

Experiences in Biodiversity Research: A Field Course

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Iowa State University Digital Press
Ames, Iowa



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*This is a publication of the
Iowa State University Digital Press
701 Morrill Rd, Ames, IA 50011
<https://www.iastatedigitalpress.com>
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Acknowledgments

I would like to thank Drs. Tracy Heath, Amy Toth, and Corinna Most for their mentorship of and enthusiasm for this project. I would also like to thank the students who took the first offering of this course. Their enthusiastic participation was essential for its successful development.

Welcome to Experiences in Biodiversity Research



Biodiversity research encompasses all of the rich diversity of life on earth, but can be challenging to break into for those without previous experience. This course provides a hands-on introduction to accessing and performing research in the biodiversity sciences. Source: Corinna Most, used with permission.

Course Description

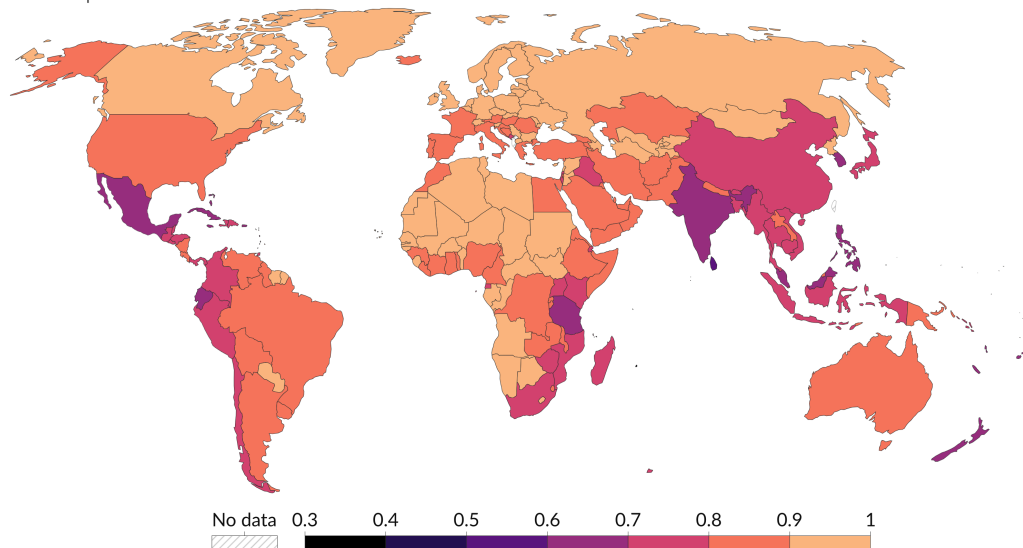
Iowa State University is home to many researchers studying the most pressing scientific issues of our time: climate change and the biodiversity crisis. However, the sub-disciplines of the life sciences focusing on these problems lack diversity in many forms and remain

difficult to access for those without prior experience. Studies¹² have shown that there are significant barriers preventing individuals from historically marginalized backgrounds from gaining experience or comfort in biodiversity research. For many, these barriers include lack of exposure to the outdoors and field/laboratory experiences, as well as unclear processes for accessing opportunities in research or graduate education. Experiences in Biodiversity Research is a course for early undergraduates to provide experience in the practice of biodiversity research and to demystify the path to careers in this field.

Red List Index, 2023

Our World
in Data

The Red List Index¹ shows trends in overall extinction risk² for groups of species. It is an index between 0 and 1. A value of 1 indicates that there is no current extinction risk to any of the included species. A value of 0 would mean that all included species are extinct.



Data source: Birdlife International and International Union for Conservation of Nature

Note: Extinction risk estimates for mammals, birds, cycads, amphibians and corals are used to calculate the Red List Index. National and regional Red List Indices are calculated by weighting by the fraction of each species' distribution occurring within them.

OurWorldInData.org/biodiversity | CC BY

Biodiversity loss is a global crisis, however biodiversity is not uniformly distributed and certain areas of the world show greater extinction risk. Tackling this issue will require people from all over the world with diverse ideas and experience to work together toward solutions. Source: Our World in Data, CC BY 4.0.

