Michigan Technological University

2023

Undergraduate Research & Scholarship Symposium

Welcome to the 2023 Undergraduate Research & Scholarship Symposium!

This symposium highlights cutting-edge research conducted over the past year by some of our best and brightest undergraduate students at Michigan Tech and Keweenaw Bay Ojibwa Community College (KBOCC).

Each student was mentored by a faculty member who took great care to guide them through the exhilaration, frustrations, painstaking work, and rewards of the research process. They have spent long hours in the lab, library, or out in the field collecting data, conducting interviews, reviewing primary and secondary sources, designing experiments, testing hypotheses, and analyzing their findings. The results of their work help us to build new models, encourage innovation, live in a better way, and deepen our understanding of the world around us. Through the process, they've built strong relationships and acquired skills that will help launch their future careers.

The projects showcased today represent a wide array of disciplines and highlight the diversity of research areas and avenues possible at Michigan Tech and KBOCC. Many of the students presenting their work today have been supported by university programs such as the Summer Undergraduate Research Fellowship (SURF) and the Undergraduate Research Internship Program (URIP). Our sincere thanks go out to everyone who has supported our students: faculty mentors, families, departments, colleges, and communities. In particular, thank you to the Portage Health Foundation and the DeVlieg Foundation for funding URIP.

I know you will enjoy interacting with these exceptional students and learning about their research journeys, experiences, and outcomes. I encourage you to come with an open mind, to ask challenging questions, and to help these students on their path to create a brighter tomorrow.

Sincerely,

Marika Seigel
Dean, Pavlis Honors College

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1. Application of Machine Learning to Predict Underground Fire Location

Student Presenter: Jake Maxon, Mining Engineering
Faculty Advisor: Snehamoy Chatterjee, Department of Geological and Mining Engineering and Sciences

Introduction:

Underground fire presents a two-fold hazard, consuming the oxygen supply quickly and generating harmful gasses that can be lethal to workers. Timely fire detection is instrumental to prevent worker death and injury. Implementation of gas monitoring devices in every mine passage is not financially feasible, and heuristic monitor placement is not optimal. The goal of this research is to identify fire location by taking measured airflow velocities and flowrates within an underground network and developing a machine learning model that can reliably predict fire location using a limited number of monitoring devices.

Materials and Methods:

The fire flowrates and fire locations we obtained from running several fire simulation models for an underground mine. A dataset containing passageway (feature) flowrate data was split into two subsets; a training and testing set. Training data was then used to rank the features using neighborhood component analysis (NCA). A machine learning model for fire location estimation was then developed using a probabilistic neural network (PNN). Different models were trained using varying amounts of features and spread parameters. The model with the best statistics from the validation data then attempted to classify fire location using the testing data . The top ranked features were then analyzed to assess their spatial correlation underground to determine if any airways could be eliminated from the model's estimation due to their close proximity and theoretically similar data readings. Heuristically selected feature sets, varied from 3 to 8, were then retrained and tested. The purpose is to validate the PNN's ability to create accurate models while eliminating features that would be very similar, and to determine the relationship of error and feature number more robustly. This relationship would allow companies to assess the linear cost of increasing gas monitors with the increase in accuracy they provide.

Results and Discussion:

We have found very strong evidence that this method can provide a solution that can be accurate, adaptable, and consistent with varying input conditions. This research has the potential to continue as more work with bigger datasets should be considered. This model works very well, however a greater use of a graphic user interface or implementation into a current software would allow for greater widespread use in the industry. Greater outreach would allow companies to assess financial investment into accuracy of fire detection, and would allow for safer working conditions if fire were to break out underground.

2. Spray-Based Deployment of a Fungal Biocontrol on Invasive Buckthorn Sprouts

Student Presenter: Abraham Stone, Ecology and Evolutionary Biology
Faculty Advisor: Tara L. Bal & Sigrid C. Resh, College of Forest Resources and Environmental Science & Ecosystem Science Center

Introduction:

Invasive buckthorns (Rhamnus cathartica, Frangula alnus) are a prominent threat to ecosystems across the United States. Post cutting and herbicide treatment, buckthorn colonies easily persist in the form of cut stem resprouts and germinating seed banks that, if not regularly treated, lead to the reestablishment of the population. Few management practices provide a long-term solution in effectively removing well-established buckthorn colonies. We seek to establish viable alternative methods to buckthorn management that reduces herbicide usage while providing commercial appeal in the form of a native biocontrol fungus, Chondrostereum purpureum.

Materials and Methods:

Our research explores ways to increase the efficiency of deployment potential by developing and testing a spray-based C. purpureum application on cut buckthorn sprouts. We selected a local strain of C. purpureum (DR-365) isolated from a nearby trembling aspen. While previous research used a thick squeeze-bottle-applied gel, a thinner spray-based application of C. purpureum emphasizes ease of use, while aiming to maintain high rates of inoculation and sprout mitigation. To do so, we created three field test sites in buckthorn infestations in which we counted buckthorn sprouts and native tree saplings. We then manually injured buckthorn in three subplots to test control (no spray application) and treatment, with one additional plot reserved for destructive sampling. Samples from this reserved plot would then be cleaved and measured for staining distance from inoculation site; C. purpureum infection causes visible dark lines of zonation along its infection border. We tracked this to observe the intrusion of fungal hyphae into buckthorn wood over the growing season and monitored native species condition.

Results and Discussion:

Samples collected during the summer indicate definite fungal growth over time, however visual analysis suggests that buckthorn is adept at both stimulating growth in locations far from the injury site as well as cutting off resources (compartmentalization) to infected regions. While we expect sprout counts to remain high, evidence from sampled stems imply some successful C. purpureum inoculation. Surveys conducted late summer and early fall demonstrated little to no systemic infection on any native, uninjured trees within our plots. Year one results in spring of 2023 for this trial spray application will be collected in June and compared to sprout counts to observe long-term effects of spray-based fungal inoculation on buckthorn regrowth.

Since C. purpureum is likely more effective as a pathogen than as a saprotroph, buckthorn may prove a worthy adversary for topical C. purpureum application – we anticipate further studies to fine-tune spray creation, focus inoculation on living tissues, and observe the potential for solid inoculum as an application for larger buckthorn trees. Should a viable liquid biocontrol product be produced through this research, it could be of use to forest health specialists, invasive species managers, and a foray of industry practitioners with stakes in buckthorn management.

3. Using DNA Metabarcoding to Evaluate Dietary Resource Partitioning Between Two Sympatric Tilefish

Student Presenter: Tessa Tormoen, Ecology and Evolutionary Biology
Faculty Advisor: Kristin Brzeski, College of Forest Resources and Environmental Sciences & Jill Olin, Department of Biology

Introduction:

Resource partitioning between sympatric species is a primary mechanism that structures ecological communities, but quantifying distinct factors contributing to species coexistence in remote environments remains a challenge. Golden and Blueline Tilefish are benthic, deep-sea, sympatric species with valuable ecosystem and fisheries roles. Evidence of similar resource use among these Tilefish has only been recently observed, but not quantified. Innovative DNA metabarcoding techniques can use genetic markers in stomach content samples to parse out taxonomic units. By using the DNA metabarcoding technique, we can specifically describe whole dietary composition to understand resource partitioning between the species.

Materials and Methods:

Whole stomachs were collected from Golden (n = 40) and Blueline (n = 20) Tilefish as a part of a fishery-independent longline survey of the mid-Atlantic Ocean from Georges Bank to Cape Hatteras in 2017 and 2020. Upon capture, Tilefish stomach contents were immediately immersed in 95% ethanol in the field. Prior to performing genetic analysis, samples were homogenized and ethanol was removed using a Vacufuge. DNA was extracted using a DNeasy Powersoil Pro Extraction Kit. To amplify diet content, a two-step polymerase chain reaction (PCR) library preparation technique was performed for each primer pair. The first PCR performed a gene-specific amplification using metabarcoding primers to target multiple taxa. The second PCR attached an individual identifier that bioinformatically separates the samples, and additionally attached Illumina sequencing adaptors for high through-put sequencing on an Illumina Miseq. Next, to identify diet composition, I am implementing a bioinformatic pipeline where I will de-multiplex, conduct quality control, sort sequences to compare to genetic repositories, and assign taxonomy to each diet item. I will visualize dietary composition differences with a non-metric multidimensional scaling ordination in R package vegan and assess dietary niche overlap with the Pianka's index of niche overlap in R package EcoSimR.

Results and Discussion:

Anticipated results will describe the dietary differences between Blueline and Golden Tilefish, including taxonomic units and identifiers. The results should depict a whole dietary understanding for each sample and reflect any potential prey overlap between species. This research will be the baseline for understanding whole dietary composition for sympatric Tilefish fish species. As ocean waters warm, thermal and depth preferences for these species may begin to overlap, potentially inducing competition. This research will also help to influence better fisheries decisions, especially if certain prey species decline, which may impact Tilefish populations.

4. Locating Tourism Rhetoric: A Comparative Study

Student Presenter: Lena Lukowski, Mechanical Engineering and Scientific and Technical Communication
Faculty Advisor: Mark Rhodes, Social Sciences

Introduction:

Tourism is a loosely-defined and ever-evolving concept. While being focused on temporary travel, tourism is also used by locations as an economic resource. However, rhetoric surrounding tourism changes from place to place. A diverse culmination of demographics, culture, and environments shape a locale while simultaneously shaping tourism and its rhetoric. Location and the rhetoric of tourism are not direct influences, but they work interchangeably to produce effective tourism, generating more travel and bringing more consumerism into each location's economy. I question tourism rhetoric's relationship with location and how these ideas work cohesively to flatten the tourism industry.

Materials and Methods:

I collected data alongside the "Amtrak Tourism: Train, Cities, and Sustainability" summer study-away program offered by MTU. This trip allowed me to visit 6 different locations across the United States where I researched the locational differences in landscape, demographics, and culture, as well as noted the different forms and examples of tourism rhetoric that were presented. In each respective location, I conducted interviews with government officials, tourism bureaus, and other tourism stakeholders. Questions included discussing the main tourism attractions found within the cities, how the city is working to increase tourism, and the general impact that tourism has on the citizens and the community. I also used photography to document these tourism landscapes.
Taking a representative sample of six key tourist destinations in each city, I then coded the photographs using content analysis. These codes were then sorted into descriptive sub themes pertaining to the overall theme of each photograph. These subthemes then generated the three broad themes of "Historic, Nature, and Marketing." Cross-analysis of these themes and sub-themes by location points towards how tourism rhetoric and location are related.

Results and Discussion:

Overall, tourism is used to give meaning to a place. The content analysis reveals that despite the differences in physical location and characteristics, there are overarching themes that connect tourism. These themes of Historic, Nature, and Marketing can be further divided into several subthemes. For example, Nature can be divided into preservation and landscaping, allowing for further discussion of the different ways locations use nature, both crafted and natural forming, to generate a greater tourism industry. These themes help show that in order for a location to have successful tourism, there needs to be a synergy between the location and the rhetoric surrounding it. Using these themes essentially 'flattens' the idea of tourism into a set of building blocks to base its rhetoric. The found themes create a methodology that can then be applied to all locations, producing a tourism industry that shapes the location and generates economic support despite the specifics of the location. However, this research is very subjective, and warrants further investigation to discover if there are other themes that may be present in traveling to different areas of the United States, and internationally.

5. Incorporating Dermcidin Into a Composite Hydrogel to be Used in Wound Healing

Student Presenter: Marli Hietala, Biomedical Engineering
Faculty Advisor: Rupak Rajachar, Biomedical Engineering Department

Introduction:

Hydrogels are hydrophilic crosslinked polymers characterized as being biocompatible, biodegradable, and possess good adhesion properties. Their unique ability to mold to irregularly shaped wounds plays a crucial role in their use as a scaffold for wound repair and ability to deliver active agents to aid in wound healing.The peptide, dermcidin, has been found to protect neuronal cells exposed to hydrogen peroxide against oxidative stress. The goal of this work is to incorporate dermcidin into a reactive nitrogen and reactive oxygen species (RNS and ROS) releasing hydrogels as a means to better control the delivery of these species to promote wound healing.

Materials and Methods:

The first aim of this experiment is to incorporate the dermcidin into an RNS releasing hydrogel. The approaches used will be to incorporate the protein during polymerization, and after the hydrogel has formed. The first method will crosslink dermcidin with the PEG-fibrinogen hydrogel and it will become part of the matrix [3]. In the second method dermcidin will form a non-covalent bond with the hydrogel where it will fill in the porous region of the gels' matrix. The second aim will be to characterize the mechanical and chemical properties of the hydrogels (swelling, stiffness, and degradation behavior). Rheometry measurements will be made to characterize the stiffness. The swelling behavior of the hydrogels will be assessed by determining the swelling ratio, a function of the hydrogel dry and wet weight. Degradation of behavior will be determined by period visual observation and use of a BCA assay to measure protein content in the degradation media (sterile PBS at 37C) [4].

