Summer Research Symposium – Fall 2013

Summer Research Symposium – Oral Presentations
Wednesday, October 23, 12:40–2:00pm, Carver Science

The symposium will start with everyone gathered in Jordan Lecture Hall for the Welcome and the first presentation. The remaining presentations will be held concurrently. Audience members will have time to switch rooms between presentations.

Carver 215 (Jordan Lecture Hall)
12:40 – Welcome – Dr. Pat Singer, Chair of the Division of Natural Science
12:45 – Kent Irwin
1:05 – Taylor King
1:25 – Hannah Longstreet, Tony Saucedo, Lauren Tirado, Demetre Van Arsdale
1:45 – Hannah Longstreet, Tony Saucedo, Lauren Tirado, Demetre Van Arsdale, Grace Williams

Carver 231
1:05 – Michael Frank
1:25 – Estefan Herrera
1:45 – Andrew Dexter

Summer Research Symposium – Poster Presentations
Wednesday, October 30, 1:00–2:00pm, Carver Science Atrium

Casey Croson, Louis Joslyn, Sara Reed
John Greaves
Mike Henry
Rob Heise
Kent Irwin
Sarah Jermeland
Ruth Roberts, Katie Westlund, Nick Yaeger
Patrick Thompson
Grace Williams

Abstracts:

Casey Croson, Louis Joslyn, Sara Reed
Dr. Albert H. & Greta A. Bryan Summer Research Program – Simpson College
Determining Critical Locations in a Road Network
Critical locations in infrastructure are roads that, if damaged, would cause a large disruption in the ability of vehicles to navigate a city. In this poster, we consider critical locations in the road network of Indianola, Iowa. The presence of cut vertices and values of betweenness for a given road segment are used in determining the importance of that given road segment. We present a model that uses these critical factors to order the importance of separate road segments. Finally, we explore models that focus on betweenness to improve accuracy when discovering critical locations.

Michael Frank
The Valparaiso Experience in Research by Undergraduate Mathematicians
Investigating Anthropogenic Mammoth Extinction with Mathematical Models
One extinction theory of the Columbian mammoth (Mammuthus columbi), called overkill, hypothesizes that early humans overhunted the animal. We will employ three

different approaches to test this theory mathematically: analyze the stability of the equilibria of a differential equations system, develop a differential equations model, and develop a discrete stochastic simulation. The system of ODEs is a modified predator-prey model that also includes immigration and emigration. The simulation is a stochastic temporospatial model based on a rectangular grid system designed to represent North America at the end of the last ice age. Using this simulation, we model the migration of humans into North America and the response in the mammoth population. These approaches show evidence that human-mammoth interaction would have affected the extinction of the Columbian mammoth during the late Pleistocene.

John Greaves
Stowers Institute for Medical Research
Non-uniform expression of epithelial polarity genes during development of Nematostella vectensis
Epithelial layers are found in most multicellular animals. By studying the *de novo* formation of polarized structures such as epithelial sheets we can gain insight into the emergence of multicellularity during our evolution and the pathology of impaired epithelialization in developmental disorders and cancer. *N. vectensis* embryos arecomposed of two epithelial sheets, the ectoderm and the endoderm, and provide us with a unique model system to study formation of epithelia. Formation of epithelial layers is manifested as early as the blastula stage of development. When and where are epithelial genes expressed during this process? We chose genes that are essential for the formation of epithelial layers and performed *in situ* hybridization in early and late developing embryos. We expected to see ubiquitous expression of key epithelial determinants in both the ectoderm and endoderm of early and late developing *N. vectensis* embryos. The gene expression profiles from the *in situ* data show that there is no ubiquitous pattern of the apical and basal epithelial markers. Instead, the following genes showed endodermal expression: *par-6, par-3, aPKC, stardust,* α*-catenin and dlg* (bolded genes enriched in the apical domain). The genes *strabismus* and *lgl* both showed ectodermal expression with *lgl* enriched in both apical and basal domains. Additionally, *lgl* showed an unexpected asymmetric expression. The expression patterns of these epithelial markers have shown that there is not a ubiquitous expression pattern in early developing *N. vectensis*embryos. They have also outlined some interesting patterns to be further characterized.

