EARTH SYSTEMS
VOLPERT SCHOLARS AWARD
Project Synopses, 2016

Ariel Bobbett
Earth Systems – Biosphere Track, B.S. 2017
Advisor: Peter Vitousek (Biology)

Investigating Nitrogen-Fixing Capabilities of ʻUala by ^{15}N Nitrogen Dilution
In tropical grasslands, nitrogen is usually the limiting nutrient for plant growth, and nitrogen is the only element that can be added to ecosystems through biological fixation. Recently, there's been an expansion and growing diversity in the list of recognized biological nitrogen fixers and there is some controversy over whether or not ʻuala (sweet potato), ko (sugarcane), kikuyu grass, and buffel grass can fix nitrogen.

The purpose of this project is to determine whether or not these plants fix nitrogen by growing these crops and known nitrogen-fixing and non-fixing plants in long-term nitrogen amended soils and measuring nitrogen fixation by nitrogen isotope dilution. This project will improve understanding of biological nitrogen fixation on a smaller scale, as well as provide insight into native Hawaiian agricultural practices. We will work closely with the Ulu Mau Puanui community organization for education and outreach to Hawaiian students and general community about the history and science of traditional rainfed ʻuala cultivation.

I enjoyed working with Peter Vitousek last summer at Puanui for my internship in Earth Systems, and I'm excited to return and build upon my work with him in the form of an honor's thesis. I've learned a lot about the theory behind using isotope analysis in my coursework, but I've never undertaken a project myself. Through learning isotope analysis I will gain a valuable new tool, especially since I hope to have a career in interdisciplinary environmental research in the future. I'm looking forward to finding ways to incorporate cultural and educational aspects of native Hawaiian agriculture into this project.

Michaela Elias
Earth Systems - Food and Agriculture Track, B.S. 2017
Advisor: Roz Naylor (Earth System Sciences)

Analysis and Comparison of For-profit and Non-profit Urban Farms to Determine Best Practices and Sustainability Goals
My objective for this project is to research if and how for-profit urban farms can achieve economic viability while still incorporating beneficial social and environmental values and policies. Urban agriculture projects have historically been intentionally designed to be small scale, multi-purpose, decentralized and extremely varied in form and function. They are intended to engage diverse social

groups and remain productive while sustaining and even regenerating natural resources. These concepts, which often conflict with the ethos of traditional businesses, are nevertheless desirable in terms of social and ecological sustainability. Through my research I propose to study various existing urban farming projects in New York and San Francisco to ascertain what methods they employ in an attempt to be economically sustainable while still striving to incorporate social and environmental values in order to determine whether these objectives are really feasible and, if so, what type of framework is needed to meet these objectives. As part of this process, I will identify a set of best practices for urban farming, as well as identify obstacles or shortcomings and potential methods for overcoming them. I plan to use this research for an honors thesis in Earth Systems relating to the sustainability and future of urban farming.

I am very excited about this research because so many of the experiences I have had and paths I have chosen, both at Stanford and in other contexts, have fueled my interest in food systems issues, specifically my interest in the urban agriculture phenomenon. Many of my classes are focused on the issue of feeding a growing global population, especially as an increasing percentage migrates to urban areas, and urban agriculture has emerged as one approach to addressing a broad range of food systems issues. Through this research I hope to be able to apply the knowledge and critical skills I have gained through my Earth Systems classes and return to Stanford in the fall with a deeper understanding of the issues I am studying.

Jonathan Fisk

Earth Systems – Biosphere Track, B.S. 2017, M.S. 2017
Advisor: Giulio De Leo (Hopkins)

Precautionary Alaskan Salmon Fishery Management in Light of Multiple Climate Change Variables

For the last two summers, I have worked under Dr. Giulio De Leo building several marine ecological models. While the first two projects, during the first summer, had more practical applications, my work was largely based on the work of others, and required heavy guidance. Conversely, I had more independence on my third project, but was instead focused on a topic far more theoretical but with huge practical implications, as changes in water temperature and other parameters (pH, salinity, turbidity, nutrients, etc.) driven by global climate change might have dramatic impacts on habitat quality and, ultimately, on the productivity of our fisheries. It is thus crucial to gather an in-depth understanding of the effects of climate change on fishery performances of species of conservation and commercial interest.

