**Teaching Dossier**

My dossier includes a statement on my personal teaching experience and philosophy along with several items that demonstrate my experience as an effective educator.

Navigation of teaching dossier: Click on links below to view an item. Click on “**Teaching Dossier”** at the top of any page to return here.

**Items in teaching dossier:**

**A.** [**Statement of teaching experience and philosophy**](#Item_A) **pg. 3-5**

Based on my experience as an instructor, I have come to focus my teaching on four core elements of effective pedagogy: incorporating active learning and conceptual exploration as tools to meet ambitious content goals, delivering course material in a way that resonates with a diverse student body, using regular formative assessments to gauge student learning, and equipping students with the skills of scientific inquiry to promote lifelong learning.

**B.** [**Principles of Ecology syllabus (Fall 2021)**](#Item_B) **pg. 6-12**

My syllabi provide students with the core information needed for success in my course. This includes a clear content schedule, my office hours, multiple ways to contact me, clear learning outcomes and student expectations, an attendance/absence policy, information for students seeking learning accommodations, and a clear breakdown of the course grade.

**C.** [**Leaf herbivory lab (Principles of Ecology, Fall 2021)**](#Item_C) **pg. 13-17**

I developed this lab for my Principles of Ecology course. This is a field-based active learning exercise, wherein students collect, analyze, and interpret data to test predictions of the plant apparency hypothesis. This lab complements lecture content that introduces students to alternative hypotheses that account for variation in interactions between herbivorous insects and plants. This lab was particularly well-received by students.

**D.** [**Lab assignment (Ornithology, Fall 2020)**](#Item_D) **pg. 18-20**

I developed this assignment for my Ornithology lab. For this assignment, students use Next Generation Weather Radar to explore the dynamics of local bird migration. Next Generation Weather Radar is increasingly used in modern ornithology as an invaluable tool for forecasting bird migration, refining our understanding of major migratory flyways, and even estimating population sizes of birds with different migratory strategies. This assignment thus gives students a hands-on introduction to a key tool used by ornithologists working on a wide range of issues.

**E.** [**In-class short writing assignment (General Zoology, Spring 2022)**](#Item_E) **pg. 21-21**

Students in my General Zoology class are required to complete 10 short in-class writing assignments related to lecture content over the course of the semester. These assignments are designed to reinforce key concepts from lecture while also giving students the opportunity for self-guided exploration of course content at a deeper level than is possible in lecture. This assignment requires that students do their own research to find and then describe examples of exaptation and evolutionary co-option, which is a recurring theme throughout the history of animal evolution.

**F.** [**Lecture exam (Principles of Ecology, Fall 2021)**](#Item_F) **pg. 22-29**

This is the second lecture exam I wrote, administered, and graded for my Principles of Ecology class during the fall of 2021. Topics covered include population growth models, life tables, life history evolution, mating systems, group living, and the Ideal Free Distribution.

**G.** [**Example student work (Principles of Ecology, Fall 2021)**](#Item_G) **pg. 30-33**

For the laboratory portion of my Principles of Ecology course, students design and implement a small scientific study, working in small groups. The students are free to choose whatever topic interests them. The final project associated with this activity is a short paper written in the format of a scientific publication. The learning goals associated with this project include familiarizing students with hypothesis testing, study design, data collection, data analysis, and scientific writing. Included is an example of two students’ work (names removed for privacy) from the fall of 2021.

**H.** [**Student evaluations (General Zoology, Spring 2021)**](#Item_H) **pg. 34-46**

As an early-career educator, I pay close attention to student evaluations to pinpoint areas that need improvement and gauge which aspects of my pedagogical methods are effective. I believe this is one reason that I consistently receive positive feedback from students. Included here are student evaluations from two sections of my General Zoology course from Spring 2021. Student evaluations from all of my courses are available on my personal website under the “Teaching” page.

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item A: Statement of teaching experience and philosophy**

I have been fortunate to serve as an instructor for a variety of undergraduate courses, including Ornithology, Principles of Ecology, General Zoology, and Evolutionary Biology. I have also been a graduate lab instructor for Ornithology, Introductory Biology, Animal Biology, Introductory Ecology and Evolution, and Animal Behavior. Since my first teaching experience in Introductory Ecology and Evolution, my philosophy on how to be an effective educator has evolved with every course I have taught. Based on my experiences and review of the education literature, my teaching focuses on the following elements of effective and inclusive pedagogy:

1) Challenge students with inquiry-based projects that encourage conceptual exploration of a subject to meet ambitious content goals.

2) Present material using multiple modalities and perspectives that resonate with a diverse student body, including an emphasis on the enormous yet underappreciated contributions of marginalized groups to different fields.

3) Expose students to course material multiple times, especially through regular formative assessments and revisable summative assessment methods.

4) Equipping students with the tools of scientific inquiry through participation in research.

As a student and teaching assistant, I found that many professors adhere to either a content- or inquiry-centered teaching philosophy. Content-centered teaching focuses on conveying the current state of scientific knowledge across several topics to students. By contrast, inquiry-centered teaching focuses on the actual process of scientific discovery and developing students’ critical thinking skills, often at the expense of content quantity. Just as I believe that the most impactful science involves content-inspired conceptual innovation, I believe that the most effective learning occurs when conceptual exploration by students leads them to discover the principles underlying the natural world. To this end, I strive to develop meaningful inquiry lessons that support and reinforce ambitious content goals. For example, as instructor for Principles of Ecology, I teach students multiple hypotheses to account for variation in herbivore-plant interactions. Students often struggle to differentiate alternative hypotheses (e.g., the plant apparency versus resource availability hypothesis), so I designed an activity wherein students quantify herbivory rates on several local plant species and explore which plant traits best predict variation in herbivory. This activity helps clarify the predictions made by alternative foundational hypotheses through students own participation in the scientific process, from data collection to data analysis and interpretation.

I also have weekly, student-led discussions of the primary literature in my upper-level courses (Ornithology and Principles of Ecology). Such discussions have been fruitful because they reinforce content from lectures (which benefits students of all levels), while also giving advanced students the chance to pursue more complex lines of inquiry than those presented in lecture.

