Maple Scholars Proposals for Summer 2020

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Hickory Scholars Proposals for Summer 2020

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2	Assessing Leadership Development in the Rieth Village Community	Tom Hartzell	Coordinator of Residential and Undergraduate Programs

#1

Temporal Polyethism in Social Insects

Comparison of Progression of Temporal Polyethism and Associated Behaviors in Honey Bees (*Apis mellifera*) and Ants (*Atta, Lasius*, *Camponotus, or Pogonomyrmex*)

Dr. Andrew Ammons, Department of Biological Sciences

The following project is open for new students for summer research in 2020. Upon approval, one or two students may be chosen for this project.

"Temporal Polyethism in Social Insects" Description:

Temporal polyethism is a process of division of labor that occurs in highly eusocial insects (ants, termites, bees, and wasps). In the development of this phenomenon, major changes in insect activity change over time as individual insects age. This usually refers to the sterile "worker" caste in eusocial insects. As workers age, they engage in activities restricted to inside the nest or hive (nursing, cleaning, maintenance) while they are young, eventually graduating to outside-nest activities such as foraging, nest defense, or marking trails and landmarks as they reach older ages. Temporal polyethism is an efficient method of dividing labor between nestmates, and is most pronounced in the bees and ants (Hölldobler and Wilson, 2008).

Much research has focused on this age-based process of polyethism in different ant and bee species. Many basic physiological parameters can change greatly over this process of aging. In Jerdon's jumping ant, for example, venom sacs are empty at eclosion but develop during foraging and are most full at the peak development of foraging age (Haight, 2012). Many physiological states seem to pre-condition certain individuals for certain tasks, as foraging ants of *Dinoponera australis* have lower stored fat (*i.e*., decreased lipid content) than non-foraging workers or reproductive individuals (Smith *et al*., 2011). There is an evolutionary and physiological flexibility in this polyethism, as well, as has been shown in studies of behavioral pacing in workers of the honey bee (*Apis mellifera)*. Behavioral pacing in the development of pre-foraging activities can be accelerated or slowed based on manipulation of colony demographics or other factors, but the overall pattern of behavior cannot be eliminated (Siegel *et al*., 2013). A very rapidly accelerated pattern of polyethism produced through experimentation, especially in the development of "precocious foragers" in honey bees, can even lead to such colony-level stress that adult bees die at rates that cannot be compensated for, leading to the collapse of the entire colony (Perry *et al*., 2015).

Even with such research that has been conducted over the last few decades, much remains unknown about how temporal polyethism has evolved, is maintained genetically, or how progression of this process differs between different social species. In this study, some of these questions will be addressed utilizing a comparative approach with various ant and honey bee species as the focus.

The Maple Scholar for this project will assist in the attempt to successfully rear honey bee colonies and ant "farm" nests, paint mark individual ants and honey bees for the purposes of observing and tracking them over their lifetimes, and analyze the behavioral results to compare the pacing, activity, and development of temporal polyethism among these species.

For this project, the student will be expected to participate in the laboratory elements of research (including rearing insects in incubators) as well as become adept at honey bee hive inspection, management, and observation in the apiary. In addition, the Maple Scholar will learn how to observe and quantify animal behavior using ethogram techniques, how to care for and manipulate insects in culture, and how to practice focal and scan sampling during field observations of animal behavior. Other skills to be practiced might include taking physiological measurements of insect samples (weight, length, protein content, *etc*.), compound and dissecting microscopy, and assisting the principal investigator with apiary maintenance.

Student and Investigator Expectations:

Student enthusiasm, self-motivation, independence as a researcher, and commitment to the project are a major factor in selecting Maple Scholar finalists.

The principal investigator's hopes and goals for the summer would be to have a student engage in active research, design their own experiments with guidance, and learn how to present research in a professional format.

Student applicants would be aided by some biology or science background (appropriate for first or second year Biology majors), but this is not necessary for applying. Attendance at informal journal clubs will be necessary for the student to train in the interpretation of scientific publications.

The anticipated results from summer research for the participant would be the completion of an independent research project. This project would be suitable for presentation at local or national scientific conferences. All scholars are also asked to write a research paper using the guidelines of the National Conference on Undergraduate Research. Student research may also contribute to eventual scientific publication, in which case the student would be listed as a co-author.

