

Influence of Experimental Sheet Flow on Aquatic Food Webs of the Central Everglades



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Florida Coastal Everglades Long Term Ecological Research



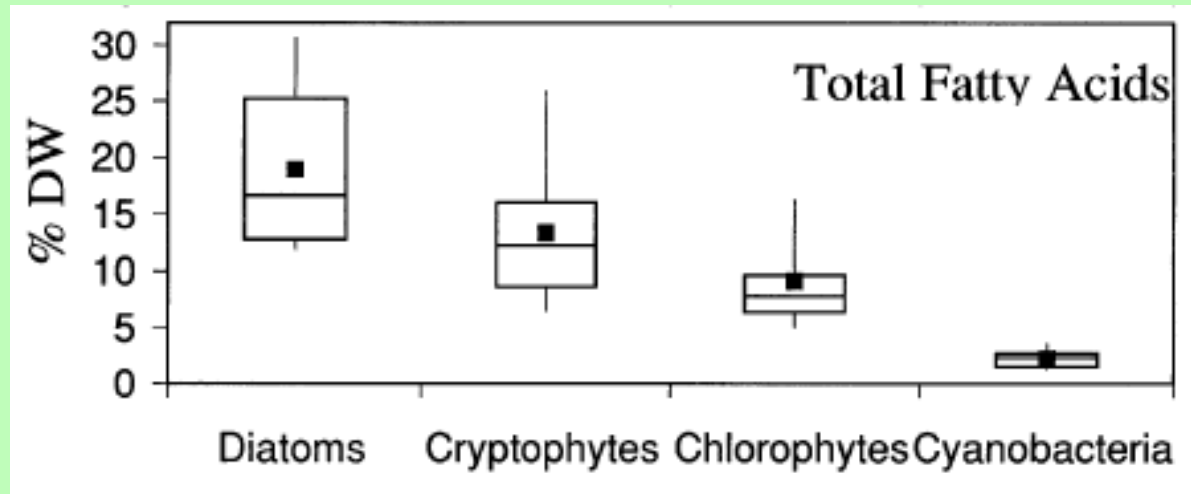
Water and Nutrients in the Everglades

- A main goal of Everglades restoration is to return the historical *quality, quantity, timing*, and *sheet flow* of water
 - Increase the connectivity of habitats
 - Redistribute organic matter and nutrients
- Increased flow may cause *nutrient enrichment* by *loading* to recipient environments
 - Potential to alter the taxonomic and biochemical composition of periphyton
- The biochemical composition of primary food resources may affect important driver of food-web dynamics
 - Secondary production
 - Consumer, growth, reproduction, other physiological responses

