Seasonal variation in stream metabolism in shaded and unshaded sand dominated streams of the southeastern Louisiana coastal plain

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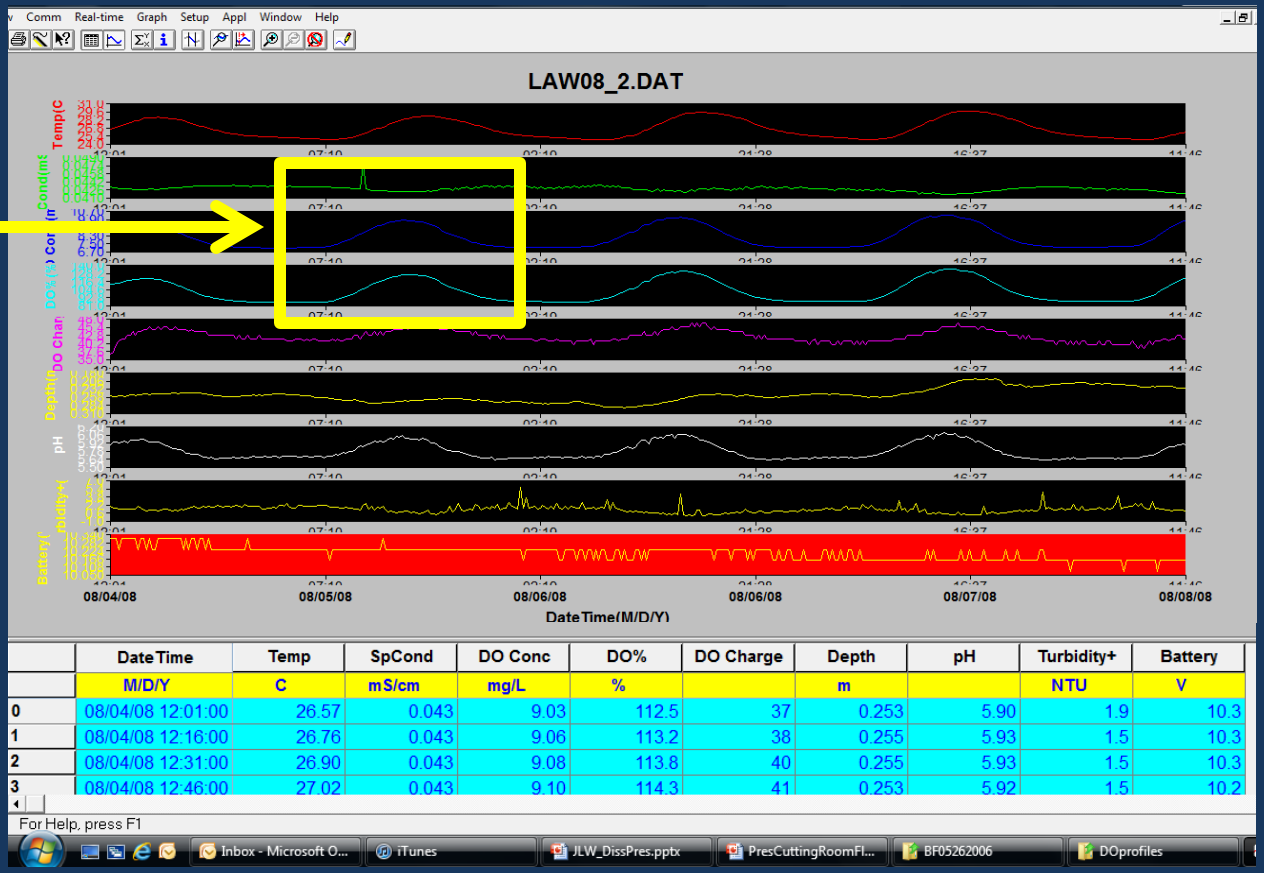
Stream Ecosystem Metabolism

- Made up of two components:
- Gross Primary Production (GPP) usually carried out by algae or macrophytes
  - Controlled by light; stimulated by nutrients
  - Reduced by herbivory, shading
- Ecosystem Respiration (ER)
  - Heterotrophic bacteria, and other organisms including autotrophs
  - Limited by temperature; stimulated by organic matter input
- Much discussion as a metric of stream health

Calculating Metabolism

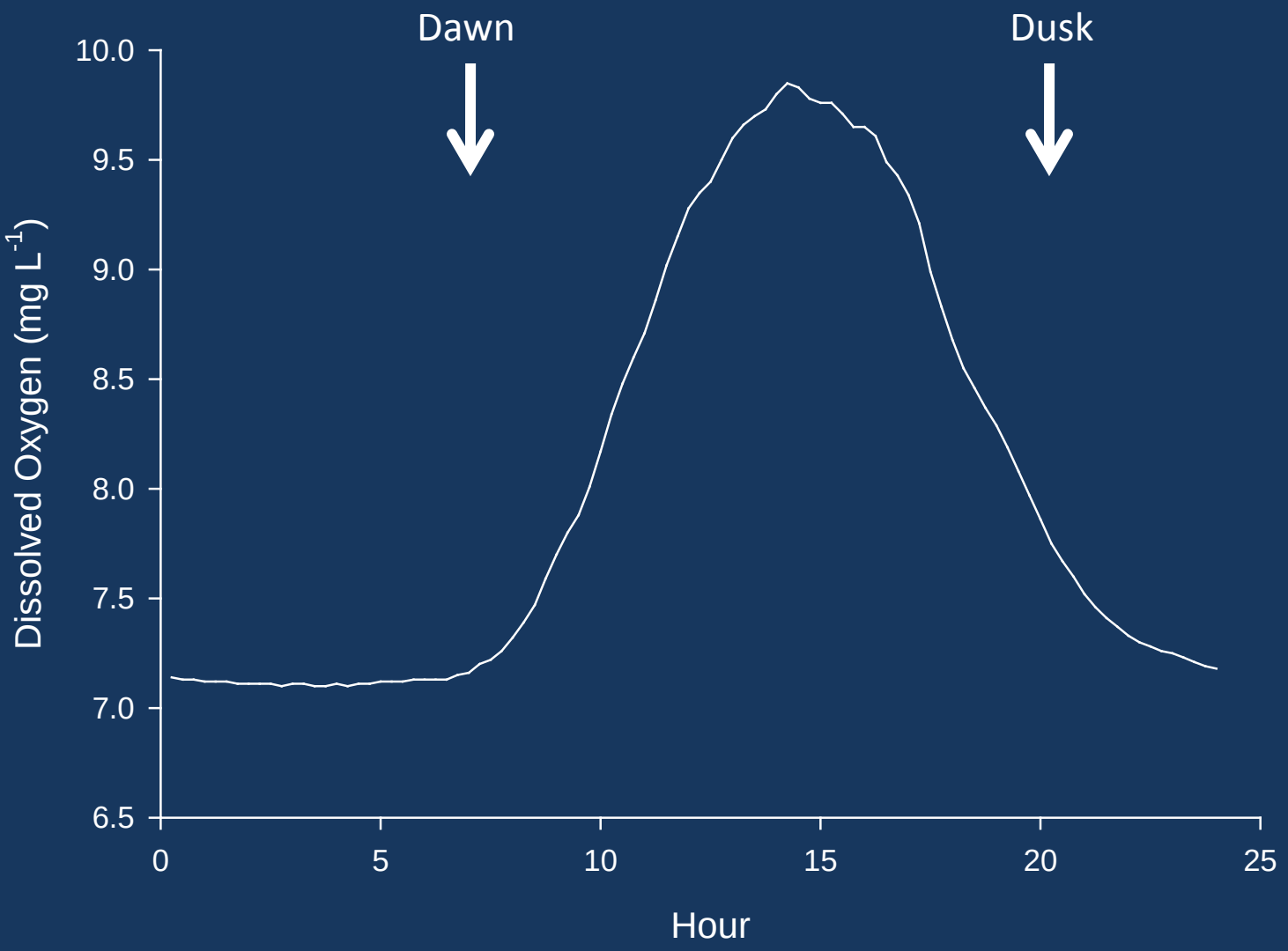
- $\Delta DO = GPP + ER + E$
  - Where E is the exchange of O_2 with the atmosphere and is a product of the reaeration coefficient (K) and the difference between DO at saturation and ambient DO
  - $\Delta DO = GPP + ER + K(C_s - C)$
- At night one can assume no primary production, thus: $\Delta DO = ER + K(C_s - C)$
- K will vary as a function of stream velocity, turbulence, depth to width ratio, etc

