Insights into the Management of Wetlands under Disturbance from Experimental and Theoretical Models

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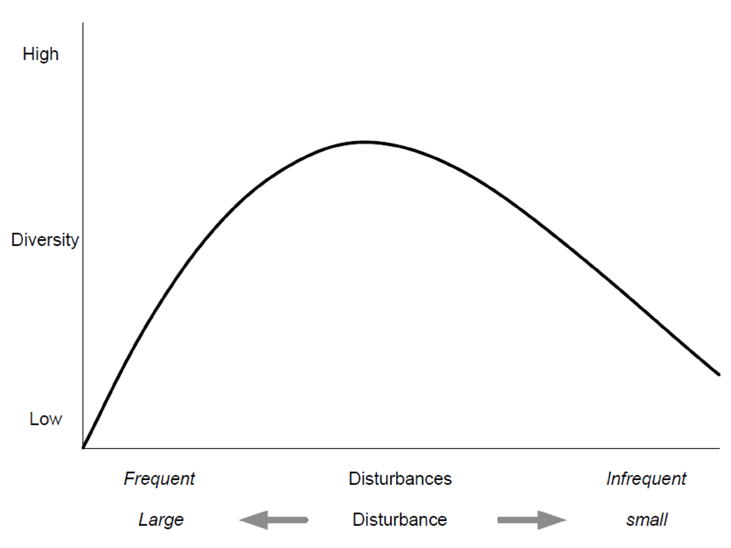
Introduction

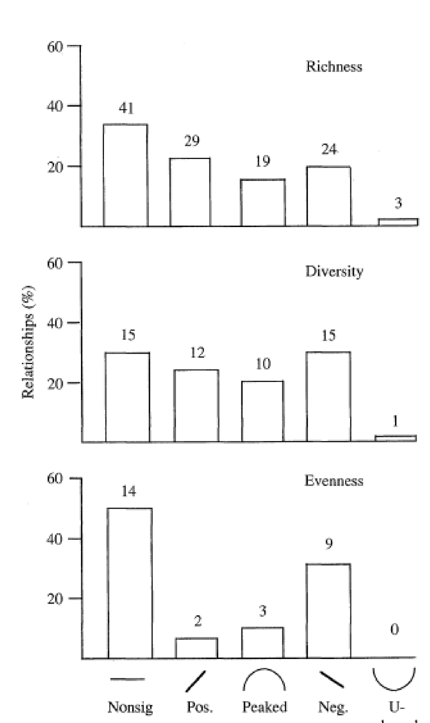
Understanding self-organization of nature is a key to success of environmental management. Wetlands, like other ecosystem types, are frequently or infrequently influenced by natural or anthropogenic disturbances. Thus the self-organization of a wetland system would be better understood by predicting the ecological response to variable disturbance regimes. Using naturally transplanted aquatic microcosms and simulation models, I tested how ecosystem productivity (energy acquisition) responds to variable disturbance regimes in general.

Ecological succession under disturbance

Is there a consistent pattern in the responses of ecosystem-level traits (e.g., productivity) to the gradient of external disturbance regimes as addressed in the intermediate disturbance hypothesis (IDH)?



(IDH)

