MarXiv Summary

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MSP for the anthropocene

Marine protected areas (MPAs) designate a static spatial zone for protection from some, or all, human activities. With climate change, species are likely to shift in response to warming oceans, quite possibly outside the boundaries of the MPAs that were meant to offer protection. In addition, the designation of an area as a partially-protected MPA may spur unintended human impacts. So how do you plan for climate change and human uses when species migrate? Ecological niche models may offer a solution.

Ecological niche models (ENMs) "predict the probability of environmental suitability for a species in an area and can anticipate climate change influences on species distribution." In addition, ENMs are useful when you have limited data on the geographic distribution of a species needing protection. Through a case study of Brazil's MPAs, the authors use ENMs to show how the network may be expanded to account for the anthropocene.

Starfish are a keystone species in Brazilian waters. They have limited distributions and suffer from anthropogenic pressures, making them an excellent example for this methodology. Occurrence records of 12 threatened species of starfish were used in this analysis, but since few records were found, the Maxent algorithm was used to model their distribution. Environmental conditions like dissolved oxygen, pH, salinity, and others were factored into climatic models of ocean conditions along Brazil's coastline. These conditions allowed Maxent to predict the areas where starfish could live.

Spatial planning was performed using the Zonation software framework, which generates a map of ranked conservation priorities. Spots on the map that are extremely important for conservation have a value of 1, down to those where the low conservation value is assigned a 0. The core-area Zonation rule was used to find the areas that protected the rarest species. Using this data, the authors found three solutions: one that found the best sites for expanding the current MPA network with today's climate, another for expanding the MPA network to serve both current and future climates, and the third solution which expanded upon the second by avoiding areas prone to human impacts.

Out of the 12 species modeled, 10 significantly expanded their ranges in the modeled future climate. The best 10% of the modeled conservation solutions ended up protecting nearly 16% of suitable starfish habitat by expanding the current MPA network with today's climate. Taking future climate into account, about 15% of suitable habitat was protected, but this was reduced to around 10% if human impacts were also taken into account. Clearly, humans are impacting important starfish habitat, and as such, future conservation efforts should focus on mitigating human pressures.

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