1. O'Brien, L.T., Bart, H.L., and Garcia, D.M. 2020. Why are there so few ethnic minorities in ecology and evolutionary biology? Challenges to inclusion and the role of sense of belonging. *Social Psychology of Education*. 23(2): 449-477. <https://dx.doi.org/10.1007/s11218-019-09538-x>.
2. Riegle-Crumb, C., King, B., and Irizarry, Y. 2019. Does STEM stand out? Examining racial/ethnic gaps in persistence across postsecondary fields. *Educational Researcher*. 48(3): 133-144. <https://doi.org/10.3102/0013189X19831006>.

Course Goals

- Prepare students for future careers conducting research in the biodiversity sciences.
- Expose students to a variety of biodiversity research contexts to increase their experience and engagement with biodiversity sciences.
- Demystify the process of accessing research opportunities by teaching students how to find, access, and prepare application materials for research opportunities.
- Provide students with a research experience in biodiversity sciences to expand their professional experience and increase their research literacy in order to empower them to seek future research opportunities.
- Facilitate regular cohort-building opportunities to increase student sense of belonging in biodiversity research.

Course Learning Objectives

Following this course, students will be able to access, perform, communicate, and peer-review biodiversity research.

- Access future research opportunities through the preparation of professional materials that communicate your skills and interest in research opportunities.
- Perform biodiversity research through making and translating your observations of the natural world into research questions, hypotheses, and experimental design that are grounded in scientific literature.
- Communicate the research process to your peers in a clear, effective, and engaging manner.
- Practice peer-review by providing regular, constructive feedback through comments and questions on the work of your fellow students.

Course Learning Outcomes

- Gained valuable skills in field- and lab-based research methods through hands-on experiences.
- Developed a question, hypothesis, and methods for a research proposal and presented their research project proposal to their peers.
- Gained familiarity with accessing potential research opportunities and a strong sense of how to present themselves as a competitive applicant.
- Formed relationships with peers and faculty that will promote their success at ISU and in future research-based careers.

Course Materials

You will need to purchase a field notebook for this course. It is your choice which kind of notebook you use. The only requirement is that it have plenty of space for you to record observations for nine field entries, two semi-formal reflective writing assignments, and two peer review responses. For instance, a 6×9 inch notebook should plan on at least 4 pages for each field entry and reflective writing assignment and 2 pages for each peer review. If you have large handwriting, plan for more space. If you like to write and sketch a lot, also plan for more space. If you prefer a larger notebook, then you can get by with fewer sheets. If you would like a very durable option, Rite in the Rain provides excellent field notebooks, but a less expensive option protected from the elements (e.g. Ziplock bag) is also fine. Keep in mind that some ink runs when wet and that pencil doesn't always write well when wet when considering your preferred writing tool.

All other course materials will be provided to students. There is no course textbook. As this course is a hands-on experiential course, it is important that you come to each class period prepared for the day's activities and ready to engage with your peers over the materials. While some of the work in this course is individual, other components will involve peer review or group work, thus your preparation for class is also key to ensuring that your peers have an engaging learning experience. Please see the semester schedule for what each week's pre-class requirements are. Due dates are provided for every assignment. With that in mind, life happens. If situations arise that make it difficult for you to prepare adequately for the week, please contact the course instructor ahead of time so they can help you make different arrangements.

Course Format

This course is heavily experience-based, so it is essential to come to class each week. Please review the course schedule each week to ensure you are properly prepared for class and ready to engage with your fellow students. All course materials will be available through the course Pressbook and Canvas. Here you will find the syllabus, description of course assignments, any supplied course reading materials, and other relevant information.

Most assignments will be completed individually, but occasionally they may be completed in a group. Additionally, some assignments will undergo peer review. Peer reviewers will be assigned. For group assignments, all members of the group are expected to contribute equally to the assignments, as this is essential for their success. Challenges with group dynamics are a natural part of life. If issues do arise, know that your instructor is very eager to help you navigate them.

Occasionally material will be presented to students, but most of this course will require

pre-class preparation and hands-on work. Course instructor(s) are here to help facilitate course success and answer any questions you may have.