Lawrence Creek
Aug 5, 2008

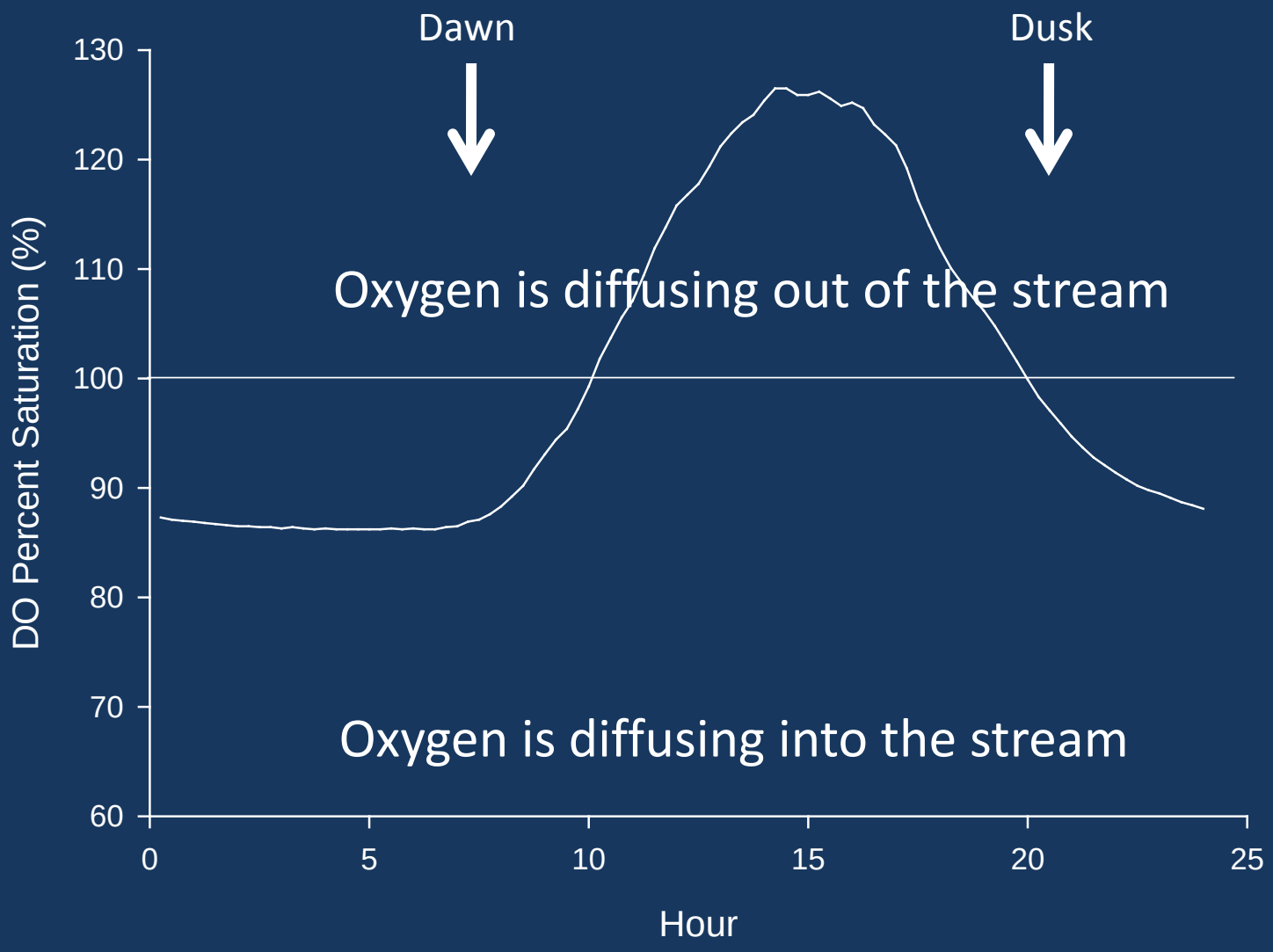


	DateTime	Temp	SpCond	DO Conc	DO%	DO Charge	Depth	pH	Turbidity+	Battery
	M/D/Y	C	mS/cm	mg/L	%		m		NTU	V
0	08/04/08 12:01:00	26.57	0.043	9.03	112.5	37	0.253	5.90	1.9	10.3
1	08/04/08 12:16:00	26.76	0.043	9.06	113.2	38	0.255	5.93	1.5	10.3
2	08/04/08 12:31:00	26.90	0.043	9.08	113.8	40	0.255	5.93	1.5	10.3
3	08/04/08 12:46:00	27.02	0.043	9.10	114.3	41	0.253	5.92	1.5	10.2

