Dry Disturbance and Fish Reduction Produce Enhanced Crayfish Densities in a Freshwater Wetland

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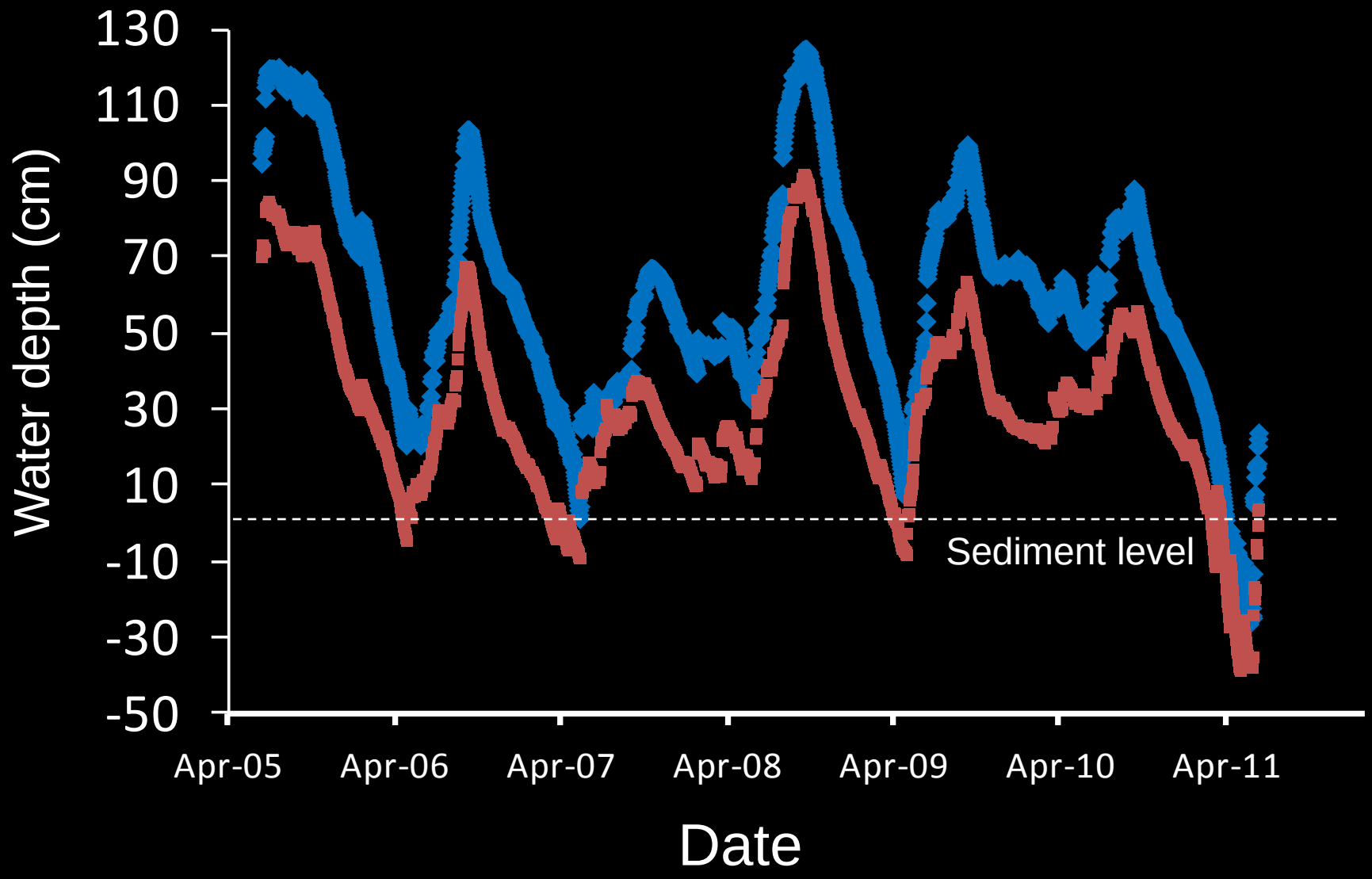
Average slough water depths in the Everglades from two locations (2005-2011)



