



Identification of the Most Perilous Areas for Rare Animals in the Continental United States



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Introduction

The United States (US) Endangered Species Act (ESA) prevents species extinction; however, the number of recovered species lags far behind the number of species still listed. Hotspot analysis is a simple way to identify important areas for conservation of rare species. Jenkins et al. (2015) identified priority areas in the US for the protection of endemic species (Figure 1A). To improve recovery efforts for the ESA, our objective was to identify hotspots for threatened and endangered (i.e., rare) animal species impacted by specific threats. By identifying these threat hotspots, we can determine where in the US specific conservation strategies are needed to mitigate biodiversity loss (Haines et al. 2012). Our null hypothesis was that hotspot priority areas identified by Jenkins et al (2015) would overlap with our threat hotspots for rare animal species.

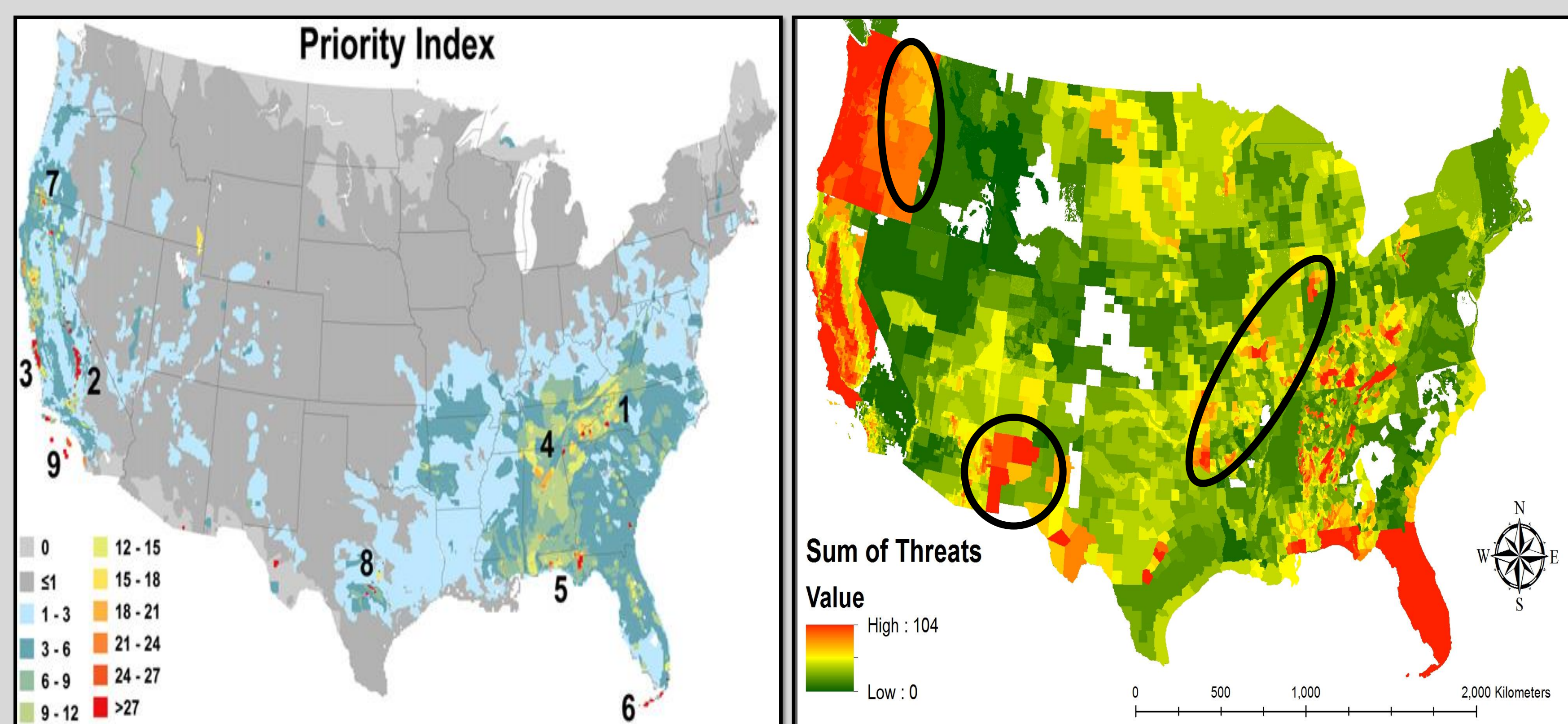


Figure 1. A) Biodiversity hotspots for endemic US species indicating priority areas for conservation in the continental US as indexed by Jenkins et al. (2015). B) Threat hotspots identifying a sum of 6 threats impacting rare animal species in the continental US. Circles outline heavy threat impact areas that occur outside of identified priority areas.

Methods

Based on a review of ESA listing decisions from 1975-2017, we identified six overarching threat categories that cause species to decline and require federal protection: habitat modification, overutilization, pollution, species-species interaction, environmental stochasticity, and demographic stochasticity. We then screened federal listing decision documents to determine threat occurrence (i.e., presence/absence of a given threat in a listing decision) for each threat category for all animal species listed between 1975 and 2017 (Leu et al. *In Press*). We then combined this database with a database of all the US Fish and Wildlife Service's current spatial ranges for listed animal species available on the Environmental Conservation Online System (www.ecos.fws.gov). Using ArcGIS and the Spatial Analyst Tool, these databases were combined by converting spatial range shapefiles of rare animals into 1km resolution raster files. We then used the raster calculator, under cell statistics, to combine raster files into threat hotspot maps (i.e., maps showing the greatest overlap of species impacted by each threat category).

Results (Threat Hotspot Areas For Rare Animals)

