The Icarus challenge - Predicting vulnerability to climate change using an algorithm-based species' trait approach

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Like Icarus, the world's ecological resources are "flying too close" to the sun, and climate change will impact near-coastal species through temperature, sea-level rise, and ocean acidification and indirectly through changes in invasive species and land-use patterns. Importance of these stressors varies by species and geographically, and understanding, much less management, of these impacts is hindered by the number of species dispersed over wide geographical areas. One approach to addressing this challenge is assessing vulnerability from species' traits, including environmental ranges, life history attributes, and biogeographic patterns. Advantages include the ability to assess literally thousands of species over wide geographical areas and use of available information. Current applications of trait-based climate analyses have relied on expert opinion, where a select group assigns vulnerability. While expert analyses can be conducted in a timely manner, potential limitations include biases and lack of transparency and repeatability. To address these limitations, we are developing an "algorithm-based" approach, where a species' vulnerability in an ecoregion is automatically calculated from known traits using a set of a priori rules. We are testing the approach using the brachyuran and lithodid crabs (381 species) and rockfish (74 species) over 12 Marine Ecosystems of World ecoregions (Gulf of California through Beaufort Sea), with the vulnerability analysis synthesized in a web-based tool. In a preliminary analysis, 170 crabs and 39 rockfish were assigned high vulnerability in one or more ecoregions. Key traits in predicting vulnerability include whether the species is endemic, highly specialized, undergoing population declines, relative abundance in the ecoregion, and its biogeographic distribution relative to the geographical pattern of ecoregion-scale sea-surface temperatures. However, generating general rules for ocean acidification remains problematic.

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