EARTH SYSTEMS
VOLPERT SCHOLARS AWARD
Project Synopses, 2017-18

2017-18 Earth Systems Volpert Scholars

- Annie Dillon
- Jessica Eggers
- Songhee Han
- Blaire Hunter
- Madeline Lisaius
- Elise Miller
- Ashley Overbeek
- Kira Smiley
- Ada Statler-Throckmorton

Annelise Dillon

Earth Systems – Human Environmental Systems, B.S. 2016
Civil & Environmental Engineering – Atmosphere/Energy, M.S. 2017
Advisors: Dan Reicher (Stanford Graduate School of Business, Stanford Law School), Brendan Martin (Executive Director of The Working World)

Building an Aggregate Fund for Community-Owned Solar Projects

Community-scale solar projects, defined as distributed grid-connected solar arrays in the range of 0.25-5 MW, can fill in the gaps left by utility-scale and residential solar in building out our country's renewable energy infrastructure. The large upfront investment needed for residential solar PV can be prohibitive for low-income populations, who are often the last to enjoy the benefits of the clean energy movement. Community solar projects allow subscribers to see the financial benefits of solar without having to install solar PV on their own rooftops. This makes solar energy much more accessible, as it avoids the high upfront cost of solar PV equipment and makes it possible for residents of multi-tenant buildings without rooftop space to procure solar energy for their electricity usage. In addition, community solar projects allow for more cost-effective and efficient PV designs, as solar panels are installed in a concentrated area that is optimal for solar rather than distributed on individual rooftops that might have shading problems.

Community ownership models for community-scale renewable energy projects can expand the benefits seen by local populations by sharing profits among local subscriber-owners rather than concentrating them among external investors. A group of organizations, including Cooperative

Energy Futures and Co-op Power, are building out networks of community-owned solar projects among low-income populations in MN, MA, and NY. With the help of The Working World, an organization that facilitates the formation of workers' owned cooperatives, these organizations want to build an aggregate fund that will allow them to more easily access financing in order to scale their efforts. I am working as the Project Manager for the aggregate solar fund, keeping the different components of the project on track and facilitating the overall cohesion of its many moving parts. I will help with whichever aspects of the project need additional hands while maintaining a managerial role that allows the project leads to focus on their individual deliverables.

Jessica Eggers

Earth Systems – Biosphere, B.S. 2019

Advisors: Seth Walk (Department of Microbiology and Immunology, Montana State University), Scott Fendorf (Earth Systems Science, Stanford University)

Lack of access to safe drinking water has been shown to be an environmental health disparity for some rural, poor and minority communities in the United States. On the Crow Reservation in Montana, greater than 23% of wells exceed the U.S. EPA health standards in uranium, manganese and/or nitrate, with low level arsenic also present. While health effects of exposures to individual metals in drinking water are known, minimal research has been done on effects of exposure to mixtures of these metals. My research project, based at Montana State University, will be examining the relationship between naturally occurring arsenic and agriculturally introduced sulfate. It is possible that arsenic and sulfate are combining to form more bioavailable and toxic compounds - thioarsenicals. The health effects of thioarsenicals are poorly understood, but could be having a tremendous impact on Crow Tribal members drinking this water.

I will be testing the toxicity of arsenite and arsenate to get a primary understanding of cell death at various exposures. I will then culture Sulfate Reducing Bacteria (SRBs) that live in the human gut and transform sulfate into hydrogen sulfide. This reduction then allows hydrogen sulfide to potentially combine with arsenic to make thioarsenicals. Three SRBs will be cultured anaerobically, one that has strong sulfate reducing power, one that has little to no sulfate reducing power, and one of average power. After being cultured, the SRBs will be exposed to arsenic at various concentrations and tested for cell death and toxicity. Additionally, the samples will be sent to another lab for further analysis on the proportions of sulfate, hydrogen sulfide, arsenite, arsenate, and thioarsenicals present in each SRB culture.

With the help of Seth Walk (my MSU advisor), and Scott Fendorf (my Stanford advisor) this project seeks to determine if arsenic and sulfate can combine to form a more toxic compound in drinking water that should be regulated by the EPA. The next step in this project is to

communicate the results of the research and collaborate with the community to determine how to ensure access to safe drinking water.

This continuing summerly research project is extremely important to me because it allows me to do hands-on, in-depth research, working on a project related to my community. I am Crow and spent the first half of my life growing up on the Reservation. I was raised in a house that did not have potable running water, feeling the effects of this problem first hand. This project empowers me to help my people solve a complex problem of water quality, using the education I am lucky and privileged to receive.

