Higher Education Research Council Fellowship
Boise State University
Final Report

Academic Year 2017-18

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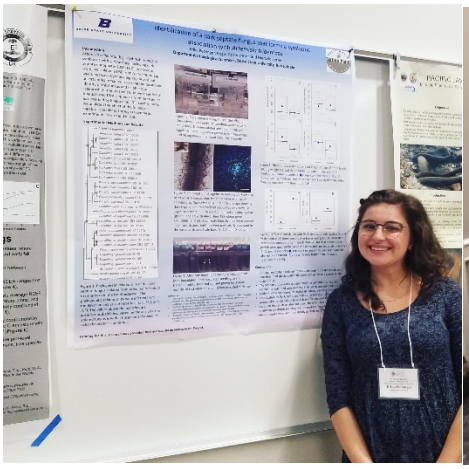

BOISE STATE UNIVERSITY

Idaho State Board of Education

Introduction

The Institute for STEM & Diversity Initiatives administered the HERC Fellowship at Boise State University for Fall 2017 and Spring 2018. All STEM department chairs were notified of the HERC Research Fellowship application. The application was also disseminated to all STEM undergraduate students. We changed the process this past year to allow for joint faculty and student applications. This change requires students to identify a research faculty to work with and their faculty mentor must nominate them for the fellowship. We had 103 students apply for Fall 2017and Spring 2018 positions. For Fall 2017, 9 students were awarded the HERC fellowship, and 8 students were awarded the fellowship in the Spring semester.

We saw an increase in the number of underrepresented minority HERC fellows to 41% of the awardees and the majority of the recipients were first-time student researchers. HERC fellows presented final research projects at either the Undergraduate Research Conference or the Idaho Conference of Undergraduate Research at Boise State University. One fellow presented her research at the Northwest Scientific Association in Olympia, Washington in April. Another student disseminated his work at the Annual Biophysical Society Meeting. And finally, 10 students attended the Pacific Sociological Association annual conference in Long Beach, CA. Students and faculty mentors are from a variety of disciplines (please see below).

On behalf of the Institute for STEM and Diversity Initiatives, we thank the Higher Education Research Council for their generous support in helping build meaningful high impact practices for our undergraduate students.

HERC Funding:

The Higher Education Research Council provided $55,000 to support undergraduate students in their pursuit of faculty mentor supported undergraduate research experience. Please see table below of how stipends and travel awards were dispersed.

Stipends	**Amount**
Fall 2017 Research Stipends	$27,000
Spring 2018 Research Stipends	$24,000*
Student Travel to Professional Conference	**Amount**
Supplemental travel to National Biomedical Engineering Society (1student)	$600
Pacific Sociological Assoc. Conference (10 students)	$3,900
Total	**$55,500**

*The Institute for STEM & Diversity contributed $500 additional research dollars for Spring 2018

Demographics of Fall 2017 and Spring 2018 Undergraduate Research Fellows

Discipline	Research Awards Received
Anthropology	1
Biology	2
Civil Engineering	2
Computer Science	1
Electrical Engineering	1
Geophysics	1
Geosciences	3
Mechanical Engineering	1
Mechanical Engineering	2
Microbiology & Biochemistry	1
Molecular Biology	1
Physics	1

Gender	Research Awards Received
Female	7
Male	10

Race/Ethnicity	Research Awards Received
Hispanic/Latino	7
Caucasian	12
Other	5
Note: Students could be included into more than one category according to both their race and their ethnicity.	

Pacific Sociological Association Conference Attendees—HERC Travel Award

Student Name	Discipline	Award Received
Erin Applegate	Sociology	Travel
Jeff Cates	Sociology	Travel
Joshua Cox	Sociology	Travel
Ashlee Jenee Enbysk	Sociology	Travel
Michelle Fretwell	Sociology	Travel
Christina Kopper	Sociology	Travel
Lampe Lampe	Sociology	Travel
Harbor Neher	Sociology	Travel
Erin Neumeier	Sociology	Travel
Jacqueline Phillips	Sociology	Travel

Fall 2017 HERC Research Fellow Student Abstracts:

Omar Betancourt
Faculty Mentor: Dr. Jim Browning, Department of Mechanical & Biomedical Engineering
Research Title: Development of a Phase-Controlled Magnetron Experimental Fixtures

Magnetrons are microwave vacuum electron devices that use the interaction of electrons with a slow wave circuit in a crossed electric and magnetic field. For most magnetrons, phase is almost never preserved, which makes it difficult to synchronize an array of magnetrons to achieve higher total power output. This research is focused on developing a cavity magnetron by utilizing gated field emission arrays. The electron injection is controlled by the gate field emitter arrays (GFEA) in order to control the phase of the device. An experimental system is being designed and fabricated to demonstrate the phase control concept using a commercially available cooker magnetron as the test device. It has the potential to improve radar systems, medical imaging, particle accelerators, etc.