Rob Heise
Department of Energy's Science Undergraduate Laboratory Internships Program - Ames National Laboratory
Simulations of UV and Blue Micro-Cavity Organic LED's
The emission from micro-cavity (mc) organic LEDs (OLEDs) was simulated through the use of a rigorous scattering matrix approach. An emission source profile was extracted from an ITO device and then used to calculate the emission from many mc OLED devices of varying thicknesses. Emission peaks ranged from ~370 - ~470 nm. We found that the source profile from the OLEDs depends upon the thickness of the MoOx layer, this being due to differences in the structure of the emitting layer. Current work involves the use of a Monte Carlo simulation to better understand the hole and electron recombination within the emitting layer.

Mike Henry (with D. H. Youngblood, Y.-W. Lui, J. Button)
Cyclotron Institute - Texas A&M University
Determining Physical Continuum Background Using the Calculated Cross-Section of the Giant Monopole Resonance
The choice of continuum is a limiting factor in the cross-section measurement of giant resonances. The continuum is difficult to calculate due to a number of contributing factors; such as beam impurities, nuclear interactions, and background radiation.

Assuming ideal multipole strength distributions and using experimentally determined widths and centroids, a calculation of the expected cross-section is made and then compared with the experimental cross-section measured from alpha scattering on ^{90}Zr. This comparison is used to refine our assumptions of the continuum.

Kent Irwin
Environmental Science – Simpson College
Testing Bait Types and Scents for Small Mammals
When conducting a population study, it is important that traps are working at their maximum efficiency. In order to have the best results, it is important to have bait and scent types that attract a wide variety of species and have high capture rates. In the mid to early 1990's a hantavirus scare set new standards for field methods when it came to cleaning traps. This would remove any scent of a previous occupant which may help encourage new specimens. Bait types are also an important factor. When attempting to trap small mammals it is a challenge attempting to attract carnivores such as shrews and herbivores such as field mice. The purpose of this experiment was to determine what trap conditions provided the highest number of captures as well as the widest variety. In this study, I used various traps and trail cameras at the Whitebreast Research Station in western Marion County, Iowa. The target animals included small mammals, such as mice, voles, and shrews. There was also a rotation of various baits that were traditional and untraditional. I also used scent from captive small mammals to simulate previous habitation of a trap. Animals captured were identified to species, weighed, eartagged, and released at the location of capture. For each capture, we noted the bait selected and whether a trap had scent from a previous animals. It was found that the animals had a strong preference for the peanut butter bait which is consistent with initial thoughts. The animals more importantly had shown a preference for clean traps. This means that the drastic change in field methods in the 1990's may have been a change for the best.

Sarah Jermeland (with Andrew Best, Andrea Ekey, Alyssa Everding, Jalen Marshall, Carrie N. Rider, Grace Silaban)
Summer Undergraduate Research Institute in Experimental Mathematics – Michigan State University – Lyman Briggs College
Protein-Protein Interaction Detection Using Mixed Models
Membrane protein-protein interactions (PPI) play an important role in biological processes; however, knowledge about membrane proteins is limited. Mating-based Split Ubiquitin System is a technique used to investigate interactions between proteins by utilizing yeast as a heterologous system. The observed fluorescence scores are a result of PPIs. The fluorescence scores may be affected by various fixed and random effects such as overall mean, test versus positive controls, plate effect, and PPI effect. We model these effects using a statistical mixed model and apply it to a simulated data set. The success of the simulation study implies that our mixed model may fit the actual PPI data.

