



2015 Annual Meeting

Montana Academy of Sciences

Student Union, Montana Tech, April 10-11, 2015

Abstracts for Oral Presentations

Composition Operators on Weighted Bergman and S^p Spaces

Waleed Al-Rawashdeh

Montana Tech

Let φ be an analytic self-map of open unit disk \mathbb{D} . The operator given by $(C_{\varphi}f)(z) = f(\varphi(z))$, for $z \in \mathbb{D}$ and f analytic on \mathbb{D} is called composition operator. For each $p \geq 1$, let S^p be the space of analytic functions on \mathbb{D} whose derivatives belong to the Hardy space H^p . For $\alpha > -1$ and $p > 0$ the weighted Bergman space A_{α}^p consists of all analytic functions in $L^p(\mathbb{D}, dA_{\alpha})$, where dA_{α} is the normalized weighted area measure. In this presentation, we characterize boundedness and compactness of composition operators act between weighted Bergman A_{α}^p and S^q spaces, $1 \leq p, q < \infty$. Moreover, we give a lower bound for the essential norm of composition operator from A_{α}^p into S^q spaces, $1 \leq p \leq q$.

Identification of heavy metal hyper-accumulating fauna in the Butte Montana region through the use of ICP analysis

Olivia Cogull

Montana Tech-Undergraduate Research Program

In many parts of the country human activity has contaminated soils through mining operations. One of the major contaminates from mining are heavy metals like Lead, Cadmium, Copper, and Zinc in

concentrations that exceed safe human exposure. Consequently, remediation of the contaminated soil is now needed in these areas. Remediation of contaminated soils can be expensive, labor intensive, and disruptive to the native habitat. Phytoremediation is a method of remediating soils by the use of plants that accumulate high levels of contaminants from the soil into the plant's tissue. Plants that are used for the removal of soil contaminants are known as hyper-accumulators; meaning plants that can accumulate metal levels exceeding that of the soil in which they reside. Ideally native plants are to be used in the phytoremediation to reduce the risk of introducing invasive species to the area. The list of known hyper-accumulators native to Montana, or accumulators that can grow in Montana, specifically the Butte-Silver Bow area is limited. Research was done on tissue samples collected from plants growing in the un-reclaimed Butte Priority Operative Soil Unit (BPOSU) that were analyzed by means of inductively coupled plasma mass spectrometry (ICP-MS) for the levels of heavy metals in the tissue, so the plant may be determined a hyper-accumulator or not. Parameter tests included analyzing the soil at the location of the each plant, and site evaluation of the plants location.

Determining Nitrate and Phosphate Levels in Blacktail Creek

Garrett Craig

Montana Tech- Undergraduate Research Program

Nitrates (NO_3^-) are nitrogen-oxygen chemical units which combine with various organic and inorganic compounds that are commonly used in fertilizers. Phosphates (PO_4^{3-}) are inorganic chemicals that are important in biochemistry and ecology. In small quantities, both nitrates and phosphates are essential for the health of aquatic ecosystem. However, even a small increase in either nutrient can lead to an accelerated plant growth, algae blooms, low dissolved oxygen, and the death of certain fish, invertebrates, and other aquatic animals.

Blacktail Creek in Butte has previously had high levels on contaminants, including the nitrates and phosphates that were evaluated. Blacktail Creek is approximately nine miles long and empties into Silver Bow Creek west of Butte. The sampling plan included an approximately 1.5 mile reach along Blacktail Creek's most contaminated section, with eight sites being analyzed. During field sampling, grab samples and water flow data were taken to obtain concentrations and to calculate Total Maximum Daily Loads for the nutrients of interest. The data was compared to previous analyzed data, and similar conclusions were reached. The majority of the sites had elevated nitrate and phosphate loading, with the phosphates being the most highly elevated contaminant. The lower four sites on the sampling reach had the highest nutrient loading levels, and all four of these sites have the similarity in being located below the mouth of Grove Gulch that flows into Blacktail Creek. This finding supports the conclusion that the Grove Gulch inlet contributes a significant level of nutrient loading to Blacktail Creek.