Donato Callahan
Faculty Mentor: Dr. Sondra Miller, Department of Civil Engineering
Research Title: Air Quality and Particulate Matter

Particulate matter (PM) can be a combination of solids and liquids including dust, soot, smoke and sand. Fine particles--defined as having a diameter less than 2.5 microns, PM2.5--pose varying negative health and ecologic effects. These in turn can have economic effects. Adverse health effects of PM2.5--which are easily inhaled and get trapped deep in human lungs--can cause an irregular heartbeat, decrease lung function, trigger asthma symptoms, cause non-fatal cardiac arrest, and lead to death for those with pre-existing respiratory issues. Ecologic effects include changes in freshwater pH, nutrient imbalances, and loss of ecosystem diversity. This research focused on understanding the effects of air quality--specifically PM--on human health, ecologic, and economic effects.

Vanessa Campfield
Faculty Mentor: Dr. Owen McDougal, Department of Chemistry

Research Title: Isolation, Purification and Characterization of Novel Steroidal Alkaloids from *Veratrum californicum*

Cyclopamine and other steroidal alkaloids found in *Veratrum californicum* are known teratogens which inhibit the Sonic hedgehog (Shh) signaling pathway which has resulted in embryo deformities including but not limited to cyclopia; as observed in lambs. This pathway is also active in over 20 types of cancer; allowing overproduction of cancerous cells and tumor growth. Examination and analysis of alkaloid extractions from *Veratrum californicum* has confirmed various abundancies of cyclopamine and other alkaloids in different sections of the plant; with the highest abundancy residing in the root and rhizome section. Observation of bioactivity through the use of Shh Light II cells shows the greatest pathway inhibition is found from the root and rhizome portion of the plant compared to the leaf and stem portions. Further analysis of the root and rhizome extract by High Pressure Liquid Chromatography and MS has verified the presence of uncharacterized, novel compounds. This project concentrates on extracting, isolating and characterizing these novel compounds followed by testing bioactivity levels of the Shh pathway for synergistic effects caused by various combinations of novel compounds with cyclopamine.

Andrea Carrizales
Faculty Mentor: Dr. Gunes Uzer,
Research Title: Effects of Lamin A/C Depletion on Nuclear Structure and LINC Complex

It is hypothesized that silencing the lamin A/C gene, LMNA, will caused deformation in the nucleus of a mammalian cell. In order to test this, we transfected Mesenchymal Stem Cells with an siRNA transfection reagent and used fluorescence imaging to analyze the results. The results showed that silencing LMNA affects both Nesprin 1 and Sun 1 proteins, which are part of the LINC complex, and changes nuclear shape.

Karen Fulk
Faculty Mentor: Dr. John Ziker, Department of Anthropology
Research Title: Food Sharing in Siberia: Social Network Analyses Using Frequencies of Transfers Versus Nutritional Values and Quantities Shared

Informal household networks are utilized for tundra foods distribution in Ust'-Avam, Taimyr Region, Russia. Most families in Ust'-Avam rely upon subsistence for their livelihood, chiefly hunting, fishing and trapping. Variation in household ability and household interest in subsistence activities create inequalities in local food production. To adapt to subsistence challenges, food exchanges occur between kin and neighbors, thereby redistributing foods and decreasing food inequalities between households. These exchanges are vital to buffer consumption risk, especially in particularly vulnerable households. A focal sample of ten women in the community provides the core of a food sharing network of 51 households. The food transfers are portions of meat and fish transferred to the women from primary procurers or their intermediaries, as well as the women's sharing of these foods to additional households. Using the results of social network analysis, we consider the frequencies of these transfers, and the quantity and nutritional content (total calories, protein and fat content values) and calculated monetary valuations of exchanged items. In considering who gives what to whom, this research provides yet another opportunity to examine

relevant variables and their effects within the widely debated explanatory hypotheses of food sharing.

