

# NDSU EXPLORE

UNDERGRADUATE EXCELLENCE IN RESEARCH AND CREATIVE ACTIVITY 2019

# WELCOME



Welcome to NDSU EXPLORE! This is the fifth year of this wonderful annual event that recognizes and celebrates the vast types of research and creative projects in which our undergraduate students participate. You'll have an opportunity today to interact with some of the best and brightest people at NDSU and I know you'll be impressed with the level of cutting-edge research they're conducting across many areas of the university.

Studies show that students involved in undergraduate research or scholarly activity report a higher degree of satisfaction with their overall academic experience and feel more connected with faculty. NDSU EXPLORE gives our undergraduate researchers valuable experience in presenting their work and your role in it is important. Connecting with them and asking questions about

their research will help them as they learn to share their information with the public. This also develops critical thinking and problem solving skills and gives students the opportunity to contribute new knowledge and ideas to their respective disciplines.

During the last ten years, NDSU has ranked among the top public research universities for R & D expenditures. With nearly 80 corporate partners, NDSU has engaged with local, state, regional and national collaborators to address complex problems and uncover new solutions. By helping prepare our undergraduate researchers, we are creating the next group of graduate students and research experts who will move us even farther beyond this mark. Thank you for your commitment to our students and to NDSU EXPLORE.

**JANE M. SCHUH, PH.D.**

**Vice President, Office of Research and Creative Activity**

# SCHEDULE

All events will be held on the second floor of the Memorial Union.

## **9:30-11:30 a.m.**

Student Presentations – Morning Session

*Oral Presentations – Rose Room*

*Poster Session – Plains Room*

## **11:30 a.m.-12:45 p.m.**

Luncheon for Student Presenters and Mentors

*Great Room*

## **Scott Meyer**

Executive Director of Entrepreneurship Initiatives, NDSU College of Business

“Growing our own: Entrepreneurship and the modern day land-grant university”

New businesses account for the vast majority of job growth in the United States. In rural states like North Dakota, it is essential to start new businesses since it is often difficult to attract existing businesses. Despite the urgency of this issue, entrepreneurship is at a 30 year low. As a land grant university, it is now time for NDSU to see itself as an integral member of the entrepreneurial ecosystem, preparing students to go back to their communities ready to create their own opportunities.

## **1-3 p.m.**

Student Presentations – Afternoon Session

*Oral Presentations – Rose Room*

*Poster Session – Plains Room*



## **GUEST SPEAKER**

Scott Meyer is the Director of Entrepreneurial Initiatives at North Dakota State University in Fargo. He is a former city councilor who founded TEDxBrookings, Creativity Week and 1 Million Cups in Brookings.

Meyer founded 9 Clouds, an automotive inbound marketing agency based in Sioux Falls, SD.

Meyer has been awarded The South Dakota Spirit of Entrepreneurship, Top 40 Under 40 by Prairie Business Journal and Young Entrepreneur of the Year in South Dakota.

# ORAL PRESENTATION SCHEDULE

## MORNING SESSION

9:30-11:30 a.m.

Rose Room

### Hannah Pearson

Psychology

Detecting Suicidality and Impulsivity in Unfamiliar Face Images

### Arin Tamimi

Psychology

Thinking Aloud: Revealing People's Thought Processes

### Chrystian Ulrich

Computer Engineering

Into the Depths: Game Concept

### Ethan Couser, Megan Kongable, Jamison Quanbeck,

### Tristan Schettler

Grand Challenge Scholars Program, College of Engineering

Micro-Agriculture for Nutritious Food

### Monica Zent

Chemistry and Biochemistry

Expression and Purification of TAB3 CCD: An Autophagy  
Regulatory Protein

### Benjamin Eichholz

Mechanical Engineering

An Experimental Study of Pulsatile Flow Diversion using  
Superhydrophobic Mesh

### Atiya Khan

Plant Pathology

Characterization of genes required for both Rpg1- and rpg4-  
Mediated Wheat Stem Rust Resistance in Barley

## AFTERNOON SESSION

1-3 p.m.

Rose Room

### Maxwell Sabin

History

1898-1899: North Dakota Goes to War

### Jeremy Dikau

Anthropology

Twelve Steps on the Road to Recovery

### Tyrel Iron Eyes

Anthropology

Lakota Code Switching: Assimilation and Resistance

### Hyun Jun In

Visual Arts

Sound of Fargo

### Brandon Stoick

Mechanical Engineering

Fake News Identification: A Comparison of Parts of Speech and  
N-grams with Neural Networks

### Kate Volk

Biological Sciences

Can regional differences in physiological traits impact restoration  
success? The relationship between stomatal traits and water-use  
efficiency in Prairie Smoke (*Geum triflorum*)

### Sean Gunderson

Physics

Prediction of Critical Points on Spinodal Hypersurfaces  
in Multidimensional Phase Diagrams

### Hashem Sonbol

Civil Engineering

Rainfall Intensity-Duration Curves for Post-Wildfire Debris  
Flows: Tools to Assist with Early Warning Systems

# POSTER PRESENTATION SCHEDULE

## MORNING SESSION

9:30-11:30 a.m.

Plains Room

### Daniel Asa

Chemistry and Biochemistry

Autophagy: Purification and elucidation of TAB2

### Greta Beck

Sociology and Anthropology

Lifeways behind the Spanish American War: The food and toys that provided escape for soldiers and children

### Mariah Billadeau

Apparel, Design, and Hospitality Management

Ecotex

### Alexa Braaten

Pharmaceutical Sciences

Estrogen metabolite and their role in human asthma

### Claire Campion

Biological Sciences

Genotoxicity Assessment of Agrochemicals on Honey Bee Spermatozoa Using the TUNEL Assay

### Taylor Czech

Animal Science

Effects of nutrient restriction during mid- to late-gestation on maternal and fetal pancreatic exocrine function in sheep

### Korie DeBardlabon

Biological Sciences

Let me out: emergence patterns of an important pollinator, *Megachile rotundata*

### Martin Eichers

Mechanical Engineering

DDGS Biocomposite 3D Printing Filament

### Emma Ewen

Mechanical Engineering

Self-Actuating Shading System

### Ashley Fults

Crop and Weed Sciences

Woolly Cupgrass Response to Herbicides

### Jesse Gallagher

Biological Sciences

Germination success in prairie plants is mediated by the soil microbial community

### Benjamin Geffre

Chemistry and Biochemistry

Effect of Density Functional on Optical Properties of Ir(III) & Ru(II) Complexes

### Sara Gibbs Schnucker

Geology

Statistical approaches to identifying the origin of undocumented paleontological collections: A Mazon Creek example

### Bailey Gillis

Biological Sciences

The Effects of Red Swamp Crayfish on Experimental Populations of the Amargosa Pupfish

### Lauren Grant

Psychology

An Examination of Body Image, Eating, and Sexuality Among Female Emerging Adults

### Rebecca Haller

Chemistry

Chemoselective Oxidations of 5-(Hydroxymethyl)furfural and its Derivatives

### Reed Jacobsen

Biological Sciences

Pancreatic Microvasculature Phenotypes in Healthy and Cancerous Environments

### Victoria Krabbenhoft

Human Development and Family Science

Dating Behaviors and Body Image Among Female Adolescents

### Claudia May

Animal Sciences

Bovine *VDR* and *GPRC5C* genotypes are associated with udder conformation traits in crossbred beef cattle

### Neil Olson

Plant Sciences

The Influence of Plant Population on Industrial Hemp Performance in North Dakota

### Roshni Pandey

Pharmaceutical Sciences

Laser-capture microdissection of murine lung for differential cellular RNA analysis

### Dev Patel

Biological Sciences

Effect of Nutrition and Body Size on Flight Performance of Alfalfa Bees

### Kaitlyn Peterson

Plant Sciences

FODMAP levels of HRS Wheat: Occurrence and Production during Bread Making

### Sydney Thielbar

Accounting

An Exploratory Study of Teacher as Servant: Good and Bad Learning Environments

**Dylan Wald and Kimberly Whaley**  
Mechanical Engineering  
Heat Flow Meter Apparatus Development

**Rikki Walter**  
Biological Sciences  
Variation in Critical PO<sub>2</sub> and flight metabolic rate among castes in the bumble bee, *Bombus impatiens*

**Sydney Yingling**  
Biological Sciences  
Environmental Factors and Maternal Investment

## **AFTERNOON SESSION**

**1-3 p.m.**

*Plains Room*

**Tristan Anderson**  
Geosciences  
Reconstruction of Pleistocene Glaciers and Climate in the Baker Creek Valley, Great Basin National Park USA

**Lauren Cappelen and Jacob Zielinski**  
Criminal Justice  
Police Response Times in Relation to Crime Rates

**Kat Freebern**  
Exercise Science  
Accuracy of Mobile Weather Applications in Reporting Real-Time Humidity Measures

**Triston Ihrke**  
Mechanical Engineering  
Novel Honeycomb Infill Fabrication Pattern for Additive Manufacturing

**Stephanie Jensen**  
Dietetics  
Kids in the Garden Program Increases Family Familiarity of MyPlate and Economic Value of Gardening

**Shayna Karuman**  
Architecture  
River Oaks Meditation Garden

**Sarah Koep**  
Civil and Environmental Engineering  
Modification of granular activated carbon using natural citric acid from *Citrus aurantiifolia* for enhanced fluoride removal in drinking water

**Nolan Love**  
Health, Nutrition, and Exercise Science  
The Validity and Reliability of Devices and Apps to Assess Outdoor Relative Humidity

**Thomas Marcouiller**  
Geosciences  
Evaluating the Optically Stimulated Luminescence Properties of Massive Glacial Outwash Ridge Deposits

**Emily Mulvaney**  
Visual Arts  
Human Nature

**Sophia Portlas**  
Criminal Justice and Political Science  
Political Solidarity in the #MeToo Era

**Elizabeth Rono**  
Biological Sciences  
Transgenerational plasticity in sex ratio distribution in a species with temperature-dependent sex determination: A possible response to global climate change

**Kambri Schaner**  
Pharmaceutical Sciences  
Combination Antibiotic Release from a Bone Void Filling Putty and In Vitro Antibacterial Activity against *Staphylococcus aureus*

**Rachel Scheffert**  
Health, Nutrition, and Exercise Science  
How much (or how little) do people actually eat?

**Halley Score**  
Mechanical Engineering  
The Effect of Temperature on the Torrefaction of Biomass in Molten Salt

**Margaret Swanson**  
Biosystems Engineering  
Barley Plant Extracts for Green Nanoparticle Synthesis: Environmental Applications

**Zach Tarble**  
Biological Sciences  
Does genetic diversity of native prairie fragments differ from that of seed propagated for restoration? A genomic comparison using *Helianthus maximilliani*

**Christian Tunheim and Conner Lynch**  
Civil and Environmental Engineering  
Repurposed Styrofoam Lacquer and Adhesives

**Prajakta Warang**  
Microbiological Sciences  
Investigating the role of ethanolamine utilization in growth of *Listeria monocytogenes* on ready-to-eat meats

# ABSTRACTS

## Tristan Anderson

GEOSCIENCES

Project Adviser: Benjamin Laabs,

Geosciences

Reconstruction of Pleistocene  
Glaciers and Climate in the Baker  
Creek Valley, Great Basin National  
Park USA

The South Snake Range in Great Basin National Park hosted at least seven valley glaciers during the last Pleistocene glaciation, the largest of which occupied the Baker Creek valley. A suite of terminal moraines and other glacial landforms in the valley indicate the extent of the past glacier. The magnitude of Pleistocene climate change in this sector of the Great Basin is poorly known, however, and can help to better understand the relative roles of temperature and precipitation in driving glacier expansion. A numerical model of glacial mass balance and ice flow was applied to Baker Creek Valley to derive a list of temperature and precipitation combinations accompanying the last glaciation. The modeling program takes into account monthly calculations of mass and energy based on relative meteorological data and shows ice flow to the known ice extent. Temperature and precipitation values can be manipulated from the relative modern; temperature can be changed as a flat rate and precipitation as a multiplier. Model results indicate that if during the last glaciation precipitation was similar to modern, then the temperature would be 8.8°C at the max ice extent. This data is similar to data found using similar methods in the Ruby and East Humboldt Mountains in the Northern Great Basin, which was found to be 9.2°C for maximum ice extent.