While I believe that inquiry-based methods are excellent tools for effective learning, I also have come to realize that no single teaching style can successfully reach all students. Just as my students vary greatly in learning style, they also differ in their career goals and personal experiences. Indeed, I have taught students that aspired to be everything from pharmacists and gastroenterologists to game wardens and scientific illustrators; students who have never left their rural corner of northwest North Carolina and students from the heart of Los Angeles. I have found that such factors can significantly influence whether certain course materials resonate with students or not. For some students, place-based examples of adaptation and coevolution in Appalachian butterflies might inspire them to look more closely at the flora and fauna in their own backyards. Other students might be hooked by the bizarre courtship displays of New Guinean birds-of-paradise or finding their first salamander under a log in the forest. To cater my teaching to such diversity in student interests, I survey students’ career goals and personal interests at the beginning of each semester and use this information when creating lessons. I have found that this is an effective method of leveraging students’ curiosity to inspire self-directed learning.

I also have come to appreciate that the history of science is often taught to students in a way that underrepresents the contributions of women, people of color, indigenous people, and others. This lack of racial, ethnic, gender, and socioeconomic diversity in classroom content not only paints a misleading picture of history but further discourages students from marginalized and minoritized backgrounds from participating in science. I therefore make sure to emphasize the many significant contributions to various fields in ecology and evolution of marginalized groups. For example, while Charles Darwin is rightfully celebrated for his contributions to evolutionary biology, there is a long history of evolutionary thought well before Darwin which helped paved the way for his ideas. When pre-Darwinian evolutionary thinkers are discussed in the classroom, most focus is on European figures such as Jean-Baptiste Lamarck and Erasmus Darwin. Yet there is a rich history of pre-Darwinian evolutionary thought in many regions, including ancient China and the Islamic world during the Golden Age, and I highlight the contributions of individuals from these societies (e.g., Zhuang Zhou, Al-Jahiz, and Ibn Khaldun) in my lectures. I believe such actions are small yet important steps to making my classrooms a more inclusive learning environment.

Ultimately, no matter how effective I might believe a given method of instruction is, I must be able to monitor my students’ learning throughout the semester to identify topics that students struggle with. Ideally, this is done in a way that also promotes student learning. I believe that regular, “low risk” formative assessments are an excellent way to achieve both goals. For example, by giving students short in-class writing assignments on course content, I can proactively pinpoint and address areas of misunderstanding as they arise. This also empowers students to identify topics they are struggling with and identify study methods that support their own learning. Importantly, the regular use of various methods of formative assessment (e.g., weekly quizzes, classroom polls, and group discussions) also exposes students to course material multiple times over a semester, which further enhances learning.

Finally, I think the most influential educational experiences often occur outside the classroom and can be synergistic with an active and inclusive research program. At a basic level, it is not possible to teach all that is known of the living world and our understanding of biology is constantly evolving. Therefore, equipping students with the tools of scientific investigation through research activities encourages learning beyond my courses. As an undergraduate working in an evolutionary genetics lab, I received valuable lessons by participating in weekly lab meetings and paper discussions, designing and implementing my own experiments, and even chatting over coffee with my advisor and graduate students. Additionally, the support network I had in my lab was essential for me as a first-generation college student with a disability, learning to navigate the foreign world of academia away from home for the first time. These experiences were enormously valuable for my success in graduate school and beyond, but my undergraduate lab mates were successful outside of academia as well, in diverse areas such as biotechnology, conservation, and healthcare. As such, another core component of my teaching philosophy is to encourage undergraduates (especially those from underprivileged backgrounds) to participate in all aspects of my research program in ways that support their own interests and career ambitions. Indeed, as a graduate student, I mentored four undergraduate student research projects. In my first two years as a professor at Lees-McRae College, I have mentored ten undergraduate student research projects, with three of these students as co-authors on forthcoming, peer-reviewed publications.

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item B: Principles of Ecology syllabus (Fall 2021)**

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###### BIO 433-01 and 02

Principles of Ecology – Syllabus

**Course:** Principles of Ecology **Professor:** C. Porter

**Term:** Fall 2021 **Class Day/Time:** MWF 10-10:50AM (01)

MWF 11-11:50AM (02)

**Room:** Bowman 206 (**sec.** **01**) or 109A (**sec.** **02**)

see schedule for lab **Lab** **Day/Time:**  W 2-4:50PM (01)

**Office Location:** Bowman 103 M 2-4:50PM (02)

**Email Address:** porterc@lmc.edu **Office Hours:** MWF: 8:00 – 10:00 am

Tu: 11:00 am - 12:00 pm

F: 12:00 – 1:00 pm

**Telephone:** 307-760-2275

1. **Course Description** -This course is a study of relationships between organisms and their biological, chemical, and physical environment. Prerequisites: BIO 121 or 221 & CHM 101 or 111.
2. **Textbooks**: *The Economy of Nature*, 8th ed. Robert E. Ricklefs (2018)*.*

**ISBN-13:** 978-1-319-28268-4

**ISBN-10:** 1-319-28268-7

**III. Brightspace** - Most lecture material is posted **before** it has been presented in class. There may also be additional readings or other material posted under the resources tab. Grades will be posted on the gradebook.

**IV. Learning Outcomes** - Principles of Ecology is a course which investigates the relationships between organisms and their biological, chemical, and physical environment. Students who successfully complete the course have:

1. developed an understanding of factors that regulate growth and structure of populations
2. understood the structure and functioning of communities
3. become aware of physical and biological interactions that drive ecological and patterns
4. understand the interaction between ecological and evolutionary processes/patterns
5. gained first-hand experience in ecological data collection, analysis, and presentation.

Learning outcomes will be assessed using quizzes, in-class assignments, exams, and reports.

**V.** **Course Policy** -This course is designed to enhance and increase students' knowledge and appreciation of ecological systems, how individuals are adapted to natural environments, and the interrelationships between species within ecosystems. **All students are expected to take an active role in the classroom.** Disruptive behavior including cell phone use, surfing the web, or causing a distraction will not be permitted. Disruptive students will be asked to leave the class, and this may count toward that student’s attendance.

**VI. Attendance Policy** -Lecture material, **including paper discussions**, will be included in all quizzes and exams, so poor attendance will negatively affect a student’s grades. **Lab attendance is mandatory**. Missing two labs will result in a 10% overall grade reduction. Missing three or more labs will result in course failure. If a student fails to attend or stops attending class for four consecutive class meetings, he or she may be administratively withdrawn from all classes. In addition, the College reserves the right to require at any time the withdrawal of a student whose social conduct or academic progress is considered unsatisfactory as outlined in the Student Handbook or Code of Conduct. Grades will be determined according to withdrawal guidelines. For college-sponsored events (e.g., athletic competition, performance, field trip), students will be allowed to complete some missed work. It is often not possible to make up a laboratory. Students must contact the professor and make arrangements *before* departing for a college-sponsored event.