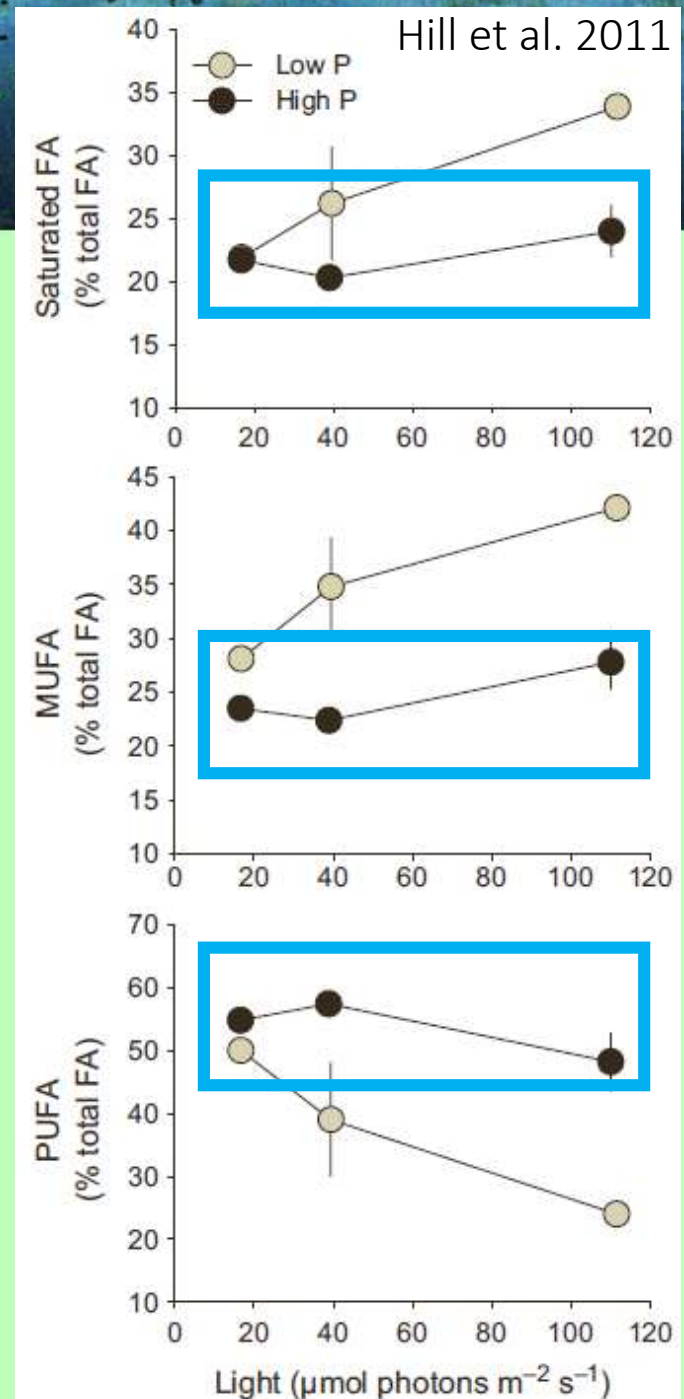


Periphyton as a Bioindicator

- Nutrient enrichment alters the taxonomy and biochemical composition of algae
 - Decrease in cyanobacteria, increase in chlorophytes
 - Increase essential PUFAs (poly-unsaturated fatty acids)
- High-light and low-nutrient environments may produce algae deficient in nutrients and PUFAs, including essential FAs (EFAs).



Brett and Müller-Navarra 1997





Questions

Nutrient Loading:

- Will *nutrient loading* occur with increased sheet flow without increases to the concentration of the limiting nutrient phosphorus (P)?

Basal Energy Shift:

- Will loading increase the *dietary quality* the primary source of organic matter for consumers?

Trophic Effects:

- Will effects transfer through the food web to improve *consumer body condition and growth*?

Conceptual Diagram

Low Sheet Flow

Increased Sheet Flow

Secondary Consumers:

Low

High

Growth Rate:

Low

Increased

Fatty Acid Content:
Primary Consumers (Grazers):

Low total FA

High total FA

Stoichiometry:

More Bacteria FA/SAFA/MUFA

More Autotrophic FA/PUFA

Grazing Access:

High C:P

Low C:P

Associational Resistance:

Present

Degraded

Taxonomy:

Bacteria and

More Edible

Primary Producers (Periphyton):

Inedible Algae

Algae

Fatty Acid Content:

More SAFA/MUFA

More PUFAs

Stoichiometry:

High C:P

Low C:P

P Uptake:

