

BIODIVERSITY BREACHING BOUNDARIES IN A WARMING OCEAN

OVERVIEW

Marine biodiversity is changing more rapidly than at any point in recent history, and understanding these changes is critical to inform solutions for healthy marine ecosystems and productive coastal communities. This opportunity provides a fellow access to data on marine biodiversity from sites around the world generated by the [Marine Global Earth Observatory \(MarineGEO\)'s network](#) of partners and the potential to employ new technologies to assess current and predicted biodiversity change in a changing climate.

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 marine species, ranging from benthic invertebrates to fishes to seabirds, 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 the character of benthic ecosystems, tropicalizing temperate fishery stocks with potential impacts on food security, and spreading harmful algal blooms poleward. These changes will increase as the ocean continues to warm and trade globalizes, with strong consequences for the functioning of marine ecosystems and the services they provide to people.

Understanding which species “win”, which “lose”, and why, is key to predicting how biodiversity, ecosystems, and the people who rely on them will fare in a warmer world. This in turn relies on quantitative data on the changing distributions of species on large regional to global scales. Understanding where, why, and how marine biodiversity is changing is essential towards effective management and solutions to sustain its benefits for both nature and society.

Coordination across space and emerging technologies are increasing our capacity to catalogue, monitor, and detect changes in biodiversity throughout the world. A central example involves environmental or eDNA, fragments of genetic material shed into the water by marine organisms, which can be sequenced to detect and track marine organisms, even by non-specialists, in a standardized way. eDNA is fast becoming a standard tool for tracking biodiversity, although its application across broad biogeographic gradients to examine local extinctions, invasions, and range shifts is still limited. Maturation of such technologies and associated implementation networks is revolutionizing biodiversity science, with potential to democratize biodiversity science through hosting by the open-access Ocean Biodiversity Information System, along with community contributions such as iNaturalist. These databases collate millions of records that can be leveraged to understand the global distribution of marine species through space and time.

Coordinated networks—including Smithsonian’s MarineGEO program and affiliated partners such as the Global ARMS program (NMNH), Healthy Reefs for Healthy People (NMNH), Reef Life Survey, and Marine Biodiversity Observation Network—are facilitating the deployment of new technologies and linking data contributors internationally, leading the way toward making it possible for the first time in history to monitor the ocean’s biodiversity using robust, standardized methods at large scales. MarineGEO’s network of scientists has a strong track record of developing and employing such standardization to

address questions about large-scale patterns and processes in marine ecosystems. The successful climate fellow has the potential to play a role in advancing this mission.

POTENTIAL RESEARCH THEMES

MarineGEO seeks to support a postdoctoral fellow to develop a novel research project at the interface of marine biodiversity and climate change science that leverages emerging technologies and extensive data from MarineGEO's network of partners. Possible research projects may include, but are not limited to, those that can:

- synthesize across large-scale and long-term datasets to illuminate regional to global trends and/or consequences of climate-driven biodiversity change in the coastal zone;
- translate the research to inform decision making in management and conservation, 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; and/or
- build capacity for regular, standardized, eDNA sampling of coastal marine life, focusing on the Americas, and integration of new technologies, protocols and data tools with existing MarineGEO research to boost capacity for addressing climate-related questions and solutions.

PROGRAMS AND ASSETS

The fellow will have access to long-term biodiversity data collected as part of the MarineGEO program and partner initiatives, including multiple years of survey data from 15 observatory sites around the world, taxonomic and genetic data from multiple intensive biodiversity surveys (BioBlitzes), and from current and past network projects, such as the Panamex, PANELS, and BEACON projects, which continue to generate biodiversity data from coordinated eDNA sampling. Proposals that incorporate strategic collection of new biodiversity data at MarineGEO partner sites are especially welcome.

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; and the National Museum of Natural History's Laboratory for Analytical Biology and new Ocean DNA initiative. Engagement with MarineGEO network partners can include the National Estuarine Research Reserve System, the Pacific eDNA Coastal Observatory (PECO), Marine Biodiversity Observation Network (MBON), Reef Life Survey (RLS) network, and the UN Ocean Decade program Marine Life 2030, among others. Collectively these include data from 100,000s of georeferenced biodiversity observations collected in standardized fashion, often with associated environmental data. Open data sharing is a core tenet of MarineGEO.

ADVISORS

Smithsonian staff active in the MarineGEO program may serve as advisors for the climate fellows, facilitating access to datasets and project assets, including Emmett Duffy and Jonathan Lefcheck of MarineGEO (headquartered at SERC), along with other scientists across the Smithsonian as appropriate.