



## A Statistical Approach to Understand the Impacts of Rare Stressors on Rare Species

Researchers create statistical models using observational data to predict real world phenomena. However, a model is only as effective as its design, and for any given model, researchers are usually interested in determining the importance of any individual predictor.

This issue poses a challenge in species conservation, where the resulting management actions depend on reliably estimating influences of observed variables. Matters are made complicated when observations of a managed species are very rare, and the occurrence of stressor variables are also rare.

Presenting their findings in *Scientific Reports*, researchers have arrived at a new methodology for inferring the influence of a rare stressor on a rare species. The approach blends predictive models with nonparametric permutation tests, and the authors illustrated the new methodology with two case studies involving rare amphibians in Yosemite National Park in California.

The Sierra Nevada yellow-legged frog (*Rana sierrae*), a federally listed endangered species, is known to be negatively impacted by non-native fish. The Yosemite toad (*Anaxyrus canorus*), a federally listed threatened species, is potentially affected by packstock. In both cases, the stressor and the animal are rare in occurrence, both occurring only in about 10 percent of possible habitat patches.

Researchers first predicted species occupancy with a statistical model that includes all predictors *except* the stressor, to stratify and rank potential habitat by predicted suitability. A stratified permutation test then evaluates the association between stressor occurrence and amphibian occupancy, all else equal.

The new methodology confirms the known negative relationship between fish and *Rana sierrae*, but finds no evidence of a negative relationship between current packstock use and *Anaxyrus canorus* breeding. This statistical approach has potential broad application for interpreting observational data of rare species and potential environmental stressors.

### This Brief Refers To:

Matchett, JR, PB Stark, SM Ostoja, RA Knapp, HC McKenny, ML Brooks, WT Langford, LN Joppa, EL Berlow. 2015.

**Detecting the influence of rare stressors on rare species in Yosemite National Park using a novel stratified permutation test.** *Scientific Reports* 5:10702 doi:10.1038/srep10702  
<http://www.werc.usgs.gov/ProductDetails.aspx?ID=5278>



Meadows are primary habitat both for Yosemite toad breeding and for packstock grazing, but both are relatively rare. This double rarity presents challenges for assessing packstock impacts. Photo: USFWS

### MANAGEMENT IMPLICATIONS

- Researchers present a new nonparametric statistical method for exploring whether a variable *matters* in observational or experimental data, based on matching cases using predicted outcomes.
- This matching allows one to impose a weak “*all else being equal but for the variable in question*” condition in research situations where randomization and experimental intervention are infeasible.
- The new method detected the known strong negative influence of non-native fishes on the occupancy of lakes by Sierra Nevada yellow-legged frogs (*Rana sierrae*).
- However, the same method suggests that contemporary levels of packstock grazing in meadows of Yosemite National Park do not have negative effects on the distribution of breeding by Yosemite toads (*Anaxyrus canorus*).

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