Analysis of Urban Humans and their Spatial Allowance for Predators

Theodore Darnell

Montana Tech-Undergraduate Research Program

This research addresses varying degrees of social tolerance to wildlife within the urban environment. Rapid growth of the urban environment is thought to create new interactions between humans and wildlife. These new interactions are made unique by the modern urbanite's perspective of wildlife. In the summer of 2013, the occurrence of a mountain lion (*Puma concolor*) in a Butte, Montana neighborhood incited a variety of comments regarding public opinion of urban-wildlife. Research and wildlife managers suggest that to develop a strong, effective urban wildlife management strategy we must first have a comprehensive understanding of the local urbanites' disposition towards urban wildlife (Patterson, Montag, & Williams, 2003). A survey was developed using the tripartite model of attitude assessment to measure Butte residents' attitude towards urban -wildlife. The tripartite model assumes that an attitude is equally influenced by three factors, cognitive, behavioral, and affective. The survey asked respondents questions alluding to their wildlife-education, experiences, and past behaviors. Respondents were then scored according to the amount of influential factors involved in developing their attitude towards urban-wildlife. Respondents were also asked to rank wildlife based on the amount of tolerance afforded to an individual species within an urban setting. The respondents' attitude score was compared with their urban-wildlife tolerance ratings. This research suggests that the cognitive and behavioral attitude influences have the largest bearing on a Butte resident's attitude toward urban-wildlife.

Examining Antibody to Sin Nombre Virus in Rodents Associated with Peridomestic Habitats in North East Montana.

Paul Engstrom

Montana Tech-Undergraduate Research Program

Hantaviruses are rodent-borne pathogens that produce chronic persistent infections in their reservoir hosts. Sin Nombre virus (SNV) is a type of hantavirus carried by deer mice (*Peromyscus maniculatus*). Infected deer mice shed virus in urine, saliva, or feces, and human contact with the virus can lead to a serious illness called hantavirus cardiopulmonary syndrome. Most studies examining SNV in the rodent host have been conducted in natural settings where human contact with the virus is unlikely. This study, performed in a peridomestic setting (in and around buildings), where contact with the virus is more likely, adds data to a previous study in west central Montana. Mice were live trapped for 3 consecutive nights every two weeks from May to August 2014, at 2 sites in NE Montana. Captured individuals were ear tagged, and species, body mass, sex, reproductive condition, presence of scars or wounds, and location of capture were recorded into a field journal. Blood samples were collected from the retro-orbital sinus of each captured animal. These blood samples were frozen until they could be analyzed. Blood samples were analyzed for antibodies (IgM) to SNV. Deer mice were the most common species captured at both study sites and antibody positive deer mice were detected at both study sites. Antibody prevalence was found to be variable both spatially and temporally with highest prevalence in the middle of the summer.

Design and Development of Large Scale Data Collection for Eyes Free Text Entry

Vernon Foley

Montana Tech-Undergraduate Research Program

Entering text on a touchscreen is challenging when users are unable to receive visual feedback due to their situation or disability. We are working on a recognition-based approach that attempts to infer the user's intended text from a sequence of noisy tap data. We need to gather large amounts of such eyes-free data to develop and test our recognizer. We first interviewed users in the low vision and blind community to explore the best ways to engage users in our data collection effort. With the information gathered in the interviews, we are developing a cross-platform data collection interface that will enable us to reach a large population of users who are visually-impaired. We will describe our current progress in the development of our eyes-free data collector.

Chronic Fatigue Syndrome: A study of Southwestern Montana Health Care Providers Diagnosis Criteria and the Treatment Plan.

Reece Gendreau

Montana Tech-Undergraduate Research Program

This study is a way to qualitatively gauge the knowledge of Southwestern Montana Health Care Providers in regards to Chronic Fatigue Syndrome. CFS is "a debilitating and complex disorder characterized by profound fatigue that is not improved by bed rest and may be worsened by physical or mental activity" (CDC 2015). Additionally this study is used to better understand what diagnosis criteria is being used to determine and differentiate this difficult and controversial syndrome, and also the treatments which are being used to help in the healing process of patients suffering from CFS. This study will discuss the common practices in use in the Southwestern Montana region.

An Investigation of the Common Loon, (*Gavia immer*), on Spencer Lake and Blanchard Lake, Montana: Identifying Populations of Banded and Non-Banded Birds of the Common Loon.

Spencer Hale

Montana Tech- Undergraduate Research Program

Common Loon (*Gavia immer*) studies were conducted between May and August, 2014 at known loon territories in the Whitefish, Montana area. Data were collected on nesting pairs at Spencer

Lake and Blanchard Lake, both of which are a few miles of Whitefish. Loon pairs were observed and behaviors recorded as well as leg-band identifications, foraging habits, territorial behaviors, chick stages, and nesting success. The study covered 46 hours of observational study. Based on prior data provided by the Montana Common Loon Working Group and the Flathead National Forest Service, it is possible to identify pairs that are returning to the same locations and remaining with the same breeding pair. This summer research provided valuable data including identification of nesting pairs on both Blanchard and Spencer Lake, adult band data from both of these lakes, and both lakes had chick hatch dates allowing for a comparison between both lakes of study noting their differences as possible causes for differing nest success and hatch dates between Spencer Lake and Blanchard Lake.