Lawrence Creek – Aug. 5, 2008



Lawrence Creek – Aug. 5, 2008



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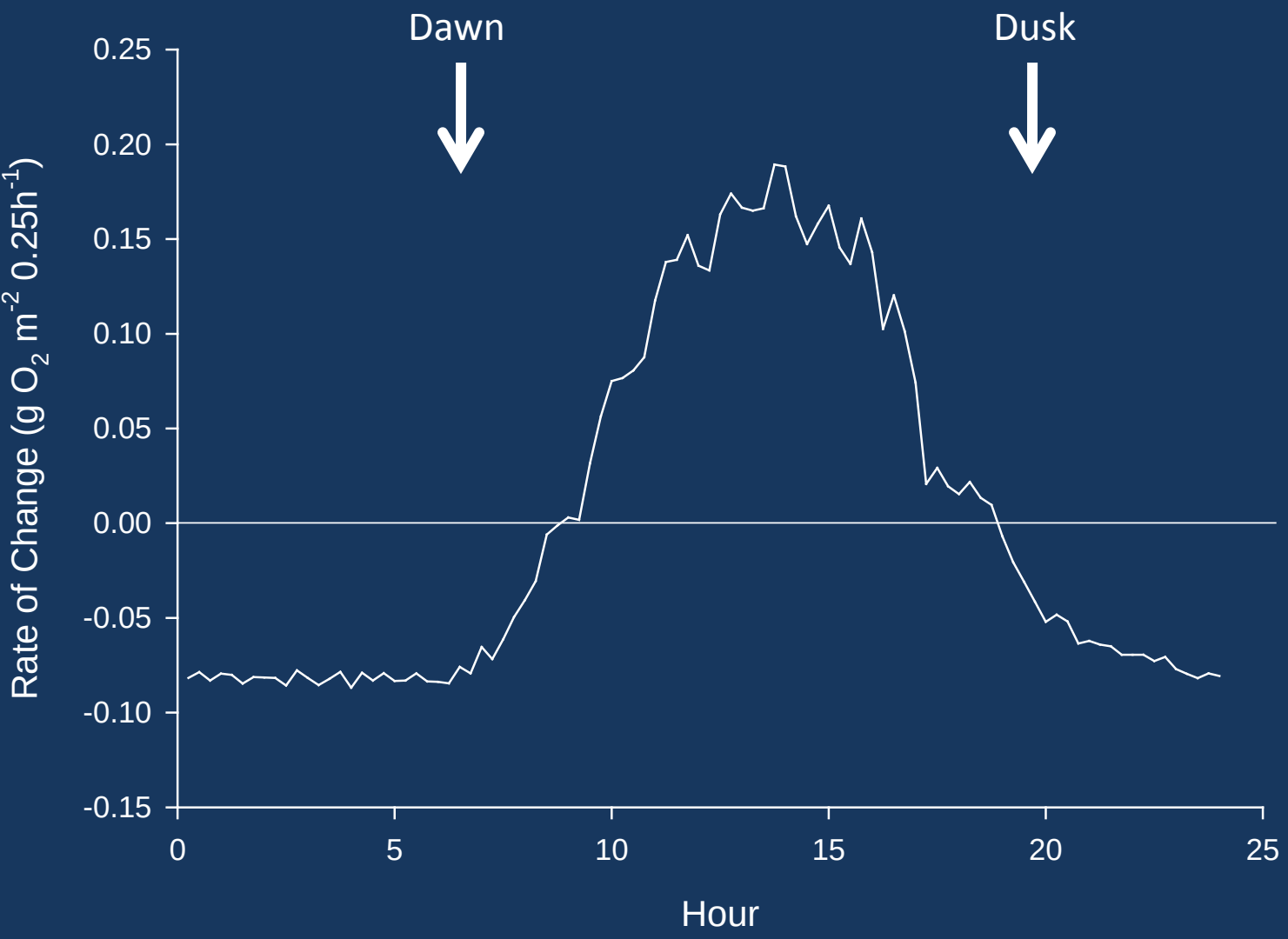
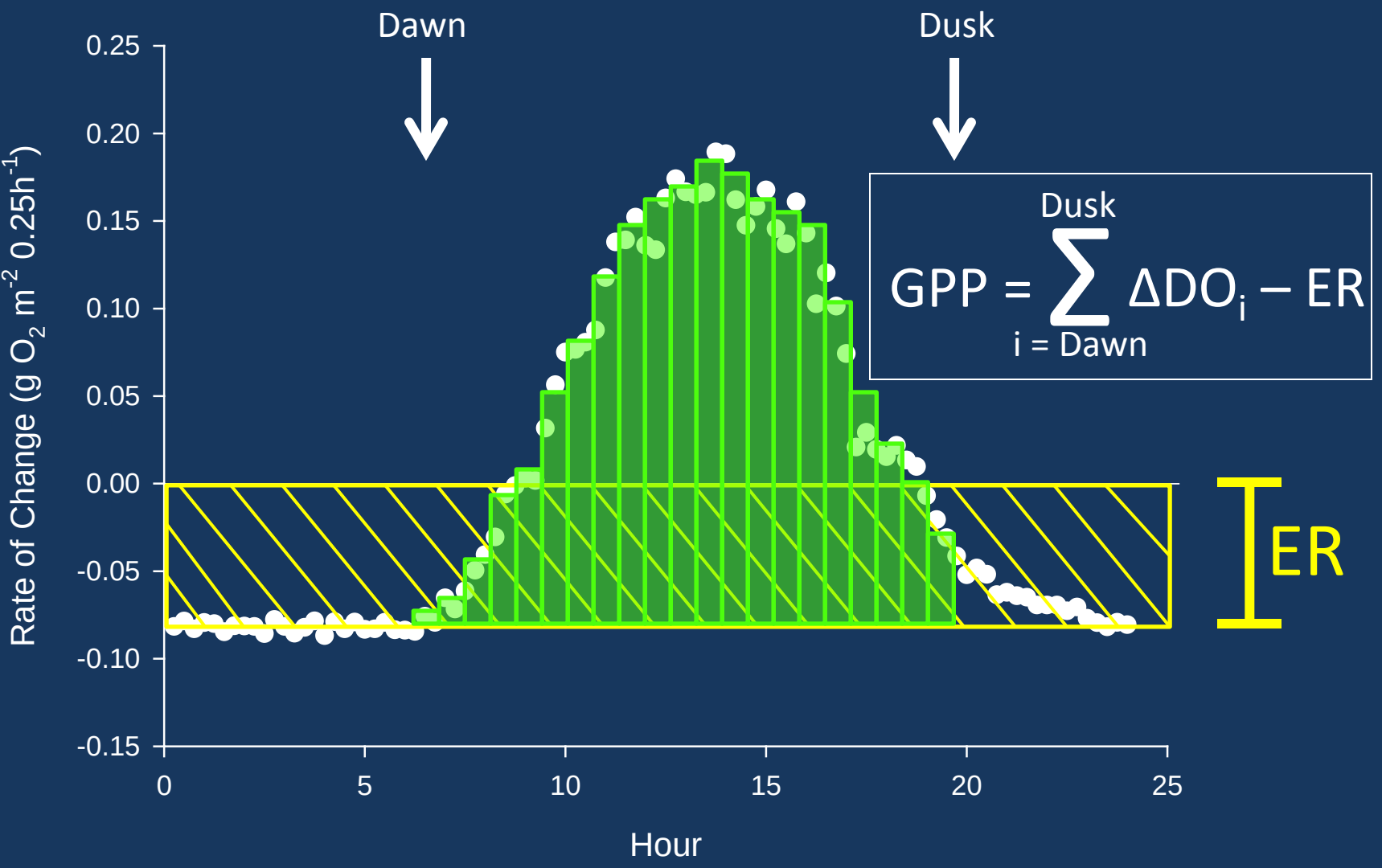


