

The Effect of *Phragmites australis* Invasion on Southern Leopard Frog Tadpole Survival on Long Island

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Abstract

Phragmites australis is a type of invasive plant whose destructive ecological effects include displacing native species and altering the structure of wetlands. Our research explored the possibility that *P. australis* has a detrimental impact on the survival of the southern leopard frog (*Rana sphenocephala*) and is a factor in the decline of the frog on Long Island. We raised southern leopard frog tadpoles at six different sites with three different levels of invasion: none, medium, and heavy. The tadpoles were raised in mesh enclosures *in situ* and their growth and survival was monitored. Basic aspects of water quality were evaluated to determine if the presence of *P. australis* made a notable difference. Results indicate that *P. australis* alone does not have a detrimental impact on tadpole survival, but may be harmful in conjunction with other stress factors such as disease. Water temperature tended to be lower as invasion levels increased, presumably due to an increase in shade. It is possible that the decreased water temperature slows tadpole development. Further research could explore the possibility that *P. australis* does not prevent tadpoles from surviving physically, but affect the adults behaviorally by altering the structure of wetlands. It is possible that sites with heavy *P. australis* invasion are not seen as suitable breeding habitat.

Introduction

Within the past several decades, the non-native plant *Phragmites australis* has become a more aggressive invader of wetlands, especially coastal marshes [1]. One study [1] has indicated that human disturbance may be a contributing factor allowing the plant to spread and grow more successfully. Thus, it is possible that *P. australis* has spread with

more intensive land-use practices. Southern leopard frogs (*Rana sphenoccephala*) have a broad distribution and are a common species throughout their range [2]. However, the species has declined dramatically on Long Island, reaching near extirpation. This experiment tests the hypothesis that *P. australis* invasion reduces southern leopard frog tadpole survival and is a contributing factor to the decline of the species on Long Island.

Methods

Six ponds were carefully chosen to accurately represent three different levels of *P.*

australis invasion: none, medium, and heavy. Table 1 lists all six sites, their level of invasion, and pond type while Figure 1 depicts their location on Long Island. Table 2 outlines the criteria used to classify each site

Table 1

Descriptions and Locations of Sites Used to Test the Effect of <i>Phragmites australis</i> on Southern Leopard Frog Tadpole Survival						
Site Number	1	2	3	4	5	6
Level of Invasion	Medium	High	None	None	High	Medium
Pond Type	Large Coastal Plain Pond	Large Sandy Coastal Pond	Sphagnum Bog/White Cedar Swamp	Farm Pond	Small Sandy Coastal Pond	Large Sandy Coastal Pond

Figure 1: Six different sites representing three different levels of *Phragmites australis* invasion were chosen in Suffolk County on Long Island.



Table 2

Parameters for determining the level of <i>Phragmites australis</i> invasion		
No Invasion	Medium Invasion	Heavy Invasion
<ul style="list-style-type: none"> No <i>P. australis</i> visibly present either because it does not occur or is effectively controlled Pond substrate does not contain <i>P. australis</i> roots or debris 	<ul style="list-style-type: none"> Light can easily penetrate <i>P. australis</i> stand The minority of the pond substrate where <i>P. australis</i> stand ends and open water begins is composed of <i>P. australis</i> roots and debris Native flora still significantly present and easily found <i>P. australis</i> stand grows in clumps and has open patches 	<ul style="list-style-type: none"> Sunlight cannot easily penetrate <i>P. australis</i> stand The majority of pond substrate where <i>P. australis</i> stand ends and open water begins is composed of <i>P. australis</i> roots and debris. Native flora almost completely outcompeted by <i>P. australis</i> <i>P. australis</i> stand grows densely and is devoid of open patches

Individual water samples were taken at each site and water quality was measured using a YSI instrument. Tadpoles were kept in aquatic mesh enclosures with PVC framing to eliminate predation as a variable. Each site had six enclosures and each enclosure contained six tadpoles. The enclosures were checked once a week to monitor basic environmental conditions and tadpole survival. Dimensions of the enclosures at sites with no invasion and medium invasion were 66cm x 58.4cm x 50.8cm. At sites 2 and 5 (heavy invasion), the dimensions were 66cm x 58.4cm x 66cm. At each site, detritus was raked from the pond bottom and dried to eliminate macroinvertebrates. 200 grams of the dried detritus were added to each enclosure to provide food. At sites 2 and 5 only, the effects of *P. australis* were simulated within each enclosure by constructing mini “stands”. Two rocks were placed in a sock for weight and five stalks of *P. australis* with root bundles were cut to approximately 16 inches in length and added to the sock. The top of the sock was tightened shut using rubber bands to create one “stand”. Each enclosure received four “stands.” Figure 2 depicts the completed “stands”.

Figure 2: In order to mimic the full structural and chemical effects of *Phragmites australis* at sites with high levels of invasion, mini “stands” were made that could be placed in each enclosure.



