Considering the Hidden Threats of Climate Change

A NEW APPROACH PUTS OVERLOOKED SPECIES ON THE CONSERVATION RADAR

By Meryl C. Mims, Deanna H. Olson, David S. Pilliod and Jason B. Dunham

Conserving species in the face of multiple threats is a daunting task, and new threats due to climate change are increasingly being recognized. Some of the species at greatest risk are cold-blooded vertebrates — reptiles, amphibians and fishes — yet these ectotherms often slip through the cracks of routine assessments.

Since they draw their energy from the external environment, ectotherms are strongly tied to climate, but it's not just temperature that affects them. Changing rain or snowfall creates a complex picture that involves humidity, stream flows, the persistence of springs and ponds and other conditions they depend on. However, their cryptic natures — and our often limited knowledge of their ecology — can make it especially challenging to assess how vulnerable they are to climate changes.

Single-species climate risk assessments help, but natural resource managers need assessments for scores of species at state and regional scales — assessments that help identify taxa and regions that should be prioritized for conservation actions. Since resources aren't available to study every cold-blooded species in detail, managers need cost-effective, multi-species approaches to address conservation priorities in a changing climate.

We developed a regional multi-species assessment in the Pacific Northwest — a region known for its diverse climates. The core of this approach is the Rarity and Climate Sensitivity (RCS) index (Mims et al. 2018).

The RCS provides a broad-scale assessment of entire taxonomic groups. As the name suggests, it takes into account two key concepts: rarity and climate sensitivity. On the one hand, rarity is calculated using data from agency databases, VertNet and sources such as iNaturalist. On the other hand, it also considers their climate sensitivity. At one end

The collared lizard (*Crotaphytus bicinctores*) was the reptile with the highest rarity and climate sensitivity index in our study area.

Credit: Charles R. Peterson

of the spectrum are species in areas with little variation in temperature or precipitation. Adapted to these narrow windows of climate suitability, these species may be especially sensitive to changing climate conditions. At the other end of the spectrum are species that occur in locations with a broad range of climate conditions. More generalist, they tend to be less sensitive to climate changes.

'Aha' moments

As climate change alters conditions on the ground, the RCS can help measure the vulnerability of species. Many status assessments consider rarity, but by combining rarity with climate sensitivity, the RCS index provides a more comprehensive perspective and can provide new insights into species that may need conservation attention.

Our analyses of 114 freshwater fishes, reptiles and amphibians native to Oregon resulted in plenty of "aha" moments. For fishes, RCS values were generally high, including species that were state-listed as sensitive, threatened or endangered, as well as local endemics known to be potentially at risk, such as western chubs (*Gila* spp.).

Some species that were already on the radar for conservation concerns showed additional evidence of climate sensitivity. They included several salamander species, such as two *Rhyacotriton* species proposed for listing under the Endangered Species Act. But other species that aren't state-listed popped into the spotlight, too. The western pond turtle (*Actinemys marmorata)* had the top RCS ranking among state-listed reptiles, but five non-listed reptiles showed even higher RCS rankings.

Several interesting taxonomic patterns emerged. We found high RCS values for 37 percent of fish species, as compared with 23 percent of amphibians and 17 percent of reptiles. Also, high RCS values — showing rarity and climate sensitivity — did not always align with traits traditionally thought to be tied to climate vulnerability, such as low fecundity or dispersal.

What was true for one taxon did not always hold true for another. For example, we saw a correspondence among longevity, body size and age at maturity for reptiles, but we didn't see that in amphibians or fish. Combining RCS with a traits-based approach may give us a more nuanced understanding of climate sensitivities across diverse taxa.

Considering bias

We were concerned about bias, since combining diverse datasets for multiple species can introduce biases into an assessment. To address this, we considered the geographic extent, data source and spatial grain considered in developing the RCS index. For each, we found the index to be robust.

Credit: William P. Leonard

Credit: Charles R. Peterson

▲ Several salamander species, including the Siskiyou Mountains salamander (*Plethodon stormi*) showed high climate sensitivity.

◀ Observations in the field can be uploaded to crowdsourced platforms like iNaturalist.

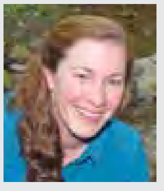
To address geography, we considered Oregon's cold-blooded vertebrates at three levels: within state boundaries; across the tristate area of Oregon, Washington and Idaho; and across all ecoregions overlapping Oregon. RCS values did not change substantially among them.

To address data sources, we considered information from VertNet, state databases and regional experts. Again, we found that the RCS was robust, suggesting that data from a variety sources, including museum records, species experts and iNaturalist could be used.

Finally, we found the spatial grain of our analysis did not influence the RCS index, although we were unable to consider very fine-grained microclimates, which can be critical for ecotherms.

In the end, we found that considering both rarity and climate sensitivity together can help us compare climate responses of entire classes of wildlife. Little-known species can be effectively addressed by this approach, which can bring to light new information about their likely climate sensitivities.

The index not only brings together a range of species for consideration. It may also help bring together management agencies' wildlife, nongame and fisheries sectors, which often work independently of one another. While we were working in Oregon, the tool can be used in other regions with other taxa. Each time it's applied, we hope, it will be further tested and honed.



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Getting Stand-out Data from the Crowd

By Charles R. Peterson and Patrick D. Giltz

Crowdsourced data are an increasingly important source of information on the distribution, abundance and activity of organisms. Large numbers of observations from a broad geographical range are continuously being added at a relatively low cost.

One of the most significant repositories of crowdsourced data is iNaturalist, a program supported by the California Academy of Sciences and the National Geographic Society. It provides a way to geo-reference and document observations of any organisms that can be photographed or audibly recorded, which greatly helps with confirming identification.

As of December 2018, over 15 million observations of more than 193,000 species have been contributed by over 421,000 people. Several programs, websites and applications exist for amphibian and reptile observations, but iNaturalist is the largest source of crowdsourced observations for herpetofauna. Some 263,000 observations of over 3,100 species of amphibians have been contributed by more than 48,000 people, and over 496,000 observations from over 5,100 species of reptiles have been contributed by more than 71,000 people. The number of observations contributed to iNaturalist is growing rapidly, roughly doubling between 2017 and 2018.

It isn't perfect. Problems and challenges include the lack of a sampling design, the absence of negative data, the degree of quality control and data security. Geoprivacy (the resolution of geographic coordinates for observations) is also a serious issue. iNaturalist allows users to set the level of geoprivacy for their observations and automatically obscures the coordinates for endangered, threatened and sensitive species.

But iNaturalist is providing critical data for the conservation of amphibians and reptiles, and since the data are easily shared and annotated by other users, it's helping to create a social network of naturalists.

To learn more about iNaturalist, visit www.inaturalist.org.

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