May 17th, 9:00 AM - 12:00 PM

GIS Suitability Analysis to Identify Critical Habitat for the Cascades Frog (Rana cascadae)

Victoria Niewohner
Western Washington University

Identifying Critical Habitat for the Cascades Frog (*Rana cascadae*)

Victoria Niewohner, 2017
ENVS 422, Huxley College of the Environment, Western Washington University

Introduction

The Cascades Frog (*Rana cascadae)* is listed as near threatened by the International Union for Conservation of Nature (IUCN) and is under review to be listed as endangered or threatened under the Endangered Species Act (ESA)[1,2]. This species ranges along the length of the Cascades from northern Washington to northern California with another population on the Olympic Peninsula[1].


Walter Siegmund 2009

There have been declines in *Rana cascadae* populations in the southern Cascades in California, especially around Lassen Peak[3,4].Several factors have been theorized for the decline of *Rana cascadae* around Mount Lassen including the fungal diseases, chytridiomycosis, habitat desiccation, introduced fish, and habitat loss[3,4]. Despite local declines, the frogs are relatively widespread in the remainder of their range[3].

A species listed under the ESA can have critical habitat designated for it. Critical habitat is area that is essential to the survival and recovery of the species[4].The designation of critical habitat is important for the recovery of listed species as species were more than twice as likely to have an improving population trend when critical habitat had been designated for them for 2 or more years in the late 1990's[5]. Despite this, some say that there is a mismatch between the intent of critical habitat designation and the practice of designating it because many designations are based on known locations of populations instead of a habitat suitability model and often do not include currently unoccupied habitat[4]. Although *Rana cascadae* is not designated under the ESA yet, if it is, it would be beneficial to know possible areas of critical habitat to expedite the process.

Question

What areas are suitable for *Rana cascadae* and could potentially be designated as critical habitat?

Methods

To identify potential critical habitat for *Rana cascadae,* I performed a habitat suitability analysis in ArcGIS. I followed the general method of creating a suitability index by weighting and combining important habitat factors[6,7]. I identified important factors for *Rana cascadae* based on a literature review[1,2,3] and downloaded corresponding data including water features[8], climate variables[9], land cover[10], and elevation. Elevation was eliminated from the analysis because it was correlated with latitude.

To perform the analysis, I found a dataset of frog point observations[11] and downloaded the IUCN range for reference[1,2]. I made a custom projection based on an Albers Equal Area Conic projection so that distortion was minimized around the observations. After converting the data into this projection, I determined which water features to exclude (salt water, dams, etc.)[1,2,3]. The first part of the analysis followed Figure 1.

After extracting the values, I determined the 5th-95th percentile of the extracted climate values to exclude outliers. Using raster calculator, I altered the climate rasters by calculating the z scores of the 5th-95th percentile. For land cover, I determined how many of the observations fell into the different land cover classes. The remaining analysis followed the data flow diagram in Figure 2. Distance to water was given a larger weight because of a somewhat higher importance.

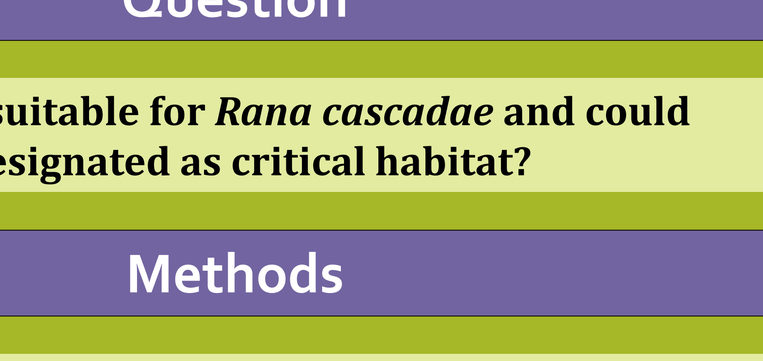

Figure 1. Part 1 of the analysis.