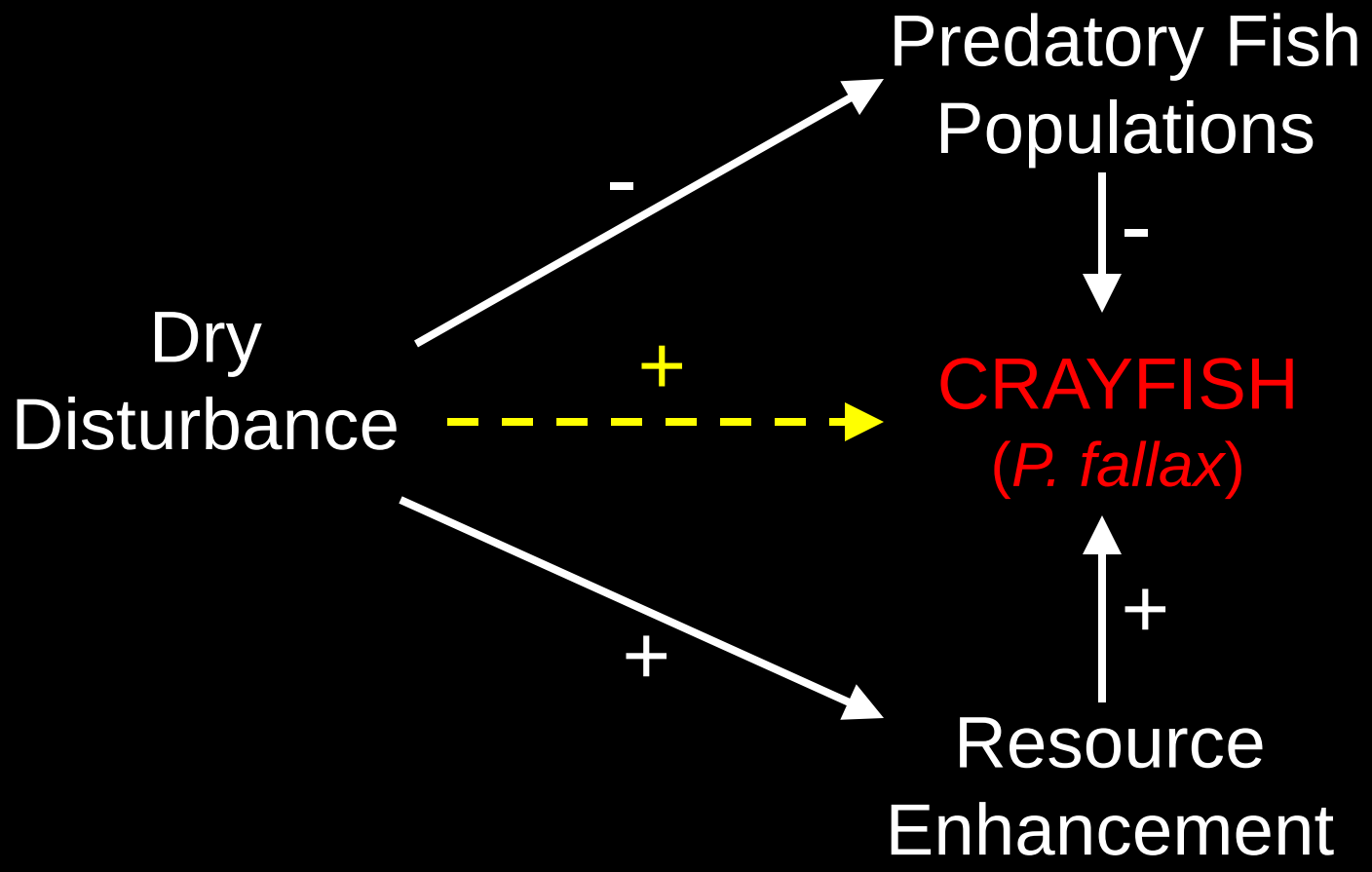
Hydrologic Pattern → Ecosystem Function

Hydrologic Pattern → Wading Bird Nesting Success

Observation: Supranormal wading bird nesting years were associated with severe droughts (low water levels) in the previous 1-2 years.

Frederick and Ogden (2001) Wetlands 21:484-491.

Hypothesis: Drought conditions *(dry disturbances)* enhance secondary production in the year(s) <u>after</u> the drought.



A. Experimental evidence that predatory fish limit wetland crayfish (*Procambarus fallax*) recruitment.

B. Experimental evidence that drying (and fish reduction) enhances crayfish density.

C. Patterns of crayfish density and hydrologic variability in Everglades sloughs

Evidence that sunfishes limit crayfish recruitment.

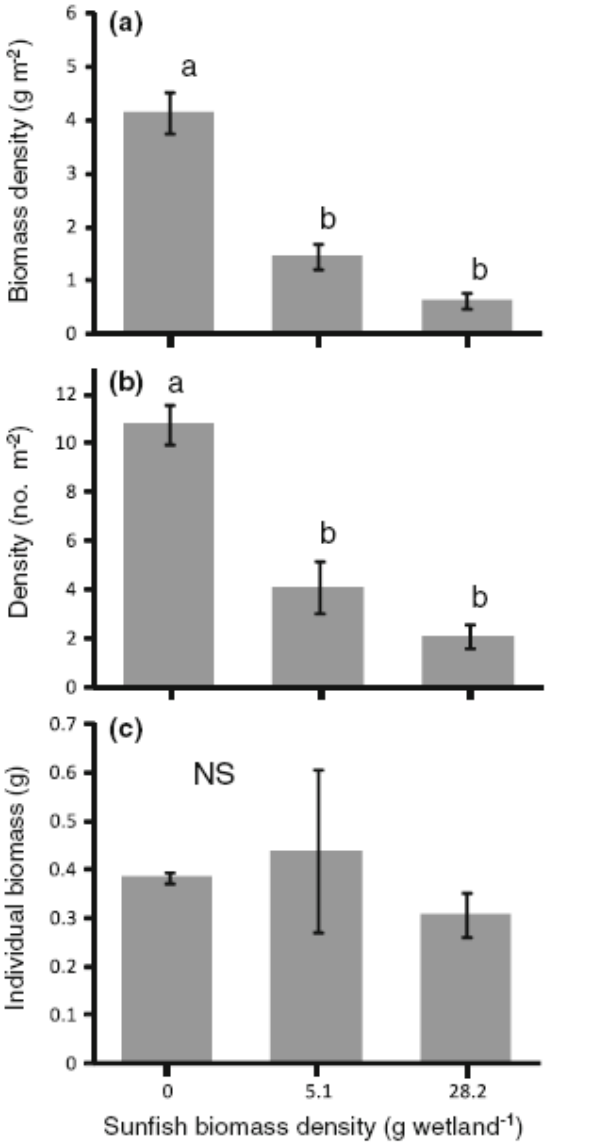
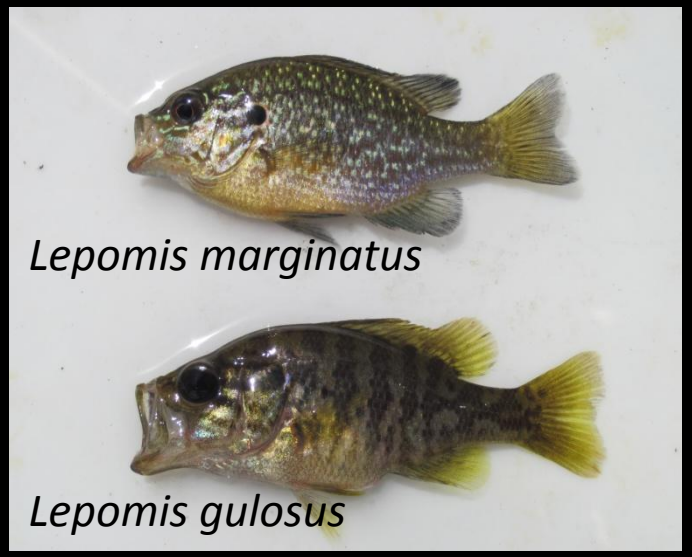


