Managing for Invasive Species and Pesticide and Fertilizer Exposure: How Golf Courses Can Bolster Amphibian Communities

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Objectives:

1. To test the interaction of three stresses (i.e. invasive species, insecticide exposure, and fertilizer exposure) that can affect amphibian population diversity on golf courses.

Start Date: 2003
Project Duration: two years
Total Funding: $59,000

During this year of funding, we have completed our proposed study for year I on the interactive effects of two invasive species, pesticide exposure, and fertilize exposure in 1000-liter cattle tank ponds. Additionally, we initiated a pilot study in seven ponds on golf courses and protected areas to determine how amphibian species may differ in survival and development.

We are currently analyzing the results and preparing to write a manuscript; additionally, portions of this data will be presented at the annual meeting for the Society of Environmental Toxicology and Chemistry meeting on November 10th in Austin, TX. The objective of our proposed study was to test the interaction of three stresses that can affect amphibian populations and which may impact amphibian diversity on golf courses.

We reared spotted salamanders (*Ambystoma maculatum*), American toads (*Bufo americanus*), and southern leopard frogs (*Rana sphenocephala*) together in cattle tank ponds that contain 1000 L water, plankton, and 1 kg leaf litter.

Bullfrogs are a common invasive species in golf course water features.

Pond communities were exposed to presence of invasive species (0 invasives, 4 overwintered bullfrog tadpoles, 2 fish, or both invasives), insecticide exposure (0 or 2.5 mg/L carbaryl), or fertilizer exposure (0 or 10 mg/L nitrate). Each treatment was replicated four times.

Amphibians were added to ponds shortly after hatching and reared through metamorphosis. We also measured the food resources (chlorophyll & zooplankton) in the ponds to determine if our treatments could indirectly affect amphibians through altering the amount of available food.

Preliminary analyses indicate that all treatments singly and interactively affected the amphibians and their food resources. Generally, single stressors often had apparent positive effects on amphibians (with the exception of fish presence which had a strong negative effect on all amphibians), but two or more stresses negatively affected the community.

With this data we will be able to determine the effects of multiple stressors (invasive species, pesticide exposure, and fertilizer exposure) so that the single and interactive effects of each stress can be clearly determined and attributed to an explicit effect. We will also be able to understand the mechanism of treatment effects based on changes that occurred in the zooplankton and algal communities (i.e., the food resources for salamanders and anurans, respectively).

*Southern leopard frogs (*Rana sphenocephala*) were exposed to invasive species, insecticide, and nitrate.*

In our pilot study on golf course pond and protected "control" ponds, we found that amphibians had greater survival, larger masses, and faster time to metamorphosis in control ponds than in golf course ponds. This study gives us a framework to pursue our proposed study for next year and allowed us to work out methodology.

Summary Points

- Pond communities were exposed to presence of invasive species (0 invasives, 4 overwintered bullfrog tadpoles, 2 fish, or both invasives), insecticide exposure (0 or 2.5 mg/L carbaryl), or fertilizer exposure (0 or 10 mg/L nitrate).
- All treatments singly and interactively affected the amphibians and their food resources.
- Amphibians had greater survival, larger masses, and faster time to metamorphosis in control ponds than in golf course ponds.
- Single stressors often had apparent positive effects on amphibians (with the exception of fish presence which had a strong negative effect on all amphibians), but two or more stresses negatively affected the community.