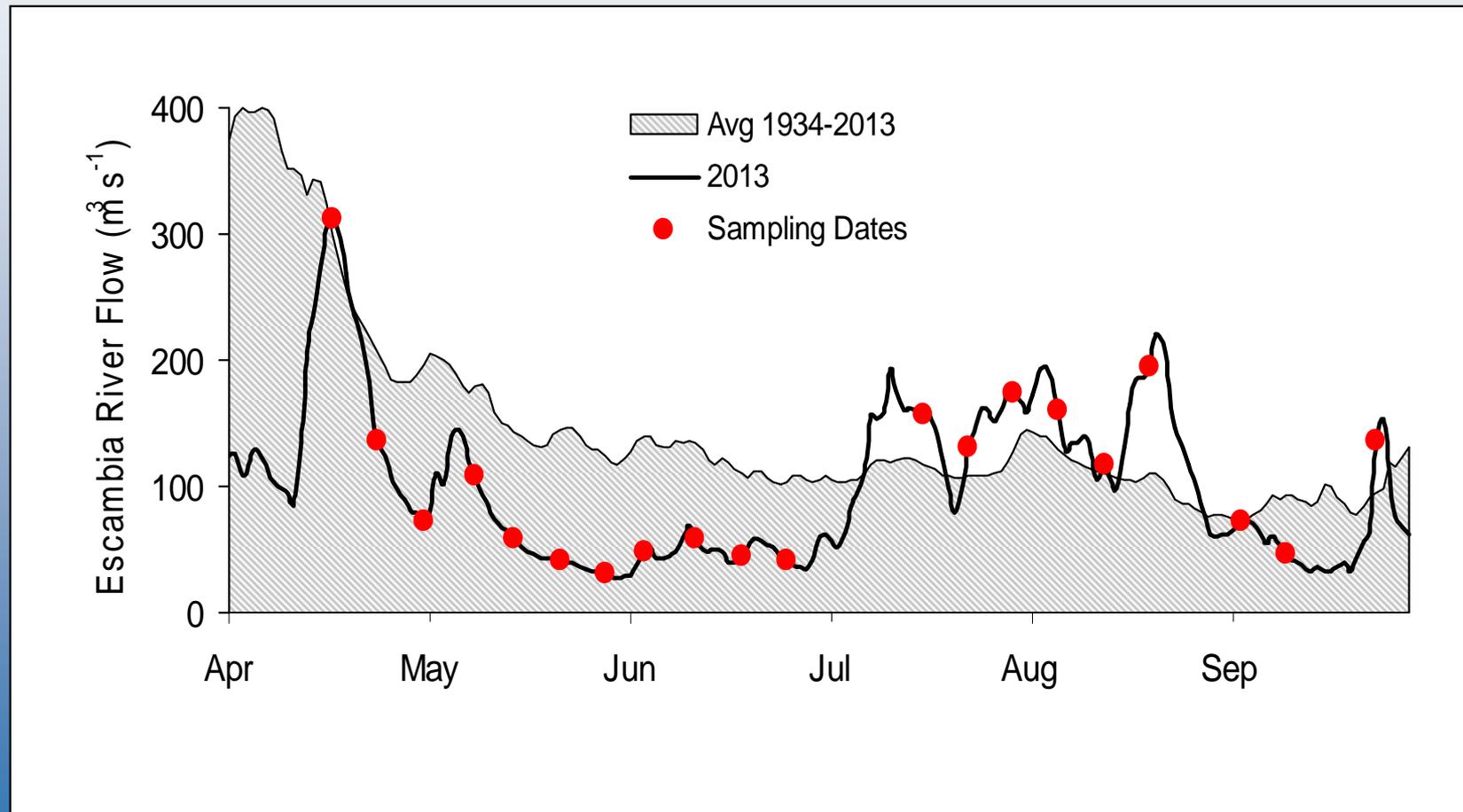




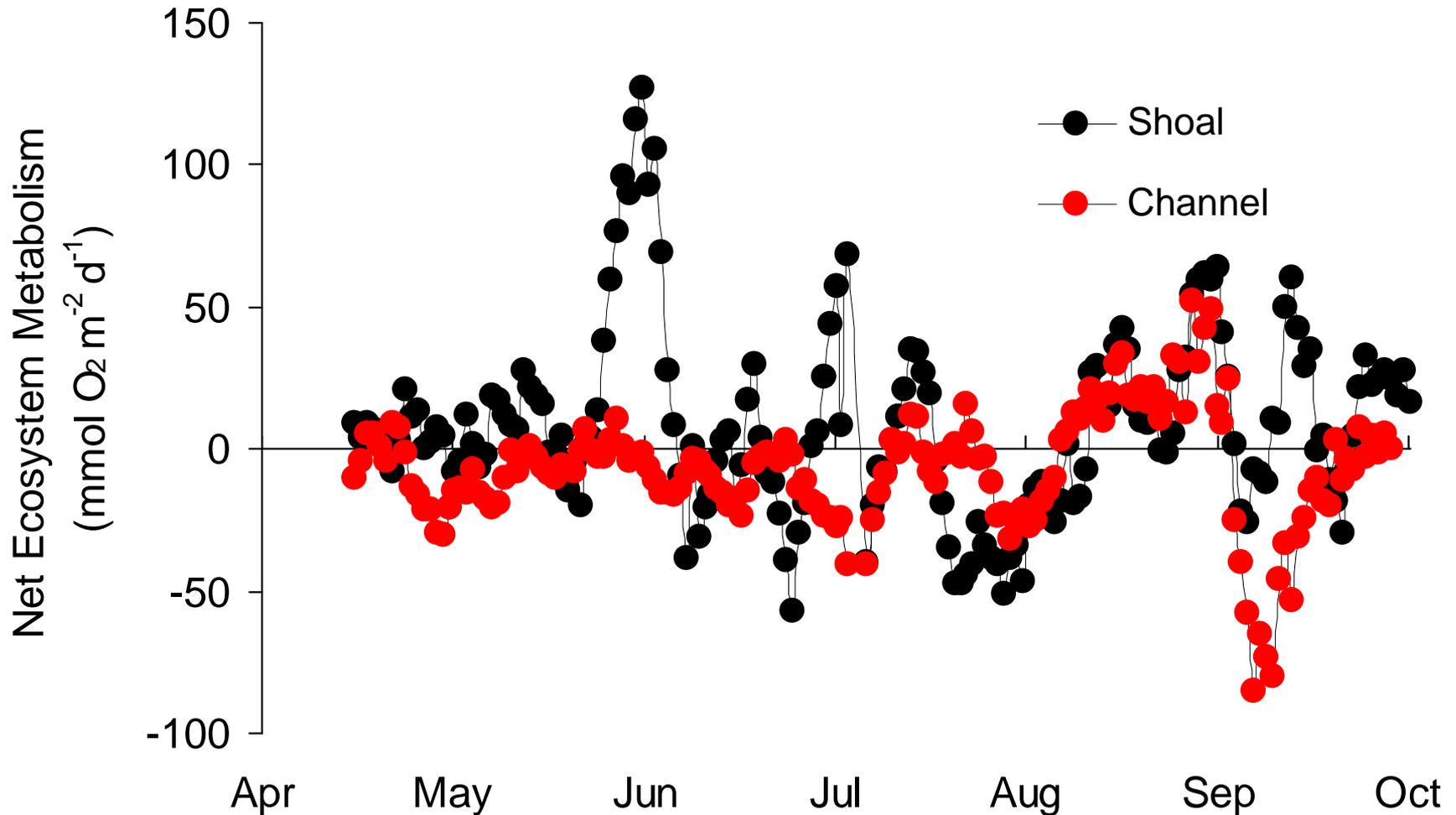
K-Z Model