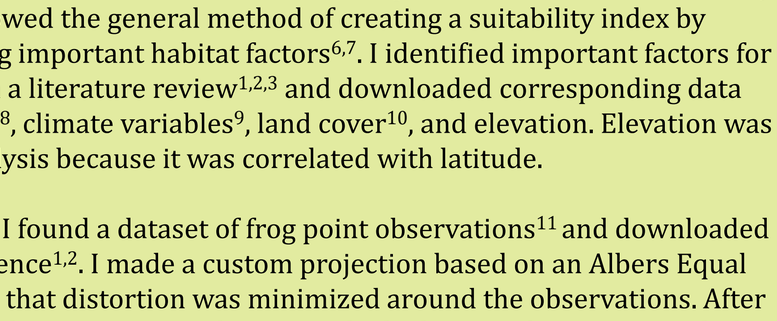

Figure 2. Part 2 of the analysis.

I determined the area in each index class of the output suitability raster by multiplying the number of pixels by their size. I also calculated what percentage of each class was in urban or developed areas. To identify locations which could possibly be designated as critical habitat, I isolated the index class representing the most suitable areas.

Results

The output suitability raster revealed four categories which I have called "very suitable", "suitable", "moderately suitable", and "less suitable" (Figure 3). The "very suitable" areas are ones which could potentially be designated as critical habitat because they are the most ideal for *Rana cascadae* according to my habitat suitability model (Figure 4). Much of the potential critical habitat is located within IUCN's range for *Rana cascadae,* but there are areas outside of the range which meet the requirements of the species (Figure 4). Of the area analyzed, the majority is "moderately suitable", followed by "suitable", then "less suitable", and finally "very suitable" (Table 1). Even though an area may be suitable based on certain habitat requirements such as climate, if it is urban or developed, it becomes less suitable for the species and would be less likely to be viable critical habitat. Of the "very suitable" areas which are potential critical habitat, 8.33% is in urban or developed areas (Table 1).

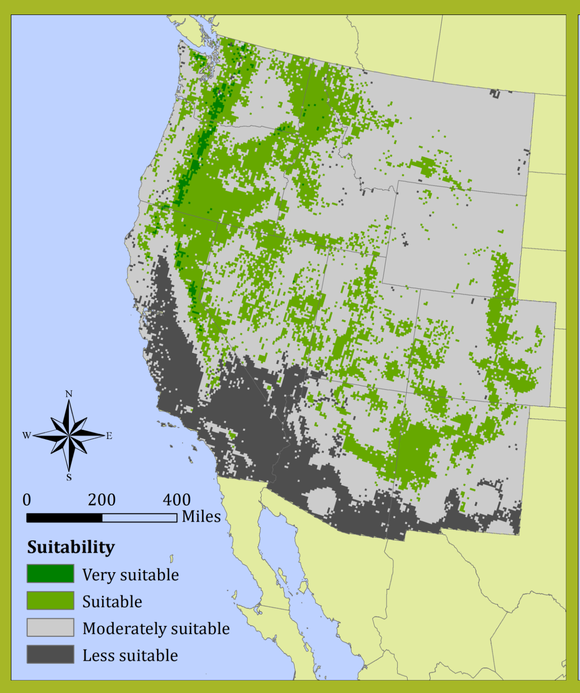

Figure 3. Map depicting the suitability in the western United States for *Rana cascadae.* This dataset is the output suitability raster created in Figure 2.

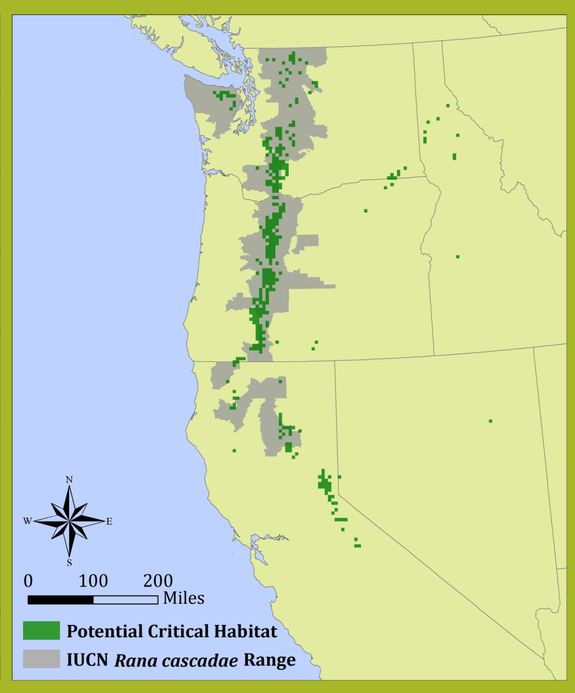

Figure 4. Map showing the area which could potentially be designated as critical habitat for *Rana cascadae.* This area was very suitable in the output suitability raster as shown in Figure 3. The IUCN range for *Rana cascadae* is also shown for reference.

