

# Biodiversity breaching boundaries in a warming ocean

## OVERVIEW

The composition and distributions of marine biological communities are changing faster than at any time in the past two million years as a result of warming climate and associated oceanographic changes, coastal development, invasion of non-native species, and other human-mediated stressors. Understanding how, where, and why marine biodiversity is changing is important to sustaining healthy ecosystems and the people who depend on them. The Smithsonian's MarineGEO program seeks a motivated fellow to synthesize large-scale data generated by MarineGEO and partners to explore how changing climate and other stressors are shaping distributions of coastal marine life and the impacts on ecosystem processes.

## IMPORTANCE

Climate change and human-mediated transport of species are reorganizing global biodiversity on a scale not seen since the Arctic was last ice-free more than two million years ago. Over 80% of studied marine species are tracking shifts in sea surface temperature, generally in a poleward direction, and marine species are moving faster than those on land. This poleward expansion is causing wholesale shifts in benthic ecosystems, tropicalizing temperate fishery stocks with potential impacts on food security, and spreading harmful algal blooms poleward. These changes are increasing with continued warming and globalized trade, with strong consequences for the functioning of marine ecosystems and the services they provide to people. Understanding which species "win", which "lose", and why in the new ocean is key to predicting how ecosystems and the people who rely on them will fare in a warmer world, and to designing effective management and nature-based solutions to sustain its benefits for nature and society. This in turn relies on quantitative data on species distributions and how they are changing on large regional to global scales.

Coordination of research and emerging technologies offer new promise to achieve this understanding by increasing our capacity to catalogue, track, and detect biodiversity change across large spatial scales. For example, environmental DNA (eDNA) shed into the water by organisms can provide a potentially standardized snapshot of diversity often unavailable by other methods, and collectable by non-specialists. Maturation of eDNA and other technologies is revolutionizing biodiversity science, and linking through research and community science networks such as MarineGEO and iNaturalist offers promise to democratize that science. A growing list of databases now collate millions of records that can be leveraged to understand changing distributions of marine species through space and time.

## POTENTIAL RESEARCH THEMES

MarineGEO seeks a postdoctoral fellow to develop a novel research project at the interface of marine biodiversity science and climate change science, leveraging emerging technologies and extensive data from MarineGEO's network of partners. We seek proposals that can synthesize across datasets towards a high-resolution regional or global picture of climate-driven biodiversity change in the coastal zone. Research themes could include, but are not limited to:

- Understanding the magnitude and spatial variation of changes in coastal ocean life by synthesizing data from time series biodiversity observations and coordinated experiments;
- Exploring how climate-mediated changes in coastal oceanography influence geographic range and distribution shifts of coastal ocean species and biogenic habitats;
- Exploring how traits of species that are increasing vs declining with ocean warming change ecosystem processes such as biogenic habitat provision, trophic support for harvested fish populations, and carbon storage.

Projects that design research to inform decision-making in management and conservation are especially welcome, e.g., by identifying key taxa, traits, and interactions related to climate "winners" and "losers", or transition hot spots for climate change impacts on coastal communities. In addition to high-impact peer-reviewed publications, anticipated outputs include, but are not limited to: generation and sharing of novel

biodiversity data and/or tools that advance MarineGEO's mission of standardized, global observation of changing coastal marine ecosystems, contribution to Smithsonian collections; and engagement with MarineGEO and affiliated networks towards a coordinated global census of biodiversity.

### **PROGRAMS AND ASSETS**

Coordinated networks, including MarineGEO and affiliated partners, are facilitating the deployment of new technologies and networking with one another to reach broad international audiences, leading the way toward making it possible for the first time to monitor the ocean's biodiversity using robust, standardized methods at large scales. The successful climate fellow will have access to biodiversity data collected as part of MarineGEO and partner initiatives, including survey data from ~15 observatory sites and nearly 100 project partners around the world, taxonomic and genetic data from "BioBlitzes" in both the Pacific and Atlantic oceans, and from current and past network projects, such as the Panamex, PANELS, and BEACON projects, and other collaborative initiatives. These data come mainly from biogenic nearshore habitats such as seagrass meadows, coral reefs, and oyster reefs, as well as deployment of settling panels to track marine invertebrate recruitment and community development in a standardized way across time and space.

The fellow will have opportunities to collaborate with colleagues and leverage assets from several Smithsonian units, notably MarineGEO's administrative home at the Smithsonian Environmental Research Center; as well as the National Museum of Natural History's Laboratories of Analytical Biology and world-class collections. Engagement with MarineGEO network partners can include the Global ARMS program (NMNH), Reef Life Survey, Marine Biodiversity Observation Network, and the Pacific eDNA Coastal Observatory, among others. Collectively these include data from 100,000s of georeferenced biodiversity observations collected in standardized fashion, often with associated environmental data. Combining datasets from OBIS, GBIF, and BIOTIME is also encouraged.

### **ADVISORS**

The Fellow will work with MarineGEO Director Emmett Duffy, in residence at SERC, with potential co-advisor(s) from a diverse group of Smithsonian staff active in MarineGEO and related Smithsonian programs as appropriate.