Metabolites, Metabolic Hormones, and Hematological Profiles in Mountain Goats (*Oreamnos americanus*) before the Breeding Season and during the First Trimester of Pregnancy

M. R. Herrygers¹, R. Garrott², C. Butler², J. G. Berardinelli¹

¹Dept. of Animal and Range Sciences, ²Dept. of Ecology, Montana State University, Bozeman, MT, USA,

Objectives were to evaluate the relationships among energy-related metabolites, hormones, and hematological variables in mountain goats (MG) before the breeding season and during the 1st trimester of pregnancy. Does were from herds in the Palisades (PAL) and NE Yellowstone (NEY) areas. Samples were collected from July to Aug. (before breeding season) and mid-Jan. (1st trimester of pregnancy). Sera was assayed for insulin (I), thyroxine (T4), triiodothyronine (T3), b-OH-butyrate (bOHB), blood urea nitrogen (BUN), and total protein (TP). Concentrations of TP did not differ ($P > 0.05$) between pregnant (P) and non-breeding season (NB) does. bOHB, I, BUN, and T3 concentrations, and the T3:T4 ratios were greater ($P < 0.05$) in NB does than in P does. Whereas, T4 concentrations were greater ($P < 0.05$) in P does than in NB does. Obviously, NB does have a different profiles of metabolites, metabolic hormones and select hematological variables compared to P does. In conclusion, these differences may be related to P does utilizing and partitioning nutrients to support placental and fetal growth and development. These differences may also be related to the effect of season, since there were no non-pregnant does were sampled in Jan. Another factor that may be important for interpretation of these differences is location. All NB does were sampled in the PAL, while all P does were sampled in the NEY.

BH3I-1 derivatives inhibit the filamentous growth of the CEA10 strain of *Aspergillus fumigatus*

Rochelle Johnson, Joy Goffena, David K. Butler, Kurt A. Toenjes

Montana State University-Billings, Billings, MT.

Recent and exciting advances in medical therapies for cancer and organ failures have greatly extended the life span of afflicted patients. However, these therapies often place the patient at risk for potentially lethal fungal infections. As the number of immunocompromised patients continues to rise, there has been an increase in associated opportunistic fungal infections. Treatment options for invasive mycoses caused by *Candida albicans* and *Aspergillus fumigatus* are surprisingly limited. *A. fumigatus* is the most common *Aspergillus* species associated with invasive pulmonary aspergillosis, accounting for over 60% of cases. *Aspergillus* grows as a filamentous mold with true hyphae originating from the germination of asexual conidia. *A. fumigatus* is not a dimorphic fungus as is the case with *C. albicans*, however, as both grow in hyphal form it seems possible that small molecules that inhibit the transition of *C. albicans* budded cells to hyphal growth (often referred to as the germination of blastoconidia) may also inhibit the germination of *Aspergillus* conidia. We tested BH3I-1 and derivatives against *A. fumigatus* strain CEA10 in YPD media. BH3I-1 and five of the derivatives inhibited at a 200 μ M concentration based on general observation via microscopy as well as eleven showing promising inhibition at possible different concentrations. Out of these inhibiting molecules, seven also shown inhibition within the prior *C. albicans* assay. We are currently employing a micro-plate reader to obtain quantitative levels of inhibition with increasing concentrations of molecule. Molecule 54 at the 300 μ M concentration showed similar inhibition to that of BH3I-1 at the same concentration.

Developing Reproducible Antibacterial Surfaces Using Thermal Imprint Technology

Emily Kooistra-Manning

Montana Tech- Undergraduate Research Program

Staphylococcus aureus is a naturally occurring bacterium carried in human respiratory systems and on skin. Dangerous *Staphylococcus*-infections in hospitals are of specific concern due to the high traffic and open wounds that exist in such facilities. One way these facilities can prevent on-site contraction of *Staphylococcus*-infections is through rigorous disinfection of surfaces exposed to human contact. While disinfection with cleaning solutions can be effective, this method provides only a temporary solution. In contrast to temporary disinfection of surfaces, another approach may be to prevent the spread of *Staphylococcus*-infections by engineering surfaces that are inherently antibacterial. Physicochemical properties of bacteria and the surfaces on which they live can influence bacterial adhesion to a surface. Recently, studies have been conducted which examine the effect of nanoscale features on biological specimens. Researchers have found that particular patterns naturally dissuade bacteria from attaching to and contaminating surfaces.