Lawrence Creek – Aug. 5, 2008



Stream Ecosystem Metabolism

- Gives us an idea of the energy flow in a system
  - Net ecosystem production (NEP) = GPP + ER
  - Autotrophic (NEP > 0) or heterotrophic (NEP < 0)

- In general, streams that get a lot of sunlight are usually autotrophic

- Streams that are heavily shaded, are usually heterotrophic


Courtesy of Ryan Sponsellor

- Autotrophic
- Lots of sunlight
- Most energy provided by algae (autochthonous)
- Moderate-sized streams (mid-order)

- Heterotrophic
- Very little sunlight
- Energy derived from allochthonous sources
- Usually small headwater streams

Coastal Plain Streams of Louisiana

- Slow moving
- Lots of woody debris
- Sandy sediments

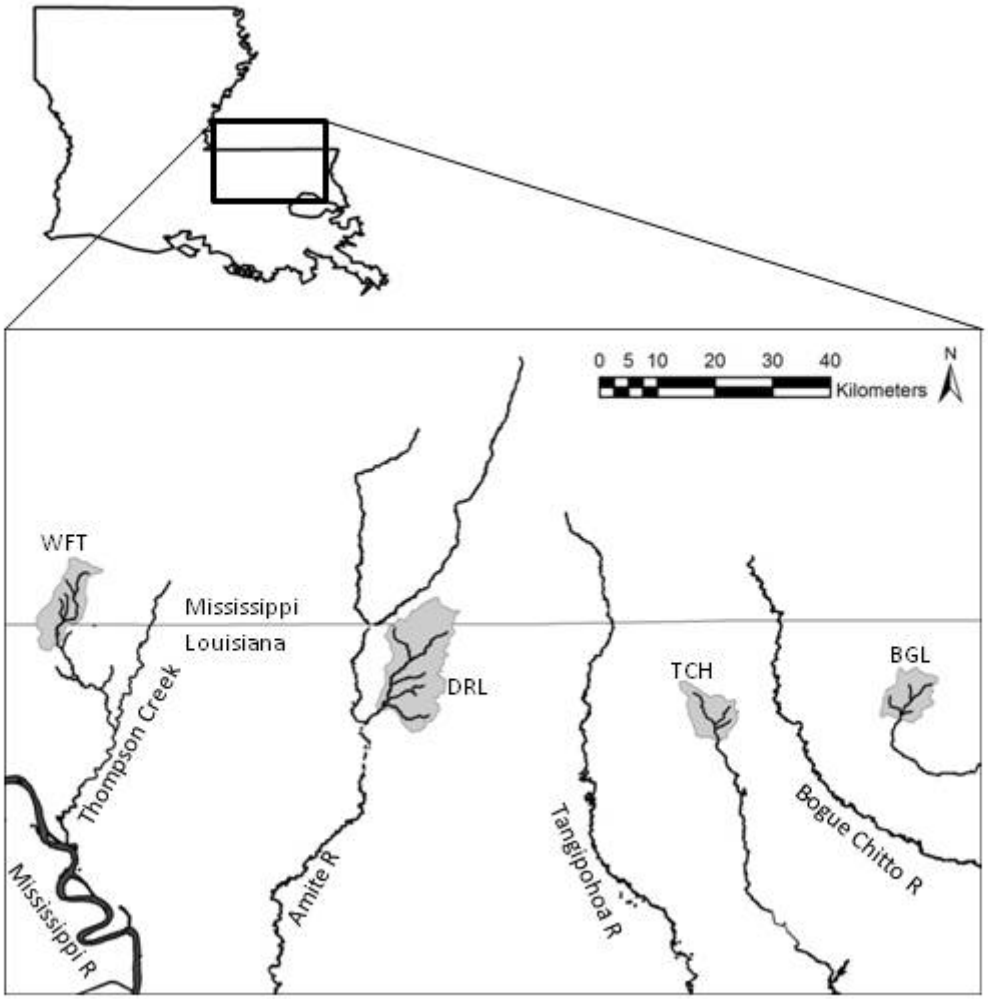
- Some streams (mid-order streams) have a flashy hydrograph that may result in a dynamic system – re-sorting sediments, altering channel, and displacing woody debris and vegetation

