PURDUE UNIVERSITY

Institute for a Sustainable Future

ISF RESEARCH EXPO

Abstract booklet-FALL 2023

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Fall 2023 ISF Research Expo

Sorted by category & registrant/presenters

The Intersection of Bobcat Migrations and Public Sentiment in Indiana

Author(s): ** indicates presenter(s)*
Hannah I. Reyes*: Animal Sciences with a concentration in Pre-Veterinary Medicine
Abigail A. Seybert: Natural Resources and Environmental Science (NRES)
Anthony T. Tan: Computer Science
Luca M. Iacobucci: Wildlife
Sierra A. Hunnicutt: Ecology, Evolution, and Environmental Biology

Abstract:
In recent years, migrating species, such as the bobcat (Lynx rufus), have been spotted cross-state traveling in Indiana. Habitat corridors are essential for these migrations by combating habitat fragmentation and maintaining biodiversity despite environmental stressors. With private land ownership encompassing approximately 98.2% of the state, per the Indiana Department of Administration, it is important to consider the public perception of coexisting with bobcats. Our research aims to assess public perception concerning bobcats, with the objective of tailoring corridor development strategies along the Wabash River in alignment with these insights. Our survey-based approach targets landowners and visitors of locations like state and county parks, the Niches Land Trust properties, and conservation easement properties near the Wabash River valley. We will initiate our analysis from prior questionnaires conducted in Indiana about people's emotions when encountering white-tailed deer (Odocoileus virginianus) in public and privately owned properties. The studies involve the perspective of rural and urban residents, classifying them further into licensed hunters, farmers, ranchers, and individuals not involved in these practices (Stinchcomb et al., 2023; Stinchcomb et al., 2022; Stinchcomb et al., 2022). Our overarching mission is not just to pave the way for more conservation initiatives centered on corridor development, but also to heighten public awareness in regions where bobcats and humans cohabit. It is crucial for mitigating bobcat-human conflicts as human communities expand. Encountering these felines and other wildlife navigating public roads and neighborhoods as they journey northward, defines the urgent need to advance our conservation efforts.

Mentor(s):
Dr. Kristen Bellisario, John Martinson Honors College: Clinical Assistant Professor and faculty Fellow with Center for Global Sounscapes

Abstract Number: 2

Research Areas(s):
Biodiversity

How does road proximity in Tippecanoe County impact acoustic richness and dispersal of birds using comparative AI vs human-based recognition?

Author(s): ** indicates presenter(s)*
Sierra Hunnicutt (Ecology, Evolution, and Environmental Biology)*
Luca Iacobucci (Wildlife)
Hannah Reyes (Pre-veterinary medicine and animal sciences)
Abigail Seybert (Natural Resources and environmental sciences)
Anthony Tan (Computer science)

Abstract:
Roads cause various negative effects for wildlife such as fragmentation, destruction, and degradation of habitat (Hui et al. 2018). Roads create artificial boundaries for wildlife, raising the need for wildlife corridors to connect the fragmented habitats. Wildlife is often inhibited or impacted by human development, specifically roads, whether by affecting mortality, limiting territory size, or reducing species dispersal. Bobcats (Lynx rufus) have historically held a crucial position in the Indiana ecosystem as prominent mesocarnivores that feed on rabbits, rodents, and birds. This study will attempt to determine how proximity to roads in proposed bobcat corridor land may impact the acoustic richness and dispersal of bird species in the area. We used camera traps and acoustic sensors in six locations along the Wabash River in various states of ecological health and with varying proximities to Tippecanoe Country roads to collect acoustic data on the **types** and frequencies of bird calls heard in each location. The intent of this large-scale study is to determine viable land for conversion into wildlife corridors that would encourage bobcat population movement back into northern Indiana.

Mentor(s):
Dr Bellisario, Honors College

Developing a Wildlife Corridor: How Vegetation influences Bobcat (Lynx rufus) Habitat Preference in Tippecanoe County, Indiana

Author(s): ** indicates presenter(s)*
Abby Seybert* (Natural Resources and Environmental Science), Sierra Hunnicutt (Ecology, Evolution, and Environmental Biology), Luca Lacobucci (Wildlife), Lydia Pultorak (Wildlife), Hannah Reyes (Animal Science), Anthony Tan (Computer Science)

Abstract:
Forest vegetation can be a powerful indicator for ecosystem health in terms of plant species, plant coverage, and diversity. When considering new wildlife corridors, these vegetative factors are important in finding ideal pieces of land for certain wildlife to thrive. One such species, the bobcat (Lynx rufus), has a wide range across the United States. However, the bobcats' habitat in Indiana has been limited to the southern region due to urbanization and land development. This has led to significant habitat reduction and fragmentation, increasing the edge effects for the species. With a wildlife corridor, the bobcat could expand its range northward towards Tippecanoe County and improve its habitat connectivity. The purpose of this study is to find the vegetative landscape preference of bobcats and apply this information to future wildlife corridor development in Tippecanoe County. To investigate the bobcats' ideal plant habitat, vegetation quadrats were conducted in each cardinal direction at six different locations across the county. Each location was strategically placed to consider different land types, including agricultural - forest borders, dense forest, and river's edge locations. In each quadrat, the plant species' names and counts were collected in addition to the overall plant coverage of the square meter plot. The gathered data will recommend precise land acquisitions to landowners and land trust organizations for the creation of vital wildlife corridors along with their associated management considerations.

Mentor(s):
Dr. Kristen Bellisario, John Martinson Honors College

Abstract Number: 4

Research Areas(s):
Biodiversity, Environmental Stressors

How does a detection algorithm perform when adapting a current CNN to monitor human influence on a remote acoustic sensing project?

Author(s): ** indicates presenter(s)*
Tan, Anthony*
Luca Lacobucci
Abigail Seybert
Sierra Hunnicutt

Abstract:
The conservation of biological diversity is an important goal of ecologists and conservationists today. With the advent of passive acoustic monitoring and camera traps, measuring the biodiversity of an area has never become easier. However, parsing through thousands of videos, photos, and sound files is a long and tedious task. Machine learning and its powerful capability to quickly provide accurate results has revolutionized environmental monitoring. However, many models have yet to be tested on accuracy and efficiency. Here, we aim to show that an object detection model (MegaDetector) and acoustic classifier (BirdNet) to camera trap and acoustic sensor data will detect humans, animals, and non-animal images and the acoustic classifier for bird richness, other animal sounds, and non-animal sounds. These detections will be utilized in the overall Niches Corridor Ecology project for a least cost path analyses to select habitats suitable for wildlife corridors. To do this, we will test an object detection model's performance in detecting humans, animals, and non-animal images and the acoustic classifier on animal sounds and non-animal sounds. We will compare results with a random selection of manual labeled data to verify accuracy and to compare the processing time of the model versus manually labelling data. We aim to calibrate the model to optimize accurate predictions comparable or quicker than other models currently being used.

Mentor(s):
Dr. Kristen Bellisario (Honors College)

Abstract Number: 5

Research Areas(s):
Biodiversity

How can acoustic monitoring and AI-CNN technology predict the influence that other mesocarnivores have on bobcat (Lynx rufus) habitat selection in a midwestern river valley?

Author(s): ** indicates presenter(s)*
Luca Iacobucci, Wildlife*. Sierra Hunnicutt, Ecology, Evolution, and Environmental Biology. Hannah Reyes Charles, Pre-Veterinary Medicine and Animal Sciences. Abby Seybert, Natural Resources and Environmental Sciences. Anthony Tan, Computer Science.

Abstract:
Many species rely on forest interior habitat to thrive, reproduce, and disperse. Wildlife corridors are a way to encourage the dispersal of species into previously unavailable habitat. Corridors have become a necessity for certain species because of urbanization. The bobcat (Lynx rufus) is one of these species. With the historic overexploitation of bobcats by European settlers in the Midwest, the species has yet to return to areas like northern Indiana. There have been studies on the population dynamics of already established overlapping territories of mesocarnivores with bobcats; however, this study aims to elucidate the impacts of already established mesocarnivore territories such as eastern coyotes (Canis latrans) and raccoons (Procyon lotor) on new arrivals of bobcats from southern Indiana. By using remote acoustic monitors, AI-CNN technology, and camera traps, we aim to explain the relationship between wandering bobcats and other stationary mesocarnivores. We deployed camera traps as well as acoustic monitors (n = 6) in locations on the southern and northern sides of the Wabash River to track if bobcats were able to cross the river given the presence of other mesocarnivores. We will then use the photo, video, and audio recordings from our sensors to estimate population density of mesocarnivores in the immediate area and inform decisions on wildlife corridor creation to NICHES Land Trust.

Mentor(s):
Dr. Kristen Bellisario, Honors College

Abstract Number: 6

Research Areas(s):
Biodiversity

The use of genomic diversity as a key conservation metric: An example using mammalian whole-genome resequencing data

Author(s): ** indicates presenter(s)*
Jong Yoon Jeon* (FNR), Erangi J. Heenkenda (FNR), Andrew J. Mularo (BIO), Andrew N. Black (FNR), John W. Bickham (external), Gina F. Lamka (external), Safia Janjua (external), Anna Brüniche-Olsen (external), Janna R. Willoughby (external), and J. Andrew DeWoody (FNR and BIO)

Abstract:
Many international, national, state, and local organizations rank threatened and endangered species to help direct conservation efforts. For example, the U.S. Fish and Wildlife Service (USFWS) lists threatened and endangered species at the national level, and the International Union for Conservation of Nature (IUCN) regularly publishes the Red List, an international list of threatened species. Despite its importance as a critical aspect of biodiversity, current approaches to categorizing the conservation status of a given species do not explicitly consider genetic diversity. We estimated genomic diversity metrics derived from publicly available mammalian data and examined their statistical association with formal Red List conservation categories. We also considered biological factors that could impact genomic diversity and quantified their relative influences. Our analyses revealed that genome-wide heterozygosity and measures of autozygosity are associated with the current Red List categorization because demographic declines that lead to "listing" decisions also shape levels of standing genetic variation. We argue that by virtue of this relationship, conservation organizations like USFWS and IUCN can leverage genome sequence data to help infer conservation status in otherwise data-deficient species. To facilitate this idea, we suggest a new genetic criterion for conservation assessment.

Mentor(s):
Dr. J. Andrew DeWoody, Department of Forestry and Natural Resources (FNR) and Department of Biological Sciences (BIO)

Abstract Number: 7

Research Areas(s):
Biodiversity, Sustainable Communities, Environmental Stressors

Population genomics supports the elevation of Evolutionary Significant Units to taxonomic species: the case of the White Sands Pupfish (Cyprinodon tularosa)

Author(s): ** indicates presenter(s)*
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Samarth Mathur - Department of Evolution, Ecology and Organismal Biology, the Ohio State University, Columbus, Ohio, USA
Janna R. Willoughby- College of Forestry, Wildlife, and Environment, Auburn University, Auburn, Alabama, USA
Brian L. Pierce - Natural Resources Institute, Texas A&M University, College Station, Texas, USA
Sarah J. Turner- Natural Resources Institute, Texas A&M University, College Station, Texas, USA
David Rizzuto- Natural Resources Institute, Texas A&M University, College Station, Texas, USA
J. Andrew DeWoody- Department of Forestry and Natural Resources, Purdue University, Department of Biological Sciences, Purdue University

Abstract:
Ecological speciation can arise from divergent selection and lead to the evolution of distinct species, but the relative contribution of neutral processes to rapid speciation has been largely overlooked or rejected. Substantial phenotypic variation in the White Sands pupfish (Cyprinodon tularosa) occurs among ecologically dissimilar desert springs and streams endemic to New Mexico's Tularosa Basin. C. tularosa is designated as Endangered by the IUCN (2022); two Evolutionarily Significant Units (ESUs) have been defined based partly on genetics. Herein, we present genomic data that demarcate the two ESUs, but reveal unexpected hidden diversity. Pairwise nuclear comparisons reveal no discrete islands of divergence but extraordinarily high levels of genome-wide differentiation (global FST≈0.40). Both nuclear and mitochondrial genome sequence data showed a clear pattern of reciprocal monophyly between ESUs. Demographic modeling of the joint allele frequency spectrum indicates that the two ESUs likely split only ~5 kya and that both have undergone major bottlenecks within the last few centuries. Our results indicate the genome-wide disparities between the two ESUs are not primarily driven by divergent selection but by neutral drift due to repeated bottlenecks. The observed differentiation is of a magnitude most often associated with distinct species, which has important implications for the conservation of these endangered fish. While rapid speciation is often associated with natural or sexual selection, here we show that isolation and drift has produced a new vertebrate species within a few thousand generations. We discuss these evolutionary insights in light of the conservation management challenges they pose.

Mentor(s):
Dr J Andrew DeWoody

Abstract Number: 8

Research Areas(s):
Biodiversity, Sustainable Communities

Role of para fluvial processes on downstream transport of eDNA in lotic environments

Author(s): ** indicates presenter(s)*
*Kush Paliwal, Department of Civil Engineering
Dr. Antoine Aubeneau, Department of Civil Engineering

Abstract:
Traces of genetic material abound in the environment. The DNA extracted from field samples containing these ubiquitous biological remains (molecules, cells, or tissue) is called environmental DNA (eDNA). Measuring eDNA extracted from water samples is easy, sensitive, and non-intrusive and has emerged as a practical way to estimate species distribution. Because eDNA is transported in the environment, knowing where it originated remains a challenge, particularly in flowing waters. The interpretation of eDNA data gathered so far from experiments or surveys is hindered by a significant amount of unexplained variability. We propose a simple conceptual model to account for the seemingly erratic transport behavior: eDNA settles out of the water column and accumulates in the riverbed; continuous settling and resuspension events control the downstream transport and trigger the variable local concentrations. We conducted experiments in a laboratory channel to test our conceptual model. eDNA transport on a clean streambed (under limited and enhanced hyporheic exchange) resulted in a breakthrough curve without much noise, whereas experiments on an eDNA-loaded streambed resulted in obscured transport patterns. We were also able to measure eDNA retention (downstream transport length) for the clean bed. The exchange between the water column and the sediment bed could explain both the observed variability, attributed to bed accumulation and random ejections, and the average distance eDNA traveled under varying hyporheic fluxes. Our study demonstrates that para-fluvial processes control environmental-DNA transport in flowing systems and that we can thus tell where it came from.