### VII. Additional Resources, Class Support, and Recommended Readings - Any additional resources will be posted to Brightspace.

**VIII. Grading** - Grades for this course will be determined based on a **700 point scale**. There will be 4 exams (100 points each), 1 research paper (100 points), a class paper discussion (50 points), 10 in-class assignments (10 points each), and 5 lab assignments (10 points each). **50% of your own paper discussion grade will be based on your participation in discussions led by others, so read the papers carefully and come to class prepared to discuss them.** Make-up exams are permitted with an **excused absence** **only** (e.g., doctor’s appointment, court date). You must inform me ahead of time to schedule a make-up exam. Grades will be assigned using the following percent scale, and grades will not be rounded up.

% Scale: 93-100 A; 90-92.9 A-; 88-89.9 B+; 83-87.9 B; 80-82.9 B-; 78-79.9 C+; 73-79 C; 70-72.9 C-; 68-69.9 D+; 63-69 D; 60-62.9 D-; <59 F

**IX. Communication with Students** - Lees-McRae College sends official communication to students through their student e-mail address. Every student is assigned an lmc.edu e-mail address. This is the only e-mail address recognized by the College. Faculty and staff have been instructed to only accept and use College e-mail addresses (e.g., az0123456@lmc.edu) for messages with students. *Students should compose e-mail messages in a professional manner and include in their messages a greeting, the body of the message, and a salutation.*

#### X. Career Considerations - Career Education is a high priority at Lees-McRae College. Students are encouraged to attend class in business casual or professional attire.

#### XI. Academic Integrity - The goal of the faculty at Lees-McRae College is to foster a spirit of complete honesty and a high standard of academic integrity. The attempt of any student to present as their work that which they have not honestly performed is regarded by the faculty and administration as a most serious offense and renders the offender liable to severe consequences and possible suspension.

The College expects that all students will refrain from the following behaviors as described in the faculty/student handbook: cheating, plagiarism, collusion and lying. Please refer to the student handbook for further details.

XII**. Accommodations for Students with Documented Disabilities or Special Learning Needs -** The office of Accessibility Services assigns reasonable accommodations to students who request and provide appropriate documentation for those services. At Lees-McRae College, any student with a documented disability must self-disclose to the Coordinator of Academic Support Services (Ms. Libby Gragg [gragge@lmc.edu](mailto:gragge@lmc.edu)) to design an Accommodations Plan. Using the plan, the Coordinator composes a Letter of Accommodations which students present to their faculty.

##### Students should initiate the Request for Accommodations by contacting Ms. Gragg before or as soon as possible after classes begin as possible. Students who have a documented condition must take the initiative to privately speak with their instructors on the first day of class and throughout the semester to ensure a successful learning experience. The Coordinator for Academic Support Services’ office is located in the Burton Center for Student Success.

**COVID-19 Control Measures -** Please refer to the [COVID policy](https://www.lmc.edu/about/covid-19/index.htm) on the LMC website. The Campus will continue to follow state and CDC guidelines to keep us BOBCAT STRONG!

**Inclement Weather Policy -** On days where the weather causes a delay in opening campus, we will work on a compressed class schedule. See the table below for clarification.

**Course Outline** -

|  |  |  |  |
| --- | --- | --- | --- |
| **DATE** | **TOPIC** | **CHAPTER** | **LAB** |
| 16 Aug | Introduction | 1 | **No lab this week** |
| 18 Aug | Adaptations to the physical environment and climate change | 2 - 4 |  |
| 20 Aug | *Paper discussion* |  |  |
| 23 Aug | The causes of climate | 5 |  |
| 25 Aug | Biological communities | 6 | Lab 1: Estimating density (meet at Elk Valley Preserve)  **LAB ASSIGNMENT 1** |
| 27 Aug | *Paper discussion* |  |  |
| 30 Aug | Energy flow | 20 |  |
| 1 Sep | Nutrient cycles | 21 | Lab 2: Ecosystem structure I  (meet at Elk Valley Preserve) |
| 3 Sep | *Paper discussion* |  |  |
| 6 Sep | **Labor Day – no class** |  |  |
| 8 Sep | Adaptation, natural selection | 7 | **No lab this week** |
| 10 Sep | *Paper discussion* |  |  |
| 13 Sep | **Exam I** |  |  |
| 15 Sep | Life history evolution | 8 | Lab 3: Ecosystem structure II  (meet in Bowman 109A)  **\*Bring laptop to lab\***  **LAB ASSIGNMENT 2** |
| 17 Sep | *Paper discussion* |  |  |
| 20 Sep | Mating systems | 9 |  |
| 22 Sep | Family, society, and evolution | 10 | Lab 4: Group foraging and vigilance (meet in Bowman 109A)  **\*Bring binoculars if you have them to this week’s lab\***  **LAB ASSIGNMENT 3** |
| 24 Sep | *Paper discussion* |  |  |
| 27 Sep | Population structure | 11, 12 |  |
| 29 Sep | Population growth | 12 | Lab 5: Ideal free distribution in ducks (meet at the Mill Pond) **\*Bring binoculars if you have them\*** |
| 1 Oct | *Paper discussion* |  |  |
| 4 Oct | Population growth | 12 |  |
| 6 Oct | The causes of population change | 12 | Lab 6: Populus population growth models (meet in Bowman 109A)  **\*Bring laptop to lab\***  **LAB ASSIGNMENT 4** |
| 8 Oct | *Paper discussion* |  |  |
| 11 Oct | **Exam II** |  |  |
| 13 Oct | **Mountain Day of Service – no class** | 14 | **No lab this week** |
| 15 Oct | *Paper discussion* |  |  |
| 18 Oct | **Fall Break – no class** |  |  |
| 20 Oct | Predation | 14 | **No lab this week** |
| 22 Oct | *Paper discussion* |  |  |
| 25 Oct | Herbivory | 14 |  |
| 27 Oct | Parasitism | 15 | Lab 7: Populus predator-prey  (meet in Bowman 109A)  **\*Bring laptop to lab\*** |
| 29 Oct | *Paper discussion* |  |  |
| 1 Nov | Competition and coexistence | 16 |  |
| 3 Nov | Mutualism | 17 | Lab 8: Herbivory and the apparency hypothesis  (meet in Bowman 109A)  **\*Bring laptop to lab\***  **LAB ASSIGNMENT 5** |
| 5 Nov | *Paper discussion* |  |  |
| 8 Nov | **Exam III** |  |  |
| 10 Nov | Indirect effects and HHS | 16.4, 18.4 | Independent projects (meet at Elk Valley Preserve) |
| 12 Nov | *Paper discussion* |  |  |
| 15 Nov | Indirect effects and trophic interactions | 16.4, 18.4 |  |
| 17 Nov | Biodiversity | 22 | Independent projects (meet at Elk Valley Preserve) |
| 19 Nov | *Paper discussion* |  |  |
| 22 Nov | Island biogeography | 22 |  |
| 24 Nov | **Thanksgiving Break – no class** |  | **No lab this week** |
| 26 Nov | **Thanksgiving Break – no class** |  |  |
| 29 Nov | Stability, diversity, and disturbance | 18, 19 |  |
| 1 Dec | Causes of recent extinctions | 23 | Independent projects due (meet in Bowman 109A) |
| 3 Dec | *Paper discussion* |  |  |

