Implications of habitat-mediated density dependence in Crawfish Frogs (*Lithobates areolatus*)

Auriel M.V. Fournier

Population Ecology

Spring 2015

Background

Density dependence, if it exists, is very important in understanding the population ecology of a species. While there are some exceptions (the Allee effect) where a minimum viable population is important, often lower density populations have higher individual survival. Density dependence is often not the only factor impacting survival of a population, or a certain part of a population, environmental variables can also play a huge role. Either by releasing a segment of the population from the limting factors creating density dependence, or by making the limiting factors more limiting, or adding additional limitations. This coudl be done by providing additional food, or additional shelter or by introducing new predators, removing shelter or adding new chemicals into the environment that limit growth or survival. These relationships have been examined in many invertebrates, but species with longer life spans can have similar mechanisms but they are more difficult to tease apart. Amphibians provide a good vertebrate model organism because they have a fairly quick life cycle and the parts of their life cycle where they are thought to experience density dependence are fairly short (several weeks/months) instead of years as in larger longer lived organisms or organisms with different reproductive strategies. These ideas have been examined in several life stages (eggs (Vonesh and De la Cruz 2002) (aquatic alrval and terrestrial juvenile stages (Altwegg 2003) (juvenile terestrial stage (Harper and Semlitsch 2007) but not often in differing habitat conditions. Though Patrick et al (2008) did exampine habitat and density dependence in wood frogs (*Rana sylvatica*) in relation to environmental covariates which could play a role by limiting growth or resources and incuding density dependence at densities where it would not occur under 'ideal' or 'typical' conditions.

We are looking at a variety of densities and four different habitat/vegetation scenarios to examine the role of restored versus unrestored wetland habitats and native vs invasive (fescue) vegetation. Non-restored habitats or those with non-native vegetation might not provide sufficient resources for the individuals or may create a more stressful environment by having different chemical or other triggers of stress (CITATION).

UV impacts on density dependence (Blaustein et al. 2003)

overcoming density depenedce and insecticides (Boone 2005)

Experimental Design

We created four rafts of mesocosms to be deployed at Woolsey Wet Prarie, a local restored wetland in Fayetteville, AR. TWo rafts were deployed in the restored wetland portion of Woolsey, and two in the farm pond portion of woolsey. Within these two rafts there were a fully factorial design of combinations of two plant communities (fescue and native prarie) and differing densities (1,3,6,21,24,48 tadpoles). We selected these two plant communities to see if the non-native fescue grass has a different impact on tadpole density then the native prarie grass. We choose densities across a wide range (1-48) to ensure that we picked densites extreme enough to be able to determine if there are density dependence effects.

Our responses are both survival and growth. To measure survival the mesocosms are checked at regular intervals and individuals in each mesocosm are counted. Growth was measured by assessing the size and weight of tadpoles at regular intervals. We predict that there will be density dependence, and that fescue grass will have more negative density dependence then prarie grass because it exudes chemicals which impact

tadpoles. We predict that tadpoles will grow better and be less susceptible to density dependence in teh restored wetladn then the farm pond.

