Drought and Large Fish Re-Colonization Have Variable Effects on Macroinvertebrates in Experimental Wetlands

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Introduction

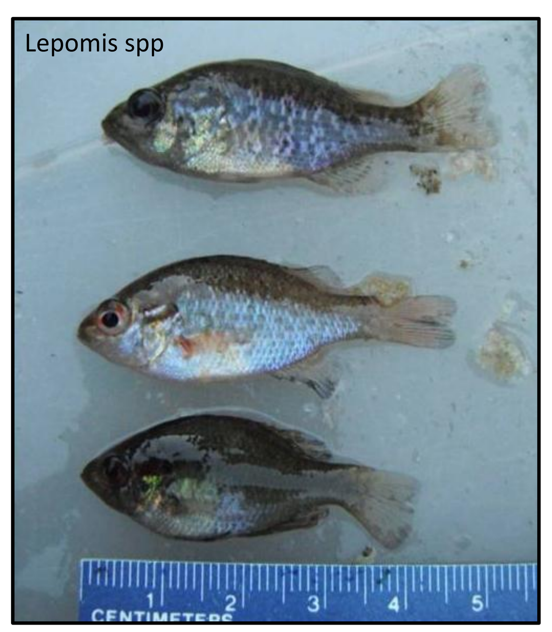
Drought leading to local dry-disturbances (no surface water) has the potential to dramatically alter freshwater animal communities.[1,2] Drying may kill a fraction of local populations, but upon re-flooding the disturbance can also alter food web interactions as well as resources for re-colonizing animals and plants. The net effects of a drying and re-wetting cycle on aquatic invertebrate populations depends on invertebrate life history and taxon-specific sensitivities to predator reduction and habitat changes generated by the drying.[3,4] Some taxa may be enhanced following dry-disturbances while others experience reductions.

In the Florida Everglades, dry-disturbances vary spatially and temporally and can be exacerbated by water management practices. Large-bodied predatory fishes, like sunfish (Centrarchidae) are important top predators in aquatic ecosystems[3,5] and they generally decline in the Everglades following years with low water levels.[6]

We examined the net effects of drying history and predatory sunfish on population growth (density) of large wetland macroinvertebrates (crayfish and dragonflies) with a 6-month experiment that manipulated drying history and large-bodied fish.

Objectives

To quantify the population responses of crayfish (*Procambarus fallax)* and dragonflies (Order: Odonata) to drying history and sunfish re-colonization in wetlands



Methods

We altered the hydrologic history and presence of sunfish (*Lepomis* spp.) in nine 18-m^2 experimental wetlands with natural slough vegetation. We simulated a dry-disturbance by drying six of the wetlands in May for 2 weeks. Upon re-flooding, we stocked three of the previously dried wetlands with sunfish (6 fish per tank), which created three different treatments: previously dried without sunfish (slow re-colonization), previously dried with sunfish (fast re-colonization), and permanently wet with sunfish. The experimental wetlands were stocked or re-stocked with adult crayfish (*P. fallax*), grass shrimp, mosquitofish, and *Utricularia spp*. Dragonflies re-colonized wetlands through natural reproduction. Adult activity was measured twice weekly by recording the number of individuals from each species that landed on or hovered over each tank. Using 1-m^2 throw traps we quantified the mean densities of invertebrates, fish, stems, and the volume of submerged vegetation in the wetlands six months after re-flooding. Abundances (number or g/m^2) were analyzed with ANOVA using wetlands as replicates (n=3 per treatment).