This is a tentative schedule of topics, labs, and exams that may change as necessary during the semester.

**Lab Assignments**

1. Stats and sampling
2. Forest structure – energy pyramids
3. Group foraging and vigilance
4. Populus population growth
5. Herbivory and plant apparency

**INCLEMENT WEATHER COMPRESSED CLASS SCHEDULE**

|  |  |
| --- | --- |
| **MWF** | |
| Regular Time | Compressed Time |
| 8:00–8:50 a.m. | 10:00–10:30 a.m. |
| 8:00–10:50 a.m. | 10:00–11:50 a.m. |
| 9:00–9:50 a.m. | 10:40–11:10 a.m. |
| 10:00–10:50 a.m. | 11:20–11:50 a.m. |
| 10:00–11:50 a.m. | 11:20 a.m.–12:30 p.m. |
| 11:00–11:50 a.m. | 12:00–12:30 p.m. |
| 11:00 a.m.–12:20 p.m. | 12:00–12:50 p.m. |
| 12:00–12:50 p.m. | 12:40–1:10 p.m. |
| 12:00–1:20 p.m. | 12:40–1:30 p.m. |
| 12:00–1:50 p.m. | 12:40–1:40 p.m. |
| 1:00–1:50 p.m. | 1:20–1:50 p.m. |
| 2:00 p.m. *or later* | Regular schedule |

|  |  |
| --- | --- |
| **TR** | |
| Regular Time | Compressed Time |
| 8:00–9:20 a.m. | 10:00–10:50 a.m. |
| 9:30–10:20 a.m. | 11:00–11:30 a.m. |
| 9:30–10:50 a.m. | 11:00–11:50 a.m. |
| 11:00–11:50 a.m. | 12:00–12:30 p.m. |
| 11:00 a.m.–12:20 p.m. | 12:00–12:50 p.m. |
| 12:30–1:50 p.m. | 1:00–1:50 p.m. |
| 1:00–1:50 p.m. | 1:30–2:00 p.m. |
| 2:00 p.m. *or later* | Regular schedule |

|  |  |
| --- | --- |
| **Labs** | |
| Regular Time | Compressed Time |
| 12:00–2:50 p.m. F | 12:40–2:20 p.m. F |
| 1:00–3:50 p.m. MWR | 1:30–3:10 p.m. MWR |
| 2:00–4:50 p.m. T | 2:10–5:00 p.m. T |
| 2:00–4:50 p.m. MW | Regular schedule |

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item C: Leaf herbivory lab (Principles of Ecology, Fall 2021)**

**Lab 8 – Leaf herbivory: testing the plant apparency hypothesis**

This lab will explore whether plant species that vary in leaf “apparency” differ in patterns of herbivory.

**Background**

In lecture this week we will be talking about herbivory; the dominant biotic interaction in most of the world’s ecosystems. Indeed, the removal of plant tissue by herbivores represents the major transfer of energy into animal food webs (Turcotte et al. 2014). Given the intense pressure that plants are under by herbivores, we might expect plants to invest a lot of energy into defenses. However, plants have several competing energetic demands and limited resources to invest in defenses. Furthermore, plants can vary tremendously in life history characteristics that might make them more or less likely to invest heavily in defenses. For example, some plants have leaves that are extremely long-lived, whereas others produce leaves only for very short periods of time. Leaves that are longer-lived are more “apparent” or available to herbivores and thus likely to suffer greater herbivory than shorter-lived leaves, all else being equal. Thus, a classic prediction is that plants with longer-lived leaves should invest more in leaf defenses against herbivores (Coley 1988) and thus experience lower rates of herbivory as a result. Furthermore, by investing heavily in defenses, plants may be unavailable to many generalist herbivores, since only herbivores with specialized adaptations may be able to overcome the plant’s defenses.

**Materials and Methods**

In today’s lab, we will test the plant apparency hypothesis by comparing the extent of insect herbivory and diversity of insect herbivores attacking some common plants around Banner Elk for which we have data on the “lifespan” of their leaves (collected from a large plant trait database). The basic protocol is straightforward: we will have a list of plant species to target and walk around the field station looking for these leaves in the leaf litter or any still attached to trees. Specifically, your group will pick a particular location, search for 10 leaves from each target species, bag them, and move on. **It is important to randomly select leaves (i.e., make sure you’re not only selecting those with or without damage), so that we obtain an unbiased estimate of herbivory.** After doing this, you will move to a different site at least 500 m from your other sites and repeat this process a total of 5 times (so we make sure we sample multiple individual plants – not just the same one repeatedly). Once we finish collecting leaves, we will take them inside and record 1) the percentage of leaf area removed by herbivores and 2) the diversity of insects that fed on the leaves (we will use an indirect measurement of this).

To quantify herbivory, we will visually estimate the percentage of the leaf that has been lost to or damaged by herbivores. In class, we will complete a brief training session by practicing visual estimation of herbivory. This has been shown to produce highly accurate estimates of herbivory (Johnson et al. 2016).

We will also record the diversity of herbivores that have consumed each plant species’ leaves. Although we cannot accurately identify insect herbivores to species or even genus in most cases simply by looking at the damage they leave behind, we can measure a proxy of herbivore diversity. Specifically, we can record the number of different “damage types” on each species. Damage type refers to the pattern or “morphology” of damage left behind by an herbivore. Herbivore taxa differ in the damage types they leave behind, and studies have found that the diversity of herbivore damage types on leaves is a good predictor of the diversity of herbivorous insects (Carvalho et al. 2014). Thus, if we find significantly different numbers of damage types on different plant species, we can make inferences about the range of herbivores that are able to use that resource (remember: a prediction from the plant apparency hypothesis is that longer-lived leaves might be unavailable to many herbivores; only a few specialists). We will assign damage that we encounter to six general categories (Figure 1): hole feeding, margin feeding, piercing and sucking, skeletonization, mining, and galling.