Mentor(s):
Dr. Rao S. Govindaraju, Civil Engineering

Abstract Number: 9

Research Areas(s):
Climate and Weather

Modeling Eocene-Aged Oceanic εNd Distribution with CESM 1.2

Author(s): ** indicates presenter(s)*
* Adam Aleksinski, Department of Earth, Atmospheric and Planetary Sciences, Purdue University
Matthew Huber, Department of Earth Atmospheric and Planetary Sciences, Purdue University
Jiang Zhu, National Center for Atmospheric Research
Alexandra Jahn, Department of Atmospheric and Oceanic Sciences, University of Colorado, Boulder

Abstract:
The Eocene-Oligocene Transition (EOT), in which the modern Antarctic ice sheet first became permanent, was a key event in the development of the Cenozoic icehouse climate and is important to understand if we are to reliably anticipate long-term consequences of anthropogenic climate change. The environmental factors in which the EOT took place are still uncertain, but it is thought that the contemporaneous opening of the Drake Passage played a role due to the resulting changes in the global ocean circulation. To better understand the changes in the ocean circulation at the EOT, we combine εNd measurements taken from the fossil sand shark Striatolamia macrota to determine the marine aqueous conditions proximal to Seymour Island, Antarctica, with isotope-enabled climate model simulations. In order to understand the connection between εNd measurements and the real-world ocean circulation regime of the late Eocene, it will be necessary to model the marine distribution of εNd using Eocene-aged boundary conditions. However, data on the global Nd sources at the Eocene have large uncertainties.
Here, we use the iCESM 1.2 general circulation model to simulate the ocean and climate systems of the Eocene, and their impacts on oceanic εNd. Presented are the results of an early-Eocene (~55 Ma) control experiment with 6x preindustrial levels of CO2, shallow Southern Ocean gateways, and neodymium and εNd prescribed as paleorotations of modern-day measurements. Future work will test εNd responses to altering these boundary conditions, as well as to simulate these in a 35 Ma paleogeography.

Mentor(s):
Matthew Huber, Department of Earth, Atmospheric and Planetary Sciences

Abstract Number: 10

Research Areas(s):
Climate and Weather

Scaling of human heat stress with global warming: is it misleading to look at temperature only?

Author(s): ** indicates presenter(s)*
Qinqin Kong* (EAPS);
Matthew Huber (EAPS)

Abstract:
Numerous studies have examined the scaling of temperature with global warming, and identified hotspots where temperatures are projected to rise faster compared to other areas. These hotspots have garnered substantial attention because of concerns on the growing impact of heat on human health and socio-economic systems. However, human heat stress depends not only on temperature, but also on humidity, radiation and wind speed. This raises the question that whether the temperature warming pattern can accurately pinpoint regions with rapidly exacerbating heat stress.
To address this question, we use the wet-bulb globe temperature (WBGT), a standard metric for assessing heat stress, to investigate how human heat stress scales with global warming. We found contrasting scaling pattern between WBGT and temperature concerning both annual averages and seasonal variations. The Amazon and northern mid-latitudes (especially the Mediterranean region), identified as temperature scaling hotspot, do not stand out for heat stress due to a compensation effect of reduced relative humidity. This suggests that these temperature scaling hotspots are largely a result of surface energy re-partition from latent to sensible heat as climate warms. In contrast, the Sahel zone emerges as a prominent hotspot of heat stress intensification possibly due to changes in the West African Monsoon.

Mentor(s):
Matthew Huber; EAPS

Abstract Number: 11

Research Areas(s):
Climate and Weather

Influence of opening the Miocene Canadian Archipelago gateways on the Intertropical Convergence Zone: a model study

Author(s): ** indicates presenter(s)*
Xiaoqing Liu*1, Matthew Huber1, Nicholas Herold2
1Department of Earth, Atmospheric and Planetary Sciences, Purdue University, USA
2Applied Climate Science Pty Ltd., Adelaide, Australia

Abstract:
Here we explore the effects of the opening of Canadian Archipelago (CA) gateway on the Intertropical Convergence Zone (ITCZ) by performing numerical experiments with Community Climate System Model 4, forced with 400 ppm of atmospheric CO2, early to middle Miocene geography. Our results demonstrate a northward shift of the ITCZ with the open CA compared to the closed CA. This shift results from a more robust southward atmospheric energy transport across the equator with the open CA, which compensates for an increase in northward ocean heat transport (OHT), primarily contributed by the Atlantic Ocean. The increase in northward Atlantic OHT is a consequence of the strengthening of the Atlantic Meridional Ocean Circulation, which is caused by a greater formation of North Atlantic Deep Water when the CA is open compared to when it is closed. In addition, the enhanced northward OHT in the Atlantic leads to increased surface warming of the North Atlantic, and this simulated North Atlantic warming with the CA open better represent the proxy data compared with the CA closed experiment.

Mentor(s):
Matthew Huber

ISF: Data-Driven Discovery of the Nonlinear Schrödinger Equation as a Governing Equation for Extreme Weather Events

Author(s): ** indicates presenter(s)*
Willliam Messman*- Department of Mathematics and Department of Physics
Zhaoyu Liu – Department of Earth Atmospheric and Planetary Sciences

Abstract:
The purpose of this project is to provide a data-based approach for determining between multiple competing models for atmospheric blocking via the use of sparse regression methods such as PySINDy and Subsampling Sparse Bayesian Regression (SubTSBR) for identifying the governing equations from the data. This project examined the effectiveness of such methods in correct identification of governing equations through their application to partial differential equations relevant to the current models of atmospheric blocking such as the Burgers equation and the nonlinear Schrodinger equation, both with and without the addition of noise to the system. We then apply the regression methods to both simulation and real atmospheric data for discovery of the underlying governing equation. We have found both the SubTSBR and PySINDy approaches to be effective on identification the Burgers equation for noisy data and have determined that the PySINDy approach is effective on the identification of the nonlinear Schrodinger equation with noisy data, providing confidence in the method's ability to accurately identify a governing equation for atmospheric blocking from noisy real world data. Atmospheric blocking is thought to be involved in extreme weather events such as heat waves, and so a better understanding of the driving equations behind this phenomenon will help to better understand, predict, and plan for such events in the future.

Mentor(s):
Professor Lei Wang - Department of Earth, Atmospheric, and Planetary Sciences
Professor Guang Lin – Department of Mathematics and School of Mechanical Engineering

Abstract Number: 13

Research Areas(s):
EVs, Climate and Weather, Risk and Resilience

Exploring the Relationship between Temperatures and EV Adoption: The Case of California and New York

Author(s): ** indicates presenter(s)*
Gaia Cervini, CE*
Jinha Jung, CE
Nadia Gkritza, CE

Abstract:
Electric vehicle (EV) users living in colder or warmer climates experience shorter traveling ranges, slower acceleration, and longer recharge times, which might discourage the adoption of EVs. To explore the relationship between temperatures and EV adoption, a study is conducted in the United States (US), using California and New York as case studies. We collect land surface and air temperature data at the ZIP code level in addition to sociodemographic, charging infrastructure, and land cover data. We then use random forest machine learning to predict battery electric (BEV) and plug-in hybrid electric (PHEV) vehicle population, population change rate, and penetration. Our findings reveal that sociodemographic predictors significantly influence BEV and PHEV population, population change rate, and penetration. However, temperature also plays a role in explaining variations in EV adoption: cold temperatures prove to be a significant factor explaining the variation in BEV and PHEV population and population change rate in California, while warmer temperatures emerge as influential in New York. Whether the significance of temperatures in predicting EV adoption is due to consumer perceptions is to be confirmed, since both EV population and temperatures are correlated to developed land. Understanding the interplay between temperatures and EV adoption is crucial as extreme weather events become more frequent and persistent. This study highlights the importance of considering both climatic and sociodemographic factors in designing geotargeted interventions to promote EV adoption and contributes to fostering sustainable transportation options.

Mentor(s):
Nadia Gkritza (CE), Jinha Jung (CE)

Abstract Number: 14

Research Areas(s):
EVs, Environmental Justice

Measuring Indiana's transportation and environmental equity using large-scale data

Author(s): ** indicates presenter(s)*
*Rajat Verma, Lyles School of Civil Engineering
*David Holguien, Lyles School of Civil Engineering
Satish V. Ukkusuri, Lyles School of Civil Engineering
Konstantina "Nadia" Gkritza, Lyles School of Civil Engineering

Abstract:
The USDOT has made equity a top issue for all transportation modes and has mandated that states should take steps to address equity (and accessibility) in statewide transportation programs. A review of literature shows that there is a substantial gap in the goal of addressing equity concerns and the practical implementation of equity assessment, primarily owing to a lack of industry standards. In this study, we explore two components of transportation and land use equity – accessibility to workplaces and other places and environmental justice measures pertaining to vehicular and industrial pollution. We propose generalized parametric metrics of accessibility and environmental justice (A&EJ). Using data of Indiana and the U.S. from multiple public and private sources, we then explore their relationships with socio-economic status (SES) and land use indicators of neighborhoods using factor analysis. We also develop an interactive analytics application for analysts to visualize the spatial relationships between the SES and A&EJ measures. We will deploy this tool to the Indiana Department of Transportation and metropolitan planning organizations of Indiana.

Mentor(s):
Satish V. Ukkusuri, Lyles School of Civil Engineering
Konstantina "Nadia" Gkritza, Lyles School of Civil Engineering

Abstract Number: 15

Research Areas(s):
EVs, Sustainable Communities

EV ADOPTION AND CHARGING STATIONS IN INDIANA: EVIDENCE FROM A STATED PREFERENCE SURVEY

Author(s): ** indicates presenter(s)*
*Bruno Cesar Krause Moras
Ph.D. Student, Lyles School of Civil Engineering
Prasanna Humagain
Post-doctoral Research Associate, Lyles School of Civil Engineering
Konstantina (Nadia) Gkritza
Professor, Lyles School of Civil Engineering and Agricultural & Biological Engineering

Abstract:
The transportation sector is the largest contributor to greenhouse gas emissions. To mitigate this issue, many initiatives have been put into practice: one with the greatest potential to attenuate the situation is Electric Vehicle (EV). This study aims to investigate the public perception of EVs and their charging stations. A stated preference survey was conducted to examine the knowledge and experience of Indiana's public about it. The final questionnaire was reviewed and approved by Purdue University's Institutional Review Board (IRB Protocol #158). Verification and screening questions were added to the survey to prevent poor-quality responses. A total of 1069 participants are considered in the study. The respondents were divided into three groups: current EV users, past EV users, and non-EV users. The research included questions common to all groups as well as specific questions for each niche. Among the characteristics observed in current EV users are male gender, living in urban areas, young age, and not living alone. Regarding charging technologies, it is observed that non-EV users have less knowledge about different types, with the majority (64.95% of the group) not knowing any of the most common charging technologies. It is also noteworthy in this group that only 10% of the sample would always feel capable of charging an EV. Electrified highways are a type of charging still unknown to the public, as only 7.45% of non-EV users have ever read or heard about them. The next steps include studying the factors that influence the adoption of EVs over time.

Mentor(s):
Konstantina (Nadia) Gkritza
Lyles School of Civil Engineering and Agricultural & Biological Engineering

Abstract Number: 16

Research Areas(s):
EVs, Electrification

Experienced and non-experienced EV users charging preferences: A multivariate analysis using a stated-preference survey in Indiana

Author(s): ** indicates presenter(s)*
Kenny Chandra Wijaya*, Civil Engineering Department

Abstract:
This study investigates the charging preferences of electric vehicles (EV) and non-EV users in Indiana. The decisions (dependent variables) include charging level (level 2 and DCFC), and power transfer mode (DWPT). From the SP survey descriptive analysis, we could identify experienced and non-experienced EV users charging decision difference especially for level 2 and DWPT options. Furthermore, using discrete choice model we found significancy and impact dissimilarity of trip cost, charging time, EV's SoC, amenities availability, and sociodemographic variables toward charging options for experienced and non-experienced users. The findings provide crucial insights for infrastructure development and policy formulation to accelerate mobility electrification.

Mentor(s):
Konstantina Gkritza, Civil Engineering and Agricultural Biological Engineering Department

Abstract Number: 17

Research Areas(s):
cyberinfrastructure

Purdue IT Research Computing Resources

Author(s): ** indicates presenter(s)*
Lan Zhao, Rajesh Kalyanam, Carol Song
RCAC

Abstract:
The Rosen Center for Advanced Computing (RCAC) (http://www.rcac.purdue.edu) is the research computing arm of Purdue Information Technology (Purdue IT), the University's central IT organization. RCAC provides a large and diverse set of high-performance computing, data-intensive and cloud computing resources, high-speed network connections to national research wide-area networks, and large data storage and archival systems to the broad research communities at Purdue and elsewhere. RCAC also provides resources, expertise, services, and software development efforts to the national research community through partnerships with national cyberinfrastructure projects such as the ACCESS (formerly XSEDE), Open Science Grid (OSG), and the Science Gateways Community Institute (SGCI). In this poster we will introduce the high performance computing and data resources RCAC provides to the researchers at Purdue as well as across the nation. We will also highlight RCAC's research software engineering (RSE) expertise that covers a broad spectrum of services, including user support, consultation, training, and documentation; software installation; computation optimization and scaling; large-scale data management; capacity planning; cluster deployment; and software solution and tool development, integration, and hosting services.

Mentor(s):

Abstract Number: 18

Research Areas(s):
cyberinfrastructure

Simplifying and Streamlining Scientific Data Exploration, Visualization and Dissemination

Author(s): ** indicates presenter(s)*
I Luk Kim*, Carol X Song, Lan Zhao, Rob Campbell
RCAC

Abstract:
Scientific data exploration, visualization, and dissemination is critical for information discovery and advancing knowledge across science and engineering domains. However, researchers face challenges in developing online applications for their data dissemination as they often lack web development expertise. . In this poster, we showcase our effort in addressing these challenges via several collaboration projects in developing interactive tools for exploration, visualization, and sharing of scientific datasets ranging from SWAT model outputs, satellite remote sensing data useful for hydrological modeling, modeled crop yields generated by AgMIP GGCMI group, to preprocessed and classified crop data and climate data in Arequipa, Peru, and gene coexpression network data used by genomics researchers. A comprehensive survey of these data dissemination tools, together with the critical attributes that guided our selection of the technologies and software frameworks for these tools will be presented. We will also discuss our future work to further simplify the process of data dissemination by offering a guided framework with templates and libraries for creating customized web-based tools for dataset dissemination, empowering researchers to not only share datasets but also seamlessly integrate advanced analysis methods leveraging the capabilities of high-performance computing (HPC) resources.