Songhee Han

Earth Systems – Biosphere, B.S. 2018

Advisors: Erin Mordecai (Biology, Stanford University), Andy MacDonald (Biology, Stanford University)

Forests vs. Cities: A Municipality-Level Study on the Effects of Deforestation and Urbanization on the Zika Epidemic in Colombia

Recent and rapid land use changes, both anthropogenic and non-anthropogenic, have fundamentally transformed the earth's land surface. The consequences of land use and land cover change modifies how infectious diseases are transmitted by changing the way vector populations are distributed. Colombia is one of several countries suffering from high deforestation rates in the Amazon rainforest. Colombia also experienced a major epidemic of Zika virus in 2015-2016. This makes the country an ideal case study to investigate how deforestation may have impacted the recent epidemic.

I will study the potential effects of deforestation on Zika and use other potential drivers, such as road networks, nighttime lights imagery, number of hospitals, and GDP. This project is designed to answer three main questions about the Zika epidemic in Colombia: 1) What variables related to urbanization have strong correlations with both deforestation and Zika prevalence rates? 2) How does the urban-rural gradient influence Zika? 3) What role does deforestation play in epidemics related to urban-dwelling mosquito species like *Ae. Aegypti*?

I enjoyed working with Erin Mordecai last summer through the biology VPUE program and I'm excited to return and build upon my work with her and Andy MacDonald in the form of an honor's thesis. I've learned to use ArcGIS to extract essential data from spatial information. This summer, I hope to utilize other sophisticated spatial analysis tools, such as Google Earth Engine, in order to better quantify the relationship between deforestation and urbanization. Being an Earth Systems major has taught me to think globally about specific phenomenons and to be open to interconnections. Mindful of how closely and complexly we humans and our environment are connected, I look forward to continue researching how the biosphere

influences the anthrosphere (also visa versa) and communicating my scientific findings with the general public.

Blaire Hunter

Earth Systems – Human Environmental Systems, B.S. 2018

Advisors: Rob Dunbar (Earth Systems Science, Stanford University), Fiorenza Micheli (Biology, Stanford University), Susan McConnell (Biology, Stanford)

Chasing Salmon: A Global Exploration of Marine Aquaculture

Aquaculture has emerged as a key topic in discussions of global food security and marine conservation. The growth of aquaculture also has symbolic value, representing the final domestication of our last wild food source: seafood.

Change, however, is never without controversy. Critics note the environmental impacts historically associated with aquaculture and believe it is not worth the potential harm to marine ecosystems. Others worry that the relatively new aquaculture industry will displace traditional fishermen and fishing communities. Proponents of aquaculture view it as a promising force for good that can provide food and employment with minimal negative environmental impacts, while also taking pressure off wild catch fisheries, leading to the mutual benefit of both sectors. For my project, I will travel to British Columbia, Norway, and Chile to study salmon aquaculture in three distinct socio-ecological contexts. I will undertake this project with Daniel Cryan, a junior studying Marine Biology at Stanford. We intend to interview federal managers, researchers, local fishermen, members of the salmon farming industry, and other stakeholders about their perceptions regarding the environmental impacts of salmon farming. We will also explore the dynamics between the salmon farming industry and local wild-catch fisheries by interviewing members of each group about their relationship with the other. Ultimately, we would like to understand why aquaculture is better received in some places but not in others. We will share our findings in a series of informative podcasts about the reality of modern day aquaculture.

Chasing the story of salmon farming will be an opportunity to add a human perspective to the statistics and science around aquaculture. By sharing this experience in podcasts, I will also practice the art of communicating in an accessible format. I will first become a question-asker and story-gatherer before I can become a problem solver. I think that the experience of deeply

studying one topic in a variety of contexts and regions will allow me to see global themes in local complexities.