For this proposed project, I will leverage on my previously modelling experiences to address the following very compelling overarching question, namely how climate change and, specifically glacial melting, will affect the conservation and management of the Alaskan salmon fishery. In particular, I will use previous research and historical data on salmon dynamics in Alaska to calibrate a demographic model for salmon and I will use it to explore how different environmental factors - such as rates of glacial melting, freshwater lens extension, and extreme climate events - can affect fishery performances. During this project I will have an even greater degree of intellectual independence than my projects, gathering data by coordinating with

multiple researchers, while again focusing on a project that is highly practical. Additionally, this project is inherently interdisciplinary, using computer models to assess environmental and marine ecological dynamics, and then analyzing the results through socioeconomic and environmental justice lenses to describe the trade-offs of different management strategies, weighing in concerns on the viability of Alaska's economies and natural systems. This proposed project will allow me to begin my extensive analysis of Alaska's salmon fishery management system, which I intend to focus on for my M.S. Thesis in the coming year.

Joe Hack

Earth Systems – Biosphere Track, B.S. 2017
Advisors: Rodolfo Dirzo (Biology), Beth Morrison (Biology)

An Analysis of Bird Biodiversity and Pest Management Services Along a Gradient of Agricultural Intensification

Nearly half the world's land area has been converted to agriculture, which is the number one driver of biodiversity loss, and the demand for food will only increase over the next 30 years as the world's population grows to nine billion. We all therefore have a clear interest to make farming at once both more productive and supportive of biodiversity.

Diversified farms, which purposely retain natural habitat, seem like one promising way to accomplish these two aims, though their purported benefits —increased biodiversity and ecosystem services — deserve further testing. Therefore, I hope to assess how diversified farms affect both avian biodiversity and ecosystem services in the form of pest management this summer with my project. To understand how avian biodiversity changes with intensification, I will compare avian species richness across natural settings, intensive organic monocultures, and organic diversified farms in central coastal California. I will also analyze diet changes across this same gradient in order to understand which species provide pest management services and how strong those services are on each type of farm.

I am excited to complete a thesis project this summer. I have loved birds since I was 12 years old, so I can think of no better topic for my culminating academic experience at Stanford than this one. Moreover, I am confident that I will grow as a scientist through this project. Finally, I appreciate the opportunity to contribute to the challenge of creating more biodiverse agriculture, an issue that I find fascinating and hope to work on in my future as a conservationist and scientist.

Madeline Lisaius

Earth Systems – Land Systems Track, B.S. 2018
Advisors: David Lobell (Earth Systems Science), Meha Jain (Earth Systems Science)

Mapping Smallholder Wheat Yields and Sowing Dates in Northern India Using Micro-Satellite Data

The project, 'Satellite Mapping of Agricultural Regions' aims to better understand factors contributing to reduced wheat yields and to identify potential interventions to increase food security in northern India. Rather than using coarse district-level crop statistics provided by governments, satellite imagery will be used to better understand how factors such as irrigation access and soil quality are associated with low and high yields with the end goal of providing recommendations to eventually enhance yields.

Organizations have historically collected data by interviewing farmers and using time- and cost-intensive methods in the field. By developing methods to ask questions at large spatial and temporal scales at low cost, this project will make significant contributions to remote sensing as a method of assessing change. Using data collected by the partner organization CYMIT alongside fine spatial resolution satellite imagery at the level of individual fields, we hope to identify factors leading to reduced yields. Date of crop sowing seems to be a particularly influential factor with the introduction of no-till agricultural practices and a potential intervention.

This project contributes to the larger body of work on agricultural systems. As data is collected on yield and sow date in space and time, regions that are always high or low yielding can be better identified alongside characteristic landscape data (such as soil type and irrigation practices) for intervention. The results will hopefully inform policy on what interventions should be prioritized.