The principal investigator agrees to all mentor responsibilities as listed in the faculty guidelines. Appropriate supervision, support, and encouragement for the student will nurture a one-on-one mentoring relationship. Any students will be treated as colleagues in the discovery of knowledge. The advisor will be available to guide, discuss issues, and train in the use of techniques, but will also try to allow the student to develop as an independent researcher designing their own project. Expectations for student scholars include working full 8-hour days (and some weekends) for the duration of the project, being receptive to guidance offered by the advisor, and being passionate about doing science.

References

Haight, K. (2012) ***Patterns of venom production and temporal polyethism in workers of Jerdon's jumping ant, Harpegnathos saltator*****. Journal of Insect Physiology; 58:12, 1568-1574.**

Hölldobler, B. and E. O. Wilson. 2008. ***The Superorganism: The Beauty, Elegance, and Strangeness of Insect Societies.*** **New York: W. W. Norton & Company.**

Perry, C., Sovik E., Myerscough M., and A. Barron. (2015) ***Rapid behavioral maturation accelerates failure of stressed honey bee colonies.*** **Proceedings of the National Academy of Sciences; 112:11, 3427-3432.**

Siegel, A., Fondrk M., Amdam G., and R.E. Page. (2013) ***In-hive patterns of temporal polyethism in strains of honey bees (Apis mellifera) with distinct genetic backgrounds.*** **Behavioral Ecology and Sociobiology; 67: 1623-1632.**

Smith C., Suarez A., Tsutsui N., Wittman S., Edmonds B., Freauff A., and C. Tillberg. (2011) ***Nutritional asymmetries are related to division of labor in a queenless ant.*** **PLoS ONE; 6:8, e24011.**

#2

Bovine Lung Physiology

Cows vs. Yaks – What is the mechanism underlying Yak tolerance of low oxygen?

Neil Detweiler, Biological Sciences

Description:
Yaks are a species of cattle in the same genus (*Bos*) as common domesticated cattle but evolved in the high altitudes of the Himalayas and the Tibetan plateau. While yaks readily tolerate the low-oxygen environment of high altitude, common cattle develop severe pulmonary (lung) hypertension. There has been little research into the molecular physiology of yak lungs. In humans and model organisms such as mice and rats, pulmonary arteries actively constrict when exposed to low oxygen, a phenomenon known as hypoxic pulmonary vasoconstriction. This is an important mechanism by which blood flow in the lungs is directed to regions that can most effectively provide oxygen. However, upon exposure to high altitude, which lowers the oxygen levels of the entirety of both lungs, this can lead to pathologically elevated pulmonary blood pressure.

TRPC6 channels are sodium and calcium permeable ion channels that contribute to the depolarization of the plasma membrane when active. TRPC6 channels have been shown to play a critical role in hypoxic pulmonary vasoconstriction. Recently, it has been shown that TRPC6 channels in pulmonary artery smooth muscle cells of mice are translocated to the plasma membrane and activated by ceramide and sphingosine 1-phosphate, respectively, which are produced in response to hypoxia. It is not known whether this pathway is consistent in cattle or yaks. The goal of this project is to evaluate the effects of exogenously applied ceramide and sphingosine 1-phosphate on TRPC6 currents in freshly-isolated cow and yak pulmonary artery smooth muscle cells.

Background expected:
This project is to students with at least some background in biology and chemistry. It is hoped that the project will provide experience that will strengthen the student's application to graduate schools in the biological sciences or health-related professional schools.

Anticipated Results:
The hypothesis is that the pathway is intact in cows but not yaks, providing a mechanism by which yaks exhibit a largely diminished response to hypoxia.

Alternatively, it may be that yaks' response to ceramide and sphingosine 1-P is intact, but the hypoxia-induced production of ceramide and sphingosine 1-P is reduced. If this seems to be the case, the project will change course to investigate differences in upstream signaling.

Agreement with Mentor Responsibilities

a) I agree to carry out the mentor responsibilities outlined in the Maple Scholars Proposal Guidelines.

b) I plan to meet most days with the student to monitor progress and provide assistance, but I do expect the student to treat it as their own project and exercise a great deal of independence. I do not plan to be present for the entire day every day, although I will be flexible particularly at the beginning when bigger chunks of time may be required when I train the student in necessary techniques. There may be a week of family vacation in which I won't be in Goshen.

c) I expect that the student will spend 8 hours per weekday working on the project, though the demands will vary depending on the stage of the project. Some experiments may require longer hours, though many experiments have significant waiting periods (hours) where no work is required. I hope that the student will be excited enough about the project to spend some time on evenings or weekends reading, reviewing data, and brainstorming. As stated above, I hope that the project will lead to results that, when combined with other future results, will culminate in a publication for the students involved.