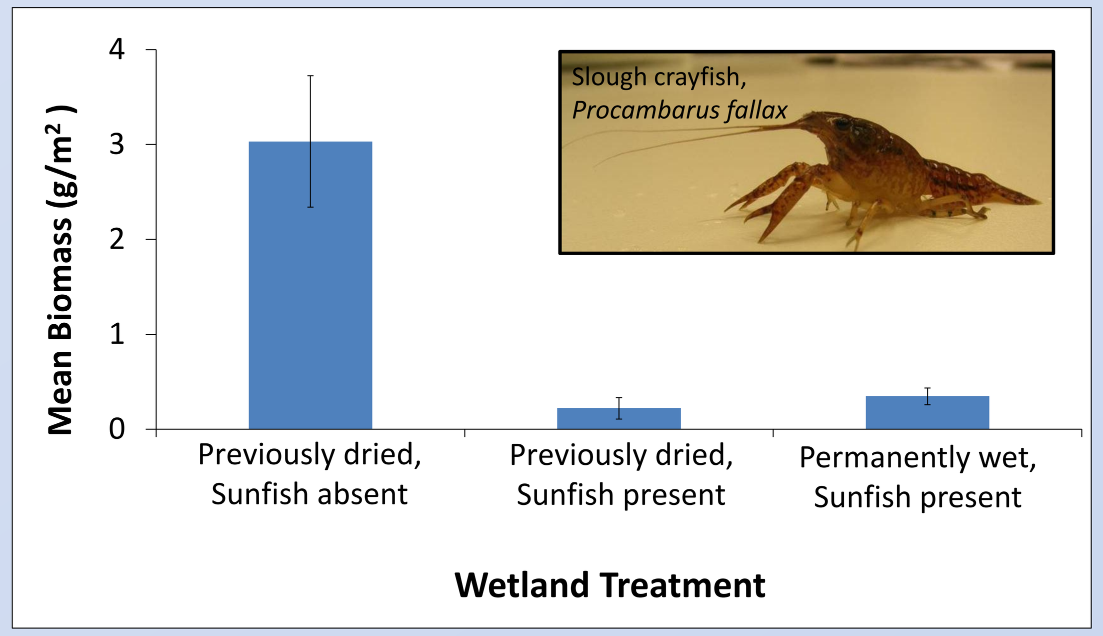


Figure 1. Response of crayfish biomass to treatments. Bars represent treatment averages ± 1 SE.

Results and Conclusions

- Crayfish biomass was higher in the treatment without sunfish than in treatments with sunfish (Figure 1, p=0.0043), and crayfish density showed a similar pattern (p=0.0539).
- When sunfish were present the drying history did not affect crayfish biomass density (Figure 1).
- Crayfish populations in wetlands with sunfish were dominated by small juveniles, suggesting that the direct consumptive effects of the sunfish were preventing recruitment of crayfish to larger juvenile and adult sizes.
- Larval dragonfly densities (all species combined) were higher in the continuously flooded wetlands than in the previously dried wetlands (p=0.0095) and were unaffected by the presence of sunfish in wetlands that had previously dried (Figure 2a).