Model Description

Our model is a time series model and allows a parameter in the matrix to change with each time step. We are allowing the Fecundity of adults paramter to vary, which is a function of the number of tadpoles, their survival and the number of adults.
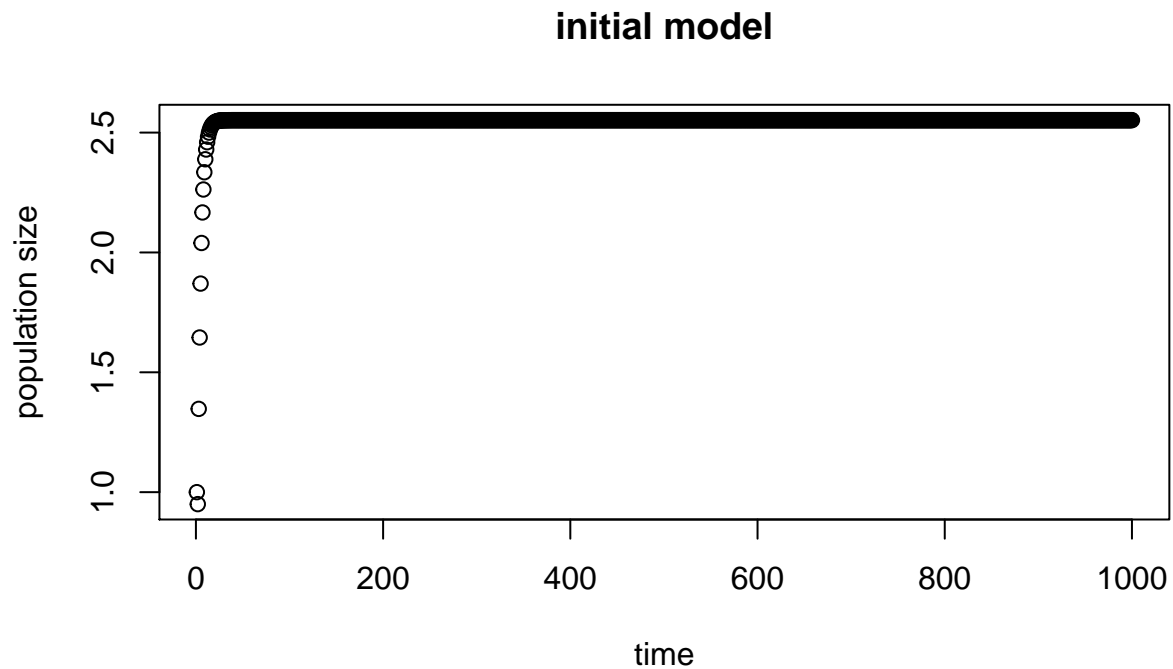
Results

Discussion

Figures

Figure 1 - Our initial population model using the parameters given to us in class
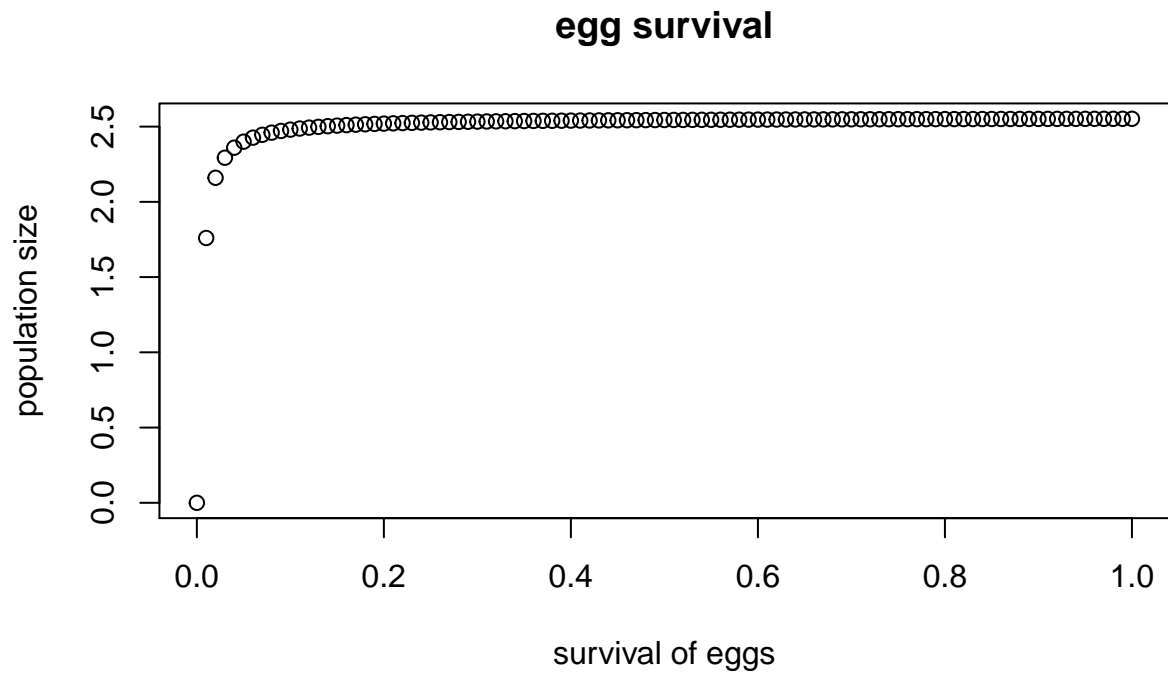
egg survival