Fig. 3 Effect of initial sunfish biomass density (0, 5.1 and 28.2 g dry mass per wetland) on *P. fallax* a biomass density (g dry mass m^{-2}), b density (number m^{-2}), and c individual size (g), mean ± 1 SE, $n = 3$ wetlands treatment^{-1}. Different *letters* indicate significant difference at $\alpha = 0.05$ with a Tukey test, *NS* not significant

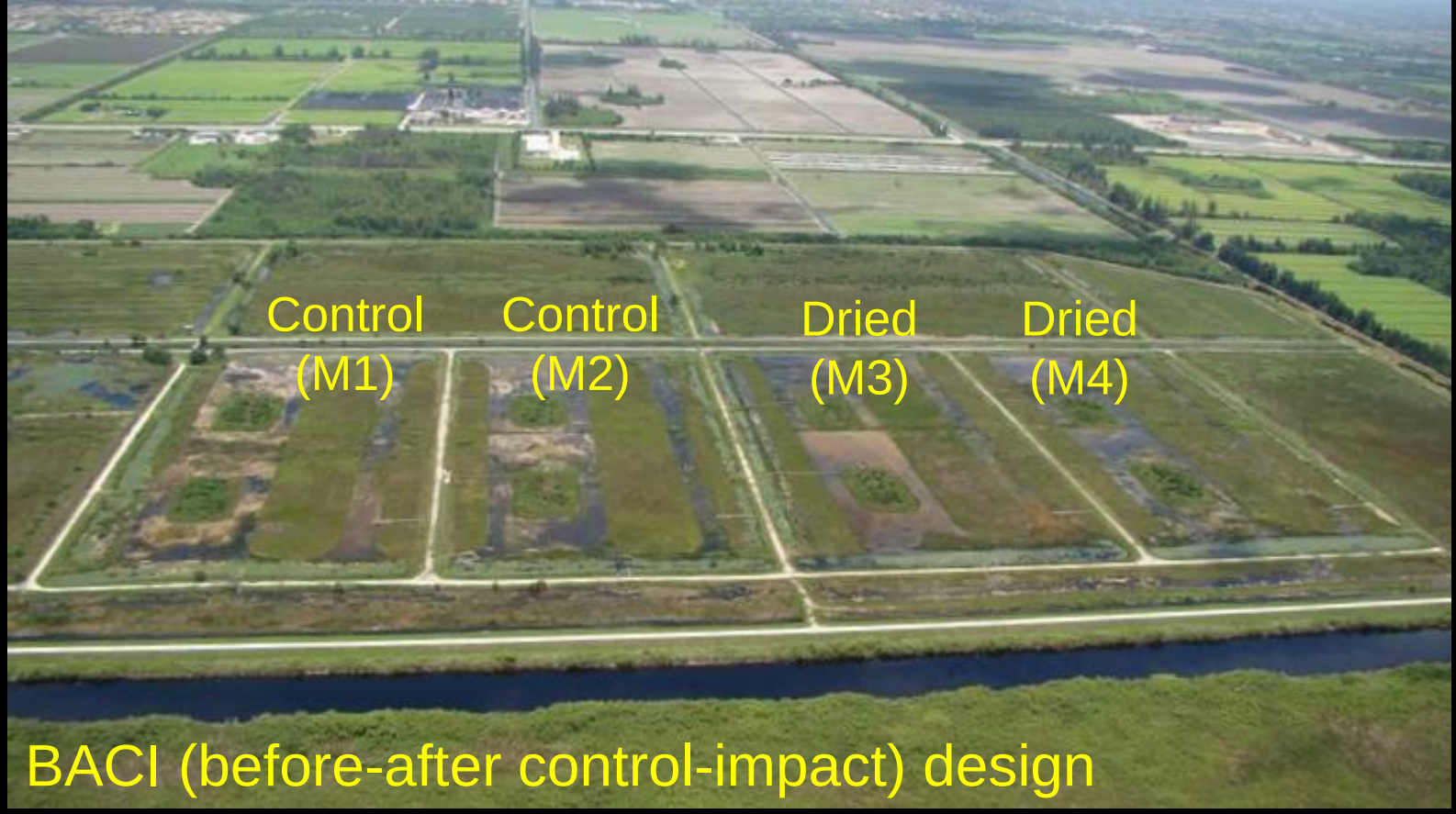


Kellogg and Dorn (2012) *Oecologia*

Slightly Larger Experimental Units

Loxahatchee Impoundment Landscape Assessment (LILA)