A picture containing tree, plant

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**Statistical Analyses**

We are interested in testing whether one continuous variable (leaf lifespan) affects another continuous variable (% herbivory and # of damage types) across the species in our sample. When we are interested in the relationship between a continuous independent variable (*x*) and a continuous dependent variable (*y*; dependent because we are testing whether its values are dependent on x), we use an approach called linear regression.

**Figure 1.** Different types of herbivorous insect damage on leaves. Top row, from left to right: hole feeding, margin feeding, and piercing/sucking. Bottom row, from left to right: skeletonization, leaf mining, and galling.

A linear regression line has an equation of the form ***y = a + bx***, where ***x*** is the explanatory variable and ***y*** is the dependent variable. The slope of the line is ***b***, and ***a*** is the intercept (the value of *y* when *x* = 0). The slope is particularly important for telling us the “direction” of the relationship between *x* and *y* (for example, when the slope is positive, *y* increases with increases in *x*). A statistically significant slope indicates that there is a statistically significant relationship between our two variables.

Most computer programs will also report to us an *r*2 value, otherwise known as the coefficient of determination. The coefficient of determination measures the proportion of variance in the dependent variable (*y*) that is predictable from the independent variable (*x*). Essentially, this is a measure of how “strong” the relationship between our two variables is.

For today’s lab, use the linear regression calculator at the following link:

<https://www.graphpad.com/quickcalcs/linear2/>

Lab Assignment (10 points)

Name­­­\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

Use the data collected during the lab to complete the following.

1. Plot the relationship between leaf lifespan and the average % herbivory for each plant species we sampled. (1 pts)

2. Report the *r*2 value, the slope, the sample size (listed as number of XY pairs on the calculator output), and the *p*-value for the comparison plotted in 1). (2 pts)

3. Are these results in agreement with the plant apparency hypothesis? Explain. (2 pts)

4. Plot the relationship between leaf lifespan and the total number of damage types for each plant species we sampled. (1 pts)

5. Report the *r*2 value, the slope, the sample size (listed as number of XY pairs on the calculator output), and the *p*-value for the comparison plotted in 4). (2 pts)

6. Are these results in agreement with the plant apparency hypothesis? Explain. (2 pts)

Literature Cited

Carvalho, M. R., P. Wilf, H. Barrios, D. M. Windsor, E. D. Currano, C. C. Labandeira, and C. A. Jaramillo. 2014. Insect Leaf-Chewing Damage Tracks Herbivore Richness in Modern and Ancient Forests. PLoS ONE 9:e94950.

Coley, P. D. 1988. Effects of plant growth rate and leaf lifetime on the amount of anti-herbivore defense. Oecologia 74: 531-536.

Johnson, M. T., J. A. Bertrand, and M. M. Turcotte. 2016. Precision and accuracy in quantifying herbivory. Ecological Entomology 41:112-121.

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[**Teaching Dossier**](#Teaching_Dossier) **-** **Item D: Lab assignment (Ornithology, Fall 2020)**

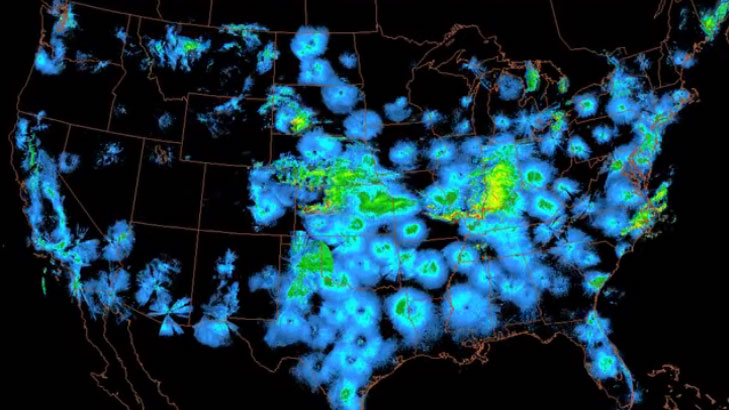
**Lab Assignment 1: Migration and Weather Radar**

As we’ve discussed in lab, weather radar can be used to study flight behavior of a variety of organisms (e.g., insects, bats, etc.), including birds. This has become an especially important tool for studying spring and fall migration of songbirds, which primarily migrate at night and a height of 1000 - 3000 m above the ground surface. For this assignment, you will use NEXRAD data to study songbird migration around Banner Elk.

**Radar Basics**

At a basic level, weather surveillance radar emits pulses of radiation into the sky**.** This radiation is reflected off objects in the sky (e.g., clouds, rain, insects, birds, bats, etc.) and returned to the radar. Importantly, the returning radiation carries information about location, altitude, degree of reflectivity, and direction/speed of an object’s movement. We can use all this information to distinguish birds from other objects in the air.  
  
So, how do we know the signal we’re detecting are birds and not something else? A comprehensive exploration of the details is beyond the scope of this exercise, but there are a few important characteristics we can look for:

**1)** Songbirds will only enter the radar after sunset (again, they are migrating at night).



**2)** As birds ascend into the sky and move away from radars, they are detected as intense concentric “rings” in the sky (Fig. 1). These rings are often described as resembling jelly-filled donuts.

**3)** Depending on the season, birds will predictably be moving either ~North-South or South-North.

**Figure 1.** NEXRAD image showing heavy songbird migration across the Midwest. Note the distinct concentric rings (blue on the outside, green on the inside), which are birds.

**4)** In general, birds move about 15-20 kts faster than the prevailing wind (assuming it is a tailwind). Dust, pollen, and other debris will only move at the same speed as the prevailing winds.