Mentor(s):

Abstract Number: 19

Research Areas(s):
Streaming data cyberinfrastructure for sustainability research

A scalable streaming sensor data analysis cyberinfrastructure

Author(s): ** indicates presenter(s)*
*Jaewoo Shin, Rosen Center for Advanced Computing
*Lan Zhao, Rosen Center for Advanced Computing
Carol X. Song, Rosen Center for Advanced Computing
Rajesh Kalyanam, Rosen Center for Advanced Computing
Jian Jin, Department of Agricultural and Biological Engineering
Jacob D. Hosen, Department of Forestry & Natural Resources
Ananth Grama, Department of Computer Science
Dongyan Xu, Department of Computer Science

Abstract:
Rapid advances in technology have produced large volumes of data, in particular, through data streams from sensors and devices. Effective utilization of such data has been hampered by the lack of ready-to-use cyberinfrastructure (CI) solutions for data providers to manage the data and for data consumers to access the data through facile APIs. To address such challenges, we developed StreamCI, a flexible and scalable CI platform that helps researchers to easily collect, manage, process, and access streaming data in real-time. StreamCI is developed using an open-source software stack including RabbitMQ, node.js, MongoDB, Grafana, and HUBzero. The backend of StreamCI is deployed on Purdue's composable system called Geddes which provides scalable operation using Singularity containers and Kubernetes autoscaling services. In this poster, we will describe the design and implementation of StreamCI. We will also showcase the successful application of StreamCI in collecting, processing, analyzing, and visualization of diverse types of data across disciplines, including crop sensor data, water and air quality sensor data, IoT device data, and advanced manufacturing data. Finally, we will discuss StreamCI's future endeavors, which involve enhancing support for machine learning workflows and streaming data processing.

Mentor(s):
Lan Zhao, RCAC
Carol X. Song, RCAC

Abstract Number: 20

Research Areas(s):
Climate and Weather, Risk and Resilience

Prediction of storm surge on slowly evolving landscapes under climate change

Author(s): ** indicates presenter(s)*
Mohammad Ahmadi Gharehtoragh*, David Johnson
Department of Industrial Engineering
Department of Political Science

Abstract:
Storm surges are a major concern for coastal communities, as they can cause significant damage and loss of life. In order to mitigate the impacts of storm surges, accurate prediction of their occurrence and severity is essential. However, existing numerical models used to simulate storm surge and wave, particularly high-fidelity ones needed to capture dynamics near protection features like levees, are computationally expensive. Because of that, surrogate models for the prediction of storm surge are recognized as great tools for emulating the approximation of storm surge and wave. Once these models are trained on synthetic datasets that usually come from a hydrodynamic model such as ADCIRC, they can be used to cheaply predict surge and wave from other storms not in the training set.
However, existing research focuses on accurate prediction of storm surge on a static landscape, with storm parameters used as predictors. In this research, we applied artificial intelligence to storm surge and wave simulations to predict storm surge and wave as a function of storm parameters, geographic location, and landscape data (e.g., surface and bottom roughness, bathymetric/topographic elevation, vegetation canopy). The findings of this study demonstrate that this approach can produce acceptably accurate results useful for planning studies. Our method can be used to generate new landscape scenarios and estimate risk in a larger ensemble of future conditions than can feasibly be explored using more expensive hydrodynamic modeling.

Mentor(s):
Dr. David Johnson, Industrial Engineering Department

Abstract Number: 21

Research Areas(s):
Risk and Resilience

Agent-Based Modeling of Resident Flood-Hazard Relocation Decisions With Relocation Subsidies

Author(s): ** indicates presenter(s)*
Fangyuan Li*, School of Industrial Engineering
Pragathi Jha, School of Industrial Engineering
David Johnson, School of Industrial Engineering and Political Science

Abstract:
Relocating coastal residents to regions with less flood risk is becoming increasingly important as sea levels rise and climate change intensifies. Most studies treat voluntary relocation as a passive response to disasters, however, viewing it as a preventive measure has the potential to reduce flood risk and benefit coastal residents. Moreover, most studies adopt a single decision-maker perspective without considering the goals, preferences, and interactions among many stakeholders involved in the process.
We propose an agent-based model to simulate the relocation process in coastal Louisiana over the planning horizon. The government offers a relocation subsidy plan to incentivize residents to relocate earlier. The subsidy amount and timing are determined through interactions between the government and single-family homeowners, modeled using a stylized game-theoretic approach.
High-resolution Coastal Louisiana Risk Assessment (CLARA) data will be incorporated into the agent-based model. This includes household-level flood depth estimates and structure information, community-level demographic information, and direct economic damage.
The outcomes of this research will answer pivotal questions: Is the subsidized pre-disaster relocation plan cost-effective in mitigating flood risk? To what extent does this plan benefit stakeholders? What are the social implications of this strategy? Insights drawn from the agent-based model could steer the development of more effective disaster policies. The model can also help understand stakeholder interactions, informing strategies for better stakeholder engagement and community acceptance.

Mentor(s):
David Johnson, from the School of Industrial Engineering and Political Science

Abstract Number:22

Research Areas(s):
Environmental Justice, Risk and Resilience

Alternative Risk Metrics to Evaluate Tradeoffs between Efficiency and Equity of Risk Reduction

Author(s): ** indicates presenter(s)*
Prof David R Johnson, School of Industrial Engineering
Pragathi Jha, School of Industrial Engineering*
Dr Nathan B Geldner, PhD, The Water Institute

Abstract:
Traditional benefit-cost analysis (BCA) is criticized for its benefit-cost ratios (BCRs) being reductive, simplifying all benefits and costs into one value. This often overlooks distributional impacts for pure economic efficiency. Specifically, in flood risk management, BCA tends to favor affluent communities with high value assets and may result in inequitable risk reduction provisions.
This research analyzes ranked preferences for flood protection projects included in Louisiana's Comprehensive Master Plan for a Sustainable Coast, a 50-year, $50 billion USD suite of infrastructure investments primarily targeting risk reduction and coastal restoration. In addition to BCRs, we also estimate cost effectiveness measures such as the reduction, per unit of project cost, in the expected number of residential structures inundated over the planning horizon. Measures like this intentionally ignore the replacement costs of structural assets, implicitly valuing protection of each household equally regardless of wealth. In a sense, we consider how preferences vary, depending on whether decision makers' preferences are to protect wealth or to protect households. We then overlay census data to estimate the risk reduction which would be afforded across different demographic categories by project portfolios of varying budgets, examining differential outcomes across income, race, and urbanicity. Our analysis suggests that the choice of metric has a substantial impact on the rank-ordered preferences for flood protection projects, and that dramatic increases in equity can be obtained by placing only a small weight on metrics that are wealth-agnostic.

Mentor(s):
Prof David R Johnson, School of Industrial Engineering

Assessment of fine particulate matter (PM2.5) in Purdue campus after Canadian wildfire in June 2023

Author(s): ** indicates presenter(s)*
Subin Han, Human and Health Sciences

Abstract:

At the end of June, central Indiana was covered by smoke caused by Canadian Wildfires. This smoke containing particulate matter (PM) decreased air quality and caused adverse health outcomes. Once inhaled, small PM can reach deeper lungs and cause respiratory diseases. Moreover, some toxic metals can be also contained in the PM produced from the combustion, which can negatively affect the respiratory and nervous systems. In this study, the concentrations of PM2.5 (≤ 2.5 μm) were measured at three different places outside of the Civil Engineering building, HAMP from June 28th to 31st. A deployable particulate sampler equipped with a polyvinyl chloride (PVC) filter was used to collect PM2.5. The collected samples were gravimetrically analyzed and then mass concentrations were calculated. In addition, metal contents in PM2.5 were also analyzed using X-ray fluorescence (XRF). The results show that the highest PM2.5 concentration was found on the first day (107 ± 9 μg/m3) which was three times higher than the United States Environmental Protection Agency (EPA) National Ambient Air Quality Standards for PM2.5 (35 μg/m3 for 24 hours). Because it rained in Indiana on the second day, the PM2.5 concentrations decreased to 70 ± 1 μg/m3 on the second day and 100 ± 4 μg/m3 on the third day, respectively. In all PM2.5 samples, the metals were found lower than the detectable level of XRF. From the results, the composition of PM2.5 in this study could be mainly organic matter. To analyze the detailed composition, further study is required.

Mentor(s):
Dr. Jae Hong Park, Human and Health Sciences

Abstract Number: 24

Research Areas(s):
Environmental Stressors

Metals in toenails as biomarkers for assessing chronic exposure to welding fumes

Author(s): ** indicates presenter(s)*
Chang Geun Lee *, Jung Hyun Lee, Sa Liu, Ulrike Dydak, and Jae Hong Park
School of Health Sciences, Purdue University

Abstract:
Chronic overexposures to have been linked to a range of diseases. While some metals such as manganese (Mn) are known to cause neurotoxic effects and hexavalent chromium (Cr) are well-known carcinogens, the dose-response in chronic exposure is not fully understood. Therefore, biomarkers are crucial in identifying the impacts of the chronic exposures. In a previous study, we found that toenail Mn concentration was an excellent biomarker for chronic exposure to Mn. However, the use of concentrations of other metals in toenails as biomarkers has not been explored. In this study, we collected welding fumes and toenails from 14 welders and 13 controls to investigate the relationship between welding fumes exposure and toenail metal levels for Mn, iron (Fe), zinc (Zn), and Cr. We measured metal concentrations in welding fumes and toenails using inductively coupled plasma-optical emission spectrometry. Additionally, we calculated the area under curves (AUCs) of the receiver operating characteristics (ROC) curves to assess the ability of toenail metal levels to distinguish between welders and controls. Our results showed that metal concentrations in toenails were significantly higher in welders than controls. Metal concentrations in toenails (μg/g) for welders and controls were Mn (3.9, 1.5), Fe (62.3, 22.1), Zn (73.1, 79.9), and Cr (2.6, 0.4). Mn concentrations in toenails had the most capability to distinguish between welders and controls (AUC = 0.91), followed by Fe (0.73), Cr (0.58), and Zn (0.54). These findings highlight the potential of toenail metal concentrations as a biomarker for chronic exposure to metals.

Mentor(s):
Dr. Jae Hong Park

Abstract Number: 25

Research Areas(s):
Environmental Stressors, Measurement of Heavy Metals

Experimental design and testing of a portable x-ray tube based KXRF system to measure lead in bone

Author(s): ** indicates presenter(s)*
Thomas R Grier1*, Chandler J Burgos1, Maruf Khan1, Marc G Weisskopf2, Kathryn M Taylor3, Aaron J Specht1
1Purdue University, School of Health Sciences, West Lafayette, IN 47906
2Harvard T.H. Chan School of Public Health, Boston, MA 02115
3United States Army Research Institute of Environmental Medicine, Natick, MA 01760

Abstract:
X-ray Fluorescence (XRF) is commonly used to measure cumulative exposure to lead. For many years, a method called K-shell x-ray fluorescence (KXRF) had been utilized to detect the adverse effects of metal exposure on human health. Although the equipment had undergone numerous advancements, it still has some limits. Due to its bulkiness, liquid nitrogen cooled germanium detectors, and radioisotope use it is not very portable. A handheld L-shell XRF (pXRF) has been utilized recently as a replacement, but this system cannot measure trabecular bone and has uncertainty linked to skin thickness. In this study, we developed a new portable K-shell XRF for bone lead measurement utilizing a 140kV x-ray tube with two CdTe detectors in a 90-degree geometry with a ten-minute measurement time. Lead concentrated standard bone phantoms were measured to test the limitations of the system. Molybdenum sheets were used for the shielding and optimization of the beam. Using two CdZnTe detectors with 1cm3 active area during a measurement gave us a limit of detection (LOD) of 0.6 ug/g bone mineral for our new bone measurement system. This can be compared to the LOD for previous KXRF and pXRF at 2-3 ug/g and 2-10 ug/g respectively. Thus, our new measurement system can detect lead at a factor of 3 greater efficiency than previous approaches enabling it for measurements of nearly all environmentally exposed populations for cortical and trabecular measurements. Future work with this device will focus on the development of simultaneous measurement of other metals of concern.

Mentor(s):
Aaron Specht, School of Health Sciences

Abstract Number: 26

Research Areas(s):
Environmental Stressors

New Insights on Indoor New Particle Formation in Residential Buildings

Author(s): ** indicates presenter(s)*
Satya S. Patra*, Jinglin Jiang, Chunxu Huang, Xiaosu Ding, Emily Reidy, Paige Price, Vinay Kumar, Conner Keech, Gerhard Steiner, Antonios Tasoglou, Philip S. Stevens, Nusrat Jung, and Brandon E. Boor.

Abstract:
Indoor new particle formation (NPF) can be a significant source of sub-3 nm particles in buildings. The current study aims to characterize indoor NPF events initiated by monoterpene ozonolysis. Field measurements of both particle and gas-phase concentrations were carried out in a mechanically ventilated residential building for various terpene-releasing household products. Overall, frequent particle nucleation (42/45 experiments) and growth (33/45 experiments) were observed across all experiments. These indoor NPF events occurred at lower ozone concentrations than those outdoors. Higher indoor monoterpene concentrations, emitted directly from the products, compensate for the lower ozone concentration, thereby driving the ozonolysis reaction forward. In the ozonolysis of several tested terpene-based products, not all nucleation and growth processes occurred in the same manner. Pulsed-terpene injection experiments, such as spraying air fresheners, resulted in instantaneous, rapid particle growth, but experiments using aromatherapy products exhibited a relatively gradual growth of particles. NPF intensity was strongly related to AER and monoterpene concentrations. The observed indoor particle growth rates were significantly higher than the reported outside particle growth rates. Coagulation and condensation scavenging by larger pre-existing particles are known significant loss processes for freshly nucleated particles and their low-volatility gas-phase precursors. This aspect was evaluated by atomizing ammonium sulfate to create artificial condensation sinks. The presence of condensation sinks significantly inhibited NPF indoors.