#3

Air Quality

TRAQR Traveling Air Quality Recorder

John Buschert, Physics Department

Description:
Air quality in Elkhart County has been of some concern due to the presence of major industries and pollution sources upwind and also many smaller local manufacturing facilities. The EPA measures air quality fixed sites all over the country but in Elkhart County there are just two.

In 2017 we worked on developing a device based on a Raspberry Pi that can measure air quality and record it. Outfitted with sensors for various pollutants, temperature and humidity, in addition to a clock and GPS, it is designed to log data about the air quality anywhere it is taken. Then it connects via Wi-Fi to upload its data to a website. The plan is to make this into a more robust device and produce many of them. Mounted on people's cars we will collect data and start to map the air quality of the county.

This year's project will include:

1. Device Electronics. We will complete the design testing and construction of several devices. The prototypes have demonstrated nearly all of the basic features. Some more work is still needed to test the program and see that it properly responds to the car turning on and off by entering a kind of sleep mode. Further improvements could include some type of live indicator to the driver of the current air quality such as tones or lights.
2. Device Software. Software has been written (in Python) but it needs a lot of reworking and commenting to make it easier for new students in the future to understand the code and be able to modify it as needed.
3. Web page. The web page for displaying the data in map form is working but could be improved in several ways and we this code also needs to be extensively documented.
4. Calibrating. The sensors will need to calibrated in some fashion by exposing them to known concentrations of pollutants.
5. Testing. We will make several TRAQR devices and try them out in various vehicles in all kinds of weather and with different W-Fi systems.
6. Data collection. Once we have useable devices we will give them to people who live in various parts of the county and drive regularly. We'll need to keep them all in working order and watch the data as it comes in to see what patterns emerge.
7. Connections. We will try to identify others interested in our data and those with expertise to help us understand and interpret the data. As a start we will contact local, state and federal government agencies with responsibilities for air quality and monitoring.
8. Confronting. If we identify local sources of unhealthy levels of emissions, we may contact them to share what we have found and try to help them find ways to reduce the emissions.

Students will participate in all aspects of planning, designing, building, testing, collecting data, managing the system, modeling, as well as searching for others' data and contacting other parties about our data.

Background expected:
Students with a variety of backgrounds will be considered but applicants should have taken General Physics and have some computer programming experience. Electronics experience would be very helpful and chemistry might be of some use.

Anticipated Results:
The aim is to build several such devices and test them by the end of the Maple Scholars program. The student(s) will be fully involved in the design, construction, programming and testing of the devices as well as all the other areas outlined above.

Agreement with Mentor Responsibilities
I agree to serve as a mentor for a Maple Scholar student. I will be directly supervising the student(s) typically by working directly with them for several hours in the morning of each weekday. I plan to be present for all or nearly all of the colloquia. I expect the student(s) to put in full time work on the project for the duration of the 8 weeks. I may be gone for a one week period but will prepare the student to carry on independently during that time.

#4

Game Theory

Game Theoretic Models of Power, Cooperation, and Resource Allocation

David Housman, Mathematics

Description:
The first veto by a United States President was against a bill apportioning congressional representatives to states. The United Nations Security Council passes measures by simple majority but five permanent members can veto any measure. Some European parliaments have representatives assigned based on votes for a political party. Some New York State county councils have members with weighted votes because they represent different numbers of constituents. How can voting power be defined and distributed fairly in these types of situations? After each decennial census, states must create districts of roughly equal population sizes for each representative. How can states avoid political gerrymandering of district boundaries?

Under what circumstances will self-interested individuals cooperate with other self-interested individuals? This is a central question underlying attempts by scholars to understand how cooperative behavior has evolved in humans and other organisms. One model that has been extensively studied has been repeated play of the two-player Prisoners' Dilemma game. How can this work be extended to other situations and more players?

By collaborating, several cities can save money on upgrading their water treatment facilities. What is a fair way of allocating the savings? Several people have inherited an estate, but they differ in their opinions about the worth of each item in the estate. What is a fair way of allocating the estate? Different sportswriters have different rankings for college football teams. What is a fair way of melding these different opinions into a single ranking? In these situations, do the agents involved have incentives for stating their true costs, valuations, or rankings?