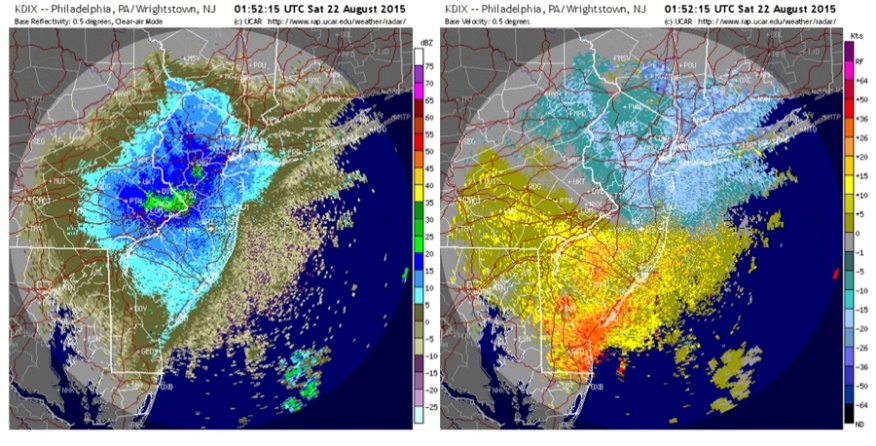
**5)** Birds can migrate against relatively heavy crosswinds, whereas insects cannot. So, if an object is moving north at 12 kts and there is a 10 kt wind out of the west, you can be pretty sure it’s a bird.

**Accessing and Interpreting Data**

**1.** Go to <https://weather.rap.ucar.edu/radar/>

**2.** Under “Product”, first select “Base Reflectivity”. You can use whatever Background you prefer (I like choosing black).

**3.** If you’re attempting to look at migration from the previous night, the End Date should be “Today”. Also, first select “Single image” for loop duration.

**4.** The end time will depend on when you want to look at migratory conditions. In general, migrant activity peaks around 1:00 am. Note: to convert UTC time to EST time, simply add 5 (if you’re in daylight savings time, add 4). In other words, 1:00 am EST would correspond to 0600 UTC.

**5.** Find the Roanoke, VA station on the map (FCX is the abbreviation) and click on it.

**6.** This is where you will see the concentric rings mentioned previously (also in Fig. 2) if bird migration was happening. If the concentric ring isn’t visible, there was likely no to little migration happening. More intense signals indicate more birds migrating.

**Figure 2.** (Left): Reflectivity image showing heavy migration over Philadelphia. (Right): Velocity image showing NE to SW movement of birds along the Atlantic coast.

**7.** Clicking on the Reflectivity image will give you a Velocity image showing how fast and in what direction objects are moving.

**8.** The direction of objects is indicated by the shift from cool colors to warm colors. In Fig. 2, we clearly see cool colors in the Northeast and warm colors in the Southwest, indicating Northeast to Southwest movement. This suggests these are birds, given that this is during fall migration.

**9.** The “warmest” warm color indicates the velocity of objects. In Fig. 2, these birds were moving at around 20-25 kts.

**10.** Go back to the main Radar page and go to “Loop Duration”. This will show you how migration progressed over the night. For duration, select the amount of time prior to your end time that you want to explore. For example, if your image ends at 1:00 am and you want to see how migration progressed from 7:00 pm on, select “6 hours”. This may take a bit to load. Remember, birds should appear in the radar just after sunset. Note that the concentric ring will not move (the radar station is fixed), but if there are migrating birds, it will become more intense.

**Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_**

**Assignment**

Choose a night over the next week to evaluate migratory activity. Avoid rainy nights or nights with extremely high winds, as birds will not be moving much. Use the instructions above to evaluate migratory conditions and, based on this, answer the following questions:

**1)** Do you see evidence for light or heavy migrant activity? Justify your answer by copying and pasting screenshots of your reflectivity and velocity images.

**2)** What direction were birds moving?

**3)** What velocity were birds moving at?

**4)** At what time was migrant activity highest? Hint: use a loop image over the course of the night to evaluate this.

**5)** What direction was the prevailing wind coming from on the night in question? Does this help explain the migratory activity you observed?

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item E: In-class short writing assignment (General Zoology, Spring 2022)**

**In-class SWA 5**

Last week we discussed the spicules of carnivorous sponges as an example of co-option and exaptation. For your homework, do your own research and **find and describe** a **different** example of co-option and exaptation in the animal kingdom.

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item F: Lecture exam (Principles of Ecology, Fall 2021)**

Biology 433: Exam II, Fall 2021 Name:\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

You are permitted to use a calculator (**not one on a phone**) for this exam.

Here are some equations that may be useful:

*N*t = *N*0***λ****t* = Geometric growth model

*N*t = *N*0*ert* = Exponential growth model

*dN*/*dt* = *rN* = Exponential population growth rate

*dN*/*dt* = *rN*(1 - *N*/*K*) = Logistic growth model

**Multiple choice.** **Circle the correct and best answer** **(3 pts. each)**

1. A mature female sockeye salmon swims up to 5000 km from her Pacific Ocean feeding ground to the mouth of a coastal river in British Columbia and then another 1000 km upstream to her spawning ground. Once there, she lays thousands of eggs in her single reproductive event and dies shortly after. The salmon's reproductive life history is referred to as:

1. nonparous
2. evenparous
3. oddparous
4. iteroparous
5. semelparous

2. Which of the following did Ghalamboor and Martin (2001) find in their study?

1. Birds in northern latitudes invested most in adult survival at the expense of offspring survival
2. Birds in southern latitudes invested most in offspring survival at the expense of adult survival
3. Birds in northern latitudes invested most in offspring survival at the expense of adult survival
4. Birds in northern and southern latitudes invested the same amount in offspring and adult survival

3. In retrospect, Cole’s Paradox was a result of

1. calculation of exponential rather than geometric rates of increase.
2. an assumption of equal survival rates for juveniles and adults.
3. an assumption of semelparity as the ancestral condition in vertebrates.
4. an error in Cole’s computer program.
5. a misapplication of the ideal free distribution.

4. Which of the following are factors that influence the evolution of clutch size?

a) the decrease in parental survival as clutch size increases

b) the increase in offspring survival as clutch size increases

c) the decrease in offspring survival as clutch size increases

d) the increase in parental survival as clutch size increases

e) a and c are correct

f) a, b, and c are correct

5. You are studying a species of bird that is usually monogamous but sometimes exhibits polygyny. You have the choice of studying this species in several different habitats, but for your study you need to assume that polygyny **does not** occur. Which of the following habitats would you work in if you need to **avoid** cases of polygyny?