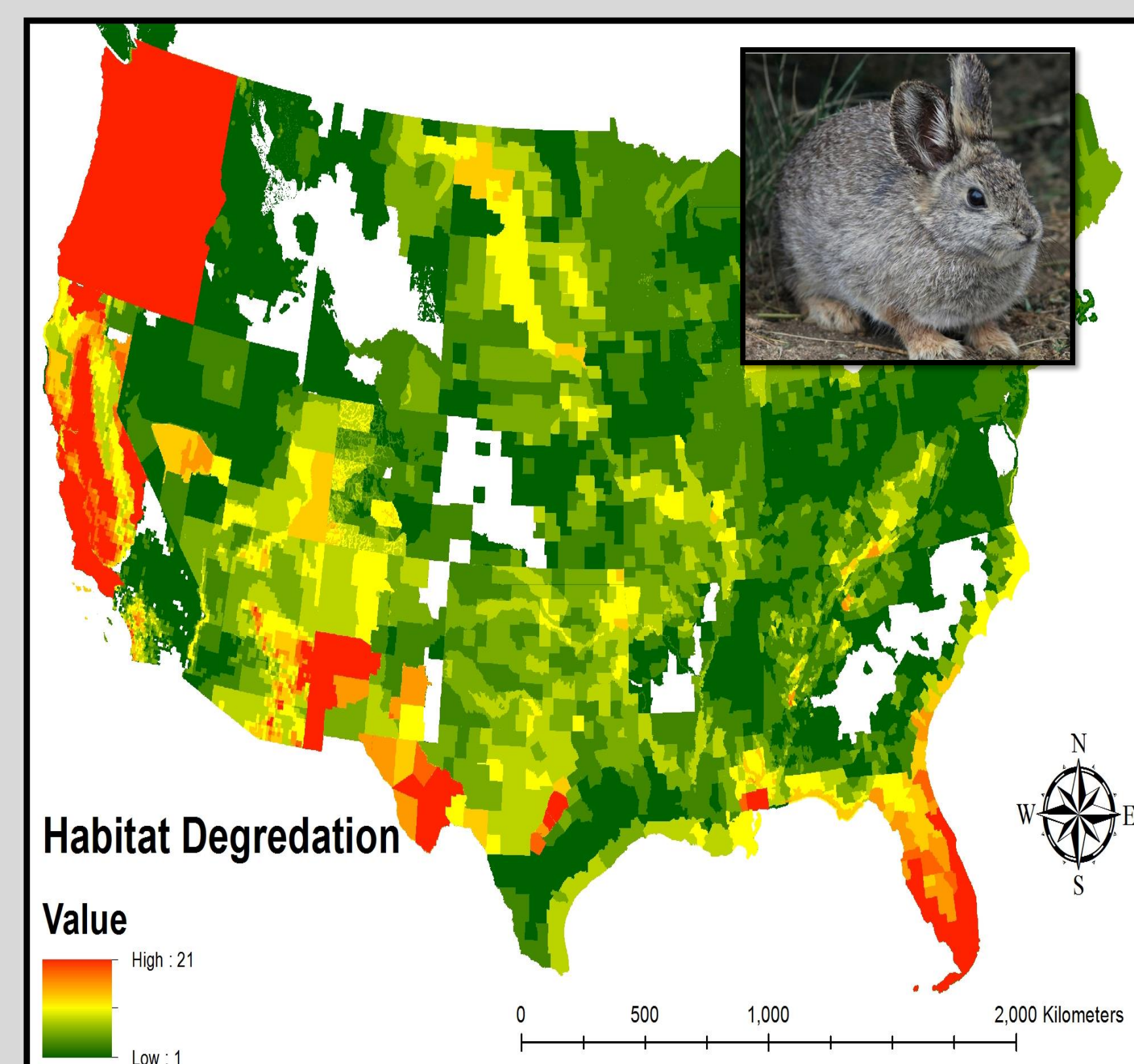


Figure 2. Habitat Modification (e.g., *Brachylagus idahoensis*).

