

College of Science and Engineering



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Student Research
Poster Symposium

April 18, 2025
1:00 – 3:00 PM
Farris Center
Gymnasium

Welcome from the Dean College of Science and Engineering

Welcome to the inaugural College of Science and Engineering Student Research Symposium, which inherits the mantle of the symposia held over the 30-year life-cycle of the College of Natural Science and Mathematics.

Today you will see some of the research that is being undertaken by students in the college. This year we have research from many fields – there are 54 posters involving 79 students, mentored by 39 different faculty members. We encourage you to drop by the Farris Center Gymnasium to join us in celebrating the accomplishments of our students.

I look forward to seeing you there.

Cordially,

Stephen R. Addison

Stephen R. Addison, Dean
College of Science and Engineering



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Department of Biology



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Does Trait Matching Predict Plant-Pollinator Interactions Across an Urban Gradient?

Student Author: Mia Alikhan

Faculty Mentors: Opeyemi Adedoja and Coleman Little

Pollinators provide invaluable ecosystem services to agriculture and the environment with honeybees alone contributing an estimated \$15 billion per year (Zawislak, n.d., 2019). The majority of plants rely on pollinators for genetic exchange and diversity. However, pollinators are declining due to several factors including land use change which affects pollinator and plant diversity, and plant-pollinator interactions, over 94% of plant-pollinator interactions in North America have been lost in the last three decades (Mathiasson & Rehan, 2020). This study aims to examine different areas in Central Arkansas and evaluate how fragmentation and land-use type affect plant-pollinator interactions, network turnover, and trait matching. Twelve sites around Central Arkansas were chosen on a gradient of land development (urban, suburban, and rural areas) based on the proportion of natural areas at 250 m around each site. Trials will be conducted in 15-minute observation periods via a meandering walk, and a phytocentric approach will be used to identify and record plant-pollinator interactions using common protocols described by Kaiser-Bunbury (2017). Plant traits and diversity will also be recorded at each site. The Bipartite R package will be used to determine Connectance, Modularity, Nestedness, Shannon Diversity, and Extinction Slope. Anthropogenic urban habitats are expected to have an increased number of generalist and exotic species and plant-pollinator interactions, while rural areas are expected to have a mix of native specialist and generalist species. Urban, suburban, and rural sites are expected to have a higher beta diversity indicating a dissimilarity in species composition.

Identifying the Binding Partners of FszA and FszB in *Dictyostelium discoideum*

Student Author: Paul Asamoah

Faculty Mentor: Kari Naylor

Mitochondrial dynamics (fusion, fission, and motility) are important to the homeostasis of the cell and play a role in mitochondrial related diseases such as Alpers disease, and neurodegenerative diseases such as Parkinson's disease. However, the direct connection between mitochondrial dynamics and neurodegenerative diseases remains unclear. *Dictyostelium discoideum* is a mitochondrial disease model system and our lab has established it as a model for studying mitochondrial dynamics.

This study investigates the binding partners of FszA which is hypothesized to be involved in *D. discoideum* mitochondrial dynamics. To carry out this project, we first established a mitochondrial isolation protocol. Using FLAGA-FszA cells, several lysis methods were tested followed by various differential centrifugation protocols. Using porin as a marker, western blotting was carried out to confirm enrichment of mitochondria. Preliminary results indicate that filter lysis is more effective than homogenization with a Potter-Elvehjem homogenizer. A simple 3 step differential centrifugation process using 600xg and 10,000xg results in mitochondrial enrichment in the appropriate fraction.

Co-immunoprecipitation experiments using anti-FLAG magnetic beads is currently being conducted to isolate FszA proteins along with their binding partners. Mass spectrometry will be used to identify these binding partners. Identification of FszA binding partners will contribute to our understanding of mechanism used by *D. discoideum* to carry out mitochondrial dynamics and eventually into diseases effected by defects in mitochondrial dynamics.

The Effects of Warming and Shade Tolerance on Germinating Willow Oak

Student Author: Emma Busted

Faculty Mentor: Erin Wiley

Determining how trees are affected by climate change is a major factor science is still trying to understand. Higher temperatures may drastically affect trees and their ability to survive and grow. Different temperatures affect the rates of photosynthesis and respiration, which are vital for proper growth. A plant's ability to survive different stressors relies on that plant's ability to maintain a positive carbon balance. Low light levels, or shade, are stressors where maintaining positive carbon balance is particularly difficult to ensure proper physiological processes. This experiment focused on how a shade-tolerant tree, *Quercus phellos* (Willow Oak) can survive with both temperature and shade stressors. Willow oak acorns were germinated in two temperature chambers with three shade levels in each chamber. One chamber with ambient temperatures and the other was 10 degrees higher. The light-level treatments include full sun, one layer of shade cloth, and two layers of shade cloth. For those with two levels of shade cloth, the height of saplings was significantly taller on average for both temperature treatments. In terms of temperature, there was a significant effect on the root length of saplings, with shorter roots in the warmer temperature chamber. It was also found that temperature with light levels produced some significant differences between the warm chamber with no shade and one layer of shade developing shorter root length. The colder chamber with no shade produced significantly longer roots than the rest. The number of leaves was also tested, but that produced no significant differences across temperature, light levels, and both.

In The Weeds: Peppered Shiner (*Miniellus perpallidus*) Presence Associated with Water Willow Beds and Notes On Reproductive Ecology and Critical Habitat

Student Authors: Michael Calvert and Jessica Rath

Faculty Mentors: Ginny Adams and Reid Adams

Miniellus perpallidus, the Peppered Shiner, is a rare minnow endemic to eastern Oklahoma and southern Arkansas that has faced population declines and range contraction. Previous data suggest populations of the Peppered Shiner may be extirpated, or nearly extirpated, from the entirety of its Oklahoma range and the Ouachita, Caddo, and Little Missouri rivers in Arkansas. The only recent collections have been in the Saline River from Benton downstream to Warren, Arkansas. Ongoing research indicates the Peppered Shiner tends to be most abundant in wadeable pool/run habitats from July to September, and presence in these habitats may be related to variability in stream hydrology. A majority of sites in the Saline River where Peppered Shiners have been detected have inundated beds of Water Willow (*Justicia americana*). We analyzed the morphology of 63 Water Willow beds across the historic range of Peppered Shiner. We found Peppered Shiners adjacent to Water Willow beds that were deeper at the middle, margin, and three meters away with slower current velocities than Water Willow beds without Peppered Shiner detections. Gravel aggradation leading to shallowing of Water Willow beds may be linked to the extirpation of Peppered Shiner from the Ouachita, Caddo, and Little Missouri rivers. Additionally, we discuss our plan for examining Peppered Shiner reproductive ecology and critical habitat.

Assessing Thermal Tolerance of Fishes in the Cossatot River, with a Focus on the Endemic Rocky Shiner (*Notropis suttkusi*)

Student Authors: Becca Chamoun and Peyton Manry

Faculty Mentors: Ginny Adams, Reid Adams, and Matthew Gifford

The Rocky Shiner (*Notropis suttkusi*) is a leuciscid endemic to the Red River drainage, with a limited distribution in the Blue, Kiamichi, and Little rivers. As an endemic species, Rocky Shiner is particularly vulnerable to climate change. Because of the incomplete data available on its range and life history, temperature may be a contributing factor to its limited distribution. We used Critical Thermal Maximum (CT_{max}) to determine the highest temperature Rocky Shiner could tolerate while maintaining equilibrium. Using a field-based approach, we tested 21 species in July 2024 alongside the Cossatot River and released fish after trials. Thermal Safety Margin (TSM), the difference between CT_{max} and acclimatization temperature (mean temperature recorded 10 days before trials), was used to compare the thermal vulnerability of Rocky Shiner to other leuciscids tested. Rocky Shiner (n=24) exhibited similar mean CT_{max} values (37.7 °C SE ± 0.11) and TSM (12.2 °C) compared to other leuciscids, but tended to have higher mean agitation (T_g) temperatures (35.0 °C SE ± 0.27). The thermal habitat of our study site was examined by deploying thermal arrays (HOBO loggers) across mesohabitats where Rocky Shiner was observed. During the 9-hour period these loggers were deployed, maximum temperatures ranged from 33.49 °C to 35.54 °C. Similarities in CT_{max} values across leuciscids indicate temperature alone does not necessarily limit the distribution of Rocky Shiner. However, the T_g values and small temperature differences (< 2 °C) between mesohabitats and CT_{max} values indicate the need for future research on Rocky Shiner thermal limits.

