

## VOLPERT SCHOLARS AWARD 2015, Project Synopses

Yari Greaney, B.S. '16, M.S. '16

Earth Systems, Land Systems

Faculty Advisor: David Freyberg (Civil and Environmental Engineering)

Secondary Advisor: Georgina Avlonitis (ICLEI – Local Governments for Sustainability)

### **Resource management along the urban river in Lilongwe, Malawi**

The Lilongwe River flows through Malawi's largest city, Lilongwe, providing drinking water for 80% of the city's residents and an irrigation source for urban farmers. However, rapid rural-urban migration has caused dense informal settlements to amass along the river's banks and floodplains. To secure adequate food supplies and income, many of these residents engage in land use activities that threaten the river's water quality. These activities include illegal dumping of toxic substances, agricultural production on wetlands, and deforestation. The International Council for Local Environmental Initiatives (ICLEI) has established a capacity-building workshop program in Lilongwe with the goal of improving the city's ability to sustainably manage its natural resources while actively alleviating poverty, under the program title Urban Natural Assets (UNA). The aim of the study is to illustrate the impact of varied socio-ecological characteristics along the river, in order to facilitate informed decisions about land management that will maintain local food security without degrading the quality of the water resource. Through land use mapping using GIS software, rapid assessment process (RAP) interviews and surveys, and water quality sampling, this project will highlight spatial relationships between land-use practices, local river water quality, and the resource management recommendations of distinct communities along the urban river. This research will also provide a comparison between the resource management priorities identified by communities along the river and those identified by higher-level decision makers at the UNA workshops. This project will provide UNA and the local government with an increased understanding of how different land uses impact the quality of the river, which populations will be most impacted by different resource management decisions, and the needs and priorities of different communities along the river. This research allows me to mesh together my interests in ecosystem service sustainability, urban agriculture, local government structure, and poverty alleviation, all centered around a river in a rapidly developing urban environment, in a project that will go to direct and immediate use. This study will push me to be creative, adaptive, and rigorously interdisciplinary, because I want to provide as useful a description of the socio-ecological system as possible to the decision makers in the UNA workshops.

Lauren Gibson, B.S. '17

Earth Systems, Biosphere

Faculty Advisor: Elizabeth Hadly (Biology)

Secondary Advisor: Alexis Mychajliw (Biology)

### **Can social behavior buffer against anthropogenic perturbations? A case study of an endangered mammal, the Hispaniolan Solenodon**

For my Volpert scholar research project, I will use an interdisciplinary toolkit to investigate how Hispaniolan solenodon social dynamics, group size, and habitat use varies with different magnitudes of human disturbance in the Dominican Republic. My toolkit includes the use of camera traps, ecological transects, geographic information systems (GIS), local ecological knowledge, and genetic techniques. These data will be shared with collaborating conservation groups in the Dominican Republic for immediate use in conservation efforts. My data, when combined with data generated by my graduate advisor, Alexis Mychajliw, will help test whether it is body size, a suite of ecological traits, or life history traits that predisposes a species to extinction, providing an even broader conservation impact than either of our projects might have standing alone.

My research draws together a series of fields that do not usually overlap in a single project: genetics, population biology, ecology, conservation, environmental education, and human-animal interactions. By weaving all of these subjects into my project, I will create a project with farther-reaching implications and

more realistic, implementable solutions than a project spanning a single field of study would create. Working with local people and organizations will give me experience both with collaborating with diverse groups of people and with mobilizing local knowledge to create large-scale conservation changes that incorporate current knowledge with new scientific discoveries. With this research under my belt, I will be ready to take on a variety of other conservation challenges, utilizing the skills I pick up in the field to come up with viable approaches to other interdisciplinary environmental problems.