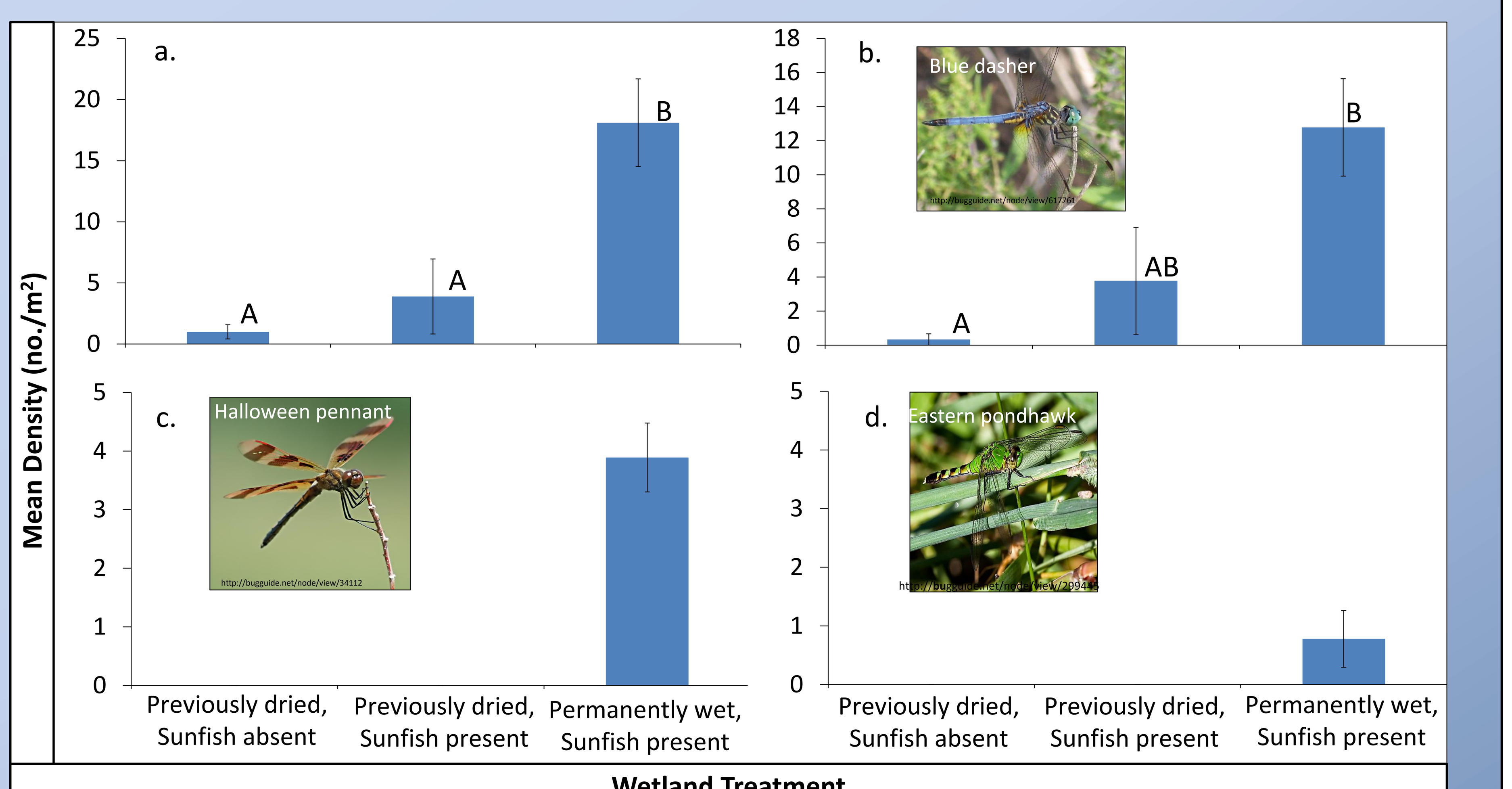


Figure 2. Mean larval densities of a) all Libellulids, b) Blue dasher, *Pachydiplax longipennis*; c) Halloween pennant, *Celithemis eponina*; and d) Eastern pondhawk, *Erythemis simplicicollis*. For a) and b), bars with the same letter are not significantly different from each other. Error bars represent one SE.

Table 1. Mean total adult individuals (1 SE) observed hovering <1m over or landing in wetlands within each treatment over 53 observation days (approximately 9 hours per tank).

Species	Treatment		
	Previously dried, Without sunfish	Previously dried, With sunfish	Permanently wet, With sunfish
P. longipennis	11.3(4.8)	10.3(2.3)	11.7(2.9)
C. eponina	11.3(1.2)	14.3(1.8)	15.3(2.2)
E. simplicicollis	3.7(2.2)	1.7(1.7)	2(1.2)

Table 2. P-values from ANOVA and means (1SE) for selected response variables estimated via throw trap.

Response Variable	p-value	Treatment		
		Previously Dried, Sunfish Absent	Previously Dried, Sunfish Present	Previously Dried, Sunfish Present
Habitat Structure (Vegetation)				
Stem density (#/m^2)	0.8985	550(167)	602(59)	518(163)
Utricularia spp. (mL/m^2)	0.0352	11(11)	32(31)	804(331)
Other Animals				
Grass shrimp (#/m^2)	0.5236	15(1.8)	24(11.5)	12(3.4)
Damselfly (#/m^2)	0.1630	0.9(0.6)	7.1(3.5)	3.1(0.8)
Mosquitofish (#/m^2)	0.0467	40 (2.9)	21(7.3)	20 (3.4)
Mosquitofish (g/m^2)	0.2459	870(109)	484(181)	942(238)
Planorbidae (#/m^2)	0.2545	2.8(2.0)	6.3(3.8)	11.4(3.8)

Results and Conclusions, con't

- The three most abundant dragonfly species showed approximately the same pattern, with *C. eponina* found only in all wet treatment replicates, *E. simplicicollis* found in two of the wet treatment replicates, and *P. longipennis* found in all three treatments but generally less abundant in dried treatments (Figure 2).
- Daily observations of adult activity over the six months did not differ between treatments (Table 1, all p-values > 0.3185), suggesting that differences in larval densities may be due to mortality occurring in the wetland and not adult oviposition choices.
- Mosquitofish densities were highest in the permanently wet treatment, but mosquitofish biomass did not differ between treatments. Densities of other animals also did not differ between treatments (Table 2).
- Stem densities of *Eleocharis cellulosa* were similar across all treatments, but the volume of submerged vegetation (*Utricularia* spp.) was higher in the continuously flooded treatment (Table 2).
- The results of this experimental study indicate that crayfish population growth is enhanced by sunfish reductions that can be caused by droughts, while dragonflies are not as sensitive to sunfish and may suffer indirect losses due to other changes caused by dry-disturbances.

References
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