Wiess School of Natural Sciences
Ecology and Evolutionary Biology
Rice University

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Final report

Project: **Linking climate change to the structure and functioning of native communities**
PI: Dr Volker Rudolf (volker.rudolf@rice.edu)
Co-PIs: Drs. Amy Dunham & Caroline Masiello
Shell Center Fellow: Amber Roman

1. Background

The project started in January of 2011, but due to the severest drought in Texas on record and one of the hottest springs-early summers on record, we had to add another spring season to conduct the proposed studies. The final report summarizes the main activities and findings, as well as current products and expected products.

2. Key activities & findings

i) In the spring of 2011, we successfully developed an experimental protocol that allows us use a very cost-effective setup to heat up to 60 entire experimental ponds. Our data shows that this approach raises the temperature by 3-4.5ºC on average while still following the natural diurnal temperature fluctuations and variation among days. We are very excited about this result (in fact it worked better than we expected). Developing this protocol was a major goal of our proposed work and thus a big achievement. This setup will be a major component for much of our future research to examine how project climate warming could influence the dynamics of local amphibian pond communities.

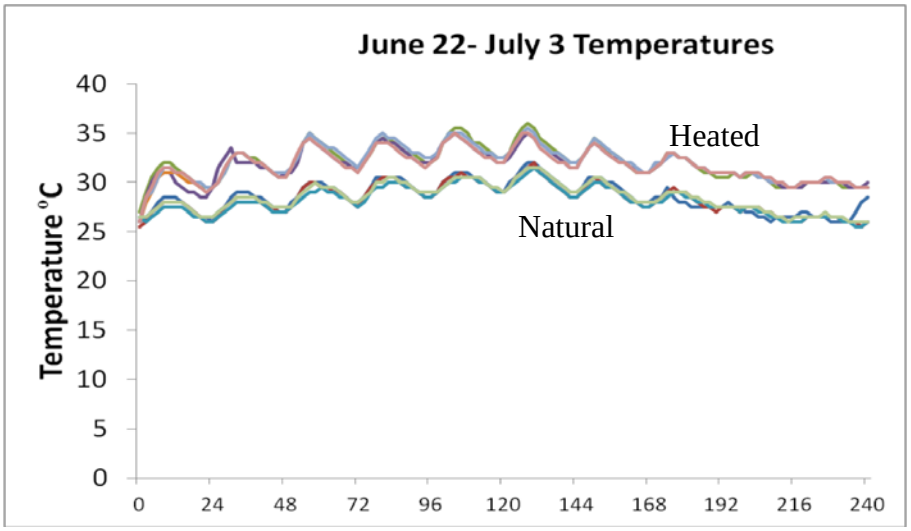

Figure 1: Temperature dynamics in four heated and four tanks with natural temparature dynamics for a 240 hrs period.

ii) In 2012 we used this setup to conduct one large scale experiment to test a) how three Texas amphibian species respond to simulated increase in temperature as predicted by future climate change scenarios for this regions, b) how this increase in temperature will

affect competition among two of the species and c) the effect of predation. We monitored the survival, development & phenology of the respective species, how it affects ecosystem processes such as primary productivity and zooplankont community structure. Our results revealed several findings. First, we found that the increase in temperature differentially affected the survival and growth rate of the three species. This suggests that climate warming could have different consequences for each species. Second, we found that heating altered the effect of competition and predation, and the effects were not additive. For instance, survival of the Bronze Frog (*R.sphenocephala*) was reduced when ponds experienced higher temperatures, and this negative effect was amplified in the presence of interspecific competition, while predation reduced the negative effects. We are currently in the progress to prepare the data for publication.