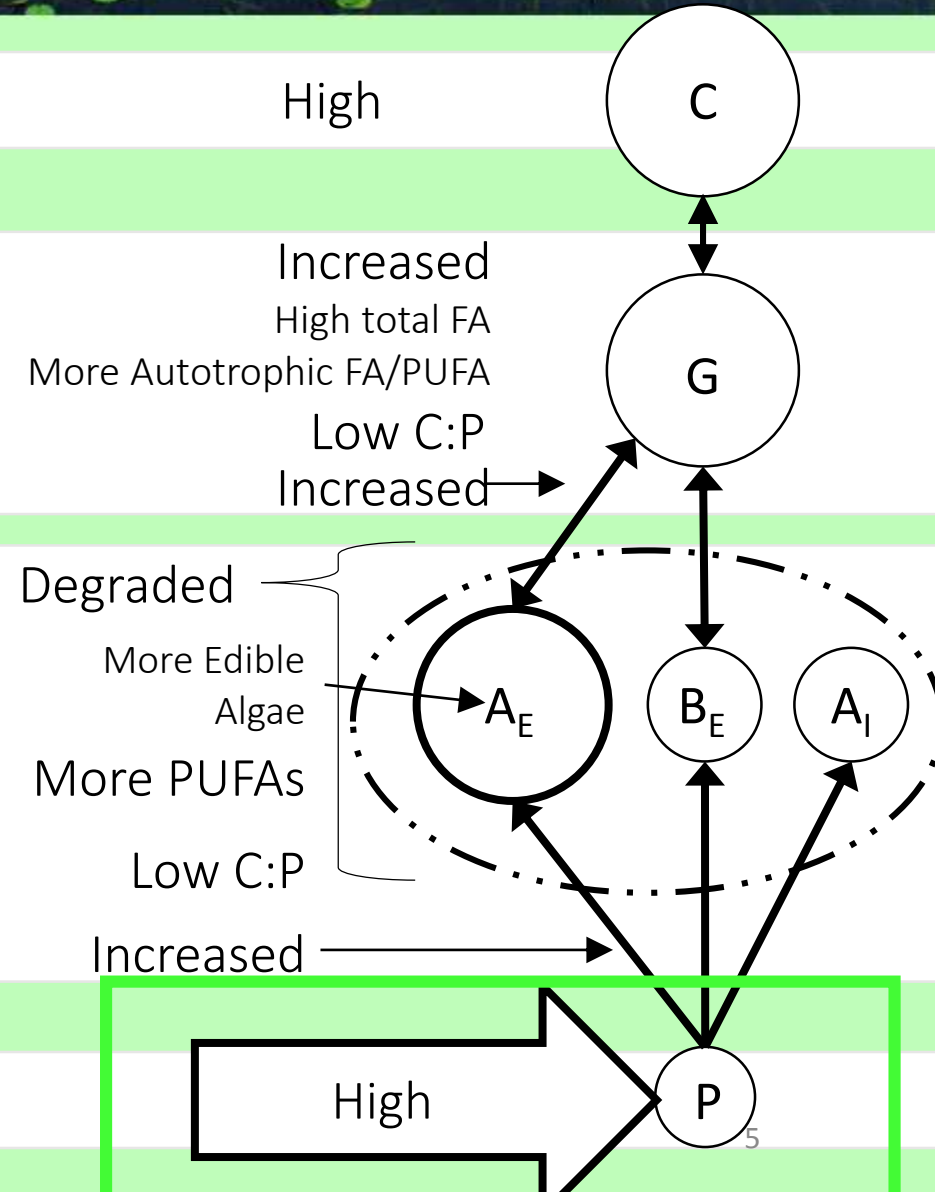
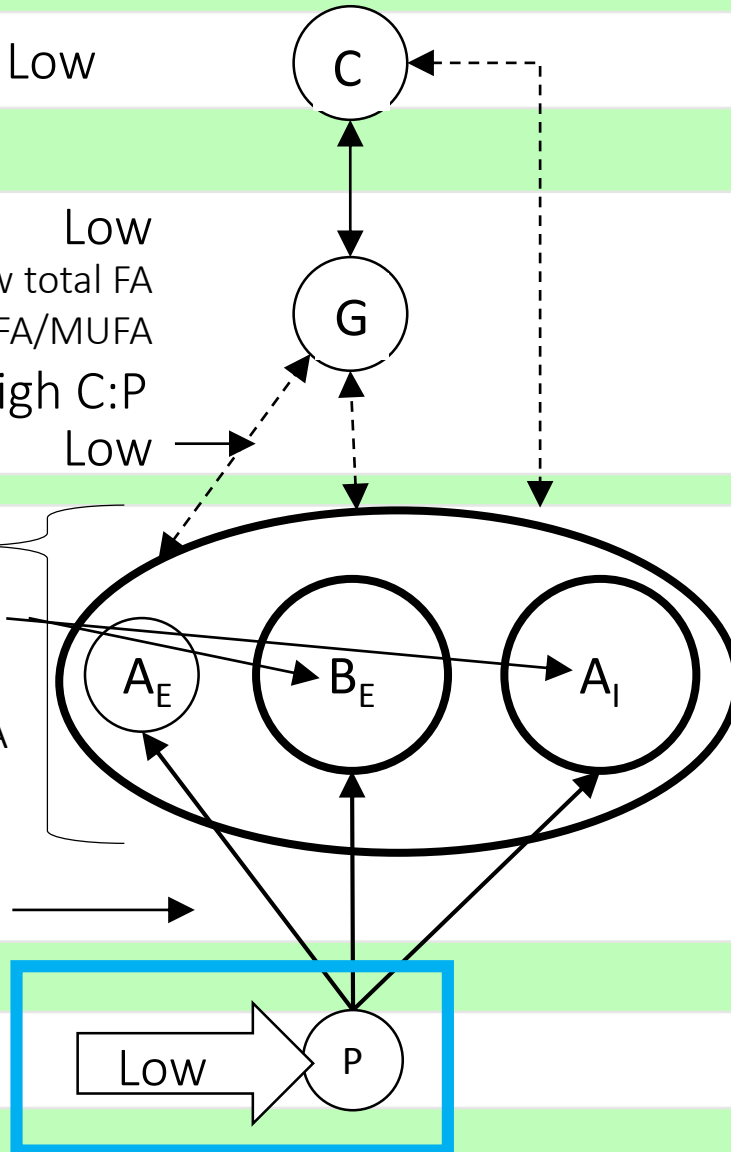
Low

