Measuring aquatic ecosystem metabolism in the southern Everglades

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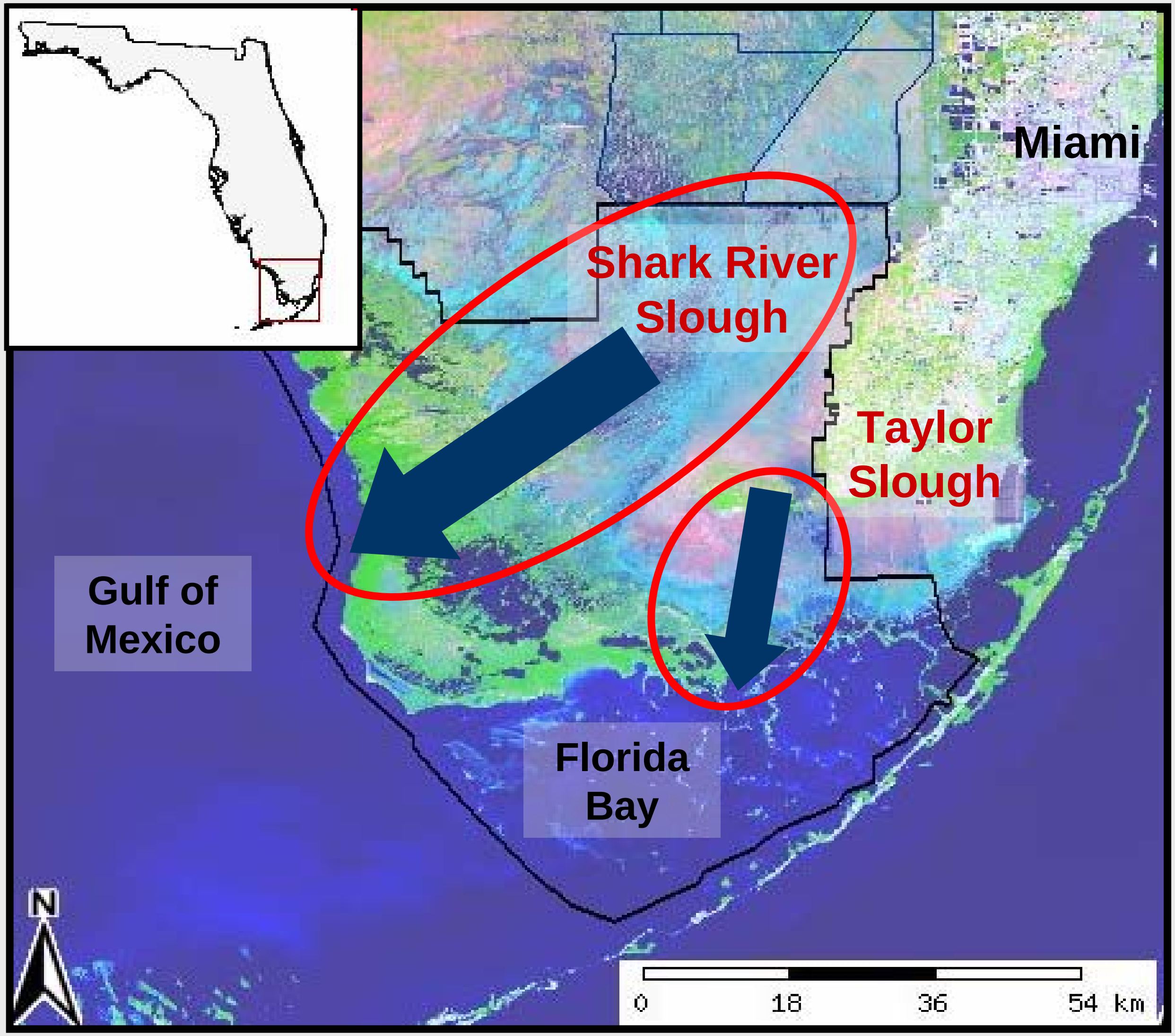
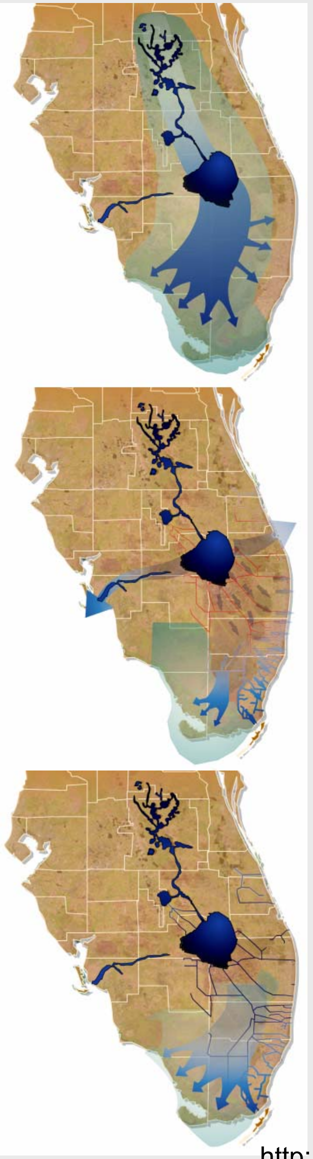
Everglades National Park



