**Tony Gamble and Aaron Griffing (Biological Sciences) for their project, “Comparing Regenerative Abilities in New Caledonian Geckos.”**

**Introduction:** The capacity to regenerate damaged or lost appendages as an adult is not exhibited by the majority reptiles, birds, and mammal species (Carson, 2007). However, many lizards readily autotomize (voluntarily shed) their tails in response to attempted predation (Bellairs and Bryant, 1985), after which embryonic gene families are expressed, resulting in tail regeneration (Jacyniak et al., 2017). Though the regenerated tail does not possess some of the original elements of the tail (e.g. bony elements), it exhibits full regeneration of numerous important structures, such as blood vessels, nervous tissue, cartilage, and scales (Bellairs and Bryant, 1985; Jacyniak et al., 2017). However, some lizards have lost this ability. New Caledonian crested geckos (Correlophus ciliatus) successfully heal wounds following autotomy, but do not regenerate their tails past a small, knob-like tail bud. Sarasins' giant geckos (Correlophus sarasinorum), close relatives to C. ciliatus, retain the ancestral ability to regenerate their tails following autotomy. Because this loss of function has occurred in recent evolutionary history (~6–11 million years ago; Skipwith et al. 2016), C. ciliatus provides an "evolutionary knockout" to comparatively study the cellular and genetic changes that prohibit successful regeneration. Though extensive investigation has been placed on successful regeneration of lizard tails (Bellairs and Bryant, 1985; Jacyniak et al., 2017), there have been no studies on the loss of regenerative ability in lizards. The purpose of our study is to compare transcriptional activity and cellular composition between successfully regenerating tails and unsuccessfully regenerating tail buds.

**Significance:** Relative to lizards, most mammals, including humans, can regenerate very few tissues as adults. For example, human spinal cord injury is a persistent and difficult to treat condition (Kakulas, 1999). Understanding the mechanisms that prevents successful tissue regeneration in our lizard model may shed new light on aspects of our own biology, including our limited capacity for nervous tissue regeneration. As such, our proposed research has significant implications concerning human health and injury therapeutics.

**Innovation/Forward Thinking:** The loss of regenerative ability in C. ciliatus, which is analogous to the loss of regeneration in mammals, has yet to be studied. Using high-throughput transcriptome sequencing (RNAseq) and detailed morphological investigation (histology) in a novel comparative framework (C. ciliatus vs. C. sarasinorum), we will provide the first investigation of transcriptional activity and cellular organization in an unsuccessfully regenerating lizard.

**Zhongzhe Liu and Matthew Hughes (Civil, Construction and Environmental Engineering) for their project, “Dairy-Manure-Derived Catalyst for Energy and Resource Recovery from Wastewater Biosolids.”**

**Introduction:** The major research goal of this project is to evaluate the catalytic effect of dairy manure biochar on increasing pyrolysis gas (py-gas) yield during wastewater biosolids pyrolysis. Pyrolysis is a process which decomposes carbonaceous materials (e.g. manure, biosolids) upon heating under anaerobic conditions. The resulting products are biochar, py-gas, and bio-oil. Biochar is usually used as a precursor for activated carbon making or as a valuable soil amendment which improves plant growth. Py-gas and bio-oil can both be used as a fuel. However, bio-oil from biosolids pyrolysis normally accounts for at least 40% of the total product mass1 and requires costly pretreatment due to its corrosive and unstable properties before it can be used as a clean fuel2. In contrast, py-gas can be easily burned in gas engines for energy recovery. Therefore, cost-efficient catalyst is of great interest for reducing bio-oil yield and increasing py-gas yield during the biosolids pyrolysis. A new process is proposed by using dairy manure biochar as the catalyst for improving energy and resource recovery from wastewater biosolids (Figure 1).

**Significance:** The negative impacts of improper disposal of dairy manure on environmental water quality, public health, and air quality are a common problem around the world. As a dairy land, Wisconsin is currently facing this tough problem. For example, one third of the residents of Kewaunee County, Wisconsin, currently do not have reliable drinking water supplies due to the contaminated groundwater majorly caused by local unsafe manure disposal. Manure pyrolysis can destruct and stabilize contaminants in its biochar. On the other hand, in the United States, over 8 million dry tons of wastewater biosolids are produced annually and 60% of biosolids are land applied3, such as the heat dried biosolids produced by municipalities such as the Milwaukee Metropolitan Sewerage District (MMSD). However, some residual pollutants in biosolids such as emerging contaminants of concern (e.g. antimicrobials) could pose threats to the water system during land application. Catalytic biosolids pyrolysis (e.g. using manure biochar as a catalyst) can enhance energy recovery in terms of upgraded py-gas and bio-oil. Also, pyrolysis can convert biosolids to a clean biochar product by destructing residual pollutants.

**Innovation/Forward Thinking:** The protection of public health and the environment and the production of renewable energy are our responsibilities in a forward-thinking and sustainable community. We need to develop technologies capable of synergistic processing and disposal of various environmental wastes such as dairy manure and wastewater biosolids. An innovative process as proposed in this project can convert wastes to useful products that contain minimized contaminants. This project will be the first research to determine the catalytic effect of manure biochar to improve the energy recovery during biosolids pyrolysis. In particular, this project reflects the Marquette's Jesuit mission, Clean Water, and the themes in Marquette's strategic plan, Sustainability of Valuable Resources and Research in Action.

**Henry Medeiros, Miguel Hernandez Virto, Brian Stumph and Weihua Liu (Electrical and Computer Engineering) for their project, “Quantification of Dispersal Patterns of Invasive Insects with Unmanned Aerial Systems.”**

**Introduction:** Invasive species are often inadvertently transported from their native range to novel habitats where they often have strongly negative impacts on food security, public health, economic interests, and native species biodiversity. As an example, in the United States, annual economic losses from invasive species are estimated at $120 billion (Pimentel et al., 2005), and these severe impacts are predicted to continue (Paini et al., 2016). A key element to the mitigation of invasive pest damage to both natural environments as well as agricultural production is understanding their migration patterns.

In this project, we propose to study the dispersal patterns of invasive insect species employing a small unmanned aerial system (sUAS). This system, equipped with recently developed novel laser imaging technology, can collect on-field high-resolution data to be latter processed in a computer vision algorithm pipeline, generating accurate geotagged detections that can be easily studied over a scaled map.

**Significance:** Although there are studies about insect dispersal, they are limited to mark-release-recapture techniques with a human in the loop, which have significant drawbacks. Recapture is a very laborious, time-consuming, and error-prone task. In addition, due to the labor-intensive nature of the process, very few samples of the insect motion can be captured, typically < 5% (Merckx et al., 2009), which negatively impacts the accuracy of the resulting dispersal models.

Preliminary results show that, with our present method, we are able to detect 60% of the insects used in outdoor tests (Virto et al., 2017), drastically improving the counting accuracy of the current manual methods, and being much more time efficient.

**Innovation/Forward Thinking:** To the best of our knowledge, this is the first automated insect detection system in the literature. The future work on the sUAS design and sensing equipment, as well as in the video processing algorithm, will allow us to create a fully automated system which is easy to implement and can be used for a wide range of mark-and-release applications.