2019 Schmidt Environmental Solutions Fellows

University of California, Santa Barbara
The Schmidt Family Foundation

Research Fellows

The Schmidt Research Grants provide funds to exceptional fellows to launch new experiments or carry out needed field research that will generate solutions to problems compromising the health of the environment.

Erin Dillon // Healthy shark populations are thought to be critical to maintaining robust and functional coral reef ecosystems - but exactly how many sharks should be on a coral reef? While we know that many coastal shark populations have declined steeply over the last several decades, longer records of change allude us. This hinders our ability to understand natural variation in shark assemblages over time and space, to interpret sharks' functional roles on coral reefs in natural and human-impacted systems, and to properly manage shark populations. Erin is developing and applying a new paleoecological tool to determine pre-exploitation shark baselines and explore how humans have influenced shark assemblages over long reaches of ecological time. By defining historical ranges of variation, this work can help assess shark declines and recoveries with respect to local historical baselines and shape management goals that better reflect what is healthy for a given region.

Natasha Krell // Farmers in East Africa often experience extreme climate shocks such as high year-to-year rainfall variability, a phenomenon which is only increasing under modern climate change. Farming systems dependent on rainfall need innovations that not only increase food production but also improve human health and well-being, and limit environmental degradation. To address this challenge, Natasha combines real-time data from in-field environmental sensors with social science surveys to analyze the couplings between farmer decision-making and climate variability in African contexts. She also studies farmers' access to agricultural information through mobile technologies, and specifically investigates how women and disadvantaged farmers integrate technology to improve their livelihoods. She is interested in improving dissemination of agroclimatic alerts for informed agricultural decision-making in response to climate shocks and extreme weather events.

Kelly Speare // Kelly's dissertation work focuses on the community ecology of coral recruitment in Moorea, French Polynesia. Kelly's past work asked how different benthic communities shape coral settlement and showed that coral larvae make amazingly complex settlement decisions on the scale of millimeters. However, pervasive local threats to coral reefs, such as overfishing and nutrient pollution, are causing significant changes to reef community composition. With funds from The Schmidt Family Foundation, Kelly will build on her past work to ask how local stressors may impede coral settlement via alterations in coral reef community composition. The outcomes of this work will provide valuable insight to how communities can strategically manage local stressors to maintain resilient coral reefs with high levels of coral recruitment.

Accelerator Fellows

Research Accelerator Awards provide an opportunity for graduate students who do not have other research funds to conduct off-site fieldwork needed to take their environmental science research to the next level.

Lily Zhao // As both the severity of storms and the frequency of mass bleaching increase, it becomes particularly urgent to conduct a global analysis that identifies reefs with the ability to recover beyond our expectations. Lily's work seeks to uncover "bright recoveries" – or reefs that have recovered beyond the expectations of today's coral reef science. Through semi-structured interviews with coastal communities near these reefs, Lily hopes to discover latent ecological, socioeconomic, cultural and institutional factors that enable bright recoveries to uniquely rebound from acute disturbances. Lily's work takes place in Mo'orea, French Polynesia, which has a complex tapestry of social dynamics representative of coral reef communities globally, making it the ideal study location to begin this research while field-testing an interview tool for deployment throughout the tropics. Specifically, Lily will investigate socially differentiated perceptions of the ideal reef state throughout the island, catalog research priorities, and identify these latent reef recovery factors. By identifying the cultural and institutional factors that foster bright recoveries, this work will hopefully ultimately facilitate the extension of recoveries to new systems.

Terra Dressler // Southern California steelhead/rainbow trout are critically endangered due to extreme habitat loss resulting from human disturbance. Surviving populations inhabit the southern range limit for the species and experience much more extreme temperatures and lower oxygen levels relative to their northern counterparts. As temperature rises due to climate change, these fish are at increasing risk of threat of extinction. Terra's research explores the environmental limits of these populations by measuring physiological effects of these stressors and how they differ between geographically and genetically distinct populations. This knowledge will inform management and conservation practices that aim to maintain viable populations of these iconic fish.

Elizabeth Forbes // Carbon flux, the rate of carbon emissions from an ecosystem to the atmosphere, is a crucial component of an ecosystem's carbon budget, determining whether a system acts as a sink or source of atmospheric carbon. Many forms of anthropogenic change (e.g. wildlife loss, land-use change) can drastically change carbon flux, with potentially critical implications for global carbon budgets. However, tools for measuring carbon flux are extremely expensive and highly technical, greatly constraining the scale and types of ecosystems where this critical data can be collected. Elizabeth's research involves developing an inexpensive, autonomous, remote-sensing carbon flux sensor, and demonstrating the utility of this technology in improving resolution of carbon flux data and an ecosystem's carbon budget. This project will utilize innovations in both engineering and computer science to address a problem in environmental sciences: how to make data collection accessible and able to scale up to landscape levels.