http://fcelter.fiu.edu/data/GIS/interactive_map/



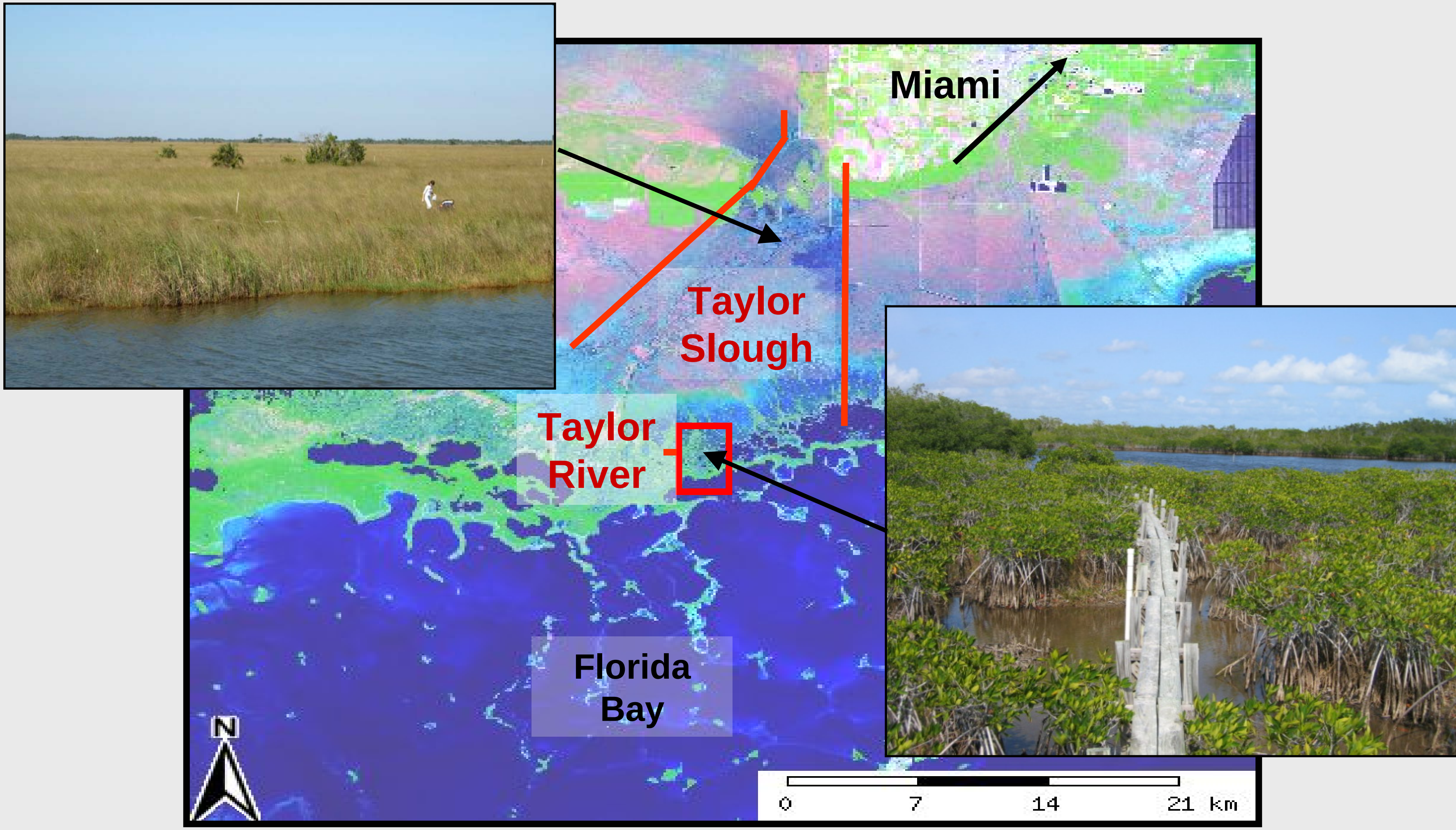
Historic Flow

Current Flow

Planned Flow

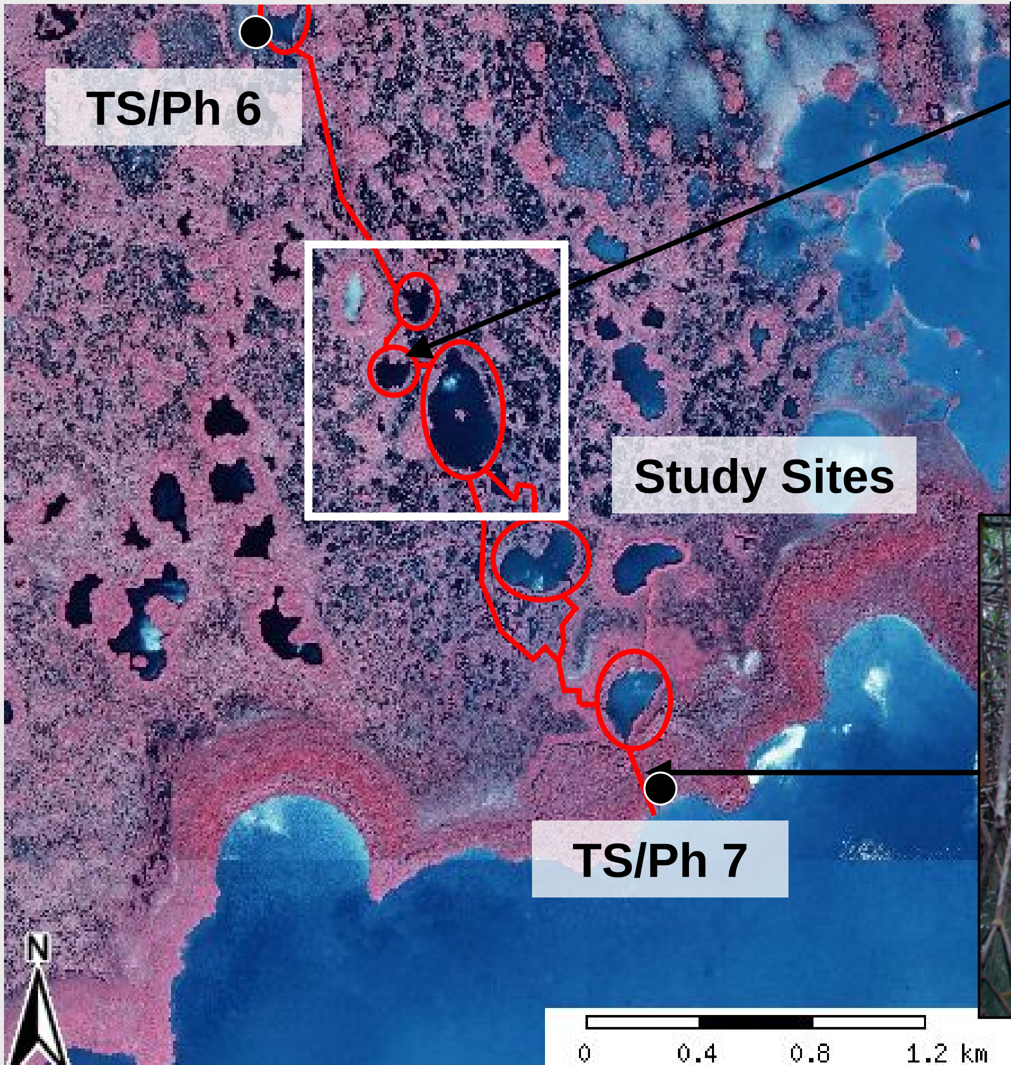
http://www.evergladesplan.org

The Taylor Slough Watershed



Photos: http://fcelter.fiu.edu/about_us/photos/
Map: http://fcelter.fiu.edu/data/GIS/interactive_map/