Replicate 8 hectare wetlands



BACI (before-after control-impact) design

2009-2010 Experiment

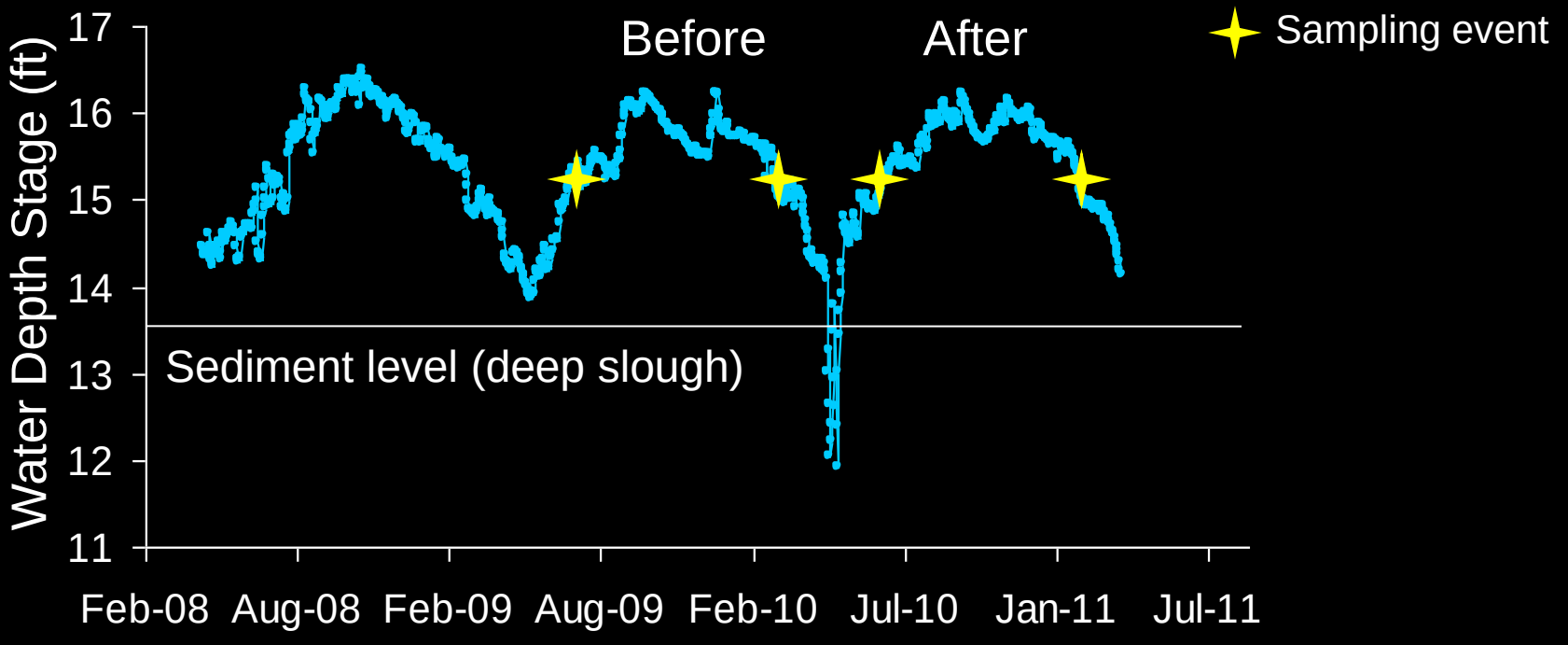
Dried two wetland macrocosms and “reduced” large fish in 2010.

Response variables:

1)Fish predators (Catch-Per-Unit-Effort)

2)Crayfish densities (throw trap sampling)

Simulation of Drought and Fish Reduction



Fish netting followed by rotenone application.