Mentor(s):
Prof. Brandon E. Boor, Civil Engineering Department

Abstract Number: 27

Research Areas(s):
Environmental Stressors, Sustainable Communities, the Built Environment

Coupling an Olfaction Chamber with Proton Transfer Reaction Mass Spectrometry for Evaluating Human Response to Scented Product Emissions

Author(s): ** indicates presenter(s)*
Jordan Cross*
Brian Magnuson
Zachary Limaye
Brandon Boor
Nusrat Jung

Abstract:
This study is focused on the design, production, and operation of a controlled environmental olfaction chamber to evaluate human physiological and emotional response to volatile chemical emissions from scented household products in addition to careful characterization of the volatile organic compounds (VOCs) present in these product emissions

Mentor(s):
Dr. Nusrat Jung and Dr. Brandon Boor, both CE

Abstract Number: 28

Research Areas(s):
Environmental Stressors, Sustainable Communities, Risk and Resilience

Field Evaluation of a Photoionization Detector for the Real-time Measurement of Volatile Organic Compounds During Chemical Disinfection Activities in Residential Buildings

Author(s): ** indicates presenter(s)*
Xiaosu Ding, Lyles School of Civil Engineering, Purdue University
Hongbo Lu*, Lyles School of Civil Engineering, Purdue University
Jinglin Jinag, Lyles School of Civil Engineering, Purdue University
Dr. Antonios Tasoglou, RJ Lee Group Inc
Dr. Nusrat Jung, Lyles School of Civil Engineering, Purdue University

Abstract:
Photoionization detectors (PIDs) are low-cost sensors (LCSs) that are widely used for real-time volatile organic compound (VOC) monitoring in buildings. Performance assessment of PIDs often lack valuable real-time information that is needed to evaluate how PIDs track transient indoor VOC emission events in buildings. The objective of this study is to evaluate the real-time field performance of an isobutylene-calibrated PID in detecting indoor VOC mixtures released from spray-based chemical disinfectants through co-location measurements with a state-of-the-art proton transfer reaction time-of-flight mass spectrometer (PTR-TOF-MS).

Mentor(s):
Dr. Nusrat Jung, Assistant Professor at Lyles School of Civil Engineering

Abstract Number: 29

Research Areas(s):
Environmental Stressors

Lipid-Mediated Inflammation Contributes to Metabolic Syndrome-Associated Pulmonary Susceptibility Nanoparticles

Author(s): ** indicates presenter(s)*
Akshada Shinde1*, Arjun Pitchai1, Li Xia1, Christina Ferreira2, Jonathan Shannahan1:
1School of Health Sciences, Purdue University, West Lafayette, IN, USA,
2Purdue Metabolite Profiling Facility, Purdue University, West Lafayette, IN, USA

Abstract:
Metabolic Syndrome (MetS) is a combination of abnormal metabolic disturbances including dyslipidemia, obesity, enhancing the risk of cardiovascular disease, and other chronic diseases. Several epidemiological assessments demonstrate individuals with MetS exhibit exacerbated inflammatory responses following inhalation of particulates. The mechanisms of these inflammatory responses remain unelucidated and prevent the development of strategies to protect this vulnerable population. Nanomaterials are increasingly utilized in numerous applications and processes resulting in nanoparticles exposures during product use and development. Since lipids are dysregulated in MetS and are intricately involved in inflammatory regulation, we hypothesize particulate exposure-induced modifications in lipids mediate MetS susceptibility to inflammation. To evaluate this, mice were fed either a control diet or a high-fat western diet for 14-weeks. Mice were exposed to silver nanoparticles (AgNPs) via oropharyngeal aspiration or water (control). Acute pulmonary toxicity endpoints were evaluated 4 hours after exposure to capture potential variations in pro-inflammatory mediators. Analysis of bronchoalveolar lavage fluid demonstrated AgNP exposure resulted in neutrophilia in both health and MetS models.Gene expression of the inflammatory markers chemokine ligand-1 and macrophage inflammatory protein-2 were upregulated equivalently in both models. Gene expression of IL-6, IL-1B, and monocyte chemoattractant protein-1 were decreased in control MetS compared to healthy controls. Pulmonary lipids were evaluated utilizing an MRM profiling approach which demonstrated unique induction of pro-inflammatory lipid mediators in the MetS mouse model following AgNP exposure compared to the healthy model. Overall, our data suggests dysregulation of pro-inflammatory lipid mediators contributes to exacerbations in inflammatory responses observed in MetS following particulate exposures.

Mentor(s):
Dr. Jonathan Shannahan, Department of Health Sciences (Toxicology)

Abstract Number: 30

Research Areas(s):
Environmental Stressors

Lipid Regulation of Nanoparticle-Induced Pulmonary Inflammation: Sex and Disease Variations

Author(s): ** indicates presenter(s)*
Arjun Pitchai*, Shinde, Akshada Avinash, Kiley Robison, Jenna Nicole Swihart, Jonathan Shannahan.

Abstract:
Metabolic syndrome (MetS) presents a significant public health concern, diagnosed when an individual exhibits a minimum of three out of five risk factors: abdominal obesity, systemic hypertension, insulin resistance, hypertriglyceridemia, and/or low HDL cholesterol levels. Traditionally, assessments of nanoparticle safety have centered around healthy models. However, recent evidence highlights that individuals with MetS are more susceptible to the adverse health impacts of particulate air pollution. Our previous research found that a mouse model with MetS experienced increased pulmonary inflammation 24 hours after exposure to silver nanoparticles (AgNPs) compared to a healthy mouse model. This inflammation was accompanied by a reduction in specific lipid mediators of resolution. Furthermore, our investigations revealed that while inflammation subsided in the healthy model, it remained elevated for up to 21 days after AgNP exposure in the MetS model. Notably, when a specialized pro-resolving mediator (SPM), resolvin D1 (RvD1), was administered, it mitigated the exacerbated effects observed in the MetS model in response to AgNP exposure. Our ongoing study posits that other SPMs, such as resolvin E1 (RvE1), protectin D1 (PD1), and maresin, which are also known to be dysregulated in MetS following AgNP exposure, might hold promise for alleviating these enhanced inflammatory responses.

Mentor(s):
Jonathan Shannahan

Abstract Number: 31

Research Areas(s):
Environmental Stressors

The kisspeptin system in the developing zebrafish and differential gene alterations following two exposure periods to the agricultural herbicide atrazine

Author(s): ** indicates presenter(s)*
Sydney Stradtman*, Jenna Swihart, Jennifer Freeman

Abstract:
Atrazine is an herbicide preventing broadleaf and grassy weeds on agricultural fields in the US but this herbicide has been banned in the European Union since 2003, based mainly on risk of contamination of surface and groundwater. Atrazine is categorized as an endocrine disrupting chemical (EDC), altering release of luteinizing hormone from the pituitary through gonadotropin-releasing hormone in the hypothalamus. The mechanism that leads to this disruption is not yet clearly defined. In this study, molecular targets in the kisspeptin signaling system within the neuroendocrine system were explored to elucidate a mechanism that coincides with the multiple observed adverse health outcomes along the endocrine axes. Using the zebrafish model, expression of genes associated with the kisspeptin system (kiss1, kiss2, kiss1ra, kiss1rb) were first examined during different stages of development (24, 48, 72, 96, or 120 hours post fertilization, hpf) using qPCR. Expression of the four genes significantly increased throughout development (p<0.05). Second, it was determined if a developmental atrazine exposure perturbed expression of these genes using qPCR comparing two developmental exposure periods [1-72 hpf or 72-120 hpf]. Atrazine treatments included 0, 0.3, 3, or 30 ppb (µg/L) to represent concentrations around the current US EPA regulatory level in drinking water of 3 ppb. Results indicated preferential increase in kiss1 and kiss2 expression from the embryonic (1-72 hpf) atrazine exposure (p<0.05) with no changes observed for the receptors (kiss1ra, kiss1rb) (p>0.05). Future studies are needed to further investigate the association of the kisspeptin signaling system and atrazine endocrine disruption.

Mentor(s):
Jennifer Freeman, Health Sciences

Abstract Number: 32

Research Areas(s):
Environmental Stressors

Classification of the toxicity in early-life exposure to lead in zebrafish sorl1 mutants

Author(s): ** indicates presenter(s)*
Wagner Antonio Tamagno1,2,* and Jennifer L. Freeman1,2
1 - School of Health Sciences, Purdue University, West Lafayette, IN, USA
2 - Institute for the Sustainable Future, Purdue University, West Lafayette, IN, United States.

Abstract:
Exposure to lead (Pb) is a public health problem responsible for several adverse health outcomes dependent on exposure dose and life stage of exposure. In recent studies, an increased incidence and severity of Alzheimer's disease cases was observed in patients exposed to Pb and other heavy metals. Based on these findings, in this study exposure to low doses of Pb [1, 10, or 100 ppb (µg/L)] during embryogenesis (1 to 72 hours post-fertilization, hpf) in wild-type (5D) and a sorl1 deletion mutant strain was evaluated. During the exposure period (1-72 hpf), spontaneous movement rate at 24 hpf, heartbeat rate at 48 hpf, and hatching rate up to 72 hpf was evaluated. No increase in lethality was observed throughout the experiment (i.e., above 97% survival in all treatment groups), along with no significant differences in time to hatch. The rate of spontaneous movement and the rate of heartbeat were altered in the sorl1 mutant in the group exposed to 10 ppb Pb, indicating increased susceptibility and a gene x environment interaction. Furthermore, the assessment of the larvae's cognitive capacity by the AST was mostly impaired in the sorl1 mutant treated with 10 ppb Pb. In this test, there was no difference between the 10 ppb Pb wild-type and sorl1 mutant groups, but the cognitive impairment was accentuated in the treated mutant groups overall. These conclusions indicate that Pb alone is capable of affecting cognition but the sorl1 genetic variant background results in more pronounced impairment.

Mentor(s):
Jennifer L. Freeman - Health and Human Sciences

Molecular Markers of Thermal Oil Refinery Effluent Exposure in Fish

Author(s): ** indicates presenter(s)*
*Sophia Horn - Purdue University, Department of Biology
Anna Bushong - Purdue University, Department of Forestry and Natural Resources
Hallie Jackson - Purdue University, Department of Biology
Tyler D. Hoskins - Purdue University, Department of Forestry and Natural Resources
Maria S. Sepúlveda - Purdue University, Department of Forestry and Natural Resources

Abstract:
A small stream in Illinois is home to the State-threatened Bigeye Chub (Hybobpsis amblops), but also receives thermal effluents from a refinery. The combination of refinery effluent and thermal stress may impact fish health resulting in decreased recruitment. The objective of this study was to evaluate molecular responses from Fathead Minnows (Pimephales promelas) in relation to temperature and water type. We hypothesized that regardless of temperature, P. promelas exposed to effluent (EFF) water would have increased expression of hepatic detoxifying enzymes (cytochrome P4501A, cyp4501a and glutathione-s-transferase, gst) and oxidative stress genes (catalase, cat and superoxide dismutase, sod) relative to controls. Male adult P. promelas were exposed to either EFF, upstream (UPS), downstream (DNS) or aged water (controls) in two separate trailers at 20°C and 30°C. Fish livers were sampled on days 30 and 60. Liver RNA was extracted for relative gene expression, determined via two-step real-time quantitative polymerase chain reactions (RT-qPCR) with a β-actin reference gene. Regardless of sampling time, there were no main effects of water treatment on any of the genes relative to controls. There was week evidence for differential cat and gst expression between exposure lengths at high temperatures. Overall, this study showed no evidence of oxidative stress and some evidence of P. promelas exposed to the EFF having increased hepatic detoxification. This is consistent with water chemistry results showing non-detectable polyaromatic hydrocarbons present in the waters tested. In addition, our results suggest temperature alone can impact gene expression.

Mentor(s):
Maria S. Sepúlveda - Department of Forestry
Tyler D. Hoskins - Department of Forestry

Abstract Number: 34

Research Areas(s):
PFAS, Environmental Stressors

Evaluation of PFAS in animal feeds used for lab-based toxicity testing

Author(s): ** indicates presenter(s)*
YounJeong Choi*, AGRY
Linda S. Lee, AGRY, EEE, ESE
Tyler D. Hoskins, FNR
Mahsa Modiri Gharehveran, AGRY
Maria S. Sepúlveda, FNR

Abstract:
Per- and polyfluoroalkyl substances (PFAS) are highly stable and amphiphilic, resulting in widespread use and subsequent contamination of environmental media and biota. Numerous animal toxicity studies have been conducted due to concerns regarding toxicity. The widespread presence of PFAS and the low parts per trillion (ppt) health advisory levels for drinking water have prompted the implementation of several contamination elimination protocols. Additionally, low-dose experiments are urgently needed, but due to unknown pathways for PFAS entry, low-dose studies are extremely challenging. Yet studies of PFAS in common animal feeds have not been conducted, despite the likelihood that they could introduce unwanted PFAS into experiments. We examine the levels of PFAS in 18 different animal feeds, representing a range of diets fed to different taxa. According to our study, PFAS levels in feeds were correlated with ingredient composition (plant-based versus animal-based) or dietary habits of lab animals (amphibian, fish, invertebrate, mammal). The highest detection levels and frequencies were found for PFOS, PFHxS, PFOA, and short-chain perfluoroalkyl carboxylic acids. PFAS profiles can be differed based on the ingredients in food. In our study, we demonstrate that PFAS contamination is widespread in animal feed. PFAS exposure interpretation is enhanced by reducing food-sourced PFAS, albeit a challenging task.