Taylor River

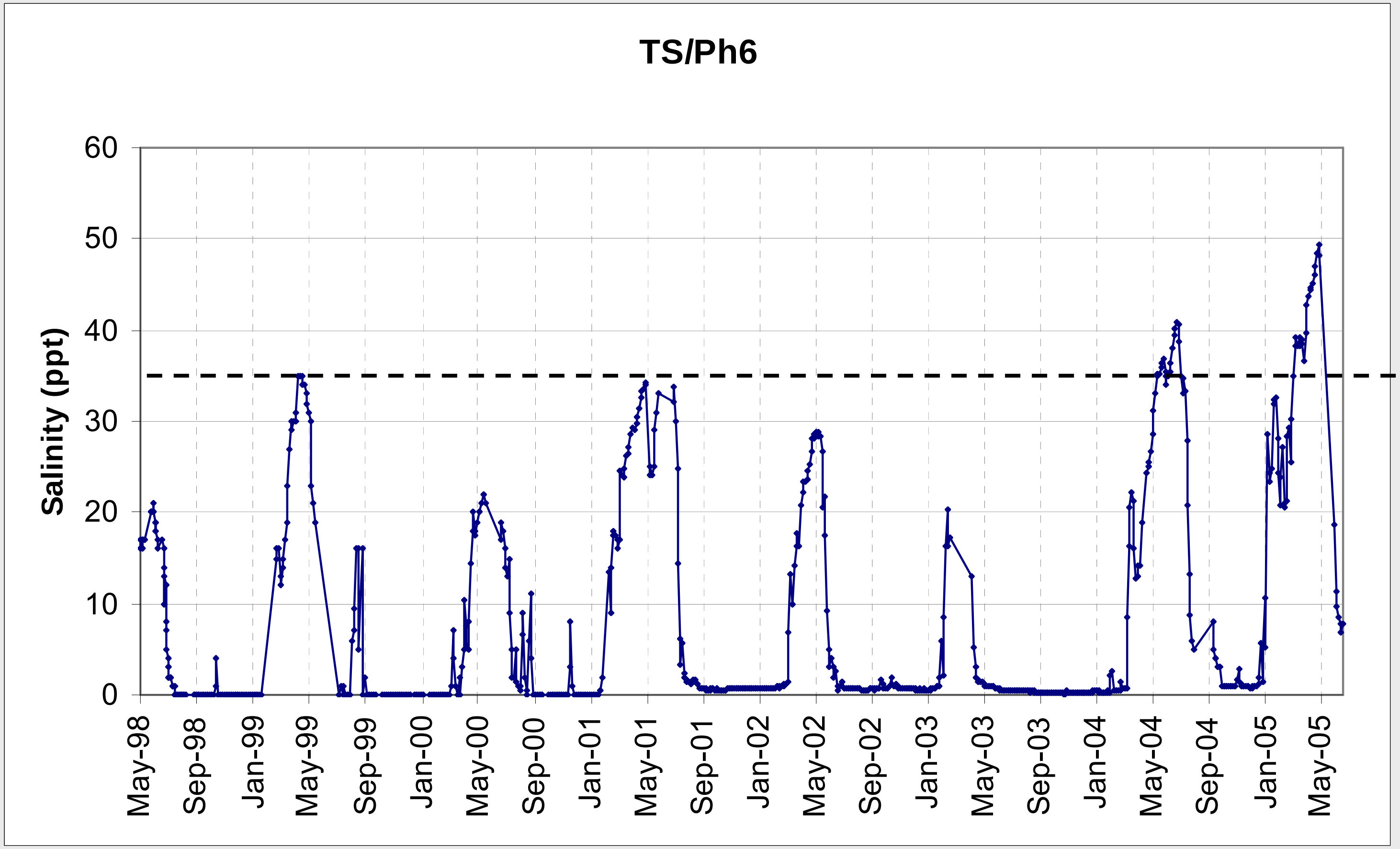


http://fcelter.fiu.edu/data/GIS/interactive_map/

Photo by Steven Davis

http://fcelter.fiu.edu/about_us/photos/

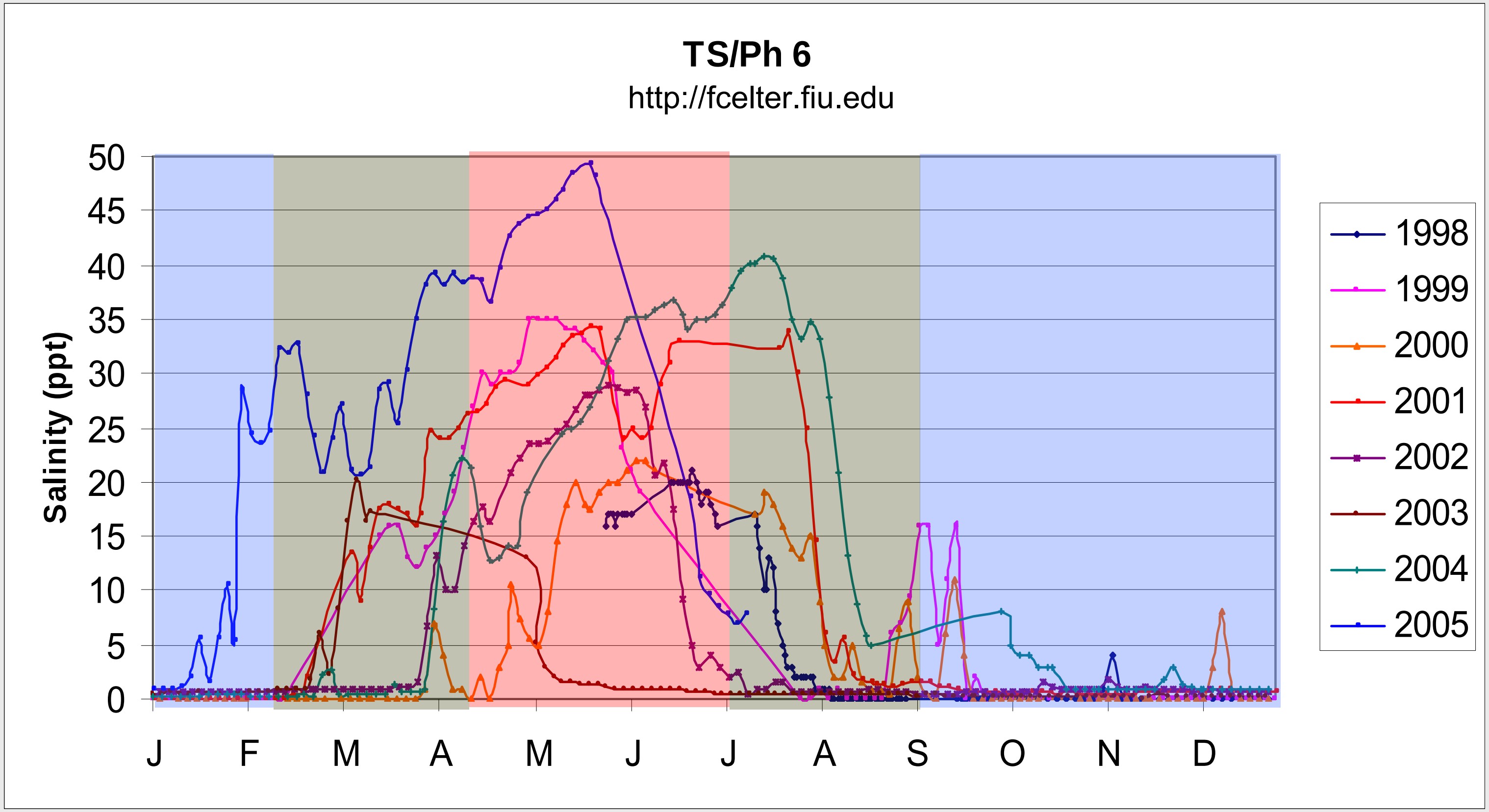
Taylor River Seasonality



Full-strength Seawater ~35ppt

http://fcelter.fiu.edu

Taylor River Seasonality

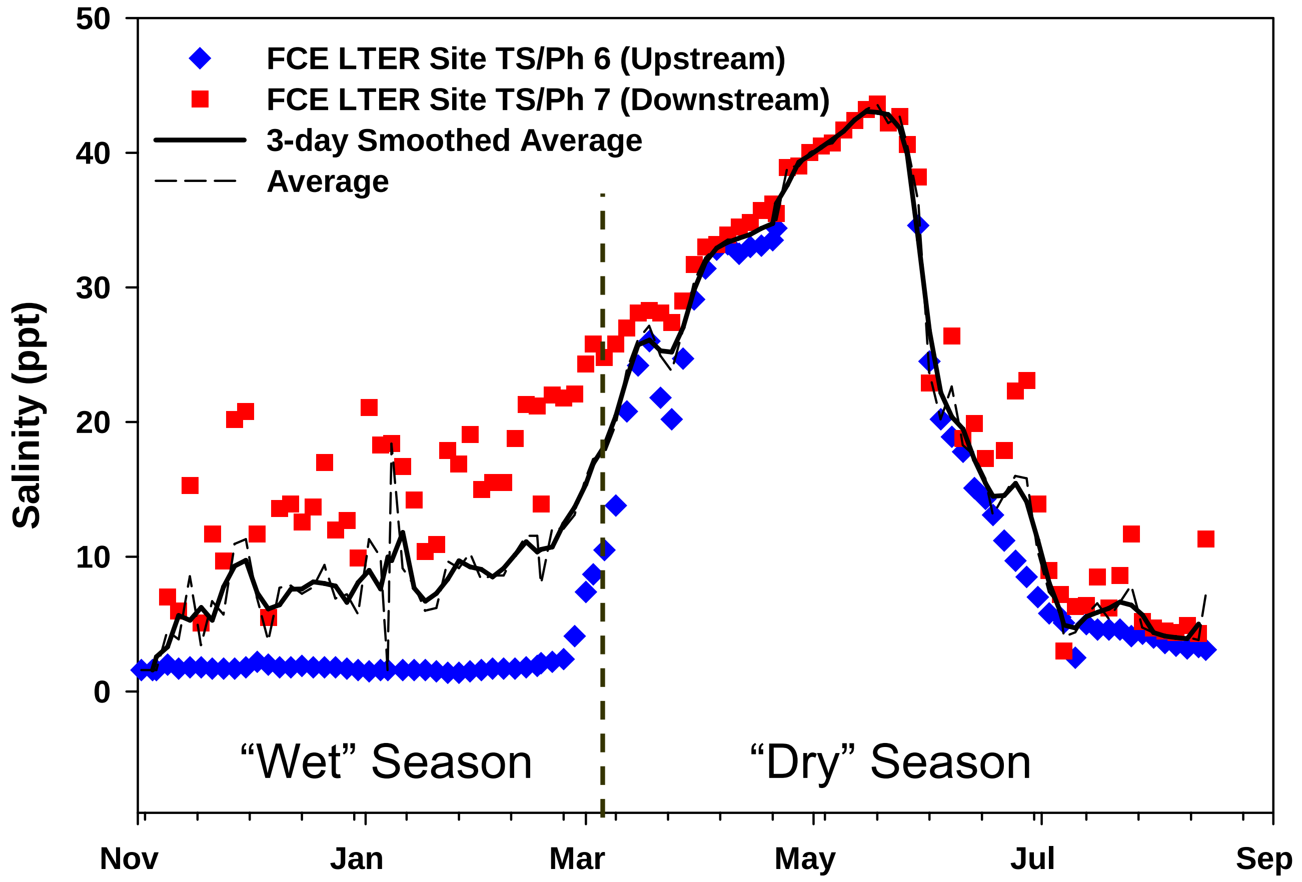


Blue – Oligohaline "Wet" Season – September to February

Red – Euhaline "Dry" Season – March to August

Taylor River Seasonality

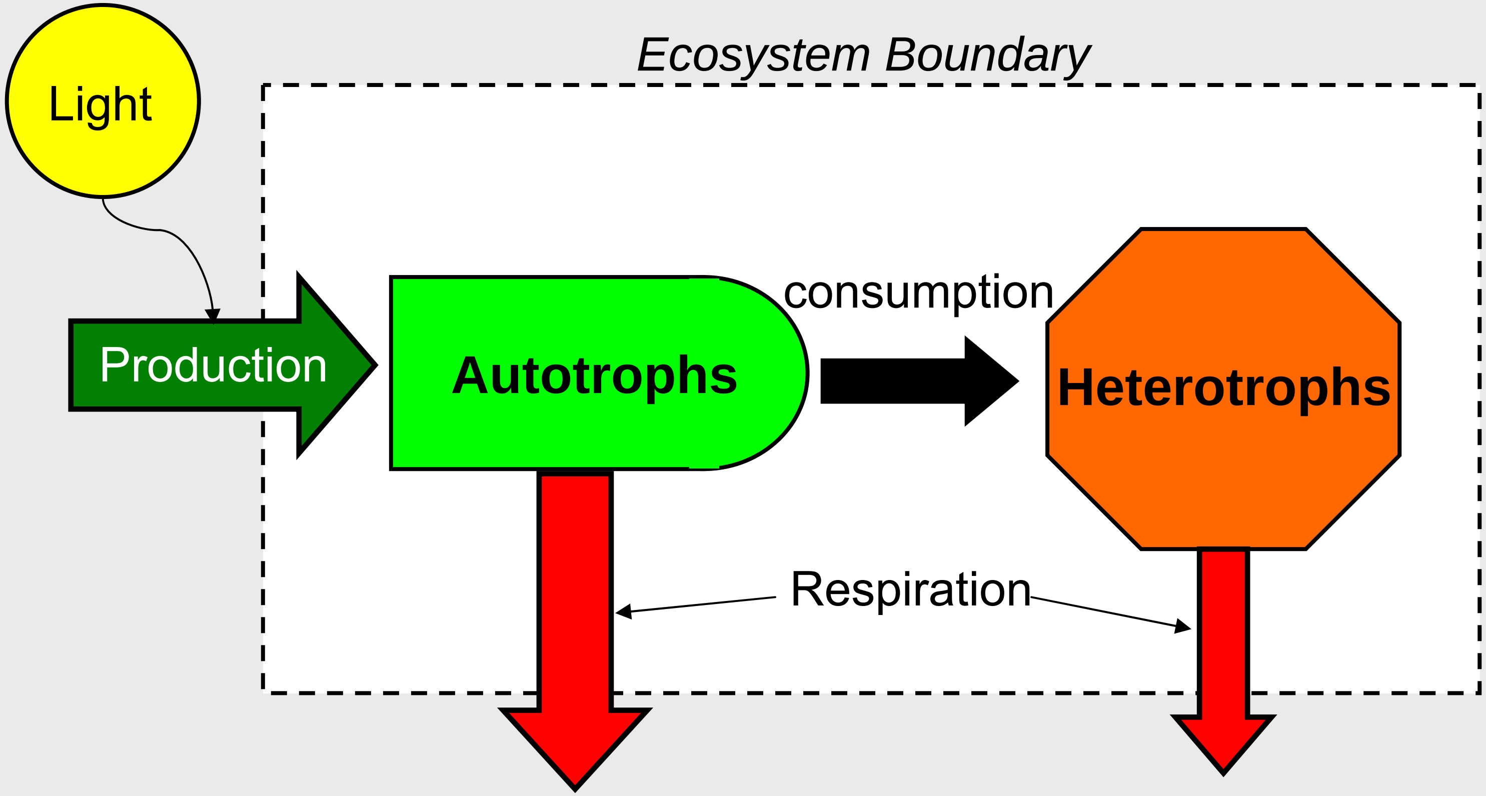
2008 - 2009