Investigating the Molecular Mechanisms via which the Plant Growth-Promoting Bacterium, *Azospirillum brasilense*, Improves Growth in Salt-Stressed Rice

Student Authors: Hannah-Grace Fritz, Avery Gilkey, Anna Bommers, Matthew Calhoun and Dylan Neuhaus

Faculty Mentor: Arijit Mukherjee

Major food crops, such as rice and maize, display severe yield losses (30-50%) under salt stress. Furthermore, problems associated with soil salinity are anticipated to worsen due to extreme weather. Therefore, it is necessary to implement sustainable agricultural strategies, such as exploiting beneficial plant-microbe associations, for increased crop yields. Plants develop associations with beneficial microbes [e.g., mycorrhiza, plant growth-promoting bacteria (PGPB)]. PGPB improve plant growth via multiple mechanisms, including protection against biotic and abiotic stresses. *Azospirillum brasilense*, a PGPB, can mitigate salt stress in different crops. However, little is known about the molecular mechanisms by which *A. brasilense* mitigates salt stress. Previously, we established an experimental system in which *A. brasilense* inoculation improved plant mass in rice grown under high salt concentrations (100- and 200 mM NaCl), seven days post-inoculation (dpi). We hypothesized that *A. brasilense* inoculation would regulate the expression of rice genes involved in salt-stress response, nutrient and ion transport, and abscisic acid and jasmonic acid signaling, among others. Using RNA sequencing, we identified the transcriptomic changes in rice plants during *A. brasilense*-mediated salt stress tolerance at seven dpi. Our results identified key gene expression patterns in rice via which *A. brasilense* help improve growth in rice. To identify the early plant transcriptomic changes in salt-stressed rice upon *A. brasilense* inoculation, recently we completed an RNA-seq experiment and are currently analyzing the results. In this study, we expect to identify differentially expressed genes in salt-stressed rice involved in the initial perception and response to *A. brasilense*.

Exploring the Effect of Time Since Fire on Bee-Flower Interactions and Functional Diversity of Wild Bees

Student Author: Sarah Grace

Faculty Mentors: Coleman Little and Opeyemi Adedoja

Bees are important pollinators of plants, playing an essential role in maintaining the food webs in many terrestrial ecosystems. In recent years, bee populations have been declining globally due to factors that influence the availability of suitable floral resources and nesting sites. One such factor affecting bee habitat in Arkansas fire adapted ecosystems is changing fire regimes. Many studies have recorded incredibly diverse floral and bee diversity in areas approximately 1-3 years post-burn. There is also evidence suggesting that functional traits of bees may predict community response to fire. This study intends to observe how bee and floral diversity differ across areas with varying time since prescribed fire in the Camp Robinson Special Use Area. Functional traits will also be recorded and found in literature to further understand the community dynamics of bees in the plots. Bees will be sampled in 15 plots and 3 treatments; recently burned (> year 2022), intermediately burned (years 2020 – 2022), and infrequently burned (<year 2020). Floral diversity and open ground surface will be determined in each plot. To collect specimens, hand-netting and bee pans will be utilized to get a wider scope of bees. We will also record bee visits to each flower over a meandering 10-minute walk. Ultimately, we expect that both bee and floral diversity will be higher in more recently burned plots than intermediately burned plots and infrequently burned plots, and that functional diversity will vary among burn times.

The Remobilization of Fine Root Carbohydrate Reserves in Response to Defoliation of Green Ash (*Fraxinus pennsylvanica*)

Student Author: Hannah Hayes

Faculty Mentor: Erin Wiley

Defoliation is a forest stressor causing leaf loss due to drought, herbivory, or other disturbances. After severe defoliation, trees remobilize nonstructural carbohydrates (NSCs) for leaf re-growth, but it is not clear whether NSC storage in all organs is equally affected. In particular, it is not clear if and how the NSC reserves of fine roots—which are not typically considered to be a major storage organ—are impacted during leaf re-growth. To better understand how defoliation affects NSC dynamics, we subjected sixteen mature Green Ash (*Fraxinus pennsylvanica*) trees to the following treatments: control (n=6), full defoliation (n=5), and full defoliation and girdling (n=5). We then monitored changes in fine root starch and sugar for 3 weeks. Girdling allowed for us to make a distinction between remobilization for local NSC use, which supports root metabolism, and distant use, which supports leaf re-growth.

Defoliated trees were found to have lower sugar concentrations and decreasing starch concentrations over time, relative to controls. Girdled trees, which cannot transport sugars aboveground, were found to have significantly more sugar than defoliated trees and no significant decrease in starch over time. The results of our study suggest that defoliated trees may remobilize NSC from fine roots to support leaf re-growth following defoliation events. While NSC remobilization aboveground helps leaf area recovery, lower NSC could affect nutrient uptake and mycorrhizal colonization, reduce osmotic adjustment and drought tolerance, and/or make fine roots more vulnerable to pathogen attacks.

Storm Impact on External Nutrient Loading into an Arkansas Drinking Reservoir.

Student Authors: Tate A. Hill, Haley N. Racioppo and Lydia U. Bradshaw

Faculty Mentor: Halvor M. Halvorson

Storm events drive the external loading of sediments and nutrients including nitrogen (N) and phosphorous (P) into reservoirs. Cypress Creek is the main external input into Brewer Lake, a drinking reservoir for more than 80,000 people in central Arkansas. Brewer Lake exhibits algal blooms linked to inorganic nutrient availability, leading to nuisance odor and taste issues. To understand the impact of storm events on the external loading of Brewer Lake, we sampled Cypress Creek prior to and during storm events. At least three samples were processed per storm to analyze data for Total N and P (TN/TP). Storms were ranked by severity via difference between baseflow and peak maximum discharge at a collected sample. Seasonal impact of severity and peak concentration of TN/TP were analyzed using ANCOVA, with samples grouped by wet (November-April) or dry season (May-October). Storm severity was positively correlated with the concentrations of TP (Spearman Correlation, $\rho=0.881$, $p<0.001$) and TN (Spearman Correlation, $\rho=0.864$, $p<0.001$). Seasonality of storm event in relation to peak concentration was insignificant for TN (ANCOVA, $F_{1,14}=0.24$, $P=0.63$), but significant for TP (ANCOVA, $F_{1,14}=4.99$, $P=0.047$) with the dry season being higher in average peak concentration. This suggests that higher storm severity increases the degree of enrichment of TN and TP, with seasonality trending to be linked to nutrient concentration at peak discharge. More analysis of inorganic nutrients, turbidity, the frequency of storm events, and particulate N and P will provide a greater understanding of external loading from Cypress Creek into Brewer Lake.

Bite Force and Head Shape Plasticity in *Crotaphytus collaris*

Student Author: Jackson Holsted

Faculty Mentor: Matthew Gifford

Seasonal plasticity suggests that variation in specific phenotypes occurs seasonally in individuals responding to environmental changes and can impact their performance within a community. Bite force is a crucial performance trait that helps determine mating success, territory characteristics, and prey type. Head morphology is measured and compared among individuals when looking at differences in bite force, and specific aspects of morphology influence bite force more than others. *Crotaphytus collaris* populations in Arkansas are ideal for studying seasonal plasticity. Common in the southwest desert prairies, the Ozark highlands of Arkansas represent their eastern range limit. Overlogging and fire suppression increased invasive plant presence. In Arkansas, research has examined population demography and reintroductions, but none have considered variation in performance or phenotypic plasticity. As environments change due to global warming and human actions, trait plasticity could be a key factor in population persistence. This study examined bite force and head morphology in male and female *C. collaris* during the breeding and non-breeding seasons to test for patterns of change between individuals and populations in different glade habitats. We hypothesized that bite force and head size would peak during the breeding season and decrease afterward, with males exhibiting more pronounced changes than females. Mixed-effects models revealed a significant seasonal increase in bite force, with males exhibiting consistently higher values than females across glades. Bite force was significantly correlated with SVL, while head width showed seasonal trends. Head length showed no significant variation. These findings highlight possible relationships between morphology and performance across seasons.

Effect of Genes for Conserved Steroidogenic Enzymes HSD-2/3 and their Role in Food Communication and its Impact on Lifespan in *Caenorhabditis elegans*

Student Authors: Paola Ibarra, Rachael Wehrle, and Levi Friddle
Faculty Mentor: Mindy Farris

Dietary restriction (DR) has been shown to extend lifespan in numerous model organisms, from the nematode *Caenorhabditis elegans* to mammals. Although the precise mechanisms remain unclear DR likely influences multiple hormone signaling pathways.

This study investigates the role of the conserved steroidogenic enzymes HSD-2 and HSD-3 in food communication and their impact on the lifespan of *C.elegans*. We hypothesize that organisms can sense when their food (bacteria) does not have food (peptone) and that hormonal signals may trigger increased survival responses and stress resistance in these conditions.