Results

P. australis was not demonstrated to have substantial qualitative effects on water quality.

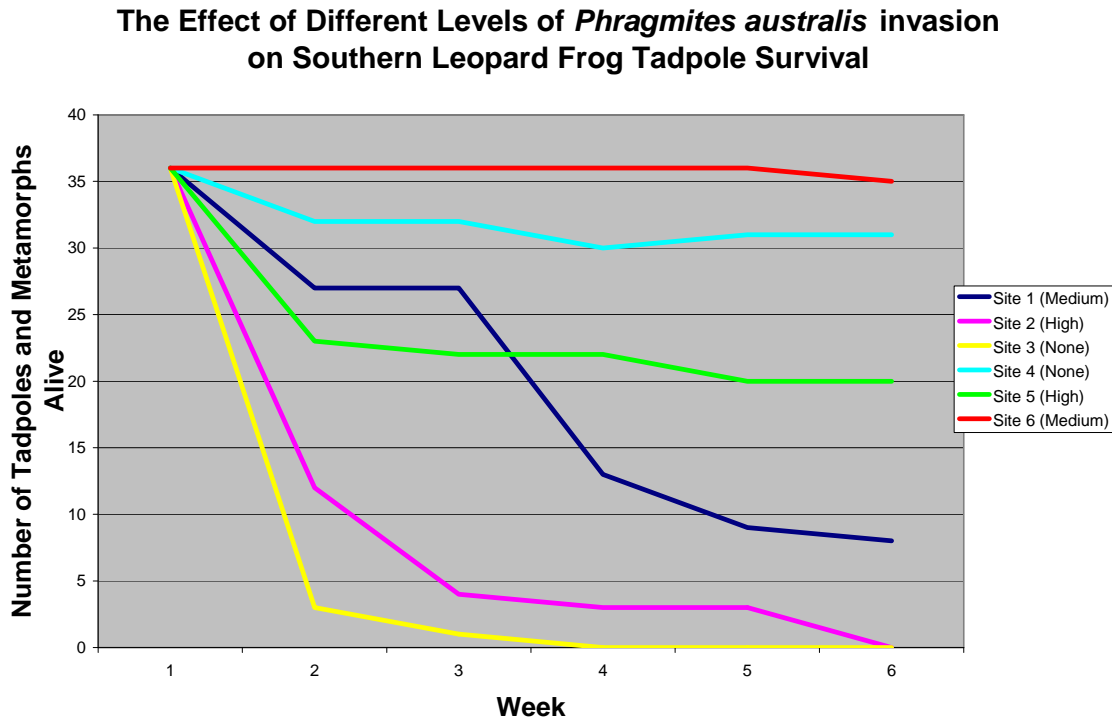
Water temperature was the only aspect affected by *P. australis*, with water temperature decreasing as invasion levels increased, most likely due to increased shade. At Site 6, the water temperature remained fairly high despite medium invasion because the water was shallower than most other sites. Table 3 shows the water quality measurements recorded at all six sites.

Table 3

Aspects of Water Quality at the Experimental Ponds Used to Determine the Effects of <i>Phragmites australis</i> on Southern Leopard Frog Tadpole Survival					
Site Number	<i>Phragmites australis</i> Invasion Level	Temperature (°C)	Conductivity (ms/cm)	Dissolved Oxygen (mg/L)	pH
1	Medium	29.4	0.053	8.74	7.2
2	Heavy	23.3	0.175	3.36	5.5
3	None	34.4	0.046	7.57	4.7
4	None	31.8	0.105	13.60	7.9
5	Heavy	24.9	1.429	10.19	4.8
6	Medium	31.4	0.300	10.30	8.3

Tadpole survival appeared to be independent of *P. australis* invasion. The most successful sites were Site 6 and Site 4, where the majority of tadpoles made it to metamorphosis. Site 1 and Site 5 were moderately successful, with some of the tadpoles making it to metamorphosis, but with significant death. At Site 2 and Site 3, 100% of the tadpoles died. Pond 2 was the only pond to dry out and no longer had enough water to sustain tadpoles by week 5. Chart 1 displays the survival trend at each site.

Chart 1



Discussion

It is not likely that *P. australis* by itself reduces southern leopard frog tadpole survival.

However, its structural effects on wetlands have minor implications. A more thorough quantitative analysis is important. *Phragmites australis* creates more shade than what might normally occur in a particular wetland. Being ectotherms, frogs depend on the environment to maintain their body temperatures. Reduced amounts of direct sunlight lead to lower temperatures and further research could explore the possibility that these reductions may slow the development of tadpoles or create more stress and leave them vulnerable to disease. Further research could also explore the possibility that *P. australis* does not prevent tadpoles from surviving physically, but affect breeding adults behaviorally by altering the structure of wetlands. Southern leopard frogs tend to breed in open water with emergent vegetation [2]. It is possible that sites with heavy *P. australis* invasion are not seen as suitable breeding habitat.

References

[1] T.E. Minchinton and M.D. Bertness, "Disturbance-mediated competition and the spread of *Phragmites australis* in a coastal marsh," Ecological Applications, vol. 13, no. 5, pp.1400-1416, Oct. 2003.

[2] B.P. Butterfield, M.J. Lannoo, and P. Nanjappa. "*Rana sphenocephala*", in Amphibian Declines: The Conservation Status of United States Species, Berkeley, California: University of California Press, 2005, pp. 586-587.