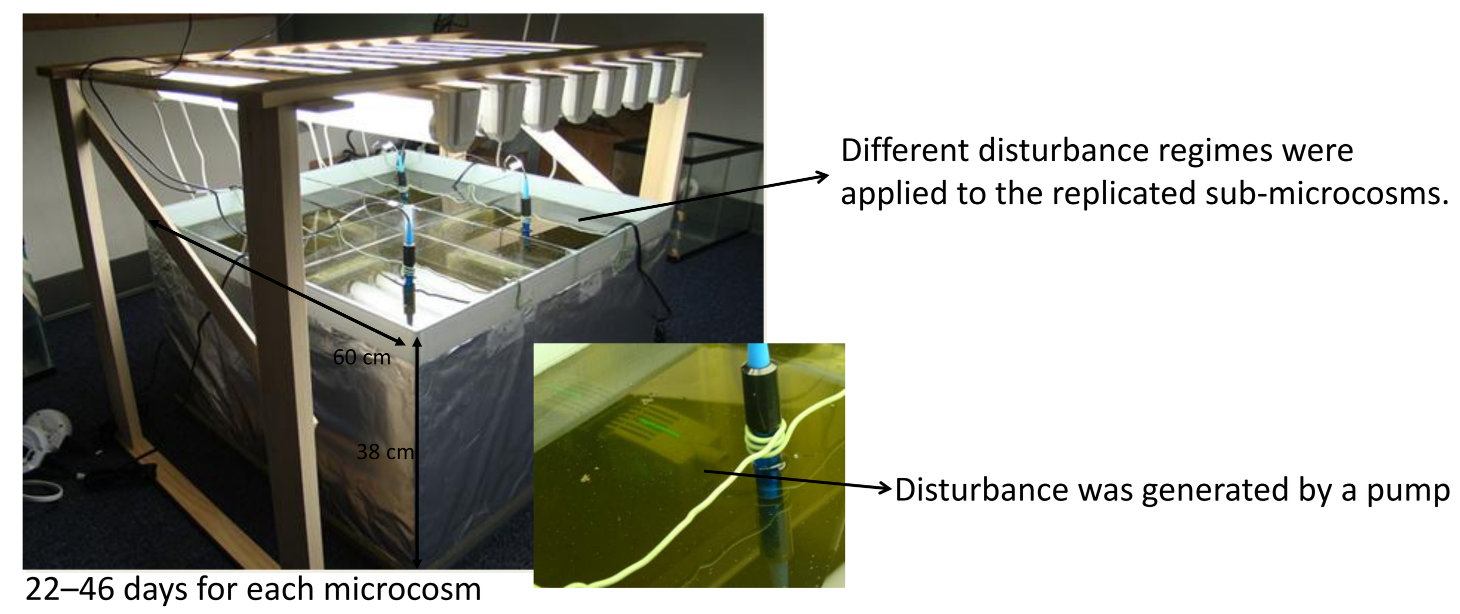


(Mackey & Currie, 2001)

Is there a consistent pattern of ecosystem-level trait versus disturbance regimes regardless of the biotic and abiotic composition of the system?

Experimental approach (microcosm)

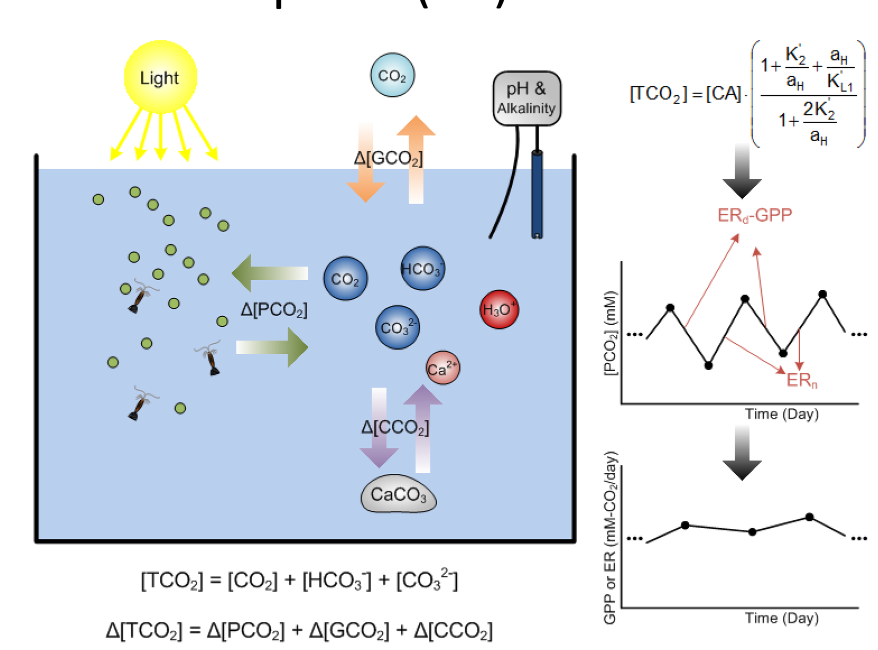
Freshwater aquatic microcosms transplanted from lakes in FL
Four water motion disturbance regimes in a microcosm



22–46 days for each microcosm

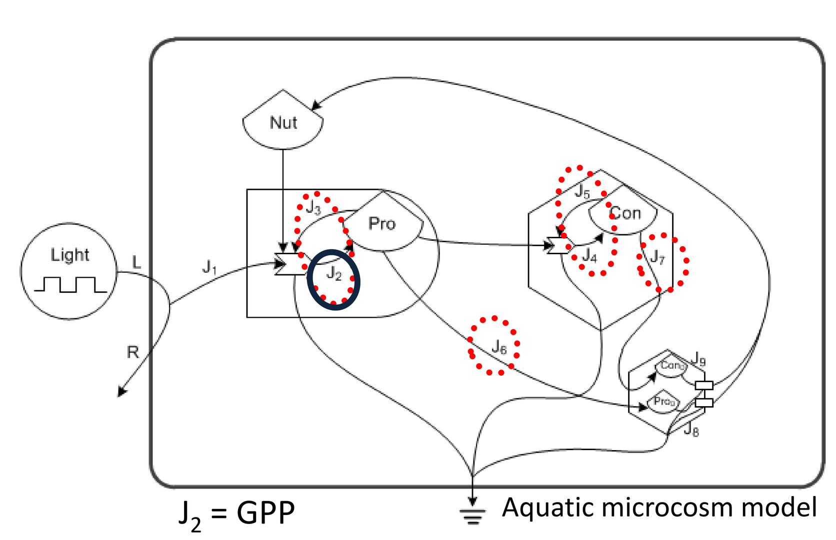
Initial stabilization(1–20) → Disturbance (5–10) → Post-disturbance(15)