Topics, Experiences, and Assignments

Field Notebook

A scientist's first task is to observe. Many biodiversity scientists come to their profession through a love of experiencing the natural world first-hand. Their curiosity of and care for nature are often drivers of their work as scientists. These intangibles are what will help sustain us as we face the climate and biodiversity crises. So, we observe because we love, but we also observe because it is the first step of the scientific method. Our observations are what lead to questions, hypotheses, and experiments that expand our knowledge about the natural world around us.

This semester you will be recording many observations of multiple different field sites. Your field observations can take many forms: notes on what you see or hear, sketches of your surroundings, questions that come to mind. But do not restrict yourself in the kinds of ways you take in your observations. If, for example, you feel like writing a poem while observing a field site – write it. See where that poem leads; it could very well lead to an insightful biological question. Leverage your creativity and inspiration to drive creative scientific thinking. Eventually, your field notebooks should start including questions, hypotheses, and ideas for experiments, but the path you take to get to that point is up to you.

The second component of the field notebook are the reflective writing assignments. These assignments serve to promote meta-cognition of all you have been learning about during the semester. Thus when initiating these assignments, spend some time flipping through your previous observations. See if you find any common themes in what you have been looking at – it is possible, but not required for these assignments to help you start to think about potential research proposals. You are also welcome to use them as an opportunity to consider how what you learn in this class relates to other classes or areas of your life. Their purpose is to be reflective – they don't have any particular requirements, other than that you practice reflective thinking (a highly useful life skill, if anything). They should take several pages of your notebook. There is no particular length requirement, but a reflection of about 500 words should be sufficient to achieve the assignment's purpose – but if you feel like writing more, please don't hesitate to do so.

The final component of the field notebook is the peer review. A key component of practicing science is reviewing the work of your peers. Thus we will be engaging with peer review on several occasions throughout the semester. Two of those occasions will involve

the field notebook. For each of these, you will exchange notebooks with a classmate, read through their recorded observations and reflections, and provide a written response. This will give you a chance to see alternative approaches you might be interested in trying with your own field notebook as well as an opportunity for you to make suggestions to your peers to help them grow in their observation and reflection skills. You will provide a typed summary of your impressions as well as any question that arose while you were reviewing their field notebook for them to think about going forward. Thus, while your field notebook is mostly a personal thing, it will be seen by two classmates and me for a final review. Consequently, it is not a completely private document; however it is expected that you keep private anything you read by your peers unless they have given you their explicit permission otherwise.

Project Proposal

You will write up and present a short project proposal. The purpose of this assignment is to help you to begin independently performing biodiversity research. This project will not be a perfectly polished proposal but will be a first step towards future research activities. To prepare your proposal, you should begin by drawing from your field experiences and observations you have been recording in your field notebook. Simply let your curiosity guide you through the first few weeks of the course before you would even consider settling on a topic. As you are recording your observations in the field notebook start to notice if there are themes or questions that keep drawing your attention. This might be a trail worth following.

Once you start to settle onto a question, you can begin to think of possible hypotheses to test as well as explore some of the current literature. We will be covering how to read a scientific paper in week 6 so it will be around that time that you can start taking this next step in the research process. Reading the literature is important because it lets you know what work is already out there – it provides context and a foundation to your question. If you find that someone has already addressed your question, that is not necessarily a reason to abandon it – consider how you might tweak the question: are you using a different study system or a different geographic location, for example? It is also okay to deem whether results are replicable – this is a core value of science but is sometimes forgotten in scientists' excitement for new findings (we are only human, after all).

As you expand your understanding of the topic and settle on hypotheses to test, consider what experimental design would allow you to test it. You will have some ideas for how to go about collecting data from the field trips we will take, but you are not limited to those methodologies. This part may be challenging, so you will schedule one-on-one meetings

with me to discuss your ideas and we will strategize on how you can approach the topic. The meeting should occur by early November.