## Greta Beck

SOCIOLOGY AND ANTHROPOLOGY

Adviser: Kristen Fellows, Sociology and

Anthropology

Lifeways behind the Spanish  
American War: The food and toys  
that provided escape for soldiers  
and children

The Spanish American War of 1898, although brief, made an impact on not only the soldiers who fought, but also the children on the homefront. The men of Company B, who were from North Dakota, and their children are examples of how everyday items can serve as a means of distraction from the world. During this period, toys were beginning to be mass produced as child labor laws were becoming more effective and children were allowed more playtime. While handmade and imagination games were popular, the most commercially favored toy was the Teddy Bear. About half of the children at the turn of the century lived in poverty, and had to make due with what they had. Children in America and the Philippines would have struggled with the challenges of childhood and parents going off to war. As children had some influence on what parents purchased for them, and could decide whether to play with what was given, they could appropriate their parents' goals of using toys as means for socialization. Cooking materials and food presented to soldiers of the Philippine insurrection were limited and policed. While food items were mostly kept to items of sustenance, there were some infrequent items that would have reminded them of home, such as chocolate and candy. Although neither party could control what they were given to eat or play with, they had agency in that they could choose what to eat and what to play with, therefore influencing buying decisions of the future.

Keywords: Spanish American War, Company B, Lifeways, Toys, Food, Supplies, Soldiers

## Mariah Billadeau

APPAREL, DESIGN, AND HOSPITALITY  
MANAGEMENT

Adviser: Chad Ulven, Mechanical  
Engineering

### Ecotex

93% of purified bottled water around the world contains microplastics. There are many products that use microplastics, but synthetic textiles produce the most: 35% of all the microplastics in our water system is from washing synthetic textiles because when we wash our clothes the plastics get into our water system and cannot be filtered out, so we are consuming these toxic plastics daily. Ecotex technology uses natural fibers with a carefully blended wax intertwined with the fibers to make it water-resistant and flexible as well as breathable, to eliminate textile microplastics.

I came up with the idea as I was interning in Australia when we met an Aboriginal Australian who talked about how they stayed dry in the Daintree Rain Forest. The wax on leaves are flexible and water resistant so I started to do research on a type of leaf wax that would be suitable for textiles. I found a Brazilian tree that has a hard wax that is safe, even for consumption. I wanted to blend it with a natural softer wax to give a soft feel, so I chose the wax/oil from sheep's wool used in cosmetics. After this research, I found more detailed information on the waxes to create Ecotex that uses only natural fibers and the blended wax.

I have not been able to test the product because I need to buy natural fiber textiles and unweave them to add the micro wax and then weave them back together. I plan to do this with some help from the engineering department when I have access to their machinery. I do expect the wax to react well with the fibers, and at a micro level, I expect it not to leave a waxy film and still be breathable, flexible, and water resistant.

If this textile works out, it could help eliminate 236,000 tons of microplastics every year from our oceans.

## Alexa Braaten

PHARMACEUTICAL SCIENCES

Co-Investigators: N.S. Ambhore,  
C.M. Pabelick, Y.S. Prakash, S.  
Venkatachalem

Adviser: Sathish Venkatachalem,  
Pharmaceutical Sciences

### Estrogen metabolite and their role in human asthma

Background: Epidemiological data suggests prevalence of more asthma in women than men, showing an important role of sex steroid hormones, especially estrogen, in lung diseases. Furthermore, earlier reports suggested estrogen metabolites 2-Methoxyestradiol (2-ME) and estriol (16 $\alpha$ -hydroxyestradiol; 16HE2) have a divergent role in airway remodeling. 2-ME exhibit anti-mitogenic, anti-inflammatory and anti-proliferative effects, whereas 16HE2 has mitogenic, pro-inflammatory, and proliferative properties. CYP1A1/CYP1B1 and CYP3A4 enzymes mediate estrogen metabolism into 2-ME and 16HE2 respectively. The ratio of these enzymes differs in male and females, with studies reporting hepatic expression of CYP3A4 predominant in females. However, expression of these enzymes in male vs. female lungs and the role of estrogen metabolites has not been extensively explored in airway-remodeling.

Methods: In this study, we examined expression and activity of CYP1A1, CYP1B1 and CYP3A4 in asthmatic and non-asthmatic primary human airway smooth muscle (ASM) cells. Furthermore, we evaluated the effect of estrogen (1nM), 2-ME (1nM), 2-HE (1nM) and 16HE2 (1nM) on PDGF stimulated ASM proliferation using MTT and bright field cell count assays and underlying mechanisms involved.

Results: Both asthmatic and non-asthmatic human-ASM showed expression of CYP1A1, CYP1B1 and CYP3A4. However, expression of CYP3A4 was more in female ASM compared to male. PDGF significantly increased ASM proliferation in asthmatic and non-asthmatic cells which significantly downregulated with 2-ME and 2-HE; with pronounced effect observed in males, whereas estrogen and 16HE2 showed no significant change.

Conclusion: This study indicates female ASM express more CYP3A4 which mediates estrogen metabolism into 16HE2 and affect inflammatory and proliferative activity of cells involved in airway remodeling.

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## Claire Campion

BIOLOGICAL SCIENCES

Co-Investigators: H. North, A. Rajamohan,  
J. Bowsher

Advisers: Julia Bowsher and Heather  
North, Biological Sciences

### Genotoxicity Assessment of Agrochemicals on Honey Bee Spermatozoa Using the TUNEL Assay

Agrochemicals and their widespread use are among the suspected reasons for pollinator decline. Some evidence suggests that pesticides can act as contraceptives. Few studies have investigated the sublethal effects of agrochemicals on spermatozoa. Of special concern is whether agrochemicals impact drone sperm quality, in terms of genotoxicity. Spermatozoa serve as an unintentional biomarker for xenobiotics in the environment, making them an accessible way to measure reproductive impacts of agrochemicals found in the hive environment. It is unclear how honey and bee bread made from contaminated resources might affect hive members such as drones, who don't actively forage. Here we use terminal deoxyribonucleotidyl transferase (TDT)- mediated dUTP nick end labeling (TUNEL) assay as a measure of genotoxicity for spermatozoa. Honey bee spermatozoa were exposed to the agrochemicals Imidacloprid, Thiamethoxam, Clothianidin and Glyphosate. Spermatozoa were pooled from multiple drones. Each treatment consisted of a cell concentration of  $5 \times 10^6$  cells/ml in semen buffer. Semen buffer was made with a 10nm concentration of each agrochemical. Preliminary results suggest this is an accurate and reliable assay to measure any DNA damage agrochemicals have on spermatozoa. Thus, the purpose of this study is to assess the reproductive impacts of agrochemicals in drones and the role this effect has on colony health.

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## Lauren Cappelen, Jacob Zielinski

CRIMINAL JUSTICE

Adviser: Steven Briggs, Criminal Justice  
and Political Science

### Police Response Times in Relation to Crime Rates

Police departments across the United States try to minimize response times to reported crime events in an effort to discourage potential future offending. Examinations of the impact of faster response times yield unexpected findings due to police department resource allocation decisions. We seek to address this problem and answer the question of whether faster response times reduces crime by using events that are expected to alter only response times. In order to do this, we used the Marathon and State Fair in St. Paul, Minnesota, to create events that we had hoped would change the response time of police to calls for service. After we collected data on the crime rates and response times from the police department, we checked to see if the change in response times had an effect on the crime rate in St. Paul, Minnesota. We hope that our research can aid the police in future resource allocation efforts.

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## Ethan Couser, Megan Kongable, Jamison Quanbeck, Tristan Schettler

GRAND CHALLENGES SCHOLARS  
PROGRAM, COLLEGE OF ENGINEERING

Adviser: Achintya Bezbaruah, Civil and  
Environmental Engineering

### Micro-Agriculture for Nutritious Food

The ultimate goal of this project is to provide nutritious food for those who do not have easy access to it. However, since this objective is meant to be accomplished in all countries, there will be several unique conundrums to address. The system must be universal, cheap to produce, and use materials that are readily available to the locality. This set of requirements makes it difficult to create a generic template to go by, due to the vast differences in accessible materials from location to location. The two biggest components to look out for are electricity and water supply. If any of these are missing or are in minute quantities, the system will require at least a partial revamp. This is why for now, the team is focusing on one locality: The Democratic Republic of the Congo (DRC).



## Taylor Czech

ANIMAL SCIENCE

Co-Investigators: R.J. Trotta, M.A.