Results and Discussion:

The expected outcome of this research is that we will be able to develop a dermcidin composite hydrogel with controlled physical properties that can be further tailored for use as a wound healing support. This hydrogel will open the door for exploring the process of wound healing and balancing the protective and detrimental effects of oxidative stress in a wound healing microenvironment.

6. Investigation of a novel zinc-based alloy for bioabsorbable vascular stent applications

Student Presenter: Henry Summers, Materials Science & Engineering
Faculty Advisor: Jaroslaw Drelich, Materials Science & Engineering

Introduction:

Vascular angioplasty with stenting is a surgical procedure that widens arteries to restore blood flow and is most often performed using permanent metallic stents. Drawbacks with these permanent stents, such as late stent thrombosis, in-stent restenosis, and invasive removal procedures, have driven researchers to investigate materials that can harmlessly resorb into the body upon completion of their role as arterial scaffolding. Iron and magnesium alloys, as well as polymers, have been investigated to fill this role, however, have been found to be inadequate alternatives. Zinc (Zn) alloys have emerged as promising candidate materials due to excellent biocompatibility and corrosion uniformity.

Materials and Methods:

The goal of this study is to investigate the microstructural changes that occur throughout several manufacturing and processing stages of stents. The grain size and intermetallic content of a novel senary Zn based alloy containing silver (Ag), copper (Cu), manganese (Mn), zirconium (Zr), and titanium (Ti) is determined in as-cast ingots, extruded rods, and cold drawn tubes. Additionally, the response of the extruded rods to a heat treatment of 390 deg. C is evaluated at several durations to determine the impacts on strength, ductility, and corrosion rate. Scanning electron microscopy (SEM) is used for imaging cross sections of all alloy conditions for grain size analysis. SEM energy dispersive spectroscopy (SEM-EDS) is used to examine the elemental distribution and identify locations and sizes of secondary phases within the zinc matrix. X-ray diffraction (XRD) is used to determine the identity and relative amount of intermetallic phases present in each sample type. Compressive and tensile mechanical tests are used to determine the strength and ductility differences between the as-extruded and heat-treated rod. Finally, potentiodynamic corrosion tests are used to evaluate and compare the corrosion rates of as-extruded and heat-treated rod.

Results and Discussion:

In this study, the effectiveness of various heat treatment durations on a novel Zn-Ag-Mn-Cu-Zr-Ti alloy was investigated. This characterization included analysis of the microstructural evolution occurring from both hot extrusion and heat treatment, as well as an evaluation of mechanical and corrosive properties before and after heat treatment. Based on the results that were obtained, the following conclusions can be made: Hot extrusion results in significant refinement of microstructure, as the average grain size of 70 +- 40 μm for the as-cast ingot was reduced by 87%, the alloy experiences ~50 MPa decrease in tensile strength as a result of thermal treatment but the ductility is improved from ~7 to 24-26%, and finally, the corrosion rate was found to be reduced from approx. 0.7 to 0.2 mm/year after heat treatment. The results of this study indicate that the temperature for heat treatment of the Zn-Ag-Mn Cu-Zr-Ti alloy could be reduced below 390℃. Further examination of the response to heat treatment at lower temperatures is required for optimization of alloy processing for stent applications

7. Public Tourism Infrastructure and Accessibility: Comparison of Metropolitan and Rural Structures Using Grounded Theory Thematic Analysis

Student Presenter: Riley Powers, Scientific and Technical Communications
Faculty Advisor: Kathryn Hannum, Department of Social Sciences

Introduction:

While there has been much work within the scope of accessible public tourism infrastructure, there is little study on the intersection of population size and density on accessibility for disabled travelers. How do the size and scale of public transportation infrastructure affect individual perceptions of accessibility?

Materials and Methods:

Data collection was attempted in two different metrics, qualitative autoethnography using landscape and public social media content collection. Auto-documentation was collected via a three-week exploratory trip riding public transit such as buses, trams, and trains. This information-photos, journals, and observations were collected in Portland, Sacramento, and Aspen and via the U.S. Amtrak train system on the Empire Builder, Coast Starlight, and California Zephyr lines.

Thematic Analysis of the Social media site Reddit was used to supplement the data. Data was taken from the anonymous social media site Reddit. Adapted from Sandhu (2020), a new method was synthesized. A selection of Subreddits were chosen based on anticipated relevance, indicated from the literature review. Within each community, inner-Subreddit terms were used to gather the top three posts for each topic, and correlating comments were selected. The results of an inner-Subreddit are ranked by internal algorithms that attempt to find the most relevant post based on word associations. Grounded theory was the basis of analysis created by Glaser and Straus (1967). Open codes, the informal collection of associated ideas, were synthesized. Codes were then formulated into themes and the continual interpretive analysis of the codes.

Results and Discussion:

There was a significant connection between the perceived experience of accessibility and the interactions disabled travelers encounter with employees of the transit system. The bus driver, conductor, or other transit employees would “make or break” the experience for riders. This corroborates the experience of the Primary Investigator (PI). Many times, drivers of buses and trams appeared to become increasingly annoyed at their presence because it required more work for them, one even disparaging the PI for the additional time they needed to enter the bus. Other times, drivers that were polite or helpful in ensuring safe travel made the experience overall more enjoyable.

From this data, the original hypothesis cannot be validated. However, the findings from this work further the findings of other works in the field. For instance, this project validated the findings of Hashim et al. (2012), which posited that through qualitative analysis of public spaces, it mattered more for individuals the actions of employees rather than the physical barriers present.

8. Autonomous Terrain Classification

Student Presenter: Andrew Freel, Robotics Engineering
Faculty Advisor: Anthony Pinar, Electrical and Comnputer Engineering

Introduction:

Autonomous navigation is becoming more and more present in the modern world, from in commercial vehicles to small aurtonmous vehicles whjich can be used to a substantial variety of tasks. As such, the ability of vehicle to properly understand its environment is important. A sepcific instance is knowledge of the specific terrain on which the vehicle is traversing, as this could play a big part in the vehicle's decision making and how to approach its navigation. Thus, the purpose of this project is to create an algorithm that performs this terrain classification task.

Materials and Methods:

Before beginning, a literature review took place in order to better understand what work has previosuly been done in this field. The next two steps occured simaltaneaously; a small autonomous vehicle equipped with an IMU, RGB camera and a usb microphone was used to collect physical data on campus, and time was (and is still being) spent on learning the basics and fundamentals of machine learning in the context of this, for example the use of neural networks. Going forward, the understanding of machine learning will be further developed, and as this progresses, the physical data will be brought in and tested as the algorithm is developed.

Results and Discussion:

The research is still ongoing, and the primary expected outcome is algorithm that can accurately classify a terrain given visual, audio and/or imu datasets. If all goes to plan, this algorithm will be a new approach on the problem or at least improve upon previous approcahes to the problem. This will hopefully add an impactful contribution to this sector of research; a sector which will likely be playing a bigger and bigger role in autonomous navigation in the future.

9. The Effect of Strict Opioid Limits on ER Utilization in the Upper Peninsula Health Plan

Student Presenter: Maxwell James, Statistics
Faculty Advisor: Qiuying Sha, Statistics

Introduction:

In January 2018 a new law was enacted that made it much more difficult for patients to be prescribed opioids. On January 4th, 2018, Public Act 247 was passed and set in place guidelines and procedures that healthcare providers must follow before and during any and all opioid prescriptions that they fulfill. The goal of this study was to analyze data provided by UPHP which contained patient information and medication usage from 2017-2020. Using the information we wanted to determine whether or not ER utilization of opioids increased after the passing of Public Act 247.

Materials and Methods:

We examined the data using the statistical software R and performed pre-processing techniques, such as Box-Cox transformation to handle skewness, spatial sign transformation to handle outliers, and scale/center to normalize the data. After the preprocessing was completed, we were left with a data set that was ready to have tests applied to it. For each member there was a corresponding number for ER utilization before and after the passing of Public Act 247. After analyzing the data post preprocessing we determined that it met certain criteria that would allow for a paired t-test to be performed. Using the pharmacy data, we were able to get a list of the top 15 most used opioids during our time period. The unit price of these opioids was calculated by dividing the cost by the amount supplied. If there was more than one prescription per day then the unit price was averaged out for that day. This was then plotted out as a time series using the date of prescription. After analyzing the time series we determined that inflation of the price of medication would not affect our results.

Results and Discussion:

The paired t-test of the 893 subjects yielded a test statistic of t = -1.8639. With 1080 degrees of freedom in the test a p-value of 0.0313 was reported. Using the standard alpha of 0.05 the conclusion of the test was significant. In Figure 2 it can be observed that there is slightly more skewness to the right with the after ER utilization. Since this was a paired t-test design there was no need to account for covariates in the study such as age, gender, or weight.

Since the p-value of 0.0313 is less than alpha of 0.05 we can conclude that there is significant evidence to suggest the ER utilization of opioids by members of UPHP has increased since the passing of Public Act 247 in January of 2018. Further exploration of the data could yield even more interesting results. With the new semester starting soon I wish to continue working with the data and hopefully answer more questions that UPHP might have.

10. Improving North American Right Whale Satellite Tags Using a Degradable Tip

Student Presenter: Twila Martinson, Material Science & Engineering
Faculty Advisor: Paul Sanders and Rupak Rajachar, Engineered Biomaterials

Introduction:

Monitoring behavioral patterns of marine mammals is a vital component in the ongoing study of general ocean health and the ecology of individual populations. Satellite telemetry tags collect data to assess survival, reproduction, and behavior of marine cetaceans. One problem associated with implantable tags is the shear force generated at the tissue-tag interface. This leads to the development of persistent wounds [2]. As a whale swims, the blubber layer glides across the muscle layer. A tag that reaches the muscular layer can cause extensive damage to the muscle tissue with its sharp tip designed to cut through the blubber during deployment.

Materials and Methods:

A degradable whale-tag tip may improve the biocompatibility of the tag, and as a result, reduce the development of persistent wounds. This may be accomplished by heat-treating the 316L stainless steel used to make the sharpened tag tip. Samples of heat-treated sharp tag tip of varying temperatures and times were made to assess the actual blunting process of the tip in simulated service conditions. A carburizing heat treatment of 6,8,12 hours at 900°C in graphite and cast iron chips was used. Samples were then immersed in 3.5 wt% NaCl solution for 48 hours with agitation. The media containing the metallic degradation products was collected and the cytotoxicity of the degradation products was determined by assessing cell viability in culture with live-dead staining and imaging as an initial measurement of biocompatibility.

Results and Discussion:

The goal of this project is to modify the current satellite telemetry tag tip design to create a self-blunting tip by means of heat treatment and further determine that the approach does not produce significant degradation product cytotoxicity. There is the intent of using these initial findings as support to implement the improved modifications in actual tags designed for future deployment.

11. Automated Manufacturing Improves People's Daily Lives

Student Presenter: Bo Eyre, Mechanical Engineering
Faculty Advisor: Marika Seigel, Department of Humanities

Introduction:

Automation is on the rise, so we conducted research on how this affects customers, employees, and employers affected by new automation technology. The specific fields we evaluated were collaborative robots and 3D printed prosthetics because Alyssa and I have industry experience in those fields.

Materials and Methods:

Our research was conducted through analysis of peer reviewed journal articles, customer reviews, and personal industry experience.

Results and Discussion:

We concluded through our research that automation improves people's lives for several reasons. In 3D printed prosthetics, costs are reduced and prosthetics become available to people who couldn't previously afford them. Collaborative robots reduce operating costs and waste while providing a safe work environment. In addition, workers skill sets are developed faster when mundane welding tasks are completed by a robot and workers can focus on where their skills matter.

12. Effects of Fusion Protein PAX3-FOX01 Presence on Cancer Cell Traction Force Transmission in Varying Microenvironments

Student Presenter: Kathleen Pakenas, Biomedical Engineering
Faculty Advisor: Sangyoon Han, Mechanobiology Lab, Biomedical Engineering

Introduction:

Rhabdomyosarcoma (RMS), the most common childhood soft tissue cancer, is divided into categories: alveolar (containing PAX-FOX01 Fusion Protein, otherwise known as fusion-positive) and embryonal (fusion-negative). This study examines the tendency of fusion-positive FPRMS to be more malignant, or spread more robustly throughout the body, than FNRMS. The tumor microenvironment (TME) is different for these two cancer types: FPRMS secretes a sparsely linked collagen extracellular matrix, whereas FNRMS secretes far more collagen to its stiffer environment. This study investigates the effects of differing collagen density and microenvironment stiffness on traction force exerted by cells of the two subtypes.