Written assignment

500-1000 words. The purpose of the writing assignment is to help clarify your thinking on the topic before you put together a presentation. Thus, it will be due one week before the presentation takes place. It should include an introduction to the topic along with any of your own relevant field observations, your research question along with reasoning for the question, research hypotheses, explanation of proposed experimental design including methodologies, types of data collected, and a general explanation of how you will interpret those data depending on the result. The assignment should include references to primary research articles to support the proposal. These can include background context, ideas for methodological implementation, or other supporting information as you see fit. The proposal should have with narrative flow and a logical argument. Think of a proposal as a prequel to a research paper – you have figured out your rational, research question, and approach – you just do not have the results yet. Consequently, the proposal should be written in a way that is stylistically similar to a research article.

Citation Styles

You should use the following citation style for your written proposal:

Author (Last, Initials). Year. Article title. *Journal Name*. Volume(issue): page numbers.

It will look something like this:

Valenzuela, N. 2008. Relic thermosensitive gene expression in a turtle with genotypic sex determination. *Evolution*. 62(1):234-240.

For more than two authors:

Whiteley, SL, et al. 2021. Two transcriptionally distinct pathways drive female development in a reptile with both genetic and temperature dependent sex determination. *PLOS Genetics*. 17(4):e1009465.

Presentation

10 minute presentation. The purpose of the presentation is to provide an opportunity for you to practice communicating science to your peers. The presentation should include the same content as the written portion, but the distinction here is that you will be engaging your audience in a different way. The best presentations tell a good story, so think about how you can translate your proposal into a story – typically you will want to start with

background information so the audience members have some understanding of the context. You can use your background information strategically to build up to the research gap you have identified and the corresponding question you are framing for your research. The question then leads naturally into the hypothesis or hypotheses you are interested in testing. The final part of your presentation will be your experimental plan – what do you intend to do to test the hypothesis? Try to envision all possible outcomes from the experiment and how that will support or refute your hypothesis and inform on the interpretation of your results. There will be opportunities for questions from your peers at the end. It is important to try to ask questions of your peers in order to practice giving this kind of feedback. This is a very common way in which scientists provide feedback to each other on their work. If you attend departmental seminars or conferences, you will witness this first hand.

Professional Materials. Students will develop materials that will aid them in applying for research opportunities. This will include a CV, a personal statement, and an email template to use when inquiring about research opportunities from potential mentors. We will work through several drafts of this assignment to ensure students have a final version that they can be confident in and build upon as they gain more experience. The professional materials will also go through peer review by classmates. As a result of this, please be respectful of each other's personal information and varied levels of types of experiences.

Formatting. All written assignments should be formatted in the following way: 1 inch margins, 12 point Calibri font, and double spaced. Your first and last name should be placed in the header of the document, not in the main body. All assignments should be submitted as .docx or .pdf file types. Files should be named thoughtfully and intentionally e.g., Lastname_PeerReview1.docx

Student Evaluation

This course is satisfactory/fail. To fulfill the requirements of this this course, students must actively participate in course activities and submit all assignment materials by their due dates, unless alternative arrangements are made with the course instructor ahead of time.

Evaluation in this course will come through multiple means including peer review on assignments, in-class discussions on individual and group work, a final presentation, and feedback from instructors.

All graded assessments will be returned with feedback within 7 days of the due date. Personalized feedback will be provided for each assignment and reflection.

Generally course deadlines are firm. If you anticipate difficulties completing coursework

by the deadline, please come talk to me in advance. If you are in need of an extended deadline, you will need to contact me at least two weeks before the due date to request a new, extended due date that will better accommodate your circumstances. Once we come to an agreement, I will send you an email confirming the changes. Exceptions will be made for emergency situations.

Module 1: In the Field

Learning Objectives

Perform biodiversity research through making and translating your observations of the natural world into research questions, hypotheses, and experimental design that are grounded in scientific literature.

Fieldwork Basics

Course-based fieldwork has been shown to be associated with increases in student



In these courses students gain hands-on experience in the skills necessary for practicing science. Source: Corinna Most, used with permission.

success and retention.¹ A successful field experience depends on proper preparation. One of the most important ways to prepare for the field is through dressing appropriately. As fieldwork occurs outdoors, all kinds of weather and environmental conditions can be experienced. It is important for our safety and our comfort that we dress to meet these conditions.