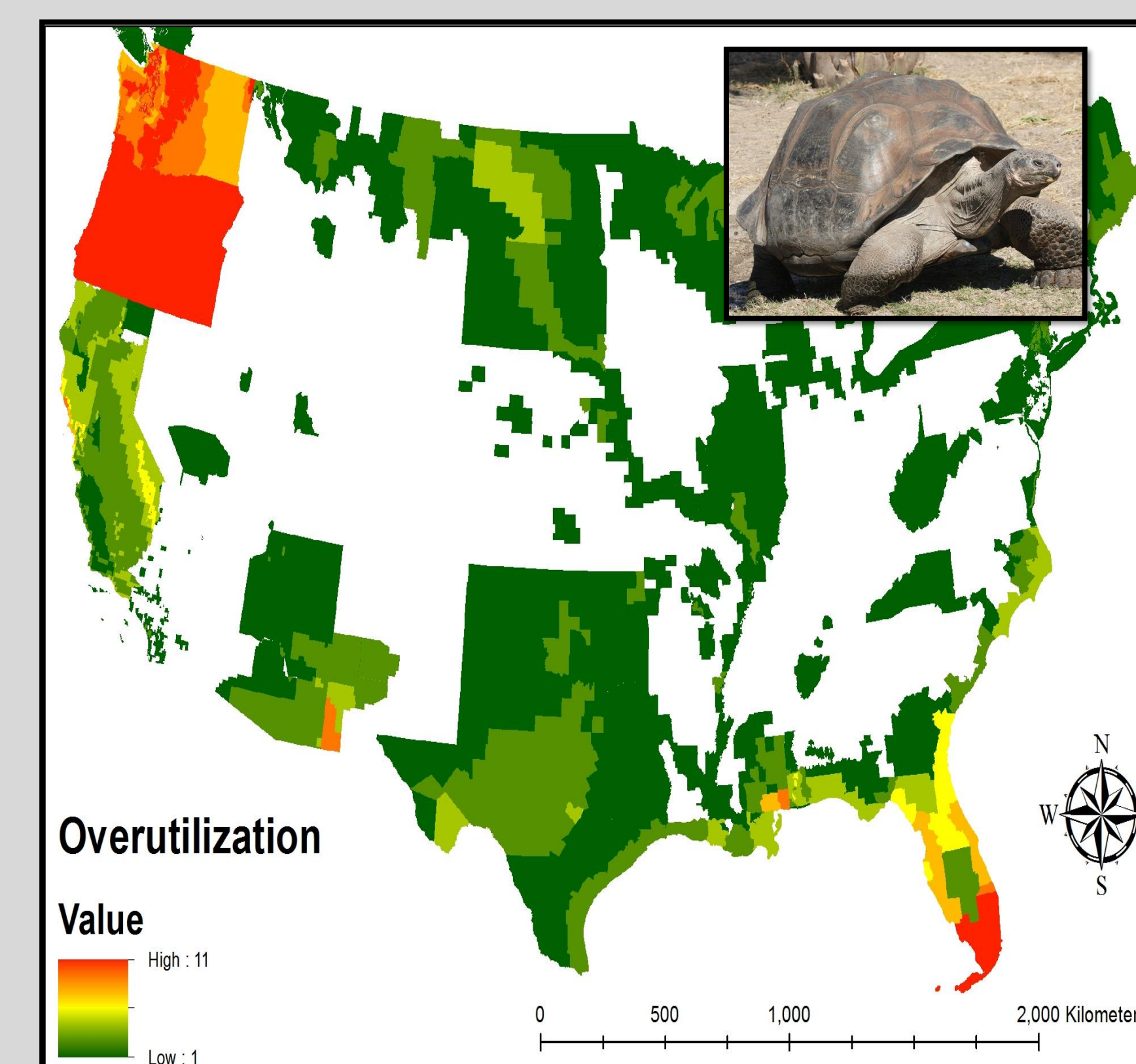


Figure 3. Overutilization (e.g., *Gopherus polyphemus*).