Increased

Rate of Supply of Phosphorus:

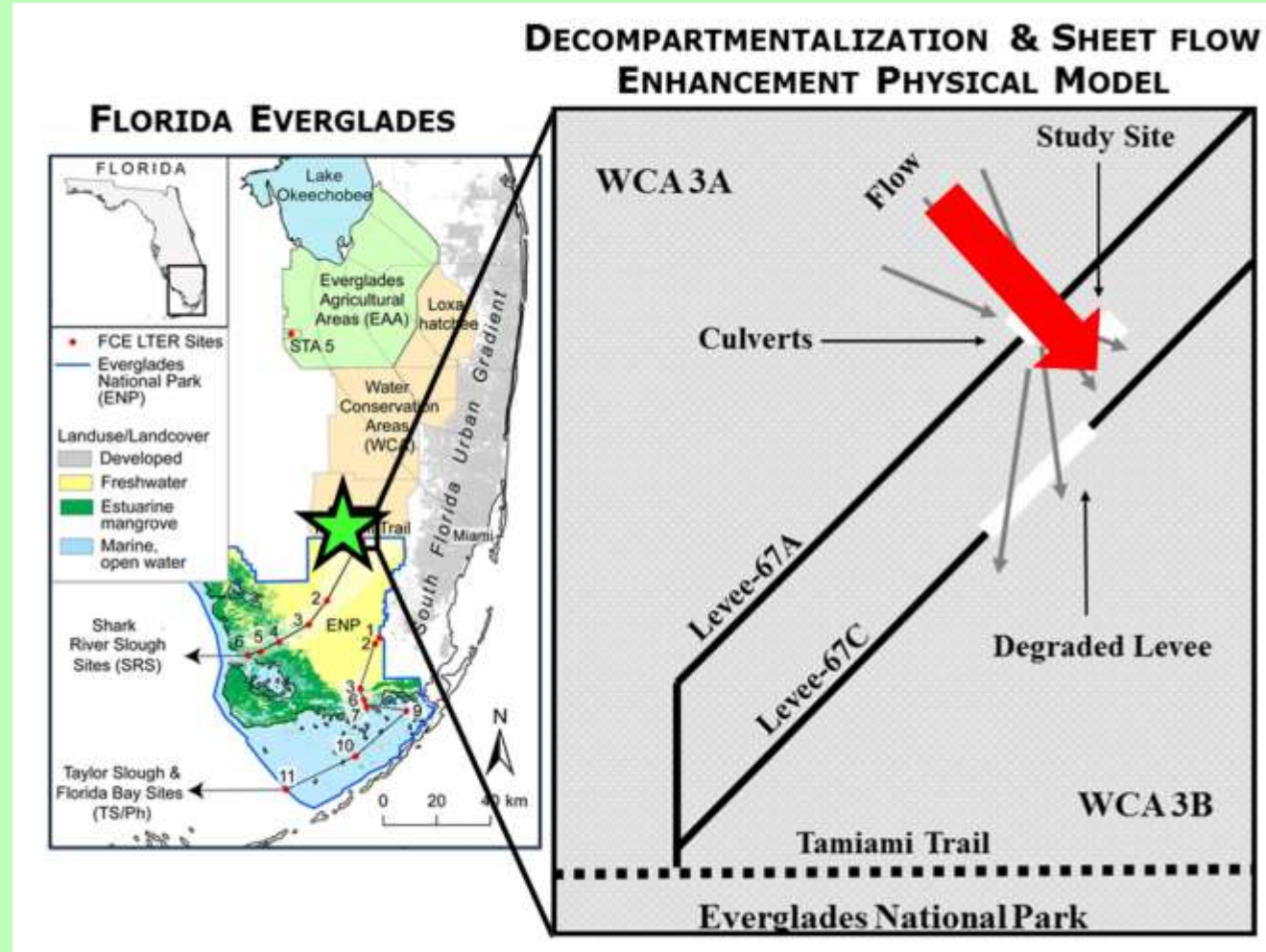
Low

High



Methods: Food Web Manipulation

- 20 - 1x1m enclosure cages
 - 2000 ml periphyton mat from surrounding marsh
 - Artificial vegetation for biofilm growth
 - Consumers added at ambient marsh densities
 - Sailfin Molly, E. Mosquitofish, Riverine Grass Shrimp
 - Base lined body conditions in laboratory
- Two time periods
 - October: Pre-Flow ($<1 \text{ cm sec}^{-1}$)
 - November: During-Flow ($>3 \text{ cm sec}^{-1}$)
- Periphyton and consumers sampled at 0 and 3 weeks, biofilm sampled only at 3 weeks.