Joel Johnson
Faculty Mentor: Dr. Jodi Brandt, Department of Human Environment Systems
Research title: Statistical Analysis of Idaho Counties Through USDA Census and Survey Data

The management of public lands has widespread implications for the regions they influence. For National Forests, management plans are developed to cover 30 year periods, and the current plan for the Salmon-Challis National Forest (SCNF) is being updated in accordance with the 2012 Planning Rule. The revisions are being made with a focus on ecological, social and economic sustainability. In this study, we examine three counties within SCNF area-of-influence, and compare them with four similar counties outside the SCNF region. We track how farm sizes change over time through differences in total cattle, average herd size, and the total number of farms. We used data compiled by the USDA Census and Survey programs at 5 years intervals from 1978 through 2012 and analyzed trends using repeat-measured ANOVA. Results showed that the number of cattle and average herd size declined over time ($p < 0.001$) but we found no significant difference in the number of farms over time ($p = 0.37$). These results will inform analyses of the effect of changing National Forest management, i.e., allowable grazing, on the ranching sector in the Salmon-Challis area and provide information for decisions on the management level.

Cybil Lesbyn
Faculty Mentor: Dr. Daniel Fologea, Department of Physics
Research Title: Models of intercellular communication through passive propagation of electrical signals

Continuous communication between cells is essential for creating and maintaining fundamental functionalities of cellular assemblies. Such fast communication pathways are controlled by chemical and physical signals that employ intra and extra cellular components of only closest neighbors. However, electrical signals may quickly propagate for long distances through extra cellular environments owing to their particular electrical properties. To explore such possibilities, we modeled the cellular environment by considering a connected network of passive circuit elements composed of capacitive and resistive elements. The electrical model was tested in simulations to investigate the passive propagation of electrical signals in response to point stimulations consisting in local membrane depolarization of single cells. Our results suggest that physiologically-relevant electrical signals may propagate long distances in a short time, which may provide passive pathways for inter-cellular communication. In accordance to the electrical model, these communication pathways are equally effective for both excitable and non-excitable cells. Consequently, passive communication may substantially contribute to electrical-based communication in brain and muscles. In addition, the model may be expanded to investigate signaling between non-excitable cells such as bacteria, which could be further exploited to better understand the role played by long-distance electrical signaling in bacterial colonization and biofilm formation.

Erika Petzinger

Faculty Mentor: Dr. Marcelo Serpe, Department of Biological Sciences
Research Title: Identification of a Dark Septate Fungus That Forms a Symbiotic Association with Artemesia Tridendata

In previous work, we isolated a dark septate fungus from *Artemisia tridentata* (big sagebrush) roots. In this study, we used partial sequences from three genes to identify this fungus. Based on phylogenetic analyses, the isolated fungus appears to be a non-described species within the *Darksidea* genus or a closely related sister group. The *Darksidea* is within the family Lentitheciaceae in the Pleosporales and the Ascomycota. To investigate the nature of the symbiotic association, we analyzed the root tissues colonized by the fungus and the effect of inoculation on seedling growth under *in vitro* conditions and in soil. The hyphae of the fungus penetrated the epidermis, cortex, and vascular cylinder and were detected in between and inside root cells. After two month of growth *in vitro*, non-inoculated and inoculated seedlings had similar root lengths and fresh weight. However, dry weight was higher in non-inoculated than inoculated seedlings ($p < 0.05$). In soil, inoculation did not affect the fresh weight of seedlings. Based on the results *in vitro* and in soil, the effect of the isolated fungus on sagebrush seedlings was somewhat affected by the growing environment and ranged from slightly parasitic to commensalistic.

Wesley Sandidge
Faculty Mentor: Dr. Michael Callahan, Department of Chemistry
Research Title: Analyzing Variability in Exoplanetary Eclipses

A transit occurs when a planet passes in front of its star as seen from Earth, which causes the amount of light we observe from the star to drop while the planet is crossing the face of the star. A secondary eclipse occurs when the planet passes behind the star, during which time the star blocks out light from the planet. Studying observations from NASA's Kepler Mission of exoplanetary transits and eclipses allows us to study the variability of an eclipse from one transit to another. Variability in an eclipse could result from variations of atmospheric condensates or volcanic activity on the planet. The Kepler Science Team has provided a Python package called lightkurve. This package allows data from the Kepler, K2, and TESS missions to be easily analyzed and plotted. The lightkurve package can be used to plot the data for the exoplanets that we are targeting in our study. In this presentation, we discuss our work looking for variability in the eclipses of two short period planets: HAT-P-7b, a hot Jupiter orbiting an F8 star.