To build on this research, further work to create a reliable, cost-efficient, and reproducible antibacterial surface is needed. In this project, potentially antibacterial surfaces will be developed using thermal imprinting. A non-pathogenic form of *Staphylococcus aureus* will be used as a model *Staphylococcus* organism to test and quantify bacterial health on such surfaces. Although medical facilities present an obvious market for such surfaces, these patterning techniques can be used on other surfaces such as door knobs and toilet seats. Because of the inexpensive fabrication methods

and materials, this research could lead to antibacterial surfaces being made readily available to populations no matter their socioeconomic backgrounds.

Indigenous community impacts of large corporations in Arctic communities: specific focus on social justice and sustainability for the Swedish Sami.

Jon-Eric Krans, Sonja H. Bickford, and Nate Bickford

University of Great Falls, Great Falls, Montana, USA

In recent decades more global attention has focused on the Arctic. This can be seen in the both the development of industries as well as the expansion of the Arctic Council's membership. Countries with at least some part located above the Arctic Circle are; Norway, Greenland, Canada, United States, Russia, Finland, and Sweden. The focus on the indigenous people, specifically the Sami of Sweden, presents a good case for assessing impacts of development on northern, Arctic, communities. Population density in Sweden is recorded as 21.4 people per square kilometer, with a higher population density in southern Sweden. The majority of the Sami people live in small to medium-sized communities, in remote regions, resulting in a disconnect with the modern world. One industry that is already present in the Swedish Arctic is mining, especially for ore and carbon. However, now other industries, including multinational enterprises (MNE's), such as Facebook, which recently built a new five acre data center near the Arctic Circle, are beginning to realize the opportunities the Arctic region and its environment have to offer. The question of how sustainable business can be conducted in the Arctic will be answered by analyzing the impacts on the Sami communities and how people react and should react to these changes within their communities. This study analyzed current events through literature review and interviews of representatives from the impacted Arctic regions. The increased development has resulted in both negative and positive impacts such as reduction of land use, but increased employment opportunities.

Preparation for Using Fiber Optic Cables to Monitor Distributed Strain and Temperature Profiles in an Underground Mine Setting

Hannah Kuchinsky

Montana Tech-Undergraduate Research Program

Early detection of rock movement signaling imminent underground space or pit wall collapse in mines has the potential to prevent loss of life and serious injuries from mine disasters. Unlike most traditional instrumentation that provides data at a single point, fiber optic cables can be deployed in a network that allows continuous monitoring of distributed profiles of ground movement and temperature variations.

Researchers at Montana Tech and UW-Madison are collaborating to demonstrate that this fiber optic-based Distributed Strain and Temperature (DST) technology can be employed in an

underground mine to reliably and accurately detect ground deformation of different characters, and fluctuating temperature profiles. The focus of the research is a field experiment that will be conducted at Montana Tech's Underground Mining Education Center (UMEC). In order to demonstrate the field performance of the technology under a variety of conditions, strain-sensing cables will be attached to the rock faces with grout and epoxy, and grouted into boreholes, and a temperature-sensing cable will be submerged to significant depths in two flooded shafts, allowing continuous monitoring of the water in the shafts and the air in the drift between. Data will be compared to that collected using traditional geotechnical instrumentation and to predictions made using numerical models. Laboratory experiments and tests will be conducted to support the field deployment and modeling aspects.

This presentation summarizes the preliminary work done to support the field deployment, focusing on preparation/calibration of the cables, design and implementation of the laboratory experiments, and development of the field instrumentation plans.

Using Click Chemistry to Modulate the Aggregation of the Parkinson's Disease Protein

Tyann Kuehn

Montana Tech-Undergraduate Research Program

Parkinson's disease (PD) is a neurodegenerative disorder characterized by the presence of protein aggregates called Lewy bodies. These plaques are primarily composed of oligomers of the protein α -synuclein (α S), which is a small protein of 140 amino acids that is natively unfolded, however the folding of this protein has been found to be accelerated in the presence of metal ions, particularly copper. One ideology that has been used for therapeutic removal of endogenous metal ions is chelation therapy. Click chemistry, or the Copper-Catalyzed Azide-Alkyne Cycloaddition (CuAAC), involves the reaction of an alkyne and an azide, resulting in the formation of a 1,2,3-substituted triazole. This reaction is well known for being extremely versatile, accommodating a wide variety of functionalized alkynes and azides. Recently, click chemistry was used to successfully generate a copper chelator in situ where copper ions within protein deposits acted as both the catalyst and target of the reaction. We are looking to extend this ideology to PD therapy, by preparing a small library of click reagents that will be selectively activated in the Cu-containing aggregates of α S. Following the click reaction, the newly formed products will act as a Cu-chelator, removing the Cu from the protein thus aiding in the degradation of the Lewy bodies.