Vasquez-Hidalgo, K.A. Vonnahme,

K.C. Swanson

Adviser: Kendall Swanson, Animal Science

### Effects of nutrient restriction during mid- to late-gestation on maternal and fetal pancreatic exocrine function in sheep

To examine the effects of nutrient restriction on fetal and maternal ovine exocrine pancreatic function during mid- to late-gestation, 41 singleton ewes ( $48.3 \pm 0.6$  kg BW) were randomly assigned to dietary treatments: 100% (control; CON;  $n=20$ ) or 60% of nutrient requirements (restricted; RES;  $n=21$ ) from day 50-90 (mid-gestation). At day 90, 14 ewes (CON,  $n=7$ ; RES,  $n=7$ ) were slaughtered. The remaining ewes were subjected to treatments of nutrient restriction or remained under a control diet from day 90-130 (late-gestation): CON-CON ( $n=6$ ), CON-RES ( $n=7$ ), RES-CON ( $n=7$ ), and RES-RES ( $n=7$ ) and were slaughtered at day 130. The pancreas was weighed, subsampled, and assayed for digestive enzyme activity. Enzyme activity was expressed as U/g, U/g protein, or U/pancreas (total content). Total protein content in the pancreas was expressed as g/pancreas. Differences between means were determined using contrasts in the MIXED procedure of SAS. Fetal and maternal pancreatic mass increased ( $P<0.04$ ) with day of gestation. Nutrient restriction during mid- ( $P=0.01$ ) and late-gestation ( $P=0.01$ ) decreased maternal pancreatic mass on d 130. Total fetal pancreatic  $\alpha$ -amylase, trypsin, and protein content increased ( $P<0.05$ ) with day of gestation. Maternal nutrient restriction during late-gestation tended to decrease ( $P<0.08$ ) fetal pancreatic trypsin activity. Nutrient restriction during late-gestation tended to increase ( $P=0.07$ )  $\alpha$ -amylase:trypsin in fetal pancreas but tended to have the opposite response in maternal pancreas ( $P=0.10$ ). Total maternal pancreatic content of trypsin and protein tended to increase ( $P<0.07$ ) as gestation progressed. Nutrient restriction of gestating ewes decreased total content of  $\alpha$ -amylase ( $P=0.04$ ) and tended to decrease total content of trypsin ( $P=0.06$ ) and protein ( $P=0.06$ ) in the maternal pancreas on d 90. Nutrient restriction during mid-gestation on d 90 and during late-gestation on d 130 decreased ( $P=0.04$ ) maternal  $\alpha$ -amylase activity. Maternal nutrient restriction impairs pancreatic exocrine function by reducing maternal and fetal digestive enzyme activity.

Key words: maternal nutrition, fetal programming, digestive enzymes

## Korie DeBardlabon

BIOLOGICAL SCIENCES

Adviser: Kendra Greenlee, Biological

Sciences

### Let me out: emergence patterns of an important pollinator, *Megachile rotundata*

Circadian rhythms play an important role in synchronizing biological processes. These rhythms are often influenced by semi-predictable periodic cues, such as photoperiod or thermoperiod. The alfalfa leafcutting bee, *Megachile rotundata*, is a solitary, cavity-nesting bee known to synchronize its emergence using thermoperiod as the dominant cue. Bees emerge as adults from brood cells placed in series in a cavity. Brood cells are constructed by females with leaves and provisioned with pollen, nectar, and a single egg. Offspring go through all of juvenile development and metamorphosis in the cavity. It is unknown if certain variations in thermoperiod affect the timing of emergence. Because brood cells are built in series in the nest, adult offspring must emerge in a specific order to prevent bees placed at the back of the cavity from emerging before those in the front. Thus, regulating emergence is important. On average, male *M. rotundata* are smaller than females, and often the brood cells at the front of cavities contain male offspring. Because of this, bee weight and sex are hypothesized to affect timing of emergence. To test this hypothesis, we disarticulated nests and placed individual brood cells in an apparatus that automatically records emergence time. We placed bees in various thermoperiods and recorded emergence time, sex, and dry weight of adult bees. Understanding the roles sex and weight play in emergence and how these factors interact with different thermoperiods will help us to understand the maternal contribution to offspring development.

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## Jeremy Dikau

ANTHROPOLOGY

Advisers: Kristen Fellows and John Creese,  
Sociology and Anthropology

### Twelve Steps on the Road to Recovery

Drug addiction is something that plagues the lives of many around the world. Once a person has become addicted, it becomes increasingly difficult to achieve and maintain sobriety and this has lasting implications for both the addict and those around them. While there are programs and services out there to assist those in recovery, an addict must buy into the process of recovery in order to kick the habit. My research asks about the importance of structure within programs like Narcotics Anonymous (NA) and whether or not they provide more than just a structure to keep addicts from using. Employing ethnographic methodologies, my study analyzed the relationship between NA and the addicts that attend such meetings over a period of four months. Through my research, I found that the twelve steps and traditions of NA are integral to adding structure to the lives of the addicts who choose to follow them. However, following things such as the twelve steps is a relatively small part of recovery, while the social connectedness enabled by NA tends to be the aspect of this program that most helps an addict maintain sobriety.

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## Martin Eichers

MECHANICAL ENGINEERING

Adviser: Dilpreet Bajwa, Mechanical  
Engineering

### DDGS Biocomposite 3D Printing Filament

Three-dimensional (3D) printing, also known as additive manufacturing, is a rapidly evolving technology with applications in many different industries. The 3D printing material market is expected to grow to \$1.41 billion by 2021, and the current U.S. market accounts for 37% of the global demand. The lack of local, low-cost, bio-based material for 3D filaments is a significant limitation to the widespread implementation of 3D printing. Currently, research is being conducted at NDSU to study the feasibility of developing biodegradable biocomposite filament using DDGS (Dried Distillers Grains with Solubles) and PLA (Polylactic Acid). DDGS is an abundant coproduct produced through dry-milled ethanol production. Currently, this material is added to animal feed due to its low cost, however, its composition displays potential for alternative applications. Producing a PLA-DDGS filament will significantly decrease the operating cost of 3D printing by reducing material costs. To improve the mechanical properties of the PLA-DDGS biocomposite filaments, plasticizers and coupling agents such as tributyl-acetyl citrate (TBAC), glycerol, and epoxidized soybean oil are being introduced to the PLA-DDGS blend. 3D filament is extruded using a twin-screw extruder and then slowly cooled in a hot water bed. The extruded filament is tested to determine its physico-mechanical properties and 3D printed to evaluate its performance for 3D printed parts. It is expected a viable formulation will have equivalent or superior properties compared to standard PLA filament.

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## Benjamin Eichholz

MECHANICAL ENGINEERING  
Adviser: Yan Zhang, Mechanical  
Engineering

### An Experimental Study of Pulsatile Flow Diversion using Superhydrophobic Mesh

Every year, around 30,000 people suffer from a ruptured brain aneurysm, and it is estimated that 6 million people in the United States currently have an unruptured brain aneurysm. Aneurysm rupture is usually caused by the constant, pulsing flow of blood through the vessel causing a fluid shear stress on the aneurysm cavity wall. One of the most common methods of treating an aneurysm is to divert the blood flow away from the fragile aneurysm by inserting a flexible mesh tube, known as a stent flow diverter, into the vessel. These expandable stents are made from medical-grade metals. Some biocompatible superhydrophobic coatings, which repel water and other liquids, have been studied and used in some biomedical applications. The goal of this experiment is to study the effectiveness of superhydrophobic coated mesh on the flow diversion control over standard cavities with pulsatile flow conditions similar to cardiovascular flow. This will be done by constructing a standard cavity model and using superhydrophobic coated mesh to divert flow through the cavity model much like it would be done in an actual blood vessel. This research will give further insight into using superhydrophobic coating for biomedical purposes, especially in complex cardiovascular cavities, and it will also investigate the effects of using this coated mesh in treating aneurysms.

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## Emma Ewen

MECHANICAL ENGINEERING  
Adviser: Chad Ulven, Mechanical  
Engineering

### Self-Actuating Shading System

Environmental adaptation is a beneficial characteristic of many systems. Self-actuating materials have been rising through the ranks of technology as researchers at Harvard and NASA are creating new and exciting products. One such category of research is a self-actuating louver. With this project, the purpose was to combine two materials, one with a higher coefficient of thermal expansion, so that upon heating, one material will expand faster than the other, and the sample will deflect. At this stage in the project, the design has been updated to a crimped shape that unfolds when its thermally-activated frames are heated. This expansion will provide shade, and, upon cooling, the system will return to its original shape.

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## Kat Freebern

EXERCISE SCIENCE  
Adviser: Shannon David, Health, Nutrition,  
and Exercise Science

### Accuracy of Mobile Weather Applications in Reporting Real- Time Humidity Measures

Many sports begin training outside in the summer for upcoming fall seasons. For athletic trainers and coaches, deciding when to give ample water breaks or how to make training adjustments is crucial to ensure athlete safety during hot temperatures and high humidity. The purpose of this study was to determine which mobile app is most accurate in relaying real-time humidity data. Researchers collected data at four different times throughout the day for fourteen days in a row. Data for wind speed, temperature, visible weather conditions, and humidity was collected by way of various technological devices (digital and psychrometer) and mobile weather applications. There was a relatively high correlation ( $r = .847$ ) between the Weather Bug app and the wet-bulb sling psychrometer. The Weather Channel application had an even higher correlation ( $r = .85$ ) with the sling psychrometer and, therefore, shows the most accuracy in relaying real-time humidity measurements. While high temperatures and humidity pose a threat to the health of those who are conditioning outside in the summer months, heat related illnesses and dehydration can be prevented with the knowledge of accurate weather measurements. With these findings, we can feel confident with the Weather Channel mobile application to give us this information.

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## Ashley Fults

CROP AND WEED SCIENCES

Adviser: Kirk Howatt, Plant Sciences

### Woolly Cupgrass Response to Herbicides

Woolly cupgrass is an invasive species found throughout the central United States, especially in corn-growing regions. In 2018, it was identified for the first time in North Dakota, in Cass and Richland counties. It is highly competitive and difficult to control, but there is not sufficient information on effective herbicides. Separate greenhouse experiments were conducted to evaluate efficacy of eight pre-emergence (PRE) or 14 post emergence (POST) herbicides to woolly cupgrass. Trials were established in a randomized, complete-block design with three and four replicates, for PRE and POST experiments, respectively, and repeated. Herbicides, each at typical use rate, were applied in a spraying chamber. Data were collected 2 and 4 weeks after application. The PRE-herbicides trifluralin, s-metolachlor, pyroxasulfone and dimethenamid-p did not allow woolly cupgrass seedlings to establish. The most effective POST herbicides included glyphosate, glufosinate, and pinoxaden.

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## Jesse Gallagher

BIOLOGICAL SCIENCES

Adviser: Laura Aldrich-Wolfe, Biological Sciences

### Germination success in prairie plants is mediated by the soil microbial community

Functional roles of microbial communities in prairies are poorly understood and their significance undervalued. I tested germination in four native and two exotic invasive species on sterilized and unaltered native soil. Germination was successful in the native *Geum triflorum* and the exotic *Potentilla recta*. The soil microbial community increased germination in *G. triflorum* and possibly reduced germination in *P. recta*. Alteration of the soil microbial community may influence performance of native and exotic species differently.