What is ecosystem metabolism?

- **<u>metabolism</u>**: ***the sum of all chemical changes in living cells by which energy is provided for vital processes and activities and new material is assimilated*** (Merriam-Webster Dictionary)

- **In Ecosystems: the biological activity of all living organisms within the ecosystem boundary; generally, <u>primary production</u> and <u>respiration</u>**



What does ecosystem metabolism tell us?

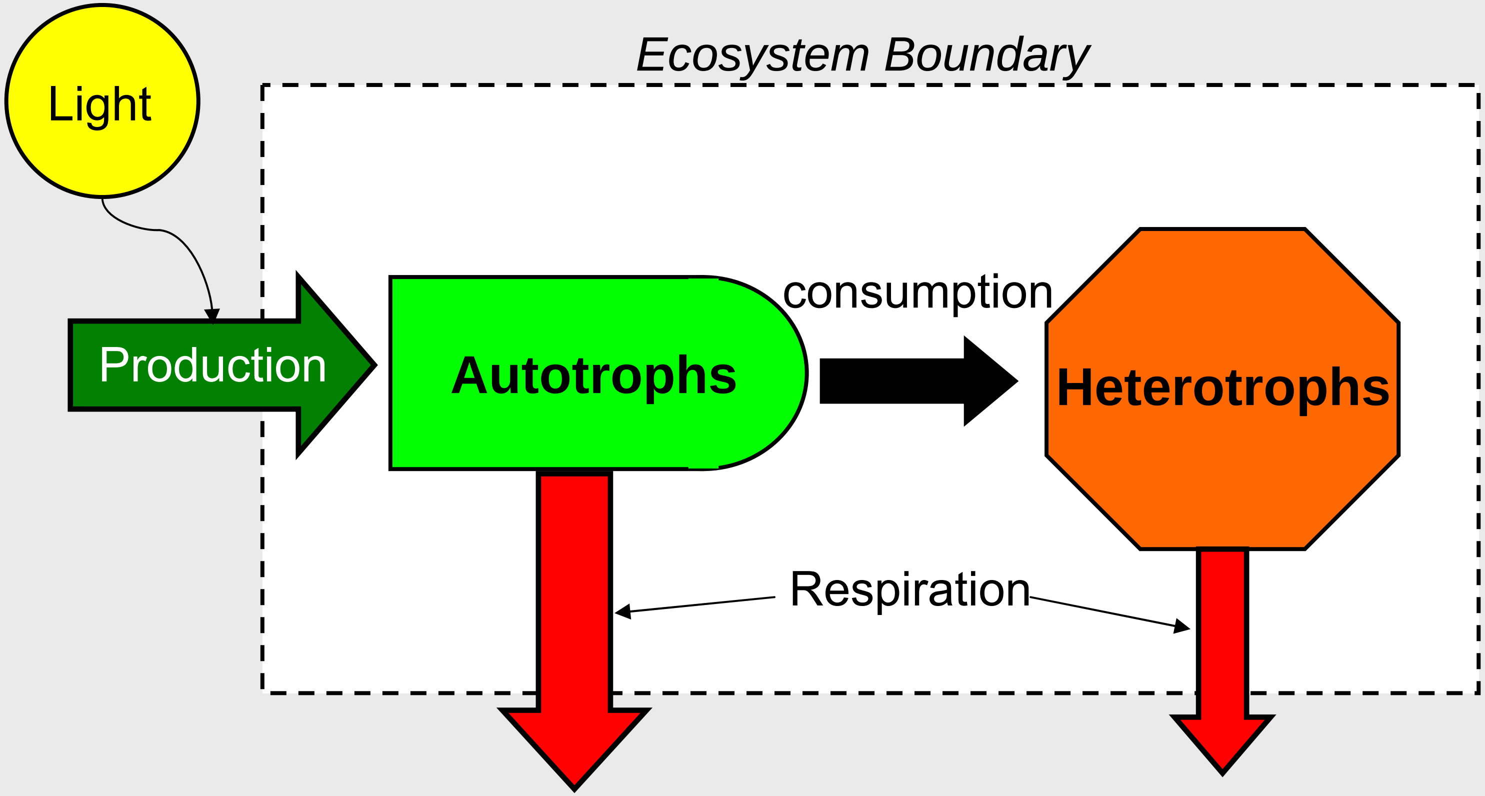
The balance of carbon between the ecosystem and its surroundings:

Gross Primary Production (GPP)

Ecosystem Respiration (R)

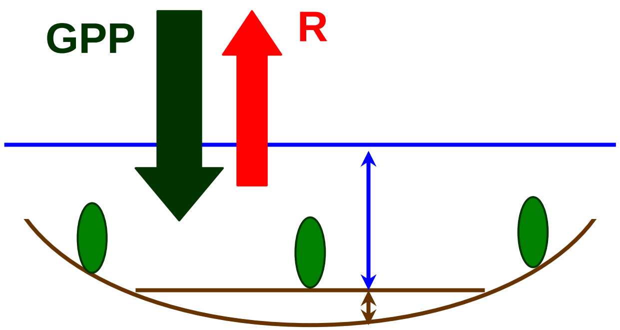
Net Ecosystem Production (NEP)

NEP = GPP - R



How does metabolism change with time?

Oligohaline "Wet" Season



+ Low Salinity

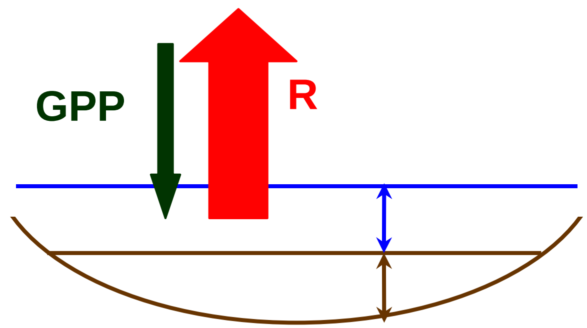
+ Submerged Aquatic Vegetation (SAV)