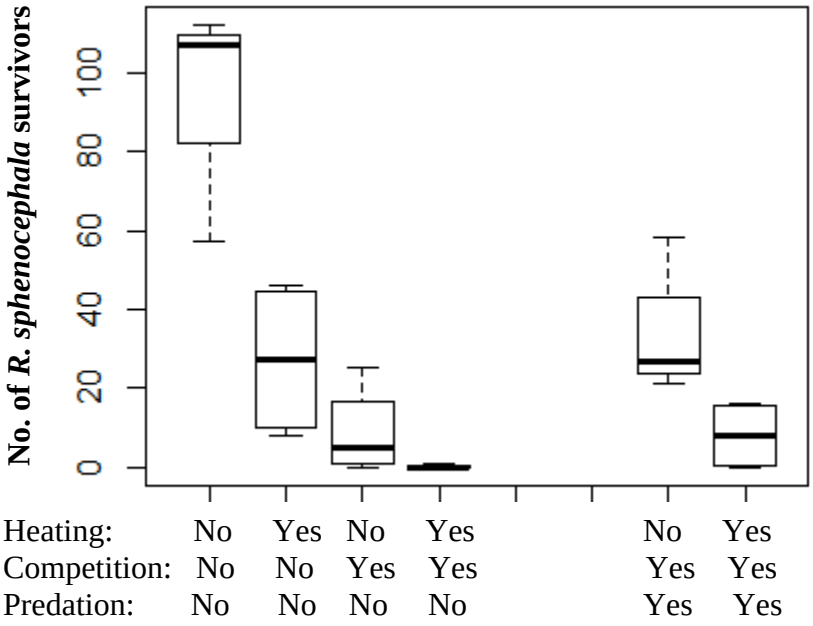

Figure 2: Example of differences in survival of *R. sphenocephala* tadpoles as a function of simulated climate warming (heating), presence of interspecific competitors (competition), and predators.

iii) In spring 2011 and 2012, we also raised two salamander species under laboratory conditions at three different temperatures to measure their individual response (survival and growth rates) in response to these temperatures and how both species differ. Overall, we found that this method was not well suited because of difficulties with live food and high mortality rates of both species.

iv) We also initiated another experiment in March 2012, where we manipulated the relative arrival time of four amphibian species to examine how shifts in the phenology of species alter competitive interactions in these amphibian communities. The data suggests that arrival time indeed alters competitive interactions, thereby altering the survival and

E-mail Volker.rudolf@rice.edu | **Office** 713-348-2834 | **Fax** 713-348-5232 | Rice University Wiess School of Natural Sciences–MS 170
6100 Main Street | Houston, TX 77005 | **natsci.rice.edu**

phenology of amphibian species. We are awaiting analyses of other ecosystem variables, including primary productivity (periphyton & phytoplankton biomass).
After that, we will prepare the data for publication and hope to submit a manuscript by the end of the year. This data has been used in a pre-proposal for NSF in 2012 (unsuccessful), but we plan to resubmit the proposal again in 2014.

v) The shell center fellow Amber Roman has taken the lead on all this project components and supervised seven undergraduates that helped her to conduct the research.

3. Products

- Rice undergraduates employed for the project:
  - Molly Cisneros (EEB Major)
  - Emily Sartain (Biology Major)
  - Kathleen Abadie
  - Samantha Masaki (EEB Major)
  - Emily Crowder (EEB Major)
  - Emily Wheeler (EEB Major)
- One undergraduate student undertook an independent study in spring 2012 (part of experiment **iv** explained above)
- One grant proposal to NSF (will be resubmitted in 2014)
- 2 publications are expected to be submitted by the end of 2013

4. Conclusion:

The goal of this project was to develop methods and gather preliminary data to examine how climate driven changes in temperatures and breeding time a) affect local amphibian species, b) the structure of natural communities and c) ecosystem processes? We have successfully developed an experimental setup test these questions. In addition, we have obtained important preliminary data in support of our theory indicating that climate mediated changes in temperature and breeding phenology have the potential to alter the performance of species, species interactions, and structure of pond communiites. These findings will be used in future proposals to obtain NSF, US-EPA, and DOE funding. Furthermore, we expect that on top of this we will publish two papers in peer reviewed journals. In addition, we were able to engage one Shell Center Fellow and seven undergraduates in all aspects of primary research (from designing experiments to publication) and think across disciplines

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Undergraduates doing field work