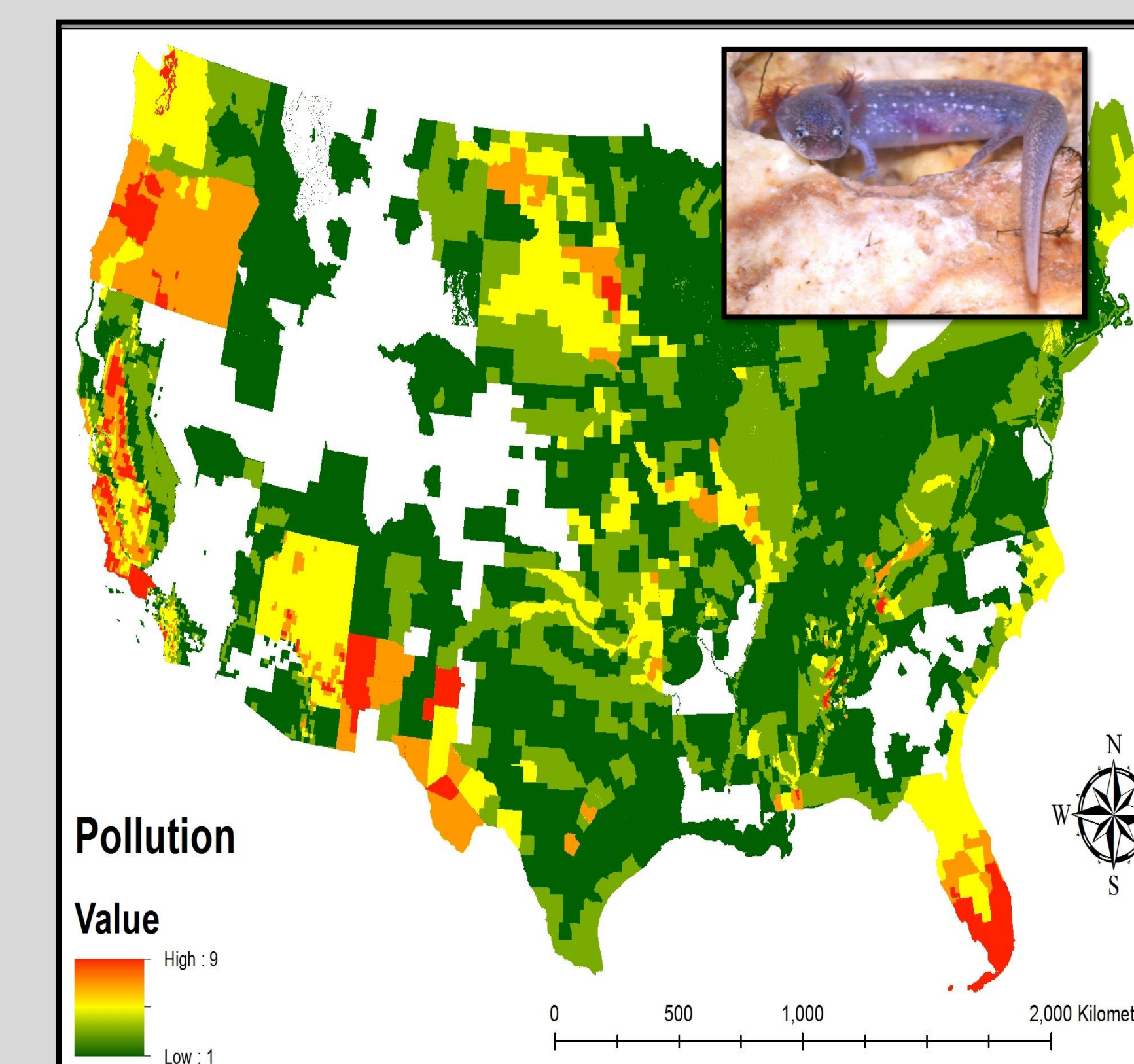


Figure 4. Pollution (e.g., *Eurycea waterlooensis*).

