Using Environmental and Natural History Traits to Predict On-Going Global Amphibian Die-offs

Kristina Frogoso[1] , Scott Connelly[2]
University of Arkansas at Little Rock[1], Odum School of Ecology, University of Georgia[2]

Introduction

Recent losses in global biodiversity are widespread, and it is believed by many that we are in the beginning of a sixth major extinction event. Declines in amphibian diversity are recognized as playing a large role in these biodiversity losses. Dramatic declines in amphibian populations are largely due to threats including habitat loss and infectious diseases. A disease in particular that has been associated with widespread amphibian losses is chytridiomycosis, which is caused by the fungal pathogen *Batrachochytrium dendrobatidis* (Bd) (Daszak et al. 2003).

It is known that a number of environmental factors may play a role in the prevalence of Bd. Additionally, not all amphibian species are affected equally when exposed to Bd, which may be due to a variety of natural history characteristics that each species possesses. To help predict and prevent further disease-driven amphibian declines it is important to determine which environmental and natural history traits most affect a species' vulnerability to chytridiomycosis (Bielby et al. 2008).

Question

Can we use environmental and natural history traits to predict the threat status of amphibians?

Results

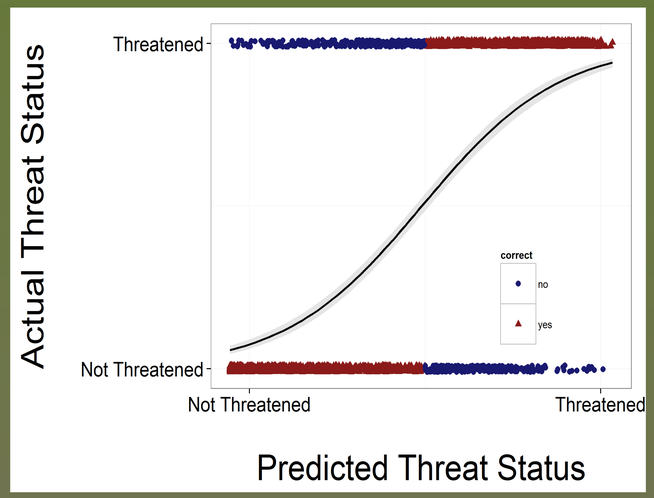


Figure 1. Logistic regression plot of predicted vs actual threat status. The multiple regression relationship for the data set with known threat status was applied to the data set with unknown threat status. Correct predictions (1799) over total predictions (2333) resulted in 77% accuracy.

Results (continued)

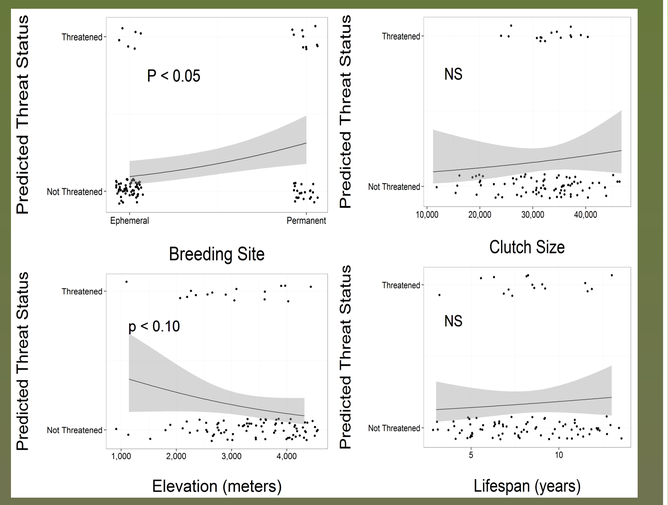


Figure 2. Logistic regression plots of several natural history traits vs predicted status (U.S. and Canada frog species only).

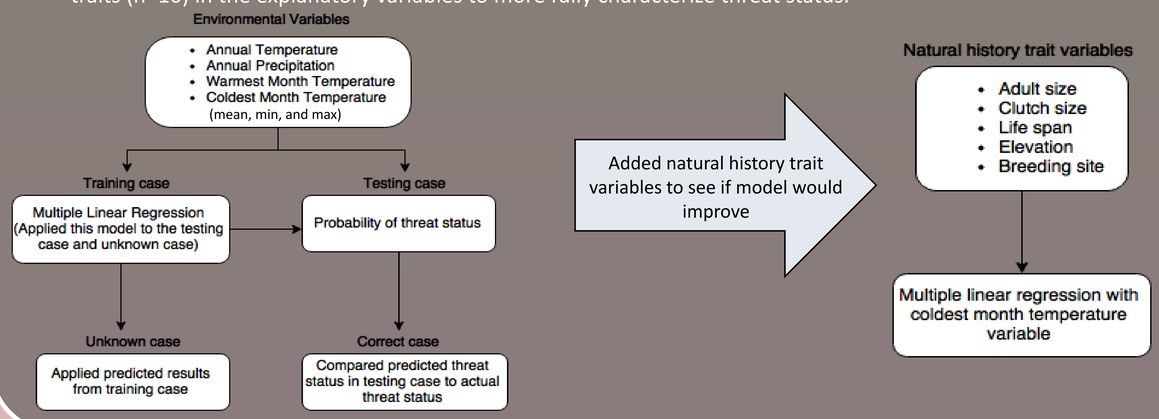
- Species with more permanent breeding sites tend to be more threatened ($p < 0.05$).
- Species occurring in lower elevations tend to be more threatened ($p < 0.10$).
- We found no strong relationship between clutch size and threat status ($p = 0.41$).
- Nor did we find a relationship between amphibian lifespan and threat status ($p = 0.78$).
- Breeding site type was the strongest predictor of threat status.

Table 1. Several species that are threatened and use permanent breeding sites.

Species	Treat status
Rana chiricahuensis	VU
Rana sierra	EN
Rana muscosa	EN
Rana fisherii	EX
Rana pretiosa	VU
Rana tarahumarae	VU
Rana daytronii	VU

Methods

A multiple linear regression (logit) was generated with RStudio to model the relationship between environmental variables (n=12) and amphibian threat status. We then included amphibian natural history traits (n=10) in the explanatory variables to more fully characterize threat status.



Conclusions and Future Work

- Using characteristics of amphibian species with known threat status, we were able to predict threat status (that is, potential population declines due to disease) of amphibian species with unknown conservation status with 77% accuracy.
- Results of these models can be used by biologists to focus conservation efforts. Specifically, amphibians found in areas with permanent bodies of water and in lower elevations may justify the most intensive conservation management.
- Little is known about the biology of many of the over 6,000 species of amphibians found worldwide. Increasing our understanding of some of these species may be useful in better predicting ongoing population declines.
- A more thorough integration of trait data with species that were incorrectly predicted may increase the reliability of our threat status model.
- These widespread losses of amphibian species are occurring with largely unknown, and undocumented ecological consequences. Further research should address how these losses affect ecosystem properties and potentially human well-being.

Acknowledgements

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References

Bielby, J., Cooper, N., Cunningham, A., Garner, T., & Purvis, A. (2008) Predicting susceptibility to future declines in the world's frogs. *Conservation Letters,* 82-90.

Daszak, P., Cunningham, A., & Hyatt, A. (2003) Infectious disease and amphibian population declines. *Diversity Distributions,* 141-150.