Biological diversity is fundamentally important to the functioning of all natural and human-engineered ecosystems. Yet we still have only a very rudimentary understanding of biodiversity as a dynamic process--how has it been shaped in the past, and what are the expectations as we move into the future? How will associated ecosystems adapt to global change? A grand challenge in understanding the origins of biodiversity is to disentangle the influence of evolutionary and historical processes operating at larger spatiotemporal scales from ecological processes operating at smaller scales. One underexploited system that provides an opportunity to integrate ecological and evolutionary processes is that of remote island archipelagoes, in particular when the component islands are arranged chronologically, as is found in "hotspot" islands with multiple discrete volcanoes each providing elevational gradients with contrasting physiological barriers (temperature and rainfall) across the gradient, and that have incurred radically different anthropogenic impacts.

Our proposed research aims to use the Hawaiian Island chronosequence as a natural laboratory for understanding community interactions that underlie biodiversity dynamics and environmental change by incorporating new technologies and theoretical approaches, coupled with standardized sampling protocols, thus providing temporal replicates of the same ecological and evolutionary processes across gradients of elevation. The primary goals of the project are two-fold: (1) Characterizing the biotic community using metabarcoding and related approaches to look at soils &/or atmospheric attributes; microbial diversity; and arthropod and plant diversity. (2) Look at how entire communities are changing (especially in the context of invasions and disease) across the elevation gradients and over the chronosequence using approaches including ecological interaction networks; assessing the predictability of patterns of community assembly and diversification/ extinction; effect of trophic level on diversification; and the effect of interactions on diversification. We will make use of a National Ecological Observatory Network (NEON) site on the Big Island of Hawaii, and integrate the data generated with data currently being generated as part of a NSF Dimensions in Biodiversity project. The data will be integrated into a statistical and Bayesian framework in order to determine signatures of change from ecological processes to evolutionary processes over gradients of elevation, precipitation, and time.

The research will train 3 postdocs, including one who will serve as PI for the proposal, and gain experience in leading the effort. It will also train a graduate student, and 3-12 undergraduates. The dynamic landscape of Hawaii offers a natural laboratory for training in this area. Existing programs at UH Hilo (Pacific Internship Programs for Exploring Science, PIPES) and Partnerships for Reform through Investigative Science and Math, PRISM) provide opportunities for graduates to develop lessons for K-12 audiences, with particular focus on Pacific Islanders. The research will (1) integrate students (undergrad, grad, postdoc) into all aspects of the work (field, lab, theory). Importantly, this will introduce quantitative and theoretical science to students within a familiar setting. (2) Develop theoretical tools for predicting biodiversity response in the face of invasions, extinctions, and other impacts of societal relevance including climate change, urbanization, etc. We plan to incorporate research experiences for undergraduate students at two of the major minority serving institutions in Hawaii, UH Hilo and UH Maui Community College. Finally, project biennial meetings will be coordinated with a major conservation conference in Hawaii bringing together scientists and land managers, which not only provides the opportunity to communicate directly to the local community, but also involves stakeholders in planning of future research directions.