Joey Peters // Giant kelp is the foundational species of one of the most productive and dynamic ecosystems on Earth: the California kelp forest. While otters are known to be important in maintaining kelp forests via their role as consumers, Joey's research will examine how expanding populations of sea otters in southern California contribute to kelp forest nutrient cycling and primary production, which could further facilitate the recovery of both sea otters and giant kelp. To determine the strength of these potential feedbacks, Joey will use a combination of bioenergetics modelling to quantify nutrient loading by sea otters rafts through their waste, nutrient analyses and growth experiments to determine utilization by giant kelp, and drone-captured multispectral imagery to develop kelp canopy "health maps" that pinpoint otter-driven nutrient hotspots. This multifaceted approach will elucidate if sea otters are important nutrient recyclers in kelp forests, which could redefine their functional role in the ecosystem.

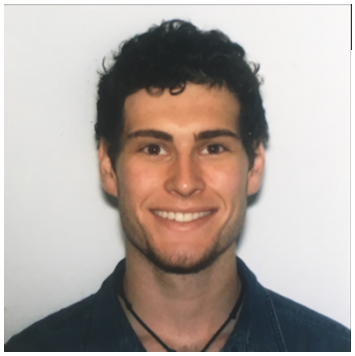
Nicol Parker // California's surface waters face toxic concentrations of current use pesticides. In fact, more than a third of California's river and stream reaches have been assessed as impaired by pesticides and in exceedance of aquatic health benchmarks. The California Department of Pesticide Regulation, the agency responsible for pesticide oversight, has identified the ability to understand and model irrigation practices as a key limitation to effective pesticide risk assessment and mediation. Nicol's research evaluates improved methods to model irrigation effects for pesticide risk assessment in the regulatory context. Nicol will collect field data to model the influence of irrigation practices on pesticide transport to surface waters. Ultimately, these models should allow for better protection and management of water quality in California river and stream ecosystems.

Dana Cook // Many coral reefs are disappearing under a field of algae, resulting in lower-value ecosystems - both in terms of biodiversity and human uses (e.g. fisheries). Dana seeks to harness natural biotic interactions to reverse these coral-to-macroalgae regime shifts. Macroalgae in coral ecosystems are controlled by herbivores, typically fishes, and studies have shown that it can take far more herbivory to remove established macroalgae than to prevent their colonization, making restoration back to the more desired coral state especially challenging. In this work, Dana will explore: (1) if a trade-off between competitive ability and palatability exists among macroalgae species in Polynesian coral reefs; and if so, (2) whether the superior competitors are highly preferred food for herbivores; and (3) whether herbivores aggregate to and consume patches of preferred macroalgae, thereby switching the patch to a state that can be colonized by coral. Ultimately, Dana's work will guide fisheries management to facilitate the reversal of macroalgal dominated states.

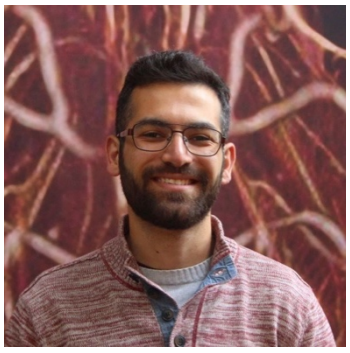
Kyle Neumann // Declines in the health of stream ecosystems in Mo'orea, French Polynesia caused by development and agriculture are likely contributing to declines in both reef and human health. Kyle's research quantifies the spatial and temporal variation of runoff on Mo'orea, including freshwater discharge, nutrient fluxes, total suspended solids (a measure of sedimentation), and plume dynamics - and the impact of these on the health of nearshore reefs. Specifically, this project builds on an existing community-driven stream monitoring program to reveal microbial mediation of nutrient dynamics, and identify hot spots for human pathogens. These data will deepen our understanding of the processes mediating nutrient cycling, identify target areas for ecosystem restoration, and provide potentially life-saving information to people living on Mo'orea.

Summer Research Mentorship Fellows

This summer program pairs a graduate student with an undergraduate student in a research partnership during the summer to significantly advance a shared environmental research project. Below, the graduate student fellows are pictured in top photos and listed first, with undergraduate students shown in bottom photos and listed second.