Figure 2 - Our sensativity analysis of egg survival, showing that unless egg survival is below 10% it will not have an impact on population size.
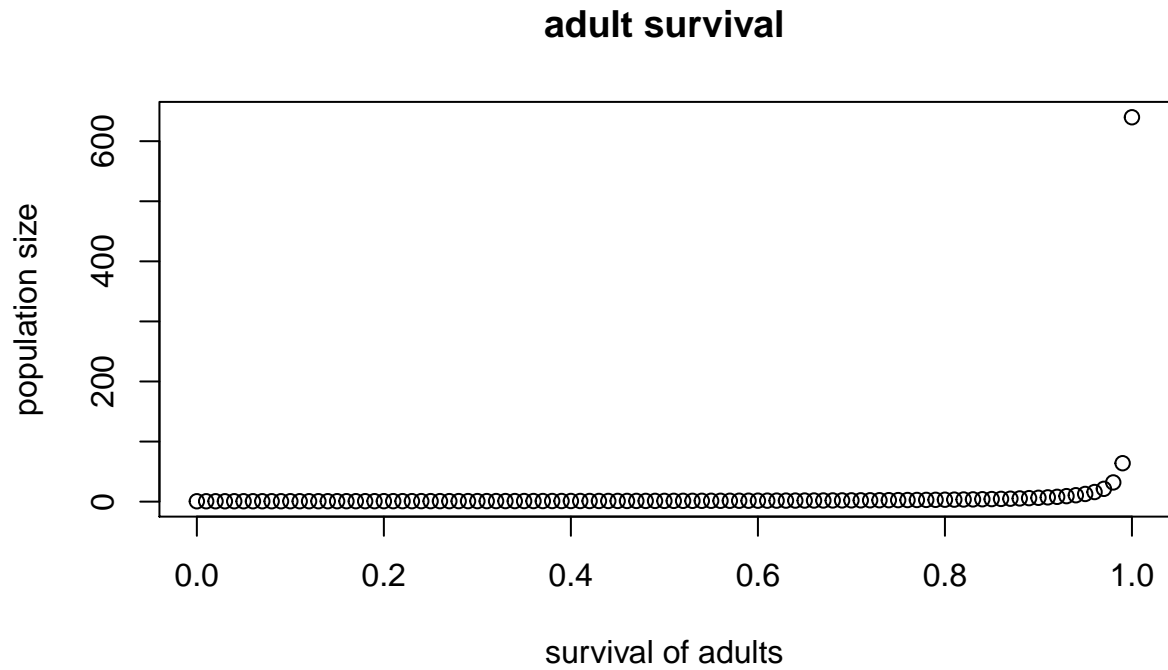
adult survival

Figure 3 - Our sensativity analysis of adult survival, showing that unless adult survival is above 90% it will not have an impact on population size.

References

Altwegg, R. 2003. Multistage density dependence in an amphibian. Oecologia 136:46–50.

Blaustein, A. R., J. M. Romansic, and J. M. Kiesecker. 2003. SPECIAL ISSUE : AMPHIBIAN DECLINES Ultraviolet radiation , toxic chemicals and amphibian population declines. Diversity and Distributions:123–140.

Boone, M. D. 2005. Juvenile Frogs Compensate for Small Metamorph Size with Terrestrial Growth: Overcoming the Effects of Larval Density and Insecticide Exposure. Journal of Herpetology 39:416–423.

Harper, E. B., and R. D. Semlitsch. 2007. Density dependence in the terrestrial life history stage of two anurans. Oecologia 153:879–889.

Patrick, D. a., E. B. Harper, M. L. Hunter, and a. J. K. Calhoun. 2008. Terrestrial habitat selection and strong density-dependent mortality in recently metamorphosed amphibians. Ecology 89:2563–2574.

Vonesh, J. R., and O. De la Cruz. 2002. Complex life cycles and density dependence: Assessing the contribution of egg mortality to amphibian declines. Oecologia 133:325–333.