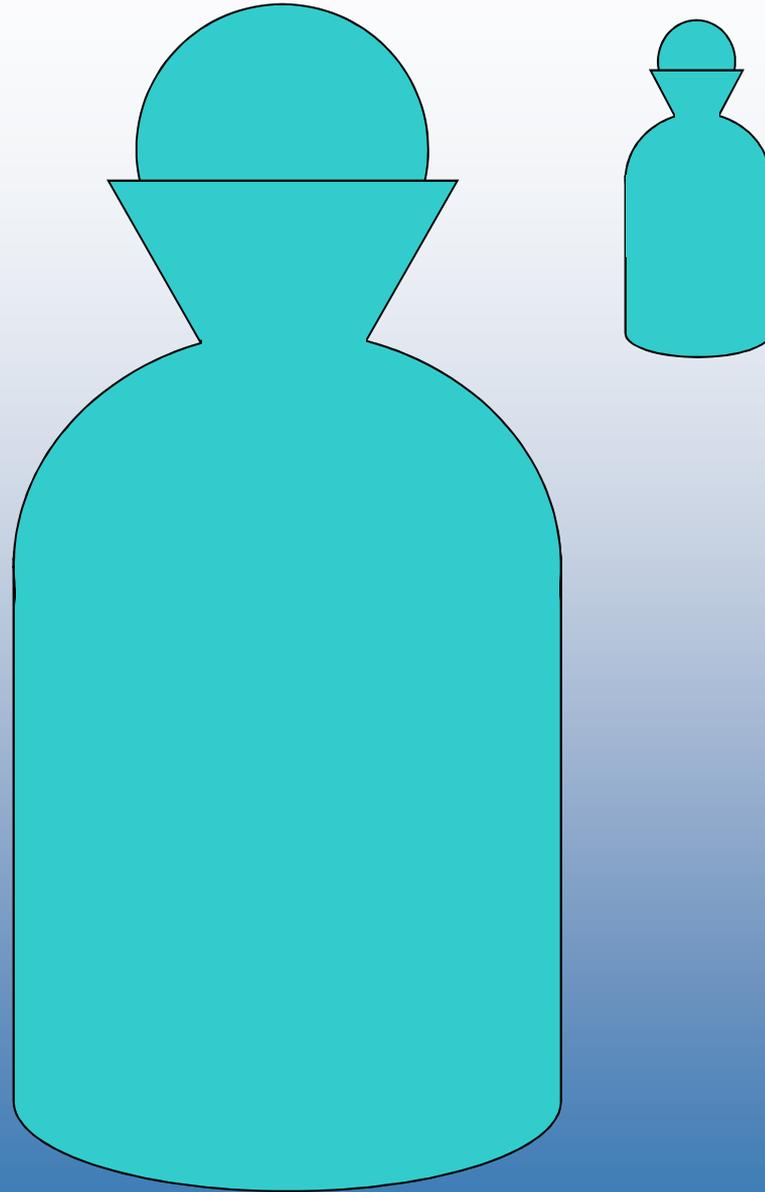


River flow during study



Net Ecosystem Metabolism





CTD time series