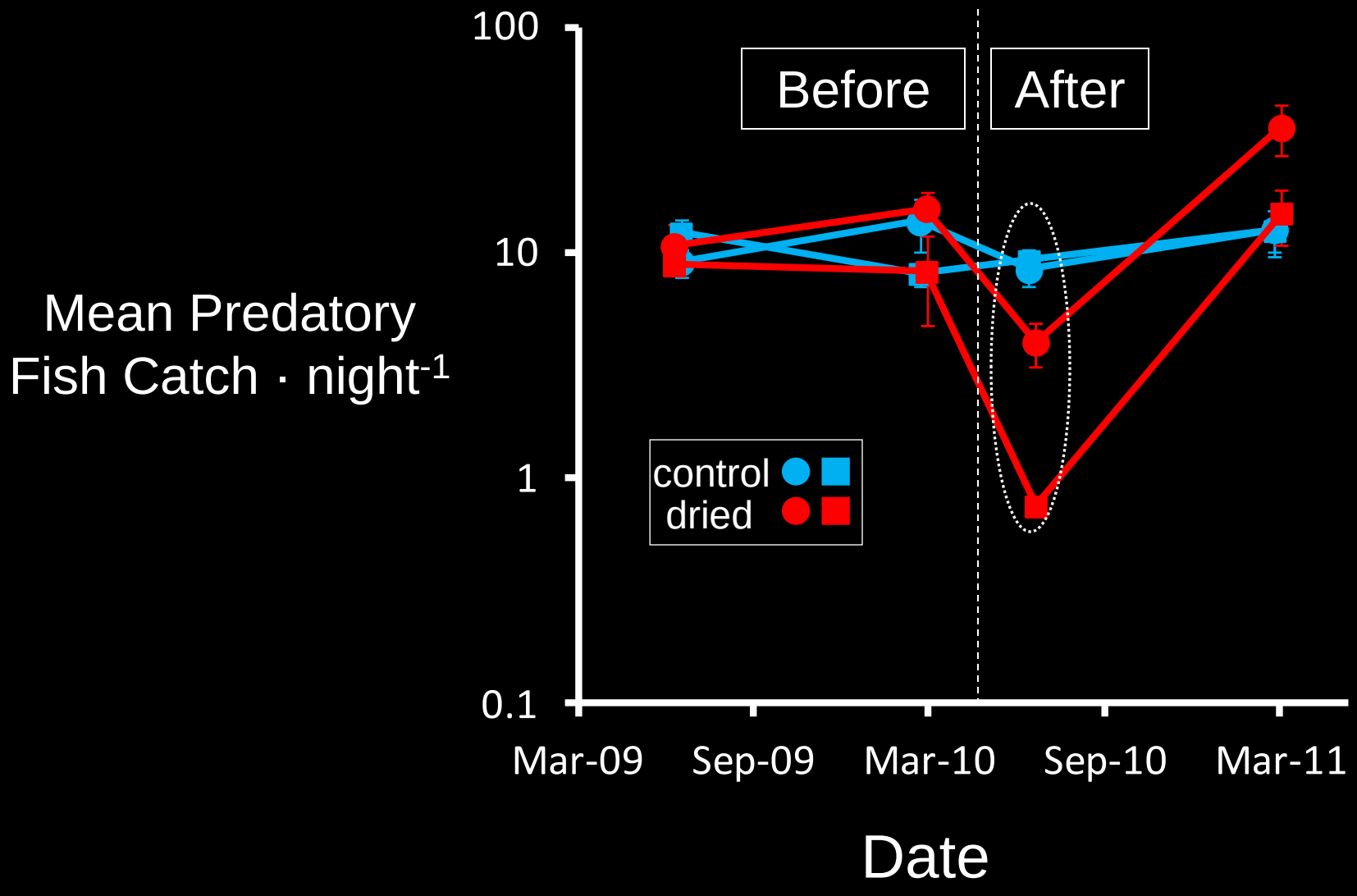
Did the manipulation significantly reduce predatory fish catches?

Measure of Fish (predator) activity-density

= Standardized catch per night

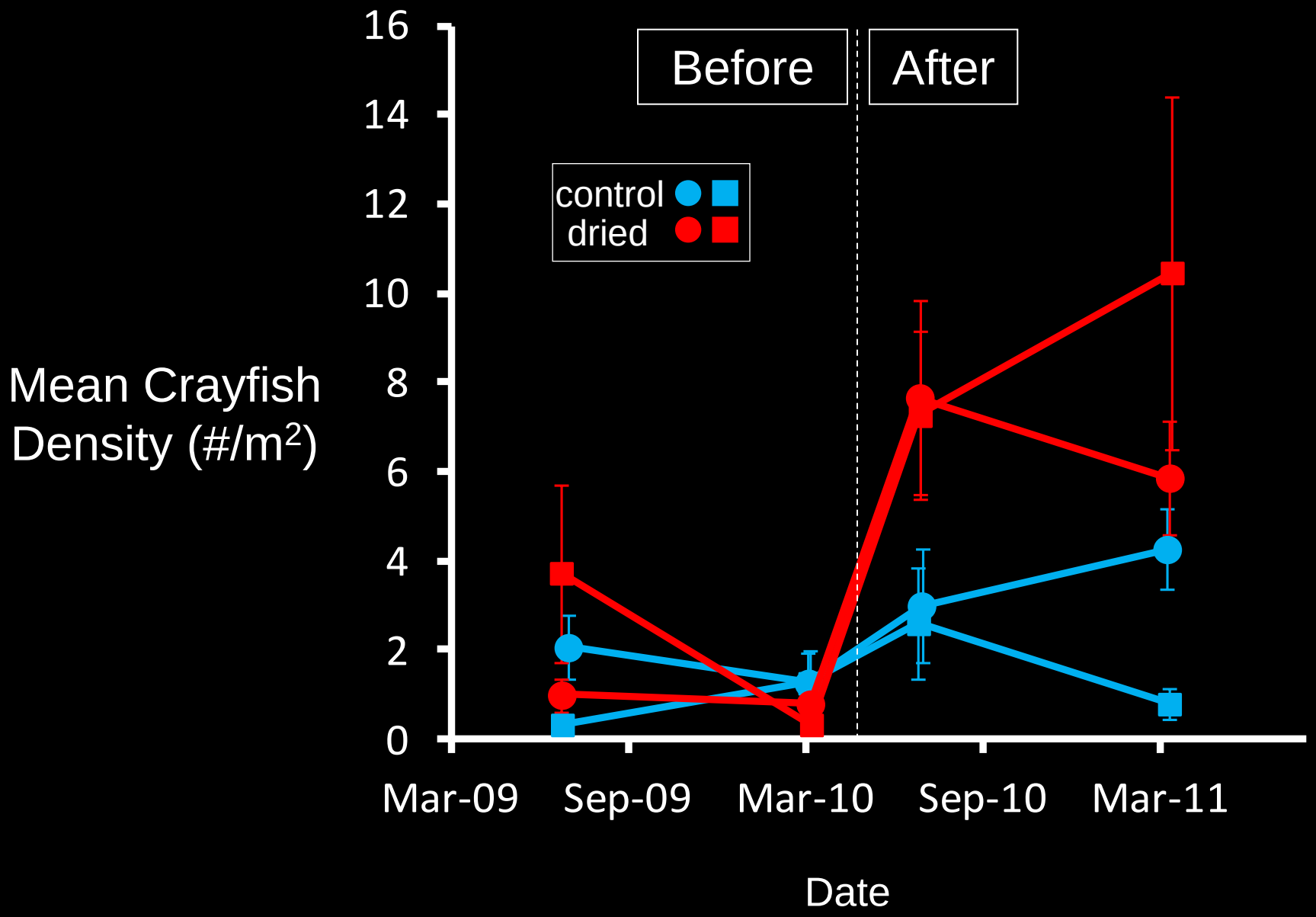
Large Fish (> 5 cm SL) abundance

TRT x Time(Period): P<0.001



Did the densities of crayfish change in response to the manipulation?