Generally long pants and sturdy shoes are essential. Long sleeves are often a good idea, but can somewhat depend on preference. If they are required, you will be informed ahead of time. It is important we consider the fit and type of fabrics we are wearing as we may be more comfortable in some than in others – comfort is more important than fashion as being comfortable will help us put our focus on the experience rather than our level of discomfort. Additional considerations are a hat, sunscreen, and bug spray. If it is raining but not storming we will most likely go outside so be sure to wear something rainproof. If you have any issues acquiring appropriate gear, please contact the instructor ahead of time and they will work to help find a solution. No one's field experience should be limited by access to appropriate gear. It is also essential to always bring water. A snack may be nice as well, but that is personal preference.

Classes of Field Trips

Note to instructors: This course implements several classes of field trips throughout the semester to expose students to a variety of biodiversity research settings and biodiversity researchers. Be sure to ask the researchers you partner with to give a short, personal bio at the beginning of each field trip, so that students can find points of connection with them. It is especially beneficial for them to share their path as a scientist, so that students can see there are many ways forward.

Data Field Trips

For data field trips, we will join a biodiversity scientist from our institution in the field to do some hands-on data collection and analysis. These field trips take part over at least two weeks. Week 1 involves data collection in the field while week 2 involves learning how to analyze the data we have collected.

1. Beltran, RS et al. 2020. Field courses narrow demographic achievement gaps in ecology and evolutionary biology. *Ecology and Evolution*. 10(12):1-13.

Example 1: Herbaria Specimens

Week 1: This field trip will cover rationale for collecting plant specimens, specimen collection ethics, how to collect and press plants and/or plant parts, gathering relevant information for specimen label generation, and drying plant samples. We will select and press plant specimens in the field.

Week 2: In this field trip we will learn how to mount the plant specimens collected the previous week. Additionally, we will receive an introduction to the Ada Hayden Herbarium and learn about the history, diversity, and importance of herbaria. We will also learn about how research is conducted in herbaria, what kinds of questions herbaria are ideal for helping us answer, and how specimens can be used in research.

Example Make-up Assignment

In order to make up for the missing field trip to the Herbarium, please watch videos 1–3 and 7 on the Ada Hayden Herbarium website to learn more about the Herbarium. After watching the videos, write about what you learned as an entry in your field notebook.

Additionally, please make your own herbarium specimen. Use the specimen sheets provided here as a guide for how the specimen should be constructed. However, since you will not have actual plants, please make a drawing of the species of your choice that clearly illustrates the plant's features. In addition to the drawing, please create a label for your specimen that includes at minimum: species name and common names, detailed location of where it was collected (hypothetical), name of collector (you), and date of collection.

Reading Paired Field Trips

For reading field trips, we will pair up with a biodiversity scientist from our institution that has a local field site about which they have ideally published papers. We will learn that field research is happening in our own backyard and leading to genuine scientific contributions. It also presents an excellent opportunity to practice reading scientific literature – with the added benefit of a real life connection to the scientist who published it. Consequently, assigned papers should be read before going on the field trip so questions can be asked of the scientist and discussions of the paper can take place at the field site. See the Appendix 5 for a guide to help direct reading of a scientific paper.

Example 1: Prairie Restoration

Visit the Iowa State Central Ag Farms to learn about the role of wetlands in remediating nutrient runoff and experiments testing the role of seed mixes on restoring ecosystem services.²

Example 2: Temperature and Hormones in Turtles

Visit the Iowa State Horticulture Farm to learn about experiments on the effects of temperature on circulating hormones in female painted turtles.³

Example 3: Ancient Maize DNA

Visit a maize diversity domestication demo plot and learn about ancient DNA research in maize and what it can teach us about maize domestication and historic human societal dynamics.⁴



Research field sites can take many forms. Once such site is Iowa State University's Horticulture Farm. It provides a resource for many kinds of research including on painted turtles. Source: Nick Topping, used with permission.