Taylor King
Environmental Science – Simpson College
Methods of Multiflora Rose Control
The goal of my research is to determine the most effective method of multiflora rose control based on 1) the kill rate of the multiflora rose 2) the kill rate of the surrounding native plants 3) the ease of application 4) the long term effectiveness at preventing regrowth. I had 5 control methods- **two foliar applications**, 1) crossbow low volatile weed/brush herbicide 2) Roundup (quick pro) herbicide. **2 Stem removals**, 1) Tordon RTU chemical application 2) Removal with pruners and no chemicals. **Untreated control plots**. Each treatment was applied to four 3×3 meter multiflora rose plots. I applied treatments in june and made observations for 4 weeks, I will continue my

research next summer looking at differences in pollination rates and soil content before and after treatment.

Hannah Longstreet, Tony Saucedo, Lauren Tirado, Demetre Van Arsdale
Mathematics – Simpson College
A Differential Equations Model on Prairie Restoration
The objective of this project is to create a modified SIR-type model to show the changes in land usage between prairie land, converted land (to agricultural area, settlement areas, and other), and restored prairie land. The model is analyzed by finding and classifying equilibrium solutions. The model is then applied to Midwestern prairies since European settlement in the nineteenth century.

Hannah Longstreet, Tony Saucedo, Lauren Tirado, Demetre Van Arsdale, Grace Williams
Mathematics – Simpson College
A Multivariate Analysis of Ground Dwelling Invertebrate Richness on a Restored Prairie
Prairies are an important type of ecosystem that supply resources necessary for many endangered animals and plant species. However, since humans began populating the area, prairie land has decreased dramatically. In this project, we perform statistical analysis of different plot treatments (high diversity, low diversity, and monoculture) to see how different plant seedings can affect the invertebrate community. We use data collected from a restored prairie along the Platte River near Grand Island, Nebraska. Data was collected in June 2012. We compared measures of community structure (i.e. richness and diversity) for both the plant and ground-dwelling invertebrate communities. We performed NMDS and ANOSIM tests using DECODA software (Minchin (1989)). Plant diversity comparisons were found to have differences amongst the various plot treatments. However, invertebrate diversity among different plot treatments yielded insignificant results.

Rachel Rice (with Jennifer Brown, Steve Feller, Mario Affatigato)
Physics – Coe College
Using ^{10}B NMR to Determine Intermediate Range Structure of Alkali Borates
10B nuclei produce an extremely wide field during Nuclear Magnetic Resonance (NMR) spectroscopy. This makes them uniquely valuable when studying the intermediate structure of borate glasses. An ongoing ^{10}B NMR study is being performed in partnership with the University of Warwick, UK. Crystalline and glassy samples of alkali borates were prepared for use in the study. X-ray diffractometry and scanning thermal analysis were used to analyze the purity of the samples and their structure.
This research was funded by the National Science Foundation under grant 126315 and PHY-REU-1004860.

Ruth Roberts, Katie Westlund, Nick Yaeger
Dr. Albert H. & Greta A. Bryan Summer Research Program – Simpson College
The MLB All Star Challenge
We developed logistic models to determine which batters in each position should make the Major League Baseball All Star teams. We collected 36 different statistics on players from 2009 to 2012 and analyzed them using the statistical software JMP. Our models are based on a feature subset selection of only 3 of these statistics and they are effective at predicting the 2008 and 2013 All Star batters. Our results suggest that although players make the All Star team based on their on-field performance, other factors seem to determine which are the starters versus the reserves.

Patrick Thompson
Environmental Science – Simpson College
Snake Abundance in Restored Prairies vs. Reed Canary Grass
Reed canary grass, (*Phalaris arundinacea*), is an invasive species that creates very dense

monocultures. It provides very little nutrients, and is so thick that mammals and waterfowl have trouble living in it. Reed canary grass was originally introduced for hay and a thick, quick growing grass for pastures. Now reed canary grass can be found along ponds, lakes, and wet open areas. These properties raise some questions. If the reed canary grass is so dense that it prevents mammals and other animals from living in it what snakes can live in it? If snakes live in reed canary grass what do they eat? With these questions to answer, a hypothesis arose, reed canary grass will have a lower abundance of snake species and prey items compared to the restored prairie.