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## Benjamin Geffre

CHEMISTRY AND BIOCHEMISTRY

Adviser: Svetlana Kilina, Chemistry and Biochemistry

### Effect of Density Functional on Optical Properties of Ir(III) & Ru(II) Complexes

Iridium and Ruthenium metal complexes have highly tweakable and potentially desirable optical properties. The major potential applications would be in photovoltaics and light-emitting electronics. In an effort to better understand these properties and how to tweak them to be more desirable, a computational study using Time-Dependent Density Functional Theory (TDDFT) was performed on 3 metal similar complexes: Ir-1, Ru-1, and Ru-2. The multiple sets of oscillator strengths and absorption spectra for each complex was calculated under TDDFT, each set employing one of thirteen density functionals. These were compared to the experimental absorption spectra of the complexes. Natural transition orbitals were also calculated for each complex, employing the respective best fit functional.

The computational study shed light on several notable observations. Ir-1 has an optically active first excited, compared to the optically inactive first few excited states for both of the Ru complexes. Comparing Ru-1 and Ru-2, the addition of a BODIPY substituent on Ru-2 added a peak at around 425 nm independent of functional, but otherwise provided little additional absorption at higher wavelengths. In all 3 complexes tested, the “bluer” or higher energy transitions had higher  $\pi-\pi^*$  character, while the “redder” or lower energy transitions had higher charge-transfer character.

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## Sara Gibbs Schnucker

GEOLOGY

Adviser: Lydia Tackett, Geosciences

### Statistical approaches to identifying the origin of undocumented paleontological collections: A Mazon Creek example

As digitizing collections becomes commonplace, it is likely that the existence of undocumented specimens will lead to major delays in collection organization and impede future research on such specimens. A recent investigation into the taxonomic diversity of the “Mazon Creek” collection housed at North Dakota State University has led to a dilemma in regards to dealing with undocumented, donated collections. An attempt to locate the original source of a collection of approximately 600 (part/ counterpart) fossils labelled originally as Mazon Creek siderite concretions resulted in the discovery that the collection is a combination of at least two donated collections from two distinct formations. The first batch was donated to the collection prior to 1978, with no indication of the original donor. This collection has been identified as Mazon Creek in origin. The second batch, comprised entirely of Pennsylvanian-age plants, was donated by a North Dakota State faculty researcher and was collected from the Brazil Formation of Greene County, Indiana. The fossils from this area, dubbed the Stanley Cemetery flora, are slightly older than the Mazon Creek (with some overlap) and dominantly terrestrial. Although the two collections have distinct labelling schemes, approximately one-half of the specimens are lacking in any label whatsoever. Using faunal and floral identifications, it became apparent that this third group is a combination of the two collections, containing both plants and animals that could be Mazon Creek or Stanley Cemetery in origin, leading to the difficult task of identifying the origin of temporally similar and preservationally identical fossils. Through the application of varying statistical analyses, and the utilization of known fossil occurrences from the Mazon Creek and Stanley Cemetery localities (sourced from the Paleobiology Database, Mazon Creek identification guides, and the original description of the Stanley Cemetery flora (Wood, 1963)), we are aiming to identify (to the highest certainty possible) the origin of the unlabelled specimens. We have tentative provenance determinations, with the unlabelled flora specimens showing similarity to the Stanley Cemetery and the unlabelled fauna specimens showing high similarity to the Mazon Creek. This research represents an approach to dealing with uncertain provenance that may be useful for other collections managers.

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## Bailey Gillis

BIOLOGICAL SCIENCES

Adviser: Craig Stockwell, Biological Sciences

### The Effects of Red Swamp Crayfish on Experimental Populations of the Amargosa Pupfish

Invasive crayfish species threaten the persistence of numerous desert fishes, but how crayfish density influences native fish persistence is not well understood. One hypothesis predicts that negative impacts increase with higher crayfish densities, while an alternative hypothesis predicts that impacts decrease with higher crayfish densities, presumably due to interference competition. To test these hypotheses, we established experimental populations of Amargosa Pupfish and Red Swamp Crayfish. Treatments included allopatric pupfish; pupfish + 1 crayfish; pupfish + 4 crayfish and pupfish + 4 tethered crayfish. The latter two treatments were compared to evaluate if conspecific interactions among crayfish affected impacts on pupfish. Adult survival did not differ between the control and low-crayfish treatments. Adult survival was significantly lower for the high-density crayfish treatment compared to the control. However, adult survival did not differ between the low-crayfish and high-crayfish treatments, nor between the high-crayfish and high-density tethered treatments. Juvenile productivity did not differ between the control ( $705 \pm 92$  juveniles / tank) and low-crayfish treatment, while both of these treatments had higher juvenile productivity than the high-crayfish treatment. When comparing the two high-density crayfish treatments, tethering resulted in significantly higher juvenile productivity. Our results show density-dependent effects of crayfish on experimental pupfish populations. Limiting conspecific interactions among crayfish did not affect adult survival, but increased juvenile production. Our results suggest that short-term solutions to crayfish invasion may be simply to reduce crayfish densities.

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## Lauren Grant

PSYCHOLOGY

Adviser: Elizabeth Blodgett Salafia, Human Development and Family Science

### An Examination of Body Image, Eating, and Sexuality Among Female Emerging Adults

Body image along with sexuality are important factors during early adulthood. The purpose of this study was to examine the relationships between body dissatisfaction and both sexual activity and sexual satisfaction in female emerging adults. In addition, we examined the relationships between disordered eating patterns and both sexual activity and sexual satisfaction. Participants were 505 female emerging adults with a mean age of 21.59 (SD=3.6). Surveys were used to collect the data. We found that higher levels of body dissatisfaction correlated with higher levels of sexual activity. We also found that higher levels of disordered eating behaviors were correlated with lower levels of sexual satisfaction. Our results indicate that maintaining a positive body image and healthy eating style can impact sexuality for women.

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## Sean Gunderson

PHYSICS

Adviser: Sylvio May, Physics

### Prediction of Critical Points on Spinodal Hypersurfaces in Multidimensional Phase Diagrams

The prediction of phase diagrams of one- or multi-component systems is of fundamental importance in many fields of applied science as well as for students in thermodynamics courses. One of the most distinctive features in phase diagrams is the location of the so-called critical points on spinodal hypersurfaces. These points characterize the onset of a phase transition with infinitely short tie lines.

Textbooks provide a procedure for identifying the location of critical points for systems with a single degree or two degrees of freedom, but no simple procedure is available so far for multicomponent systems with higher degrees of freedom. We derive such an equation - a remarkably simple one - from first principles. It is valid for any number of components in a thermodynamic system and is likely to be found in future textbooks.

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## Rebecca Haller

CHEMISTRY

Co-Investigators: E. Serum, C. Sutton, M. Sibi

Adviser: Mukund Sibi, Chemistry and Biochemistry

### Chemoselective Oxidations of 5-(Hydroxymethyl)furfural and its Derivatives

To further the research of green organic chemistry, labs need access to many renewable chemicals which often come at a steep price. To increase the availability of these chemicals at a lower cost, we established a green chemoselective procedure using chlorous acid prepared from sodium chlorite and sulfamic acid in aqueous-acetone solution. This process results in an oxidation reaction with only aldehydes to the exclusion of a variety of functional groups, without compromising selectivity.

This research was sponsored by ND EPSCoR through NSF Grant OIA-1355466.

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## **Triston Ihrke**

MECHANICAL ENGINEERING

Adviser: Bashir Khoda, Industrial and  
Manufacturing Engineering

### **Novel Honeycomb Infill Fabrication Pattern for Additive Manufacturing**

In additive manufacturing (AM), porous structures are often used as infills to reduce the build time and cost. However, providing physical stability to the skin and mechanical integrity to the object is a functional requirement for any infill pattern. Prismatic closed cells, i.e. honeycomb structure, are often used as infill in AM parts. These cells are periodic in nature and uniform in density. In this research, a new fabrication pattern for honeycomb infill is proposed for additive manufacturing applications. The proposed pattern can accommodate controllable variational honeycomb infill while maintaining continuity with relative ease. First, the honeycomb unit cell geometry is defined for uniform and non-uniform voxel size. A continuous tool-path is then designed to achieve the honeycomb structure. Finally, the structures are fabricated with the variational and uniform pattern and are then compared to the traditional pattern using compression testing. The results show that the proposed designs perform better under compression load and can absorb more energy compared to the traditional counterpart.

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## **Hyun Jun In**

VISUAL ARTS

Adviser: Anthony Faris, Memorial Union  
Gallery

### **Sound of Fargo**

Difference is a common element among individuals and groups, places and lives. These variations make us unique but also connect us with others through social relationships. As a difference becomes more visible, by culture or location for example, there may be both wonder and fear at the change of what we consider normal. This idea of normal is central to my work as I explore how time, repetition and immersion can alter I ideas of what is strange, positive and negative. I create animations that reflect my journey from South Korea to Fargo, ND that attempt to communicate what is shared among humanity and what culture looks like from a human outside looking in.

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## **Tyrel Iron Eyes**

ANTHROPOLOGY

Adviser: John Creese, Sociology and  
Anthropology

### **Lakota Code Switching: Assimilation and Resistance**

This paper looks at historical and contemporary attitudes regarding code-switching among the Lakota people. Code-switching is the act of changing styles of speaking or the language spoken depending on various factors such as environment, audience, forum, medium, etc. Using an ethnohistoric approach, I sought to explain why English has become the dominant language in the U.S., as well as the indigenous resistance to this monoglot standard, particularly as it relates to Lakota people. The argument being made is that Lakota language speakers and learners assert their identity through their language choices. The idea of identity being tied to language is a recurring mentality throughout history, with repercussions on a national and international scale.

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## Reed Jacobson

BIOLOGICAL SCIENCES

Adviser: Jiha Kim, Biological Sciences

### Pancreatic Microvasculature Phenotypes in Healthy and Cancerous Environments

Angiogenesis is the process of forming new blood vessels. Cancerous tumors adapt this process to supply its increasing oxygen and energy needs for growth. Tumor vasculature displays atypical characteristics causing poor perfusion and a hypoxic tumor micro-environment. Hypoxia is known to accelerate tumor metastasis, and poor perfusion can lead to impeded drug delivery. The suboptimal vasculature is thought to be caused by poor pericyte investment on the microvasculature. To study this abnormality, in vitro cell culture was utilized. In previous research it was found that when pericytes expressed higher amounts of Desmin proteins compared to other pericyte markers, the investment was much more sufficient than lower Desmin expressing pericytes. The higher Desmin phenotype correlated with reduced hypoxia and better perfusion. Based on these observations, it is hypothesized that pericytes cultured with endothelial cells would display relatively higher amounts of Desmin. To test this, pericytes were co-cultured with a variety of other cells. Gene expression of pericyte markers was then tested via qRT-PCR. It was found that (1) when pericytes were cultured with different cells and in different conditions, their protein expression changed significantly. (2) Pericytes co-cultured with endothelial cells relatively expressed the most Desmin, and (3) pericytes co-cultured with pancreatic cancer cells expressed the least amount of Desmin. Important communication occurs between the endothelial cells and pericytes that allows for healthy microvasculature. Further study in the molecular pathways that lead to differing pericyte phenotypes could potentially yield new treatment options to allow for better cancer medication delivery and reduced hypoxia.