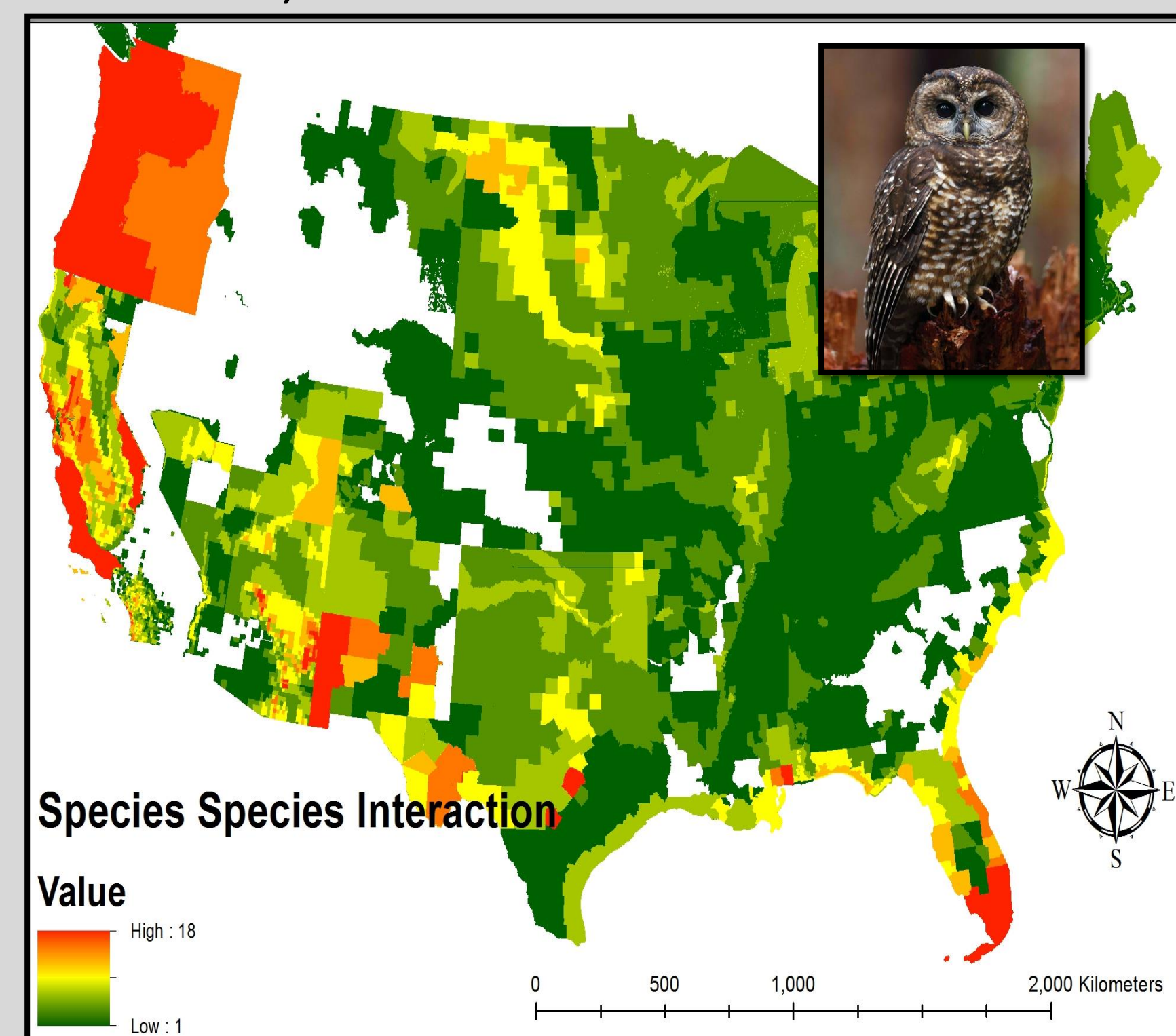


Figure 5. Species-Species Interactions (e.g., *Strix occidentalis caurina*).