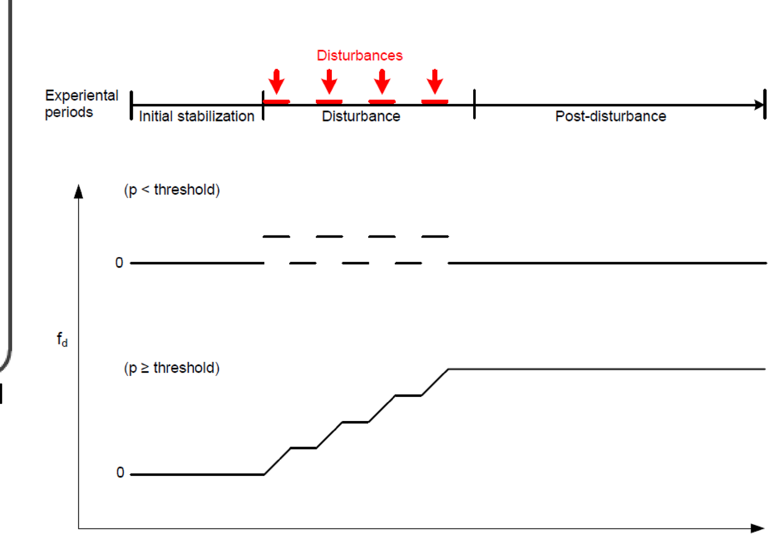
Continuous measurements of ecosystem-level production (GPP) and consumption (ER)



Hypothetical mechanism (simulation model)

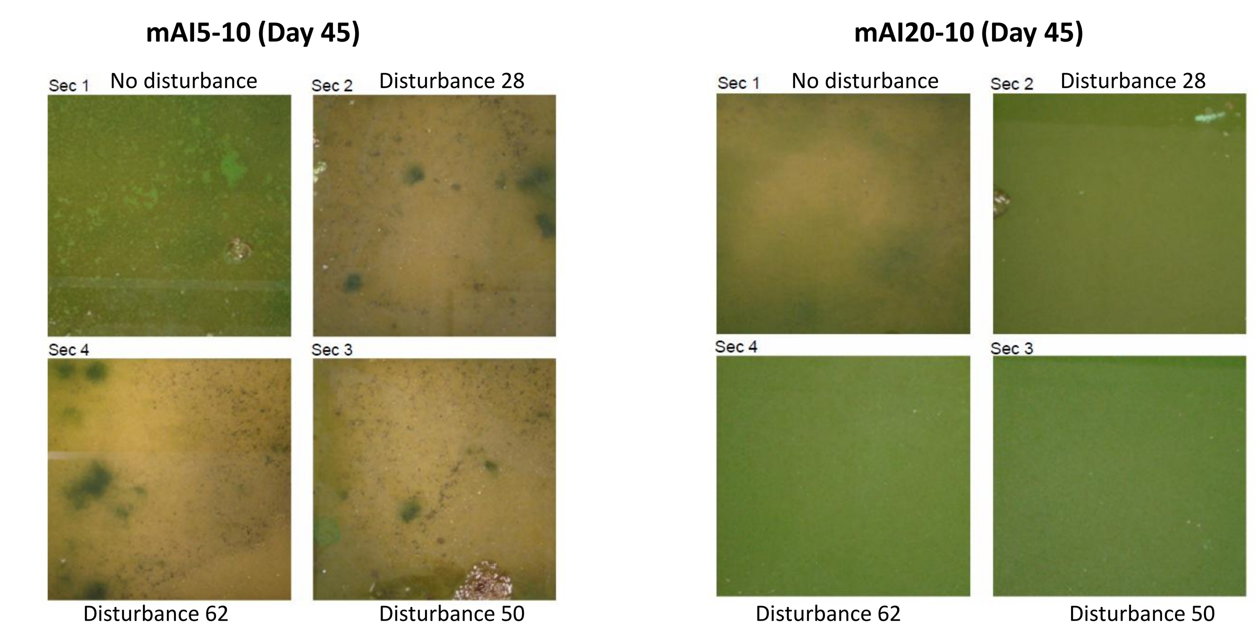
(1) Disturbances alter the intrinsic rates of energy flow pathways.
(2) Disturbance thresholds exist. (alternative stable state)