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## Stephanie Jensen

DIETETICS

Adviser: Julie Garden-Robinson, NDSU Extension, Food and Nutrition Safety

### Kids in the Garden Program Increases Family Familiarity of MyPlate and Economic Value of Gardening

Gardening has emerged as a valuable way to teach the youth skills, increase their intake of fruits and vegetables as well as their fitness levels. In addition to the listed benefits above, growing produce in a home garden can be less expensive than purchasing produce from a grocery store and can be rewarding. Studies have found that children who assist in the garden not only gain self-confidence, but also a sense of responsibility and appreciation of growing food. Children are more likely to try new fruits and vegetables they help grow. The “Kids in the Garden” program is an eight lesson curriculum highlighting the benefits associated with gardening, making recipes and consumption of fruit and vegetables at a young age. Based on a collection of children’s books, it involves preschool-aged children and their parents and/or guardians in lessons about gardens, seeds, critters, roots, leaves, stems, flowers and fruits. Lessons feature hands-on gardening, cooking and tasting activities with the use of picture-based learning. Of the 25 participating families, 18 completed pre- and post- surveys, where we saw an overall increase of participants recognizing the economic value of gardening and familiarity of MyPlate. Based off this information, we can conclude the program positively impacted participants.



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## Shayna Karuman

ARCHITECTURE

Adviser: Kevin Kettner, Advising  
Resource Center

### River Oaks Meditation Garden

Humankind seeks shelter not only as a means of security, but comfort and community. This very domestic attraction we face calls upon architecture to orchestrate spaces which play upon the unlikely melody between familiarity and experimental design. Architecture facilitates dwelling by refining and synthesizing the daily activities, experiences and exchanges between an individual and their community. By studying the resistance and compliance we face in architecture, society, and nature, we are able to manifest the sensation of comfort and purpose: the basic needs of life.

The Walker Dwelling reflects Georgia Iris Walker's individuality as well as her most intimate relationships: art, nature, and loved ones. A hierarchy of Georgia's relationships with these passions is displayed through the interior and exterior design components of her home. Reflecting her devotion to painting, the home's primary space is fluid studio space. Additionally, the design includes the kitchen dining space, a dark room, bathroom, lofted bedroom, and a healthy and diverse flower bed. In compliance with suitability, the dwelling is made of natural stucco with a framework of recycled wood varieties. The home's design corresponds with Georgia O' Keefe's original home as well as the constraints and design philosophy of the Cripple Creek community.

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## Atiya Khan

PLANT PATHOLOGY

Adviser: Robert Brueggeman,  
Plant Pathology

### Characterization of genes required for both Rpg1- and rpg4-Mediated Wheat Stem Rust Resistance in Barley

*Puccinia graminis f. sp. tritici* (Pgt) race TTKSK and its lineage pose a threat to barley production world-wide, warranting the efforts to identify, clone, and characterize the rpg4-mediated resistance locus (RMRL), the only effective resistance to these exceptional Pgt races. The RMRL contains two nucleotide binding site-leucine rich repeat (NLR) resistance genes, Rpg5 and HvRga1, which are required together for resistance. The two NLRs have the head-to-head genome architecture with one NLR, Rpg5, containing an integrated C-terminal protein kinase domain, characteristic of an integrated sensory domain resistance mechanism. Fast neutron mutagenesis of line Q21861, the original RMRL source, was utilized in a forward genetics approach to identify genetic components that function in the RMRL or Rpg1 broad spectrum resistance mechanisms, as Q21861 contains both genes. A mutant was identified that compromises both RMRL- and Rpg1-mediated resistances and was designated the required *P. graminis* resistance 9 (rpr9) gene.

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## Sarah Koep

CIVIL AND ENVIRONMENTAL  
ENGINEERING

Adviser: Achintya Bezbaruah, Civil  
and Environmental Engineering

### Modification of granular activated carbon using natural citric acid from *Citrus aurantiifolia* for enhanced fluoride removal in drinking water

Excess fluoride in drinking water is a global issue having detrimental health effects. The World Health Organization's fluoride guideline of 1.5 mg/L is exceeded in drinking water sources used by over 200 million people worldwide, particularly in rural areas, leading to concerning health problems such as fluorosis. To address the need for defluoridation technology feasible for rural use, this study considered the simple and inexpensive lime (*Citrus aurantiifolia*) modification of granular activated carbon (GAC) for improved fluoride adsorption. The lime-modified GAC was able to remove approximately 50% more fluoride than unmodified GAC.

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## Victoria Krabbenhoft

HUMAN DEVELOPMENT AND FAMILY SCIENCE

Co-Investigators: K. Leonard, E. Blodgett Salafia, E. Johnson

Adviser: Elizabeth Blodgett Salafia, Human Development and Family Science

### Dating Behaviors and Body Image Among Female Adolescents

Only in recent years have atypical eating attitudes, body dissatisfaction, or the desire for thinness been examined in the context of romantic relationships, and not many direct conclusions have been drawn. In this study, 200 middle school and high school adolescents between the ages of 12 and 18 years old participated in the Eating Attitudes Study (EATS). Participants were given questionnaires to assess their dating behaviors, eating attitudes, body dissatisfaction, and desire for thinness. We then used an independent sample t-test analysis to obtain results. Dating status did not significantly predict any of these outcomes. However, we found a significant relationship between females' desire to date and atypical eating attitudes, body dissatisfaction, and desire for thinness. These results suggest that the act of dating alone does not contribute to atypical eating attitudes, body dissatisfaction, or the desire for thinness, but the desire to date does.

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## Nolan Love

HEALTH, NUTRITION, AND EXERCISE SCIENCE

Adviser: Shannon David, Health, Nutrition, and Exercise Science

### The Validity and Reliability of Devices and Apps to Assess Outdoor Relative Humidity

With heat stroke being the third leading cause of death in athletics, heat illness is an important area for sports medicine teams to be aware of and to work towards prevention. In order to follow these guidelines, athletic trainers have been trained to use instruments such as the wet bulb globe temperatures (WBGT), sling psychrometer, and heat index guidelines to make essential decisions regarding athletic participation in various weather conditions.

The purpose of this study was to test validity and reliability of devices and smartphone applications in order to assess outdoor relative humidity. The Weather Channel and Weather Bug are two commonly used weather applications by athletic trainers and coaches. Therefore, sling Psychrometer, digital Psychrometer, and Weather Channel and Weather Bug apps were used to record temperature and humidity for two weeks at four times during the day.

The primary conclusion of this study is when measuring outdoor relative humidity, The Weather Channel, Weather Bug, sling psychrometer, and a digital psychrometer are all viable applications and devices to use. The Weather Channel is the most consistent across all the devices, followed by the sling psychrometer and the Weather Bug. The digital psychrometer is the least viable of all the devices, and this may be due to its higher temperature readings. Longer data collection period may be needed to truly assess the validity and reliability of these devices.

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## Thomas Marcouiller

GEOSCIENCES

Adviser: Kenneth Lepper, Geosciences

### Evaluating the Optically Stimulated Luminescence Properties of Massive Glacial Outwash Ridge Deposits

Optically Stimulated Luminescence (OSL) is a well-established geologic dating technique; however, it has not been reliably applied to massive glacial outwash deposits. As a preliminary phase in a larger project to understand the deglaciation of Central Michigan, the OSL properties of these deposits needed to be evaluated. The goal of this project was to determine which grain size ranges would produce the best OSL dating results. OSL data was collected from two sediment samples taken from glacial outwash ridges and then divided into four grain sizes from each sample: very fine sand (90-150 microns), fine sand (150-250 microns), medium sand (250-355 microns), and coarse sand (355-425 microns). Equivalent dose distributions and several other parameters were compared among the data sets. It was determined that the medium sand fraction would produce the optimum OSL results for these features.

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## Claudia May

ANIMAL SCIENCES

Co-Investigators: A.K. Ward, C.R. Dahlen,  
K.C. Swanson, K.A. Ringwall,

L. L. Hulsman Hanna

Adviser: Lauren L. Hulsman Hanna, Animal  
Sciences

**Bovine *VDR* and *GPRC5C*  
genotypes are associated with  
udder conformation traits in  
crossbred beef cattle**

Udder characteristics are related to infection susceptibility and a calf's ability to suckle its dam. Teat shape, teat size, udder suspension, and udder balance are main factors producers examine when evaluating cows. Based on previous studies, our objective was to determine if *CAPN3*, *VDR*, *LETM1*, *GPRC5C*, *REN*, and *ABHD2* genes were associated with udder conformation. Crossbred heifers born in 2014 (n = 90) and 2015 (n = 73) at the Dickinson Research Extension Center were udder scored (1 to 9 scale, higher score is more desirable) as heifers, then scored at each calving and weaning event until calving 2018. Heifers were genotyped on the GeneSeek Genomic Profiler 150K, where SNP were selected for this study if located within these genes based on UMD3.1 coordinates (n = 24 SNP). Average scores per animal for each trait were modeled using general linear model procedures of SAS with fixed effects of primary breed (n = 9), year born (n = 2), frame score group (n = 4) and individual SNP. Least square means were adjusted using the Tukey-Kramer method. Significant associations between SNP and udder characteristic were: BovineHD0500009456 (*VDR*;  $P = 0.034$ ; teat size), ARS-BFGL-NGS-27636 (*GPRC5C*;  $P = 0.042$ ; teat shape), and BovineHD1900016305 (*GPRC5C*;  $P = 0.011$ ; udder balance). Ontology searches suggest *VDR* is involved with mammary tissue involution and branching while *GPRC5C* is involved with cell membrane integrity and regulation of retinoic acid. If these relationships hold true in cattle, these markers may provide a viable option for selecting improved udder conformation.

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## Emily Mulvaney

VISUAL ARTS

Adviser: Anthony Faris, Memorial Union  
Gallery

**Human Nature**

Humanity has always been intertwined with nature. The natural world is our main source of sustenance and a place that has provided peace and wonder within many humans throughout history. Ancient civilizations used nature as a means of communication of religious deities, divine powers, and a tangible vessel for ideas of existence. Although, as time passed, humans went from coexisting with nature to creating a hierarchy based on intellectual discrimination. Altering organisms, over-using resources, and polluting our environment are ways that humans are intervening and intruding on the natural world. I have created abstract sculptural forms with real dried and alive plants, then poured brightly colored gloss medium on them to represent humans disruption and imposition on nature. Through my research and my artwork, I am hoping to depict a stronger need for sustainability and appreciation for our natural world.