Seasonal Differences in hantavirus prevalence in deer mice captured in ranch buildings in southwestern Montana

Richard McEwen

Montana Tech- Undergraduate Research Program

Hantaviruses are widespread emergent zoonotic agents that cause unapparent or limited disease in their rodent hosts, yet cause acute, often fatal pulmonary or renal infections in humans (Bagamian et al., 2013). In the United States one rodent species, the deer mice (*Peromyscus maniculatus*) are the principal host of Sin Nombre virus (SNV), which causes Hantavirus Pulmonary Syndrome (Childs et al. 1994, Nichol et al. 1993). Mice spread the virus to each other when they come in direct contact. Males spread the disease more because they are more aggressive and bite each other when they fight (Bagamian et al. 2013). A previous study (Kuenzi et al. 2001) has shown that mice that live inside of ranch buildings in western Montana have a higher prevalence of antibodies to SNV than outside populations. This study also found that male mice were more likely to be infected than female mice.

A similar study was conducted in southwestern Montana testing seasonal effects instead of location. Knowing that indoor mice have higher antibody prevalence to SNV, mice were trapped in two ranch buildings during the summer and fall to examine seasonal differences in SNV prevalence in these populations.

Isolation of essential oils from Indigenous Montana flora and their antimicrobial effectiveness as a non-toxic sterilizing reagent against bacteria that cause food borne illness.

Samantha Miner

Montana Tech- Undergraduate Research Program

Bacterial resistance and the negative effects of chemicals used to kill them have become a growing worldwide public health concern. The widespread use of antibiotics in medicine and Animal husbandry have caused bacteria adaptation to antibiotics. New drug discovery has become vital in fighting the war against drug-resistant bacteria such as *Escherichia coli*, *Staphylococcus aureus*, and *Salmonella epidermis*, which have posed considerable medical problems. Essential oils are a safe, generally non-toxic and relatively inexpensive alternative to synthetic chemical based antibiotics. Essential oils hydro-distilled from indigenous Montana flora will be explored for their antimicrobial effectiveness as a non-toxic sterilizing reagent against bacteria. We hypothesis that the oils of *Lomatium dissectum*, *Arctostaphylos uva-ursi* (L.), *Chimaphila umbellata* (L.), *W. Bart Prunella vulgaris* L , *Artemisia dracuncululus* L, *Spreng Medicago lupulina* L., and *Balsamorhiza sagittata* will have significant anti-bacterial properties and variability that works to reduce bacterium's resistance.

Use of Fiber Optic Cables to Monitor Strain and Temperature in a Borehole, and Temperature Profile in a Flooded Shaft

Kaitlyn O'Connell

Montana Tech-Undergraduate Research Program

Researchers at Montana Tech are investigating the use of fiber optic cables for distributed monitoring of ground movement and temperature profiles. The highlights of Montana Tech's research with this Distributed Strain and Temperature (DST) sensing technology are:

- Deployment of special strain-sensing cable in a 300' deep borehole at a nearby mine in January, 2013. The cable was installed along with traditional inclinometer and time domain reflectometry (TDR) instrumentation to allow direct comparison of these technologies. Monitoring scans conducted after installation show that the fiber optic system detected ground deformation more than a month earlier than the inclinometer (the TDR data were inconclusive) and provided a more definitive determination of the depth of the movement, suggesting that its sensitivity and precision are higher than those of the other types of instrumentation.
- More recent deployment (fall 2013/winter 2014) of two cables to depths of 20' and 300' in a flooded shaft in Montana Tech's Underground Mining Education Center. Periodic monitoring of the water temperature profiles suggests fluctuations down to a depth of about 200' that could be seasonal, and/or could be related to the geothermal heat exchanger present in the shaft. Also, differences in the readings made using the two cables suggest that they do not provide the same data accuracy.

Although preliminary inspection of the data from these two field experiments provided some insight, a thorough analysis was not performed. This presentation will summarize the field deployment and data collection activities, along with interpretations based on comprehensive data analysis.