Bacterial deprivation (BD) can activate *C. elegans* genes for enzymes that produce hormones which may be responsible for communicating food potential. Strains of *C. elegans* used in this experiment are the N2 (control), *eat-2* (DA465, DR genetic model), *hsd-2*, and *hsd-3*. Around 180 L4 larval stage worms of each strain are harvested for lifespan assays. Minimal media (MM) plates not spotted with bacteria (*E. coli*, OP50) serve as the BD condition, while MM plates double spotted with OP50 serve as the fed control for the no peptone BD condition. A comparison of worm lifespans in these conditions will show the role of BD and hormones made by HSD-2 and/or HSD-3 in influencing food communication and lifespan regulation in *C.elegans*. Further research will be conducted by running heat-stress assays and sending worm tissue samples to the UAMS Metabolomics Core for metabolomic analysis. This will yield further insight into the metabolic pathways and metabolites produced during BD.

Examination of the Influenza Pandemic of the 1890s in Chittenden County, Vermont

Student Author: Anabeth Icenhower
Faculty Mentor: Benjamin Rowley

Influenza virus is an enveloped negative-sense single-stranded RNA genome virus with multiple surface proteins and a segmented genome, allowing for the virus to undergo antigenic drift and shift to create new variants. Influenza (sometimes known as la grippe) has become pandemic at several points throughout the 20th and 21st century, but pandemics prior to the 20th century are much less well-studied. One of the first better-documented influenza pandemics of the industrial era would be the influenza pandemic of the 1890s (1889-1894). When researching influenza pandemics, many studies have been conducted over the Spanish Flu of 1918, but very few have looked in depth into the Russian Flu of 1889. Termed the Russian Flu based on believed origin, the virus slowly made its way to the Americas in late 1889-1890. As documentation on infections and deaths became more consistent in implementation and is more accessible today via scanned handwritten death certificate documents available online, historical epidemiological research may be conducted to understand different aspects of viral spread during this pandemic. Examination of deaths on a county basis within affected states may enable discovery of trends and patterns to understand the spread of the virus. This may then better inform measures for further viral control in modern influenza pandemics. This study will examine and characterize the Russian Flu pandemic of the 1890s for Chittenden County, Vermont (the most populous county in the state).

Assessment of Antimicrobial Activity of Medieval Herbal Remedy Recipes

Student Author: Lane Langley
Faculty Mentor: Benjamin Rowley

Modern examinations of antimicrobial activity of herbs used in medieval remedies are rare. The goal of this preliminary study is threefold: 1.) Determine which herbs have already been characterized using modern methodologies through a comprehensive literature search. 2.) Identify multiple recipes translated into modern English from *The Old English Herbal* (specifically looking for recipes used against what today would be recognized as microbial infections) as starting points for new testing. For this part of the project, a recently published (2023) translation by Niles and D’Aronco will be utilized. 3.) Use modern microbiological laboratory methods (including spectrophotometry and disc-diffusion techniques) to do initial antimicrobial susceptibility testing of herb extracts used in these recipes, with replication for statistical analyses. Testing against common pathogenic bacteria, including *Staphylococcus aureus* and *Escherichia coli* (with potential for other microorganisms) will be carried out. This study will provide preliminary data and lay the groundwork for future further examination of herb extract chemical composition, as well as potential attempted reproduction/testing of the medieval recipes themselves. It will also add to the body of knowledge on the actual real-world effectiveness of medieval herbal remedies.

Investigate the Effects of Diffusible Signals from Different Plant Growth-Promoting Bacteria on Rice

Student Authors: Stephanie Long, Naia Efird, Matthew Calhoun, Anna Bommers and Dylan Neuhaus.
Faculty Mentor: Arijit Mukherjee

Plants form associations with beneficial microbes, including arbuscular mycorrhiza (AM), rhizobia, and plant growth-promoting bacteria (PGPB). In these associations, the host plants benefit from improved growth in exchange for carbohydrates for the microbe. Studies in legume-rhizobia symbiosis (LRS) and AM symbiosis have shown that a molecular dialogue between the symbiotic partners is required to initiate these interactions. Furthermore, genetic and biochemical studies identified the plant and microbial signals and the host genetic pathways involved in these symbioses. For instance, ‘Nod factors’ are secreted by rhizobia bacteria during LRS, and ‘Myc factors’ are secreted by AM fungi during mycorrhizal symbiosis. Interestingly, the direct application of these microbial signals on plants can promote their growth, and naturally, these are already commercialized. The same level of understanding doesn’t exist for interactions between plants and PGPB. One recent study showed that diffusible signals from *Azospirillum brasilense*, a PGPB, stimulated growth in *Arabidopsis thaliana*. We established an experimental system where diffusible signals from *A. brasilense* and *Azotobacter vinelandii* promoted rice growth. In the future, we will identify the underlying transcriptomic changes regulating the effects of these microbial signals on their host plant. We expect plant genes encoding receptor kinases, transcription factors, and hormone pathways to be differentially expressed. Our results will identify the host genetic pathways regulated by the microbial signals. In the long term, we plan to identify the chemical nature of these microbial signals, which can have important implications for improving agriculture sustainably and preventing human health concerns.

The Effect of Simulated Microgravity and the Female Sex on Tibia Bone Properties

Student Authors: Jalal Masoud and Samuel De Campos

Faculty Mentors: Brent Hill and Rahul Mehta

Hindlimb suspension (HLS) has been used as a model to simulate spaceflight conditions. We desired to investigate challenges that persist with females in space because the presence of gonadal estrogen help maintain bone integrity. We hypothesize that the loss of gonadal estrogen and HLS will change the bone anatomy and decrease its strength. A tail-ring, hindlimb unloading model was used for 4 wks on 16 wk female mice (n=4 for each group). There were four groups of mice: (1) SHAM non-HLU, (2) SHAM HLU, (3) OVX non-HLU, and (4) OVX HLU. Food, water, and body mass was monitored. At sacrifice, the tibia was isolated, the uterine mass was decreased in OVX mice, and plasma corticosterone levels were elevated in HLU mice. Bone elasticity (Young's modulus) was evaluated using 3-point bending. Cross-sectional structure and elemental composition (calcium and phosphorus) was evaluated using scanning electron microscopy and energy-dispersive X-ray spectroscopy. It appears that HLU did not have a significant effect on tibia elasticity; however, OVX does appear to induce a decrease in cortical and cavity area in HLU mice. We are still evaluating the biophysical properties of the tibia from the non-HLU mice. Overall, this preliminary study will provide an understanding on how to mitigate bone loss in spaceflight.

Pollinator Community Response to Urban Development in Central Arkansas

Student Author: Mary McSpadden

Faculty Mentors: Opeyemi Adedaja and Coleman Little

Urbanization is one of the leading drivers of pollinator decline, affecting population abundance and modifying species traits such as body size, tongue length, and phenology across urban gradients. Many studies have attempted to enhance floral resources in pollinator habitats, yet understanding how traits filtered by urban drivers influence the effectiveness of pollinator habitats is largely unknown. This study investigates the effect of landscape and local factors on pollinator functional diversity across a gradient of urban development. The study will be conducted in 12 study sites, varying in the proportion of urban development at 500m around each study site. The abundance and beta diversity of pollinators and flowering plants will be determined over the summer sampling season. Additionally, functional traits facilitating pollinator interaction with plants and pollinator persistence in the habitat will be identified and measured. By analyzing the relationships between certain functional traits and the diversity of pollinators and flowering plants at each site, this study will determine how urban development filters pollinator traits and the consequent effect of trait modification on species persistence in areas varying in level of disturbance. This research will aid our ability to improve existing pollinator conservation strategies by integrating trait diversity into the selection of flowering plants to enhance pollinator habitats.

Crossmodal Transfer of Object Information Across Active Echolocation and Touch

Student Authors: Ayema Mukhtar and Madison Pettingill

Faculty Mentors: Amrita Puri and Santani Teng

Active echolocation (AE), commonly employed by bats and dolphins to navigate their environment, can also be used by humans, particularly blind individuals, to gather information about the spatial layout of their environment, and some even discriminate between objects based on shape and size. Experienced human echolocators can integrate sensory information across modalities to form multisensory object representations. Here, to investigate which properties contribute most to crossmodal transfer between AE and touch, one expert blind echolocator, one echolocator-in-training, and a group of sighted AE novices completed a crossmodal match-to-sample task using eight objects with different height, volume, mass, density, and frontal surface area. Objects were constructed from LEGO® blocks, ensuring consistent surface material and texture. Participants were blindfolded and completed 28 - 56 trials in which they first echolocated a target object, then used touch to differentiate it from a distractor object. To minimize extraneous echoes, objects were placed on soft material with a noise-canceling foam panel behind them. The blind expert echolocator performed above-chance, particularly when objects differed in height (~71% accuracy) and volume (~67% accuracy). However, there was no clear benefit for trials in which objects differed by mass, density, or frontal surface area. In contrast, the echolocator-in-training and sighted novices performed at chance levels across all trials. Thus, height and volume appear to be key properties for echo-haptic crossmodal transfer in experienced blind echolocators. These findings contribute to our understanding of perceptual capabilities related to echolocation and may inform the development of innovative assistive devices for visually impaired individuals.