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## Neil Olson

PLANT SCIENCES

Adviser: Burton Johnson, Plant Sciences

### The Influence of Plant Population on Industrial Hemp Performance in North Dakota

The passage of the Hemp Farming Act of 2018 has increased grower interest for industrial hemp (*Cannabis sativa* L.) production. This increases the importance of developing management practices to attain optimum performance in North Dakota. Most research on hemp has been done in areas dissimilar to North Dakota and could be unrelatable. Most cultivars of hemp have lower germination rates and higher seedling mortality than our current commodity crops. This causes hemp to have a higher incidence of irregular plant populations. The objective of this study was to quantify the impact a reduced plant density has on industrial hemp. Two cultivars (CRS-1 and Grandi) were selected for their likelihood of being well adapted for North Dakota. Populations were reduced at the 1012 growth stage. Two replications of the following plant densities (PD) 130, 104, 78, 52, and 26 plants/m<sup>2</sup> were applied. Trait observations are organized by the number of days after planting (DAP) they were collected. Traits evaluated are leaf canopy ground cover (LCGC), normalized digital vegetation index (NDVI), plant height, stem diameter, stem branching, inflorescence length (IFL), and grain yield. The LCGC decreased as PD decreased at the 21 and 28 DAP dates. By 39 DAP all PD had canopied. The NDVI was insignificant across treatments except for immediately following application of PD treatments and at DAP 92 when the plants had signs of senescence. Unexpectedly, IFL and grain yield tend to increase as PD decreased. More research is needed to determine the PD impacts relative to growth stage.

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## Roshni Pandey

PHARMACEUTICAL SCIENCES

Adviser: Sathish Venkatachalem,

Pharmaceutical Sciences

### Laser-capture microdissection of murine lung for differential cellular RNA analysis

The lung tissue contains a heterogeneous milieu of bronchioles, epithelial, airway smooth muscle (ASM), alveolar and immune cell types. Healthy bronchiole is comprised of epithelial cells surrounded by ASM cells and helps in normal respiration. In contrast, airway remodeling, or plasticity, increases surrounding of bronchial epithelium during inflammation, especially in asthmatic condition. Given the profound functional difference between ASM, epithelial, and other cell types in the lung, it is imperative to separate and isolate different cell types of lungs for genomics, proteomics, and molecular analysis, which will improve the diagnostic and therapeutic approach to treat cell-specific lung disorders. Laser capture microdissection (LCM) is the technique generally used for the isolation of specific cell populations under direct visual inspection. Maintaining RNA quality and integrity in LCM study is the most challenging task. It is obvious that the major factor affecting RNA quality is tissue fixation method. The prime focus of this study was to address the RNA quality factors within lung tissue using the different solvent systems to fix tissue samples to obtain high quality RNA. Paraformaldehyde and Carnoy's solutions were used for fixing the lung tissue and compared RNA integrity in LCM captured lung tissue samples. Techniques of RT-PCR and the RNA Integrity Number were used to evaluate the quality of RNA. Overall, the study concludes tissue fixation solvent can alter the quality of RNA in the lung and the outcome of the results.

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## Dev Patel

BIOLOGICAL SCIENCES

Adviser: Courtney Grula, Biological Sciences

### Effect of Nutrition and Body Size on Flight Performance of Alfalfa Bees

*Megachile rotundata*, better known as the alfalfa leaf cutting bee, is a solitary bee that plays a big role in pollination of agricultural crops, primarily for the production of alfalfa seeds. Foraging distance can strongly affect the bee's population dynamics, genetic structure and life history. This research project was focused on how nutritional quantity impacts body size of *Megachile rotundata* and how the body size all in all affects foraging distance and overall fitness of the adult bee. The wet and dry weights were taken of three bee populations that were given different food quantities during developmental stages. One group was a control, one group was fed, and one group was starved. Following weight measurements, IT span and head width, wing length and wing area were measured. These measurements were used by us to calculate wing loading and excess power index which serve as good factors in determining the flight capacity of the bees. It was hypothesized that increase in body size has a positive correlation with foraging distance. This information is important to understand how the bee population reacts to landscape, how the bee pollinators affect plant population structure, and how to plan conservation strategies for plants and bees.

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## Hannah Pearson

PSYCHOLOGY

Adviser: Benjamin Balas, Psychology

### Detecting Suicidality and Impulsivity in Unfamiliar Face Images

Suicide is a leading cause of death in the United States today. "Detecting Suicidality From Facial Appearance," found that observers were able to accurately determine whether or not unfamiliar face images depicted individuals who had died by suicide (Kleiman & Rule, 2013). We replicated two of their tasks using their original stimuli. We expected observers would be able to accurately determine whether or not an unfamiliar face image depicted an individual who had died by suicide. Additionally, we included a confidence rating for each trial. We also expected observers would rate unfamiliar face images of individuals who had died by suicide as more impulsive than images of those who had not. We also extended Kleiman & Rule's study by including a 2AFC task, in which observers chose which of two faces had died by suicide rather than stating "yes" or "no" for individual faces as in the original task.

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## Kaitlyn Peterson

PLANT SCIENCES

Adviser: Senay Simsek, Plant Sciences

### FODMAP levels of HRS Wheat: Occurrence and Production during bread making

FODMAP, Fermentable Oligo-, Di-, Mono-saccharides and Polyols, is a group of carbohydrates that can cause adverse symptoms in people who have Irritable Bowel Syndrome (IBS). It is important to analyze and quantify these compounds in specific Hard Red Spring(HRS) wheat varieties grown in North Dakota in order to reduce these adverse effects. Eight common HRS wheat varieties will be used from two different years and locations in order to provide a more accurate and extensive analysis of the FODMAP content found in HRS wheat. These samples will be analyzed through several different baking lengths in order to determine whether the length of the fermenting period will affect fructan retention. This research could help create a more ideal baking method that would reduce the FODMAP content and help HRS wheat breeding programs develop new varieties with targeted FODMAP levels, in order to allow people with IBS to consume wheat products safely.

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## Sophia Portlas

CRIMINAL JUSTICE AND POLITICAL SCIENCE

Adviser: Kjersten Nelson, Criminal Justice and Political Science

### Political Solidarity in the #MeToo Era

The #MeToo movement, which went viral in 2017 on social media platforms, gives political scientists the opportunity to investigate the ways political solidarity influences gender-based movements and policy development. This exploratory study researches the impacts of #MeToo on candidate motivation and the role political solidarity plays for women during campaigns and in elected offices. Semi-structured, in-depth interviews utilizing a flexible and responsive approach were conducted with six individuals who are experienced in campaigns. Interviews were based around the topic of campaigns and candidate motivation of women to enable a detailed exploration of participants' insights and experiences. The flexible approach allowed for a discovery of information that otherwise may not have been considered. A thematic analysis was used to discover themes from the interviews, which included candidate motivation, sisterhood, and political solidarity. #MeToo served as a prominent theme throughout the interviews as a vehicle for political solidarity. Additionally, themes discussed in this research reflect on trends such as higher rates of confidence levels for younger women and an increase in women running in local and state elections. The themes found in these interviews have implications for policy makers, such as the development of sexual misconduct policies, and can be applied to further quantitative research into candidate motivation.

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## Elizabeth Rono

BIOLOGICAL SCIENCES

Adviser: Matthew Smith, Biological Sciences

### Transgenerational plasticity in sex ratio distribution in a species with temperature-dependent sex determination: A possible response to global climate change

An important component of maintaining a viable/stable population is the availability of reproductive males and females, generally referred to as the operational sex ratio (OSR). The optimal OSR varies from species to species, but due to global warming there is increasing evidence to suggest those species with temperature-dependent sex determination (TSD) have skewed or sub-optimal OSRs. Gender bias away from OSR can have significant demographic impacts and reduces effective population size. Whether global climate change and increased temperatures will detrimentally affect populations of species with TSD depends on the presence or absence of phenotypic plasticity and genetic adaptation of temperature-determined sex ratios. If plasticity and/or genetic variation exists to allow populations to keep pace with increasing temperatures, than those populations can avoid sub-optimal OSRs and have a better chance of maintaining viable populations. We use a multigenerational experiment to test for the potential of adult leopard geckos (*Elublepharis macularius*) to ameliorate the effects of increased annual temperatures on the sex ratio of their offspring. Specifically, we are testing for transgenerational plasticity in offspring sex ratios at projected future annual temperature increases (1 - 3° C). Our objectives are to determine if exposure of adult geckos to elevated temperatures influences the effect of incubation temperature on offspring sex ratios and to determine if adults exposed to elevated temperatures alter egg deposition characteristics to offset increased temperatures. Here we present data on the first of three generations.

## Maxwell Sabin

HISTORY

Adviser: Angela Smith, History, Philosophy, and Religious Studies

### 1898-1899: North Dakota Goes to War

The documentary film *1898-1899: North Dakota Goes to War* sets out to educate the viewer about North Dakota's involvement in one of America's lesser-known military conflicts from the turn of the century. It tells a story of heroism, sacrifice and determination; all attributes that are commonly associated with people from the Midwest, especially here in North Dakota.

For researching this topic, I spent many hours looking over old documents through various databases online and in person, both at the NDSU archives and the North Dakota Heritage Center in Bismarck. Furthermore, I looked over several hand-written letters and journals from the men that were there, and was able to put together an idea about what life was like for them when they were so far away from home. I read the letters from the perspective of someone that had never been away from home, as many of the younger volunteers had only been in North Dakota for their entire lives. Alongside my research, I provided most of the narration to the final film. To do this, I used vocal lessons that I had learned in my acting classes to warm up my voice and pronounce words that I otherwise would not know how to say, as many of them were Filipino.

With the completion of the film, I learned more about the history of North Dakota and myself. I had never known the story of the First North Dakota Volunteer Infantry, or the Spanish-American War as a whole. Through my research, I was able to better understand the attitudes, thoughts and beliefs of North Dakotans at the turn of the century, both the volunteers and their loved ones who helped get them home. The months of dedicated research by both my classmates and myself, as well as the hard work put into the movie, making software and voiceovers, produced a documentary film that was made to educate all of those who are interested in a specific point in our nation's history that is often times neglected and forgotten.

## Kambri Schaner

PHARMACEUTICAL SCIENCES

Co-Investigators: R. Hasan, A. Brooks

Adviser: Amanda Brooks, Pharmaceutical Sciences

### Combination Antibiotic Release from a Bone Void Filling Putty and In Vitro Antibacterial Activity against *Staphylococcus aureus*

Total Joint Replacement (TJR) surgeries are on the rise in the U.S., with an expected rate of 5 million surgeries/year by 2030. Infection accounts for ~25% of revisions for TJR surgeries. The infection rate can be as high as 20-30% after revision surgery. Current treatment with bone cement followed by surgical removal of necrotic and infected bone does not provide adequate local antibiotic. It also plays a role in the emergence of antibiotic resistance due to bacterial presence at surgical site. Moreover, single drug therapy often fails to eradicate bacterial biofilm infection.