Mentor(s):
AGRY

Abstract Number: 35

Research Areas(s):
PFAS, Environmental Stressors

Assessing How Parasite Exposure Frequency and Dosage Influences Infection Risk in PFAS-exposed Grey Tree Frogs

Author(s): ** indicates presenter(s)*
Alyssa Johnson*, Department of Forestry and Natural Resources
Jason Hoverman, Department of Forestry and Natural Resources

Abstract:
Per- and polyfluoroalkyl substances (PFAS) are persistent environmental contaminants known to bioaccumulate in the environment and adversely affect ecosystem health. PFAS exposure in wetland systems occurs alongside stressors, such as parasitism. While previous studies identified the effects of PFAS on host-parasite interactions, little information is available regarding how trematode exposure dosage and frequency impacts infection risk in PFAS-exposed tadpoles. We assessed this limitation using a two-stage experimental design with tadpoles and trematodes. Our first stage included a 10-day exposure to 10 ppb perfluorohexanesulfonic acid (PFHxS). During stage two, we exposed individual tadpoles to 50 or 100 echinostomes at three timing intervals: 0-day, 2-days, and 5-days post-PFAS exposure. Additionally, we exposed a treatment group to either 10 or 20 trematodes daily for 5 days to assess the effects of PFHxS on trematode loads with constant exposure. Results to date have found that tadpoles exposed to trematodes continually for 5 days yielded higher trematode loads than tadpoles in the 0-day group within both the control and PFAS treatments. Additionally, within the 0-day trematode exposure group, we observed higher trematode loads in PFAS-exposed tadpoles compared to the control group. Lastly, trematode loads did not differ between the control and PFAS exposure groups when tadpoles received trematodes continually for 5 days. These findings emphasize the importance of assessing the influence of contaminants on host-parasite dynamics at multiple timings and doses and suggest that trematodes may be able to infect tadpoles more effectively at lower concentrations, possibly due to decreased competition.

Mentor(s):
Jason Hoverman, Department of Forestry and Natural Resources

Abstract Number: 36

Research Areas(s):
PFAS, Environmental Stressors

Chronic Exposure to Aqueous Film-Forming Foams Leads to Evolutionary Responses in Daphnia magna

Author(s): ** indicates presenter(s)*
*Jack Morehouse Biological Sciences
Dr Jason Hoverman Forestry and Natural Resources
Dr Devin Jones Forestry and Natural Resources

Abstract:
Per- and polyfluoroalkyl substances (PFAS) have historically been a key component in aqueous film-forming foams (AFFF) used in fire suppression. With the increasing emphasis on phasing out PFAS use due to health and environmental concerns, several new chemical technologies have been used to create PFAS-free AFFF. Recent research has demonstrated that these replacement formulations are more acutely toxic to aquatic species than the traditional PFAS-containing AFFF. Given their relatively high toxicity, frequent exposure to the formulations could lead to evolutionary responses (i.e., evolved tolerance) in exposed populations. In this study, we examined the effects of chronic exposure to seven AFFF formulations (6 PFAS-free and 1 PFAS-containing) on the evolution of tolerance in the water flea Daphnia magna. Following an 84-day exposure to different concentrations of each formulation, we used a series of laboratory lethal concentration (LC50) tests on a subset of populations to examine the potential change in tolerance. We found that chronic exposure to three AFFF formulations led to a change in tolerance in exposed populations as compared to those with no previous exposure; two populations displayed increased tolerance and one showed decreased tolerance. This work is the first to examine evolved responses to AFFF formulations. Our results highlight the frequently overlooked evolutionary effects of contaminant exposure, particularly on keystone species in aquatic ecosystems, as well as the need to understand the effects of PFAS-free AFFF alternatives on the environment.

Mentor(s):
Dr Jason Hoverman
Purdue Forestry and Natural Resources

Abstract Number: 37

Research Areas(s):
PFAS, Environmental Stressors

The Relative Toxicities of Current Use Aqueous Film-Forming Foams and Next-Generation Alternatives to Aquatic Species for Informing Risk Assessment

Author(s): ** indicates presenter(s)*
Jason T. Hoverman*, Devin K. Jones, David L. Haskins, Maria S. Sepúlveda, Linda S. Lee, Youn J. Choi
Department of Forestry and Natural Resources
Department of Agronomy

Abstract:
Researchers have developed numerous per- and polyfluoroalkyl substances (PFAS)-free aqueous film-forming foam (AFFF) formulations to replace PFAS-containing AFFF used for fire suppression. While research addressing the suitability of these alternatives as replacements for PFAS-based AFFF is ongoing, we also need research that addresses their potential environmental impacts prior to their use. Aquatic habitats are critical for ecological risk characterization of PFAS-free AFFF alternatives because these systems are often highly valued by stakeholders and regulators. We examined the acute and chronic effects of six PFAS-free AFFF and a PFAS-containing AFFF on aquatic species using a series of laboratory experiments. In LC50 tests, we discovered that PFAS-free AFFF were generally more acutely toxic than the PFAS-containing AFFF. In chronic toxicity experiments with water fleas, we found that reproduction was affected in 4 of the 7 formulations and that survival decreased with increasing concentrations in 4 of the 7 formulations. We found amphibians to be relatively tolerant to sublethal chronic exposure to AFFF formulated products. Only exposure to two out of seven AFFF formulations affected amphibian growth and development. In toxicity tests with larval fathead minnows, we assessed the short-term effects of the formulations on survival and growth. Larval fish mass and length were negatively affected in most formulations. While these results dramatically increase the current knowledge of toxic effects of PFAS-free AFFF, they also highlight that adverse effects on aquatic species will likely be dependent on the focal species, life stage, formulation, and concentration being considered.

Mentor(s):

Abstract Number: 38

Research Areas(s):
PFAS, Environmental Stressors, Water Challenges

Addressing Interferent Effects Using a Ratiometric Approach for PFAS Detection Using Molecularly Imprinted Polymer (MIP) Based Environmental Sensors

Author(s): ** indicates presenter(s)*
*Dane C. Wagner, Department of Chemistry
Rebecca B. Clark, Department of Chemistry
Jeffrey E. Dick, Department of Chemistry

Abstract:
Per- and polyfluoroalkylsubstances (PFAS) are established environmental micropollutants that need a rapid and robust sensor as a first line of defense. Molecularly imprinted polymer (MIP)-based sensors have shown great promise in electrochemically detecting PFAS. However, like all binding-based sensors, they suffer from interferent effects, especially in the absence of the target of interest. Here, we address this by proposing a ratiometric sensing method. This method uses two MIP-modified electrodes in two different compartments: a compartment in which we know there is no perfluorooctanesulfonate (PFOS), and a compartment in which we add PFOS. A sample with the absence of PFOS results in a ratio of electrochemical signals of ~ 1. A sample that contains PFOS results in a ratio different from 1. We prove the principal in lab water and river water.

Mentor(s):
Jeffrey E. Dick, Department of Chemistry

Pre-differentiation short-chain PFAS exposure induce neurotoxicity via altering ER vulnerability in dopaminergic-like neurons

Author(s): ** indicates presenter(s)*
Xihui Zhao* (Weldon School of Biomedical Engineering), Shichen Wu (Davidson School of Chemical Engineering), Chongli Yuan (Davidson School of Chemical Engineering)

Abstract:
Per- and polyfluorinated alkyl substances (PFAS) are a large group of surface-active compounds, which are commonly used in industrial processes and everyday consumer products, affecting the majority of the population. The adverse health effects associated with conventional long-chain PFAS, include increased risks of cancer immune system dysfunction, and neurodegenerative diseases, which collectively led to the replacement of long-chain PFAS such as PFOA and PFOS with short-chain alternatives such as PFBA and PFBS. The health implications of short-chain PFAS, particularly neurotoxicity, however, remains understudied posing long-term health risk in the exposed population. In this study, we exposed progenitor like cells, SH-SY5Y, to 0.4 and 4 μg/L of PFBS or PFBA for four days. We then removed the PFAS upon the onset of differentiation. After 14 day differentiation, we characterized neuronal network and assessed the intensity of tyrosine hydroxylase (TH). Decreased TH intensity was observed after prior exposure to short-chain PFBA or PFBS. In addition, chemicals known to target mitochondria (MPP+) and endoplasmic reticulum (ER) (Tunicamycin) were used to test vulnerability after developmental PFBA or PFBS exposure. Our results revealed that cells previously exposed to PFBA exhibited modified sensitivity to ER stimulation. We also assessed changes in epigenetic markers to understand the potential molecular targets contributing to the establishment of a persistent neurotoxic state in DA-like neurons after prior PFBA or PFBS exposure. Collectively, our results identified neurotoxicity of low-dose PFBA or PFBS exposure in human DA-like neurons following a developmental exposure scheme.

Mentor(s):
Faculty mentor: Chongli Yuan, Davidson School of Chemical Engineering
Graduate Mentor: Shichen Wu, Davidson School of Chemical Engineering

Abstract Number: 40

Research Areas(s):
PFAS, Environmental Stressors

In situ lysimeter measurement of PFAS leaching at a historically biosolids applied agricultural site

Author(s): ** indicates presenter(s)*
Jamie Klamerus*, Kamruzzaman Khan, Linda Lee, Charles Schaefer, Maxwell Hire

Abstract:
Per- and polyfluoroalkyl substances (PFAS) are a group of synthetic chemicals known for their persistence in the environment and potential health risks. PFAS are linked to several adverse effects in human and wildlife health. The detection of PFAS in biosolids has raised concerns about their use in agricultural and land application practices. The purpose of this study was to examine the PFAS profile in soils and porewater with depth at an agricultural site with historical biosolids applications. The site selected has received biosolids at agronomic rates for corn for approximately four decades. This study utilized a total of six lysimeters, three each at two and four feet, to monitor PFAS leaching in soil. Porewater samples were collected within 1-3 days after rain events. Five porewater sampling events measured PFAS and supplemental water parameters like total organic carbon (TOC) and pH. Soil cores, taken in one-foot increments before and after the 3-month study, were analyzed for PFAS, TOC, moisture, and grain size. Current biosolids from the same wastewater treatment plant that supplied the biosolids historically were also analyzed for PFAS. All samples were analyzed using high resolution mass spectrometry for 54 PFAS and in line with EPA 1633 method. PFAS decreased with increasing depth and exhibited a direct correlation with soil TOC. The porewater samples predominantly consist of short-chain PFAS. The fluctuating PFAS concentrations between shallow and deep lysimeters are influenced by factors such as rainfall intensity, time elapsed since rainfall, and possibly, interactions at the air-water interface in the unsaturated zones.

Mentor(s):
Dr. Linda Lee, Agronomy

Abstract Number: 41

Research Areas(s):
Environmental Stressors

Accumulation and leaching of PFAS from biosolids land-applied as a waste management strategy

Author(s): ** indicates presenter(s)*
Rodrigo Alvarez-Ruiz* Linda S. Lee
Department of Agronomy

Abstract:
Anthropogenic organic compounds such as per- and polyfluoroalkyl substances (PFAS), enter water resource recovery facilities (WRRFs) and subsequently become part of biosolids, a byproduct of the water treatment process. These biosolids are either land applied as slow-release nutrients in agriculture or for waste management. To assess PFAS persistence and leaching, a 9-acre non-crop field in the US, receiving annual biosolid applications during several decades for waste management, was studied. The study included samples of representative biosolids, surface soil composites, and groundwater from nearby wells, all analyzed for 52 PFAS. Soil and biosolid samples were processed with methanol and ultrasound assisted extraction, followed by clean-up using dispersive solid extraction (dSPE) with ENVI-Carb. Water samples underwent solid-phase extraction (SPE) with HLB cartridges. Analysis was conducted through a Shimadzu Nexera X2 liquid chromatographic system coupled with an AB SCIEX TripleTOF 5600+ mass spectrometer.
The results showed that biosolids had significantly lower PFAS concentrations (330 ng/g dry weight) compared to soil that had received PFAS-laden biosolids over several decades (3960 ng/g dry weight). Additionally, the composition of PFAS subgroups differed, with biosolids containing over 60% precursor compounds to perfluoroalkyl acids (PFAAs), surface soil composites containing more than 70% long-chain PFAAs, and groundwater samples comprising over 70% short-chain PFAAs. This supports the transformation of precursors present in biosolids into PFAAs over time after biosolid land application, with long-chain PFAAs exhibiting higher topsoil retention due to increased sorption affinity, and shorter-chain PFAAs showing greater mobility.

Mentor(s):
Linda Lee, department of Agronomy

Abstract Number: 42

Research Areas(s):
Environmental Stressors, Water Challenges

USE OF GOOSEBERRY SHELL FOR THE BASIC RED 46 REMOVAL THROUGH ADSORPTION

Author(s): ** indicates presenter(s)*
Angelly Guarin * (Visitor scholar in Purdue)
Cristian Gallego (Universidad Nacional de Colombia, Medellín, Colombia)
Natalia Calvo (Universidad Nacional de Colombia, Medellín, Colombia)
Angelina Hormaza (Universidad Nacional de Colombia, Medellín, Colombia)

Abstract:
Different unconventional materials have been evaluated as adsorbents for the treatment of colored effluents from the textile industry. This work evaluated the capacity of gooseberry shell, an agro-industrial waste for the removal of basic red 46 (BR46), which is a cationic dye, widely used in different staining processes. For this analysis, a 2^3 factorial design was carried out under a discontinuous system, where the factors analyzed were, adsorbent dosage (D), initial dye concentration (Co) and contact time (t). The final concentration of the dye was quantified by UV-Vis spectrophotometry. In this way, a maximum removal of 89.39% was obtained for BR46. Additionally, Tukey's multiple range test was performed to identify if there was a statistically significant difference between the experiments.