1. a habitat in which territory qualities are nearly identical
2. a habitat in which territory qualities vary somewhat
3. a habitat in which territory qualities are highly variable
4. a habitat with many predators

6. Monogamy differs from polygyny in terms of \_\_\_\_\_\_\_\_\_\_\_, whereas promiscuity differs from polygynandry in terms of \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

1. duration of the association; the number of sexual partners
2. the number of sexual partners; duration of the association
3. duration of the association; in the frequency of extra-pair copulations
4. in the frequency of extra-pair copulations; the number of sexual partners

7. The mating system where a female associates with several males either at once or in succession is termed

1. monogamy
2. polygyny
3. polyandry
4. polygynandry
5. promiscuity

8. What is the coefficient of relationship (probability of identity by descent) of a human individual to one of its grandparents?

1. 1.0
2. 0.75
3. 0.5
4. 0.25
5. 0.125

9. It is commonly found that the proportion of time an individual spends scanning (looking) for predators decreases as group size increases. This:

a) makes an individual more vulnerable to predators.

b) is an example of kin selection.

c) allows more time for feeding.

d) is an example of the dilution effect.

10. Some shorebirds, such as terns, nest in large colonies on sandy beaches and sand spits. These birds maintain small territories surrounding their nests. Nests are packed densely on the sand, each nesting pair maintaining a fixed distance between its nest and those belonging to other pairs. The dispersion of nests within a colony would tend to be \_\_\_\_\_\_\_\_\_\_\_, whereas the dispersion of colonies across the earth would tend to \_\_\_\_\_\_\_\_\_\_\_?

1. evenly spaced; clumped
2. clumped; evenly spaced
3. random; evenly spaced
4. clumped; random

11. As habitat patches fill up with individuals, what should happen to the quality of patches if the ideal free distribution is true?

1. Patch quality should increase as they are filled but remain consistent among patches
2. Patch quality should decrease as they are filled and vary among patches
3. Patch quality should increase as they are filled and vary among patches
4. Patch quality should decrease as they are filled but remain consistent among patches

12. An experiment is conducted in which two sides of a fish tank are supplemented with food. One side of the tank receives 5 grams of food every half hour and the other side receives of 15 grams of food every half hour. A school of 40 minnows are added to the tank and the fish quickly establish an ideal free distribution. How many fish are feeding on the side of the tank that receives 5 grams of food every half hour?

1. 30
2. 20
3. 10
4. 5
5. 0

13. An endangered butterfly occurs in only two patches of forest, A and B, on a small island. Patch A has a total of population size of 500 butterflies with a λ equal to 1.1, whereas patch B has a total population size of 1000 butterflies with a λ equal to 0.95. You are tasked with identifying the population that is most likely to persist and thus needing the highest priority of conservation. Which population do you recommend for high priority conservation?

1. A
2. B
3. It depends on whether the butterflies are iteroparous or semelparous.
4. We need additional information on survivorship before we can decide.

14. In the life table for the grass *Poa annua* the survivorship for age class *x* = 3 is *l3* = 0.375. What does this mean, in words?

1. For a group of 1000 newborns, 375 will be alive at age class *x* = 3.
2. For a group of 1000 newborns, 37.5 will be alive at age class *x* = 3.
3. The survival rate from age class *x* = 2 to *x* = 3 is 0.375.
4. The mortality rate during age class *x* = 3 is 1 - 0.375 = 0.625.

15. A local population of Japanese beetles is growing geometrically with *λ*  = 2. The population on July 31 this year consists of 10 adults. How many adults will be in this population on July 31 in three years?

1. 30
2. 40
3. 50
4. 60
5. 70
6. 80

16. As a population approaches its habitat’s carrying capacity,

1. births begin to exceed deaths.
2. the per capita growth rate increases.
3. the rate of reproduction increases.
4. population growth begins to be exponential.
5. the per capita growth rate decreases.

17. The increase in number of individuals in a population per unit time depends upon

1. only the size of the population (*N*).
2. only the intrinsic rate of growth (*r* or [*b*-*d*]).
3. both the size of the population and the intrinsic rate of growth.
4. neither the size of the population nor its intrinsic rate of growth.

18. When a population grows according to a logistic model, at what population size is its **growth rate** maximal?

a) a very low population size

b) *K*/2

c) *K*

d) 2*K*

e) *rN*

19. When a population grows according to a logistic model, what happens if the population exceeds carrying capacity?

1. The population resumes exponential growth.
2. The size of the population remains constant.
3. The size of the population begins to decline.
4. The population goes extinct.

20. You are studying a population of Eastern Garter Snakes that has a population size of 100 individuals. You also estimate that the carrying capacity of this population is 300 individuals. What is the unused portion of the carrying capacity of this population?

a) 0.33

b) 200

c) .25

d) 0.67

21. Guthrey and Shaw (2013) discussed a now famous study on efforts to control Coyotes. Coyote populations show negative density-dependent growth and, as a result, it is extremely hard to reduce their numbers. Why is this?

a) as adult numbers are reduced, litter size increases

b) as adult numbers are reduced, litter size decreases

c) coyotes exhibit strong Allee effects

d) as adult numbers are reduced, juvenile survival is reduced

22. Has the population below reached a stable age distribution by year 4? Justify your answer. (9 points)

Year 1 Year 2 Year 3 Year 4 Year 5

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*n*0 0 300 400 500 600

*n*1 10 0 100 60 60

*n*2 20 5 0 30 37

*n*3 0 0 0 0 0

*N* 30 305 500 590 697

**Short answer questions.**

25. (4 pts) Pribl and Searcy (2001) tested the Polygyny Threshold Model in a population of Red-winged Blackbirds by manipulating male territory quality. What results did they find that suggested that the Polygyny Threshold Model applied to this population (hint: there are **two** key findings)?

26. (4 pts.) Sally and her sister Sue each produce two offspring if they breed alone. According to Hamilton’s Rule, Sally would have higher fitness because of kin selection by not breeding and helping her sister Sue if Sue then produces how many **additional** offspring? Show your work including Hamilton’s Rule.

27. (4 pts.) Using the life table information below, if there were 1000 individuals in the age 2 age-class this year, how many will be in the age 3 age-class next year?

Age*x* Survivorship (*lx*) Fecundity (*bx*)

0 1 0

1 .6 4

2 .3 5

3 .1 2

4 0 0

28. (7 pts.) Using the life table information above, if there were 10 individuals in each age class at time 1, how many newborn individuals (age 0) would there be in time 2?

29. (5 pts.) Assuming logistic growth, a population would grow at what percent of an exponentially growing population when *N* = 50 and *K* = 100? Show your work.

30. (4 pts.) What does an Allee effect describe? Provide one hypothetical “real world” example of an Allee effect (hint: don’t worry if it’s an example we covered or not -- just give me a plausible example).