Alec Vallota Easman and Kevin Garcia // Fracking is a primary method for U.S. natural gas production and represents a significant contribution to pollution and carbon emissions. Among potential alternatives to fracking, utilizing oil-producing microbes stands out for its capability of atmospheric carbon recycling and sustainable operations. The success of microbial fermentative reactions that produce biogases are currently limited by the build-up of fatty acid byproducts, toxic to cells in the reaction. In this project, Alec and Kevin will investigate a newly-discovered enzyme, fatty acid photo decarboxylase, for its potential to reduce fatty acid toxicity in fermentation reactions. Alec and Kevin will test the natural ability of various analogues of the enzyme from different aquatic species to generate biofuels from fatty acid substrates. They will then engineer the sequences of enzymes from the most promising species to increase reaction rate and substrate specificity. Success in this work will overcome the major barrier of replacing gas extraction through fracking with biologically-sourced natural gas production.



Sevan Esaian and Kelsey Husted // Giant kelp is a foundation species that sustains and supports thousands of other marine taxa by providing habitat structure and food in the form of dissolved organic carbon. However warming and acidifying oceans threaten to change this critical ecosystem function. Sevan's research is focused on understanding the functional role of marine microbes in facilitating giant kelp's nutrient production. Through the lens of biogeochemical cycling, he and Kelsey aim to quantify giant kelp forest productivity under ambient and stressed conditions. They will focus specifically on: (1) determining how dissolved organic carbon production may change with increased ocean warming and acidification, and (2) understanding how giant kelp's microbiome may drive this process. This work will be critical to understanding how kelp forest ecosystems may change under future climate scenarios.

Jason Maier and Andrea Morquechu Rubalcava // Globally, agriculture is responsible for 30% of anthropogenic greenhouse gas emissions, 70% of freshwater use, and occupies nearly half of all ice-free land available on earth. While these estimates consider food production as a whole, meat has some of the highest environmental intensities, a measure of environmental impact per unit of production. Meat substitutes are thus gaining momentum as an environmentally friendly alternative to traditional meat consumption. The environmental efficacy of such a solution depends on the extent to which consumption of meat substitutes actually displaces traditional meat consumption. Jason and Andrea's research uses econometric and experimental methods to understand to what extent and under what circumstances consumers choose meat substitutes instead of traditional meat products. The results will inform both how the environmental benefits of meat substitutes are conceptualized and the means by which displacement may be increased.

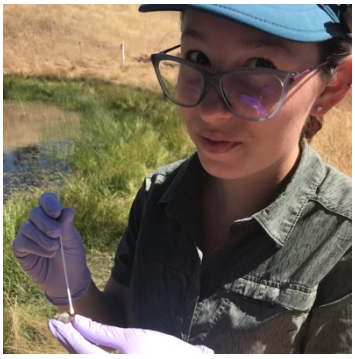
Sarah Laperriere and Blanca Lopez // Plastic in the marine environment is a global pollution problem endangering a wide range of marine organisms. The production of plastics is growing and inputs to the ocean are predicted to increase, yet the mechanisms and time frame over which plastics degrade in the ocean are unknown. The goal of Sarah and Blanca's research is to identify and isolate cultures of marine bacteria capable of degrading one form of plastic - polylactic acid (PLA). This plastic is commonly used in many ocean sensors. The ultimate goal is to be able to embed these bacteria into plastics to decrease residence times in the ocean and thus reduce global plastic pollution in marine systems.

Logan Kozal and Misa Yamamoto // Aquaculture can have a low impact on the environment while providing marine food resources to human populations. Yet, for some important aquaculture species, the future of production is threatened by climate change. Logan and Misa's research explores the effects of climate change on early life stages of the commercially important New Zealand greenshell mussel. Specifically, Logan and Misa's project explores how the parental environment can influence the biology and ecology of their offspring, and potentially prime the next generation for stressful conditions. The project will seek to identify the mechanism driving this transgenerational plasticity, and whether it is possible to condition male or female broodstock of greenshell mussels to elevated temperatures in order to improve the temperature tolerance of their offspring and will. The overall aim is to assess whether this type of conditioning intervention is a potential strategy for the aquaculture industry to mitigate the negative effects of climate change on food resources.

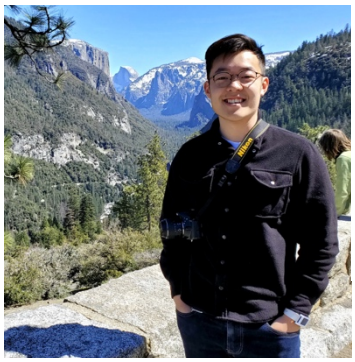
Maddie Nolan and Travis Stoakley // Over the last century, annual plants from Europe and Asia have come to dominate grasslands in California, which has drastically altered the structure and functioning of these communities. Initially, it was thought that grasslands could convert back to native communities after the cessation of disturbances like agriculture or livestock grazing, but exotic annual plants have continued to dominate. It is now clear that active restoration of grassland communities is required to re-establish native species. However, successful restoration of native grasslands in California is dependent on understanding how climate change will impact the persistence and distribution of grasslands in the future. Maddie and Travis's research will specifically explore how drought impacts the establishment of native species. More narrowly, their research examines how extended drought impacts the establishment and abundance of the native grass *Stipa pulchra* and associated native forbs. To do this, Maddie and Travis will monitor how a grassland community establishes during an extended drought and a nearby unrestored remnant native grasslands. They will also monitor small mammal disturbance in the restored and unrestored native plots. Ultimately this work can guide and inform better restoration of California grasslands under changing climate scenarios.