Game theory is the mathematical study of situations of conflict and/or cooperation. In this research, students develop a mathematical model of a situation, define fairness properties or rules of engagement, suggest solution concepts, determine solutions for their specific situation, and/or provide appropriate interpretations. Students may extend, modify, or rely on previous work done by students or results found in the mathematics, economics, biology, and political science literature, or students may begin with a totally new situation, model, properties, rules, or methods.

Background Expected:
A student participant should have the ability to read, critique, and write mathematical proofs. For some research areas, the student participant should have the ability to write computer programs to explore possibilities. Knowledge of an application area of interest would be beneficial.

Anticipated Results:
The primary goal is the development of the student's ability to undertake mathematical research and communicate their results to others. Students are expected to write a project report, offered opportunities to present their work at conferences, and offered the opportunity to turn their project report into a paper that could be submitted for publication.

Agreement with Mentor Responsibilities:
(a) Agreement: I agree to carry out the responsibilities of a Maple Scholars mentor as described in the proposal guidelines.

(b) Description of my intended interaction with students: During the first week of the summer, I typically meet with my students a few hours each day to explore possible research problems and approaches. Before the student's first seminar presentation, I require the student to present to me and I provide feedback for improvement. During the remainder of the summer, I am available to meet with my students almost daily and we negotiate how often we will definitely meet. I have had students who wish to meet for one to two hours daily for the entire program and some students who I have met with for a couple of hours each week. I have been able to take my students to one or two mathematics or game theory conferences during the summer where they have been able to present their work and interact with other faculty and students having a narrower disciplinary focus.

(c) My expectations for students: Mathematics involves a mixture of divergent and convergent thinking. Some of the most important ideas occur while taking a shower or hiking through the woods. So, I am fairly flexible about when and where students work; however, I do expect full-time effort: 40-plus hours per week and no major time commitments to other activities. If possible, I expect students to participate in one or more professional meetings where they can present their results.

Additional Information:
I have mentored over seventy undergraduate students in summer and/or academic year research (see list at http://www2.goshen.edu/~dhousman/ugresearch/ugresearch_complete.htm). Gina Richard, a Maple Scholar in 2008, won an award at Math Fest, the national summer meeting of the Mathematical Association of America, for a presentation of her research. Seth Unruh, a Maple Scholar in 2009, published "Envy-Free Divisions" in the *Rose-Hulman Undergraduate Math Journal*, Vol. 10, Issue 2, 2009, which can be accessed at http://www.rose-hulman.edu/mathjournal/. Several of my students have been selected by their peers to be the public presenters during the Maple Scholars Celebration.

The summer of 2017 was an ideal version of what can happen during the Maple Scholars program. Christian Bechler and Kenan Bitikofer found a draft paper written in 2016 which claimed to have solved a long-standing problem in "cake cutting." Aziz and Mackenzie claimed to have devised an algorithm that used a bounded number of steps to ensure that any number of people share a cake in an envy free manner. Christian and Kenan implemented and tested parts of the Aziz and Mackenzie algorithm. What appeared at first to be bugs in their code turned out to be a flaw in the algorithm and proof provided by Aziz and Mackenzie. Christian and Kenan finished the summer by constructing a five-person example in which the Aziz and Mackenzie algorithm would stop before completion. Upon receipt of the Bechler and Bitikofer paper, Aziz and Mackenzie responded with a revised paper they claim addresses the difficulty.

In the summer of 2019, Ebtihal Abdelaziz considered how to modify the nucleolus solution concept for coalition games to partially defined coalition games. In a coalition game, we are given the savings or utility that each coalition of players can generate. In a partially defined coalition game, some of these savings or utilities are not known. The nucleolus assumes that all players will collaborate and allocates the generated savings or utility so as to lexicographically maximize the minimum coalitional excess, which is a way to mathematize Rawls social contract theory in the coalition game context.

#5

North American Borderlands

Lived Narratives of the North American Borderlands

Cristóbal Garza González World Languages and Cultures (Formerly known as MLLC)

Description:

The North American Borderlands project will help a student (or a small group of students) acquire and develop critical tools to analyze and appreciate the culture, history, art, and narratives about the US borders and the immigrant communities that have formed on the border region and the American Midwest. The project will help the participant(s) understand these regions as ever-changing sociopolitical constructs that connect, separate and transform communities and individuals on all sides of the American borders. The project will have the participant(s) engage in critical research of sociopolitical formations and conceptualizations such as border security, ethnic distinctions, cultural separation, and legal and cultural citizenship, and most importantly, the project will require contacts with community members and experts that have research and/or personal knowledge about the border and how it transforms the lives of individuals and communities.