Madeline Lisaius

Earth Systems – Land Systems, B.S. 2019, M.S. 2019
Advisors: Eric Lambin (Earth Systems Science, Stanford University), Bill Durham (Anthropology, Stanford University)
Mapping the real and imagined: Deforestación in the Waorani territory

This project seeks to address disparities between detectable, perceived, and real 'deforestación,' environmental change, in Waorani Territory -- a politically recognized indigenous reserve in Amazonian Ecuador. While Waorani leadership and Waorani community members claim massive 'deforestatación,' remote sensing analysis suggest that no significant land cover change has occurred within Waorani Territory in the past decade. However, the term 'deforestación' may signify a broader range of environmental change than the word 'deforestation' signifies to a western forest manager. I hypothesize that the Waorani, in their vocalized concerns around 'deforestación,' are expressing 1) cultural memory and modern experience of massive regional environmental and social change, including land degradation such as selective logging that is not necessarily detectable by coarse spatial resolution satellite imagery, 2) repetition of language of change provided by Waorani leadership to use in asks to the government and visiting NGO outsiders and 3) an expression of future fears associated with perceived insecure land tenure. Interviews and participant observation will be used to better understand the disparity in how environmental change is communicated and measured with significant implications for Ecuadorian policy. Implications are broad for the discipline of remote sensing, for regional conservation efforts, for discourse on indigeneity as related to forested areas, and for scientific validation of community communication.

Elise Jael Miller

Earth Systems – Sustainable Food and Agriculture, B.S. 2018
Advisors: Rodolfo Dirzo (Biology, Stanford University), Lisa Schulte Moore (Natural Resources and Ecology, Iowa State University)

An Integrated Analysis of Biodiversity, Soil Quality, and Water Quality in Transitional Prairie-Rowcrop Systems in the U.S. Corn Belt

Land use and land cover change is a significant driver of ecological wellbeing on both local and global scales. In U.S. Corn Belt states, nutrient losses and soil erosion pose significant costs for farmers and lead to environmental degradation and negative impacts for human health. By demonstrating a link between land use practices that promote native biodiversity and highly desirable ecosystem services, I intend to illuminate pathways by which tallgrass prairie plantings can be tailored to landscape-specific needs, portraying biodiversity as an effective strategy to attain resource quality goals for Corn Belt farmers.

I will discover and describe the interactions between multiple ecosystem services in Corn Belt rowcrop landscapes that have recently been integrated with strips of perennial prairie landcover. This information will enable farmers to design conservation agriculture systems to optimize their goals, inform landowner expectations for the first years after prairie strip installation, and ascertain the degree of consistency of resource and habitat benefits provided by prairie strips across a variety of soil types and topographies. My work will involve statistical analysis of soil quality, water quality, and biodiversity in partnership with the multidisciplinary Iowa State University project entitled Science-based Trials of Rowcrops Integrated with Prairie Strips (STRIPS). The overarching hypothesis tested by my research and the STRIPS Project is: small areas of perennial native prairie integrated in annual rowcrop fields will produce significant benefits disproportional to their size.

As a scholar focusing on sustainable agriculture, I will need to acquire the skills to research and advocate for multifunctional resource management solutions that simultaneously sustain agricultural yields and ecological health. This project bridges my scientific inquiry with real-world, large-scale implementation that incorporates environmental considerations such as pollution and native habitat with sociological, cultural, and economic considerations of farmer decisions.

I will apply statistical methods to data from the interconnecting fields of hydrology, soil science, water quality, ecology, agricultural sciences, and conservation biology. My research will develop my statistical toolbox, supporting me in conducting rigorous quantitative analysis in the Earth Sciences throughout my career. I will also learn from mentors in multiple fields and learn to collaborate with interdisciplinary research teams. The anticipated result is a publishable, interdisciplinary research paper in the field of Earth Systems. While conducting my written report, I will become more comfortable bridging Earth science with writing skills and data visualization as I learn to communicate scientific data clearly to facilitate effective change.

Ashley Overbeek

Earth Systems – Sustainable Food and Agriculture, B.S. 2018

Advisors: Tammy Steeves (University of Canterbury, New Zealand), Liz Hadly (Biology, Stanford University)

You're the only one for me? An assessment of extra pair parentage in a critically-endangered bird with implications for conservation

The Kakī/Black Stilt (*Himantopus novaezelandiae*) is a considered a socially monogamous, critically-endangered New Zealand endemic bird with approximately 100 adults in existence. This survival and recovery of this species is contingent upon intensive population management, including predator control efforts, wild population monitoring, and captive breeding for translocation (Reed 1998; Sanders & Maloney 2002). The Kakī Recovery Programme in Twizel, New Zealand, has created a pedigree to monitor relatedness between wild breeding pairs and create pairing recommendations for captive birds to reduce inbreeding and increase genetic diversity. While Overbeek et. al. (2017) provides evidence for brood parasitism in Kakī, documentation of extra-pair parentage has never been noted in this species before. Evidence of extra-pair parentage would contextualize the accuracy of the Kakī pedigree, our understanding of individuals genetic ancestry (i.e., relatedness and inbreeding), and influence conservation management of the species.