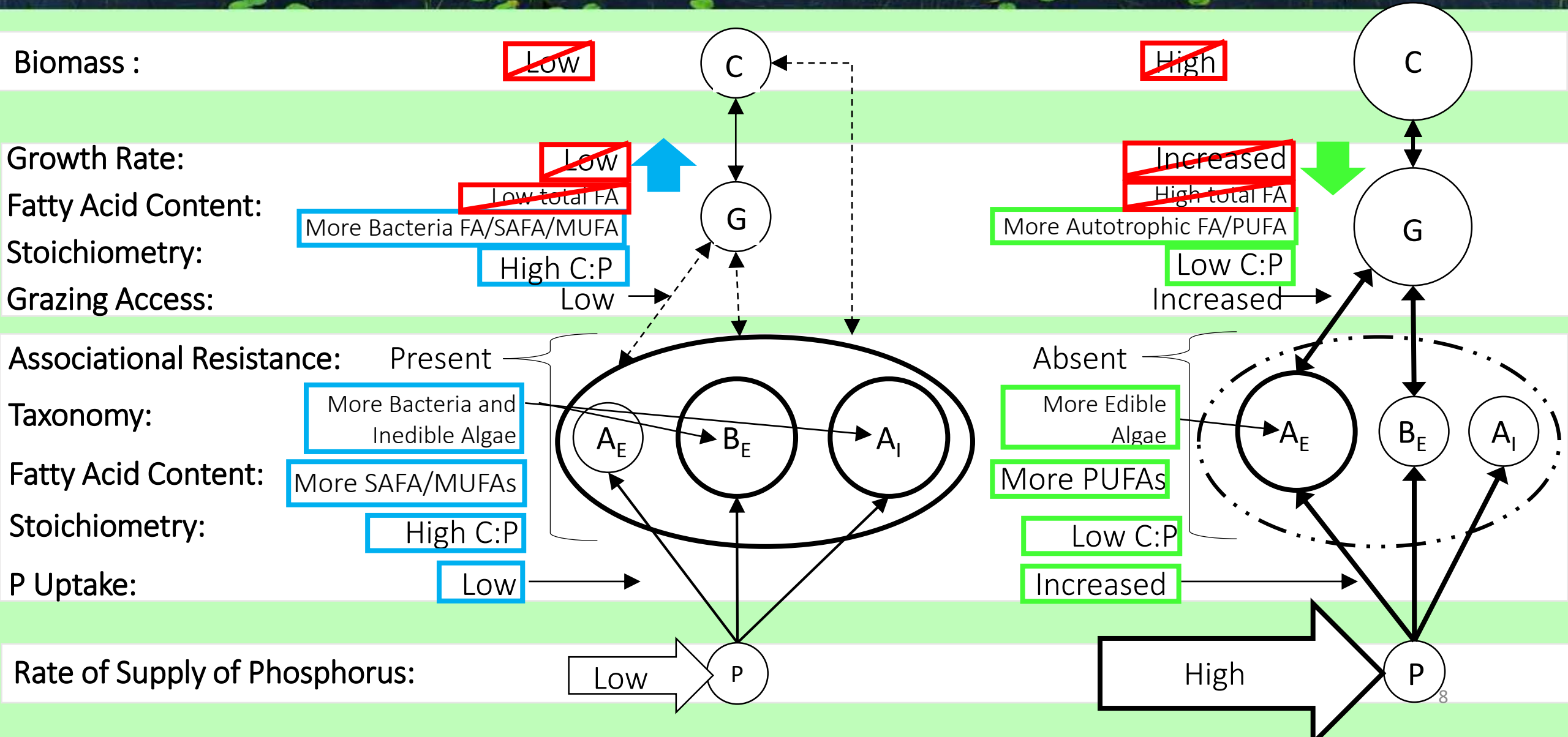
Results

		Biofilm	Periphyton	Sailfin Molly	Eastern Mosquitofish	Riverine Grass Shrimp
Stoichiometry:	C:P	▼	ns	▼	ns	ns
	N:P	▼	ns	▼	ns	ns
Algae Composition:	Diatoms	▼	▼	-	-	-
	Cyanobacteria	▼	▼	-	-	-
	Fil. Green	▲	▲	-	-	-
FA Content:		▲	ns	▼	ns	ns
FA Dietary Tracers:	Algae	▲	ns	▲	▲	ns
	Bacteria	▼	ns	▼	ns	▲
FA Saturation:	SAFA	▼	ns	ns	ns	▼
	MUFA	▼	ns	▼	▼	ns
	PUFA	▲	ns	▲	▲	▲
Growth Rate:		-	-	▼	ns	ns

Conceptual Diagram

Low Sheet Flow:
October

Increased Sheet Flow:
November



Discussion : Food Web Manipulation

- Two deviations from the hypothesis:
 - 1) “Higher quality” basal resources in November did NOT increase consumer GR and FA content.
 - 2) Each species did NOT respond the same to environmental conditions.

1) “Higher quality” basal resources in November did *NOT* increase consumer GR and FA content

Hypothesis:

- Increased sheet flow would increase P, palatable algae, and PUFAs leading to an increase consumer GR and FA content in November.

Observed:

- Low level P loading:
 - Slightly elevated P content of biofilms compared to oligotrophic regions of WCA-3A.
- No break down in physical structure/associational resistance of mat:
 - Filamentous green portion blooming on exterior of mat diluted other high-quality portions (diatoms) of the grazer diet leading to low FA content and low C:P ratio consumers in Nov.
- Decreased temperature
 - Cooler temperatures decrease Sailfin Molly and E. Mosquitofish growth (Trexler et al. 1990; Vondracek 1988).

2) Each species did NOT respond the same to environmental conditions.

Hypothesis:

- Changes to each consumer species' diet would similarly affect their body condition.

Observed:

- Feeding Guild:
 - Omnivorous E. Mosquitofish and Grass Shrimp showed less variation between months than the herbivorous Sailfin Molly.
 - Herbivores directly consumer primary production whereas omnivores are buffered by homeostatic infauna they consume and may take longer to respond.
- Feeding Mode:
 - Grass Shrimp has a unique feeding method of penetrating periphyton mats to feed more selectively.
 - May be less affected by external changes

Conclusions

- Increased sheet flow velocity leads to nutrient loading that affects food quality
 - Water column TP did not increase during the flow event
 - Observed changes to basal resources were consistent with known eutrophication changes seen in the Everglades
- Nutrient loading caused an increase in autotrophic-derived energy and was evident in biofilms
- Biofilm changes altered consumers body condition in varying degrees depending on trophic level, feeding mode, etc.
 - Demonstrates the complexity of potential effects to food web dynamics
- Future Research Directions:
 - How season may compound or eliminate effects of nutrient loading?
 - How do dietary nutrients and essential molecules in basal resources vary spatially and temporally throughout the Everglades?

Acknowledgements

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