Overnight Field Trips

An overnight field trip will help to build connection and increase a sense of belonging in the biodiversity sciences. Additional faculty members will join the trip to provide opportunities to build professional connections in a more informal setting. Visiting a field station provides opportunities for numerous field site visits and a more intensive field experience. Invited faculty with field expertise can also demo hands-on field work (e.g., live mammal trapping) to give a taste of field research.

-
2. Meissen, JC et al. 2020. Seed mix design and first year management influence multifunctionality and cost-effectiveness in prairie reconstruction. *Restoration Ecology*. 28(4):807-816.
 3. Topping, NE and Valenzuela N. 2023. Thermal response of circulating estrogens in an emydid turtle, *Chrysemys picta*, and the challenges of climate change. *Diversity*. 15(3):428.
 4. Kistler, L et al. 2020. Archaeological Central American maize genomes suggest ancient gene flow from South America. *PNAS*. 117(52):33124-33129.

Example 1:

Visit a field station such as Lakeside Laboratory for a weekend to fit in numerous field experiences and networking opportunities (See Appendix 2 for the trip itinerary).



Field trips are an excellent opportunity for students to engage in hands-on experience in biodiversity research. Source: Tracy Heath, used with permission.

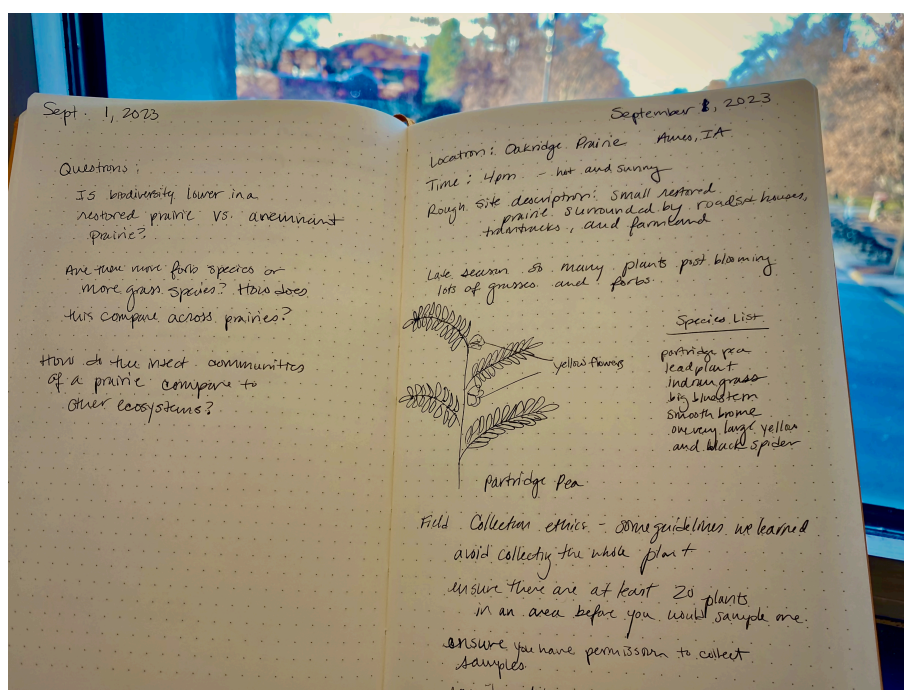
Field Notebook

During this course we will be generating a personal field notebook. Field notebooks are an essential tool scientists utilize to document their observations and their thinking.⁵Nicotra, AB, *et al.* 2022. An innovative approach to using an intensive field course to build scientific and professional skills. *Ecology and Evolution*. 12:e9446. DOI: 10.1002/ece3.9446.[\footnote] In this course the field notebook should be utilized for the following situations.

5. _____

- Observations made during each field trip.
- Questions and hypotheses generated from field trip observations.
- Reflective writing exercises (periodic and assigned)
- Notes you take in class.
- Notes you take based on readings and discussions of the scientific literature.

All content should be dated, and pages numbered. Field trip observations should include location information. Each entry type should be started on a fresh page and have a header describing the contents. This will help things stay somewhat organized throughout the semester. Set aside several pages at the beginning of the field notebook to build an index. This will help in quickly finding information in the future. Beyond this, feel free to be creative with the field notebook. Sketches, poems, or add additional content beyond what is outlined here are all encouraged. Field notebooks will be peer reviewed twice during the semester to provide constructive feedback on their content. This will help develop field recording skills and encourage the consideration of additional approaches to take with the field notebook. In addition, field notebooks will also be reviewed and assessed by the instructor near the end of the semester.