**Adrienne Pollack, B.S. '16**

Earth Systems, Sustainable Food and Agriculture, Minor: Economics

Faculty Advisor: David Lobell (Environmental Earth Systems)

Secondary Advisor: Meha Jain (Environmental Earth Systems)

### **Strategies for agricultural adaptation to climate change in India**

Research over the past decade has identified a new and formidable challenge to agriculture: global climate change. Warming global temperatures will impact major staple crop yields worldwide. Wheat is one major crop that is predicted to experience severe yield declines due to climate change, with existing studies verifying that warmer temperatures are already reducing wheat yields. South Asia is considered to be particularly vulnerable with a projected warming of 2 to 3°C by mid-century. This is especially problematic, as wheat grown in northern India provides over 20% of the calories consumed across the subcontinent. With possible yield losses of 30%, this implies a harsh disruption in consumption and food security in India.

To address warming temperatures, farmers have begun adapting wheat-growing practices. Most notably, some have begun shifting planting dates earlier in the season to avoid terminal heat stress towards the end of the growing season. Yet, it remains unclear whether and to what extent an early sowing strategy impacts crop yields. The objective of our research is to evaluate the impact of an early sowing strategy on wheat crop yields in India, with respect to seasonal temperature trends. To accomplish this, we will analyze high-resolution remote satellite imaging data, and build models incorporating data on yields and temperatures. These studies should provide a basis for policy recommendations, for example through partnering organizations including the International Maize and Wheat Improvement Center.

In my studies at Stanford, I have learned about food and agriculture through my major in Earth Systems and minor in Economics. I am excited to take this even further through applied statistics and remote sensing this summer. I will gain the guidance of Professor David Lobell, and I will build a close mentorship with my Post-doctoral advisor, Meha Jain. By combining disciplines in statistics and my studies in environmental sciences, I hope to grow from this experience by gaining an applied and interdisciplinary understanding of my education, and a new skill set that will prepare me for future employment in this field.

**Catie Mong, B.S. '16**

Earth Systems, Land Systems

Faculty Advisor: Rodolfo Dirzo (Biology)

Secondary Advisor: Ethan Shirley (Juara Foundation)

### **Perceptions of jaguars in the cattle ranching community in the Brazilian Pantanal**

The Pantanal, the world's largest wetland, is one of the most biodiverse environments in the world. This region has a long history of cattle ranching with ranches largely using traditional practices and having low cattle densities due to environmental constraints. As such, cattle ranching in this area is considered sustainable and even advocated as an important conservation tool in order to keep large areas of land intact for wildlife habitats. However, predators are an important part of any healthy ecosystem, and the Pantanal is home to the largest jaguar population in the world. As such, this has resulted in predator-ranching conflict with numerous jaguars killed each year despite Brazil's law banning hunting of all wildlife. To

date, no studies involving in-depth interviews of cattle ranchers have been done in this area. I propose conducting a qualitative study using semi-structured interviews to discover factors influencing ranchers' perceptions of jaguars and conservation as a whole. This will be useful to conservation organizations as a means of understanding ranchers' experiences in order to facilitate partnership and removal of obstacles to more sustainable cattle management.

This is a perfect example of an interdisciplinary problem involving multiple stakeholders. I am particularly excited about the opportunity to do a qualitative study. While I have previous experience in quantitative research, I have yet to fully try qualitative research outside the realm of my methodology class. In order to truly be an interdisciplinary scholar, I think it is important to be comfortable using both quantitative and qualitative research methods. I think it is a true testament to interdisciplinary nature of the Earth Systems program that I can become equally confident in lab techniques, ecology field methods, GIS, and qualitative research so solve problems that I am passionate about. As a student in the Land Systems track, I hope to further expose myself to the exciting intersection of land use, conservation, and community livelihood.