Mentor(s):
Lee, Linda S (Agronomy-Purdue)

Per- and polyfluoroalkyl substances (PFAS) occurrence in an agriculture-dominated watershed: Relative contribution of land-applied biosolids

Author(s): ** indicates presenter(s)*
1Lynda Peter* and 1,2Linda S. Lee
1Purdue University, Department of Agronomy, Ecological Sciences & Engineering Interdisciplinary Graduate Program, West Lafayette IN
2Purdue University, Environmental & Ecological Engineering, West Lafayette IN

Abstract:
This study aims to evaluate PFAS occurrence in well water and surface water relative to land-application of biosolids in an agriculture-dominated watershed. Spatial data was used in identifying potentially vulnerable wells based on their proximity to agricultural lands receiving biosolids in addition to their location with respect to groundwater flow. Surface water was collected from 93 locations within the Region of the Great Bend of the Wabash River watershed. Water samples were spiked with isotopically labeled PFAS, processed through a solid-phase extraction for PFAS, and quantified using high resolution mass spectrometry. Overall, results indicate that surface water is more vulnerable to PFAS contamination compared to well water. Total PFAS in groundwater was <LOQ – 24 ng/L while surface water ranged from <LOQ – 93 ng/L. Among detected PFAS, short-chain perfluoroalkyl acids dominated both surface water and well water with maximum total concentrations of 85 and 17 ng/L respectively. Nonetheless, long-chain homologues were detected more frequently in surface water than well water (36% and 14% respectively). PFOA and PFOS concentrations in groundwater were below the proposed EPA health advisory limit, whereas concentrations exceeded 4 ng/L in three surface water locations. While PFAS was detected in 99% of surface water samples, locations with the highest frequency of detection and PFAS concentrations were in first-order streams draining from agricultural fields or impacted by NPDES discharge. Extraction and analysis of additional stream samples to evaluate spatial and temporal trends in PFAS occurrence and distribution are ongoing.

Mentor(s):
Linda Lee
Agronomy
Environmental & Ecological Engineering

Abstract Number: 44

Research Areas(s):
Sustainable Communities

Transforming Communities through Biodiversity Sustainability Activities: The Case of a Restoring a Sacred Forest in Benin and Peacebuilding in Mali

Author(s): ** indicates presenter(s)*
Julia Bello-Bravo, PhD – Assistant Professor, Agricultural Sciences Education and Communication
Anne N. Lutomia*, PhD – Postdoctoral, Research Associate, Agricultural Sciences Education and Communication and Entomology

Abstract:

Title: Transforming Communities through Biodiversity Sustainability Activities: The Case of a Restoring a Sacred Forest in Benin and Peace building in Mali
In this poster presentation we demonstrate we discuss two projects that demonstrate how communities can be engaged to promote biodiversity be focusing on two approaches of diversity in Benin where a sacred forest has been reclaimed and Mali where university students used storytelling and photoshop to drive peace building. These projects indicate that organizations that collaborate with communities to build sustainable biodiversity. This work leads to attaining the following Sustainable Development Goals (SDGs): Goal 11 Sustainable Cities and Communities; Goal 13:Climate Action; Goal 15: Life on Land; Goal 16 Peace, Justice and Strong Institutions and Goal 17 Partnerships.

Mentor(s):

Julia Bello-Bravo, PhD – Assistant Professor, Agricultural Sciences Education and Communication

Abstract Number: 45

Research Areas(s):
Sustainable Communities, Climate and Weather, Collaboration

Scientific Animation Without Borders (SAWBO) and the Rwanda Agriculture and Animal Resources Development Board (RAB) collaboration

Author(s): ** indicates presenter(s)*
Aimable Mugabo1*; Anne N. Lutomia1,2, John Medendorp2, Barry R.Pittendrigh2 and Julia Bello-Bravo
1 Department of Agricultural Science Education and Communication1 & The Urban Center, Department of Entomology2, Purdue University.

Abstract:
The theory of convergence posits that developing countries can advance by adopting technological innovations through collaborative efforts. This research paper examines the partnership between Scientific Animations Without Borders (SAWBO) and the Rwanda Agriculture and Animal Resources Development Board (RAB) to improve agricultural education and extension in Rwanda. Through joint efforts, SAWBO transformed extension information into visually engaging animations with voice overs in Kinyarwanda, the local language, making agricultural education more accessible and The study evaluates workshops and knowledge-sharing WhatsApp groups, illustrating their significant impact on agricultural practices in the region. The findings reveal that this collaboration has successfully bridged the agricultural knowledge gap and promoted sustainable farming practices in Rwanda. The study highlights the transformative potential of technology-enabled collaborations in advancing sustainable agriculture.

Mentor(s):
Dr. Julia Bello Bravo, Department of Agricultural Science Education and Communication

Abstract Number: 46

Research Areas(s):
Sustainable Communities, Risk and Resilience

Understanding the Opportunities for Conservation-oriented Adaptations in Rhode Island

Author(s): ** indicates presenter(s)*
Mary K. Strickland*, FNR, and Zhao Ma, FNR

Abstract:
As climate change continues to impact coastal communities, municipalities and government agencies in Rhode Island have tried to improve opportunities for individuals and communities to reduce their climate change risks and the associated impacts. To understand how these efforts are organized and implemented, we conducted semi-structured interviews with town planners, coastal managers, and other environmental practitioners across the state. The interviews covered several topics: (1) climatic/environmental impacts managed by practitioners in their work, (2) their general approaches to responding to these impacts and the specific programs/projects they operate to encourage participation, and (3) the challenges they face in working with communities. Our results suggest that environmental conservation and climate change adaptation have been promoted in each municipality, but the degree to which these two types of efforts are synergistic varies across municipalities. The results also highlight the potential to integrate environmental conservation and climate change adaptation efforts which will help reduce the burden of participation on communities and increase their likelihood of engagement. Our results will contribute to improving the resilience of coastal communities to climate change impacts by minimizing the gaps between the ongoing and future environmental and planning efforts in Rhode Island.

Mentor(s):
Zhao Ma, FNR

Abstract Number: 47

Research Areas(s):
Sustainable Communities, Environmental Justice, Decarbonization

Impact of Steel Industry Decarbonization on Workers

Author(s): ** indicates presenter(s)*
Meenakshi Narayanaswami*, Mechanical Engineering; Rebecca Ciez, Mechanical Engineering, Environmental and Ecological Engineering

Abstract:
The US steel industry, which contributes 2% to the nation's greenhouse gas emissions, is facing the complex challenge of decarbonization while ensuring equity for workers. This interdisciplinary research bridges engineering and social science to address the challenge by incorporating information about worker preferences with technoeconomic assessments of low-carbon steel production technologies. Actively involving stakeholders and marginalized groups in the decision-making process is pivotal in shaping policy interventions and technology changes necessary to decarbonize heavy industry. Our work investigates steelworkers' decision-making processes concerning job choices and trade-offs between wages and other job aspects such as hours, shifts, and overtime. Using semi-structured interviews and grounded theory coding, we find that financial incentives, insurance, and retirement benefits are the primary motivators for steelworkers. Additionally, there is a high dependence of pay on production outputs and the prevalence of 4-on-4-off work schedules within the industry. With the learnings from interviews, we plan to design a choice-based survey to assess job preferences and willingness-to-pay for different job attributes and incorporate worker preferences into cost models.

Mentor(s):
Rebecca Ciez

Production Sustainability Amongst the Big 3 Hoosier Multinational Automobile Organizations: A Consideration of Whole Life Carbon Emissions Records

Author(s): ** indicates presenter(s)*
* Joel Jarrett - Polytechnic Institute
* Joon Kang - Polytechnic Institute
* Ben Traylor - Polytechnic Institute

Abstract:
The boundaries of this research project are that we are only observing data from the years 2010-2022 for the big 3 Hoosier automobile manufacturing plants: Subaru, Honda, and Toyota. This research is significant because it addresses one of the most relevant issues in our world today, the reduction of carbon emissions. With the automobile industry being one of the main contributors to these emissions, it is crucial for us to gain a comprehension of their sustainability practices for their vehicles from birth to the grave. This report will be broken down into three main categories: description of whole life carbon emissions, environmental regulations and consequences, and a carbon emission data analysis. This structure will allow the reader to be informed about the fairly new concept of whole life carbon emissions, then they can learn about the standards and consequences of emissions along with data showing any trends over the last 12 years. We are obtaining data about the total on off site releases of chemicals (in pounds) from the Toxic Release Inventory (TRI) database. It is important to analyze the full carbon emissions produced by the manufacturing of the vehicle, rather than just what comes out of the tailpipe, given the lack of existing research on the subject.

Mentor(s):
Jim Tanoos - Polytechnic Institute

Abstract Number: 49

Research Areas(s):
Biodiversity, Sustainable Communities, Environmental Stressors, Water Challenges

When Blue is Green

Author(s): ** indicates presenter(s)*
Meredith Malott, Food Science*
Jen-Yi Huang, Food Science
Andrea Liceaga, Food Science
Halis Simsek, ABE
Jiqin Ni, ABE
George Zhou, Civil Engineering
Kwamena Quagrainie, Ag Econ
Lindsey Payne, Enviornmental and ecological engineering
Abigail Engleberth, Biological Engineering
Natalie Carroll, Biological engineering
Betty Feng, Food Science
Paul Brown, Forestry and Natural resources
Nicole Wright, Ohio state, Extention

Abstract:
The When Blue is Green Project is a USDA funded Purdue lead research grant that dives into issues of the midwest diet and sustainable farming. This project has a focus in aquaponics and reducing the waste from this system. The goal of this project is to diversify the midwestern diet, create a lucrative environmentally sustainable farming opportunity, Increase domestic fish production, reduce pollution, and make the world a little bit greener. This project will achieve this by gauging the need of the stakeholders, creating economic models of this system, building an integrated novel aquaponics system, and educating the community by creating workshops and educational materials.

Mentor(s):
Jen-Yi Huang, Food Science

Abstract Number: 50

Research Areas(s):
Sustainable Communities

Emerging markets for diversifying agriculture: Case studies in the U.S. Corn Belt

Author(s): ** indicates presenter(s)*
Katherine Pivaral* - Horticulture and Landscape Architecture
Linda Prokopy - Horticulture and Landscape Architecture

Abstract:
Due to the lack of diversity in the U.S. agricultural system, Midwestern agricultural communities continue to face agronomic, environmental, and social challenges. This research is part of a funded project by the National Institute of Food and Agriculture of the United States Department of Agriculture (USDA/NIFA) focused on developing an evidence-based framework and vision of enabling a more diverse agricultural landscape across the Corn Belt (Illinois, Iowa, and Indiana).
There is limited evidence about the current system's opportunities and challenges for stakeholders interested in diversified food products. This research aims to identify and describe emerging markets with diversified food products to address this information gap. The idea is to investigate beyond the farm gate and understand the value chain of three food products. This work will be conducted in three stages; the screening stage will select the potential emerging markets of food products to work with. The description stage will be assembling the case studies through the collection and categorization of information gathered through stakeholder interviews. The categories that will be looked at include agriculture and livestock, sociocultural, economic, policy, environment, and market regions. The last stage will be to select, based on the data obtained from the previous stage, the key challenges and opportunities that influence stakeholders to diversify. Overall, the research will produce suggestions for improving the markets for diversified products for a more sustainable agricultural ecosystem across the US Corn Belt.

Mentor(s):
Linda Prokopy, Horticulture and Landscape Architecture

Unveiling consumer segmentation in the U.S. salad mix market: insights into environmental preferences and sustainable marketing

Author(s): ** indicates presenter(s)*
Maria C. Ulloa-Gomez1*, Juliano Marques1, Jose E. Velasco1, Sanchez Philocles1 and Ariana P. Torres123
1Department of Horticulture & Landscape Architecture, Purdue University, 625 Agriculture Mall Drive, West Lafayette, IN 47907
2Department of Agricultural Economics, 403 Mitch Daniels Blvd, West Lafayette, IN 47907
3Corresponding author

Abstract:
This study characterizes the U.S. market for salad mixes and segments consumers based on their preferences for environmental footprint claims. Market segmentation is a widely used strategy that includes the division of a marketplace into segments of consumers with dissimilar requirements, features, or behaviors that might require distinct marketing strategies across clusters. We performed a two-stage cluster analysis utilizing indicators of environmental footprint frequently employed to assess environmental sustainability (i.e., biodegradable packaging, low carbon footprint, low energy use, low fertilizers use, low food miles, low greenhouse gas emissions, low water use, and pollinator-friendly). Consumers were categorized into different segments based on their valuation for environmental footprint claims when purchasing salad mixes. The research categorizes the U.S. salad mix market into three distinct consumer segments: "deep-rooted," who highly value environmental claims like low fertilizer use, with higher income, urban residence, and online shopping preferences; "indecisive," showing moderate interest, often having lower income and rural residence, requiring marketing focused on affordability and convenience; and "skeptic," who place the lowest value on environmental claims and consume fewer salad mixes, necessitating education programs emphasizing benefits and discounts at chain stores to engage them. By understanding consumer preferences for environmental claims on salad mixes, we can help food companies tailor claims and build long-term trust relationships with customers. Our findings can also help researchers investigate marketing practices that support the sustainability of the leafy green industry.

Mentor(s):
Dr. Ariana Torres

Improving the Effectiveness of PICS bags through Hand warmers: A Practical Approach to Minimize Post-harvest losses.

Author(s): ** indicates presenter(s)*
*Wenbo Li
Dieudonne Baributsa

Abstract:
The study, conducted by Wenbo Li and Dieudonne Baributsa from Purdue University's Department of Entomology, aimed to enhance the efficacy of Purdue Improved Crop Storage (PICS) bags using hand warmers as oxygen scavengers. PICS bags are triple-layered hermetic storage solutions designed to preserve grains during storage. This research evaluated hand warmers as a cost-effective alternative to existing oxygen scavenger products. The study observed oxygen depletion levels in grain-filled and empty PICS bags with hand warmers compared to traditional oxygen scavengers. Results showed that hand warmers effectively reduced oxygen levels, with significant depletion observed in both jar and PICS bag setups. Additionally, grain quality remained high, with a 99% germination rate and no significant moisture changes. The findings suggest hand warmers could be a viable and efficient alternative for reducing post-harvest losses in PICS bags.