Temporal Shifts in Freshwater Mussel Community Composition in the Upper Ouachita River: A Preliminary Analysis

Student Author: David Nichols

Faculty Mentors: Kendall Moles, Ginny Adams and Reid Adams

The southeastern United States is a biodiversity hotspot for mussels with over one-third of all mussel species found in this region. Many species are in decline, with 30-40 species of mussels having gone extinct within the last 100 years and 75 currently listed as federally endangered. The Upper Ouachita watershed contains 3 federally threatened species (*Lampsilis powellii*, *Cyprogenia sp. cf. aberti*, and *Theliderma cylindrica*) and historically contained mussel beds. The Upper Ouachita watershed has historical surveys that have never been analyzed for temporal trends. We compiled five sites representing two time periods (1990s and 2000s) and compared abundances and composition to the same sites from a summer 2024 survey. Surveyors conducted snorkel surveys following an initial search for mussel presence. Two of the five contemporary sites contained live mussels. Analysis showed a shift in mussel communities in relative abundance space from historical to contemporary surveys using zero-adjusted Bray-Curtis distance ($p = 0.013$). Six species were present in historical samples and not in contemporary samples. *Theliderma metanevra* was only found in contemporary surveys. *Cyclonaias pustulosa* and *Ptychobranhus occidentalis* were significant indicator species for the 2024 surveys ($p = 0.014$). Historical surveys had higher species richness ($p = 0.074$) than contemporary surveys. There was a 58% decline in average species richness and a 59% decline in average species abundance from 1990-era sites to 2024 sites. However, one contemporary site had the highest richness of any site analyzed, suggesting temporal trends in mussel composition and abundance across the river may be site-specific.

Characterizing Internal Loading of Brewer Lake (Arkansas, USA) through Nutrient Flux and Fractionation Experiments

Student Author: Haley Racioppo

Faculty Mentors: Brian E. Haggard, Brad J. Austin, Felicia S. Osburn, Matthew H. Connolly and Halvor M. Halvorson

High nutrient loading threatens reservoir water quality. Brewer Lake, the drinking water reservoir for over 80,000 Arkansas residents, experiences occasional algal blooms and seasonal taste/odor issues. Seasonal stratification may impact whether its sediments act as an internal nutrient source, potentially influencing its algal dynamics. To investigate the lake's internal loading, we collected sediment cores during May 2024. Nutrient release rates ($\text{mg}/\text{m}^2/\text{d}$) were calculated following an incubation experiment, where the cores experienced oxic and anoxic treatments to represent the lake's mixed and stratified periods, respectively. The anoxic sediment cores had greater ammonium release rates than the oxic cores ($18.2 \pm 12.2 \text{ mg}/\text{m}^2/\text{d}$ and $-6.6 \pm 4.1 \text{ mg}/\text{m}^2/\text{d}$, respectively) while the oxic cores had greater nitrate release rates than the anoxic cores ($12.9 \pm 5.1 \text{ mg}/\text{m}^2/\text{d}$ and $-4.1 \pm 1.0 \text{ mg}/\text{m}^2/\text{d}$). Mineralization continuously releases ammonium, but nitrification can only proceed in oxic conditions, possibly driving this contrast. However, phosphate release rates were not different between the anoxic and oxic treatments ($3.3 \pm 3.8 \text{ mg}/\text{m}^2/\text{d}$ and $0.3 \pm 0.1 \text{ mg}/\text{m}^2/\text{d}$). Preliminary analysis of the anoxic sediment cores shows substantial spatial variation of phosphate internal loading rates, where higher release rates occur among sediments from the deepest lake section. Various forms of mobile and nonmobile phosphorus fractions can be unequally distributed throughout lake sediment, so future analysis to quantify these phosphorus fractions may explain the variation of phosphate release rates. Further spatial analysis of nutrient loading may allow for more targeted management action. Overall, this information and continued nutrient analysis may help explain algal blooms and taste/odor events in Brewer Lake and other reservoirs.

Effects of Home Range Thermal Quality on the Fitness of *Crotaphytus collaris*

Student Authors: Jaclyn Reifeiss, Jackson Holsted and David Adams

Faculty Mentor: Matthew Gifford

Habitat degradation has increasingly burdened ectothermic species, such as the Eastern Collared Lizard (*Crotaphytus collaris*), by increasing the costs associated with behavioral thermoregulation. Disruption in the availability and distribution of critical thermal resources potentially alters social dynamics and reproductive success. We explored how variation in the thermal quality of a home range correlated with the potential fitness of individuals in a population of *C. collaris*. Using intensive mark-recapture techniques and repeated censuses conducted on a glade in Calico Rock, Arkansas, we constructed home range estimates for every active individual throughout the reproductive period. We described thermal quality of each home range as the average D_h and total cumulative hours of estimated activity. We used the number of female home ranges overlapped by a male to estimate male fitness, which we then used to assess for correlations between fitness and thermal quality. There was a slight trend showing males occupying home ranges with high thermal quality had higher fitness. The distribution of thermal resources across glades may influence the number of reproducing males, thereby affecting the genetic diversity within these isolated populations of *C. collaris*. These data may support restoration techniques that involve introducing and distributing substrate onto Ozark glades.

Responses of the Macroinvertebrate Community in North Sylamore Creek to an Atypical Summer Flood

Student Authors: Abbey Steely, Gentry Hamilton, and Haley Racioppo

Faculty Mentors: Ginny Adams and Reid Adams

Aquatic communities often recover rapidly from predictable seasonal flooding; however, they may be more vulnerable to high magnitude atypical floods that are becoming more frequent with climate change. North Sylamore Creek, an upland stream in the Ozark National Forest, experienced an atypical, 40.6-centimeter flood event in July 2024. Less than one week after the summer flood, macroinvertebrates were sampled from four sites along the mainstem of North Sylamore Creek. A repeat sample occurred during September 2024 at all sites to assess potential macroinvertebrate recovery. Post-flood (July) and recovery (September) samples were evaluated for differences in taxa richness, community assemblage composition, and relative abundance of behavioral traits. Across the four sites, 1,581 individuals representing 23 taxa were collected in the immediate post-flood samples. In the recovery samples, 3,735 individuals representing 29 taxa were collected. Post-flood samples had significantly fewer individuals (395.3 ± 74.8 SD) per site than recovery samples (933.8 ± 256.5 SD) (Wilcoxon rank sum test, $p=0.029$). Taxon richness also varied significantly between sampling periods with post-flood samples having fewer taxa than recovery samples (20.0 ± 3.6 SD and 25.8 ± 2.8 SD, respectively) (Student's t-test, $p=0.046$). Non-metric multidimensional scaling (NMDS) ordination showed overall community composition between post-flood and recovery samples was similar (PERMANOVA, $p=0.663$), but community responses were variable across sites. For both post-flood and recovery communities, burrower and clinger taxa accounted for approximately 85% of all individuals, suggesting that the North Sylamore Creek macroinvertebrate community was generally resilient to the atypical summer flood.

Climate Change Awareness: Centering Local Communities

Student Author: Angelica Thomas

Faculty Mentor: Leah Horton

Are Arkansans aware of the inequitable distribution of risks associated with climate change? Informing the public about the local anthropogenic artifacts in their environment that place additional environmental stressors on vulnerable communities initiates the path toward creating equitable environments. Using Geographical Information System (GIS) proximity analysis, Superfund sites as symbolic environmental hazards were spatially analyzed to understand the distribution of potential risk for communities in Arkansas. County-level spatial data regarding environmental features can be used to demonstrate the necessity of understanding current environmental stressors to understand the full gravity of future climatic changes.

Lifespan and Stress Resistance of Four Strains of *C. elegans* Treated with Rapamycin

Student Authors: Trey Thurman and Christian Bailey

Faculty Mentor: Mindy Farris

Rapamycin is an FDA approved antifungal with immune and metabolic regulatory mechanisms that have been associated with antiaging. Dimethyl Sulfoxide (DMSO) is a strong organic solvent that allows cutaneous absorption of topical drugs into the bloodstream. The target of rapamycin (TOR) pathway is responsible for lipid and nucleotide synthesis in excess of nutrients; During synthesis, this pathway also inhibits catabolic processes such as autophagy. Rapamycin inhibits the TOR pathway. To investigate these effects we utilize four strains of *C. elegans*: wild type, eat-2, induced amyloid beta associated gene (gnals-1), and induced expression of amyloid beta (gnals-2), and expose them to rapamycin dissolved in DMSO as well as DMSO as a control. eat-2 mutants have altered pharyngeal acetylcholine receptors, decreasing pharyngeal function leading to dietary restriction. Worms were heat stressed on day one of rapamycin/DMSO treatment. The rapamycin is expected to have a positive impact on the lifespan extension in the gnals-1&2 and wild type strains while neutral or negative effects are expected in the eat-2 strain. All strains are expected to have decreased reproductive rates as well as smaller body size.