+ High Water Depth

+ Low Sediment Depth

= Higher GPP, Lower R

Euhaline "Dry" Season



+ High Salinity

+ No SAV

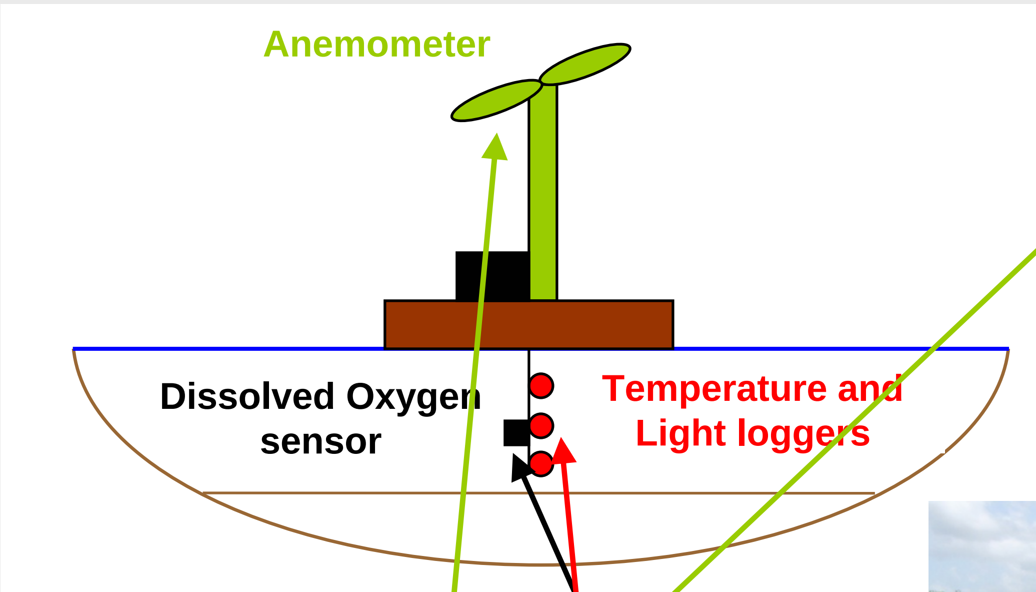
+ Low Water Depth

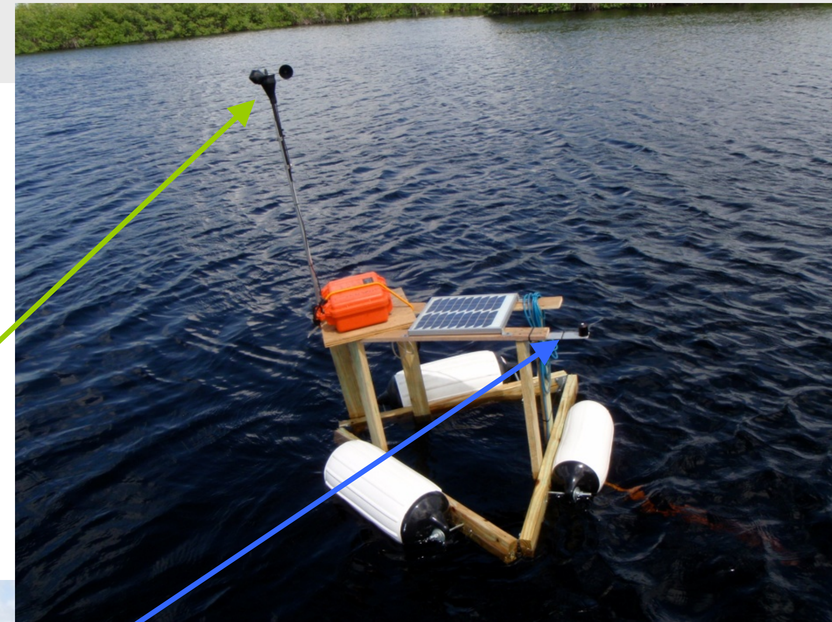
+ High Sediment Depth

= Lower GPP, Higher R

Calculating Metabolism

Floating Buoy Design



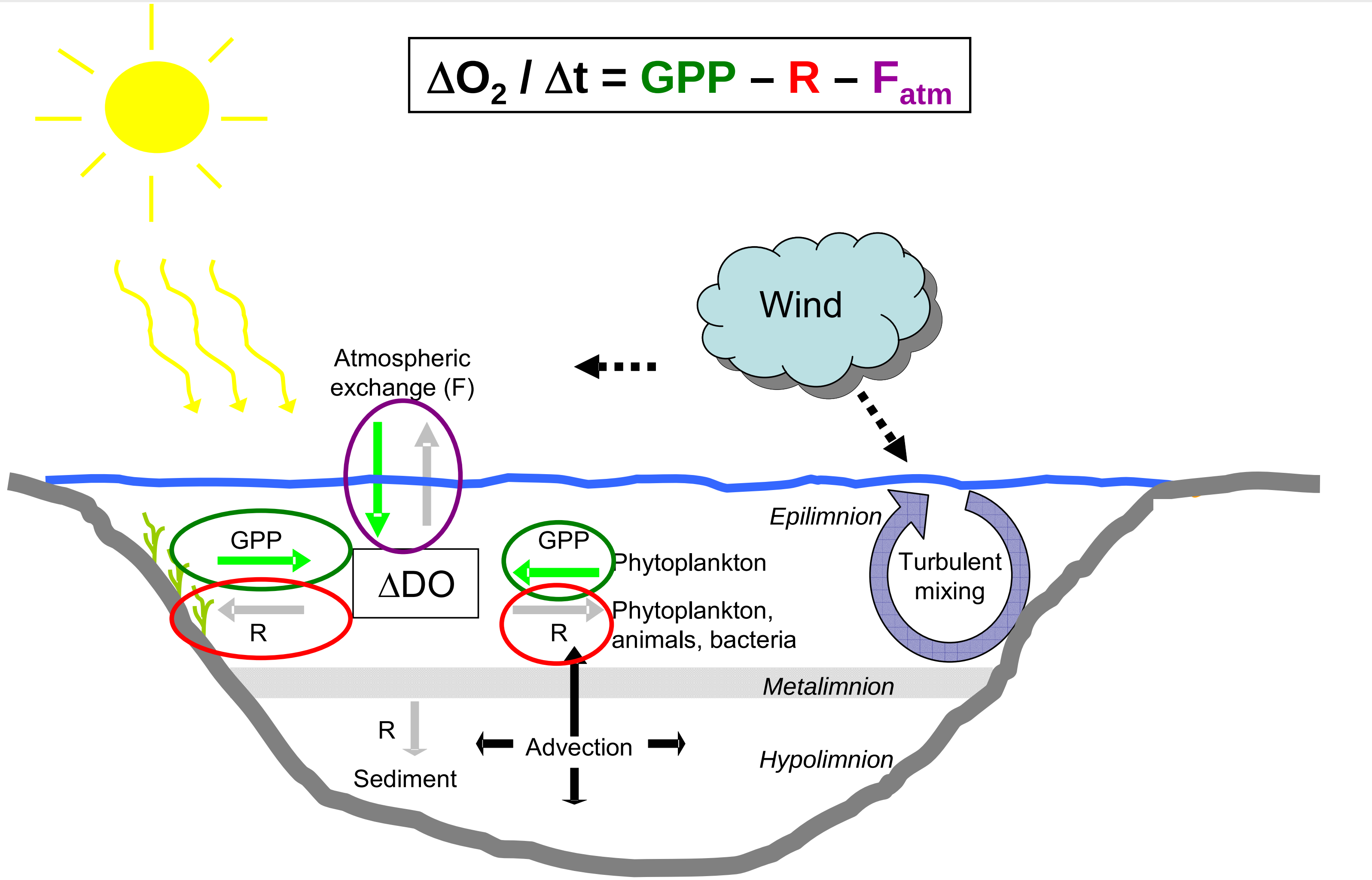


Variables Measured

% Dissolved Oxygen
Wind Speed
Water Temperature
Underwater Light
Surface Light

Calculating Metabolism

$$\Delta O_2 / \Delta t = GPP - R - F_{atm}$$



Staehr, P.A., C.E. Williamson, M.C. Van de Bogert, T.K. Kratz, G.R. Koch, P.C. Hanson, J.J. Cole, D.L. Bade. *In Prep*.

Calculating Metabolism

$$\Delta O_2 / \Delta t = GPP - R - F_{atm}$$

$$F_{atm}\ (gO_2\ m^{-2}\ h^{-1}) = k\ (O_2meas - O_2sat)$$

$$k\ (cm\ h^{-1}) = k_{600}(Sc/600)^{-0.5}$$

$$k_{600}\ (cm\ h^{-1}) = 2.07 + 0.215(wind_{10m})^{1.7}$$

$$Sc = 0.0476(T)^3 + 3.7818(T)^2 - 120.1(T) + 1800.6$$

$$wind_{10m} = wind_z\ (1.4125\ (z^{-0.15}))$$

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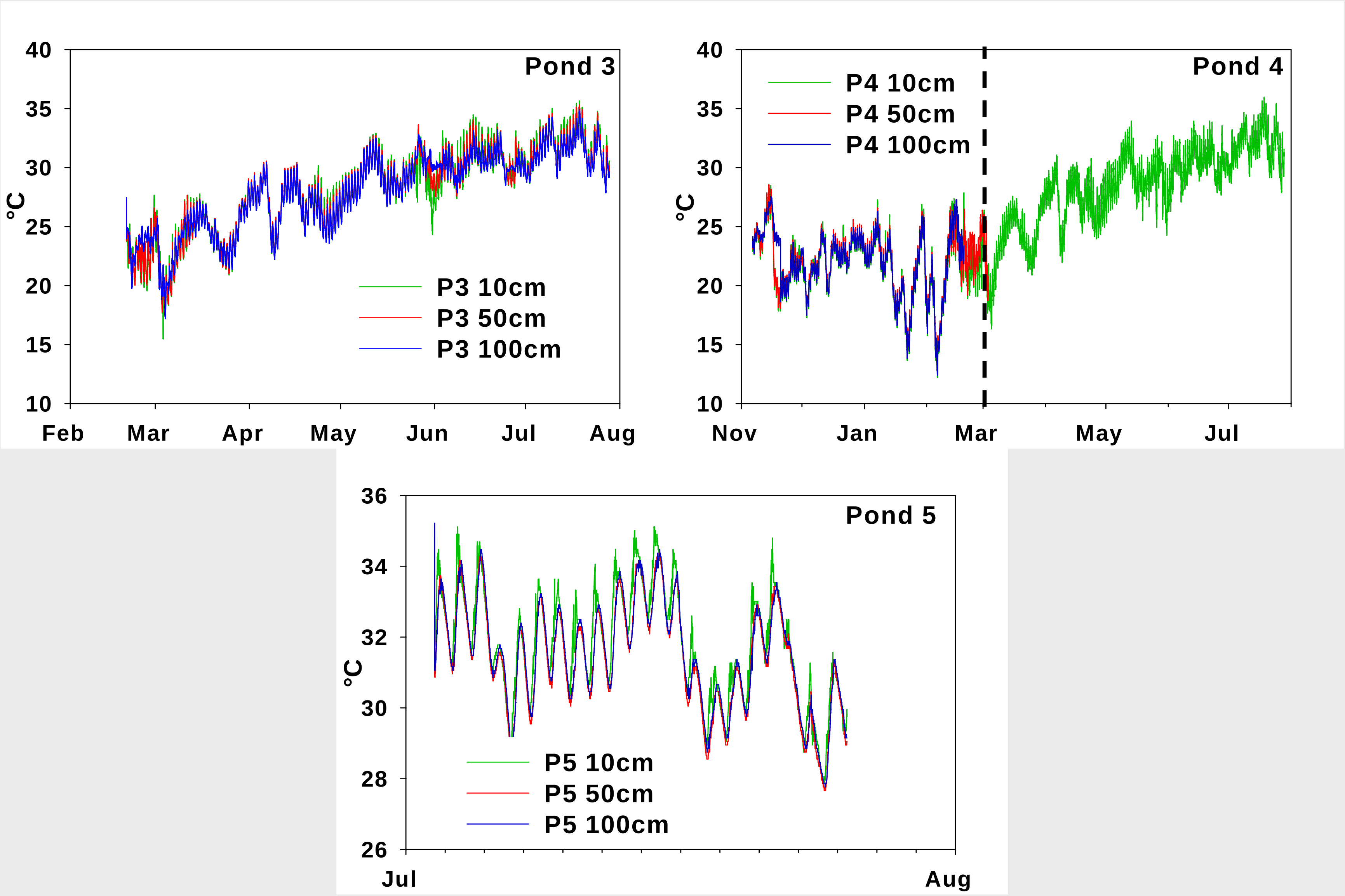
Jähne, B., O. Münnich, R. Bösinger, A. Dutzi, W. Huber, and P. Libner. 1987. *Journal of Geophysical Research* 92: 1937-1949.

Cole, J.J. and N.F. Caraco. 1998. *Bioscience* 38:764-769.

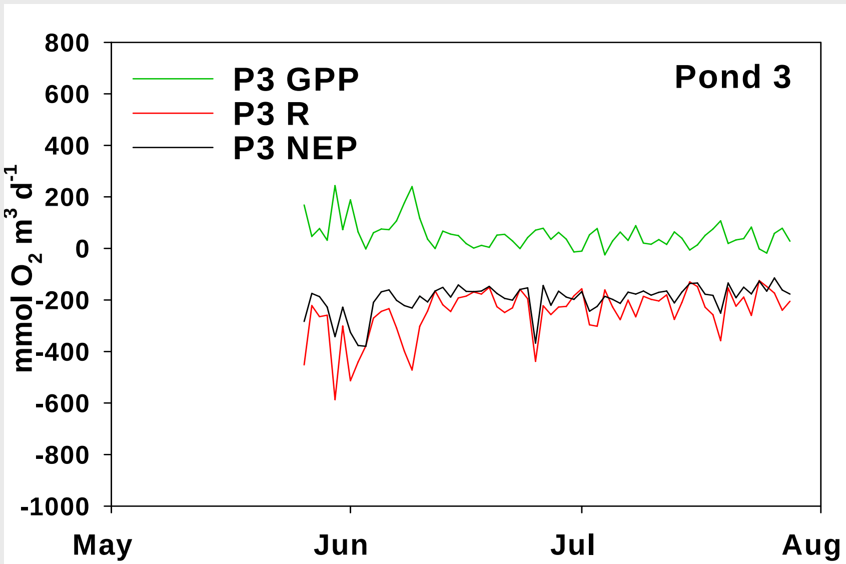
Smith, S.V. 1985. *Plant, Cell, and Environment* 8: 387-398.