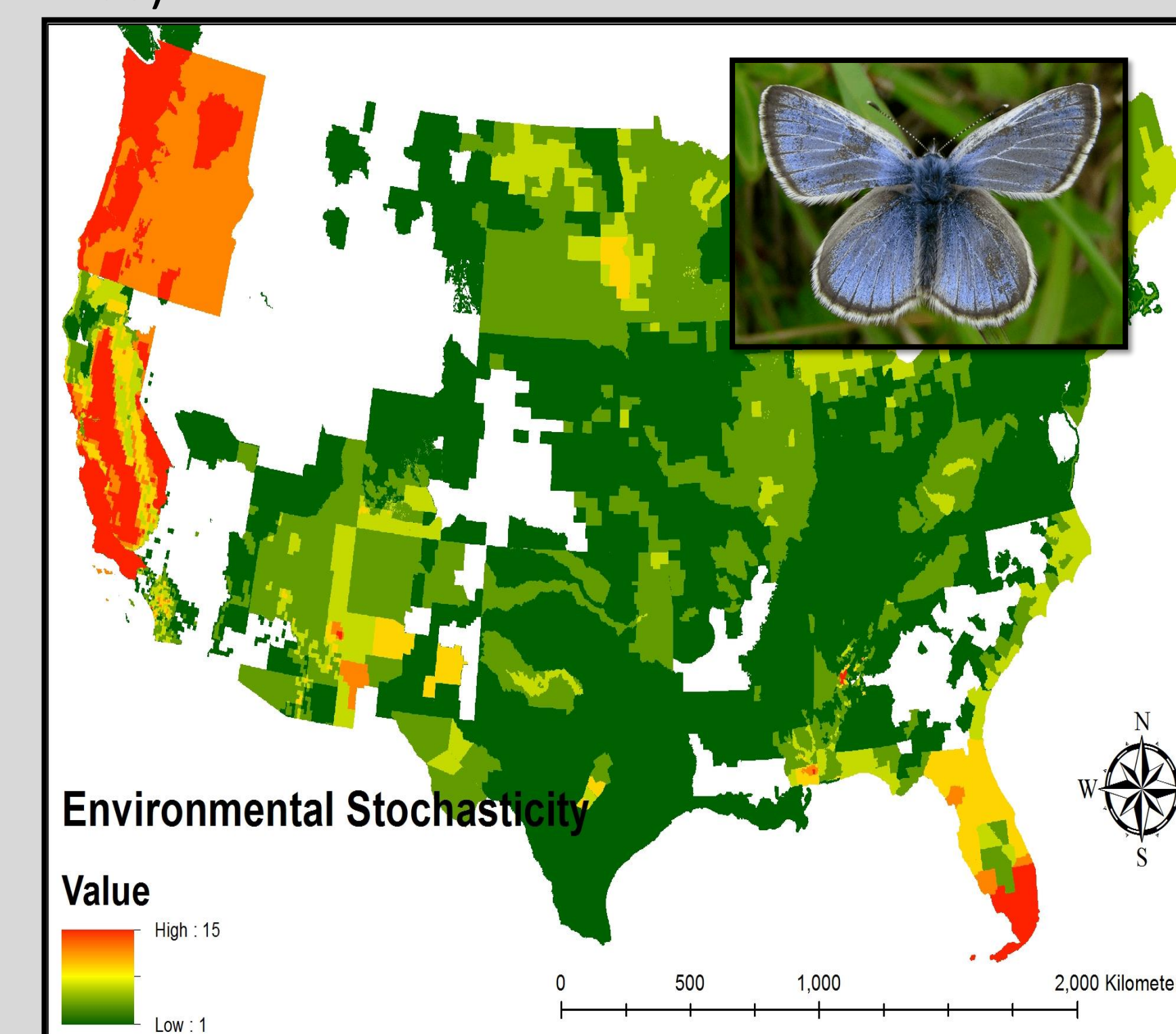


Figure 6. Environmental Stochasticity (e.g., *Aricia icarioides fenderi*).