Rosemary Mena-Werth

Earth Systems – Oceans Track, B.S. 2016
Earth Systems, Environmental Communication, M.A. 2016
Advisors: Tom Hayden (Earth Systems), Kevin Arrigo (Earth Systems), Bjorn Carey (Stanford News Service)

Discovering Hopkins: What happens above and below the water's surface at Stanford's Hopkins Marine Station

Stanford's Hopkins Marine Station is a journalistic triple point. It produces some of the most timely and innovative research in marine science. It is visually arresting. And, the researchers are full of stories from their data collection that include lobster pirates, slug orgies, and being stranded on remote islands with meter long crabs.

Normally, the stories that come out of Hopkins are articles that end up fairly contained within the scientific community. They are created to build ethos with other researchers by emphasizing logic and an absence of human bias. These are the papers I have been trained to write as a scientist, but I believe that Hopkins can be recognized and enjoyed by more people through a different approach.

My goal is to tell the story of Hopkins, the researchers, and the science in a way that reaches a general audience. Ultimately, I will create profiles of Hopkins researchers that explore their findings, their journeys to collect their data, and why they are passionate about the ocean. Additionally, I will do two short video essays that highlight the physical beauty of Hopkins and the marine life that lives below the ocean's surface, out of sight. One of these will center on undergraduate opportunities at Hopkins, and the other will show the kelp forests at Hopkins and the marine organisms that live there.

Many people, including Stanford Undergraduates, will never dive into the ocean and see what organisms live on the majority of the Earth or even recognize Hopkins as a resource for learning more about the ocean. As I improve my own science communication skills, I want to make the beauty and knowledge that resides at Hopkins accessible to a broader Stanford campus and the general public. Hopefully, by creating interest in the ocean, people will be pulled to learn more, become involved with Hopkins, and protect marine environments.

Kira Minehart

Earth Systems – Biosphere Track, B.S. 2016, M.S. 2017
Advisors: Richard Nevle (Earth Systems) Mandi Toy (National Park Service)

Understanding America's Best Classrooms: A summer as a science educator in the Grand Canyon

I am extraordinarily excited to work with the National Park Service, Geological Society of America, and AmeriCorps this summer as an earth science educator. I will be working through the Geoscientists in the Parks program, a collaboration between the aforementioned organizations to provide real world earth science experiences to recent college graduates.

This summer, I'll be located at the North Rim of the Grand Canyon National Park. I'll be the lead geology interpreter; providing various forms of science education to park visitors and staff. In particular, I will be creating geology themed exhibits for the visitor center and giving presentations, tours, and hikes focused on earth science education. I hope that my work at the Grand Canyon this summer will inspire others to care for the planet by instilling a sense of wonder and scientific inquiry.

I am thrilled to pursue my passion for environmental education, science communication, and National Parks this summer at the Grand Canyon, a place I consider to be one of America's best

classrooms. I have spent four years studying these themes with the Earth Systems program and can't wait to apply my academic knowledge in the real world. I am confident that this experience will inform my future career trajectory, inspiring me to continue working with National Parks and science education after I graduate from Stanford.

Andreas Ratteray

Earth Systems (Oceans Track) and Middle Eastern Languages, Literature and Culture, B.S. 2017
Advisors: Rob Dunbar (Earth Systems)

Reproductive Ecology and Patterns of Ontogenetic Migration by Invasive Lionfish in Bermuda

I remember when most people in Bermuda did not know what lionfish were—now it is hard to dive without seeing one. They appear in almost every one of Bermuda's marine environments, from shallow mangrove waters to deep mesophotic reefs and everywhere in between. Lionfish are insatiable predators that can outcompete native fish for food and have already done so in many Caribbean reefs. This intense competition prevents the recruitment of juvenile natives, leading to reefs systems in which lionfish dominate the biomass. The Bahamas only started reporting lionfish in 2004 yet already many of its reefs host only lionfish. So many people depend on the diversity of Bermuda's reefs, diversity that we could lose if we do not address the lionfish invasion.