Field notebooks are one important way that scientists record biodiversity data. They can take many forms and incorporate various kinds of data and observations, but represent an important record of natural history observations. Source: Thea Gessler, used with permission.

Check out this resource from the American Museum of Natural History on keeping field journals:

"What is Biodiversity?"

Reflection

Reflection is an important component of this course module. This allows us to practice skills of reflection which will serve us well both personally and professionally. For the field module, this comes through the form of reflective writing exercises. Three reflective writing exercise are assigned throughout the semester. The first two are informal and are included in the field notebook. The third comes at the end of the semester and asks you to consider your whole experience of the course. The third reflection must be typed and submitted as a separate assignment.

Field Notebook Reflective Writing

Complete a reflective writing entry in your field notebook. These assignments serve to promote meta-cognition of all you have been learning about during the semester. Thus when initiating these assignments, spend some time flipping through your previous observations. See if you find any common themes in what you have been looking at – it is possible, but not required for these assignments to help you start to think about potential research proposals. You are also welcome to use them as an opportunity to consider how what you learn in this class relates to other classes or areas of your life. Their purpose is to be reflective – they do not have any particular requirements, other than that you practice reflective thinking (a highly useful life skill, if anything). They should take several pages of your notebook (depending on page dimension). There is no particular length requirement, but a reflection of about 500 words should be sufficient to achieve the assignment's purpose – but if you feel like writing more, please do not hesitate to do so. To be effective, these need to be completed by the due date, but they will be assessed for completion upon final submission of the field notebook.

Final Reflective Writing

The final reflective writing assignment is a bit more formal. Here you should consider the course as a whole. You may wish to write about what you have learned, what you have been surprised by, elements of the course you found impactful, etc. These are suggestions; what you include in the reflection is ultimately up to you. Your reflection should be typed

and submitted by the due date rather than entered into your field notebook, and should be approximately one typed page in length.

Formatting: 1 inch margins, 12 point Calibri font, and double spaced. Your first and last name should be placed in the header of the document, not in the main body. All assignments should be submitted as .docx or .pdf file types. Files should be named thoughtfully and intentionally e.g., Lastname_PeerReview1.docx

Module 2: Peer Review

Learning Objectives

Practice peer-review by providing regular, constructive feedback through comments and questions on the work of your fellow students.

Why do we peer review?

A key component of practicing science is reviewing the work of our peers. This helps to ensure the integrity of scientific work by having another scientist who has similar expertise evaluate the strength of research findings. Often, this means a scientist may need to go back and run additional experiments, make additional observations, or reevaluate how they articulated or interpreted their findings. While it can be extra work, it invariably makes the work of scientists better. The peer review process itself can be challenging, because it requires careful critical thinking about the work and writing of another person. By practicing peer review in this course, we learn how to become better at critically and constructively evaluating the work of another and communicating that feedback in a way that is useful to our peers.

Peer review of field notebook

For this peer review exercise you will review and provide feedback on the field notebook of a peer. For each of these, you will exchange notebooks with a classmate, read through their recorded observations and reflections, and provide a written response. This will give you a chance to see alternative approaches you might be interested in trying with your own field notebook as well as an opportunity for you to make suggestions to your peers to help them grow in their observation and reflection skills. Spend some time reviewing what they have recorded. Make note of things you like as well as areas you feel they could develop more deeply. You can also offer ideas for other approaches they could try in their field notebook based on your own experience with it so far. Feedback should be constructive. It is fine to offer criticisms, but try to offer them with the lens of growth and how it can help your peer improve in their observations. If there are things you feel they are doing well, be sure to communicate that too! You will provide a typed summary of your impressions as well as any

questions that arose while you were reviewing their field notebook for them to think about going forward. See Appendix 3 for rubric with peer review guidelines.