Evaluation of Differences in Body Composition and Carcass Characteristics in Lambs Divergent in Residual Feed Intake

K.A. Perz, M.R. Whitmore, A.F. Williams, A.R. Hicks-Lynch, M. R. Herrygers, J.A. Boles, J.G. Berardinelli, and J.M. Thomson

Department of Animal and Range Sciences, Montana State University, Bozeman MT 59717

The objective of this study was to evaluate differences in growth performance, carcass characteristics and quality, and body composition in lambs selected for divergent residual feed intake (RFI). Mixed-breed 4-mo-old wether lambs (n = 65) were placed on a 47 d feeding trial in September, 2014 to obtain an estimate of individual intake. Residual feed intake, an efficiency measurement based upon the difference in actual and expected feed intake, was calculated for each lamb. Wethers with an RFI of one standard deviation greater (HIGH; less efficient; n = 6) or lower (LOW; more efficient; n = 6) than the mean RFI (approximately 0) of the 65 wethers were used in the present study. Lambs were processed, and organ weights and carcass data were collected in December, 2014. Performance measures were not affected ($P > 0.05$) by RFI class. Back fat thickness (BF) and yield grade (YG) were greater ($P < 0.03$) in HIGH lamb carcasses, while rumen weight ($P < 0.005$), total GIT and viscera weights ($P < 0.03$), and lung and trachea weights ($P < 0.03$) were greater in LOW lamb carcasses. Regression of lung weight on hot carcass weight (HCW)

indicated that lighter carcasses had heavier lungs ($P < 0.02$, $R^2=0.45$); this relationship was observed in both RFI classes (HIGH: $P < 0.04$; $R^2 = 0.68$; LOW: $P < 0.04$; $R^2 = 0.68$). In growing lambs, selection for RFI seems to affect fat deposition and visceral organ weights, although more research is necessary to understand the relationship between lung weight, RFI, and HCW.

Analysis of craniofacial skeletal and soft tissue anatomy of the eye in relation to reduced visual acuity in humans.

Sarah Queer

Montana Tech- Undergraduate Research Program

Despite nearly 100 years of research, the etiology of juvenile-onset myopia is still unknown. However, given that millions of years of brain expansion and reduced facial prognathism have brought the frontal lobes to rest directly above the eyes, while the face has become situated directly beneath them, it is likely that these adjacent craniofacial characteristics are associated with functional constraints of the visual system. As a result, this study examined to what extent the myopic eye is associated with circumscribing hard and soft tissues of the skull.

This was carried out using magnetic resonance images and associated de-identified clinical data for 112 subjects. Linear and volumetric measurements of the eye, orbit, and craniofacial anatomy were obtained using AMIRA, and linear regression analysis and ANOVA were used to test for relationships between variables, and differences among vision groups.

Results showed that increased eye ($F = 2.93$, $p = 0.05$), orbital ($F = 7.28$, $p = 0.00$), and to a lesser extent ocular fat volumes ($F = 2.26$, $p = 0.109$), were associated with reduced visual acuity across the study sample. A larger eye relative to orbital volume was also associated with diminished vision ($F = 2.55$, $p = 0.083$) though at slightly above $\alpha = 0.05$. However, this relationship became statistically significant ($F = 3.13$, $p = 0.048$) when ocular fat was also considered (eye/fat+orbit). Outside of these eye, ocular fat, and orbital relationships, no other skeletal trait of the face or cranium were found to be associated with visual acuity.

Utilization of Electrospinning Technique to Decorate Nanofibers for Biomedical Applications

Heidi Reid

Montana Tech- Undergraduate Research Program

Hydroxyapatite has long been recognized for its biocompatible properties. Because a modified form of this substance is found in up to 80% of human bone, the human immune system does not recognize it as foreign and therefore does not initiate an immune system attack. Hydroxyapatite has been used as scaffolding for bone repair, as well as for coating metallic implants. Additionally, hydroxyapatite has the ability to promote bone growth without dissolving in the human system.

This substance presents great potential for treatment and repair applications in a physiological system.

Although hydroxyapatite has been demonstrated to have great biological applications, these applications all require a substrate for administration. Electrospinning technique provides technology for creating such a substrate. Electrospinning has been used to create drug delivery systems and scaffolds for tissue regeneration. The electrospinner manufactures tiny nano- or micro-sized fibers and when these nanofibers are layered, a thick nanofiber mesh results. This nanofiber mesh provides a surface for hydroxyapatite nanoparticle attachment.