One way I can protect Bermuda's ecosystems from the lionfish invasion is by working with Gretchen Goodbody-Gringley to map the reproductive patterns of lionfish in Bermuda. We will have access to technical diving equipment that will allow us to collect specimens from sites as deep as 60 metres, data that most scientific divers cannot gather because of the high level of training required. Since it is so hard to access these deep sites, there is a shortage of data on the nature of lionfish that live on Bermuda's mesophotic reefs. If we can comprehensively describe the path that lionfish take throughout their lifecycles, then we can possibly identify 'hot spots' for lionfish reproduction. This would allow us to target removal operations to eliminate the larger and more reproductive individuals.

Nicholas Romano

Earth Systems—Biosphere Track, 2017
Advisors: Kabir Peay (Biology), Laura Bogar (Biology)

A Species Based Analysis of Fungal Communities in Jasper Ridge Biological Preserve

Fungal communities in plant roots are comprised of ectomycorrhizal and endophytic fungi, and both are critical to plant growth and serve irreplaceable functions in terrestrial ecosystems. Ectomycorrhizae wrap themselves around plant roots, forming a symbiosis with the plant where the

fungi provides mineral nutrients (Nitrogen, Phosphorous, Potassium, etc) to the plant in exchange for carbohydrates produced by photosynthesis. This symbiosis is found world-wide and occurs in over 90% of all plants.

Fungal endophytes can serve a similar function as ectomycorrhizae but present much more nuance and elusiveness in their true function. The endophytes live throughout a plant, residing in the leaves, the stem, and the roots of most plants. These fungi provide disease resistance, protection from pests, and even mitigate water stress caused by drought. Despite their many boons these fungi are not mutualists; endophytes can be parasitic, mutualistic, or somewhere in-between the two. The interaction between endophytes and plants is not well documented, and the possible interaction between endophytes and ectomycorrhizae is completely unknown. In my research I hope to first document the fungal communities present beneath four tree species (Valley Oak, Cottonwood, Douglas Fir, and Madrone), then to conduct analyses on their nutrient exchange with trees and also gain an understanding of interactions taking place between the fungal guilds.

This research represents my first self-designed project and will allow me to conduct the full cycle of scientific research, from hypothesis and design to conclusions and possibly publication. I have been assisting biological research for over 4 years and this project is the next step in my academic career. I look forward to uncovering new information and sharing it, with the larger goal of applying this knowledge to agriculture and ecosystem conservation.

Anna Wietelmann

Earth Systems – Biosphere Track, B.S. 2016, M.S. 2017
Advisors: Rob Dunbar (Earth System Science), Janet Clarke (Education Manager, Sitka Sound Science Center)

Education and Communication Internship with The Sitka Sound Science Center
The Sitka Sound Science Center is a nonprofit organization dedicated to improving understanding of the ecosystems of Alaska through scientific research and science education. SSSC is a field station and offers support services to researchers from around the nation studying in the North Pacific and the Tongass National Forest. The nonprofit's vision is to build on Sitka's legacy as a research and science education community.

My internship will be focused on three aspects of informal science education: interpretation, summer camps, and science journalism. I will be trained in interpretation to work occasionally in the hatchery and aquarium, talking to visitors about the work of SSSC. I will also assist with the summer science camps and will work with a team of science educators to deliver high quality programs across a breadth of scientific disciplines. The last part of my internship will entail learning about science communication. I will work on radio and print science stories for the local public radio station and daily newspaper. For this I will select three story ideas, work with an experienced science journalist as well as journalists from the local media to produce stories that are of interest to people living in coastal communities.

This summer, I hope to gain hands on experience in environmental education, communication, and small-scale resource management, to better inform the focus of my Coterminal Master's degree. The diverse nature of my responsibilities will serve as an excellent practical application of my interdisciplinary background. The Sitka Sound Science Center is involved in community based research, science outreach, and communication. These are three are key components of human-environment interactions that I am especially interested in. My responsibilities: curriculum development, teaching, interpretation, and science communication, will allow me to explore the intersectionalities of these processes in a small community that has strong ties to the surrounding environment. I am also interested in ultimately working at a nonprofit organization, and hope to gain insight into what it takes to run a nonprofit and what it is like to work in one.