Materials and Methods:

Bovine Collagen II of thick (5ug/mL) and sparse (0.1ug/mL) density, coated on top of 0.7kPa or 12.5kPa Qgel 920 silicone gel from Quantum Silicones, creates the 2D "tumor microenvironment" for experiments. This is coated with 40nm fluorospheres, then cells are seeded on the substrate and imaged live under total internal reflection (TIRF) or confocal microscopy with a 60x oil-immersion objective. Images of beads are processed with TFM software in MATLAB to reconstruct traction, whereas the images of cells are analyzed for membrane protrusion and adhesions. RH41 cells (FPRMS) and SMS-CTR cells (FNRMS) are the two cell lines used. Substrate stiffness was quantified using a DHR-2 rheometer.

Results and Discussion:

Results show a difference in traction force exerted by cells based on fusion protein presence or absence, but also a difference based on tumor microenvironment, varying with collagen concentration and substrate density. Some traction force microscopy images have yet to be analyzed, but results are anticipated to show more traction force exerted in stiffer environments, particularly by fusion-negative cell lines. The effects of varying collagen density will also be reported. This information will help to correlate malignancy, migration, traction force location and magnitude with tumor microenvironment changes for each subtype of RMS.

13. Moth Community Distribution Across Varying Silvicultural Treatments Post 5 years harvesting

Student Presenter: Katie Bershing, Applied Ecology and Environmental Science
Faculty Advisor: Tara L. Bal, Forest Health

Introduction:

Nocturnal Lepidoptera were sampled across seven treatment areas with differing silviculture treatments in the Michigan Tech Ford Research Forest in Alberta, MI. An area unharvested for over 60 years acted as the control forest. The remaining six treatment areas were located in the Northern Hardwood Silvicultural Experiment for Enhancing Diversity (NHSEED) that was harvested in 2017. A better understanding of the community diversity of macro-moths present in these areas can provide valuable information about forest management decisions as moths can serve as bioindicators of forest or habitat conditions (Dar and Jamal 2021, Root et al., 2021).

Materials and Methods:

Moth sampling took place over the course of three months during the summer season of 2022. Black light UV light traps were used over a 12-hour period, once per week to collect moth specimens. Traps were set approximately 7 days apart, but this schedule was weather-dependent. One trap was placed in each treatment type (7 traps per week), for a total of 7 rounds (49 separate sampling events). Moths were identified to species when possible, or at least into Family and Genus levels. Nonparametric ordination will be conducted to analyze moth community groups using the different silvicultural treatment areas in PC-ORD.

Results and Discussion:

Research is ongoing as ordination and correlation analysis will take place during winter 2023, exploring the heterogeneity of the moth community and the distribution of all species identified across the different silvicultural treatment types. This analysis will be useful in determining forest cover types moths prefer and to what extent possible is their preferred use of varying density, regenerating northern hardwood forests.

14. Using lidar to help assess the safety of grade crossings with passive warning devices

Student Presenter: Alexander Lehnert, Civil Engineering
Faculty Advisor: Pasi Lautala , Civil Transportation & Colin Brooks, MTRI

Introduction:

Highway-rail grade crossings with only passive warning devices are more dangerous than active crossings as drivers may forget what to do at these crossings. While active warning devices provide extra layers of assurance, passive crossings rely on the driver's awareness of their surroundings. An issue that drivers often face at these crossings is insufficient sight distance. Obstacles blocking a driver's sightline create a safety hazard, but quantifying the level of such hazards is challenging. I believe that publicly available LiDAR can be used to determine sight distances at these crossings and identify unsafe crossings with respect to visibility.

Materials and Methods:

Step one is to amass an inventory of passive crossings with crashes at them in the past year within Michigan, Minnesota, and Wisconsin. After obtaining the crossings to study, I gather LAZ files for the crossings from the United States Geological Survey data download site. The LAZ file is a compressed point cloud file that contains the LiDAR points. Using a converter tool in ARCGIS, I convert the LAZ file to a LAS file. This unzips the LAZ file and makes the points viewable. Further, the LAS file must be converted to raster. When this is done, the map will show a digital elevation model (DEM) of the area. This shows the elevation and area of blockages such as trees and buildings. This will also show ditches and dips in the elevation and their area.

When the DEM is acquired, the viewshed can be used to develop a sightline layer. This layer is a binary layer/no layer raster. The area covered is viewable, while everything unshaded is not. When this is finished, I take the distance from the crossing required for the posted speeds by AASHTO and determine the percentage of that distance that is visible to the driver.

Results and Discussion:

Of three crossings in Michigan that match my criteria, two have extremely poor visibility in their respective sightline triangles. The issue is, as when it comes to Minnesota and Wisconsin, when the LiDAR data is not available or does not work in ARCGIS. To make up for the data, my search expanded to Illinois. Again, the data, when available, proved fruitful. My conclusion for the study is that publicly available LiDAR can be used as a bellwether for crossings that may be especially dangerous with respect to the visibility approaching the crossing. Further, using publicly available LiDAR data, I can justify the deployment of Crossing-i technology, currently under research at the Michigan Tech Research Institute.

Using the publicly available data first and backing up initial findings with Crossing-i, we can justify changes in geometrics, surroundings, and speed limits to make these crossings safer. For instance, the sight distance necessary for a safe crossing is further at higher speeds. Small changes at the more dangerous crossings can return less risks at these crossings. The next steps in my research will be collaborating with Crossing-i research to prove these findings further and exploring reasonable solutions to the crossings to make them safer.

15. Field Testing of Climate and Soil Moisture Monitoring in an Agricultural Setting

Student Presenter: Natalie Sorensen, Geological Engineering
Faculty Advisor: John Gierke, Geological and Mining Engineering and Sciences

Introduction:

Farmers need to adjust their farming practices based on water availability, which is dictated naturally by climate and enhanced anthropogenically. The Geological and Mining Engineering and Sciences faculty and students have been working with the Universidad de El Salvador – Facultad Multidisciplinaria Paracentral (UES-FMP) to enhance research in risk reduction and water scarcity in their local areas. They want to implement a new instrument, Mark 2 (Arable, San Francisco, CA), to monitor the crops and climate. This work was designed to test the Mark 2 against independent measurements of meteorological parameters and soil moisture in a local (Houghton County) agricultural setting.

Materials and Methods:

Data from a Mark 2 was compared to data from a HOBO RX3000 weather station (Onset, Bourne, MA), which is commonly used in climate-monitoring research, on the Gierke Blueberry Farm for the past decade. To independently test the soil moisture sensors on both weather stations, I took soil core samples to gravimetrically measure soil moisture. Soil cores were collected with a 3-inch diameter, 11-inch long Shelby Tube (Humboldt Mfg., Elgin, IL). Samples of soil for gravimetric analysis were collected from 3 different levels and put in tin dishes. The steps detailed in ASTM D 2216-19 were followed in analyzing the samples. Additionally, the HOBO RX3000 uses a soil-moisture probe (Model 10HS, HOBO Onset) that measures the soil dielectric constant by inducing an electrical field and uses a calibration to report volumetric moisture content (manufacturer reported accuracy of +/- 3% of full-scale). Arable uses a Sentek Sensor Technologies (Stepney, SA, Australia) Drill & Drop soil moisture/temperature probe to provide 10-cm-averaged properties over 3 depths. To measure the volume content, conductance, and temperature before taking the soil samples, I used the Spectrum Technologies, Inc. (Aurora, IL) Fieldscout TDR 150 Soil Moisture Meter in the uppermost 5 cm.

Results and Discussion:

I am still processing data to compare the Arable Mark 2 and HOBO measurements of air and soil temperatures and precipitation (along with solar intensity, atmospheric pressure, and relative humidity–the Mark 2 is not equipped to measure wind). Statistical analysis on the correspondence is still being performed. Based on manufacturer literature, I anticipate that the comparisons will agree (i.e., 1:1 correspondence) or at least be quantifiable. The independent soil moisture results from the gravimetric analysis seem preliminarily to be more variable, which is reasonable given the natural variability of soil properties in glacial settings, where this work was performed.

16. Signature Patterns: Continuity and Change in Age-Specific Net Migration for US Counties

Student Presenter: Ben Wireman, Mathematics, with minors in Computer Science, Spanish, and Global Community Development Partnership
Faculty Advisor: Richelle Winkler, Social Sciences Department

Introduction:

This research studies age-specific migration patterns for all US counties, each decade from 1950-2020. Most counties in the US have a "signature" pattern to their migration by age that is quite consistent over time. Our research analyzes these patterns, documenting different types of counties and examining how the most recent decade (2010-2020) is similar or different from the past. This is useful for anyone making plans based on migration such as city planning, labor, and policymakers.

Materials and Methods:

Teams of demographers have generated net migration (inmigration minus outmigration) estimates each decade 1950-2010. Our team is generating similar estimates for the 2010-2020 period. Like prior teams, we use a residual method. We start with data from the decennial census, add births and subtract deaths (based on vital statistics records), and age people forward ten years to construct the expected population at the end of the decade. The difference between the expected 2020 population and the observed 2020 population must be due to net migration.

To calculate the signature of each county's migration, we store the migration rate data for each county as a matrix and calculate its principal singular component. This method of calculating the signature maximized the average linear correlation between the signature vector and the migration rates. This allows for us to use the average R^2 value as a measure of how strong the signature pattern is.

To analyze the signature types and changes we are using principal component analysis and clustering analysis to organize the migration types and then analyze their change over time. We can then compare the 2010-2020 period, with the dominant age-specific net migration signature from prior decades, by county type.

Results and Discussion:

Our research is currently ongoing. The new method is promising to yield more information about the signature patterns and their strength. We have found that the signature patterns are generally strong with the average R^2 value across all counties in the US being 0.741. Additionally, we have found this method to be useful for finding which counties have changed in their migration.

The clustering and change over time analysis is ongoing. Preliminary tests of clustering by the signature patterns are able to group these counties into clear known categories. We expect to find change in these groups and their average signatures from this past decade compared to the previous decades. So far we have found clear examples of county level changes, but are still investigating if there are clear trends across the US.

The trends we discover will be useful for policymakers and planners in specific counties and larger scales to understand how migration is changing in their area.

17. Low Cost CAN FD and Automotive Ethernet Development Baords

Student Presenter: Matt Kouba, Computer Engineering
Faculty Advisor: Aurenice Oliveira, Electrical and Computer Engineering

Introduction:

CAN FD is currently used in nearly every new vehicle, but at Michigan Tech we do not yet have any resources that can be used in a teaching environment. In addition, Automotive Ethernet which is a type of IEE802.3 Ethernet is currently on the horizon. There are no low-cost Automotive Ethernet learning systems available for purchase. This research aims to develop both an Automotive Ethernet and CAN FD system that is low cost and can be used in the classroom to teach these communication systems.

Materials and Methods:

To design these teaching systems I have used Altium Designer to design the circuit and Printed Circuit Board layout. To assemble these Printed Circuit Boards I have taken advantage of the Plexus Makerspace in the EERC. To drive the communication between two CAN FD and Automotive Ethernet Nodes an Arduino is required at each module.

Results and Discussion:

Currently we do not have final versions of our CAN FD or Automotive Ethernet learning systems. We have a prototype CAN FD PCB created and proven to work, an Automotive Ethernet PCB on order, and a production ready version of the CAN FD PCB ready to be ordered. When both the CAN FD and Automotive Ethernet learning systems are completed Michigan Tech will have the first low cost Automotive Ethernet development system for use in a classroom. By having both of these learning systems this will enable the students of Michigan Tech to learn about new cutting edge technologies that are both in use in industry and are on the horizon in industry. Not only will this be available for Michigan Tech students, I plan to make this open source so that other universities across the country can also have access to low cost development systems for Automotive Ethernet and CAN FD.

18. A Grad-CAM interpretable deep learning multi-input transfer learning model integrating SPECT MPI polarmaps with clinical and derived topological variables for Cardiac Resynchronization Therapy Decision Support

Student Presenter: Kristoffer Larsen, Statistics
Faculty Advisor: Weihua Zhou, Laboratory of Medical Imaging and Informatics; College of Computing

Introduction:

Cardiac resynchronization therapy (CRT) is an established treatment for heart failure (HF). Despite acting as a costly and invasive procedure, a significant proportion of people (30-40%) who met inclusion criteria failed to benefit from the treatment. This is due to the multi-faceted causes of late-staged HF which make predicting patient response complex. Previous work hypothesizing the use of machine learning utilizing only tabular clinical variables has shown favorably in predicting CRT patient outcomes. With the availability of medical imagery in addition to clinical variables, a deep-learning computer vision model is hypothesized to provide increased medical decision support.