Table 1. Table displaying statistics on the different suitability categories. Total area refers to the total area covered by the suitability index in Figure 3.

Suitability	Area (mi^2)	% of Total Area	% in Urban or Developed Areas
Very suitable	9,213	0.78	8.33
Suitable	287,575	24.27	1.27
Moderately suitable	728,752	61.49	1.68
Less suitable	159,590	13.47	6.19

Discussion

The "very suitable" areas in the suitability raster could potentially be designated as critical habitat under the ESA should the species be listed as threatened or endangered. However, since 8.33% of the "very suitable" areas are within urban and developed areas, they would not be ideal as critical habitat. Although "moderately suitable" and "suitable" areas are possibilities as critical habitat, the "very suitable areas should be examined first. If *Rana cascadae* is listed, more research would be required on those areas to determine if they would be appropriate to designate as critical habitat. Performing this analysis when a species is under review to be listed as threatened or endangered can help speed up the process of designating critical habitat.

Acknowledgements and References

I would like to thank Aquila Flower and Kevin Moens for their help in providing feedback and support throughout the project. Additionally, thank you to Andy Bunn for acting as my faculty mentor for the Scholars Week poster competition.

1. Hammerson, Geoffrey and Christopher Pearl. "*Rana cascadae*". *The IUCN Red List of Threatened Species* (2004). Web.
2. U.S. Fish and Wildlife Service. "Species Profile for Cascades Frog (Rana Cascadae)." Web.
3. Pope, Karen, Catherine Brown, Marc Hayes, Gregory Green, and Diane Macfarlane. 2014. "Cascades Frog Conservation Assessment." Gen. Tech. Rep. PSW-GTR-244. Albany, CA: U.S. Department of Agriculture Forest Service, Pacific Southwest Research Station. 116 p.
4. Camaclang, Abbey E., Martine Maron, Tara G. Martin, and Hugh P. Possingham. "Current practices in the identification of critical habitat for threatened species." *Conservation Biology* 29.2 (2015): 482–492. Web.
5. Taylor, Martin F. J., Kieran F. Suckling, and Jeffrey J. Rachlinski. "The Effectiveness of the Endangered Species Act: A Quantitative Analysis." *BioScience* 55.4 (2005): 360–367. Web.
6. Store, Ron, and Jukka Jokimäki. "A GIS-based multi-scale approach to habitat suitability modeling." *Ecological Modelling* 169.1 (2003): 1–15. Web.
7. Geneletti, Davide, and Iris van Duren. "Protected area zoning for conservation and use: A combination of spatial multicriteria and multiobjective analysis." *Landscape and Urban Planning* 85.2 (2008): 97–110. Web.
8. U.S. Geological Survey, National Geospatial Technical Operations Center. USGS National Hydrography Dataset (NHD) Medium Resolution for AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, and WY. Available: https://nhd.usgs.gov/data.html. Accessed April 6, 2017.
9. Hamann, A., T. Wang, D. L. Spittlehouse, T. Q. Murdock. 2013. A comprehensive, high-resolution database of historical and projected climate surfaces for western North America. Bulletin of the American Meteorological Society, 94(9): 1307-1309.
10. U.S. Geological Survey Gap Analysis Program (USGS-GAP). National Land Cover Gap Analysis Program. February 2010. Available: http://gapanalysis.usgs.gov. Accessed April 6, 2017.
11. Berkeley Mapper. Compilation of *Rana cascadae* observations from different sources. Available: http://amphibiaweb.org/species/4998. Accessed April 6, 2017.
12. IUCN (International Union for Conservation of Nature), Conservation International & NatureServe. 2008. *Rana cascadae. The IUCN Red List of Threatened Species. Version 2016-3.* Downloaded on 04 April 2017.

Questions? Please contact me at victoria.niewohner@gmail.com!