[**Teaching Dossier**](#Teaching_Dossier) **-** **Item G: Example student work (Principles of Ecology, Fall 2021)**

XXXXXXXXXXXXXXXXX

Bio-433 Principles of Ecology

Dr. Cody Porter

28 November 2021

Impact of *Rhododendron* Grayanotoxins on Surrounding Herbivory Rates

Abstract:

*Rhododendron* has been known to have a strong impact on the area it occupies for a while. However, the impact its toxins have on plants of other species is seldom researched. We wanted to explore the impact *Rhododendron* may have on neighboring plants in terms of herbivory rates, hypothesizing that proximity to *Rhododendron maximus*and their toxinscould result in neighboring trees absorbing and using those toxins as a defense mechanism against herbivory. To test this, we set out on a 70-acre piece of land in Banner Elk, North Carolina where*R. maximus* and *Fagus grandifolia* (American Beech) can easily be found growing close together and far apart. Twenty *F*. *gradifolia* trees were selected, and from each 10 leaves were measured for herbivory and the distance from the nearest rhododendron plant was also measured. Once data were collected, a linear regression was performed to find the relationship between beech distance from the nearest rhododendron and the extent of herbivory. A very weak positive relationship was found using linear regression, with a *p*-value of 0.2309. It was concluded there was not enough evidence to support our hypothesis that *F. grandifolia*was utilizing toxins from *R. maximus* in a way that reduced herbivory.

Introduction:

In today's ecosystem, *Rhododendron* plays an increasingly prominent role in the Blue Ridge Mountain ecosystem. With 11 species across The Blue Ridge Parkway, *Rhododendron* plays a huge role as a very common understory species. Characterized by its great success in an acidic environment, the plant has produced a significant population at the center of Lees McRae’s Elk Valley field preserve in Avery County, North Carolina, a 70 acre preserve. Studies have shown *Rhododendron* can impact its ecosystem by blocking sunlight and vital soil nutrients from other plants (Nilsen, E. Et al., 2001), and possibly that appearing near rhododendron alone will reduce herbivory (Orians, C. M., & Björkman, C., 2009), but a new concept is that it may be impacting mature trees nearby, which may be using the rhododendrons toxins as a defense mechanism against herbivory Rhododendron is characterized by its toxicity and use of grayanotoxins to prevent herbivory upon its leaves. Based upon the chemical makeup of the rhododendron engulfing the ridge at the field station, our study sought to examine the impact of toxins on the herbivory rate of surrounding American Beech trees. Research has shown that nearby plants often absorb toxins through the soil from the rhododendron. In analysis, the herbivory rate of American beech tree leaves should be greater as distance from rhododendron increases. We hypothesize that American Beech are acquiring toxins naturally produced by *Rhododendron maximus*through the soil and therefore their herbivory percentages will be less when in close proximity to *Rhododendron maximus.*

Materials and Methods/Procedures:

It was imperative to the success of our results that we accurately estimate the herbivory rate to the best of our ability. We relied on research done by the department of biology at the University of Toronto Mississauga. In over 4000 estimates of leaf herbivory research showed that 80 percent of estimates were correct (Johnson M.T et. al, 2015). It is our hope that experience in a previous lab setting enabled us to make accurate visual estimates. In terms of materials, we used a tape measure to record distance between beech trees the nearest rhododendron.

Our field work began by finding American Beech trees at varying distances from the nearest rhododendron plant. Each of the 20 Beech Trees selected had the distance between the base of its trunk and the base of the nearest Rhododendron plant. Our distances ranged from 1.08 to 300 feet. (Trees marked 300 feet were at least ~275 feet away from the nearest rhododendron plant.) At each tree we randomly selected 10 leaves at varying heights on the stem. Once collected, we conducted a visual estimate of the herbivory rate of each leaf.

At that point, we were able to calculate an average herbivory rate for each tree and correlate this data with its relative distance to a rhododendron.

Results:

Chart, scatter chart

Description automatically generatedWe used R (ver. 4.1.2; R Core Team 2021-11-01) to find a relation between the distance of the tree to a Rhododendron plant and the average herbivory of the tree. A linear regression was performed. Our p-value was 0.2309 at a confidence interval of .05, showing a weak correlation, however our relation was still positive, showing a rise in herbivory as distance increases.

Discussion:

Relatively new data has emerged suggesting that associational resistance takes place in coexisting areas of Birch species and *Rhododendron tomentosum.*Research asserts that neighboring plants can sense the species around them and detect the volatile compounds released. This research has opened opportunities to understand variances in cuticle depth of varying plant leaves. Furthermore, it lends evidence to explaining the distribution of species (Himanen, S. J. et al. 2010). In align with the plant apparency hypothesis, Rhododendron have sought to protect their leaves from herbivory. Their vast populations, long leaves and evergreen in nature makes them strongly apparent to herbivores. Being apparent has led to the development of thick waxy cuticles and dispersal of grayanotoxins in defense against herbivory. This research along with the coexistence of Rhododendron, Birch, and Beech species led us to believe that we would see a negative trend in herbivory rate as neighboring Beech trees approached congregations of Rhododendron.

**Figure 1.** Distance of American Beech from the nearest Rhododendron maximus (x-axis) versus the average percentage of leaf area removed by herbivores in a sample of 10 American Beech leaves per tree.

Our data suggested a weak correlation between distance and herbivory rate. In review, it was possible that there is an innate behavior that wishes to select the prettiest leaves from the tree. It is likely that our selection process of leaves from the beech trees skewed our data and failed to represent those variances present as we selected leaves lacking imperfections. This would explain the lack of strength in the correlation of our results. Another possibility is specialists that feed on *Rhododendron maximus* may also have been feeding on *Fagus grandfolia,*since many Rhododendron plants found near the Beech trees had been heavily predated on. If this were the case, future studies should also review the types of grazers that feed on *Fagus grandfolia growing*in the presence of *Rhododendron maximus.*

Although our research failed to yield strong evidence that that American Beech trees are acquiring toxins naturally produced by *Rhododendron maximus*, the weak correlation present can give sign that something may influence herbivory when near rhododendron. May this be the neighbor identity, toxin absorption, or some other phenomenon. As research continues, new examples of associational resistance in natural systems will come to progress our ecological understanding of the blue ridge ecosystem and the herbivory present.

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[**Teaching Dossier**](#Teaching_Dossier) **-** **Item H: Student evaluations (General Zoology, Spring 2021)**

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