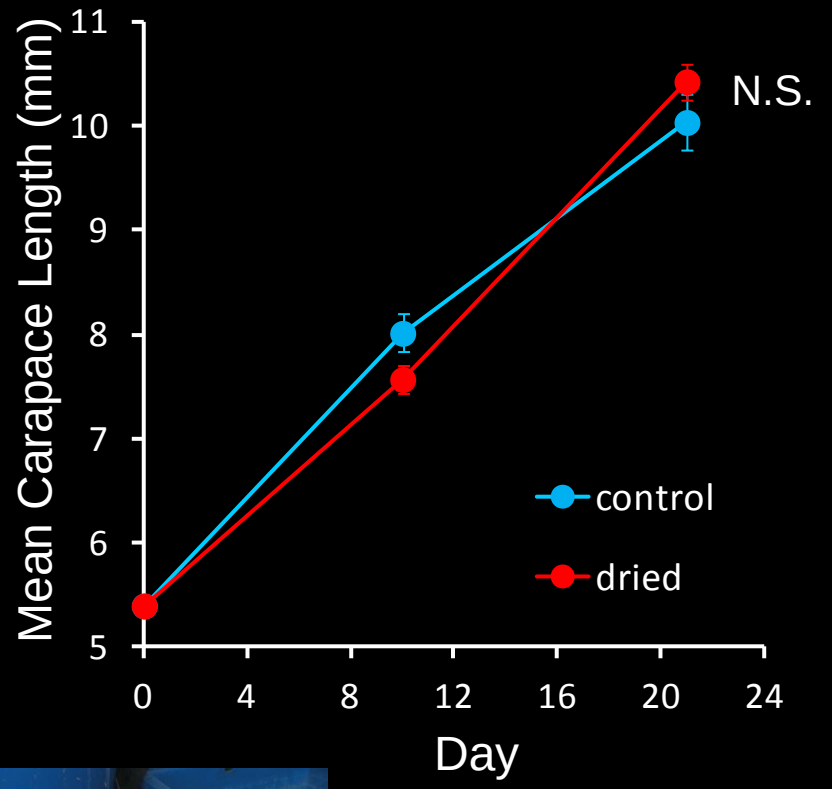
Crayfish Density
TRT x Period: P<0.001



Did juvenile crayfish grow faster on food from previously dried wetlands?

Growth Assay

Small juvenile crayfish fed bulk periphyton for 3 weeks.

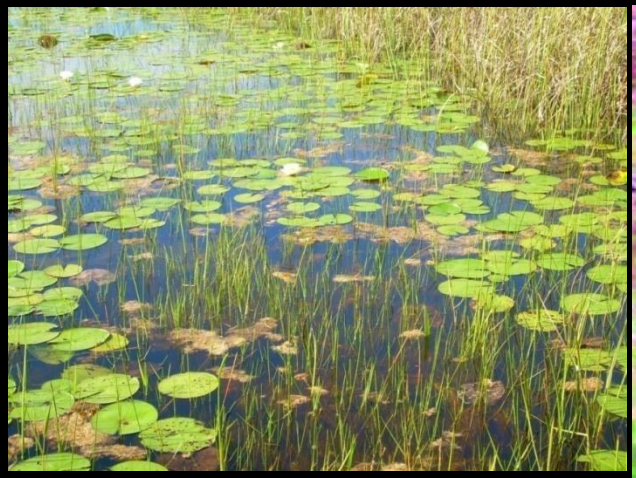


Did juvenile crayfish experience less mortality risk in the dried wetlands?

PREDATION ASSAY: survival of tethered crayfish

C. Crayfish density and hydrologic variability in Everglades sloughs

Do crayfish respond numerically to hydrologic variation in the sloughs of the Everglades?



Water Conservation Area 3A (2005-2012)

8 sites (25 ha each)

Seasons: July-Aug. and Jan.