Determining the Role of Intracellular Acidification in C3H-10T1/2 Cell Death

Student Authors: Gabriella Toland, Dallan Young, Anna Smith and Evan Holly

Faculty Mentor: Steven Runge

Apoptosis is a mode of cell death characterized by phosphatidylserine flipping, DNA fragmentation, membrane blebbing, and apoptotic bodies [1,2,3]. Apoptosis is essential for maintaining the homeostasis of cell numbers in multicellular organisms [3,4]. Caspase-independent cell death (CICD) shares many of the characteristics of apoptosis, excluding flipping of phosphatidylserine and DNA condensation [6]. This research aims to determine whether the acidification occurs before, after, or independent of caspase activation in the cell death pathway. If the intracellular acidification is inducing apoptosis and intracellular acidification is determined to occur after caspase activation, treatments can be targeted to cells with inhibited caspase activity. Alternatively, if intracellular acidification is found to induce CICD, then treatments can be targeted to cells that are resistant to apoptotic induction.

This experiment aimed to determine the pH threshold for irreversible apoptosis in C3H-10T1/2 cells. Cells were clamped using carbonyl cyanide m-chlorophenylhydrazone (CCCP), a proton ionophore, in complete, buffer expanded (HEPES pKa 7.5, PIPES pKa 6.8, MES pKa 6.1) Basal Medium Eagle (BME) for 24 hours at pH 7.2-6.2 in 0.1 pH increments. Cells were then replated in complete growth medium at pH 7.2 and assessed for viability 1, 3, and 5 days post-replating. Results indicated that the threshold of irreversible pH-induced apoptosis was at pH 6.3 when cells were clamped for 24 hours. Cells clamped at pH 6.5-6.4 were able to re-adhere once replated, but did not proliferate. This threshold will be used in further experiments examining the importance of caspase activity during intracellular acidification-induced cell death.

Department of Chemistry and Biochemistry



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Paramagnetic Cobalt-Cobalt Dimers: Gateways to Highly Magnetic Oligomers and Molecular Magnets

Student Author: Ian T. Blair

Faculty Mentor: Patrick J. Desrochers

A new paramagnetic metal-metal dimer will be described in which two cobalt(II) centers are held together by three bridging 3,5-dimethylpyrazolide ions. These dimers are synthesized by the direct reaction of potassium 3,5-dimethylpyrazolide and cobalt(II) salts in dry DMF and isolated as stable K⁺ salts, isolated as deep blue K[XCo-dimer-CoX] solids. This general synthetic process was replicated with three different halides/pseudohalides, using CoX (X= Cl, Br, SCN). These new dimers were characterized by UV-visible electronic and infrared spectroscopies. The addition of excess (10:1) potassium 3,5-dimethylpyrazolide converts the dimers to oligomers, thermally and moisture stable deep purple solids. Spectroscopic (UV-vis and IR) and elemental analyses indicate this oligomer is devoid of KX (from the dimer), and consists exclusively of Co-pyrazolide units, with Co(II) adopting typical pseudo-tetrahedral geometries. Room temperature magnetic measurements of this oligomer indicate a highly paramagnetic material. Ongoing work is investigating development of these materials as molecular magnets.

Bioaccumulation of Mercury in Longnose Gar (*Lepisosteus osseus*) and Alligator Gar (*Atractosteus spatula*) in the Arkansas and Caddo Rivers

Student Author: Zachariah Boehringer

Faculty Mentor: Robert Mauldin

Naturally-occurring cinnabar (HgS) dissociates and reforms into methylmercury, a powerful neurotoxin which can bioaccumulate and biomagnify in fish species. Longnose gar (*Lepisosteus osseus*) and alligator gar (*Atractosteus spatula*) are long-lived, top predators and therefore are good bioindicators of aquatic ecosystem health. The purpose of this study was to examine the mercury concentrations in longnose and alligator gar as a function of age to analyze bioaccumulation, comparisons based on sex, ecosystem health of the Arkansas and Caddo Rivers, seasonal variations, and species comparisons. Longnose gar in the Caddo River are born with higher levels of mercury than in the Arkansas River, followed by similar trends in bioaccumulation, thereby providing evidence of maternal transfer. Higher levels of measured mercury in samples from the Caddo River suggest an additional source of mercury from abandoned mercury mines in the Ouachita Mountains. Arkansas and Caddo River females exhibit higher mercury levels than males. Arkansas River longnose gar appear to drop in mercury levels after spawn season. Finally, sampled within the same aquatic environment, alligator gar and longnose gar appear to show similar levels of mercury and patterns of bioaccumulation, providing preliminary evidence that plentiful longnose gar can be studied as a proxy for endangered alligator gar.

Investigating Changes in Compaction of PEP-19 by Neurodegenerative Oligomers

Student Author: *Emma Brown*

Faculty Mentor: Tori Dunlap

PEP-19 is a disordered protein that regulates the binding of Calmodulin (CaM) to calcium. With calcium signaling, PEP-19 is able to bind to CaM, increasing the rate of calcium binding in the C-terminal lobe of CaM. PEP-19 is strongly associated with neurodegenerative diseases. It is found in higher levels in brain areas spared in Alzheimer's Disease and found at a deficit in brain areas affected by Parkinson's disease. PEP-19 has also been shown to prevent excess calcium signaling caused by an overload of calcium ions within the brain. However, excess PEP-19 can lead to premature neuronal differentiation and learning deficiencies. We investigated how PEP-19 and the CaM/PEP-19 complex are affected by neurodegenerative oligomers through the use of fluorescence resonance energy transfer (FRET). We used this to measure the end-to-end distance of PEP-19 by itself, in complex with CaM, and with the neurodegenerative proteins alpha synuclein and A-beta peptide.

Optimization of Picoline-based NHC Ligand Synthesis for Carbon Dioxide Reduction Catalysts

Student Authors: Owen Bussell, Katherine Peters, Robert Winzerling, Elisabeth Hicklin, Noah Taylor and Imani Mbong

Faculty Mentor: Marsha Massey

In the face of increasing energy demands, our environment is threatened by overproduction of CO₂. To combat this, inorganic chemists conduct research in the promising field of organometallic catalysis. These catalysts help facilitate the electrochemical reduction of CO₂ into energetically available fuels. My research focuses on a manganese metallic complex with a 3-methyl-1-picolybenzimidazol-2-ylidene (Mebim-pic) organic ligand that is suggested to lower the energy cost of CO₂ reduction. My work focuses on the synthesis of this ligand, as well as experimenting with methods of increasing product yield. I utilize proton NMR spectroscopy, as well as TLC to determine product purity. This helps me to alter my synthesis process to produce a purer product. Modifications to the structure of the organic ligand can change the catalytic potential of the organometallic complex it is used in, and by analyzing the structure of these modified ligands, it can help us to understand the structural components that affect catalyst efficiency. Through the synthesis of new ligands, such as Mebim-pic, we can energetically optimize the production of chemical fuels, while simultaneously reducing atmospheric CO₂.

Synthesis and Characterization of Copper Complexes Supported by A Binucleating Amide Ligand

Student Author: Jeremiah Canady

Faculty Mentor: Lei Yang

The goal of our work is to develop new copper complexes with potential application on carbon dioxide conversion. Two binucleating amide ligands were employed in order to construct binuclear copper complexes with a side-open topology. A group of Cu(II) complexes have been synthesized and characterized by X-ray crystallography, UV-vis and FT-IR. The diverse structural features of these complexes clearly demonstrated the flexibility of the ligand platform. Further characterizations of these complexes are currently in progress.

Design, Synthesis, and Activity of *N*-heterocyclic Carbene Ligand for Enhanced Electrocatalytic Reduction of Carbon Dioxide.