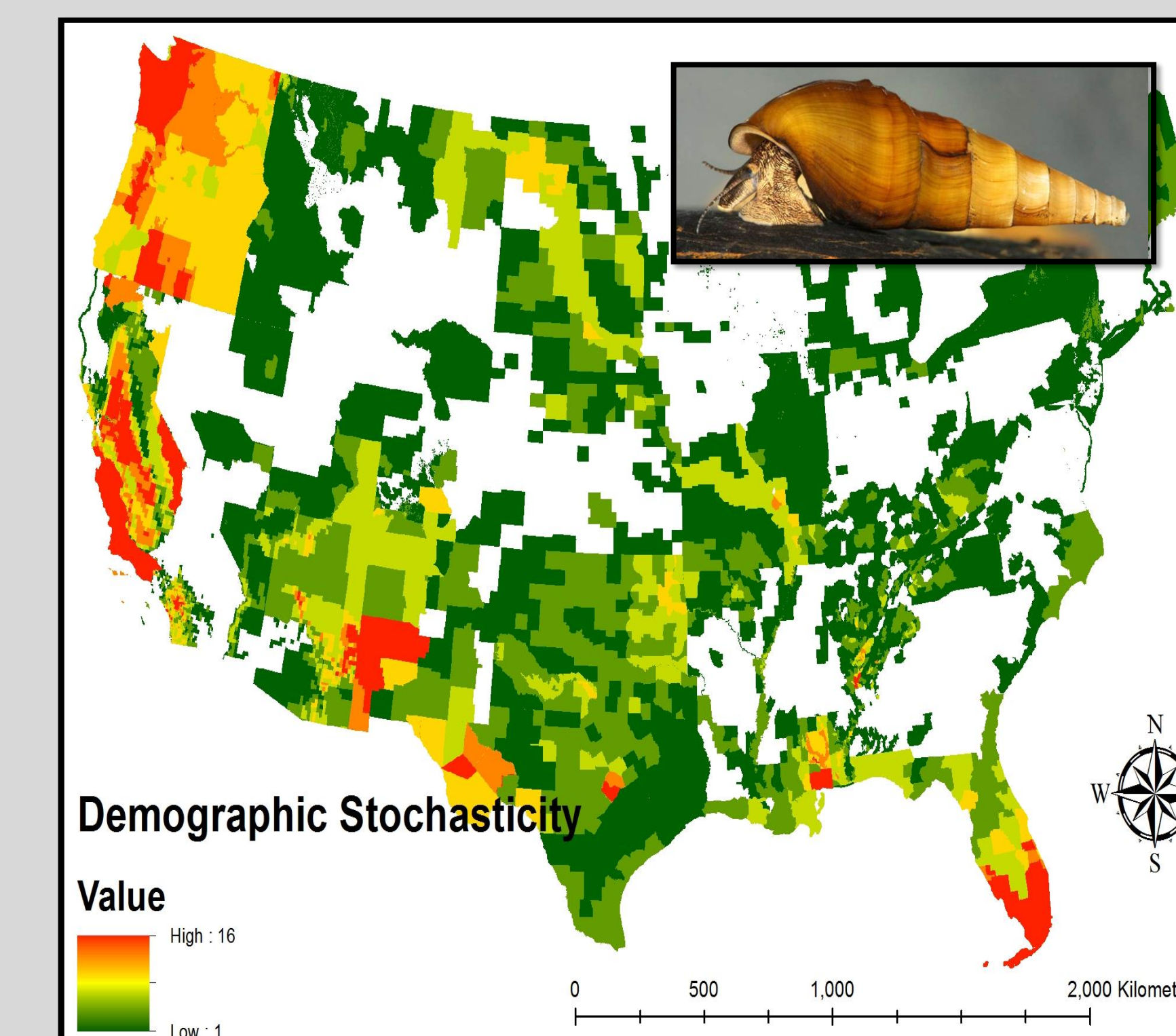


Figure 7. Demographic Stochasticity (e.g., *Leptox is foremanii*).

Discussion

We were able to combine threat data and spatial range maps for 453 rare animal species (211 invertebrates and 242 vertebrates). We identified areas in the US that contained the greatest threats to rare animals for each threat type (Figures 2-7). We found that Florida, some areas of Appalachia, the west coast and the desert southwest contained areas with the greatest number of rare animal species impacted by multiple threats. Figure 1B outlines the sum of all 6 threats for rare animal species. Based on this map, our null hypothesis was not supported. We identified important conservation areas outside of priority areas specified by Jenkins et al. (2015).

Our developed spatial framework provides a tool for identifying areas requiring conservation strategies needed to mitigate threats driving species' declines. It also provides essential information for future national conservation efforts.

Sources/Acknowledgments

- 1) HAINES, A.M., M. LEU, L.K. SVANCARA, J.M. SCOTT, K. VIERLING, S. MARTINUZZI, T.J. LANINGA. 2012. Incorporating wildlife conservation into county comprehensive plans: a GIS approach. *Northwest Science* 86(1): 53-70.
- 2) JENKINS, C.N., K.S. VAN HOUTON, S.L. PIMM, J.O. SEXTON. 2015. US protected lands mismatch biodiversity priorities. *PNAS* 112(6): 5081-5086.
- 3) LEU, M., A. HAINES, C. CHECK, D. COSTANTE, J. EVANS, M. HOLLINGSWORTH, I. RITROVATO, A. M. RYDBERG, A. SANDERCOCK, K. THOMAS, T. TREAKLE. (*In Press*). Temporal analysis of threats causing species endangerment in the United States. *Conservation Science and Practice*.

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