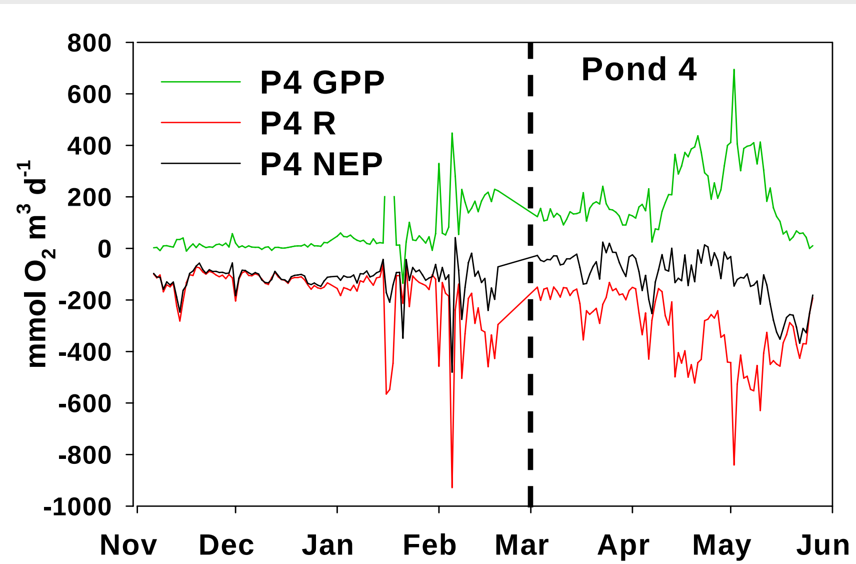
Wanninkhof, R. 1992. *Journal of Geophysical Research* 17: 721-735.