Spring 2018 HERC Fellow Student Abstracts:

Jessica Carlson
Faculty Mentor: Dr. Clare Fitzpatrick, Department of Mechanical & Biomedical Engineering
Research Title: Manipulating Cartilage Geometry on a Three-Dimensional Model of the Knee Joint

Computer modeling is increasingly prevalent in the medical field. In the Computational Biosciences Lab (CBL), we generate 3D models from magnetic resonance (MR) images to address clinical issues on a subject-specific basis. Within the knee joint, cartilage tissue lines the surfaces of bones and must be reproduced accurately in our simulations to appropriately capture load transfer and cartilage

stresses. Using computer modeling programs, we can create a 3D model and transform it into a mesh. The cartilage mesh compromised of a series of nodes and elements. By identifying the nodes on the edges of the cartilage, the geometry of these nodes can then be manipulated to curve down towards the bone. The resulting cartilage mesh typically has a sharp angular edge, which can cause significant mesh distortion. When the cartilage is loaded near these regions, the distorted edge causes artificial peaks in stress. Our goal was to replace the manual process with an automated way to create a more natural curve to the cartilage as it transitions into the bone. This will be used in ongoing research in the CBL to observe the impact of injuries on the knee and evaluate the efficiency of surgical methods to these injuries.

Eli Bring Horvath
Faculty Mentor: Dr. Cheryl Jorcyk, Department of Biological Sciences
Research Title: Ovarian Cancer and the Effects of Inflammatory Cytokines

Cyclopamine is a steroidal alkaloid in *Veratrum californicum* that is a teratogen. Steroidal alkaloids from this plant have been shown to inhibit the Sonic hedgehog (Shh) signaling pathway, resulting in embryo deformities including cyclopia in lambs. The Shh signaling pathway is prevalent in over 20 types of cancer, and contributes to the overproduction of cancerous cells and tumor growth. Qualitative and quantitative analysis of *Veratrum californicum* alkaloids has confirmed various abundancies of cyclopamine and other alkaloids in different sections of the plant (leaf, stem, root/rhizome), with the highest amount of alkaloid present in the root and rhizome. Shh Light II cells provide a luminescence assay to assess the degree of Shh pathway inhibition by chemical agents. This assay was used to evaluate alkaloid ratios by plant part. The results showed the greatest pathway inhibition was achieved by the ratio of steroidal alkaloids consistent with that derived from the root and rhizome portion of the plant, followed by stem, and finally leaf. Further analysis of the root and rhizome extract by high pressure liquid chromatography and mass spectrometry has verified the presence of uncharacterized, novel alkaloids that may be potent Shh signaling pathway antagonists. The focus of the current work is to extract, isolate and characterize novel alkaloids and evaluate their bioactivity using the Shh Light II cell assay.

Denver Lloyd
Faculty Mentor: Dr. Kris Campbell, Electrical and Computer Engineering
Research Title: Speech Characterization Using a Single Memristor

The ability of a memristor device to uniquely fingerprint a spoken word was investigated. Methods of applying an audio voice signal to the memristor were explored. The most promising method found to date is described in this work. It was shown that even words that sound very similar have characteristics in their audio signal that change the memristor response.

Omid Mohammad Mousa
Faculty Mentor: Dr. Juliette Tinker, Department of Biological Sciences
Research Title: Exploring The Ideal Excipients for a Chimeric Vaccine Against Bovine Mastitis

Staphylococcus aureus is a leading cause of mastitis, or infections in the udder, in dairy cows. Mastitis causes significant financial losses for the dairy industry, and with the rapid increase of antibiotic

resistant bacteria, such as Methicillin-resistant *Staphylococcus aureus* (MRSA), it is vital to create alternative ways to fight these pathogens. Our lab is developing and testing a mucosal chimeric vaccine against bovine mastitis containing two surface antigens from *S. aureus*. The genes for the adhesins IsdA and ClfA were cloned with those for Vibrio *cholerae* cholera toxin A2/B (CTA2/B) to create the intranasally administered vaccine. The purification of this vaccine was scaled up using 1L culture volumes and D-galactose agarose affinity purification. Purified proteins were analyzed by SDS-PAGE and bicinchoninic (BCA) assay. Currently we have produced over 15 mg of vaccine for use in future bovine vaccine challenge studies. In addition, lyophilization is a well-recognized method in the pharmaceutical industry used to store biologically active drugs that are not stable in solution, or to prolong the shelf-lives of drugs. Excipients can have a great influence on performance and stability of lyophilized drugs therefore, selecting the right stabilizers is very important. IsdA chimera was lyophilized using a variety of excipients and stored at different temperatures. The stability was analyzed using native gel electrophoresis and BCA assay.