In addition to electrospinning technique, the electrospinner also has the capabilities to “electrospray,” or to create individual nanoparticles laid down on a metal collector plate. In my research, I intend to electrospin a fiber mesh, and then use electrospraying to decorate the mesh with iron-doped hydroxyapatite nanoparticles. This endeavor involves the development and characterization of fabrication techniques for biomedical applications.

The Fantastic and The Modern Experience

Quincy Riordan

Montana Tech- Undergraduate Research Program

The genre of Fantastic literature deals with intersections of the natural and supernatural worlds. The fantastic experience is one of doubt, felt both by reader and protagonists as they attempt to reconcile a possible supernatural occurrence with the rules of the natural world. Cocteau’s *Les Enfants Terribles*, examines the fantastic’s role in the divide between childhood and adulthood, in which the fantastic and the natural worlds become the spheres of childhood and adulthood, respectively. Creative play allows children to fully experience the fantastic. However, the fantastic, like childhood, is fleeting and attempts to maintain it result in ostracism; the fantastic violates the accepted norms of the natural adult world. This research broadened the scope of research on the fantastic as a genre. Theories of the fantastic have been applied to literary texts written in the late 18th and 19th century, but have not been previously applied to modern texts, which go beyond the conventional fantastic experiences detailed in the works of Tzvetan Todorov and Rosemary Jackson. Todorov’s definition of the fantastic classifies fantastic experiences themselves as brief, while Jackson’s list of recurrent fantastic themes are best suited to works written before the establishment of the prevailing scientific paradigm. Modern literary perspective is rooted in psychological explanations for what was previously classified as fantastic. In modern literature, the fantastic’s place as the divide between the “marvelous” and the “uncanny” is unsustainable and must be redefined so that modern fantastic experiences may occupy the spaces between freewheeling creativity and abnormal psychology.

Blogging and Tweeting About Teaching: Teachers' Perceptions of Informal Online Professional Networks

H. Smith Risser¹ and SueAnn Bottoms²

¹Montana Tech of the University of Montana, Butte, MT; ²Oregon State University, Corvallis, OR

This is a case study of teachers that use blogs and/or Twitter to connect with other teachers online. This purpose of the study was to examine the perceived benefits of teachers who use blogs and/or Twitter to connect with other teachers. Social media has the potential to create a connected network of professional colleagues beyond the constraints of face-to-face meetings. In this study bloggers were contacted and interviewed in regards to the benefits to participating in online interactions. Interview data were analyzed to determine perceptions about the benefits of blogging and/or Twittering. Preliminary analysis suggests that participants identified of potential benefits such as one that creates some emotional distance that it is more convenient to interact on their own time schedule, and that they are able to learn from these interactions. The results of the study indicate that online networks can help to overcome many barriers that prevent teachers from interacting face-to-face. Although these networks may not fit into traditional professional development schema, it is clear that teachers feel that they benefit professionally from their participation in these professional networks. However, the type of interactions that participants preferred (e.g. Skype, Twitter, blogs) were influenced by the specific barriers faced by the participant in building their face-to-face professional network.

Touchless Thermal Respiratory Monitor

Jonathan Schulz, Robin Hallett

Montana Tech- Undergraduate Research Program

The ability to track a person's respiratory rate is a vital technology that has applications in medical procedures, sleep studies, and patient monitoring. Safety devices used to track breathing today, however, often require the use of wires and sensors that can create obvious restrictions in the patient's motion, ability to maneuver, or even sleep. The long-term objective of this research project is to build a system that can monitor breathing without coming into contact with the patient. The Touchless Respiratory Thermal Monitor will be built using a 1 pixel thermal sensor, 3-D printed parts, and a laser. The thermal sensor will be programmed to simply read temperature. In a later project improvements will be made to look for a temperature differential between the air that has been exhaled by the patient and the room temperature while the laser allows for proper alignment on the upper lip of the subject. A lack of this temperature difference would indicate that the patient has stopped breathing. Though the design is rather simple, complications are expected on replicating the respiratory pattern of a human. This design will incorporate a 3-D printed mouth and nose attached to a ventilator, a flow rate monitor, and a temperature-controlled bucket of water kept at 100°F. This will be compared to a human's respiratory pattern to ensure proper replication.