Mentor(s):
Dieudonne Baributsa, Entomology Department

Abstract Number: 53

Research Areas(s):
Sustainable Communities

Investigation of Fiber Orientation and Mechanical Properties of Pyrolysis Recycled Carbon-Fiber Reinforced Thermoset Composite

Author(s): ** indicates presenter(s)*
Reva Simmons* (College of Biomedical Engineering) and Harry Lee* (College of Mechanical Engineering)

Abstract:
With increasing demand of carbon fiber reinforced fiber thermoset composites, establishing a sustainable cycle for these materials becomes crucial. Pyrolysis is a process of reclaiming carbon fiber from thermoset composites by thermally degrading the polymer at high temperatures allowing the fibers to be extracted. Carbon fiber reclaimed through current pyrolysis processes for thermoset composites typically loses its original shape and orientation, making it difficult to reorganize the fibers. This study investigated the feasibility of maintaining the fiber orientations for continuous fiber reinforced thermoset composite during pyrolysis by stitching the carbon fiber layup to a conformable copper mesh during the manufacturing process. By maintaining the carbon fiber lengths and orientation through pyrolysis, an identical part or similar part can be reproduced and significantly mitigate the fiber reorganizing process. This study used the two-step pyrolysis-oxidation process to reclaim the fibers and vacuum assisted resin transfer molding (VARTM) for sample manufacturing. The changes in fiber orientations were monitored over multiple VARTM-pyrolysis iterations using microscopy for plain weave samples, both with and without the copper mesh. The potential contamination within the plies during the pyrolysis process was thoroughly investigated, and approaches to remove it before the next VARTM process were developed. Additionally, the tensile strength and stiffness of both the control and copper mesh samples were measured at each iteration to assess the decrease in structural performance over multiple iterations.

Mentor(s):
Dr. Garam Kim (School of Aviation and Transportation Technology) and Harry Lee (College of Mechanical Engineering)

Abstract Number: 54

Research Areas(s):
Sustainable Communities

Enhancing Structural Performance of Recycled Fiber-Reinforced Thermoplastic Composites Through Additively manufactured Continuous Fiber Reinforced Preform

Author(s): ** indicates presenter(s)*
Sung Jun Choi * School of Aviation and Transportation Technology

Abstract:
The rapid growth in the adoption of lightweight composite materials is also creating a growing demand for recycling methods that could retain some of the structural characteristics of composites. Mechanical recycling, which involves shredding composite parts at the end-of-life and reforming it into different parts, is a widely discussed recycling process for thermoplastic composites. However, this process involves significant attrition of fibers which results in a reduction in the mechanical and transport properties that depend on the fiber length. In an effort to enhance the structural characteristics of recycled composites, this work demonstrates a process that incorporates additively manufactured continuous fiber preforms in a geometry that is compression molded with recycled composite. The preform is designed to serve as the primary structural reinforcement whereas the recycled material serves as secondary reinforcement in the composite part. This upcycling approach was demonstrated for an aircraft overhead pin bracket geometry. Preforms were manufactured with 60% by volume of carbon fiber-reinforced Poly Ether Ketone Ketone using the 9T Labs continuous fiber Red Series® Build Module. The preforms were designed using Additive Fusion Technology to account for reshaping during the molding process and ensure the continuous fiber is located where required. Two types of recycled composite material were used to make the pin bracket: shredded carbon fiber PEKK laminate and shredded EOL additively manufactured carbon fiber reinforced PEKK. The performance of the pin bracket was evaluated by the load at the onset of failure and the ultimate load under tensile loading of the bracket.

Mentor(s):
Garam Kim

ENHANCING STRUCTURAL PERFORMANCE OF RECYCLED FIBER-REINFORCED THERMOPLASTIC COMPOSITES THROUGH INCORPORATING COMPOSITE LAMINATE PRECUTS

Author(s): ** indicates presenter(s)*
Sungjun Choi - School of Aviation and Transportation Technology
Harry Lee - Mechanical Engineering
Jacob Montrose* - School of Aviation and Transportation Technology

Abstract:
Composite recycling has gained significant attention due to the increasing global sustainability problems. The mechanical recycling process of fiber-reinforced composite parts involves shredding long continuous fibers within the composite into shorter discontinuous fibers. Since the performance of the resulting short fibers is not as high as that of the original long fibers, the application of mechanically recycled composites is limited. The objective of this study is to enhance the structural performance of recycled composite parts by integrating of a set of continuous fiber composite precuts during the molding process. The 2-dimentional precuts were positioned in the structurally critical regions of the recycled composite part, and the remaining area was then filled with shredded composite material. An aircraft overhead bin door pin bracket was used as the part geometry. The mechanically recycled material and the precuts were made from 60% by weight carbon fiber reinforced polyetherketoneketone (PEKK) composite. Three different combinations of precuts were designed to create the pin bracket, and their performance was assessed by mechanical testing of the pin bracket. Additionally, digital image correlation technology was used to analyze local strain changes and investigate the failure mechanisms of the parts throughout the testing process. The test results demonstrated the inclusion of properly designed precuts significantly improved the performance of the recycled composite part. This research contributes to the advancement of composite recycling by providing insights into methods for enhancing the structural performance of mechanically recycled composites through the strategic integration of continuous fiber precuts into recycled composite part.

Mentor(s):
Garam Kim - School of Aviation and Transportation Technology

Abstract Number: 56

Research Areas(s):
Sustainable Communities, Environmental Justice

Recycled Carbon Fiber-Reinforced Polymer Composite Additives for Cement

Author(s): ** indicates presenter(s)*
Garam Kim, School of Aviation and Transportation Technology
*Guyuan Zhang, School of Aviation and Transportation Technology
Harry Lee, Composite Manufacturing and Simulation Center
Kyubyung Kang, School of Construction and Management Technology

Abstract:
The use of fiber-reinforced polymer (FRP) composites has significantly increased across various industries, due to their exceptional physical and mechanical characteristics. However, the sustainability of composite parts remains a considerable challenge. Typically, end-of-life (EOL) composite parts are disposed of in landfills due to the high costs of recycling and the limited application of recycled composites. This project introduces a preliminary study that investigates the application of mechanically recycled composite materials for construction purposes. Carbon fiber-reinforced composite laminates, with an average thickness of 3.175 mm, were pelletized to create additives. The size of these mechanically recycled composite additives was standardized at 25.4 mm x 25.4 mm. These pelletized additives were then blended with cement to produce cement beam test specimens, which were evaluated for their flexural properties. The study considered two key variables: the surface condition of the additives and the additive content. To assess the impact of the surface condition on enhancement, one group of additives underwent surface treatment through sandblasting, while another group remained untreated. Additionally, different additive concentrations, specifically 2% and 5%, were used to fabricate cement flexural test specimens, with the aim of investigating the effect of additive content on structural performance. The test results showed that the inclusion of recycled composite additives led to a significant improvement in the maximum load and modulus of rupture (between 21% and 39% increase) as well as bending stiffness (between 12% and 27% increase) of the cement beams, in comparison to non-reinforced cement beams.

Mentor(s):
Garam Kim, School of Aviation and Transportation Technology

Abstract Number: 57

Research Areas(s):
Sustainable Communities, Industrial Ecology

A Hybrid Mechanistic Machine Learning Approach to Model Industrial Network Dynamics for Sustainable Design of Emerging Carbon Capture and Utilization Technologies

Author(s): ** indicates presenter(s)*
Abhimanyu Raj Shekhar*, Agricultural and Biological Engineering

Abstract:
Industrial networks consist of multiple industrial nodes interacting with each other through material exchanges that support the overall production goal of the network. These industrial networks exhibit complex nonlinear dynamics arising due to the multiscale nature of interactions among industries and the inherent dynamics of each industrial node. Further, these overall dynamics have a significant impact on the sustainable design of these networks, along with the resource consumption and emission dynamics of the overall network. However, understanding the overall dynamics of industrial networks is challenging as digital models do not exist for the whole network dynamics, especially for emerging industrial systems, and simulative analyses of the same can be computationally expensive. We propose a hybrid mechanistic machine learning approach based on data-driven system identification to build surrogate dynamical models of industrial nodes, which can be coupled to evaluate the overall industrial network dynamics. Further, we propose utilizing the overall network dynamics to quantify dynamic carbon footprint and design of industrial network for maximum carbon sink. The redesign of the industrial network with the modified technological parameters informed by overall network dynamics results in approximately 2% enhanced CO2 sequestration rate on the chosen case study. The dynamical models were also used to analyze the net neutralization time required to completely remove the energy-related CO2 emissions using this specific algal biodiesel network for a specific region in a particular year, providing insights into the potential of this technology to meet the climate mitigation goals.

Mentor(s):
Shweta Singh, Agricultural & Biological Engineering

Abstract Number: 58

Research Areas(s):
Sustainable Communities, Circular Economy

Material flow analysis of end-of-life electric vehicle batteries using agent-based modeling

Author(s): ** indicates presenter(s)*
Miriam STEVENS1*, Sarang SUPEKAR3, and Shweta SINGH1,2
1Environmental and Ecological Engineering, Purdue University, West Lafayette, Indiana, 47907, USA
2Agricultural and Biological Engineering, Purdue University, West Lafayette, Indiana,47907, USA
3Argonne National Laboratory, Lemont, Illinois, 60439, USA

Abstract:
Uncertainty over the desired and actual end-of-life (EOL) pathways for electric vehicles (EVs) has implications for the development of recycling infrastructure and logistics coordination. If EV batteries are diverted to stationary energy storage or other second use applications, there will be a delay in when their embodied materials become available for recycling. This potential delay makes forecasting the supply of materials for recycling challenging and reliable forecasts are needed for the optimal design of recycling infrastructure. Facility size, expected yield, and costs – and other factors affecting long-term market viability, for recycling and second use applications – depend on reliable knowledge of the quantity and composition of supply. Plausible projections on how the reuse of EOL EV batteries in secondary applications may affect the supply of batteries available for recycling would aid in planning regional closed loop supply chains for battery critical materials. To that end, we use an agent-based model (ABM) that incorporates the decisions made in determining the EOL fate of EV batteries to provide insight into how the supply of batteries may be diverted to available second use pathways including remanufacturing, repurposing, and recycling. An ABM framework previously developed for circular economy strategies has been adapted to capture the dynamics of an EV battery collection system in which cost, state-of-health, and the subjective likelihood of firms to reuse batteries are factored into a battery's selected EOL pathway. We then estimate the expected supply of recycled materials that would become available over time given reuse pathway projections from the model.

Mentor(s):
Dr. Shweta Singh

Abstract Number: 59

Research Areas(s):
Sustainable Communities, Climate and Weather

Life Cycle Assessment of Sustainable Construction Materials

Author(s): ** indicates presenter(s)*
* Kah Soon Ngooi, School of Engineering, Purdue University

Abstract:
The construction material industry is recognized as one of the largest and most energy-intensive sectors globally, contributing significantly to carbon emissions. Specifically, the cement and concrete industry alone accounts for approximately 1,500 megatons/year of CO2 emissions, translating to around 0.8 to 1.0 ton of CO2 per ton of cement produced. This makes cement production responsible for approximately 8% of global carbon emissions, making it a significant contributor to climate change. To address these concerns, this project aims to investigate the environmental impact of construction materials through the implementation of a life cycle assessment (LCA) model. LCA is a methodology used to assess the environmental impacts associated with all stages of a commercial product, process, or service's life cycle. By utilizing LCA, we can analyze and compare the environmental friendliness of different construction materials, such as Ordinary Portland Cement (OPC), Portland Limestone Cement (PLC), and other types of cement, during the manufacturing process. Additionally, the project will employ the Life Cycle Impact Assessment (LCIA) process to evaluate the potential consequences of the inventory data obtained from the LCA. LCIA allows decision-makers and professionals to gain a deeper understanding of the environmental harm resulting from resource consumption and emissions, including impacts like global warming, stratospheric ozone depletion, and terrestrial acidification. These potential impacts will be evaluated to determine which construction materials are more sustainable and environmentally favorable. It is important to continue future studies that build upon this model in order to provide compelling results and further insights into sustainable construction practices.

Mentor(s):
Faculty Mentor: ChengCheng Tao, School of Construction Management Technology
Faculty Mentor: Jan Olek, Lyles School of Civil Engineering

Abstract Number: 60

Research Areas(s):
Sustainable Communities, Great Lakes Research, Climate and Weather, Risk and Resilience

Computational Investigation of the Flood Impact on Bridge Infrastructures in the Great Lakes Region

Author(s): ** indicates presenter(s)*
*Junyi Duan, School of Construction Management Technology
Chengcheng Tao, Ph.D., School of Construction Management Technology

Abstract:
Ensuring the security of coastal infrastructure lifelines is crucial for maintaining sustainable economic development and enhancing resilience against climate change. Flood is one of the most common natural hazards that cause damage to infrastructure in the Great Lakes region. Bridges are the most vulnerable elements of the infrastructure system during flood hazards. Faced with frequent flood impacts, it is imperative that we systematically investigate and assess the risk of infrastructure due to inappropriate infrastructure design. In this paper, we conduct a computational investigation of the flood impact on bridge infrastructures in the Great Lakes region using fluid-structural interaction (FSI) modeling. The FSI model integrates computational fluid dynamics (CFD) and finite element analysis (FEA) to simulate the flow behavior of flood and its loading on the bridge piers. Case studies are conducted to simulate different scenarios of the flood wave and its impact on bridge infrastructure. The results of this study will provide coastal communities and stakeholders with a quantitative framework to predict the performance and risk of bridge infrastructure subjected to flood. This study will enhance pre-flood preparations and mitigate the long-term risk to life and property from future flood events in the Great Lakes region.

Mentor(s):
Chengcheng Tao, Ph.D., School of Construction Management Technology

Abstract Number: 61

Research Areas(s):
Great Lakes Research

Isotopic analysis of alewife, Alosa pseudoharengus, otoliths to determine early life habitat utilization and growth in Lake Michigan

Author(s): ** indicates presenter(s)*
Les D. Warren*, Department of Forestry and Natural Resources, Purdue
Kyle Brennan, Department of Geology and Geophysics, University of Utah
David Bunnell, Great Lakes Science Center, USGS
Gabe Bowen, Department of Geology and Geophysics, University of Utah
Tomas O. Hook, Department of Forestry and Natural Resources, IL-IN Sea Grant

Abstract:
Alewife (Alosa pseudoharengus) spawn in multiple habitats in Lake Michigan including drowned-river mouth lakes (DRMLs), tributaries, and nearshore environments. Due to its large volume compared to other habitats, the nearshore region of Lake Michigan has been considered the primary source of alewife recruits. However, habitat utilization of freshwater river mouths by young fish remains under-described. DRMLs and tributaries provide warmer, more productive environments compared to the relatively cool, oligotrophic Lake Michigan. Thus, on a volumetric basis DRMLs and tributaries may provide higher quality nursery habitat than Lake Michigan. Moreover, during cool years of low recruitment DRMLs and tributaries have the potential to provide a greater number of recruits to the population. Using samples collected during historic monitoring studies, we assessed otolith core stable isotope ratios of carbon (δ13C) and oxygen (δ18O) of alewife (Alosa pseudoharengus) to evaluate their early-life habitat utilization. From these results, we plan to analyze alewife otolith cores of historically strong (1998, 2005, and 2010) and weak years (1992, 1996, and 2014) of recruitment in Lake Michigan to evaluate the hypothesis that during weak years of recruitment these habitats are vital to sustaining alewife in Lake Michigan.