Fiona Noonan, B.S. '17

Earth Systems, Anthrosphere

Faculty Advisor: Nicole Ardoin (Education)

Secondary Advisor: Indira Phukan (Education)

### **Impacts of nature education on conservation-related outcomes**

As an Earth Systems major in the Anthrosphere track, I am primarily interested in the relationships between people and nature, especially in national parks. Specifically, I have been focused on how interactions with nature may instill a sense of environmental consciousness in park visitors, and how this consciousness may be harnessed to achieve a more sustainable society. This summer, I will formalize my inquiry by conducting research on NatureBridge programs in Yosemite and Golden Gate National Parks, under the guidance of Professor Nicole Ardoin, who has a joint appointment in the Graduate School of Education and the Woods Institute for the Environment, and Indira Phukan, a PhD student in the Graduate School of Education.

NatureBridge's mission is to "foster environmental literacy to sustain our planet," which they achieve through a variety of day camps, backcountry experiences, and school group programs. My research will consider the effectiveness of NatureBridge's backcountry programs to inspire conservation-related outcomes. This will build on recent research by Professor Ardoin and her team into how intermediary outcomes—such as interest, engagement, and trust—develop during the course of immersive and residential environmental education programs. Additionally, I will work with Indira to study the interplay of instructor-student pedagogy and diversity, and to pilot test various environmental education evaluation instruments.

Besides giving me a hands-on application of the sustainability, methodology, and education frameworks I have learned through Earth Systems, working with NatureBridge will also directly relate to my work with the Stanford Outdoor Outreach Program (SOOP). Understanding the ways that students best engage with environmental education will be critical in continuing to provide meaningful experiences to East Palo Alto Academy students that have limited previous exposure to the outdoors. I am hoping to apply the knowledge and skills I gain this summer to SOOP's programming and mission, and also to bettering the direction of Stanford Outdoor Education in my position as a council member next year.

Evan Patrick, B.S. '16  
Earth Systems, Biosphere  
Faculty Advisor: Rodolfo Dirzo (Earth Systems Science)

### **Analyzing the efficacy of a community-managed boreal forest in Oaxaca, Mexico**

I will examine change in vegetation cover and timber reserves over time in a community-managed boreal forest in Oaxaca, Mexico. This is aimed at testing the hypothesis that, if indigenous forestry management in the Oaxacan community of Ixtlán is effective or sustainable, the managed area should maintain a constant or increasing forest cover across time. In particular, I will compare satellite images from different time periods to measure the differences in vegetation cover across the indigenous managed area over time. This will be combined with historic and management data to connect changes in forest cover with specific forestry practices. This analysis will attempt to find the long-term impacts of indigenous forestry practices and determine if they are sustainable. I also hope to guide indigenous managed forests in the future by finding relationships between specific practices and forest cover.

During the project, I will work with the Mexican Commission on Biodiversity (CONABIO) in Mexico City to gain local knowledge of the area and receive mentorship on my project. I will also be working closely with my advisor, Rodolfo Dirzo, to incorporate Earth Systems thought into my research. Through these experiences, I hope to gain experience in interdisciplinary analysis. In my studies, I have learned to use tools like remote sensing and this project will be my chance to combine them with Earth Systems thought to produce meaningful results. Working with CONABIO will also give me important experience working in an interdisciplinary, non-scholastic research institute. From this work, I hope to understand how conservation work manifests itself outside of academia. Additionally, the project's breadth will hopefully expand my skills as an effective problem solver and collaborator. As this project is my proposed honors thesis, I expect to continue this collaborative learning experience throughout my final year at Stanford.

Indigo Johnson, B.S. '16 (Biosphere)  
Earth Systems, Biosphere  
Faculty Advisor: Rodolfo Dirzo (Biology)  
Secondary Advisor Ramón Perea García-Calvo

### **Tree recruitment in oak woodlands: Linking niche occupation and seedling traits in four co-occurring species**

My study uses oak niche occupation as a proxy for each species' ability to cope with stress. I will look at both niche characteristics and plant ecophysiological traits to establish each species' potential growing conditions and ability to respond to its environment. My work will focus on seed and seedling recruitment since seedling establishment is one of the most critical stages in the regeneration of trees (Clark et al., 1999). Knowing how regeneration differs provides a valuable insight into how to tailor restoration plans to specific species, especially in the face of the potential increase in environmental stressors. My study will look at four species at Jasper Ridge: *Quercus agrifolia*, *Quercus kelloggii*, *Quercus lobata*, and *Quercus douglasii*, in order to get a sense of the overall Oak community. Upon completion, this will provide a resource for the conservation and management of oak savannas and woodlands in California.