- Smaller streams with a shaded canopy

- Slightly larger streams with an unshaded canopy

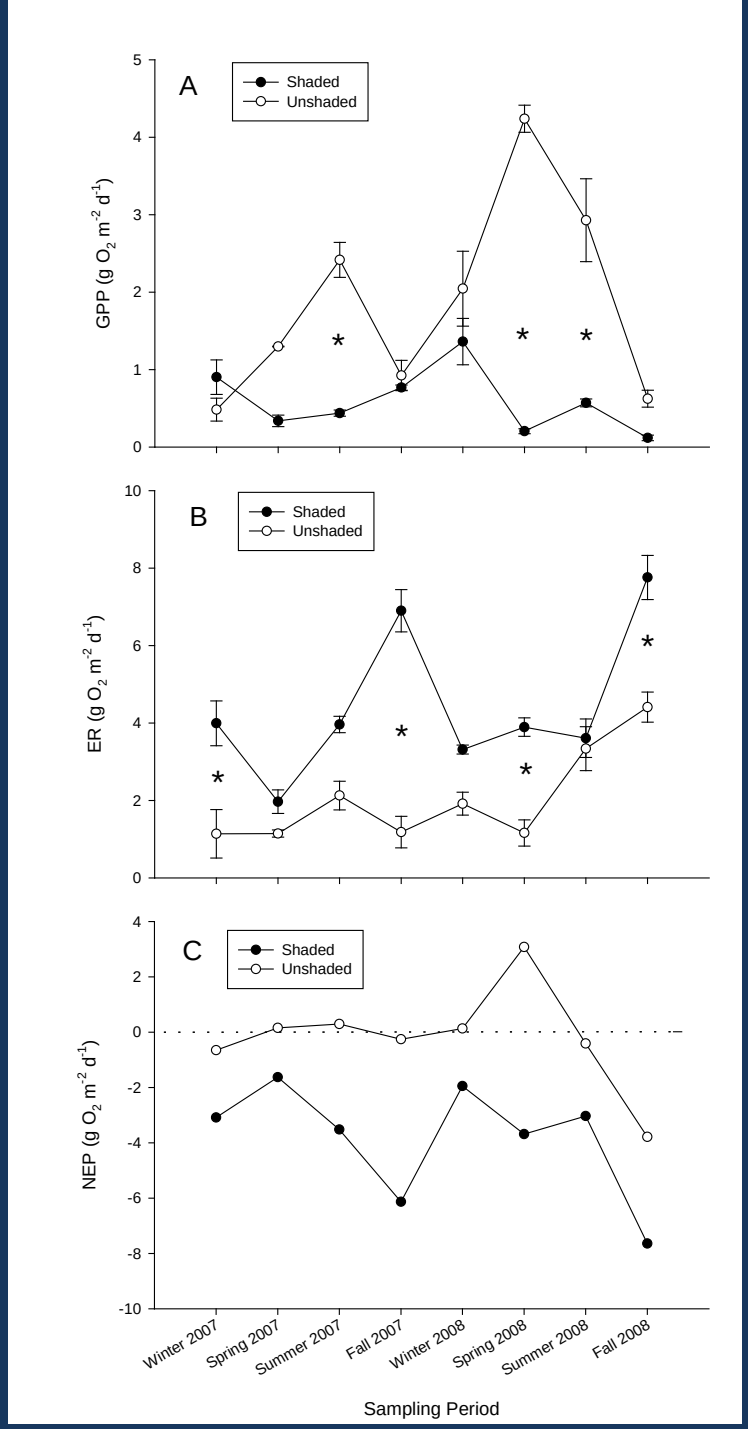
Methods

- Seasonal in 2007 and 2008
- Datasonde recorded DO and temperature for three consecutive days in 4 streams, 2 shaded and 2 unshaded
- Hydrological and physical characteristics along 10 transects upstream datasonde
  - Stream width, depth, velocity, discharge, canopy cover
  - Quantified large woody debris (LWD) via line-transect method
- Organic matter content of sediments
- Photosynthetically Active Radiation (PAR) – above canopy light taken from LSU Ag stations nearest study streams

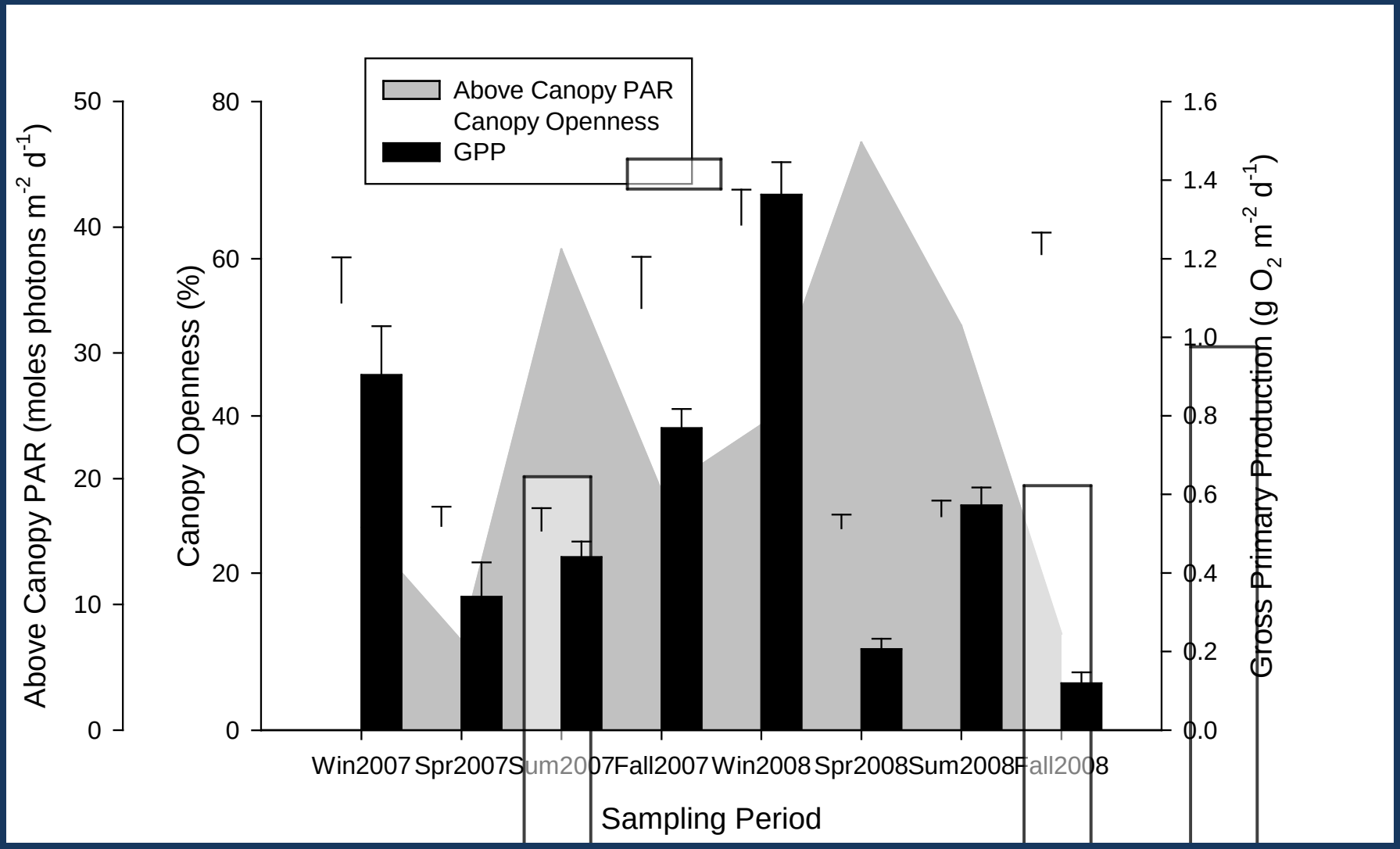

0 5 10 20 30 40
Kilometers
N
WFT
Mississippi
Louisiana
DRL
TCH
BGL
Thompson Creek
Mississippi R
Amite R
Tangipohoa R
Bogue Chitto R