Student Authors: Elisabeth Hicklin, Owen Bussel, Robert Winzerling, Katherine Peters, Noah Taylor and Ian Blair

Faculty Mentor: Marsha Massey

Anthropogenic carbon dioxide (CO₂) emissions are increasingly threatening human health and well-being by deteriorating air quality and exacerbating respiratory conditions. As CO₂ levels accumulate, there is a pressing need for efficient renewable resources that do not contribute additional carbon emissions. A proposed solution is to achieve carbon neutrality through the sequestration and electrochemical reduction of CO₂ to produce precursors for synthetic fuels. However, direct reduction of CO₂ is challenging due to its exceptional thermodynamic stability. A transition metal catalyst can be employed to address this challenge, providing alternative reduction pathways. A crucial component of such a catalyst is the ligand, which enhances the stability of the complex and optimizes catalytic activity through steric effects and electron density distribution. I propose a *N*-heterocyclic carbene ligand, 1H-benzidazolium, 1-methyl-3-(2-quinolinyl), referred to as Mebim-qui. This ligand is an advancement of the previously reported Mebim-py ligand. The Mebim-qui ligand is synthesized via a three-step reaction involving nucleophilic aromatic substitution, methylation, and metastasis. The unmethylated ligand precursor has been produced with yields exceeding 70%, confirmed by ¹H NMR. The next step is to attach the completed ligand to a metal complex to facilitate a more thermodynamically favorable reduction of CO₂, thereby advancing steps toward creating a carbon neutral alternative fuel.

Photochemical Amino Acid Radical Generation

Student Author: Ingram Pile
Faculty Mentor: Nolan Carter

Biological free radicals, biological molecules with unpaired electrons, are extremely reactive species that can cause a significant amount of damage to cells, including DNA and proteins. These free radicals are primarily produced by a reaction between reactive oxygen species (ROS), and amino acids which, when present in excessive amounts, lead to oxidative stress. Oxidative stress damages regular cell function, resulting in cellular phenomena similar to those observed in cancer cells such as genetic damage and mutation.

This study aims to investigate the role of free radicals in oxidative stress-related protein damage by developing a synthetic amino acid radical precursor as a model for protein radicals. This compound will produce an amino acid radical upon exposure to UV light, exploring the underlying mechanisms of how reactive oxygen species contribute to the initiation of cellular damage that can lead to cancer. The findings are anticipated to enhance our understanding of oxidative.

Optimizing Homogeneous Rhenium Catalysts for Enhanced Captured CO₂ Reduction Efficiency

Student Authors: Arielis Rodriguez-Gutierrez, Jared Stanley, Chris Margolis, Aaron H. Gaynes and Benjamin Goka
Faculty Mentors: Marsha Massey, Jenny J. Yang and Chantal Stieber

As our world continues to grow and develop, so does our dependence on fossil fuels, ultimately leading to higher carbon dioxide emissions. This is why technologies like carbon capture and storage (CCS) and carbon capture and utilization (CCU) are being employed to capture CO₂ before it enters the atmosphere. However, despite these efforts, emissions continue to harm our atmosphere and climate, as these processes are more energy intensive and require intermediate steps that re-release CO₂. Therefore, to decrease these effects, we envision using reactive capture of CO₂ (RCC) to capture CO₂ and use electrocatalytic processes to reduce it into value products that could ultimately lead to alternative fuel sources and create a circular carbon economy. Currently our work focuses on synthesizing various rhenium catalysts in hopes of increasing their CO₂ reduction efficiency, as well as preliminary results on homogeneous rhenium catalysis behavior.

Development of Instrument Free Protocol for Phosphate Analysis

Student Author: Shaylee Stolzer

Mentor: Ahmad Zaman Qamar

Elevated levels of phosphate in freshwater can be harmful to aquatic life. When too much phosphate enters a river, lake, or pond, it can reduce the amount of dissolved oxygen in the water. Algae have short lifespans. When they die, bacteria decompose organic matter. This decomposition consumes large amounts of dissolved oxygen from the water. This makes it difficult for fish and other organisms to survive, often leading to imbalances in the ecosystem. Monitoring phosphate levels helps environmental agencies detect pollution early and take steps to prevent serious damage. Phosphate is also a useful indicator of water pollution, as elevated levels often come from sources like agricultural fertilizer runoff, household detergents, and industrial waste. This study introduces a low-cost, instrument-free method for phosphate detection using smartphone imaging. Phosphate reacts with ammonium molybdate under acidic conditions in the presence of a reducing agent (commonly stannous chloride) to produce a blue-colored complex, known as molybdenum blue. The intensity of the blue complex correlates with phosphate concentration. Images were captured using a smartphone and analyzed with ImageJ software for quantitative analysis. An important aspect of this work involves minimizing reagent volumes, which reduces the use of hazardous molybdate-based chemicals. This approach supports green chemistry principles by decreasing chemical waste while maintaining analytical effectiveness.

Formation of Manganese Tricarbonyl Metal Complex Using NHC Ligands to Reduce Captured Carbon

Student Author: Noah Taylor

Faculty Mentor: Marsha Massey

With the amount of CO₂ in the atmosphere ever increasing from our use of fossil fuels, other methods to create the energy needed in day-to-day life need to be developed. In an effort to create a carbon-neutral cycle, the reduction of CO₂ to CO and other fuel products using RCC (Reactive Carbon Capture) methods must be considered. The reduction of CO₂ through RCC methods allows for unpurified CO₂ to be reduced allowing the use of impure CO₂ as a starting point for reduction. In our lab NHC (N- heterocyclic carbene) based metal complexes have been made to reduce CO₂. Chelating NHC ligands to the manganese pentacarbonyl metal complex and reacting with CO₂ using RCC methods allows for an economic and energy-efficient way to reduce captured CO₂ into a fuel source.

Sexual Dimorphism in Longnose Gar (*Lepisosteus osseus*) from Arkansas

Student Author: *Jenna Whisenant*

Faculty Mentor: *Robert Mauldin*

Sexual dimorphism, the physical differentiation between males and females of a species, is critical for precise observation of population dynamics and reproductive efforts. Current methods for sex identification in *Lepisosteus osseus* (Longnose Gar) rely primarily on examining sex organs internally/posthumously and conducting costly lab assays, thereby limiting practical field applications. This study aimed to determine whether external morphological traits could serve as reliable indicators of sex in *Lepisosteus osseus* populations from Arkansas.

A total of 62 specimens (27 males, 35 females) were collected from Arkansas and Caddo Rivers between 2021 and 2024. Twenty-two external measurements were recorded and analyzed using univariate statistical methods to identify sexually dimorphic traits. Results indicated significant differences ($P < 0.05$) in standard-length-normalized weight, horizontal orbit diameter, head height, jaw and skull width, caudal fin base height, pelvic girth, anal fin height, mid-snout width, and total length. The most striking difference was that females have larger weight:standard length ratios.

The sexual dimorphism found in weight, horizontal orbit diameter, total length, pelvic girth, anal fin height, and mid-snout width align with previous studies. While weight and total length remain key predictors of sex, this study suggests that orbit diameter and anal fin height may serve as additional distinguishing characteristics. Future research with a larger sample size and standardized seasonal data collection will further refine these methods, offering noninvasive/nonlethal alternatives for sex identification in *Lepisosteus osseus* populations for use in effective conservation strategies.

Department of Computer Science and Engineering



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Evaluating Choice of Dataset and Dimensionality as Modeling Decisions for LSA

Student Author: Cassandra Leder

Faculty Mentor: Zachary Stine

Latent Semantic Analysis (LSA) is a tool for text analysis that infers and encodes semantic information about texts. LSA uses a latent dimensional space by representing documents as vectors to create a matrix of topics. Topics are the essential words that describe a document's characteristics. The choice of dimensionality determines the number of topics in the topic matrix, therefore low dimensionality may potentially result in a weak representation of a document's characteristics and high dimensionality brings diminishing returns for representing a document's characteristics. To evaluate the semantic outcomes of the choice of dimensionality (k) and dataset, a network of LSA models was created. The findings suggest that model networks with different datasets, but the same sizes of k , are semantically similar to each other, regardless of dataset; yet, lower dimensionalities result in a semantic breakdown, with the LSA models with the lowest dimensionalities having the least similarity to the LSA models with the highest dimensionalities. This work is a part of broader research that asks how sensitive mechanics of semantic models are to a dataset. These findings could support future research into determining an optimal dimensionality for a given dataset.

Department of Geography



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Historical Trends in Streambed Elevation Changes at USGS Gaging Stations on the Gasconade River, Missouri Ozarks

Student Author: Calvin A. Burdess
Faculty Mentor: Matthew H. Connolly

Natural and anthropogenic disturbance regimes affect erosion and deposition patterns in river systems and alter stream channel evolution processes. In the past century, the Ozark Plateaus of Missouri have undergone notable land use changes and potential climate shifts, impacting local waterway dynamics. Previous research and rising stakeholder concerns prompted the USACE and MDNR to investigate erosion processes in the Gasconade River. We analyzed USGS historical field measurements from Gasconade River Watershed gages at Rich Fountain, Jerome, and Hazelgreen to better understand streambed erosion and deposition patterns. We calculated mean streambed elevation (MSBE) trends filtered by representative streamflow and gage proximity. The selected gages represent key positions within the watershed. Rich fountain, the most downstream gage shares the most similar pattern overall with Jerome, which lies in the central watershed along the confluence of one of the watershed's largest tributaries. These gage locations remained generally stable from the 1920s to the 1950s, with a deposition trend from the mid 1980s-2000s with little variability. However, both locations display steep trends of erosion from the early 2000s to the late 2010s. Hazelgreen, the watershed's most upstream gage, remained generally stable from the late 1920s to the late 1940s. Slight sediment deposition in the early 1950s was then followed by general stability from the mid 50s to the late 60s, with an erosion trend from the late 90s to the late 2010s. These findings concur with USGS analysis through 1994 and suggest continuing watershed process changes that inform future water management strategies.