Silvia Perritte
Faculty Mentor: Dr. Nancy Glenn, Department of Geosciences
Research Title: The use of Survey 123 to improve field data collection for IDARNG

In-situ data are the cornerstone of ecological scientific research. Ecological data collected in the field are used to analyze, identify, and validate research. Given the importance of the data, special care must be taken to ensure complete and accurate measurements. The necessary attention to detail makes field data collection very time consuming. In addition, field data can consist of separate components including paper forms, GPS, and images. Survey 123, a field data collection software developed by ESRI, offers a unique way to collect complete and detailed field data with spatial information in a data survey template. Survey 123, for ArcGIS, is a simple form-centric field data collection designed to use for spatial data, survey questions, and statistics. For this study I consolidated 14 surveys for the Idaho Army National Guard (IDARNG) Environmental Division into one master survey. My work will improve the organization and efficiency of field data collection techniques for IDARNG.

Sadie Ranck
Faculty Mentor: Dr. Julie Heath, Department of Biological Sciences
Research Title: Heritability of Telomere Length in American Kestrels

The development of advanced nanoelectronic devices based on emergent 2D nanomaterials has the potential to impact energy consumption in cloud computing, reduce harm to human and planetary health, and facilitate economic development through new device design and nanomanufacturing techniques. The unique physical properties of 2D materials make them attractive for energy-related applications such as low-power nanoelectronics, efficient thermoelectrics, novel energy storage devices, and catalysts for CO_2 conversion. In particular, 2D transition metal dichalcogenides (TMDs) have direct band gaps, high carrier mobility, and can be synthesized on, or transferred to, a variety of substrates, making them ideal 2D material candidates for flexible optoelectronics. The research presented here focuses on the development of an electrical thermometry platform to characterize thermal transport in 2D TMDs and their heterostructures. This research will develop a

greater understanding of the nucleation, growth, and heat carrying properties of these materials, which are currently on the ITRS roadmap as a potential replacement for Silicon.

Luke Telfer
Faculty Mentor: Dr. Jen Pierce, Department of Geosciences
Research Title: Structure from Motion as a Viable Tool for Quantifying Diffuse Post-Fire Erosion

Idaho's 2016 Pioneer Fire burned approximately 188,000 acres in the Boise National Forest. Post-wildfire landscapes experience increased erosion with peak erosion rates occurring in the first year following the fire (Robichaud et al., 2016). Quantifying the volume of sediment removed during this vulnerable time period is challenging and has largely consisted of determining minimum sediment volumes from debris flow deposition. Few studies have included diffuse erosion from the hillslopes due to the difficult nature of obtaining such measurements.

As part of a larger investigation of total post-Pioneer Fire erosion in a catchment of Clear Creek, we seek to develop a method for determining the volume of material removed from the hillslope by diffuse mechanisms. Using mm-scale digital surface models (DSMs) constructed with handheld Structure from Motion (SfM) photogrammetry, we model pre-erosion surfaces for 12 randomly selected 1 m2 hillslope plots. The volume of eroded sediment for each plot is derived from the difference between the pre-erosion model and the post-erosion DSM. Our results suggest that low-cost SfM photogrammetry is an appropriate tool for quantitative analysis of diffuse hillslope erosion following wildfire. However, additional research is required to fully develop the methodology for pre-erosion surface modeling.

Patrick Zrelak
Faculty Mentor: Dr. Brittany Brand, Department of Geosciences
Research Title: Fabric Analysis of Unconsolidated Pyroclastic Density Current Deposits

Pyroclastic density currents (PDCs) are gravity-driven mixtures of hot volcanic tephra and gas. These events are difficult to analyze in real time. Therefore, we must use their deposits to help better understand their flow dynamics. Previous work proves that clast orientation and deposit fabric can provide information about flow processes. We use 19 samples taken from unconsolidated PDC deposits generated in the 1980 Mount St. Helens eruption to constrain PDC flow direction and dynamics. Prior to fabric analysis, these samples were lithified using a sodium silicate vacuum impregnation technique. Then, the samples were cut in three planes: horizontal (map view), parallel to flow, and perpendicular to flow. These faces were analyzed using software that automatically measures particle orientation and produces statistics that can help demonstrate fabric strength. Horizontal plane analyses have produced orientations that correlate well with previous estimations of Mount St. Helens PDC flow directions. This study demonstrates that these techniques can be used to helped constrain flow direction in outcrops without contextual information. We are hopeful that continued analyses will produced information on particle transport mechanisms and further insights into flow rheology.