Results

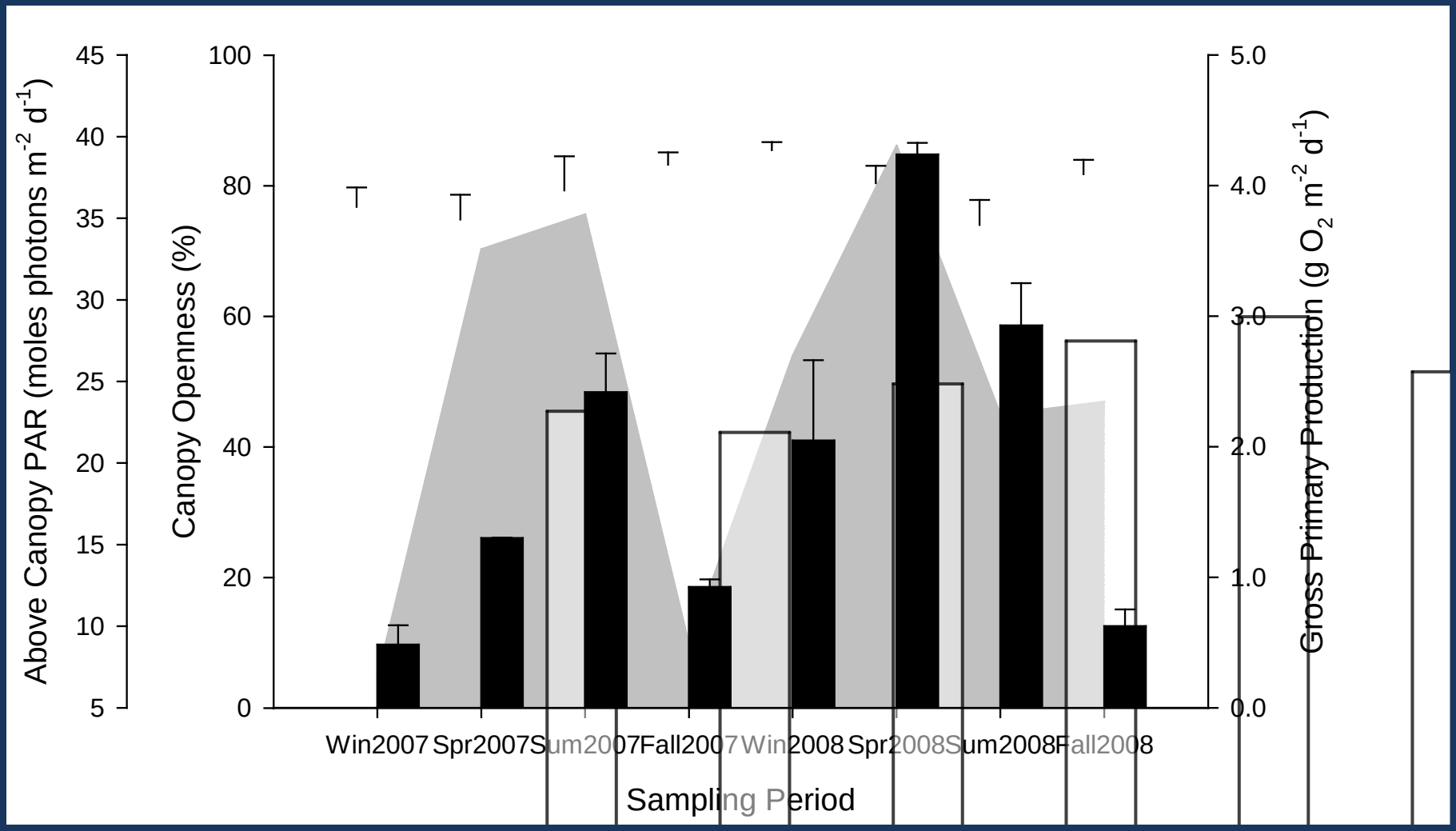
- GPP
- ER
- NEP

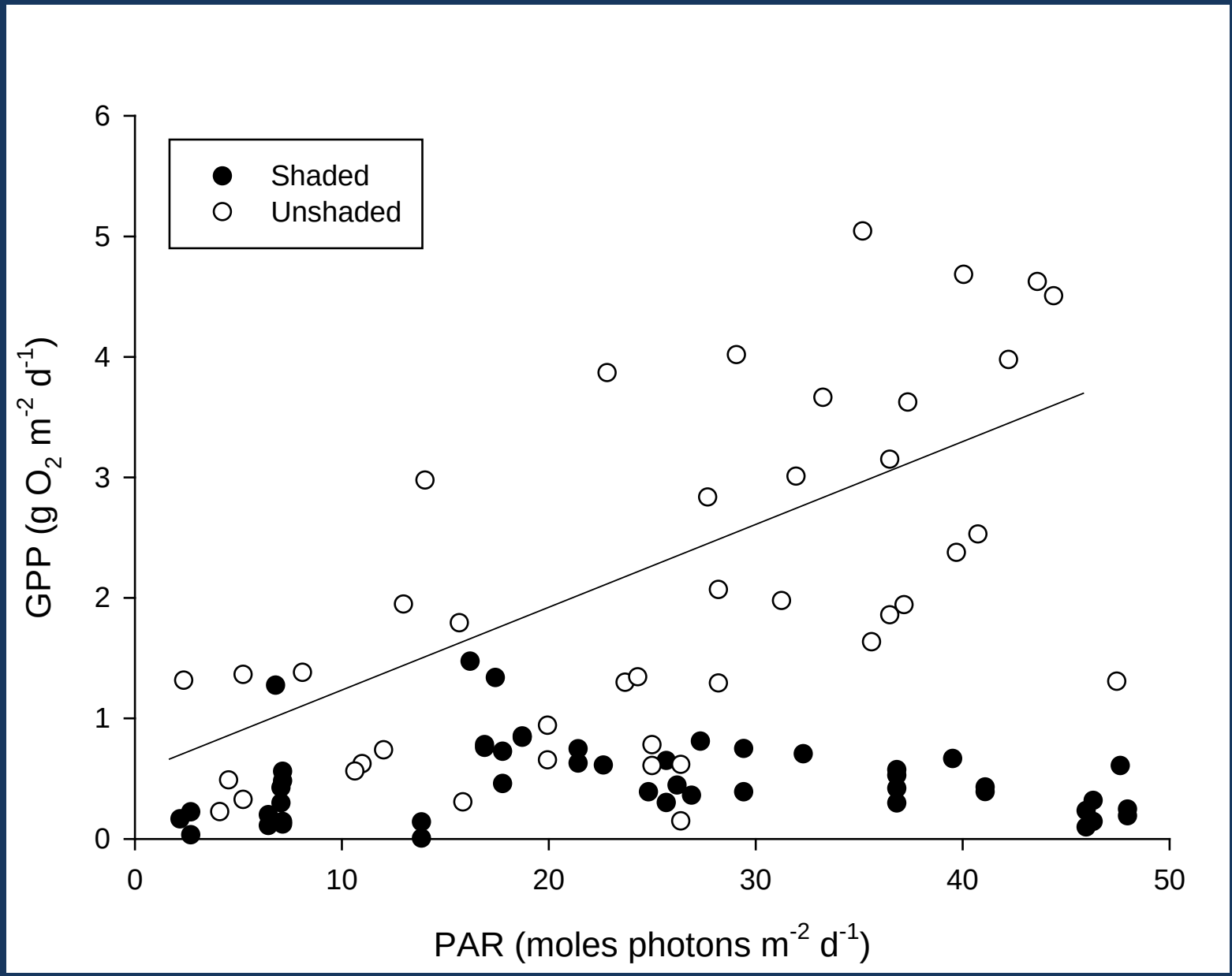


Shaded Streams:



Unshaded Streams:

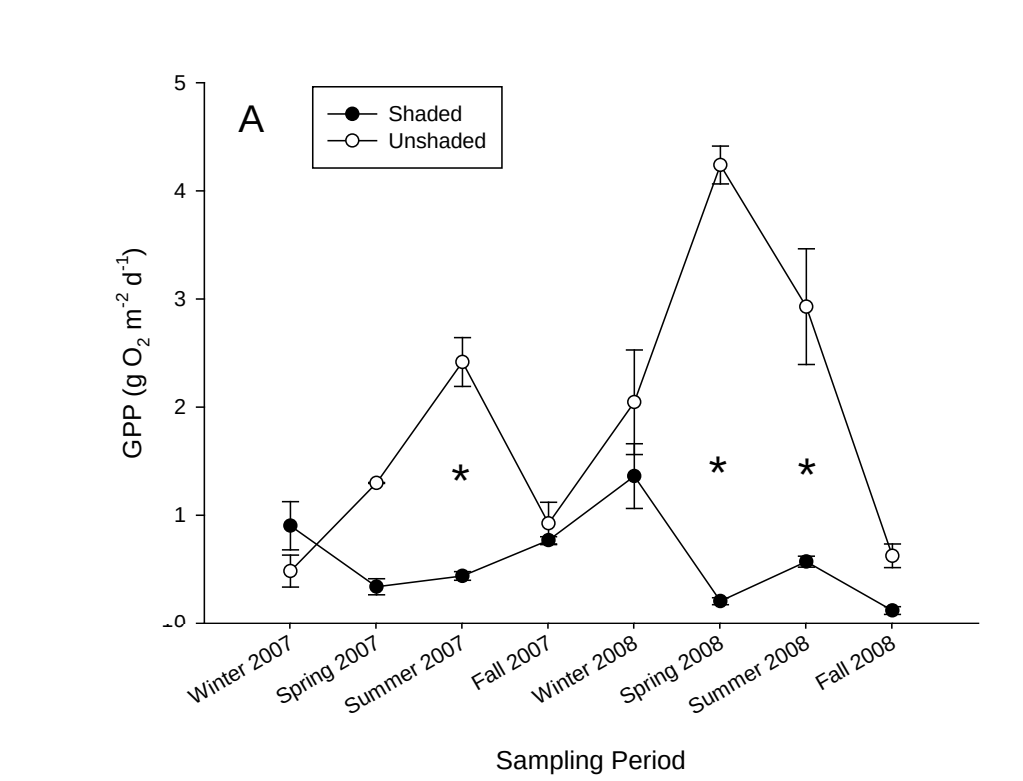



Shaded
Unshaded
GPP (g O2 m-2 d-1)
PAR (moles photons m-2 d-1)
0
1
2
3
4
5
6
0
10
20
30
40
50

$R^2 = 0.39$; $p < 0.01$

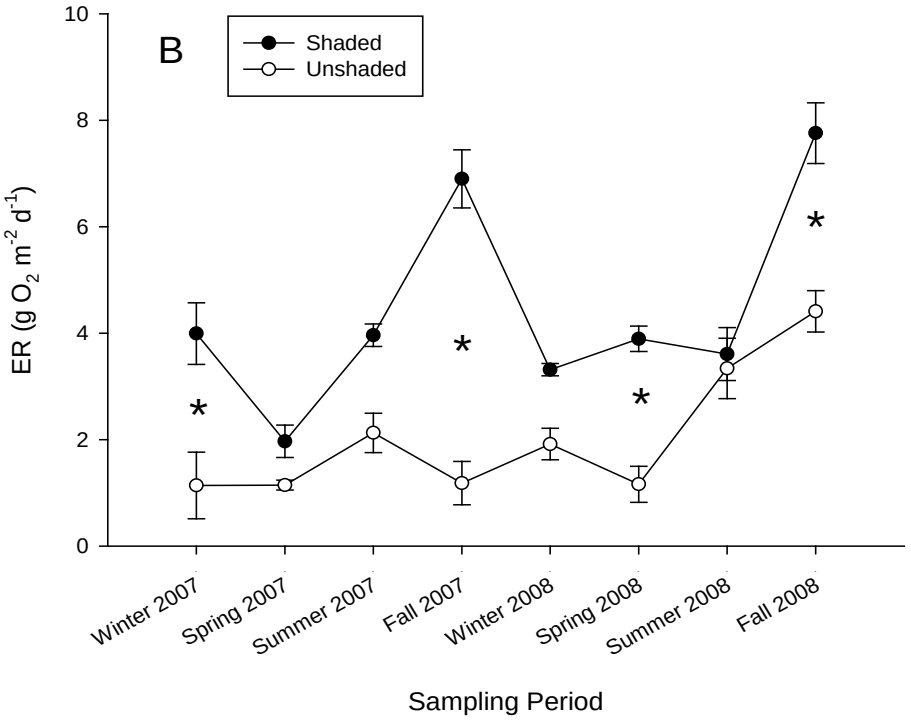
Results

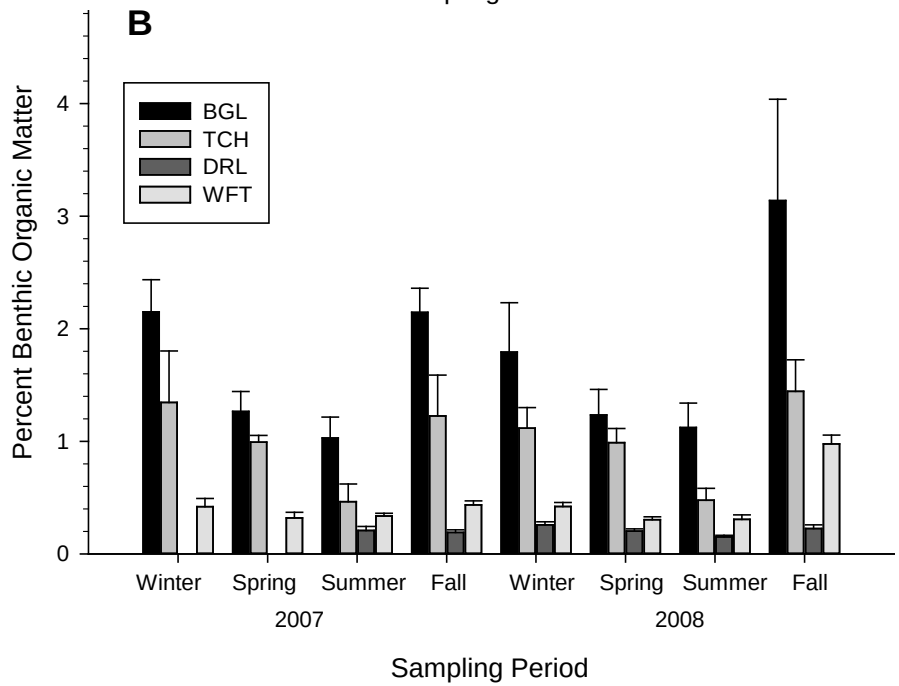
- GPP – Controlled by canopy shading and light availability
- ER
- NEP