Mentor(s):
Tomas Hook, Department of Forestry and Natural Resources, IL-IN Sea Grant

Abstract Number: 62

Research Areas(s):
Great Lakes Research

A Data-Driven Approach to Lake Michigan Turbulence Mixing

Author(s): ** indicates presenter(s)*
Nhu Hoang Van Pham*
Civil Engineering - Ecological Sciences and Engineering
Dr. Cary D. Troy
Civil Engineering - Department of Hydraulics and Hydrology

Abstract:
Lake Michigan is the largest freshwater resource for the state of Indiana with over 45 miles of shoreline, including the Indiana Dunes and several municipal facilities that offer scenic and recreational opportunities for the public. The past few decades have been one of the most dynamic and challenging periods for our coastal communities, from environmental changes such as rising water levels and prolonged extreme weather conditions to invasive benthic filter-feeders (e.g., quagga mussels) that have direct causal effects on the water clarity and the dynamics of the local food web at lower trophic levels. However, it also presents research opportunities for scientists to gain insights on how the lake is responding to these elemental changes and allow us to develop appropriate management plans to protect Lake Michigan's waters and shorelines.
A combination of moored instruments, including acoustic wave and current profiler (AWAC) and buoy deployment, along with meteorological data from local harbors and intermittent microstructure sampling has been utilized to monitor the health and behavior of Indiana-Lake Michigan waters. The data not only serves as a long-term historical record of wind-wave-current-temperature conditions but is also used to forecast seasonal stratification and lake overturning as well as simulating turbulence mixing at varied temporal and spatial scales. Furthermore, using a data-driven approach, we can accurately derive the wind forcing and wave-induced effect of these dynamics and successfully overcome the challenges of representing the Indiana-Lake Michigan nearshore waters in 1-D hydrodynamic models due to its complex nature.

Mentor(s):
Dr. Cary D. Troy (troy@purdue.edu)
Civil Engineering - Department of Hydraulics and Hydrology

Abstract Number: 63

Research Areas(s):
Great Lakes Research

Using LiDAR Imagery to Quantify Indiana Coastline Changes along Lake Michigan

Author(s): ** indicates presenter(s)*
Tasmiah Ahsan* and Cary Troy, Lyles School of Civil Engineering

Abstract:
Recent high-water levels in Lake Michigan caused extensive shoreline changes along the Indiana coastline. To evaluate recent shoreline changes of Indiana coastline, topographic LiDAR surveys available for the years 2008, 2012, 2013, 2018 and 2022 were analyzed. This study included LiDAR data of over 400 cross-shore transects, generated at 100 meter spacing. Beach profiles were generated to detect the shoreline position and quantify beach width and nearshore volume change. The analysis revealed accretion of both shoreline and beach width during low water level period. The beach was rebuilt with a median value of 3m between 2008 to 2013. On the contrary, the shoreline eroded during high water period. Both shoreline and beach width receded with a median value of 29m during the period of water level increase from 2013 to 2018. Consequently, the beach profiles lost median sand volume of 4m^3/m. In response to the water level changes, the shoreline moved with a median of 18m landward exhibiting erosion from 2008 to 2022. However, the shoreline movement varied spatially between 63m recession to 29m accretion. Similarly, the volume change ranged from 614m^3/m loss to 296m^3/m accumulation varying spatially along the shoreline. The bulk loss was experienced downdrift of Michigan city harbor near Mt. Baldy and Central beach. In addition to the spatial variation, the recession also varied slightly with shoreline type. The natural beaches were mostly recessional whereas buffered beaches, characterized by a swath of vegetation or dunes, experienced the least erosion.

Mentor(s):
Dr. Cary Troy, Lyles School of Civil Engineering

Lake Michigan Shoreline Monitoring, Evaluation, and Modelling Using High Resolution

Author(s): ** indicates presenter(s)*
Hazem Abdelhady - Civil Engineering
Sophia Ung* - Civil Engineering
Cary Troy - Civil Engineering

Abstract:
Water level fluctuations in Lake Michigan are increasingly frequent, leading to significant alterations along Lake Michigan's coastal areas. Notably, from 2013 to 2020, Lake Michigan experienced a remarkable water level rise of 2 meters, encompassing the entire historical range of water levels. This swift shift in water level resulted in widespread coastal transformations, such as the retreat of shorelines, habitat modifications, erosion of bluffs and dunes, infrastructure and property destruction, coastal flooding, and failures of coastal protection structures.
In this presentation, the focus will be on utilizing high-resolution multispectral satellite images to effectively monitor the fluctuations in Lake Michigan's shoreline. We aim to establish connections between these shoreline changes and various hydrodynamic and morphological factors in order to predict future alterations. To achieve this, we have developed an innovative shoreline detection algorithm that makes use of high-resolution multispectral imagery obtained from satellites like Planetscope and RapidEye. To ensure consistent and highly accurate shoreline detection from the imagery, we have created a fully automated framework. This framework relies on a novel water-land index known as the Direct Difference Water Index (DDWI). Additionally, our model employs a transect-free method that automatically detects shoreline changes and generates a comprehensive time series based on the input satellite images. By utilizing this shoreline time series, we have developed a model that establishes a connection between shoreline changes and variations in water level, wave climate, and sediment characteristics.

Mentor(s):
Cary Troy; Civil Engineering

Abstract Number: 65

Research Areas(s):
Environmental Stressors, Water Challenges

Improving the Remote Sensing of the Biogeochemical State of Midwestern In-land Waters

Author(s): ** indicates presenter(s)*
Andrea Slotke* (ABE), Sheng Tan (CE), Nhu Van Pham (CE), Petra Schwaab (AAE), Dr. George Zhou (ABE/EEE), Dr. Cary Troy (CE), Dr. Melba Crawford (CE, AGRY), Dr. Keith Cherkauer (ABE)

Abstract:
As water quality experiences pressure from both environmental and anthropogenic events, it is critical that we can effectively identify current potential threats in multiple waterways to reduce impact on both human and ecosystem health. In the North-Central United States, thousands of inland waterbodies provide critical ecosystem services, and the health of these systems is under stress, including from harmful algae blooms (HABs). While remote sensing has been used to identify lakes experiencing algal blooms, the goal of this NASA funded study is to improve the rapid quantification of the biogeochemical state of both river and lake water by remote analysis of optical and thermal properties so preconditions leading to HABs in Midwestern U.S. waters can be identified and the timing predicted. We are monitoring the biogeochemical state, optical and thermal properties, and hydraulic mixing of several lakes and reservoirs within the Wabash River watershed. Imagery from hyperspectral and thermal cameras from unmanned aircraft systems (UAS) and satellite remote sensing platforms, balanced by analysis of water samples and spectral reflectance ground reference information are used to quantify the current biogeochemical state of these water systems. This poster will provide an overview of field work and analysis being conducted that will enable us to extend the relationship between optical properties, supplemental information and the biogeochemical state of rivers and lakes to lakes throughout both the Wabash River and Illinois River watersheds. The evaluation of those relationships will contribute to an improved prediction model for regional HABs based on remote sensing imagery.

Mentor(s):
Keith Cherkauer (ABE), George Zhou (ABE/EEE), Cary Troy (CE), Melba Crawford (CE, AGRY)

Abstract Number: 66

Research Areas(s):
Water Challenges

Energy Efficient Water Desalination using Batch Reverse Osmosis

Author(s): ** indicates presenter(s)*
Ali Naderi Beni - Mechanical Engineering
Sultan Alnajdi - Mechanical Engineering
Sandra Cordoba* - Mechanical Engineering
Joel Aboderin - Mechanical Engineering
David Warsinger - Mechanical Engineering

Abstract:
Reverse Osmosis is set to play a vital role in providing clean water amid a growing population by treating saline water to have acceptable properties for human consumption and usage, but current limitations such as high energy consumption, brine management, membrane fouling, make it less sustainable and more difficult to implement. Batch Reverse Osmosis, a transient process where the energy requirement is lowered by reducing the pressure level that must be applied over time to the water feed, has shown potential to be the most energy-efficient reverse osmosis variant.
Our work focuses on three key aspects of Batch Reverse Osmosis Technologies: First, we propose the implementation of a Double Acting Batch Reverse Osmosis configuration with several improvements to maximize performance and solve practical issues associated with previously proposed arrangements such as high start-up time and reset time. Second, we develop a novel membrane-driven solution known as Counterflow Batch Reverse Osmosis for dewatering high saline streams to enhance water recovery, reduce effluent streams, and enhance energy efficiency compared to conventional methods and third, we work on the integration of Batch Reverse Osmosis with different renewable energy sources like solar or wave power.
Modeling results indicate that the proposed Batch Reverse Osmosis Configuration provides energy savings compared to traditional continuous reverse osmosis systems with downtime as low as 10% of the total cycle time. On the other hand, Counterflow Batch Reverse Osmosis provides capabilities of extending Reverse Osmosis to high salinities and recoveries, without using high burst pressure membranes.

Mentor(s):
David Warsinger - Mechanical Engineering

Abstract Number: 67

Research Areas(s):
Water Challenges

Hydrological Remote Sensing using Signals of Opportunity below 400 MHZ

Author(s): ** indicates presenter(s)*
Eric Smith, AAE Grad Student*
Archana Choudhari, AAE Grad Student*
Seho Kim, Former AAE Grad Student (now at JPL)
Benjamin Nold, Former AAE Grad Student (now at NASA Goddard)

Abstract:
Signals of Opportunity reflectometry (SoOp-R) employs existing non-cooperative transmitters as sources of illumination in bistatic radar. In the typical application, these sources are communication satellites. SoOp-R enables microwave remote sensing observations to be made in bands allocated for communications and is thus not limited to frequencies protected for science use. Frequencies below 500 MHz are of particular value as they are capable of penetrating through the vegetation canopy and below the top few cm of the soil, to provide sensitivity to the root-zone soil moisture (RZSM).
An observation simulation study has shown the sensitivity of the sub-surface soil moisture under typical agricultural vegetation to various combinations of observation frequency and polarization, signal to noise ratio, and temporal delay. This study showed that the combination of observations at multiple frequencies is necessary to accurately invert the soil moisture profile. Field experiments have been conducted at the Agronomy Center for Research and Education (ACRE) at Purdue University to validate the forward models used in these retrievals.
SigNals Of Opportunity P-band Investigation (SNOOPI) is a technology validation mission to demonstrate P-band remote sensing from orbit using non-cooperative signals of opportunity and with the specific technology validation objectives: (1) validate the forward model from orbit and under a variety of surface conditions, using well-calibrated in-situ observations (2) evaluate the effect of radio frequency interference (RFI) from orbit, within the frequencies of interest (3) space qualification of a prototype instrument. SNOOPI is now scheduled for launch in early 2024.

Mentor(s):
Prof. James L. Garrison

Abstract Number: 68

Research Areas(s):
Water Challenges

Water quality sampling provides insight into nutrients sources and pathways in an agricultural watershed in the Midwestern USA

Author(s): ** indicates presenter(s)*
Noah Rudko*, Agricultural and Biological Engineering, Purdue University
Dr. Jane Frankenberger, Agricultural and Biological Engineering, Purdue University
Dr. Sara McMillan, Agricultural and Biosystems Engineering, Iowa State Univeristy

Abstract:
Understanding where agricultural nutrients originate in the landscape can help prevent their transport downstream. A monitoring dataset (2017-2021) collected at two very similar HUC-12 watersheds in northeastern Indiana provided an opportunity to better interpret the hydrology and water quality of intensive agricultural watersheds. Metrics that quantify changes in nutrients during a storm event, such as the change in concentration on the rising limb of the hydrograph compared to the recession limb and the difference between concentration at peak discharge and baseflow (hysteresis and flushing indices) were calculated for Nitrate-N, Dissolved Organic Carbon, Soluble Reactive Phosphorus, and Total Phosphorus. These storm event metrics together with nutrient grab samples collected throughout the watershed provide insight into how nutrients are transported through typical agricultural watersheds in the Midwestern U.S. Our analysis shows that nutrients originate from different sources, while C-Q relationships revealed differences in constituent sources. Our results suggest these landscapes have plentiful and widely distributed sources of N that are activated in the Spring, which was observed as relatively chemostatic behavior even at the small watershed scale. We saw concentrating effects for DOC, TP, and SRP suggesting mobilization of flowpaths connecting to land-based sources, and faster travel times in the Winter for all four constituents when subsurface tile drains are most active and plant uptake is negligible. These results can be used by watershed managers to differentiate nutrient delivery mechanisms, their factors driving movement, and set reasonable expectations for when nutrient concentrations and loads will decrease after practices have been implemented.

Mentor(s):
Dr. Jane Frankenberger, Agricultural and Biological Engineering, Purdue University
Dr. Sara McMillan, Agricultural and Biosystems Engineering, Iowa State University

Abstract Number: 69

Research Areas(s):
Water Challenges

What would you do with a watershed Digital Twin?

Author(s): ** indicates presenter(s)*
Lisa Welp, EAPS*
Keith Cherkauer, ABE*

Abstract:
Expo participants will engage in creating a vision for a watershed digital twin of the Wabash River basin. Prompts will include questions like: 'What pressing societal questions could be answered using a watershed digital twin tool?' and 'What predictive functionality would be useful?' This space will be used to stimulate conversation and collect brainstorming ideas to be used in future Water Challenges research community events.

Mentor(s):
Lisa Welp, EAPS
Keith Cherkauer, ABE