Life history traits of solitary bees as mediators of responses to climate-warming: phenological shifts, body size, and life span

Anthony Slominski

Department of Ecology and Environmental Science, Montana State University, Bozeman, MT

Climate change threatens pollinators and plants due to temperature-sensitive species traits that affect pollinator-plant interactions. For example, climate-warming is causing shifts in seasonal pollinator activity and flowering periods (i.e. phenologies) that are species-specific in magnitude and direction, which has uncoupled pollinator-plant interactions. Additionally, environmental temperature during development may affect pollinator body size and life span, with implications for pollinator-plant interactions and pollinator fecundity. Species-specific responses to climate-warming indicate that certain pollinator and plant species may be more vulnerable to the negative effects of climate-warming than others. The goal of this study was to help pinpoint species of concern by experimentally determining the role of solitary bee overwintering life stage (adult vs. prepupae) as a mediator of responses to climate-warming. Using multiple bee species and temperature-controlled chambers, I subjected bees to eight manipulations, i.e. factorial combinations of two temperatures (warm vs. cool) and two durations of fall and winter (i.e. short and long). Bee emergence date, weight (before and after manipulations), and longevity following emergence were recorded. Results suggest that increased temperature may cause bees that overwinter as prepupae to advance their phenology more than bees that overwinter as adults, while bees that overwinter as adults showed a greater reduction in body size and life span compared to bees that overwinter as prepupae. These results indicate the potential for overwintering life stage to mediate bee responses to climate-warming and suggests that certain species may be more prone to either phenological responses or altered body size and life span.

Knee Joint Prosthesis: Mechanical Properties Evaluation of a Titanium Based Biomedical Alloy

Luke Suttey

Montana Tech- Undergraduate Research Program

Although the technology behind biomedical implantations has grown vastly in the past few years many complications still exist. One of the most difficult of these complications to overcome is the difference in the mechanical properties of human bone and of current prosthetic implants. The research completed in this study investigated the change in mechanical properties, induced via heat treatment, of Ti-6Al-2Sn-4Zr-2Mo (Ti-6-2-4-2); a titanium based alloy containing: 6% aluminum, 2% tin, 4% zirconium, and 2% molybdenum. Ti-6-2-4-2 is a near alpha titanium alloy containing both alpha and beta phase stabilizers. These phase stabilizers allow for the formation of the material in two different crystal structures. The ratio of the crystal structures present in the final

material induces a variety of changes in the mechanical properties of the material. A various range of heat treatments was carried out as to effect the amount of alpha and beta phase present in the material, and the tensile strength and microstructure of the material was then examined. From these two pieces of data many mechanical properties can be investigated and explained. Experimental research such this provides important preliminary information about the tested alloy's usefulness in the field of biomedical implantations.

Concurrency in a Real-Time Multi-User Simulation

Steve Wilson

Montana Tech- Undergraduate Research Program

Current methods of Real-Time simulation involving multiple users are non-scalable, difficult to develop, difficult to maintain, and expensive. Concurrent computer usage is exploding. The ability to edit documents, 3D models, and interact with multi-user simulations by users who are remote from one another is an emerging technology. Current techniques do not scale well and require a large infrastructure investment. This research addressed issues in which existing infrastructure of the clients' PCs can be leveraged to the computational demands of distributed interaction. In this research, I investigated the feasibility, of a thin server – peer client architecture for real-time multi-user simulation. This project involved a number of issues in simulating a shared environment on multiple computers, with multiple users in real-time. These issues included: latency, synchronization of state, events, clients coming into or leaving the simulation, security, and privacy. Solutions for data conflict resolution that were investigated included distributed state verification (peer voting) and master-client (one or more clients are designated as arbiters of truth).

Macroinvertebrate Community Assemblage from Canyon Ferry to Great Falls Along the Missouri River

Marilyn E. Wright, Nate Bickford.

Biological Sciences Department, The University of Great Falls, Great Falls, MT.

The Missouri River represents a major resource for the state of Montana, both environmentally and economically. Understanding macroinvertebrate community assemblage provides insight into food web structure, helping to construct a biological foundation from which water quality can be monitored now and in the future. A comprehensive description of macroinvertebrate assemblage between Canyon Ferry Dam and the mouth of the Sun River near Great Falls also serves as a marker for comparison of biologically similar reaches. In order to examine macroinvertebrate community structure between these locations, we used samples previously collected by Montana Fish, Wildlife, and Parks for a walleye larval study. After fish larvae were removed from samples, we sorted the macroinvertebrates as well as casings from debris and daphnia. Debris and daphnia were dried and weighed to obtain a comparative biomass, and macroinvertebrates were sorted and identified

to the lowest taxonomic level (order or family, species dependent). They were also sorted into functional feeding groups for further analysis of community structure between these locations. Daphniidae were determined to be predominant in Canyon Ferry, Hauser, and Holter samples, while Ephemerellidae and Baetidae were also very common across all sample locations.