Materials and Methods:

In this project, the data included: medical images, such as myocardial perfusion, systolic dyssynchrony, and wall-thickening polar maps from SPECT MPI along with clinical variables (age, disease history, medication, etc…). In addition, topological parameters characterizing the texture of the polarmaps in terms of connected components and holes were also utilized through topological data analysis persistence homology (TDA-PH). The ground truth for CRT patient response was defined as an increase in left ventricle ejection fraction by (5%). Due to the small sample size (218), transfer learning was conducted using VGG16. A nested validation structure was employed with a 5-fold stratified shuffle split for the outer loop and a 4-fold stratified shuffle split in the inner loop for hyperparameter tuning. Tabular features underwent feature selection and preprocessing transformations, while polar maps were standardized. For comparison, three machine learning models namely, SVM, Random Forest (RF), and Elastic-Net (ENET) were trained for comparison using the same clinical/topological features and nested validation structure. Grad-CAM based color visualizations were generated to interpret the computer vision model's choice of importance in the polarmaps in order to further improve the medical decision support.

Results and Discussion:

The multi-input computer vision model outperformed the current medical guideline criteria for inclusion, with accuracy (0.74 vs. 0.53), sensitivity (0.78 vs. 0.75), and specificity (0.68 vs. 0.26), respectively. Moreover, the deep learning model outperformed the machine learning models (SVM, RF, ENET), with accuracy (0.77 vs. 0.66, 0.67, 0.74), AUC (0.79 vs. 0.75, 0.72, 0.75), sensitivity (0.78 vs. 0.65, 0.75, 0.75), and specificity (0.69 vs. 0.67, 0.58, 0.73), respectively. More work is needed to validate the models, specifically with respect to the small data size. Currently, the GRAD-CAM interpretation aspect of the project is still underway. The potential implication is finding specific regions of the polarmaps or patterns which contribute to CRT response.

19. Learning from Aviation to Improve the Safety of Autonomous Vehicles

Student Presenter: Katherine Rauscher, Mechanical Engineering
Faculty Advisor: Marika Seigel, Department of Humanities

Introduction:

Although Autonomous Vehicles [AVs] have proven to be successful in preventing human error accidents, there are still a myriad of concerns with the safety of this new technology considering automation has contributed to some modern highway accidents. Similarly, as commercial flight becomes increasingly autonomous, more aviation accidents related to automation occur. However, these failures are not wholly negative as the aviation industry "fails forward," or recognizes each failure's lessons and encourages improvement. To avoid accidents and save lives, it is worth exploring how developers could benefit from reviewing aviation failures and applying their lessons to AVs.

Materials and Methods:

An in-depth literature review of previous highway and aviation accidents pertaining to automation was conducted using the Michigan Tech Van Pelt and Opie Library search tools to find appropriate scholarly sources from a variety of authors and perspectives. Official reports from the National Transportation Safety Board, the United Kingdom Ministry of Transport and Civil Aviation, and the Bureau d'Enquêtes et d'Analyses were consulted to determine the causes of various aviation accidents and the subsequent changes made to industry practices and technology to help prevent similar situations. Thorough analysis was then conducted to ideate how these changes could be applied or modified for use in the automotive industry.

Results and Discussion:

This research revealed that the safety of AVs may be improved by emulating the aviation industry and taking actions such as implementing event recorders, encouraging safety collaboration, pursuing shared control, defining the roles of man and machine, improving automation understanding, combating complacency, and developing effective simulators. However, a number of challenges to consider were discovered including personal privacy concerns, automotive safety competition, differing operator philosophies, artificial intelligence, complacency, and complex highway environments. Although there are many specific actions that could improve the safety of AVs, none of these actions can be taken without significant collaboration between the aviation and automotive industries. More than anything, developers should focus on encouraging collaboration across industries to ensure the wellbeing not only of AV operators but also of everyone on and around the road: traditional drivers, passengers, cyclists, pedestrians, and more. Ultimately, if the aviation and automotive industries commit to continuous improvement, collaboration, and persistence through challenge, the safety of Autonomous Vehicles can be improved.

20. Variance Components and Phenotypic Plasticity of Northern Red Oak (Quercus rubra) in a Replicated Common Garden Experiment

Student Presenter: Natalie Howard, Applied Ecology and Environmental Science
Faculty Advisor: Carsten Kulheim, College of Forest Resources and Environmental Science

Introduction:

Quercus rubra provides the Eastern United States with many valuable ecosystem services. Climate change may be too rapid for Q. rubra to adapt or naturally migrate to more suitable habitats. Therefore, it is crucial to determine if assisted migration is a viable strategy for ensuring the survival of the species. To understand the limitations of assisted migration for Q. rubra, we must assess how environmental and genetic conditions influence its characteristics. Our goal was to assess how environmental and genetic conditions influence the characteristics of Q. rubra by investigating the variance components of its physiological and morphological traits.

Materials and Methods:

The data used in this study comes from two replicated common garden sites, the Kellogg Experimental Forest in lower Michigan and the Ford Center in the Upper Peninsula of Michigan. Each site is planted in an incomplete random block design containing 27 blocks with 30 trees per block. The seed sources for the common gardens come from 12 different populations in 3 climate regions, cold, intermediate, and warm ranging in mean annual temperatures from 4°C to 14°C. At least one population from each climate region is represented within every block. Each population is represented by 3-6 families consisting of 42-116 individual Q. rubra trees, for a total of 855 trees between the two common gardens. The data on aboveground biomass was collected in 2019, and calculated by using the measurements for height, crown diameter, and stem diameter of each seedling. Statistical values such as mean and variance were investigated at the population and regional level using the statistical software R and its associated data packages. Phenotypic plasticity visualizations were created using the calculated statistical values.

Results and Discussion:

On the population level, the Q. rubra individuals at the Kellogg site had a higher average of estimated aboveground biomass compared to the Ford site. The visualization of phenotypic plasticity on the population level indicates that there is a high variation in the phenotypic plasticity of the aboveground biomass trait. On the regional level, the Q. rubra individuals originating from warm seed source locations had a higher average aboveground biomass compared to the other regions. The visualization of plasticity on the regional level indicates that there is high variability in the phenotypic plasticity of the aboveground biomass trait. The larger average aboveground biomass at the Kellogg site reflects the higher temperatures and milder winters of the Lower Peninsula, allowing the saplings to allocate more resources into growth, whereas the saplings at the Ford site may be more conservative in response to the harsher growing conditions in the north. The phenotypic plasticity figure displays a strong interaction between aboveground biomass and the common garden site. The results of these analyses strengthen our current understanding of assisted migration for Q. rubra and provide valuable insights on how resilient the species will be to climate change.

21. Teaching computational thinking via modeling in STEM classrooms

Student Presenter: Dominika Bobik, Computer Engineering
Faculty Advisor: Leo C. Ureel II, Computer Science

Introduction:

In the growingly digital world, children are expected to start developing computational skills almost as soon as they start school. This starts with computational thinking, which can be taught at any age and doesn't start with coding or other skills traditionally associated with computer use. Our central hypothesis is that students engaged in computational modeling and simulation in a science course are learning and applying computational thinking skills. Our project is developing a Modeler app that will introduce a series of computational modeling activities in K-12 STEM classes.

Materials and Methods:

Modeler has been created with students' needs in mind. The app has been built using the technologies that are currently the top standards used in the industry. Modeler is a web based application, which makes it accessible around the globe within seconds without the need for a, often tedious, installation of software. If desired, the app can be downloaded in a form of a progressive web application, which ensures quick access, while preserving the benefits of the web. The user interface (UI) is built with React - frontend framework that allows for efficient changes in the user interface on data updates. App uses Nextjs - server-side React framework for rendering and distributing modern multi page applications - and is hosted on Vercel, which together enable safest deployment process with frequent updates if desired. Finally, Modeler uses Supabase as a relational database of choice. Furthermore, Supabase provides authentication methods, storage and instant APIs that are widely used and trusted among the professionals.

Results and Discussion:

The work on the Modeler is ongoing. We are in the process of finalizing the backend development. Upon the completion of this last, crucial step, we will begun user research. We have partnered with teachers around the Michigan, who have expresses interest in testing the tool in their classrooms. We plan on collecting feedback from the students as well as the teachers and analyzing received responses. First and foremost, we anticipate that the tool will enhance students' test scores in respective classes. Furthermore, we anticipate that students will gain the understanding of the computer science on the broader level.

22. Using Advanced Computing Techniques to Simulate the Universe with Neutrinos

Student Presenter: Jonathan Willis, Physics
Faculty Advisor: Elena Giusarma, Physics Department

Introduction:

In this project, we investigated the use of deep neural networks to build a bridge between the fast and approximate non-standard COLA simulations with neutrinos, and the expensive and accurate full N-body simulations using deep learning. Neutrinos are elusive subatomic particles that play an important role in the evolution of the Universe. Despite being the second most abundant particle of the Universe, their properties remain unknown. Running simulations with neutrinos will continue to help us in understanding the nature of these particles and their role in the evolution of our Universe.

Materials and Methods:

We used two types of cosmological simulations publicly available: Quijote full N-body simulations and COLA approximate N-body simulations. The Quijote simulations follow the evolution under the effect of the $3h-1$ gravity of 512 particles in a periodic box size of 1 Gpc. We trained the network using a set of 100 simulations. For each simulation, we ran a COLA simulation by matching the 1) number of particles, 2) set of values of the cosmological parameters, and 3) value of the initial random seed, which gave rise to an identical initial Gaussian field for both Quijote and COLA. This project introduced a deep learning approach to correct the output of approximate non-standard simulations to match full N-body simulations. We combined the works of Giusarma and Kaushal to train a neural network to correct the positions of the particles generated by COLA. We aimed to use the NECOLAv technique to produce complex cosmological N-body simulations with massive neutrinos directly from fast and approximate simulations. The input and output of our neural network was the displacement field of the particles in a 3D box. After training the model with the GPU, we quantified its performance with the power spectrum and bispectrum.

Results and Discussion:

In this project we used a convolutional neural network to build a bridge between the fast and approximate simulations with neutrinos, and the expensive and accurate full non-standard N-body simulations. The important advantage of our approach consists in the development of fast and generalized field-level emulators for non-standard cosmological simulations needed to maximize the scientific return of upcoming cosmological missions. They will help us in understanding the physics of those particles and their role in our Universe. This method can also be extended to explore more complex, non-standard, cosmological simulations, such as modified gravity or primordial non-gaussianity effects, or be used as a field-level emulator for covariance estimation, detecting features in the cosmic web.

23. The Gut Microbiome of Fish and Its Relevance to Antimicrobial Resistance

Student Presenter: Grace Gonzalez, Medical Laboratory Science
Faculty Advisor: Casey Huckins, GLRC

Introduction:

Within the past few decades, the aquaculture industry has expanded significantly. Following the increase of fish living in captivity is an increase in disease, which is often treated by a range of unregulated antibiotics. This has resulted in widespread antibiotic resistance in microbes and the inability to treat some diseases.

Along with antibiotics, additional factors such as stress, diet, environmental microbes, and seasonal changes have been hypothesized as contributing to disease states. The gut microbiome of the host plays an essential role in overall health and is an important aspect to consider when looking at how to improve fish health.

Materials and Methods:

An experimental group of 25 Pumpkinseed Sunfish (Lepomis gibbosus) were collected via seine netting from Chassel Bay, MI and brought to the Great Lakes Research Center.

Fecal samples were taken immediately through passive collection and labeled as our immediate/wild microbiome. The fish were then separated into experimental groups of pellet or live diet. Each group was fed their appropriate diet for 3 months. At the end of the feeding period, fecal samples were collected.

After all of the samples were collected, they underwent shotgun sequencing. Shotgun sequencing is a method in which all DNA is broken into fragments and then read. These DNA fragments are compared to a database of known organisms, which allows identification and quantification of the bacteria present in the sample.

Results and Discussion:

In total, 292 strains of bacteria belonging to 162 genera were obtained from the fecal samples. The overall prominent class was gammaproteobacteria, with the most abundant orders being enterobacterales and aeromonadales. Within the “Immediate” cohort, the most abundant genus of bacteria was Aeromonas. The alpha diversity was not exceptionally high. The “Live Diet” cohort had significantly more alpha diversity and did not have one specific genus that overruled. The top five genera were plesiomonas, aeromonas, raoultella, citrobacter, and buttiauxella. Unlike the other two cohorts, which showed some diversity, the “Pellet Diet” cohort had minimal diversity. The most prominent bacteria present was Plesiomonas.

Many fish living in aquaculture systems are fed a commercial diet. Based on the data obtained from feeding Lepomis gibbosus a commercial diet, it appears that this has contributed to the genus Plesiomonas being most abundant. In order to determine whether this is true dysbiosis of the microbiome, further studies should be conducted on the overall health and wellness of commercial diet-fed fish. In other species of fish, Plesiomonas has been known to be highly pathogenic, causing inflammation, edema, necrosis, and death. Additionally, it is a concern for zoonotic disease and can cause acute gastroenteritis in humans.