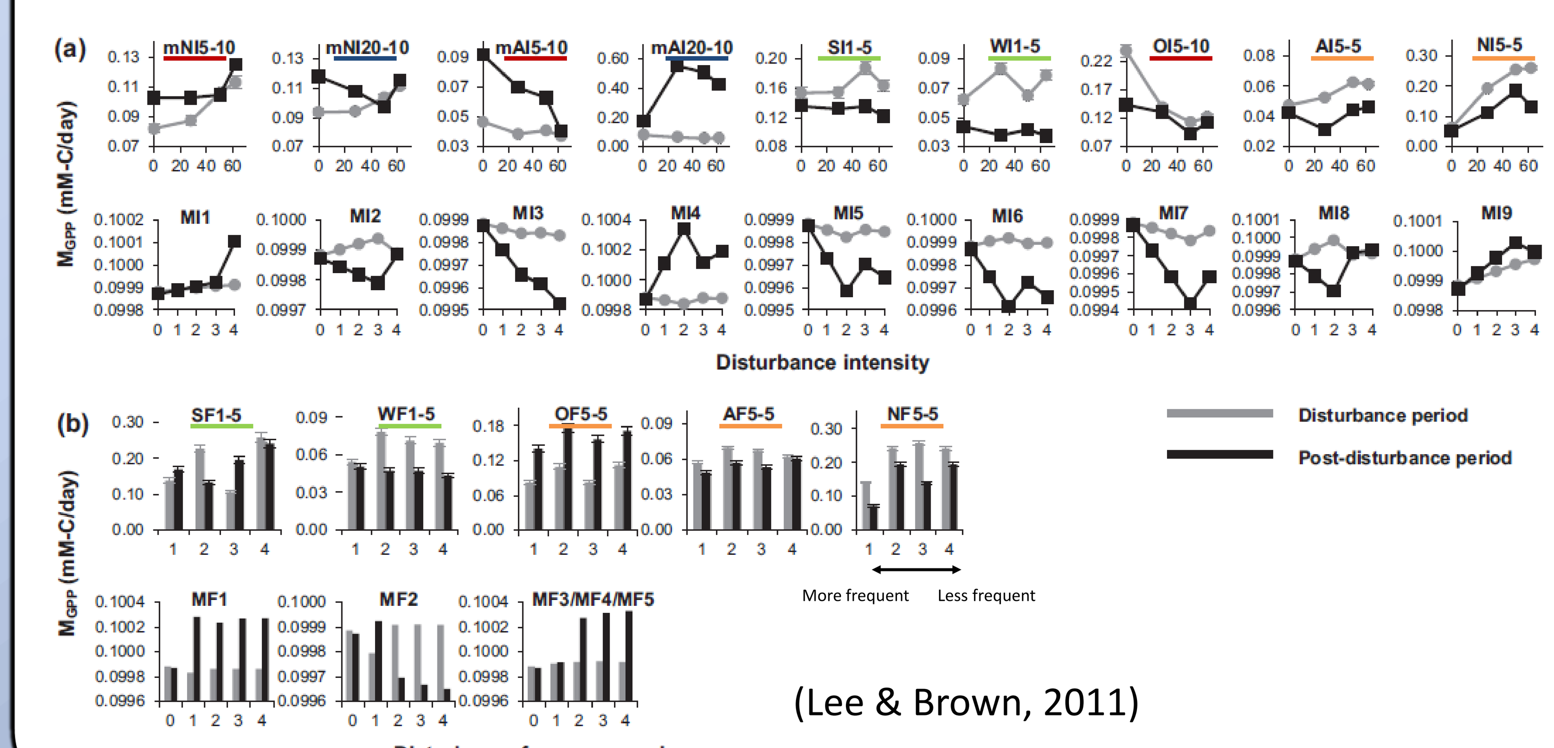
Results

Microcosms under disturbance (Top view, examples)



Relationship between disturbance and average productivity (M_{GPP})

- Microcosms with the same underline color were tested under the same disturbance regimes and test schemes but different initial samples.
- Upper: microcosm experiments, lower: simulation models
- Error bars indicate potential M_{GPP} ranges caused by ±0.02 pH measurement error.



(Lee & Brown, 2011)

Conclusions and implications for management

1. The variable responses of the aquatic microcosm productivity under the same input sequence of disturbance regimes and test schemes were attributed to different initial conditions of the microcosms. (IDH rejected)
   → *Initial conditions such as initial seeding need to be carefully selected in an environmental restoration project in consideration of prevalent disturbance regimes in the region where the project is implemented.*
2. Disturbance effect on each energy flow pathway and existence of disturbance threshold were critical for the patterns.
   → *It is important to identify local effects and thresholds of disturbances in the system management.*