Throw Traps: 5/site

Hydrologic Covariates: created with Everglades Depth Estimation Network

Model Selection Analysis

Season

Season, Hydro

Season, Hydro, Season*Hydro

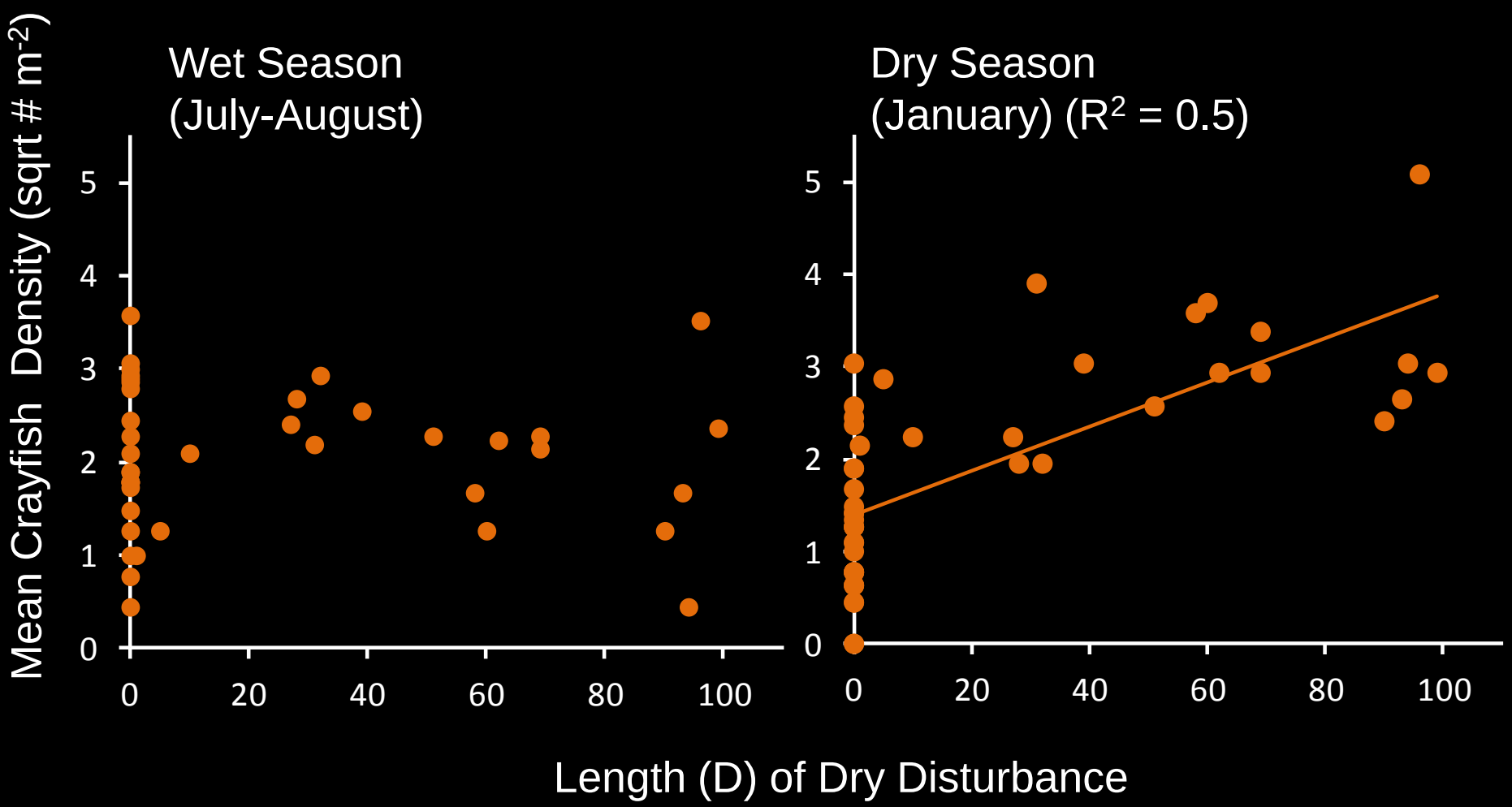
Hydrologic covariate

LD = Length (D) of the dry disturbance (water <1 cm) in the previous year.

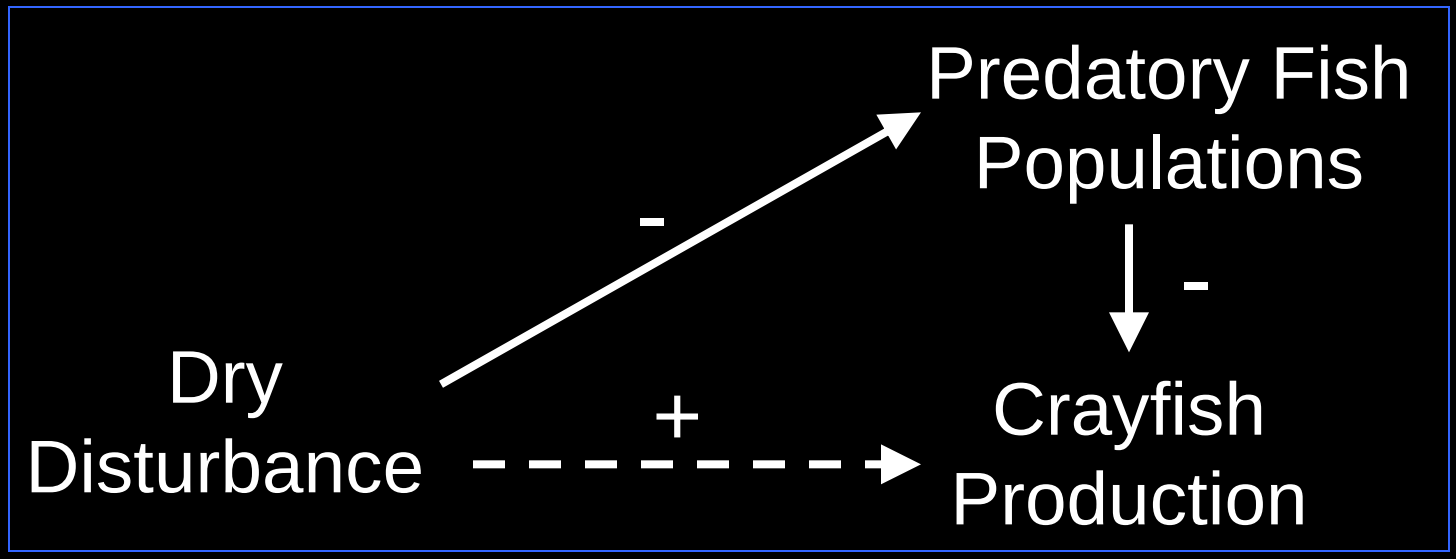
Avg360 = Average depth over past year (cm)