1. Prospective Student Research

Student Presenter: Sean Dewey, Supply Chain and Operations Management / Marketing
Faculty Advisor: Junhong Min, Marketing / American Marketing Association (AMA)

Introduction:

This research is important for the College of Business (COB) to help find the prospective student contact points that were most effective. This will help the COB to pool more resources into the contact methods that were most effective. This research has been prompted by Dr. Dean Johnson (The COB Dean) and Shannon Rinkinen (director of marketing and outreach for the COB).

Materials and Methods:

The first step is to develop survey questions to figure out where COB students first heard about Michigan Tech and the types of engagements they had here. Then, after the survey has been conducted, I will utilize marketing analytics to analyze the data and discover what the best method for contact is.

Results and Discussion:

I have yet to conduct the survey. The research is on track to be completed on April 1st. I am anticipating that we will be able to identify the best contact method for prospective students and the types of engagement the college had with them that led them to make the decision to enroll at MTU. This will allow us to decide the best way to engage our prospective students.

2. Effects of Contact Exposure to Soil-Arsenic

Student Presenter: Madeline English, Biomedical Engineering
Faculty Advisor: Smitha Rao, Biomedical Engineering, Biological Sciences

Introduction:

Arsenic (As) is classified as a Class 1 carcinogen. The goal of this research is to inform As exposure limits via contact similar to the currently regulated exposure limits for air and drinking water. This project focuses on in vitro study of the effects of As exposure by skin contact using human keratinocytes and fibroblasts as cellular models. Establishing the threshold levels of arsenic and determining the cellular impacts of exposure can help establish exposure limits and provide the necessary information to prevent illnesses related to As exposure, and lead to long-term public health policies.

Materials and Methods:

Cell Culture: Normal Human Immortalized Keratinocyte (HaCaT) (Addexbio Technologies© (Catalog: T0020001)) and Normal Human Dermal Fibroblast (HDFa) (ATCC® (Catalog: PCS-201-012)) cells in exponential growing conditions were harvested, counted, and seeded. Treatments for CellTiter Blue, Western Blot, and In-Cell ELISA were run for 24, 48, and 72 hours.

Extraction of As: Sequential extraction techniques were used to obtain the bioavailable fraction of As from the soil. Cell Titer Blue (Promega) was used to determine the effect of soil-As on cell viability. Alterations in cell adhesion markers (E-Cad), dysregulation of skin development and homeostasis (Akt), and epithelial-to-mesenchymal transition (ZEB1) were found using Western Blot and In-Cell ELISA, utilizing well-established protocols. All experiments were carried out in triplicates, and protein levels were quantitatively assessed. Data analysis was carried out using Empiria Studio®.

Results and Discussion:

Preliminary data indicates that higher As concentrations lead to decreased cell proliferation and differences in cell migration among the cell lines tested. Specifically, levels of soil-As (45 mg/kg) do not affect cell viability, migration, and protein expression, however as the As level increases (max. 900 mg/kg) cell viability decreases. Higher concentrations of As showed altered protein expression of Actin, CD44, and Zeb1, and displayed toxic effects, implicating exposure from direct contact with soil-As in skin cancer. Continuing research is focused on understanding the uptake of arsenic in cells and the extent of damage caused. Arsenic uptake methods, localization of As within the cells and long-term impacts of exposure will be explored. The outcomes of this research will be most beneficial to assessing damage from exposure to soil-As (high concentration or long term exposure), providing guidance on exposure limits, and establishing a safer environment for human settlements.

3. Continuous Vaccine Manufacturing using a Two-Stage Aqueous Two-Phase System

Student Presenter: Grace James, Sheridan Waldack, Chemical Engineering, Bioprocessing Minor
Faculty Advisor: Caryn Heldt, Heldt Bioseparations Laboratory

Introduction:

The importance of cost-effective vaccines and efficient manufacturing has led to a desired shift from batch to continuous manufacturing in the pharmaceutical industry. A continuously-processing aqueous liquid-liquid extraction method can reduce purification costs, which account for a large portion of manufacturing costs. Previously, settling conditions were optimized, but there is still room for improvement of increasing transit and recovery of the purified virus. Further understanding and in-process control into the areas of transport phenomena associated with settling and mixing will provide a necessary understanding to scale up the current bench scale process.

Materials and Methods:

This experiment demonstrates the continuous purification of a vaccine model porcine parvovirus (PPV). Citrate salt and PEG polymer stocks are mixed in line with the concentrated virus, which facilitates purification of the virus. A critical part of this process is mixing to allow the virus and impurities to contact the PEG and citrate and partition to the phase that aligns with the hydrophobicity and charge of the molecule.

Since PEG and citrate are immiscible, mixing these liquids creates an opaque turbid mixture. Investigating the turbidity with the relationship to absorbance will be used as an in-line control to verify adequate mixing and settling. To strike a balance between adequate mixing and expedited product transit, two different mixer types will be tested. A tilted conical mixer can be used for smaller working volumes to allow quicker transit of virus. Conversely, a flat-bottomed bottle mixer uses a larger working volume but provides better mixing.

Results and Discussion:

Research is still ongoing to understand the transport phenomena related to the mixing and settling. This system's recovery results have been well documented, but further investigation into why the results vary for different conditions is the expected outcome. The expected outcome is to relate turbidity to sufficient mixing and settling.

Current work is focused on characterizing the relationship between turbidity and absorbance to determine if an in line turbidity sensor can be implemented and used to regulate the process. Improving system controls can help show the feasibility of scaling this process up to an industrial setting.

4. Response of Aquatic Macroinvertebrates to Experimental Reduction of Aggraded Anthropogenic Streambed Sand in the Salmon Trout River

Student Presenter: Connor Ford, Applied Ecology and Environmental Science
Faculty Advisor: Casey Huckins, Biology Department

Introduction:

Human activities can lead to watershed erosion and fine sediment deposition in riverine systems, burying larger substrate key to many ecologic processes. Anthropogenic fine sediment aggradation in the Salmon Trout River has been linked to reduced productivity in lower trophic levels. We are investigating spatial and temporal responses of the stream's aquatic macroinvertebrate communities to recent sand removal restoration efforts. Aquatic macroinvertebrates are important indicators of stream health, and our research aims to assess if restoration efforts have led to (1) community change reflective of less degraded rivers and (2) increased taxa diversity and abundance.

Materials and Methods:

Benthic aquatic macroinvertebrates in three sites (two reference and one restoration) were sampled using a Hess sampler. Seven samples were collected from each site in June and July of 2022. These samples represent the post-restoration communities to be compared with samples collected previously in 2020 and 2021 before sand removal. Study sites were characterized following standard methods to quantify streambed substrate size-structure, sand depth, and embeddedness. During sample collection, the substrate was manipulated to dislodge macroinvertebrates for collection in the downstream net. Samples were stored in 70% ethanol. I am in the process of identifying macroinvertebrates to the lowest taxonomic level (generally family) categorizing them into functional groups (e.g., scrapers, shredders, predators, burrowers, clingers, etc.). Shannon-Weiner diversity indices will be calculated for each Hess sample, after which we will examine the data for differences in taxa, abundance, and functional feeding groups between habitat types (sandy or rocky) and before or after sand removal. Analyses will include simple linear analyses of sample parameters such as feeding groups correlated with habitat conditions such as sand depth. We will also analyze the full data sets using ANOVA to compare the community traits through time and across research sites.

Results and Discussion:

My research is ongoing with further sample processing and data analysis to be completed toward assessment of population and community-level effects of sand removal on macroinvertebrates in the Salmon Trout River. Specifically, I predict macroinvertebrate assemblages at rocky sites will have higher IBI scores and a greater percentage of individuals in the orders of Ephemeroptera, Plecoptera, and Tricoptera (EPT) that tend to include more "sand-tolerant" taxa. I also expect a greater abundance of individuals in functional feeding groups associated with less fine sediment (scrapers, shredders, collector-filterers, and predators) at rocky sites. Alternatively, sand-dominated sites will have a greater proportion of individuals in feeding groups associated with increased fine sediment deposition (collector-gatherers). Furthermore, I expect the post-restoration population and community composition to display higher diversity values, as indicated by the diversity indices. Initial observations from processed samples suggest those collected from the restoration site consist of a greater abundance and diversity of invertebrates compared to the reference sites. However, these observations are limited to a small sample size collected from July 2022 only. Further sample processing is required to accurately represent any changes in diversity, abundance, and feeding groups between sampling sites, in addition to any temporal changes between sampling years.

5. Coating Condition Modification of Non-Antibiotic Antimicrobial Polydopamine Surface Coating and Evaluation of Bacterial Adhesion Prevention

Student Presenter: Will Hagelthorn, Biomedical Engineering and Materials Science and Engineering
Faculty Advisor: Rupak Rajachar and Bruce Lee, Biomedical Engineering Department

Introduction:

The National Institute of Health (NIHP) estimates 6.2 million Americans are living with Alzheimer's disease (AD), one of the most common neurodegenerative diseases, of which chronic ethanol consumption has been shown to contribute to the underlying mechanisms. We hypothesized the local metabolism of ethanol to acetic acid/ acetate in both the periventricular nucleus of the hypothalamus (PVN) and the central nucleus of the amygdala (CeA) would drive the sympathetic nerve activity (SNA) through activation of the N-methyl D-aspartate receptors (NMDAR) and inhibition of local ethanol metabolizing enzymes or NMDAR antagonists would blunt sympathoexcitatory responses through the activation of NMDAR.

Materials and Methods:

316 SS coupons were cut to 1x2 cm and coated for 1, 3, 6, and 24 hours in solutions of 2 mg of dopamine-HCl/mL of Tris-HCl and 10 mg of dopamine-HCl/mL of Tris-HCl. The coating temperature and pH for all solutions were 35°C and 8.5, respectively. The coupons were then washed and placed in PBS. H_2O_2 release was measured after 1, 3, 6, and 24 hours using a ferrous oxidation-xylenol orange (FOX) colorimetric assay and a microplate reader set at 590 nm.
Escherichia coli (E. coli) and Staphylococcus epidermidis (S. epi) were cultured at 37°C on LB Agar and Mueller Hinton Agar, respectively. Individual bacteria colonies were collected and suspended in TSB at an absorbance reading of 0.500. Bacteria solutions were then diluted with TSB at a 1:49 ratio. 1 mL of the bacteria solution was added to 3 mL of TSB dosed with H_2O_2 at 0 µM (control), 200 µM, 500 µM, and 1000 µM. Absorbance readings were taken at 2, 4, 8, 24, and 48 hours. All absorbance readings were taken at 600 nm. This experiment will be repeated with SS coupons coated at different conditions.

Results and Discussion:

In the first experiment, it was found that H_2O_2 release can be significantly increased or decreased by adjusting the coating time and dopamine-HCl concentration. This shows that the pDA coating can be tailored to achieve a specific H_2O_2 release curve.
Data from the second experiment is still being analyzed, but it does not appear that either bacteria type formed a resistance to H_2O_2 after a single exposure. This will be determined by comparing the recorded absorbance readings of the pre-exposure and post-exposure bacteria at their respective time points (2, 4, 8, 24, and 48 hours). If this is true, it shows that the use of H_2O_2 as an antimicrobial agent may not introduce the same problems as the traditional antibacterial drugs. Research regarding the effect of multiple exposures to pDA coated SS surfaces on E. coli and S. epi is ongoing, but the results are expected to be similar to those of the exogenous H_2O_2 exposure.

6. Seismic Amplitude based Lahar Tracking for Real-Time Hazard Assessment

Student Presenter: Brendan Harville, Applied Geophysics
Faculty Advisor: Gregory Waite, Geological and Mining Engineering and Sciences

Introduction:

Lahars are a natural hazard that can occur on the flanks of volcanos due to eruptions or heavy rainfall. They're characterized as debris flows that consist of water, collected rocks and sediments, and sometimes vegetation. Volcan de Fuego is an active volcano in Guatemala that sees frequent and consistent eruptions, as well as heavy seasonal rain. Lahar flows are dangerous to many local communities and infrastructure located around the volcano. Our research aims to gain better understanding of lahar characteristics and ultimately help reduce the impact of lahars on society.

Materials and Methods:

Lahars produce ground vibrations - seismic waves - through turbulence and point forces on the stream bed. This research campaign utilizes a previously constructed seismometer station network located around Volcan de Fuego. Seismic activity is recorded at these stations, whose data will be harvested and ran through a MATLAB code that uses a set of equations set forth by Kumagai and colleagues to identify the lahar location. This MATLAB code is designed to interpret the raw seismic data gathered from the network, approximate the source of activity, and then output a visual marker on a map of Fuego signifying where an active lahar is modeled to be. We begin with a catalog of known lahar events and verify lahar locations using time-lapse and video recordings of these events.