Imani Russell and Kana Suzuki // Amphibians are in decline globally, in large part due to the catastrophic effects of one devastating fungal pathogen - *Batrachochytrium dendrobatidis,* or Bd. Interestingly, susceptibility of amphibians to Bd varies from population to population – some populations are driven to extirpation while others seem to be unaffected by disease. Similarly, virulence of Bd varies by strain, with broadly distributed strains tending to show higher virulence than more localized ones. Imani and Kana's research addresses the genetic drivers of disease dynamics between frogs and their fungal pathogen. Specifically, they aim to elucidate genetic factors in both host and pathogen contributing to these differences in disease dynamics and how these genetic factors interact with the environment. Increased knowledge of these genetic processes especially in lesser sampled species will help determine disease threat levels of these species and prioritize conservation interventions to species and populations most at risk.

Stephanie Ma and Angela Chu // Nearly two-thirds of the world's ecosystems are considered degraded to some degree and, thus, there is a huge need to focus on restoration practices to increase efficiency at all scales. However, two of the biggest challenges of restoring terrestrial ecosystems are determining which species were present prior to degradation and if a viable seedbank is present to initiate restoration. Stephanie and Angela will use environmental DNA (eDNA) and environmental RNA (eRNA) techniques, commonly used in aquatic systems, to develop methods that can be applied to understand restoration goals in terrestrial systems. Their goal is to identify which native species were present before degradation (through eDNA), which species have viable seed present in the seedbank (through eRNA), and the limitations of eDNA and eRNA methods compared to traditional seed bank assessments. Developing eDNA and eRNA methods will contribute to general understanding of successional patterns and community shifts in response to climate change and will have very practical applications for managers vying to cost-effectively restore local, native communities across a large area while also preserving local plant genetics.



Tatum Katz and Yanelyn Perez // Amphibians are the canary in the coal mine for ecosystem health and function, but are currently declining rapidly. The pathogen chytridiomycosis, caused by the chytrid fungus Batrachochytrium dendrobatidis (Bd for short), is responsible for a considerable portion of these declines. The majority of Bd research has taken place between the pathogen and the host; however, little effort has gone to understanding the pathogen outside of the host. This is a critical oversight and greatly limits the ability to accurately predict patterns of Bd spread and to effectively mitigate the disease for endangered and threatened populations. In this work Tatum and Yanelyn will explore whether insects, nematodes, soil and water can be effective reservoirs for Bd and enhance its ability to persist and spread through the environment. These hosts and reservoirs may alter Bd-amphibian dynamics to cause differing outcomes of amphibian survival or extirpation. Using the data collected in this project, Tatum hopes to build better models of Bd that are more realistic and useful in the management of Bd - and thus the conservation of many of the world's amphibians.



Michelle Lee and Tiger Lao // Predatory fish have been introduced to freshwater ecosystems around the world. These fish species introductions can dramatically change freshwater communities and ecosystem functions, such as food webs and nutrient cycling. These disruptions are not contained, as the boundaries between terrestrial and aquatic communities are linked through the reciprocal transfer of food and nutrients. Indeed, changes to freshwater communities are known to affect terrestrial plant, invertebrate and vertebrate communities. In this research, Michelle and Tiger will examine a set of high-elevation lakes in the Eastern Sierra Nevada Mountains with the aim of understanding the cascading effects of introduced trout on pollination, a vital ecosystem service that has global ecological and economic importance.

Molly Hardesty Moore and Reina Crouch // Raccoons are one of the most well-known wildlife species in major cities. They have become adorable vestiges of nature in otherwise transformed urban ecosystems, but they are also problematic pests, often carrying diseases that people or pets can contract. In order to better manage these wild populations and their potential disease risk, it is important to understand how raccoons use space and interact with features of urban ecosystems. Molly and Reina will be tracking raccoons around UCSB and Isla Vista using GPS transmitters with the goal of understanding how and why racoons use features of this urban ecosystem. As more ecosystems become heavily influenced by human development, lessons learned from studies like this can create new models for promoting wildlife conservation in urban settings that work for people and nature.