Model selection statistics

Model	AICc	ΔAICc	W_i	Hydro Parameter	Model Fit
Season, LD, Season*LD	221.9	-	0.799	**0.0237 (January)*** 0.0 (August)	0.41
Season, Avg360, Season*Avg360	225.4	3.5	0.139	**-0.0384 (January)*** 0.0 (August)	0.37
Season, LD, Season*LD, Avg360	227.5	5.6	0.049		
Season, Avg360, Season*Avg360, LD	231.0	9.1	0.008		
Season, LD, Season*LD, Avg360, Season*Avg360	232.1	10.2	0.005		
Season, Avg360	239.0	17.1	<0.001		
Season, LD	241.3	19.4	<0.001		
Intercept only	245.1	23.2	<0.001		
Season	245.8	23.9	<0.001		


Wet Season
(July-August)
Dry Season
(January) (R^2 = 0.5)
Mean Crayfish Density (sqrt # m^{-2})
0
1
2
3
4
5
0
20
40
60
80
100
Length (D) of Dry Disturbance

Dry disturbances temporarily release crayfish from limitation by aquatic predators.



A) Sunfish limited crayfish recruitment in wetland mesocosms.
B) Drying and modest reductions of large fish abundances enhanced crayfish densities in LILA wetlands.
C) Survival of juveniles was best in LILA wetlands with lower large fish abundances.
D) Crayfish densities in Everglades sloughs are higher in the winters (i.e., January) following dry disturbances.

Acknowledgments

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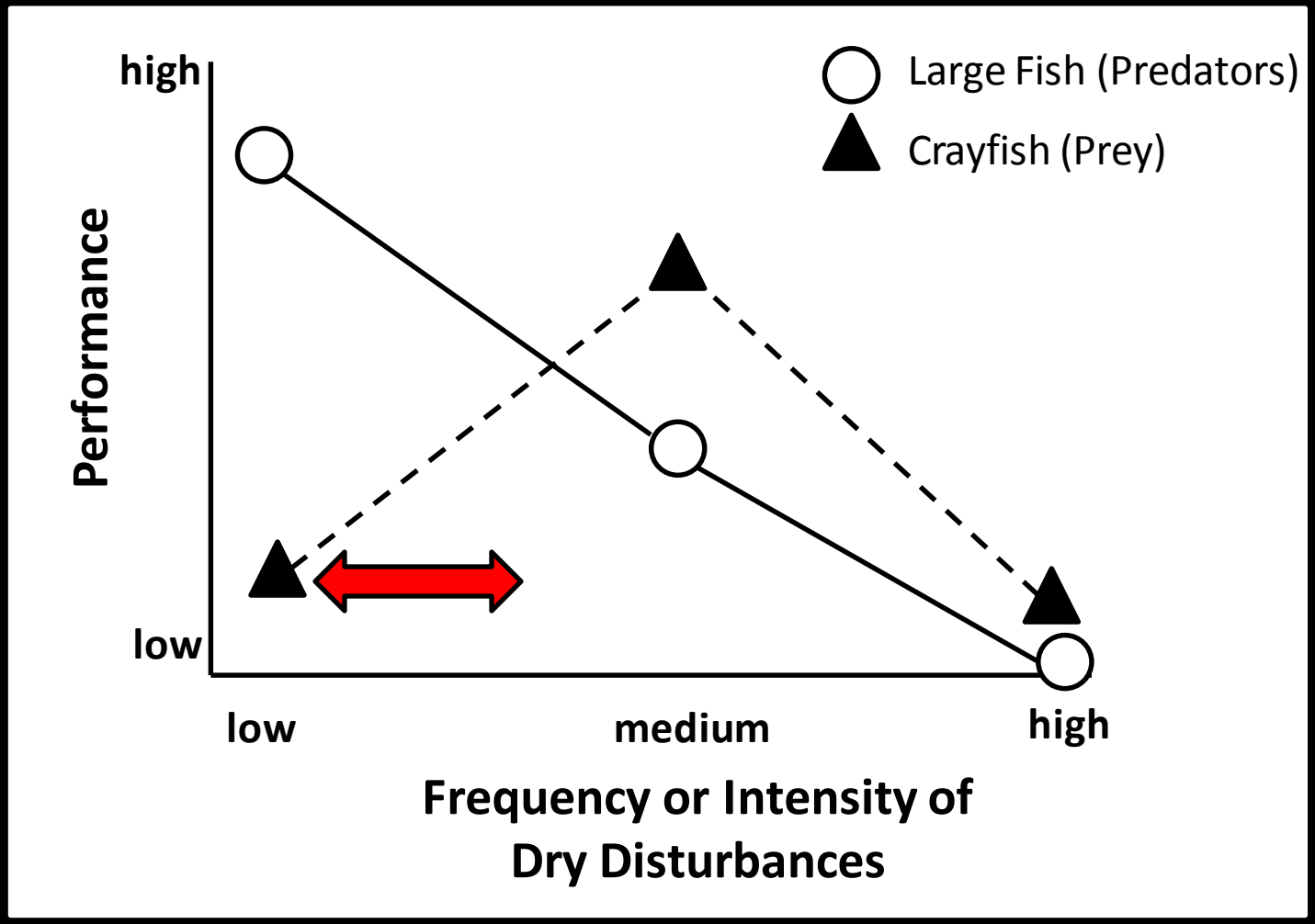
Numerous others from FAU, SFWMD and FIU who helped with the fish removal.

Questions?

The Consumer Stress Model applied to Wetlands



Small Fish Density (no response to manipulation)