Here, I propose to study genetic data of several generations of Kakī/Black Stilt (*Himantopus novaezelandiae*) in New Zealand through microsatellite analysis. The project is designed to assess the accuracy of the Kakī pedigree by addressing the question: Is there evidence for extra-pair parentage in Kakī? These findings will contribute to ongoing conservation genetic management that seeks to maximize genetic diversity in Kakī.
This question will be broken down with the following research questions:

1. How many clutches from how many family groups should be examined to proceed compelling evidence for extra-pair parentage (or a lack thereof) in Kakī?
2. If evidence of extra-pair parentage exists in Kakī, how common is it?
3. How can these findings be utilized to increase genetic diversity for this critically endangered species?
4. Given the Kakī's status as *taonga* (a treasured species), what are indigenous viewpoints on current co-management practices for Kakī conservation and how can these values be integrated into my research?

Kira Smiley

Earth Systems – Human Environmental Systems, B.S. 2018
Advisors: Peter Vitousek (Biology, Stanford University), Eeva Primmer (Environmental Governance, Finnish Environment Institute)

The Impact of Wind Turbines on Avian Species in the Finnish Archipelago and the Correspondent Valuations from Landholders

The Human Environmental Systems track has served as a springboard for thinking across various scales and disciplines to delve into the framework of solving real challenges facing our planet concerning the interaction between humans and the environment. My research project in rural Finland seeks to address an issue of environmental governance that I believe arises from a communication gap between academia and the general population. I will investigate how landholders regard the impacts of land-use and climate change on avian species due to wind turbine construction on their islands in order to both understand their valuation of these topics and discover effective ways of conveying environmental information to this population sector.

The Finnish Ministry for Employment and their Economy feed-in tariff proposal has a target of producing enough wind power by 2025 to build approximately 1000 new wind turbines. Some stakeholders are especially concerned for the well-being of the white-tailed eagle, which nearly fell into extinction in the 1960's to 1970's. The slow reproduction rate of these birds puts them at a higher risk, but the gravity of the impact of wind turbines on this species is up for debate, and therefore is a topic I will investigate. I will be using data provided by Finnish researchers as well as my own small-scale ecological survey using a point-by-point radial survey to model the land-use gradient and population distribution of the white-tailed eagle relative to the turbines. The qualitative aspect of the research will include semi-structured interviews with local residents concerning their opinions of the turbine construction and coding their comments for references to science or facts and knowledge sources as opposed to emotional statements and expressions of importance.

I am excited to reach beyond campus with this chance and have the support of outstanding mentors from the Environmental Governance Unit in the Environmental Policy Centre at the Finnish Environment Institute (SYKE). I believe that the quantitative aspect of this project complements the communication portion and will diversify my toolbox of research methods and push me to grow as an interdisciplinary scientist and future environmental policy maker.

Ada Throckmorton

Earth Systems – Human Environmental Systems, B.S. 2018
Advisors: Tom Hayden (Earth Systems, Stanford University), Felicity Barringer Taubman (Bill Lane Center for the American West, Stanford University)

This summer, I will be traveling to Kern County, California to interview rural energy workers. From the world's largest wind farm in Tehachapi to the oil fields in Bakersfield that produce 40% of California's oil, Kern runs the gamut of the energy sector. It is also a region that has seen the complex implications of climate change first hand, with drought causing devastation to agricultural production and wildfires destroying homes. I want to talk to the energy workers in

Kern County to build empathy for an often over-simplistically presented rural population. In doing so, I hope to bridge political and perhaps urban-rural, coastal-inland divides in California.

For me, journalistic ventures such as my investigation into the lives and perspectives of energy workers fit perfectly into the role an interdisciplinary environmental scholar and problem-solver. One of the ultimate environmental problems is the issue of buy-in: how to get people to care. Storytelling resonates with people, it helps them empathize with other people as fellow humans. I think that my project in particular tackles not just getting people to care about environmental problems, but also takes on people who might care about climate change and not be able to understand others who "aren't there" yet. This isn't to say that either side is correct, but rather that searching for understanding and empathy is necessary to generating solutions that people will participate in.

On a more personal level, much of my environmental scholarship has been split between the classroom and the newsroom. Both experiences have given me necessary skills in environmental communication. I feel ready now to take on the challenges of a longer-term environmental journalism project, to immerse myself in a topic I truly am passionate about and put into practice my interdisciplinary systems thinking.