Through bibliographic research and readings, the participant(s) will gain close knowledge of historical events since the Mexican-American War of 1846-47, the territorial expansion of the US, economical and politically motivated migrations, the "War on Drugs", the aftermath of the 9/11 attacks and the militarization of the border. This work will support the development of a critical understanding of how these events have (re)shaped the US Mexico border and the countries that share it.

In addition to developing a strong conceptual and historical background, field work will shape and enrich critical understanding of the border region and its current situation. The field work will include interviews with members of the local community who have crossed the border in several capacities and for different reasons. In addition to conducting interviews and listening to personal accounts and opinions, the participant(s) will consult with scholars, authorities, activist, artist and art curators, legal experts, religious leaders, and educators that can provide expert knowledge on and about the border. A variety of ethnographic, narrative, and critical tools will help the participant(s) process and organize the materials develop during the interviews and consultations. Guidance and contacts will be provided (or suggested) for every component and task of this section of the project.

Background expected:

Students that have taken 200 level courses in the humanities and social sciences will be better suited to succeed in North American Borderland. Spanish fluency will not be required, but it will facilitate some background readings and field work.

Anticipated Results:

Besides the goals stated in the description, the participant(s) will be expected to present their research to the rest of the campus community. The presentations and feedback will help the participant(s) revise and

improve their project so it can be later submitted to regional and national conferences in American Studies, Latin American Studies, Latina/o Studies, or any other pertinent discipline.
Based on conference outcomes, the participant(s) will be expected, encouraged, and mentored to submit their work to peer reviewed publications that consider undergraduate research.

Agreement with Mentor Responsibilities:

I agree to recruit and encourage Goshen College students to apply to this research project. I also agree to lead a group of fellow teaching faculty to select and recommend candidates for this project.

#6

The impact of rainfall variation on crops and groundwater recharge in rural Tanzania.

Paul Meyer Reimer, Physics Department

Description:

40% of cropland irrigation water, and drinking water for 2 billion people is drawn from groundwater that is replenished from water and snow. As populations increase and the climate changes in coming decades, stewarding this resource will increase in importance.

Soil moisture forms part of that groundwater "reservoir". The amount of near-surface water depends on rainfall, soil type, and plant respiration rates and plays a deciding role in plant health.

We will be collaborating with the research group led by President Stoltzfus on fungal toxins' impact on child development in Tanzania.

Proven risk factors for high levels of fungal toxins in food crops include crop stress and excessive moisture in stored grain and groundnut. Crops can become stressed by a lack of water at key times in plant development. But too much moisture at harvest time can be carried on into the stored harvest and encourage fungal growth. So, this Maple Scholars project is part of a larger effort to develop some remote-sensing ways to predict the risk of fungal toxin impacts.

Research goals and anticipated results:

Nowadays, satellites measure precipitation events, temperatures, and spectroscopic indications of plants and plant health and their data are made publicly available. Other public data sources map soil types around the world.

You will analyze these data sets and pertinent publications to estimate seasonal near-surface water storage in rural Tanzania.

Through our collaboration on the mycotoxin (fungal toxin) project, we hope to have access to spatial information on mycotoxin prevalence in the Kongwa district of Tanzania over the course of several years, and collaborators on the ground in Kongwa. This will hopefully allow us to analyze the relationship between spatial and temporal rainfall fluctuations and mycotoxin risk.

You, the student researcher, will learn and use GIS (Geographical Information System) software, and short programs to acquire and analyze publicly available data.

Background expected:

You need to have an interest in figuring out how to get meaningful information by synthesizing quantitative data from different sources. Any experience in programming would be helpful, though a programming class is not required.

Agreement with Mentor Responsibilities

I am willing to take on the Mentor Responsibilities as described in the faculty proposal guidelines. I will be gone for about a week of vacation during the time of the Maple Scholars Program. In the past I have arranged work for my student and/or arranged for the student to check in with another GC researcher in my absence. I have supervised eight students in the Maple Scholars program in past summers, and a similar number of students doing x-ray research projects in the Turner Laboratory before that.