I believe that this research project provides many of the critical building blocks to my success as an ecologist. Initial brainstorming and researching have improved my skills in understanding ecology and identifying areas where more research can be done. Conducting my research will reinforce concepts from almost every aspect of my education thus far, since my project focuses on the oak in an ecological system, which is very complex. I will apply principles from fields such as soil science, chemistry, and ecology, in addition to using biostatistics that I have been exposed to in several courses so far. I know that I will also discover gaps in my knowledge. I will learn things I may not have gotten the chance to otherwise, in addition to teaching me how to be self-directed with my education, an essential skill for any scholar.

Johnny Caspers, B.S. '16 (Food and Agriculture)  
Earth Systems, Food and Agriculture  
Faculty Advisor: Scott Fendorf (Earth Systems Science)  
Secondary Advisor: Patrick Archie (Earth Systems)

### **Stanford Educational Farm Worm Composting System**

This summer my research will focus on developing a worm composting system on The Stanford Educational Farm that can use the ample supply of horse manure produced by the Stanford Red Barn. I hope to create a more interconnected system on campus that can save money and also help mitigate the environmental costs associated with the transport of both animal waste and farm compost. The two main focuses of my work this summer will be to judge the effectiveness of worm composting in its ability to neutralize antibiotics and other drugs that are common in a horse's diet. Also, I will seek to create a system that is scalable and will be able to produce enough compost to supply the farm.

In pursuing this research I hope to be able to further my knowledge of the disconnected structure that is present within the U.S. agricultural system. Our nation today is home to a lot of excess in which nutrients from both fertilizer runoff and plant waste enter ecosystems and leads to large-scale damage. By creating a system that is able to cycle nutrients more efficiently and effectively I want to be able to simulate a cycle that, if scaled up, could help to solve some of the nutrient disparities that are faced by our nation and the globe as a whole. This research will benefit me as a problem solver because I will be able to look at a confined case and use it to address issues that are faced on a much larger scale.

Michael Peñuelas, B.S., M.S. '16 (Food and Agriculture)  
Earth Systems, Food and Agriculture  
Faculty Advisor: Paul Ehrlich (Biology)  
Secondary Advisor: Patrick Archie (Earth Systems)

### **Internship with The Markets Institute at the World Wildlife Fund**

Working with The Markets Institute at the World Wildlife Fund, I'll be working at the intersection of agricultural production and biodiversity conservation. The Institute is in its early structuring stages and I will be interning with its directors while they are engaged in defining how the institute will tackle the problems it has identified with large-scale food production and the niche it will fill within the space of soft commodity production and trade. The Institute's goal will remain to pressure commodity traders and processors to codify their purchasing in such a way that they can incrementally ratchet up various environmental sustainability metrics and in turn exert direct and measurable pressure on producers. It is inherently difficult to measure the success of such "pre-competitive market transformation" strategies, and my role will include evaluating metric collection and analysis frameworks. Even since the fairly widespread adoption of certification schemes pioneered by WWF, producers seeking to capture the lower-cost ends of markets have not moved because of infrastructural or cultural inertia or a failure of market forces to compel them to. I will bring a background of work with behavior change and campaign building to the WWF team and will be working to design new methods by which to shift these institutionalized structures. Historically effective certification schemes have brought industry-level actors to negotiating tables, rewarded responsible and sustainable growers, and reduced negative impacts on native ecosystems, but the impacts haven't had significant enough net effects. The novel format of the Markets Institute, and I along with it, will be working this summer to redefine the conversations around soft commodity production and trade in such a way that tangible positive results can be realized at the urgent timescales threatened ecosystems, and our climate, require.

