OCE-PRF: Deleterious mutational load in climate driven marine range expansions.

Overview

Background: Species range expansions are occurring across the globe at unprecedented rates as global warming continues to accelerate, and even more so in marine species. Evolutionary theory predicts the rapid accumulation of deleterious mutations in edge populations during range expansions (i.e., expansion load), leading to a loss in fitness. Fishing triggers similar evolutionary dynamics of population declines and lower genetic diversity, similarly increasing expansion loads. Marine species experience faster range expansions than terrestrial species due to their high dispersal ability and are heavily impacted by fishing pressure, yet, the interaction of both these processes have yet to be elucidated in a marine species.
Objectives and Approach: This study presents a unique opportunity to test the evolutionary theory of the accumulation of deleterious mutations in a rapid climate-driven range expansion and harvested marine fish, Black Sea Bass (*Centropristis striata*). In **Obj 1**, I will test **H1**: *C. striata* will show a greater expansion load in coding regions at the range expansion front compared to the historical range center and edge populations. I will test H1 by using genome-wide coding region data (EecSeq) to obtain estimates of population structure, effective population size, genetic diversity, migration rates, and quantify deleterious mutations. In **Obj 2**, I will test **H2**: range expanding populations with a greater expansion load will show evidence of decreased fitness-related traits. To approach H2 I will measure fitness-related body condition traits (body length:weight ratio, percent protein, and C:N ratio) to test whether they change between range center and the expanded range front, while accounting for other potentially confounding variables. Finally, in **Obj 3** I will test **H3**: overfishing will exacerbate the accumulation of deleterious mutational load in expanding populations. This will be tested by running simulation models that explore the interaction of range expansion and harvesting on a marine species with high dispersal potential.
Host organization: The host organization is the Marine Science Center (MSC) of Northeastern University (NU), in Nahant, Massachusetts. The MSC provides the ideal environment to enhance the participation of underrepresented groups, while interacting with a diverse and high-quality scientific community.
Sponsoring scientist: My proposed mentor is Dr. Kathleen Lotterhos, who has expertise in eco-evolutionary marine genomics and uses a combination of field surveys, experiments, mathematical modeling, genomics, and bioinformatics to address how climate has and will shape marine biodiversity. My collaborators include Dr. Jonathan Grabowski (NU Professor– fishery dynamics expert), Dr. Kiersten Curti (NOAA– Research Fishery Biologist, assessment scientist for black sea bass), and Dr. Marissa McMahan (Manomet– Marine Fisheries Division Director).
Intellectual Merit: Results of this study will challenge theoretical assumptions of the accumulation of deleterious mutations in marine range expansions. Historically, this research has been heavily dependent on quantitative modelling and terrestrial systems, failing to consider high dispersal capabilities, faster expansion rates, and harvesting pressure present in marine systems. If my hypotheses are supported (i.e., higher loads and decreased fitness are found at the expanding-front), as predicted by theory, results will have widespread implications for marine conservation strategies in a rapidly changing climate. However, if these hypotheses are rejected, our data will challenge existing scientific assumptions, suggesting marine systems undergo different processes. In addition, simulation models will advance evolutionary theory into a parameter space relevant to marine species that incorporates high dispersal, range expansion, and harvesting. This integrative dataset will advance understanding of climate-driven range expansions and the interactive effects of climate change and fishing pressure on marine species, such as Black Sea Bass.
Broader Impacts: The results of this project will be broadly disseminated to the scientific community, the local fishing community (e.g., Maine Fishermen's Forum, Commercial Fisheries Research Foundation), and fishery management officials (e.g., NOAA, Manomet, Atlantic States Marine Fisheries Commission). This project will increase participation of traditionally underrepresented groups in science by: (1) mentoring of undergraduate students in the field, in the lab, and during data analysis; (2) outreach seminars for local community colleges (e.g., Salem State), and (3) partnering with MSC's outreach program to reach high school students and teachers through their ongoing programs (e.g., Beach Sisters program at Girls Inc, Annual High School Marine Science Symposium, Science Cafe). I will develop at least two teaching modules on this research that will include a series of seminars and hands-on activities.