Department of Mathematics



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The Impact of Trade Policy Shifts on U.S.-Mexico and U.S.-Canada Trade (1993-2024)

Student Author: Will Elliott
Faculty Mentor: Sharif Mahmood

In this project, we investigate how major trade policies and economic disruptions from November 8, 1993, to December 31, 2024, affected U.S.-Mexico and U.S.-Canada trade volumes. Using structural break detection, causal impact analysis, vector autoregression (VAR), and forecasting, we identify key changes stemming from NAFTA (1994), the 2008 Financial Crisis, USMCA (2020), and recent tariffs (2020–2024). Our approach suggests that while NAFTA initially boosted trade, crises and new tariffs complicate these relationships. Impulse response functions (IRFs) show how policy changes ripple through macroeconomic indicators. Lastly, ARIMA forecasts estimate future trade trends through 2030. Our findings suggest that trade liberalization fosters short-term gains, but external shocks and protectionist measures can significantly influence outcomes. This concise study aims to offer policymakers integrated insights into the dynamic interplay between trade agreements, macroeconomic conditions, and global disruptions.

Examining Student's Attitudes Towards Statistics

Student Author: Sarah Thiele
Faculty Mentor: Nesrin Sahin

This study examines students' attitudes towards statistics in an introductory statistics course at a university in the southern United States. The study used SATS-36 survey to measure students' attitudes. There were 117 students who completed the survey both at the beginning and at the end of the semester. The results of the study revealed that, in general, students had positive attitudes towards statistics at the beginning of the semester and they further improved their attitudes in affect, cognitive competence, and effort subscales as they took a statistics course. Students had only a change in negative direction for difficulty subscale. The changes in students' attitudes for value and interest subscales were positive however these changes were not significant. The study also revealed that males had more positive attitudes than females in all subscales except for the effort subscale at the beginning of the semester. From pre-to-post survey, females showed a slight decline in their interest in statistics while males show a slight increase. The study also concluded that African American students were most resistant with their attitudes resulting in minimum increases in their attitude scores compared to other racial groups. The correlations between the subscales were highly correlated with each other at the beginning of the semester except for the effort subscale, however the correlations weakened by the end of the semester. In addition, the study concluded that the attitudes at the beginning of the semester were not strong predictors of student achievement.

Department of Physics, Astronomy and Engineering



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Wireless Power Transmission Using Electromagnetic Induction

Student Author: *Jeremy Abbott*

Faculty Mentor: *Azida Walker*

Abstract: Wireless Power Transmission (WPT) is an emerging technology that enables the transfer of electrical energy without direct physical connections. This project explores using resonant inductive coupling to deliver power to a small DC motor wirelessly. A 12V DC power adapter drives the system and utilizes a 555 timer circuit configured in a stable mode to generate a 10kHz square wave, which drives a power MOSFET switching the primary coil. The alternating magnetic field induces current in a closely aligned secondary coil, which is rectified and filtered to produce a stable DC voltage. This voltage is used to drive a motor rated for 0.5A. The project investigates key challenges such as coil alignment, energy loss, and power transfer efficiency. Results aim to demonstrate the feasibility of wireless energy transfer for small-scale electromechanical loads and lay the groundwork for future improvements in power range and efficiency.

Electronically Controlled Magnetorheological Fluid Damper

Student Author: August Childress

Faculty Mentor: Azita Walker

This project explores the interaction between magnetorheological (MR) fluid, a fluid composed of suspended ferrous particles, and magnetic fields to explain fundamental electromagnetism topics from an engineering perspective. When MR fluid is exposed to a magnetic field, the ferrous particles line up along the field lines increasing the viscosity of the fluid. The usefulness of this property is demonstrated in a simplified version of magnetic ride control suspension, which utilizes dampers filled with MR fluid and electromagnets inside to control the viscosity of the fluid, which dictates the response of the damper to forces applied to it. The intent of this project is to show how topics in electromagnetism can be applied to real world situations with an engineering twist, and to make electromagnetism more accessible to people who are not interested in intense mathematics.

Radio Telescope Observations of the April 8, 2024 Total Solar Eclipse At 1420MHz.

Student Authors: August Childress and Blayne Griffin
Faculty Mentor: Jeremy Lusk

We present radio telescope observations of the April 8th, 2024 total solar eclipse from the University of Central Arkansas campus in Conway, Arkansas using a 2.3 m SPIDER 230C parabolic radio telescope tuned to a frequency of 1420 MHz. Observations began approximately 19 min before first contact and ended approximately 2.5 min after fourth contact, continuously tracking the sun across the sky. Our radio observations show a reduction in relative intensity from the beginning of the lightcurve to the middle of totality of approximately 70%, indicating that the apparent size of the radio solar disk was larger than the apparent size of the moon and therefore only partially covered. This contrasts with optical data, where the eclipse was total. To determine the relative size of the radio solar disk, we compared our observed radio and optical data to theoretical lightcurves of the eclipse with different solar radii. From our analyses, we found that the radio solar disk is approximately $R_{1420} = 1.27R_{\odot}$. This is consistent with previously published results.

SPS @ UCA: Small Parallel Supercomputer

Student Authors: Shawn Govitz and John Phillips
Faculty Mentor: Jeremy Lusk

Modern scientific computing often requires large scale high performance computing which typically costs millions of dollars. This project allows students to learn about everything that goes into building a small scale parallel supercomputer. Students will interact with the hardware, software, and simulations that are handled by the computer. The way a parallel computer operates is different from how a normal computer operates, so it is important for students to interact with the machine.

Tesla Coils as a Demonstration of Maxwell's Electromagnetic Theory

Student Author: Blayne Griffin
Faculty Mentor: Azida Walker

Tesla Coils are a marvel of electrical engineering, first created by Nikola Tesla in 1891. At their core, Tesla Coils operate on Faraday's Law of Induction. An oscillating, or alternating, current through a coil generates a changing magnetic field. By placing a second coil within the first, the changing magnetic field then induces an electric field in the secondary coil. This electric field creates a high potential difference, or voltage, that builds as it climbs the coil. The air then acts as a capacitor, allowing the secondary coil to discharge. This project aims to show how each of Maxwell's other equations are also at play throughout the Coil, and how Tesla Coils can be used to give a direct and hands-on understanding of these laws.

Magnetic Levitation Train with Infrared Tripwire

Student Author: Addison Heidelberger

Faculty Mentors: Azida Walker and Carl Fredrickson

The maglev train is a public transport system implemented in several countries and allows for high-speed travel with minimal carbon emissions due to the use of electricity. The train is propelled by a complex system of electric motors and magnetic systems. Since this is a scaled down model, a different system is being employed. The use of an IR tripwire system powering an induction coil mounted on the track allows the train to be propelled forward and move continuously without external input after the initial moment. The track and train are 3D printed with magnets mounted with like poles facing each other which is responsible for the levitation, and the IR diodes are placed along the inside of the track in line with the induction coil which is what powers the train forward. The goal of this project is to bring light to a transportation system that could be seen in the United States in the future as we make efforts to improve carbon emissions by implementing clean energy systems.

Photometric Observations of Eclipsing Binaries

Student Author: Jackson Hill

Faculty Mentor: Scott Austin

Photometry is a method for measuring the brightness of a star in a picture. It is used for local star observations and recording in the Milky Way and, occasionally, in neighboring galaxies. Predicting the formation, behavior, and life cycles of celestial bodies is made easier by this strategy, which also helps us understand stellar evolution and interactions. Initially, I photographed a variety of celestial bodies to test the equipment and become familiar with the filtering standards before beginning observations of my primary object. In this study, the eclipsing binary 2MASS J05321923+3028282, a system in which two stars orbit one another, is the main objective to measure.

From December to April, I collected data throughout several evenings, which allowed me to collect a large number of frames over a long period of time. Processing these frames, aligning the images, and utilizing the telescope's bias, dark, and flat frames all contributed to improved image quality. Then, by comparing our target system to nearby stars with known magnitudes, I was able to calculate the brightness (or magnitude) of the system in each frame. Using these values, I was able to create a light curve that shows how the brightness of the system changes over time. By analyzing this curve, I studied the unique behavior and orbital characteristics of the binary system, overall contributing to a deeper understanding of this type of system.