#1

Artistic Expression for reimagining our Food System

Hickory Scholars Sculpture Proposal

- John Mishler, Sculpture, johnjm@goshen.edu
- John Mischler, Merry Lea, jamishchler@goshen.edu

Project Description:

This Hickory Scholars Sculpture Proposal describes a project to explore how sculpture can interact with and inform how people perceive and internalize ideas of sustainability - specifically sustainable food systems. As we work to combat the effects of climate change, we are realizing that simply telling people about data is not enough. Communicating sustainability concepts in a way that connects with people is important to make sure deep learning happens. Artistic approaches provide a means to communicate directly with the public in an emotionally impactful way. We are interested specifically in exploring sculpture using found and recycled materials as a means for reimagining our food system. We will explore what it means to work with recycled materials within the framework of values held by ML environmental learning center and explore themes related to sustainability, regenerative agriculture, agroecology, environmental education, and more.

Another important facet of this project is for the Hickory Scholar to explore what it means to use unusual media (welded sculpture) in unusual places (agricultural settings). Through their work on these pieces they will interact with other sculptors/welders and deepen their own understanding of practice in sculpture/welding today. The Hickory Scholar will also work to discover their own personal style and grow as an artist.

Anticipated Products:

Two sculptures will be fabricated at the Sculpture Lab at Goshen College. One of the sculptures will be installed at Merry Lea while the other will be installed at Goshen College. These sister sculptures will serve to draw the two campuses together and reflect the shared values of sustainability as seen at both Merry Lea and Goshen main campus. The Scholar will create these sister sculptures for Merry Lea and Goshen College using found metals from Merry Lea as well as materials from GC's sculpture studio.

John Mishler and John Mischler are the faculty co-sponsors of this proposal.

Student Background:

The student Hickory Scholar will need to have taken advanced sculpture at Goshen College and have the ability to weld. They will need to have experience with installing sculptures and to

have the ability to work with others. They also will need to be familiar with sustainability at Merry Lea/Goshen College.

#2

Hickory Scholars 2020 Proposal

Assessing Leadership Development in the Rieth Village Community

1. Proposing Faculty
    a. Tom Hartzell, Coordinator of Residential Undergraduate Programs
    b. tchartzell@goshen.edu; 260-799-5869 x-116
2. Brief Project Description
    a. Students who participate in residential programs at Rieth Village are receiving educational inputs in a variety of ways. Most obviously, this occurs through their coursework (i.e. curriculum), but another substantial conduit is the experience of living in an intentional community (i.e. co-curriculum). Moreover, daily exposure to the multisensory tapestry of the Merry Lea grounds significantly shapes their experience and outcomes (i.e. context). Development of leadership skills is a Transformative Learning Outcome (TLO) that is explicitly stated for the Sustainability Leadership Semester program, and I would argue that it is implicitly stated in the Agroecology Summer Intensive TLOs.

    What this project seeks to discover is whether these input streams – curriculum, co-curriculum, and context – are influencing our students' leadership development, to what extent, and how it is happening. Exploring answers to those questions will require surveys and/or interviews with past students who have resided at Rieth Village as part of a living-learning community. This study will also require the researcher to become familiar with the curriculum, co-curriculum, and context of our residential undergraduate programs (RUPs).
3. Anticipated Product(s)
    a. Formalized Residential Curriculum
        i. With each new cohort in our RUPs, a new effort is made co-curricularly to develop and grow their leadership skills. This largely takes place in the weekly Community Meeting. Learning which tactics and resources have had positive, neutral, or negative impacts will be instructive for the designing of a formalized residential curriculum. Having such a product will be beneficial in a handful of ways:

1. Ensuring that each student who participates in a RUP at Rieth Village is receiving the most impactful leadership development co-curriculum we can offer.
2. Providing an opportunity to share our best practices with campus colleagues. What works at Rieth Village may also work in campus residence halls. This could be a beneficial addition to RA/RD training.
3. Building resiliency in our RUP co-curriculum. Formalizing a residential curriculum would allow any person to step in and deliver it, rather than being dependent upon one individual as it is now.

b. Rich Student Feedback
    i. An ancillary product of this research will be a repository of student feedback about the most impactful piece(s) of their experience(s) related to their growth as leaders. That will be useful for crafting marketing messages. In addition to informing the development of a formal residential curriculum, this feedback could prove useful as an assessment of our curriculum and land management practices.

4. Ideal Student Background
    a. The ideal student researcher will be curious about how students live and learn well together. They will also be curious about how academic, social, and physical environments influence a student's development, especially regarding leadership skills and abilities. Students from any major with the above interests would be well suited for this project; some majors which may have natural affinity include Education, Anthropology, Sociology, or a more interdisciplinary field like Sustainability Studies, Sustainable Food Systems, or Sustainability Management.