We developed a dual Antibiotic-Releasing Bone Void Filler (ABVF) putty implant which contains a polymer matrix to provide sustained drug release. A drug release study was performed by putting the ABVF into phosphate buffered saline (PBS) and the media was collected at different time intervals. The release drug was used to assess antibacterial activity via zone of inhibition (ZOI) assay against *Staphylococcus aureus* (at  $10^7$  CFU/mL). ABVF provided sustained delivery of antibiotics for up to six weeks in-vitro with efficient antibacterial activity against *Staphylococcus aureus*. In future, the ABVF will be used in vivo rat model to assess antibacterial activity. ABVF can be an alternative treatment option for osteomyelitis after infected TJR.

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## Rachel Scheffert

HEALTH, NUTRITION, AND EXERCISE  
SCIENCE

Adviser: Sherri Stastny, Health, Nutrition,  
and Exercise Science

### How much (or how little) do people actually eat?

Three-day food diaries are a subjective glance at information provided by the participant in various human nutrition studies. Food diary entries supplied by research participants are entered into a nutrient database called Food Processor (ESHA) by undergraduate research assistants. These food and beverage entries are used for analysis of the nutritional information that reflect the typically eating patterns of the participant. The purpose of this study was to estimate the normal eating patterns of participants across different lifestyles for a variety of studies.

Participants received training information via a You-Tube video on how to properly and accurately fill out a three-day food diary that reflects two standard days and one non-standard day during a one-week timeframe. The participant is also given additional serving size guidelines for a variety of foods and beverages. After the participant returns the completed three-day food diary, it is manually entered into the ESHA system. During the process of entering, if the information is questionable either by vagueness in description or abnormal amounts the participant is contacted for clarification. Once the three-day food diary is completely entered, it is double- and triple-checked for accuracy of translation between the three-day food diary and the ESHA system. Lastly, the nutritional information calculated from the ESHA system such as calories, protein, carbohydrates, fats, and micronutrients are exported to the server for nutritional analysis to estimate the normal eating pattern of the participant.

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## Halley Score

MECHANICAL ENGINEERING

Adviser: Adam Gladen, Mechanical  
Engineering

### The Effect of Temperature on the Torrefaction of Biomass in Molten Salt

Torrefaction is a thermal pre-treatment process for biomass that increases the energy density and homogeneity of the material. The current torrefaction process is conducted at high temperatures, between 250 and 300°C, in an inert environment. Solar energy is well suited to provide the necessary energy input. However, regions of good solar resources have poor overlap with regions of good biomass resources. Thus, it is difficult to consistently maintain the torrefaction temperature (~275 °C) in the regions of good biomass. This research looked at a new method of torrefaction that utilizes a molten salt catalyst to reduce the temperature at which the torrefaction reaction occurs. The focus of this experiment was to determine the relationship between degree of torrefaction, as measured by higher heating value and fixed carbon content, and the torrefaction temperature and salt composition for this new process. A total of nine torrefaction samples were made using combinations of three different torrefaction temperatures and three different catalyst compositions. The different torrefied biomasses were tested to determine their higher heating values and fixed carbon values, which are both indicators of the materials energy content and combustion efficiency. The relationships between the higher heating value and fixed carbon value of the biomass in relation to the torrefaction temperature for each catalyst composition were analyzed. Conclusions based on the effect of temperature and catalyst composition on the level of torrefaction will guide future research that will be utilized to develop an effective solar torrefaction of biomass.



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## Hashem Sonbol

CIVIL ENGINEERING

Adviser: Beena Ajmeera, Civil and Environmental Engineering

### Rainfall Intensity-Duration Curves for Post-Wildfire Debris Flows: Tools to Assist with Early Warning Systems

Strong blazes spread by strong wind and supported by dry and hot weather are known as wildfires. Wildfires can consume houses and/or agricultural resources if they are not contained in time. They typically begin unnoticed and spread quickly by igniting brush, trees, homes or anything else that comes into contact with them. A major concern in hilly and mountainous regions is the occurrence of debris flows or mudslides during the rainfall events following a wildfire. A recent example is the devastating debris flows occurring in Montecito, California on January 9, 2018. These debris flows resulted in 21 deaths with additional 150 injuries and over \$200 million in property damages (Tiwari and Ajmera, 2018). The debris flow cut off access to utilities such as power and gas and buried major highways and local streets with 10 to 12 ft of debris (Tiwari and Ajmera, 2018). The purpose of this research is to develop rainfall intensity/duration threshold curves for post wildfire debris flow in order to better prepare for such harmful events. By analyzing the rainfall intensity in several important regions in Southern California using rainfall data provided by the National Oceanic and Atmospheric Association's website (NOAA), it will be possible to develop a threshold using which a given rainfall intensity/duration can be used to determine whether a debris flow may be triggered in the future. The findings from this study will help local authorities and communities better prepare and manage post wildfire debris flow hazards.

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## Brandon Stoick

MECHANICAL ENGINEERING

Adviser: Jeremy Straub, Computer Science

### Fake News Identification: A Comparison of Parts of Speech and N-grams with Neural Networks

The rise of the internet has enabled fake news to reach larger audiences more quickly. As more people turn to social media for news, accuracy of information on these platforms is especially important. To help enable classification of news articles at scale, machine learning models were developed and trained to recognize fake articles. Previous linguistic work suggests part of speech and N-gram frequencies are often different from fake to real articles. To explore this relationship, a dataset of 260 news articles, 130 fake and 130 real, was collected for training neural network classifiers. The first model relies solely on part of speech frequencies within the body of the text and consistently achieved 82% accuracy. As the proportion of the dataset used for training grew smaller, accuracy decreased as expected. The true negative rate, however, remained high. Thus, some aspect of the fake articles was readily identifiable, even when the classifier was trained on a limited number of examples. The second model relies on the most commonly occurring N-gram frequencies. The neural nets were trained on N-grams of different length. Interestingly, the accuracy was near 61% for each N-gram size. This suggests some of the same information may be ascertainable across N-grams of different sizes.

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## Margaret Swanson

BIOSYSTEMS ENGINEERING

Advisers: Achintya Bezbaruah, Civil and Environmental Engineering; Robert Brueggeman, Plant Pathology; Hoang Pham, Civil and Environmental Engineering

### Barley Plant Extracts for Green Nanoparticle Synthesis: Environmental Applications

Extracts of the leaves, roots, and seeds of tradition barley were individually prepared and then used to synthesize iron nanomaterials. The ability of each kind of extract to synthesize nanomaterials was determined by the mass of the nanomaterials and their efficacy in removing phosphate from water. The purpose of this study was to determine which part of the plant is the most effective for nanomaterial synthesis. This study is an effort to synthesize greener nanomaterials for environmental remediation applications.

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## Arin Tamimi

PSYCHOLOGY

Adviser: Verlin Hinsz, Psychology

### Thinking Aloud: Revealing People's Thought Processes

“Think-aloud” is a technique used in research to understand what a participant is thinking while performing a cognitive task. It is a method of collecting responses on implicit mental and cognitive processes. With this method, human participants are asked to verbalize their thoughts while performing a particular task. These verbal reports are recorded and content analyzed to understand and gain insight into our cognitive processes such as how we reach decisions. Research shows that with proper application, responses can be gathered from participants that reveal reliable features of human cognitive processes for numerous types of cognitive tasks (e.g., problem-solving, reading, usability analysis, working memory). This think-aloud technique will be illustrated with decisions in which individuals allocate resources in an interpersonal situation.

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## Zach Tarble

BIOLOGICAL SCIENCES

Co-Investigators: J. Waraniak, J. Prasifka, J. Hamilton

Adviser: Jill Hamilton, Biological Sciences

### Does genetic diversity of native prairie fragments differ from that of seed propagated for restoration? A genomic comparison using *Helianthus maximiliani*

As one of the most globally imperiled ecosystems worldwide, native prairie communities are challenged to identify and implement restoration approaches that promote resilience and long-term persistence of native prairie plants. This may include sourcing local seed, to the extent it is available, or sourcing seed from regional providers propagating seed for restoration. Maximizing long-term persistence requires that populations have the necessary evolutionary potential to adapt to changing conditions. Genetic variation provides the raw material through which selection may act, and is thus essential to adaptation. Consequently, an understanding of the distribution of genetic variation for seed from native prairie fragments alongside propagated seed sources will be important to predicting long-term restoration success. Using seed sourced from natural remnant prairie fragments, and those produced for restoration, we will examine how genetic variation may vary between native and propagated population types in *Helianthus maximiliani*. DNA was extracted from leaf tissue of native prairie populations and seedlings representing a selection from regional propagation mixes. Using Genotyping by Sequencing (GBS), we are evaluating genetic variation, inbreeding, and effective population size across population types. This data will provide fundamental knowledge of the distribution of genetic variation across native and propagated populations within a species key to restoration within one of the most globally-imperiled ecosystems worldwide.

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## Sydney Thielbar

ACCOUNTING

Adviser: Tim Peterson, Management and Marketing

### An Exploratory Study of Teacher as Servant: Good and Bad Learning Environments

In *The Servant as Leader* (1970), Robert Greenleaf discusses the abilities and qualities of a servant leader. In *Teacher as Servant*, Greenleaf elaborates on the idea of servant-leadership with a parable describing a university professor acting as a servant leader. Empirical studies have addressed the effect of managers who exhibit traits of servant-leaders on the workplace, but the effect of teachers as servant-leaders on students' learning experiences has not yet been addressed. This study addresses this gap in the research. The results show that teachers exhibiting the qualities of servant leaders turns into a better learning experience for students.

Keywords: Servant Leadership; Higher Education; Teaching

## Christian Tunheim and Conner Lynch

CIVIL AND ENVIRONMENTAL  
ENGINEERING

Adviser: Achintya Bezbaruah, Civil  
and Environmental Engineering

### Repurposed Styrofoam Lacquer and Adhesives

After considering several concepts for repurposed styrofoam products, we have decided to conduct further research into the possibility of using polystyrene foam to produce lacquers and adhesives.

It is well known that many types of solvents, namely petroleum-based solvents like gasoline and mineral spirits, work well for dissolving polystyrene foam. However, these solvents are volatile, non-sustainable, produce offensive odors, and are harmful to the environment. Therefore, we suggest that limonene, which also serves as a good polystyrene solvent, is a good alternative for our proposed application.