Airflow Resistance of 3-D Printed Porous Plugs

Student Author: Braden Lee
Faculty Mentor: Carl Frederickson

Airflow resistance is a key factor in determining the acoustic impedance of porous materials. This study will focus on measuring the airflow resistance of 3-D printed materials with circular pores. The goal of this study is twofold: first, to design a device that can successfully and accurately determine the specific airflow resistance of a porous media, and second, to study the dependence of the flow resistance on porous properties of the material. The device measures the pressure just before and just after the media to determine differential pressure, and volumetric airflow rate is measured at the output end of the device. Understanding the relationship between material properties and airflow resistance can improve the design of porous materials for applications in sound absorption and aerodynamics.

Metal Detector with Integrated Chip

Student Author: Eric LeJune
Faculty Mentor: Azida Walker

This project focuses on building a simple metal detector that operates using the principles of electromagnetic induction. The main objective is to design a device that can sense metal objects by generating a current that induces a magnetic field which is then detected with the coil of wire.

The detector works by using a copper coil powered by alternating current to create an oscillating magnetic field. When a metal object enters this field, it induces eddy currents within said object. These currents then generate their own magnetic fields, which interfere with the magnetic field of the copper coil. This interference can be detected and used to trigger an external device such as an LED or speaker.

These interactions are derived from the two electromagnetic laws: Ampere's Law and Faraday's Law. Ampere's law describes how electric current creates a magnetic field and Faraday's Law explains how a changing magnetic field induces a voltage, which leads to the eddy currents in conductive materials. The metal detector will consist of a wire coil, a battery, an integrated chip, resistors, capacitors, and the external signaling device. This project showcases how fundamental electromagnetic concepts can be applied to create a functional device of detecting metals in the environment

Beyond the Beat: Amplifying a Tuned Snare Through Electromagnetic Induction

Student Author: Elizabeth Lopez

Faculty Mentor: Azida Walker

The impact of science on our world is incredibly extensive and exceedingly diverse. This impact frequently reaches fields typically not associated with the sciences, such as the field of the arts. One significant impact of science on the arts, specifically in music, is allowing for the development of revolutionary electric instruments such as the electric guitar. My project uses electromagnetic induction through a pickup, as used in electric guitars, to turn the acoustic sound waves of guitar strings acting as snare wires into an electric current. This current is amplified through a non-inverting amplifier circuit and turned back into audible sound through a loudspeaker. Further revision of this design could serve as a rudimentary prototype alternative to some preexisting tuned drums, such as timpani and steel drums. Ultimately, this concept and design could be extended to a series of tuned, electrically amplified drums, allowing users to play more involved parts in musical pieces. The project's nature will also make it an interactive teaching instrument when introducing students to electromagnetic induction.

AI Can't Write Like That!': A Test of People's Ability to Differentiate between AI and Human-generated Text

Student Author: Honey Norfolk

Faculty Mentor: Patrick Casey

This study examines two related questions: can individuals accurately distinguish between texts written by humans and those generated by artificial intelligence (AI), and, if so, how are they able to do so? Participants are presented with four texts, two written by humans and two written by AI. The texts encompass different styles, including encyclopedic/academic, newspaper, tabloid/gossip rag, and informal text message/email styles.

The procedure involves pre-testing participants about their prior knowledge of AI, as well as their confidence in their presumed ability to distinguish AI-generated text from humans. Participants are then presented with these texts, one at a time, and tasked with categorizing the texts. After each categorization, participants are asked to explain in detail how and why they made that determination. This approach enables a comparative analysis of the effectiveness of different strategies participants employ in identifying AI-generated texts.

The findings from this research may shed light on the general public's ability to discern between human and AI-generated texts across various writing styles. Initial findings indicate that certain regularly used tactics for detecting AI-generated texts may not be as effective as previously thought. This study attempts to get significant insights into the capacity to distinguish between human and AI-generated writings across diverse writing styles by studying their tactics and confidence levels. Moreover, this research contributes to our understanding of which strategies are most effective. Such insights have wide-ranging implications for various fields, including education, journalism, and AI development.

Handheld Magnetic Generator Demonstrating Faraday's Law

Student Author: Samuel O'Connor

Faculty Mento: Azida Walker

Faraday's law of electromagnetic induction, which describes how a change in magnetic flux creates an electromotive force, is a fundamental part of electromagnetism. This principle forms the basis for many modern forms of electricity production including induction motors and permanent magnet motors. Despite their importance in modern life, most people rarely interact with electric generators or motors on a regular basis. For these reasons, this project was focused on providing a hands-on way for people to see how electricity is produced. A sixteen-magnet rotor was made which created the magnetic field and could be spun by hand. It was placed beside a stator which contained eight copper coils. When spun, the generator created a low voltage and an alternating current which was then converted to direct current using a bridge rectifier so that it could be used with simple electronic devices such as LEDs. A capacitor was also used to stabilize the rectified voltage. The voltage was measured using a digital multimeter.

High-Efficiency Fresnel Lens

Student Author: Laura Rivera

Faculty Mentor: Carl Frederickson

The use of Fresnel Lenses has traditionally been tied to optical systems to efficiently focus and direct light, however their principles can also be adapted for use in acoustics to manipulate sound waves with high precision. This project discusses the design and optimization of a high-efficiency Fresnel lens utilizing a zone plate design for sound wave applications in the kilohertz (kHz) frequency range. By adapting diffractive acoustic principles, the zone plate design aims to enhance wave focusing, improve directional control, and minimize energy loss while maintaining a lightweight, cost efficient, and structurally feasible form.

The zone plate design offers key advantages for acoustics, such as compactness, structural simplicity, and reduced manufacturing costs. The project incorporates computational modeling to simulate acoustic wave propagation, design considerations ensuring practical implementation, and performance evaluation through experimental analysis. Optimization of ring dimensions, spacing, and material properties ensures the lens performs effectively at the target frequency range. Design considerations include 3D printability, structural feasibility, and experimental validation using signal generators and microphones. These experiments aim to confirm predicted focal patterns and acoustic behavior under controlled conditions.

Some of the potential applications of this project's results include ultrasonic imaging, non-destructive testing, and acoustic energy harvesting. The results of this research could contribute to a deeper understanding of zone plate-based Fresnel lenses in acoustics, offering insights into their advantages, limitations, and future developments in wave manipulation.

Magnetic Field-Responsive Ferrofluid Lamp

Student Author: Michalina Julia Schulz

Faculty Mentor: Azida Walker

This project's purpose is to create a magnetic field-reactive ferrofluid lamp with the use of electromagnets, interactive lighting and fluid dynamics. Utilizing Arduino microcontroller, Hall effect sensor and LED lights, the lamp will respond to change in magnetic field displaying different light colors. The ferrofluid-composed of nanoscale ferromagnetic particles suspended in mineral oil will visually react to magnetic field, creating spikes and various patterns depending on the strength of the flux.

This project aims to not only use ferrofluid as an aesthetic installation but also to develop real-time user-interactive prototype. All electronics including electromagnet and LED lights will be stored in 3D printed base, with glass bowl positioned above to hold liquid. Design will be secured with 3D printed lid and silicon to ensure stability and durability.

Ideally this project will create a design object as well as engaging educational tool that will combine science, engineering and art. Through hours of research, developing, coding and testing the lamp is expected to demonstrate how principles of physics can be transformed into interactive experiences, while also ensuring safe usage and functionality. Beyond its educational value with this project, I hope to spark curiosity and foster a deeper appreciation for invisible forces that shape our world. This work was made possible with the support and encouragement of the UCA Physics Department and faculty members

Spring Loaded Speaker & Double Coil Pickup

Student Author: Caleb Young

Faculty Mentor: Azida Walker

This project covers the basics of electric guitar function. The idea is to make a custom, fully functional guitar pickup, amplifier, and speaker using the basics of electromagnetism principles and circuits. This process must have an innovative design that has not been done by others.

Physics principles that will be key to this project include Faraday's Law, Lorentz Force Law, and magnetic induction. The speaker and pickup will be the focus in terms of these principles.

For the speaker design, card stock, a foam cup, springs, electromagnet, and a permanent magnet will be used. The oscillations this combination creates will be coupled with the springs to produce a more pronounced and amplified sound.

For the pickup, a double coil on a single pickup will be used. This is done to cancel out extra noise while keeping the bright tone of a normal single coil. The base of the pickup will be 3D printed to fit into a Squire Bullet electric guitar and utilize its circuitry.

Designs for the speakers ensure that magnetic oscillations will be strong yet controlled utilizing the springs. The designs for the pickup ensure that extra noise (humming) is cut out to reduce extra circuitry in the amp as well as bringing a new design to the single pickup.

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