Results and Discussion:

Research is currently ongoing with this project. The main outcome we are working toward is a refined MATLAB code that would be able to accurately and consistently locate lahars generated on Volcan de Fuego. A properly working code would ultimately be able to provide the local volcano and seismological monitoring government body, INSIVUMEH, with a real-time lahar locating and tracking tool. Outside of the context of Fuego and Guatemala, the MATLAB code could potentially be used for other volcanoes where lahars pose a risk to the local inhabitants.

7. Using a New Approach to Mosher Ester Analysis to Determine the Absolute Stereochemistry of Secondary Alcohols

Student Presenter: Samantha Ludwick, Medicinal Chemistry
Faculty Advisor: Marina Tanasova, Department of Chemistry

Introduction:

Molecules that have the same chemical composition but different orientation in space are called stereoisomers. Though this difference may seem minor, separating, and isolating stereoisomers permits an understanding of their distinct properties, which is vital for differentiating and determining potential biological effects. The most tragic example of a failed understanding of stereoisomerism was thalidomide, which was a drug prescribed as a sedative in the 1960s. Unfortunately, thalidomide was present as a racemic mixture, with one enantiomer being a teratogen and the other being therapeutic. Thus, understanding the absolute configuration of a potentially bioactive molecule is critical.

Materials and Methods:

Nuclear Magnetic Resonance, or NMR, is the most powerful method to determine a molecule's chemical structure. Unfortunately, NMR cannot distinguish enantiomers due to the magnetic equivalence of the constituent atoms. However, it can distinguish diastereomers, or molecules that are non-superimposable, non-mirror images, which occur in molecules that have two chiral centers. Methods such as Mosher Ester Analysis (MEA) create diastereomeric esters from the enantiomeric alcohols through the addition of chiral MTPA (the Mosher Acid). Through NMR analysis of the diastereomers, the absolute stereochemistry of the initial alcohol can be determined. Traditional MEA is based on reacting a single enantiomer of an alcohol (or an amine) with both the R and S forms of MTPA to form ester (or amide) diastereomers, respectively. These diastereomers are then analyzed via NMR to determine the absolute stereochemistry of the initial alcohol or ester. In my current project, I am starting with a racemic mixture of an alcohol. Therefore, the reverse order of MEA can be implemented, or a single enantiomer of MTPA can be utilized to form the diastereomers. Separating the diastereomers allows them to be analyzed via NMR. The differences in chemical shifts of the chiral portions of the diastereomers can be utilized to determine the absolute configuration of the R and S enantiomers present in the original alcohol.

Results and Discussion:

My research is ongoing, thus my results will be different at the time of the symposium. I have obtained a set of diastereomers, yet have been challenged with separating them. My lab has recently purchased a chiral column, meaning that it will likely be able to separate the chiral molecules. After separating the diastereomers, I can perform MEA and determine the absolute configuration of the original synthesized alcohol. The purpose of applying this novel approach to MEA is to prove that it can work. If it is successful, I plan to apply it to my next research project, the synthesis of bioactive, anti-cancer agents. These molecules contain secondary alcohols of unknown configurations, which is kin to the alcohol present in my current experiment.

8. Inhibiting Local Brain Metabolism of Ethanol in the Central Nucleus of the Amygdala Blunts Sympathoexcitatory Responses Induced by Ethanol in Sprague Dawley Rats

Student Presenter: Derrick Simet, Biochemistry and Molecular Biology, Chemistry Focus
Faculty Advisor: Qing-Hui Chen, Kinesiology and Integrative Physiology

Introduction:

The National Institute of Health (NIHP) estimates 6.2 million Americans are living with Alzheimer's disease (AD), one of the most common neurodegenerative diseases, of which chronic ethanol consumption has been shown to contribute to the underlying mechanisms. We hypothesized the local metabolism of ethanol to acetic acid/ acetate in both the periventricular nucleus of the hypothalamus (PVN) and the central nucleus of the amygdala (CeA) would drive the sympathetic nerve activity (SNA) through activation of the N-methyl D-aspartate receptors (NMDAR) and inhibition of local ethanol metabolizing enzymes or NMDAR antagonists would blunt sympathoexcitatory responses through the activation of NMDAR.

Materials and Methods:

Fifteen, 6-week-old, male Sprague Dawley (SD) rats will be utilized to determine a time course by which acetate alters PVN neuronal excitability. Rats will be randomly assigned to one of three conditions, 0 minutes (saline control), 30 minutes, and 1 hour post acetate injection, with five animals in each condition. The animals will be injected through intracerebroventricular injection (ICV) using 4mM acetic acid and the CNS will be fixed by perfusion with 4% PFA following injection. Then the c-Fos expression will be determined using immunohistological imaging.
Ten, 6-week-old, male SD rats will be utilized to determine the role of acetate-NMDAR binding in altering neuronal excitability. Rats will be randomly assigned to one of two conditions: ICV 4mM acetic acid and blocker kynurenic acid (KYN), and 4mM acetic acid and blocker AP5; 5 animals for each treatment. The animals used in the previously described experiment for the 30-minute condition will be used as the control group for this experiment. Thirty minutes following injection, the same c-Fos protocol described above will be implemented.

Results and Discussion:

Based on our previous data suggesting peak acetate levels around 1hr, expect to see the greatest c-Fos expression in the 1hr post-injection group. We expect to see a decrease in c-FOS expression in the animals treated with NMDAR blockers in comparison to the control animals determining NMDAR activation alters hypothalamic neuronal activity. The future objectives are determining the impacts of acetate on the production of proinflammatory molecule production, in whole animal models, along with determining if acetate causes an increase in BDNF and NGF activation following acute application to the PVN.

9. An Evaluation of Spawning Sea Lamprey on the Misery River, a Tributary to Lake Superior

Student Presenter: Victoria Ripley, Environmental Science
Faculty Advisor: Andrew Kozich, Environmental Science

Introduction:
Spawning phase sea lamprey Petromyzon marinus have been assessed on the Misery River for >30 years, using Portable Assessment Traps (PAT's) placed directly downstream of a manmade low-head barrier. Capture/recapture population estimations have been conducted each year, but sites of release for marked sea lamprey (fin-clipped post initial capture) have periodically varied between two locations downstream of the trapping site, with one being in close proximity to the trapping location, and the alternate being >3 miles downstream of the trapping location. In 2022, as part of an investigation to address the question of whether releasing captured and marked sea lamprey at different locations downstream of the trapping site would lead to differences in recapture rates, we designed an experiment involving releasing an equal proportion of newly captured lamprey at these release locations (equal numbers at each release site, 1:1 sex ratio, sea lamprey marked uniquely for each release site). Results of this study will assist managers in determining the optimal release location for marked Misery River sea lamprey for future population estimation efforts.

Materials and Methods:
The Misery River features a low-head barrier that was constructed long ago to attempt to impede the adult upstream migrating sea lamprey population from reaching miles of available upstream spawning habitat. This was a common tactic in early efforts to control sea lamprey numbers, and Portable Assessment Traps (PATs) have commonly been placed in conjunction with these low-head barriers for assessment purposes as the standard assessment equipment for conductance of population surveys since the 1980's. My project focused on the major population assessment reevaluation objective of comparing marked sea lamprey recapture rates between two sample cohorts. From May-July 2022, two PAT's were positioned at their long-term assessment locations. Traps were inspected a minimum of twice weekly, and all captured organisms were identified, biological assessed, and released. All captured sea lamprey were identified as male or female, and marked with a "V" notch fin-clipping unit. 50% of captured males and females received a "V" notch mark on the anterior dorsal fin, with the remaining 50% receiving the mark on the posterior dorsal fin.
Anterior dorsal marked sea lamprey were released at the public access/boat launch near the outlet of the Misery River to Lake Superior, approximately 3 miles downstream of the low-head barrier and PAT location. Posterior dorsal marked sea lamprey were released immediately downstream of the low-head barrier and PAT location (approximately 100-200ft downstream).
For the duration of my project, we documented all instances when marked and released sea lamprey were recaptured in the PATs. All recaptured sea lamprey were retained and killed for more thorough biological data collections). Capture/Mark/Release/Recapture data are used to generate total population estimates for ultimate prescriptive sea lamprey control.
The major objective of this project is to test the Hypothesis that there will be no significant difference in marked sea lamprey recapture rates between the 2 release site groups, and therefore no significant difference in total adult population estimate results when using data from the two release groups.

Results and Discussion:
Data analysis is ongoing and will be complete in March 2023. Sea Lamprey have devastated fish stocks throughout the Great Lakes, including Lake Superior and the treaty fishing waters of the Keweenaw Bay Indian Community. For decades, biologists from the Great Lakes Fishery Commission (GLFC), the U.S Fish and Wildlife Service (USFWS), Great Lakes Indian Fish and Wildlife Commission (GLIFWC), and a host of other resource management agencies (including the Keweenaw Bay Indian Community Natural Resources Department (KBIC-NRD), have been concerned with this invasion, and millions of dollars have been dedicated to population assessment and control. My findings will provide valuable insight to these professionals as we continue to improve management methods for these troublesome invasive species.

10. Diffusivity Measurements of Viral Nanoparticles in PEG-Citrate Aqueous Two-phase Purification Systems Using Microfluidic Devices

Student Presenter: Neil Gupta, Chemical Engineering
Faculty Advisor: Caryn Heldt, Heldt Bioseperations Lab

Introduction:

Viruses pose a significant hazard to human health, with vaccines serving as the most effective method to combat them. Vaccine supply is bottlenecked by lagging downstream optimizations and development. Continuous end-to-end manufacturing can resolve these issues, and ATPS extraction might be the key. A novel, continuous downstream purification technique has been tested and characterized previously. However, such systems are difficult to optimize as the microscale properties have not been investigated yet. To aid in furthering the goal of continuous end-to-end vaccine manufacturing, microfluidic devices were used to observe the diffusion of viral particles at the interface of these ATPS.

Materials and Methods:

A microfluidic device is used to study the mass transport phenomena of the ATPS we've developed. This allows the experiments to be both cheap and efficient compared to other alternate approaches. Fluorescently tagged proteins can be easily detected and quantified using fluorescence microscopy. The microfluidics device is a simple Y-junction design, with 2 400 μm2 inlets joining to form a 800 (width) x 400 (height) μm2 main channel. We prepare the relevant phases for study and prepare biomolecules, such as porcine parvovirus (PPV) and bovine serum albumin (BSA), to fluorescently tag and load. Using a syringe pump, the phases are loaded into the device in a highly controlled manner. Subsequently, an inverted microscope is used to capture fluorescent images in a time series, allowing us to use analyze the shift in fluorescence over time to determine the diffusivity of viral nanoparticles.

Results and Discussion:

Time lapse experiments over the course of one hour have enabled tracking of diffusion nearly to equilibrium. With this data, we have calculated the diffusion coefficients for bovine serum albumin, a model protein, and porcine parvovirus (PPV) in the polymer-rich phase of our ATPS. The next step will be to observe diffusion of these bio molecules across the two phase interface to quantify overall mass flux. These parameters will allow rapid scale-up of ATPS for vaccine manufacturing.

11. A Five-Year Comparison of Plant Communities in the Keweenaw Bay Indian Community's Bogs and Fens: Comparing Relevés from 2017 and 2022

Student Presenter: Destine Alvarado-Seymour, Environmental Science
Faculty Advisor: Andrew Kozich, Environmental Science

Introduction:

Great Lakes wetlands have high ecological value for their water-cleansing functions and the critical habitat they provide for countless species. They are also important culturally for the region's Anishinaabe people whose teachings, traditions, and lifeways place great significance on the health of water. This project links the ecological and cultural importance of bogs and fens in the Keweenaw Bay Indian Community Reservation, with a focus on medicinal plants found in wetlands. In 2017 the Keweenaw Bay Indian Community Natural Resources Department (KBIC-NRD) conducted a preliminary assessment of plant populations in bogs and fens on the reservation. In light of ongoing threats such as invasive species, climate change, and land use, this study was repeated in partnership with KBIC-NRD specialists to detect possible changes over time. We used relevé sampling to compare current plant communities to those of five years ago. This poster summarizes the initial findings of the study.