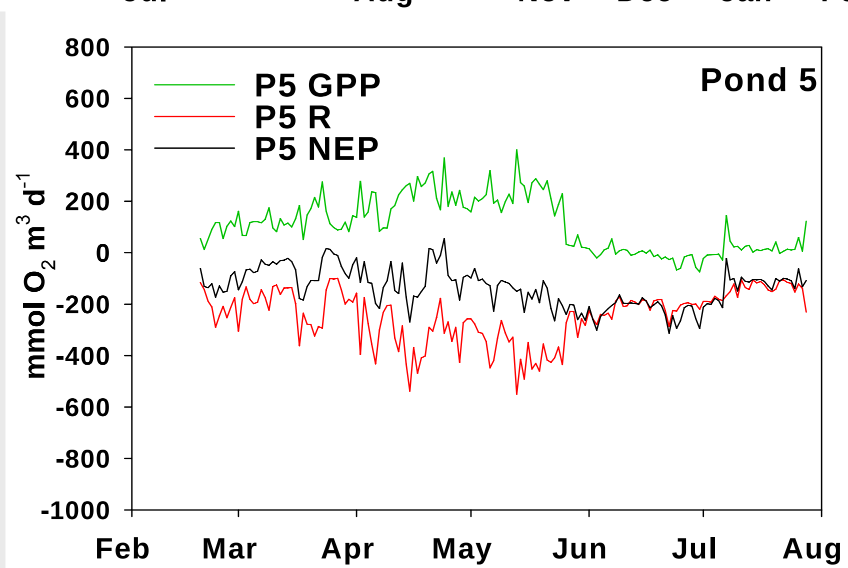
Water Temperature Profiles



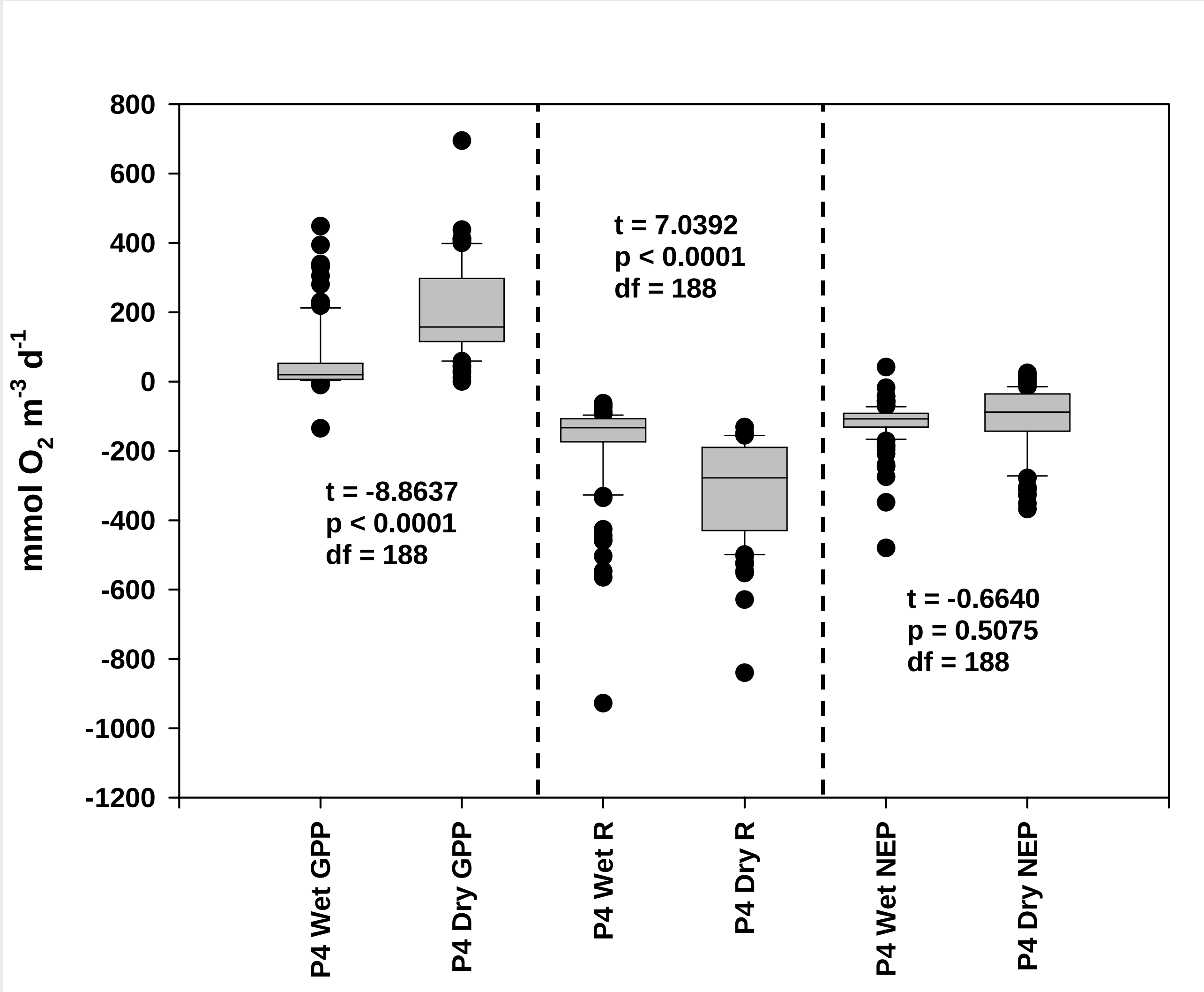
Daily Metabolic Rates



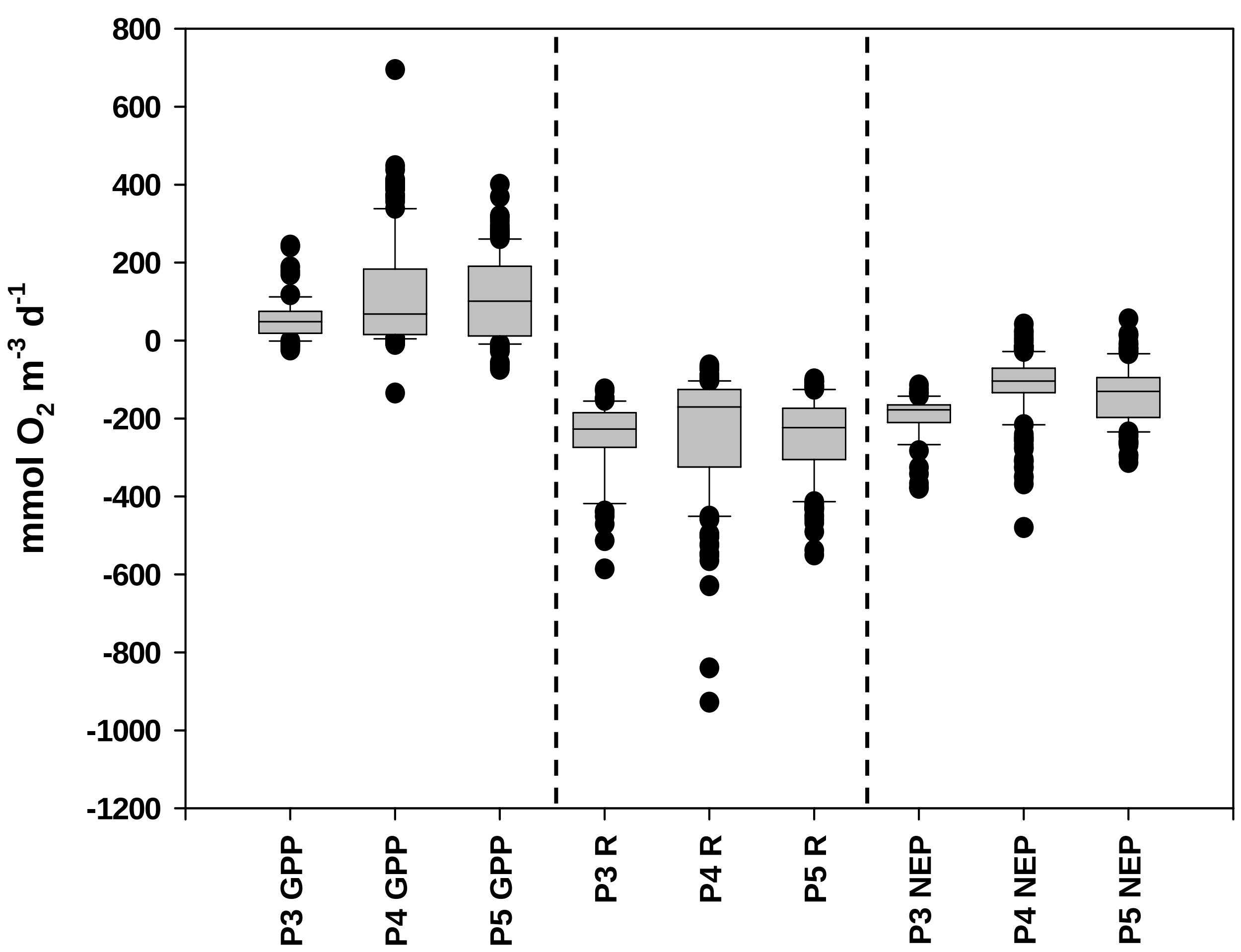




Seasonal Differences



Spatial Differences



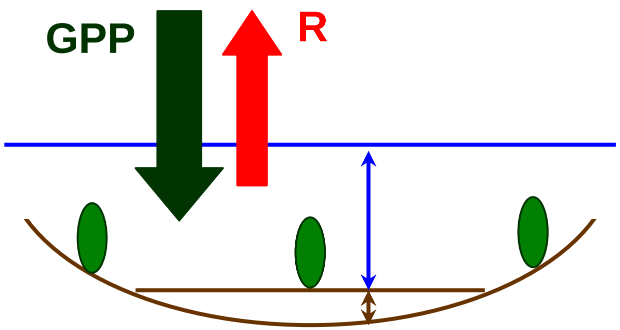
Drivers of Aquatic Production

Green Cells = Significant Positive Correlation
Red Cells = Significant Negative Correlation
$\alpha = 0.05$

	Surface Light	50cm Light	Kd	TP	Temp	Salinity	Wind
Pond 3 GPP	0.268 $p = 0.032$	0.201 $p = 0.111$	-0.155 $p = 0.221$	N/A	-0.302 $p = 0.015$	0.454 $p < 0.001$	-0.010 $p = 0.937$
Pond 4 GPP	0.595 $p < 0.001$	0.081 $p = 0.409$	-0.099 $p = 0.367$	0.007 $p = 0.967$	0.365 $p < 0.001$	0.572 $p < 0.001$	0.235 $p = 0.001$
Pond 5 GPP	0.314 $p < 0.001$	-0.353 $p = 0.107$	-0.429 $p < 0.052$	N/A	-0.414 $p < 0.001$	0.746 $p < 0.001$	0.517 $p < 0.001$

Our Predictions…

Oligohaline "Wet" Season



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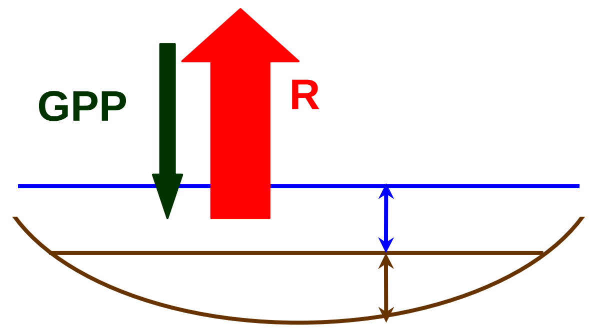
Euhaline "Dry" Season



\+ High Salinity

\+ No SAV

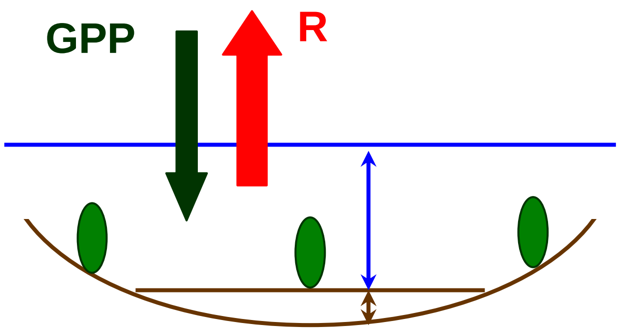
\+ Low Water Depth

\+ High Sediment Depth

= Lower GPP, Higher R

So, What Really Happened?

Oligohaline "Wet" Season



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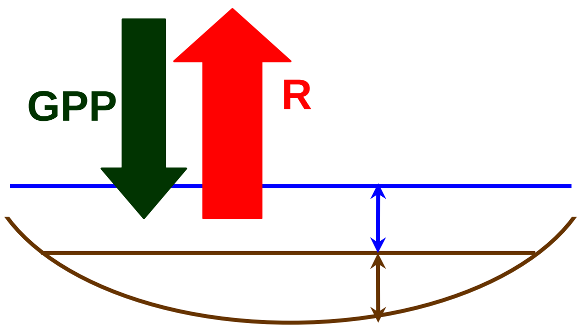

+ High Salinity

+ No SAV

+ High TP??

+ Low Water Depth

+ High Sediment Depth

= Higher GPP, Higher R

Directions of New Research

- **Expand spatial and temporal breadth of data**
- **Explore the relationship between stimulated GPP and responses in R**
    - **additions of algal extracts onto pond sediments (“priming”)**
- **Time series analysis to explore time lags**
- **Investigate the meaning of metabolic throughput in terms of ecosystem function**
- **Floc transport rates between ponds**
- **Carbon budgets and landscape metabolism estimates for Taylor River**