Alicia Menendez, B.S. '17 (Oceans)

Earth Systems, Oceans

Faculty Advisor: Kevin Arrigo (Earth Systems Science)

Secondary Advisor: Jorge Sarmineto (Princeton University)

### **Emergence of multiple ocean ecosystem drivers in a large ensemble suite with an Earth system model**

The research that I will be conducting this summer will involve me evaluating and adding surface carbon trends to a pre-established climate model that has been developed by Princeton's Professor Jorge Sarmiento's lab. This will be accomplished through evaluation of data I will receive from the Coral Triangle of the Pacific Warm Pool, and programming through the climate model. Additionally, I will gain experience in science communication through the science journal that I will be in charge of compiling, during my time in the lab. This research will be an excellent supplement to my academic career as an Earth Systems major on the Oceans Track, because it will give me valuable experience in data analysis, programming, and working in a lab. In addition, through learning how to analyze and model climate change data, I will gain a better understanding of the physical oceanographic and atmospheric processes that interact with a changing global climate. Furthermore, it will provide excellent opportunities for networking, in which I will be able to use upon graduating and looking for a means through which I can start my career in environmental science; I have a great interest in working with coral reefs, not only in terms of research, but policy as well. I would like to do research before I delve into politics, because I believe it is crucial that representatives of the world's coral reef first gain a profound academic understanding of how they function and interact with the ecosystems around them; this will help allow me to make educated, well-informed decisions in how to represent and assist with current coral reef issues. This internship will be an integral step in my career as a coral reef researcher, and eventually coral reef representative.

Isabella Badia-Bellinger, B.S. '17 (Biosphere)

Earth Systems, Biosphere

Faculty Advisor: Sue McConnell (Biology)

Secondary Advisor: Mike Gardiner (Cheetah Conservation Fund)

### **Internship with The Cheetah Conservation Fund**

Namibia hosts the world's largest remaining population of wild cheetahs, and for this reason the Cheetah Conservation Fund (CCF) has established itself in the country to protect the future of wild cheetahs. CCF is based in a hotspot region that is home to Namibia's largest cheetah concentration but is also the heartland of cattle farming. The greatest problem facing the cheetah is conflict with humans, specifically farmers who kill cheetahs in retaliation for any predator attack on their livestock. CCF has a very multi-faceted approach to creating a solution for human-wildlife conflict that is replicable in many other environments. In order to show farmers how to run a healthy, productive and protected farm, CCF runs a model farm demonstrating how to keep livestock healthy and safe from predators. This involves going out into the surrounding area and educating farmers, as well as raising guard dogs to give to farmers to protect their livestock. In addition I'll be involved with the ecological and genetic research CCF does, as well as working in conservation education with the many student groups and tourists who come visit the center.

By participating in this operation I will learn how organizations can work effectively with local stakeholders to avoid entering conflict with certain species and improve their overall livelihoods. This is often the key to conservation, so my involvement in removing the human-predator problem in Namibia and learning how to communicate with farmers is important for any future work I do in this field. In addition, I will gain animal husbandry and veterinary experience working with the guardian dogs and resident cheetahs, valuable skills for someone interested in wildlife management. Another large part of the operation is running ecosystem studies in the reserves owned and managed by CCF. I will contribute to monitoring species presence and abundance, gaining field and data analysis skills, as well as a greater

understanding of the larger ecosystem. This is important information as it relates to poaching and legal hunting, and I will see firsthand how it can be used for implementing policies that better protect wildlife. This internship is ideal for an interdisciplinary student interested in conservation such as myself as I will participate in many niches of the greater operation, from education outreach with local farmers, visiting tourists and conservation students, to hands on animal care with farm animals and big cats alike, to ecosystem monitoring. Working with CCF will allow me to contribute to an important conservation effort and learn how such an organization operates, acquiring skills that I can apply to other regions and other endangered species.