Materials and Methods:

In 2017 the KBIC-NRD conducted vegetative relevés at five study sites across the L'Anse Indian Reservation in Baraga County, Michigan. In July and August of 2022, we conducted follow-up relevés at the same sites following the same methods. Each site had multiple plots, and the same GPS-recorded plot centers were used. The relevé method we used was developed by the Minnesota Department of Natural Resources (2013). We recorded our data on standard sampling datasheets developed by the KBIC-NRD. Each plot measured 7.1m2, with a flagged stake placed at each corner marking the plot. Every plant species within the plot was recorded and given a reliability code based on the certainty of identification. Species unknown or uncertain were collected for further examination. For each species, we visually estimated the percent cover and designated it a cover class. Overall Carex cover and open water were estimated and recorded. For the transects at Pinery Lake, GPS points marked the beginning and end of the transect. As we walked the transect, we recorded all plants in our path, but no cover data were collected.

Results and Discussion:

Between 2017 and 2022, species richness decreased at West Bishop, Pequaming, and Sand Point but increased at Mud Lake and Pinery Lake. At every site, Carex diversity and percent cover increased. The population of invasive Typha angustifolia increased at Mud Lake South, and new populations of Typha angustifolia were discovered at Pinery Transect 2 and Mud Lake North Plot 3. Many medicinal plant populations, including Andromeda polifolia, Myrica gale, and Sarracenia purpurea, have either stayed the same or increased. Kalmia latafolia was present at West Bishop and Mud Lake North in 2017 but disappeared in 2022. In 2017, Kalmia polifolia was present in every plot at Sand Point, Pequaming, and Pinery Lakes, but in 2022 only a small population was recorded at Pinery Lakes. Advanced statistical analysis of results is ongoing and will be complete in March 2023.

12. Assessing Feasibility of Using Artificial Intelligence in Computational Hemodynamic Analysis for Abdominal Aortic Aneurysms

Student Presenter: Kristin King, Biomedical Engineering
Faculty Advisor: Jingfeng Jiang, Biomedical Engineering

Introduction:

Abdominal Aortic Aneurysms (AAA), or weakened portions of vessel walls, are generally asymptomatic and potentially fatal. Current practice relies on periodic monitoring and doctor discretion for surgical intervention, where methods to predict growth would be beneficial. Dr. Jiang's lab creates and analyzes 3D models made from Mayo Clinic patient Computed Tomography Angiography (CTA) scans in order to find identifying traits of growth. The model creation is time-consuming. Alternatively, an Artificial Intelligence (AI) is being developed to create these models more efficiently. This research compares the time required and accuracy of the AI models to those created by humans.

Materials and Methods:

A subset of ten Mayo Clinic AAA cases that were previously analyzed by researchers in Dr. Jiang's lab were chosen for this research project. This subset included a variety of image quality and aneurysm growth speeds. These ten cases were modeled from CTA images using Mimics Software (Materialise, Incorporated, Luven, Belgium) by a researcher not previously involved with the cases. The same ten cases were then modeled using the AI software. The ten AI models only needed slight post-processing by the human researcher. The time taken to create each model was recorded. The twenty resulting models were then run through the series of previously defined analysis processes for a variety of geometric and fluid dynamic parameter data. This analysis involved the use of Ansys® Fluent (ANSYS, Inc.) and VMTK (Vascular Modeling Toolkit, RRID:SCR_001893) software, along with code written by researchers in Dr. Jiang's lab. The results were compared in order to validate the accuracy of the AI models as they compare to the models created by humans, and to determine if the AI should be used for future work.

Results and Discussion:

After the models were created, the data was then compiled to be more efficiently analyzed. This data was collected, organized, and handed off to another experienced researcher who also analyzed the original data in order to have consistency in results. This research showed that the savings in the time required for the AI to create the 3D image segmentation models compared to the human was largely beneficial. The average time for the human to create the model from CTA scan to final model was two hours and thirty-five minutes. The average time required for the AI model to be created and touched up by the same researcher was fourteen minutes. This savings of over two hours and twenty minutes eliminates a major roadblock to this AAA analyzation method having the potential of entering the clinical workflow in the future. The accuracy of the AI model resultant parameter data is still being studied in the lab. However, whether this specific AI is accurate enough to use for AAA analysis, there is a great deal of promise shown. In the event the AI-generated models are not accurate enough to use, additional refinement in future work could make it so.

13. The Persistence and Understanding of Clothing at Historical Archeology Sites

Student Presenter: Alyssa Church, Anthropology and Human Biology
Faculty Advisor: LouAnn Wurst, Department of Social Sciences

Introduction:

Clothing artifacts, although collected and cataloged by archeologists, are not as commonly studied by them. This is due to the poor preservation of many clothing pieces. Much of what does get preserved are clothing closures such as buttons and rivets. Although these are extremely small they hold a significant amount of information that can tell us a lot about the people who lived at these archeological sites.

Materials and Methods:

Each button's diameter was measured in centimeters and inches. They were all cataloged pertaining to the design on the button which is described by a common button collecting manual, as well as other aspects of the button's form such as shank type. The material of each button was also recorded.

Results and Discussion:

There are not results quite yet. The information that will be discovered will be the diversity of button types between house sites, both family houses and male boarding houses. This will include knowledge of button sizes due to clothing differences and how those are different among house features including evidence of families and women at certain locations. Between sites there could be cultural differences as there were different groups living at each archeological site. Understanding the patterning in each site and locus will be done first then they can be compared to each other to better understand the social and cultural differences between different house sites and their relation to clothing artifacts.

14. The Influence of Weather Conditions on Color, Infrared, and Depth Camera Sensing

Student Presenter: Chethan Magnan, Computer Engineering
Faculty Advisor: Lan Zhang, Electrical and Computer Engineering

Introduction:

Even as sensing technology continues to improve, there are still errors in functionality due to noise. Noise refers to any interference between the signal and its reception point. In this context, noise refers to the visual distortion caused to the depth cameras, as this form of technology is becoming far more common for gesture recognition and related visual sensing needs. As depth cameras become more technologically advanced, we want to know whether weather conditions, specifically caused by precipitation, can generate noise and, if so, how that noise impacts the depth camera's functionality.

Materials and Methods:

Using the Rosmaster X3's Astra Pro Orbbec camera, we can understand how noise will influence its ability to perform tracking, specifically in terms of gesture recognition, and we can test the device's functionality by having the tracking trigger a command on the robot. For this study, there are two gestures: a thumbs-up triggering a 360-degree rotation and a flat palm triggering two beeps and a stop. A data set is compiled of each of these gestures from multiple different angles, from each camera, and in two weather conditions: clear conditions without any precipitation and noisy conditions with precipitation between the camera and the gesture. A pattern recognition model is then created through a tensor flow python script and finally run on the robot itself in conjunction with the robot's STM32 microcontroller, which controls its functionality. Then, the number of correctly perceived gestures and functions is compared with the two models (the clear model and the noisy model).

Results and Discussion:

The research is ongoing, but our anticipated outcomes revolve around the color and infrared camera functionality dropping at similar rates due to noise generated by moderate to severe amounts of precipitation. The depth camera trials are currently underway. The potential implications will either imply that depth cameras should be used over color and infrared sensors for gesture recognition in environments with constant precipitation, such as Houghton's winters or Seattle's showers, or that it too has a rather low functionality and will not function well in high precipitation environments. In terms of implications on the field, this research would either discern an ideal sensor used for identification, human-to-machine interaction and object identification in high precipitation environments or that there is a need for more accurate sensing technology in precipitation that we can develop.

15. Visualizing Cell Cycle Dynamics of Ovarian Cancer

Student Presenter: Ina Klasner, Computational Biology and Applied & Computational Mathematics
Faculty Advisor: Paul Goetsch, Biology Department

Introduction:

Cancer is an uncontrolled growth of cells, a malfunction of the mechanisms that regulate the cell cycle. Quiescence is reversible cell cycle arrest, and its manipulation is a known contributor to chemoresistance. However, it remains unclear how the disruption of quiescence mechanisms contributes to oncogenesis. Transcriptional regulators DREAM and Rb establish and maintain cell cycle quiescence. DREAM mediates G0 through repressing gene expression of G1/S and G2/M genes. Rb is a tumor suppressor that mediates a major G1 checkpoint into S-phase. We investigate cell cycle dynamics and how DREAM and Rb function in ovarian cancer cell lines.

Materials and Methods:

CRISPR/Cas9-mediated introduction of FastFUCCI transgenes was used to test for live cells for ubiquitination-based cell cycle indication in ovarian cancer cell line SKOV3 and hTERT-immortalized cell line BJ-5ta. The donor DNA was transfected by lipofection with Lipofectamine 3000 and CRISPRMAX, and nucleofection with the 4D-NucleofectorTM System. In parallel, a puromycin resistance gene was inserted into the AAVSI safe-harbor locus to easily isolate the successfully transfected cells. The amount of reagents, incubations, and programs were optimized for cell viability and transfection efficiency. Additionally, ribonucleoprotein (RNP) transfection with donor plasmid for knocking-in EGFP and mCherry fluorescent reporters was performed by Lipofectamine CRISPRMAX and nucleofection. Similar methodology was applied, but transfection with RNP complexes required optimization of Cas9 protein, in vitro transcribed RNA, and plasmid DNA ratios. After 2-4 days of incubation, all transfected cells were selected with puromycin for 8 days, whereupon all media was removed and replaced with puromycin-free media. Colonies of transfected cells were visualized two weeks later, and transfection methods were evaluated on viability and efficiency. Cell cycle dynamics of the FastFUCCI and fluorescently-tagged cells will be visualized with the spinning disc confocal microscope in the Chemical Advanced Resolution Methods (ChARM) lab.

Results and Discussion:

Lipofectamine CRISPRMAX and nucleofection protocols were optimized to investigate cell viability and transfection efficacy. Lipofectamine 3000 was not further investigated due to poor efficacy, and preliminary results indicate higher viability and efficacy of Lipofectamine CRISPRMAX over nucleofection in SKOV3 ovarian cancer cell lines. Further research is needed to evaluate the protocols in BJ-5ta cell lines, but higher viability and efficacy is expected over SKOV3. From preliminary data, we expect to see abnormal FastFUCCI single-cell dynamics in SKOV3 and normal dynamics in BJ-5ta with live image microscopy. We also expect abnormal function in DREAM or Rb in SKOV3 cell lines as indicated by low p130 or pRb expression in the nucleus, respectively. BJ-5ta cells will likely exhibit correctly functioning DREAM and Rb complexes, indicated by presence of both-fluorescently tagged proteins in the nucleus. This research will further our understanding of cell cycle dynamics. We hope this will inform on why some cancer cell lines enter quiescence and form cancer treatment resistance, and what transcription regulatory networks may be affected by this. This will also help establish how the DREAM complex functions in normal cells versus ovarian cancer cells.

16. Automatic Differentiation: Inside the Black Box at the Heart of Machine Learning

Student Presenter: Damion Miller, Mathematics and Computer Science
Faculty Advisor: Benjamin Ong, Mathematics

Introduction:

The derivative or sensitivity of a function's output with respect to its input has applications widespread through science and engineering. Thus there is an inherent need to calculate derivatives of arbitrary functions efficiently and accurately. Automatic differentiation (AD) is a technique for calculating derivatives through repeated applications of the chain rule. This method provides a more accurate and efficient calculation than standard finite difference approximations to a derivative. The resulting AD approximations can be used to construct useful functional information such as gradients and Hessian matrices, which can be used in application areas such as machine learning. I will be investigating AD and its implementations, making improvements on the computational cost of obtaining useful information regarding directional derivatives.

Materials and Methods:

AD exploits the property that an arbitrary function can be written as a composition of elementary operations (addition, subtraction, multiplication, division, etc.) and elementary functions (sin, cos, log, exp, etc.). Using this property we are able to assign basic derivative rules via operator overloading which calculate the derivative of a function as it is evaluated by the program. In terms of software, we will use the Julia programming language which will allow us to run simulations on modern architectures such as GPUs and FPGAs, as well as distributed computing devices while making use of its Just-In-Time (JIT) compiler. Using Julia we are able to write simple yet effective scripts for various implementations of automatic differentiation. Using these scripts we will be able to provide a Julia package that is efficient at computing various functional information such as gradient, Jacobian, and Hessian matrix.

Results and Discussion:

Research is still ongoing, but should produce a functional Julia package that can efficiently and accurately compute a wide variety of derivatives, from partial to higher order. These derivatives can be used to obtain useful functional information with many applications like machine learning. Our primary objective is to bypass the need to calculate the entire Hessian matrix and use directional derivatives of the gradient to aid in quicker gradient descents. We will do timing runs, convergence tests, and make inferences to how this information can be used in a real optimization setting.

