New Model for Global Redistribution of Marine Biodiversity

Foreseeing biogeographical shifts of marine species in response to climate change can be difficult because they deviate from expected patterns of simple poleward movement. Previous attempts at predicting global marine biodiversity patterns were based on the bioclimatic-niche and population models developed by Cheung et al, but recent evidence shows that *climate-velocity trajectories* are a simple and valuable predictor of the rate and direction of shift across a diverse assortment of marine taxa.

Creating a model that uses climate-velocity trajectories along with information on thermal tolerances and habitat preferences, scientists from the NCEAS Working Group, *Towards understanding marine biological impacts of climate change*, were able to project changes in species richness and community composition, which is crucial for adaptive ecosystem management. This new approach enables modeling of nearly 13,000 species, which is over 12 times more species than previous studies.

A significant finding from this new model illuminates how range shifts can lead to new community interactions and turnovers. Researchers found that ocean warming will lead to the homogenization of ecological communities in many regions due to the coupling of species invasions and extinctions. Changes in community composition and dynamics, including which species interact and how they interact, could have major effects on ecosystems management. The results of this model reinforce concerns over global warming and ocean governance. This model supports the idea that conservation efforts should be *proactive* and produced at sufficient scales of governance through effective marine spatial planning.

Research Identifies Changes in Cumulative Human Impact on the Ocean

As the global population continues to grow, humans have an increasing impact on marine species and ecosystems in the ocean. Until recently, no one had addressed questions concerning which human actions cause the most significant impacts and which marine ecosystems are most affected by these impacts. Motivated by the Working Group "*Putting Ocean Wilderness on the Map: Building a Global GIS Atlas of Pristine Marine Environments*", a group of scientists at NCEAS mapped the global impacts of human activities on marine ecosystems in *Science* (2008). This groundbreaking study — one of the most highly cited NCEAS publications to date, showed that there are *no* remaining marine ecosystems that are unaffected by human activities.

Five years later a new set of collaborators, including an original scientist from the 2008 study, Ben Halpern, collected the new data with the goal of assessing the spatial and temporal **changes** of human pressures on marine ecosystems. This new research, published July 14, 2015 in *Nature Communications*, compares the data collected in 2008 to data collected in 2013 on the location and extent of human impacts, and found the global cumulative impact across the nineteen anthropogenic stressors studied is increasing and primarily driven by climate change. This finding emphasizes the global need to address climate change in order to protect marine ecosystems.

Along with climate change, the condition of marine ecosystems in the open ocean is significantly influenced by commercial activities like shipping and fishing. The predominant human activity affecting coastal waters varies across the globe, but the recent model revealed that the cumulative impact is especially increasing in coastal locations. Empirically measuring the state of natural marine systems is a challenging and resource intensive feat, but based on comparisons of the modeled impacts to actual conditions the 2015 impact scores accurately represent marine ecosystems.

This new study also echoes similar findings from the influential and highly cited 2008 study, confirming that all parts of the ocean is experiencing human pressures. The current research findings provide an update on which ecosystems should be prioritized for mitigation efforts and serves as a powerful tool for marine ecosystem management. It highlights areas of high/low cumulative impacts and increasing/decreasing impact, which will improve the efficiency of current marine management and conservation strategies.

Environmental Justice and Urban Tree Canopy Cover

Monica Kunz

Urban Tree Canopy (UTC) cover is considered an environmental good or amenity and has been linked to the distribution of multiple ecosystem services, including regulation of regional climate and water cycles. Additionally, UTC cover has been associated with improving neighborhood aesthetics, noise reduction, and creating stronger social cohesion and community empowerment. Some drawbacks of UTC are increased water demand, maintenance costs, allergies, and alleged safety concerns. The costs or burdens are dependent upon many factors, with one of them being socio-economic.

A recent publication in *PLOS ONE* by NCEAS Working Group "*Ecology of environmental justice in metropolitan areas*" tackles the issues of environmental justice, urban tree canopy cover, and urban heat-island effect. These specialists in ecology and environmental justice concentrated their recent research campaign on seven major cities; Baltimore, Los Angeles, New York, Philadelphia, Raleigh, Sacramento, and Washington D.C., which represent humid temperate, Mediterranean, arid desert, and subtropical biomes.

This NCEAS Working Group hypothesized that there would be a strong negative correlation between minority neighborhoods and urban tree canopy. In some places, like Los Angeles and Sacramento, their research findings confirmed this negative correlation. But in other cities—Baltimore, Philadelphia, and New York for example—that was not the circumstance. Across the seven cities, the strongest connection was income level, not race—minority or otherwise. The researchers found that high-income neighborhoods are likelier to have more and denser UTC cover than low-income neighborhoods.

The connection between income level and tree canopy cover has important implications for urban sustainability plans that incorporate increases in UTC cover. The research discoveries from this NCEAS working group determined that for economic justice to be considered, urban sustainability goals need to be supported by stronger science on the perceived ecosystem services that are provided by UTC cover.