Limonene is naturally produced by several citrus plants, namely oranges. Orange peels can be soaked in ordinary water to extract the limonene contained within the peels. The orange peel and liquid mash can then be boiled, and the generated vapor can be distilled to produce a water and limonene mixture. Since limonene is less dense than water, the two liquids will separate out, and the limonene can be collected. This process is relatively simple, so limonene can be produced wherever the byproducts of citrus fruits are created. We believe that producers of orange juice and other citrus-based foods would provide a cheap and sustainable source of limonene that could be utilized in the production of our lacquer/adhesive product.

Using limonene as a solvent, we can dissolve used polystyrene foam to create a viscous liquid that hardens and becomes clear when left to dry in the open air. Through our preliminary research, we discovered that there has been some investigation into using this liquid as a lacquer finish for lumber products. Applications of using this liquid as lacquer include coating wood products for water and weatherproofing, applying decorative gloss finishes to wood, and possibly using the liquid as a colored wood stain if pigments can be added.

In addition to using this limonene / polystyrene liquid as a lacquer, we also investigated if this material could be used as an adhesive. Since the liquid hardens in the open air and dries clear, we believe that the liquid could be used as a glue or binder alternative in a number of applications. These could include use as a lumber binder for orientated strand board (OSB) sheeting, or as an adhesive used for holding together laminated and engineered wood products for decorative and structural applications. We have also considered that the liquid could be used as a glue for pipe fittings, based on how well it adheres to non-wooden materials.

Moving forward, we hope to perform some experiments to gain more knowledge about the feasibility of using styrofoam and limonene to produce lacquers and adhesives. We will research the feasibility of producing this product on a larger scale if our experiments produce promising results. Since used styrofoam and citrus peels are both waste products, we believe that a full scale method of production could be very cost effective since our raw materials are cheap.

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## Chrystian Ulrich

COMPUTER ENGINEERING

### Into the Depths: Game Concept

The concept for this particular game is to make a 2d puzzle that allows a shifting of perception into different 2d realms as the main premise. There are others, but that involves more minor mechanics. You can shift into the different dimensional views and get around obstacles that you would not be able to get around if you stayed in one dimension.

I have been thinking about dimensions for a while, and I have often wondered what it would be like to play a game that has more dimensions than we are currently used to. I thought this would be a good opportunity to work on getting more in tune with that idea.

I have future plans to expand from the 2d concept to 3d for visions, but since it is harder and I am just now learning a coding language, I thought it would be good to try doing it in a 2d world for now.

My goal is to gain a better understanding of the higher dimensions and perhaps make something that others would enjoy.

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## Kate Volk

BIOLOGICAL SCIENCES

Co-Investigators: Z. Yoko, J. Hamilton

Adviser: Jill Hamilton, Biological Sciences

### Can regional differences in physiological traits impact restoration success? The relationship between stomatal traits and water-use efficiency in Prairie Smoke (*Geum triflorum*)

Habitat and environmental heterogeneity contribute to fine-scale variation in adaptive traits across a species' range, which may influence seed transfer recommendations during restoration. Transfer of seeds across different environments influences plant fitness, particularly if introduced seed are poorly adapted to the site of restoration. Physiological traits that impact carbon uptake and water loss often exhibit strong regional differences, impacting plant fitness and consequently restoration success. In a common garden experiment, we investigated variation in stomatal traits (size, density, ratio, and area index) as well as carbon isotope composition (a proxy for intrinsic water-use efficiency, WUE) for seedlings of *Geum triflorum*, a perennial plant that exhibits a broad environmentally heterogeneous distribution. Seeds were sourced from populations spanning three distinct habitats: prairie, Great Lakes alvars, and Manitoba alvars. Compared to deep prairie soils, alvar habitats have a very thin layer of soil over limestone and are subjected to seasonal extremes in flooding and drought. Due to varying water availability, we predicted there would be strong differentiation in traits associated with water use across these regions. Prairie-sourced seedlings exhibited larger stomatal size, reduced stomatal density, and lower intrinsic WUE relative to alvar-sourced seed when grown in a common environment. This suggests that alvar populations have evolved a finer-scale control of water-use relative to prairie populations, reflecting adaptation to seasonal extremes. Our results demonstrate differences in physiological traits may evolve in seeds sourced from different environments, impacting potential restoration success. Fine-scale control of carbon uptake and water-loss are essential to plant persistence in varying environments and should, therefore, be considered in seed transfer recommendations.

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## Dylan Wald and Kimberly Whaley

MECHANICAL ENGINEERING

Adviser: Long Jiang, Mechanical Engineering

### Heat Flow Meter Apparatus Development

A heat flow meter apparatus is an instrument that can read the thermal conductivity of different materials. The purpose of this project is to develop an inexpensive, but accurate, heat flow meter which will be used to measure the thermal conductivity of newly developed materials. The heat flow meter apparatus is composed of a small heater, a hot plate, two sensors that measure both heat flux and temperature, and a cold plate. These components are all inside a thick foam shell to minimize environmental losses. A reference material was placed between the hot plate plus its sensor and the cold plate plus its sensor. The temperatures and voltages on both sides of the specimen were recorded in labview. These values were used to calculate a calibration constant which was found to have a precision within 1.2%. The calibration constant was then used to back calculate the thermal conductivity of the reference material, which was already known. This back calculation resulted in a thermal conductivity that was within a .0942% accuracy compared to the known thermal conductivity of the reference material. Future studies will verify that the device can accurately find the thermal conductivities of other known materials and of unknown materials.

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## Rikki Walter

BIOLOGICAL SCIENCES

Adviser: Kendra Greenlee, Biological Sciences

### Variation in Critical PO<sub>2</sub> and flight metabolic rate among castes in the bumble bee, *Bombus impatiens*

*Bombus impatiens* is a social bumble bee used in commercial pollination. In bumble bees, queens spend the winter in diapause, a state similar to hibernation, underground. Underground burrows may be a hypoxic (low oxygen) environment, which could be detrimental to bees. In *B. impatiens* worker bees, the tracheal respiratory system is positively correlated with body size. Queens, however, have tracheal systems that are much smaller than would be expected for their large body size. To determine how the size of their tracheal system affects their ability to tolerate low oxygen, we measured the critical PO<sub>2</sub>, which is the oxygen level below which the metabolism can be maintained. Queens were expected to be less tolerant to low oxygen when compared to workers because of their smaller than expected tracheal system volume. Bees were exposed to decreasing levels of oxygen via respirometry during rest, along with flight metabolic rate being measured at different oxygen levels. While at rest, queens and workers had significantly different critical PO<sub>2</sub> values, with workers being more tolerant. Critical PO<sub>2</sub> during flight did not differ between queens and workers. Together, these data suggest that the queens' small tracheal system volume may not negatively affect their ability to tolerate hypoxia. Knowing that bumble bees are tolerant of hypoxia may be of help in commercial storage, as has been done with other bee species.

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## Prajakta Warang

MICROBIOLOGICAL SCIENCES

Co-Investigators: S. Malekmohammadi, T. Bergholz

Adviser: Teresa Bergholz, Microbiological Sciences

### Investigating the role of ethanolamine utilization in growth of *Listeria monocytogenes* on ready-to-eat meats

The foodborne pathogen *Listeria monocytogenes* is of significant concern due to its high fatality rate. *L. monocytogenes* can cause a mild and non-invasive or severe and invasive infection called listeriosis. *L. monocytogenes* is commonly transmitted via ready-to-eat foods. If *L. monocytogenes* is present on these foods, it is capable of growing even during refrigerated storage. Gene expression data indicated that the ethanolamine utilization pathway was highly expressed during growth on a ready-to-eat meat product. We constructed a deletion mutant of *eutB*, encoding ethanolamine lyase. We are comparing growth of the parent strain and  $\Delta$ *eutB* on ready-to-eat meats to determine if ethanolamine utilization plays a significant role in the pathogen's ability to grow on these foods.

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## Sydney Yingling

BIOLOGICAL SCIENCES

Adviser: Nik Snyder, Biological Sciences

### Environmental Factors and Maternal Investment

Environmental factors impact the maternal investment animals provide their offspring. This in turn can alter offspring phenotype, growth, and ultimately offspring survival. We predict changes in maternal investments likely reflect the quality or physical attributes of the offspring birth or hatch environment. In this project we used a model system, Laughing gulls (*Leucophaeus atricilla*), to assess if changes in maternal investments (i.e. egg mass) and embryo phenotypes (i.e. morphometrics) reflected changes in weather (i.e. temperature, windspeed, and precipitation) during the Laughing gull breeding season. Laughing Gulls on the Maine Coastal Islands National Wildlife Refuge were monitored during nesting, incubated eggs collected, and embryos assessed. Weather data was downloaded from a weather station located on the island. Changes in maternal investments were compared to changes in weather across this single breeding season. We asked if rough weather conditions like heavy rainfall, increased wind, or extreme temperatures relative for the season would relate to changes we observed in maternal investments across the breeding season. We hypothesized poorer or more extreme conditions would lead to a reduction in overall egg mass and the resulting offspring would be smaller. This could be the result of the mother making predictions about impending weather events or receiving environmental stimuli and inducing premature egg laying. From our study, we aim to consider if changes in maternal environment can influence changes in offspring development and ultimately impact offspring survival rates.

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## Monica Zent

CHEMISTRY AND BIOCHEMISTRY

Adviser: Sangita Sinha, Chemistry and Biochemistry

### Expression and Purification of TAB3 CCD: An Autophagy Regulatory Protein

Autophagy is an intracellular degradation pathway responsible for collecting and degrading old and damaged proteins and organelles. Disruption in autophagy regulation is linked to cancer, neurodegenerative disease, and inflammation. Before therapeutics can be developed to combat the disruption in autophagy regulation causing these various diseases, the protein interactions within the signaling pathway must be thoroughly understood. To contribute to this understanding, this project focuses on characterizing the autophagy regulatory protein TAB3 and its interactions with Beclin1. Beclin1 is a key autophagy protein and has been identified as a signaling hub that is known to bind to numerous autophagy related proteins. TAB3 and Beclin1 are thought to interact through their coiled-coil domains (CCDs), and this interaction prevents the induction of autophagy during times of low cellular stress. When autophagy is up regulated, TAB3 and Beclin1 dissociate by an unknown mechanism. This project aims to characterize the TAB3 CCD and Beclin1 CCD interaction.

In the first stage of this project, the MBP TAB3 CCD fusion protein was expressed and purified. The MBP TAB3 CCD protein was expressed in an *E. coli* overexpression system. The TAB3 CCD protein was further purified using affinity, cation exchange, and size exclusion chromatography techniques. The TAB3 CCD protein has been successfully purified. Next steps in the project include investigating TAB3 CCD and Beclin1 CCD interactions with an affinity pulldown assay and isothermal titration calorimetry experiments. Structural details of the TAB3 and Beclin1 interaction will also be determined using x-ray crystallography.



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