Results

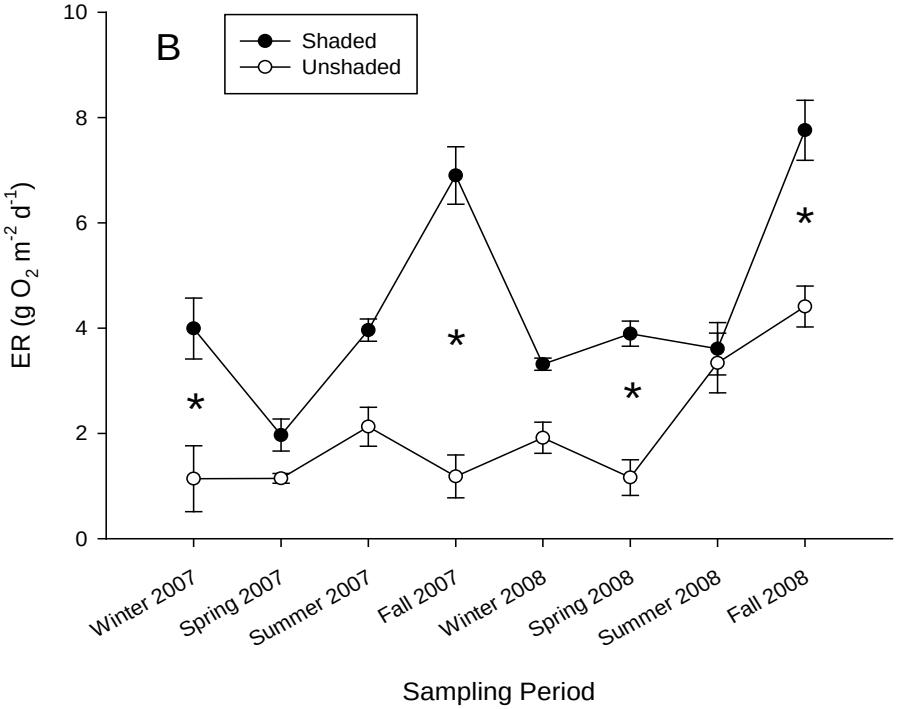
- GPP – Controlled by canopy shading and light availability
- ER – higher OM content yields greater rates
- NEP

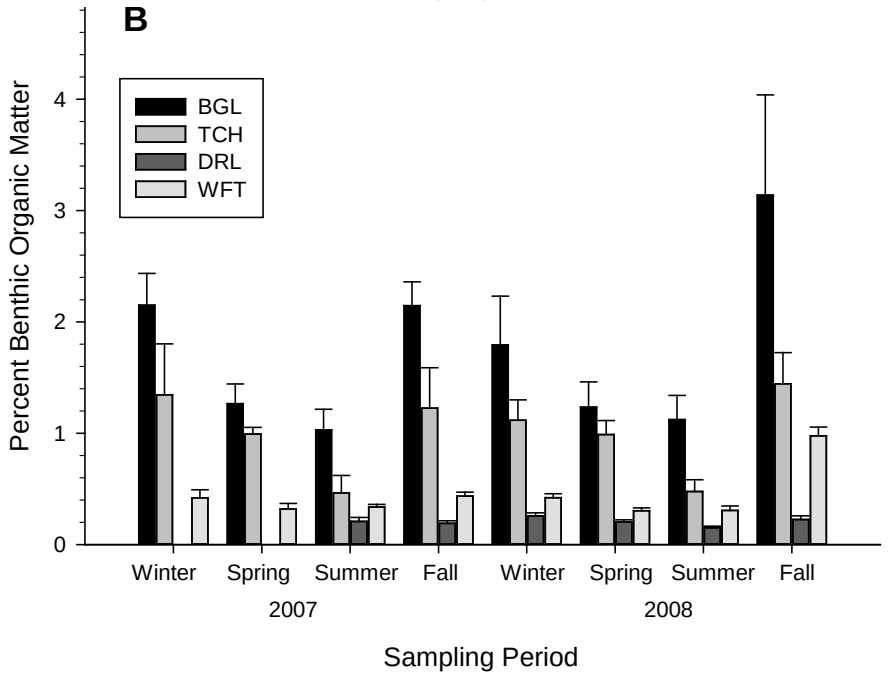




Results

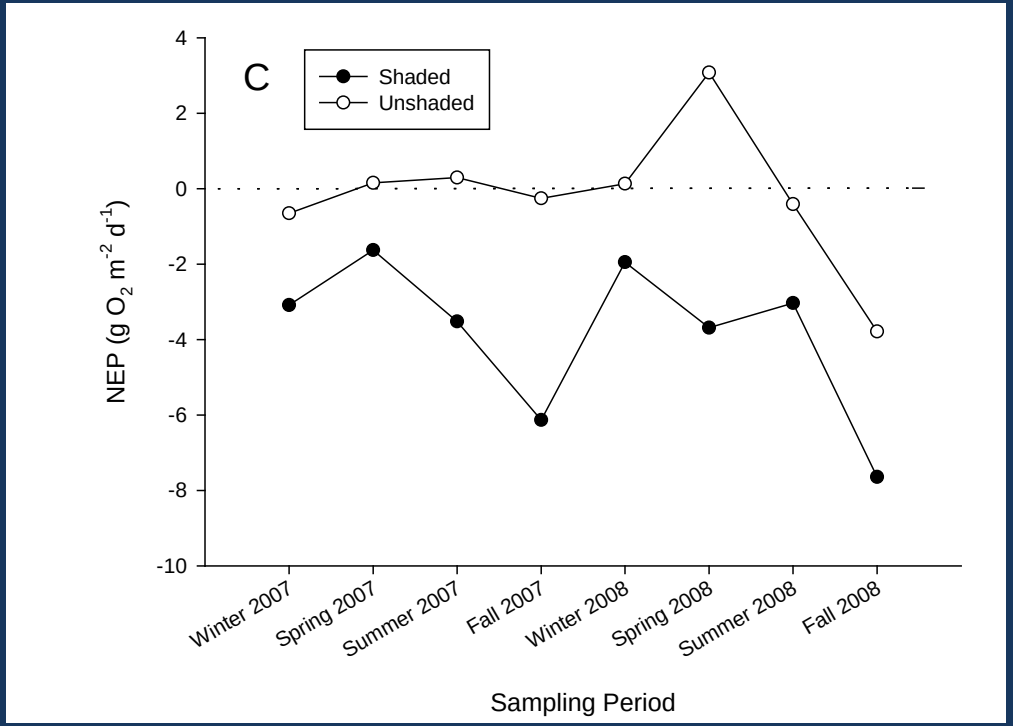
- GPP – Controlled by canopy shading and light availability
- ER – higher OM content yields greater rates; litterfall stimulated ER
- NEP





Results

- GPP – Controlled by canopy shading and light availability
- ER – higher OM content yields greater rates; litterfall stimulated ER
- NEP – only autotrophic in unshaded streams during spring/summer



Conclusions

- Light important for GPP
  - Stream size/width and stochastic disturbances (e.g., storms) open up canopy
- OM important for ER
  - Riparian canopy provides LWD input
  - Litterfall stimulates higher ER rates
- These streams rely more on allochthonous sources of OM
- Seasonal variability suggests that infrequent measurements (e.g., snapshots) may result in erroneous results

Aknowledgements

- W. Kelso and B. Roberts
- Lab: D. Kelly
- Field: A. Piehler, M. Piehler, A. Martin, A. Commegere, J. Bahm, W. Sheftall, M. Hull, D. Thomas, M. Songy, K. Dibendetto, CPB, C. Wolf, B. Leblanc, M. Campbell, C. Gray, A. Williamson, M. Sherder, L. Hart, J. Bodin, R. Harlan, P. Marcos, R. Walley, J. Meche, S. Zaunbrecher, T. Kaczmarowski, M. Baker, B. Britt, and Badger

Questions?