Undergraduate practicing taking zooplankton samples

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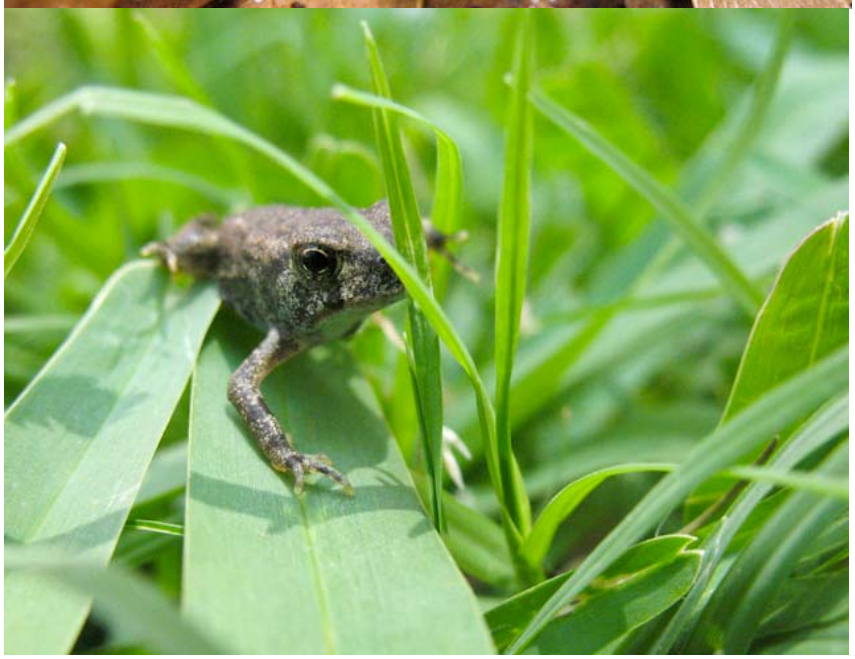
Examples of study species:
Grey Tree Frog (top) Gulf Coast Toad (bottom)



Hunters Spade Foot Toad (top); Mole Salamander (bottom)

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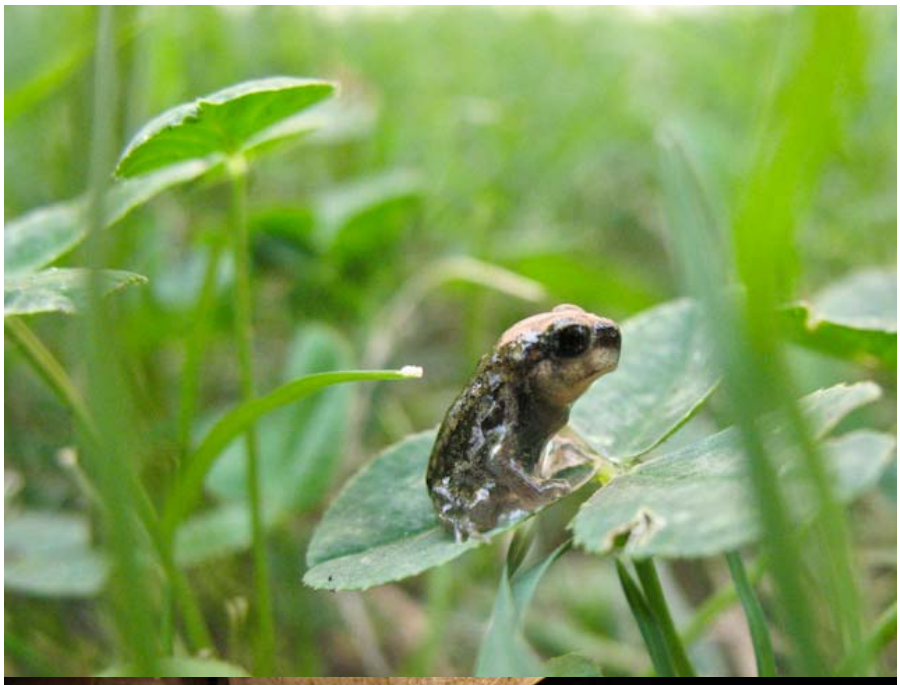

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