17. A Comparison of Production Potential Between Two Spawning Populations of Lean Lake Trout in Keweenaw Bay, Lake Superior

Student Presenter: Trevor Tangen, Environmental Science
Faculty Advisor: Andrew Kozich, Environmental Science

Introduction:

I investigated lake trout production potential (fecundity) at the Huron Islands and Traverse (aka Rabbit) Island spawning refuges in western Lake Superior, to test the hypothesis that there is a significant difference in fecundity between these two spawning populations. Fish captured during standardized fall spawning lake trout surveys by the Keweenaw Bay Indian Community Natural Resources Department (KBIC-NRD) were fully assessed, and in most cases tagged and released. Fish that died during the survey were returned to the KBIC-NRD lab for performance of fecundity estimates. I used a 10 ml flask to perform sample counts on total egg mass for each female lake trout to generate estimates of total eggs/individual lake trout (eggs/10ml; total ml per fish). Fecundity estimation data from 2022 will be compiled with previous data for analyses. Data analysis for this project is ongoing and will be presented in March 2023.

Materials and Methods:

(in progress)

Results and Discussion:

Data analysis for this project is ongoing and will be presented in March 2023.

18. Sympathetic Activity to the Heart is Increased in a Mouse Model of Hypertrophic Cardiomyopathy

Student Presenter: Haley Marchese, Medical Laboratory Science
Faculty Advisor: Robert Larson, Department of Biological Sciences

Introduction:

Hypertrophic cardiomyopathy (HCM) is the most common genetic heart disorder. HCM is characterized by abnormally thick cardiac muscle and an increased risk of other potentially fatal conditions including arrhythmias and sudden cardiac death. Previous studies in humans demonstrate that myocardial beta-1 receptor (B1R) expression is decreased in the left ventricles (LV) in HCM, consistent with reports of increased cardiac sympathetic nerve activity and norepinephrine levels. The goal of this study is to determine if mice with HCM present these same abnormalities and to further characterize cardiac sympathetic activity in HCM mice.

Materials and Methods:

We utilized the Western Blot technique to measure protein expression in LV tissue from male HCM and littermate wild-type (WT) mice. Ongoing studies will quantify protein expression in female mice, and in the other chambers of the heart including the right ventricle (RV), and left and right atria. Results are expressed relative to WT mice (n=4 male mice in each group). Furthermore, cardiac B1R function is currently being investigated in vivo by measuring left ventricular pressure and cardiac contractility (dP/dt max) in response to graded infusion of the B1R agonist dobutamine in anesthetized HCM and WT mice. Data are expressed as mean±SE.

Results and Discussion:

B1R expression is significantly reduced in the left ventricle (LV) of HCM mice compared to WT littermate controls (HCM 60±1 vs. WT 100±4; $p<0.05$). Tyrosine hydroxylase (TH) is the rate limiting enzyme in the production of norepinephrine. TH protein expression (standardized to cardiac neuronal content with PGP9.5) was significantly higher in the LV of HCM mice compared to WT mice (HCM 135±15 vs. WT 100±1; $p<0.05$). We expect to see similar protein expression patterns in the RV and atria of HCM mice. We also anticipate that increases in cardiac contractility will be blunted in HCM mice due to reduced B1R expression. In conclusion, our findings suggest that abnormalities in expression of B1R and TH are consistent between HCM mice and humans allowing us to utilize mouse models to explore new treatment targets for HCM.

19. MATLAB Code Critiquer

Student Presenter: Joseph Teahen, Computer Science, Minor in Statistics
Faculty Advisor: Leo Ureel II, College of Computing

Introduction:

Early courses in computer programming offer many challenges for both students and instructors. Students spend much of their time studying basic syntax and learning new problem-solving skills. While developing these fundamental abilities, meaningful and immediate feedback is crucial. Messages from a compiler or interpreter are inadequate at explaining an error to novices and can prove counterproductive to their understanding.

Instructors can find it challenging to maintain feedback conducive to learning because of the number of students in a given course. Further, instructors can not always be on demand to meet their student's feedback needs because of conflicting working schedules.

Materials and Methods:

Code critiquers process a student's code looking for novice antipatterns. Then it outputs targeted feedback that a novice can understand. A novice antipattern is the kind of mistake an experienced coder would never make. Once the code critiquer identifies these novice antipatterns, it offers immediate and meaningful feedback to the student while coding. The educational context of this project is the Michigan Tech First-Year Engineering Program (FYEP). FYEP is a first-year engineering experience taken by first-year College of Engineering students. This project focused on developing a code critiquer for MATLAB to be used in the FYEP environment. The code critiquer is similar to WebTA, a Java code critiquer. My work focused on abstract syntax tree (AST) generation for the MATLAB language and the development of a web application framework for presenting critiques to students and instructors. The proprietary MATLAB API for syntax and runtime testing has high memory requirements and poor performance. The API is also rigid in execution, not allowing for fine control of how they run the code and store syntax errors. I used a modified version of GNU Octave's parser to generate an AST and the Grails Framework for web application development.

Results and Discussion:

My research is still ongoing but in the late stages of development. I get to test the application in the FYEP classroom during week 6. Collecting data from instructors and students is the essential next step in the evolution of this research. With classroom data, I can see the next steps in development and analysis while also ironing out any flaws in the existing application. Student data will also allow for the examination and identification of further antipatterns that can help the application be most helpful for future instructors and students. Looking towards the potential implications, this code critiquer will significantly benefit the learning outcomes for students because it will provide immediate and relevant feedback as they program. As class sizes increase, this code critiquer will provide the necessary feedback to students that might be missing from their larger class formats. This software will be particularly effective for programming education where instructional teams are small or when instructors have limited coding experience (i.e., high school programs, underfunded departments, etc.). This code critiquer will empower students to advance their knowledge of programming in a meaningful way as they are coding.

20. UV Fluorescence in Nocturnal Animals

Student Presenter: Eric Brand, Applied Ecology and Environmental Science
Faculty Advisor: David Flaspohler, College of Forest Resources and Environmental Science

Introduction:

We are conducting research on the UV fluorescence of particular nocturnal animals (flying squirrels, owls) and the possible ecological uses for that fluorescence. Our chemistry team, through reading peer-reviewed studies, has already developed a repeatable method for the identification and extraction of Coproporphyrin I, the compound responsible for UV fluorescence.

Materials and Methods:

Fur/feather samples were taken from specimens held in one of the freezers in the Forestry building. Coproporphyrin I was separated and identified by liquid chromatography combined with mass spectrometry (LC/MS) analysis of fur/feather extracts. Samples were viewed under a microscope and pictures subsequently taken.

Results and Discussion:

Our research has yielded one of our desired results: the development of a repeatable method for the identification an extraction of Coproporphyrin I. As for the other area of study, ecology, we do not yet have results. We anticipate finding an ecological motive/use for UV fluorescence in our target species, which could possibly advance the field of mammal/avian fluorescence and its role in ecosystems, a relatively new and understudied subject.

21. Stability of Terephthalate Degrading Microbial Consortia for Plastic Upcycling

Student Presenter: Leah Harazin, Environmental Engineering
Faculty Advisor: Stephen Techtmann, Biology Department

Introduction:

A large portion of the plastic produced each year ends up in landfill or the environment. Novel solutions to upcycle plastic waste into valuable products to address the growing excess plastic waste from polluting the environment. One potential solution is to chemically depolymerize plastic waste into biodegradable molecules which can be fed to microorganisms to produce biomass. This could further be used as nutritional products, such as a single cell protein. While most processes for plastic upcycling use isolated microbial species, microbial communities have the potential to increase resistance, resilience, and metabolic flexibility to the process.

Materials and Methods:

However, the application of microbial consortia in industrial plastic upcycling processes may be limited if the microbial consortia is not stable. Here, we have cultivated a microbial community that can grow using terephthalate – a derivative of polyethylene terephthalate (PET). This community has been utilized to study the stability and yields of a microbial community used to produce biomass as a product. In this experiment, a community of terephthalate degrading bacteria (E209) was cultivated in a 10 liter fed-batch bioreactor and grown using 10 g/L disodium terephthalate. Every two to three days, spent media was removed and replaced with fresh media and terephthalate. The liquid bacterial culture was centrifuged to separate E209 biomass, which was dried to determine overall yields of biomass from terephthalate. Subsamples were collected for 16S rRNA sequencing to determine stability of the community, and amino acid composition to quantify product composition.

Results and Discussion:

The consortia was relatively stable over a one month period and was dominated by Rhodococcus. On average, 2.33g of biomass per liter were produced each month. This work demonstrates that microbial consortia can convert terephthalate into microbial biomass. In the future, this system could be utilized to divert plastic waste from landfills through microbial decomposition into biomass and other nutritional products. Biomass could be used as a temporary source of nutrients, similar to protein powder, in combat situations and emergency relief. Ongoing research will investigate the safety of using biomass as a food source and its nutritional content.

22. Comparing Endogenous Gene Tags and Transgenic Reporters

Student Presenter: Megan Guyer, Biochemistry and Molecular Biology-Biology Focus
Faculty Advisor: Paul Goetsch, Biological Sciences

Introduction:

Green fluorescent protein (GFP) is important for studying transcriptional regulation in Caenorhabditis elegans. We tested two different types of GFP reporters to determine whether transgenes accurately represent endogenous gene expression. In the transgenic reporters, the promoter, GFP-PEST reporter, and 3' untranslated region replace the gene's open reading frame, therefore only expressing the fluorescent protein. Endogenous gene tags are inserted at the end of genes after the open reading frame, allowing the fluorescent protein to tag the gene's expressed protein. We hypothesized that an endogenous tag of germline genes will act as a better reporter than a transgenic reporter.

Materials and Methods:

Initially, worms previously tagged were used to design the imaging protocol and collect preliminary data. Three germline genes, efl-1, lin-35, and dpl-1, were tagged using transgenic reporters or endogenous gene tags. A total of six strains were imaged to compare the fluorescence. The worms were imaged at three different stages: embryo, L1, and L3. Embryos were prepared for imaging by dissecting adult worms. Imaging L1s and L3s required synchronization. L1s were obtained by synchronizing adults in a humidity chamber where the adults were not given food. L3s were obtained through a limited lay where the L3s were picked 48 hours after the worms initially laid embryos. The L1s and L3s worms were staged on 5% agarose pads. The worms were viewed under a fluorescence live-imaging microscope. The proper filter was applied for viewing green fluorescence, and images were taken at 400x where possible with an exposure of 300 in black and white using the MicroManager program.

Results and Discussion:

Images of embryos for all three genes were consistently brighter with the tagged version. The green fluorescence was in the cytosol of the transgenic embryos whereas the fluorescence was nuclear-localized in the tagged embryos. For the L1 and L3 stages, the difference was less clear between tagged and transgenic worms. The bright green fluorescent dots around the middle of the worm is auto-fluorescence in the intestine due to gut granules. The dimmer green fluorescence around the gut granules is due to GFP-PEST. Auto-fluorescence in the worms made it difficult to determine the location of the GFP-PEST. Based on the images, endogenous gene tags expressed more fluorescent protein than transgenic reporters. The difference was most obvious during embryonic development. Unexpectedly, the GFP-PEST of transgenic embryos in early embryogenesis was not nuclear-localized. Through this comparison, we were able to determine that the transgenic reporter is not as accurate as endogenous gene tags at the early embryo stage. This will determine the methods for live cell fluorescence imaging for other projects, specifically for investigating DREAM function.

23. Mercury Biomagnification in the Plankton Community of Keuka Lake, NY

Student Presenter: Brian Reeves, Ecology and Evolutionary Biology
Faculty Advisor: Gordon Paterson, Biology

Introduction:

Mercury is a widespread, toxic, industrial pollutant. Mercury biomagnifies, meaning the concentration of mercury increases as it moves upwards through the food web. Many fish consumption advisories are based on the presence of mercury in top predator fish. The understanding of how mercury moves through large fish is fairly well known. However, the understanding of the trophic, or food web, interactions between small invertebrates and how mercury behaves at this level in the ecosystem is less understood. This project examines zooplankton, as well as zebra mussels and freshwater Mysis shrimp from Keuka Lake, NY to look at mercury concentrations potential trophic interactions.

Materials and Methods:

In order to collect the samples, a 500 micrometer was used to collect Mysis shrimp, while a 64 micrometer net was used to collect zooplankton. To collect sediment and Zebra Mussels, a Ponar grab was used. In the lab, all samples were dried and then run through a DMA-80 mercury analyzer. They were also run through stable isotope analysis at the MTU LEAF lab. This looks for stable isotopes of carbon and nitrogen and can provide insight into ecological characteristics.

Results and Discussion:

The analysis of mercury concentrations showed biomagnification from zooplankton to Mysis shrimp. The statistical analysis of the mercury data is ongoing, but expectation is that it will be statistically significant. The analysis of the stable isotopes revealed a mostly expected web of trophic interactions, with the zooplankton being below the Mysis shrimp and Zebra mussels in the food web. Analysis shows there is a significant relationship between nitrogen stable isotope values and mercury concentration. There is still some data analysis to be completed, but what has been completed shows that there is biomagnification happening within the plankton of Keuka Lake.