Formatting: 1 inch margins, 12 point Calibri font, and double spaced. Your first and last name should be placed in the header of the document, not in the main body. All assignments should be submitted as .docx or .pdf file types. Files should be named thoughtfully and intentionally e.g., Lastname_PeerReview1.docx

Peer review of peer professional materials

This peer review exercise will examine a peer's professional development materials which includes their email template, their CV, and their personal statement. Feedback should be provided on all three components, but focus the most on the personal statement, as this is the most challenging piece to develop. A good personal statement tells a story, gives a sense of who the writer is, and what experiences they have that make them a good fit for the position to which they are applying. Consider whether their statement communicates a story. Which parts of the story are most compelling? Where would do they need more detail, where do they need less detail? It should also describe why they are a good fit—do they draw from their CV appropriately? Are there pieces referenced on their CV you would like to see incorporated into the personal statement? See Appendix 3 for rubric with peer review guidelines.

Formatting: 1 inch margins, 12 point Calibri font, and double spaced. Your first and last name should be placed in the header of the document, not in the main body. All assignments should be submitted as .docx or .pdf file types. Files should be named thoughtfully and intentionally e.g., Lastname_PeerReview1.docx.

Module 3: Preparing Professional Materials

Learning Objectives

Access future research opportunities through the preparation of professional materials that communicate your skills and interest in research opportunities.

Materials Development

The professional materials module focuses on the development of a CV, an email template, and a personal statement. Here we will work through several rounds of revision based on peer and instructor feedback, as well as development in course workshops.

Personal Statement

A good personal statement is honest and a little bit vulnerable. This can make them challenging to write because we tend to become overly critical of our lives or consider profound or interesting experience to be relatively mundane. The personal statement should tell our story. It is an opportunity for us to provide a picture of who we are and why we would be a good fit for a particular position (be that graduate school, a research fellowship, or something else). Personal statements can take many forms and include lots of different kind of information and are typically 2–3 pages in length. It might cover our personal journey or could be an opportunity to go into greater depth on some elements of our CV. Personal life challenges or gaps in our record can be placed into greater context here and be used to showcase the learning and growth that has resulted from those circumstances. See Appendix 8 for some brainstorming questions to help start a personal statement.

There is some great general guidance here on writing personal statements:

- USC Online, “How to Write a Stand-Out Personal Statement for Your Graduate School Application”
- NSF Graduate Research Fellowship personal statement examples

Sometimes reading a great personal statement is the best way to start to visualize how to write one.

Curriculum Vita (CV)

This is a summary of qualifications. A CV is essentially a curated list. Unlike for resumes, snappy bullet points are not needed to describe positions, however further description to items can be added if needed. The top of the CV should contain your name and contact information, followed by your education information. Subsequent ordering of the next sections depends on personal interests and the position to which you are applying. It can include sections such as work experience, research experience, teaching experience, leadership, mentoring, outreach or service activities, technical skills, awards and scholarships, and professional associations. These are just some example categories. You will not necessarily have all of these and you might have other categories not listed here. If you have not yet acquired many college level experiences, consider adding elements from high school. As you build your CV over the years, you may eventually cycle these off, but in the meantime they represent relevant recent experience. Often times you can find CVs online. They may be attached to a lab or personal website of a researcher. If there is a researcher you admire, do a little online sleuthing and see if you can find a copy of their CV. This will give you additional ideas on how you might format your own.

Email Template

We will develop a draft of an email template to use to inquire about potential research positions. The email should provide a brief introduction, identify the position in which you are interested and why you are interested, and lightly touch on relevant experience you would bring to the position. Often students might attach their CV to this email upon sending it.

Workshops

Introductory Workshop

On the research retreat we will build connections with faculty through interactions in

various settings. Part of the weekend will include a panel to introduce the subject of personal statements and provide opportunities to ask questions about them: what they are, why they are important, what makes for a strong personal statement, etc. Following the panel we will pair up with a faculty member to continue the conversation during dinner.

Preparing Professional Materials Workshop I

This workshop will use a storytelling activity to help flesh out the personal statement. We will take turns telling the story of our personal statement and giving feedback on another's story. Do not read the statement, but instead recall what has been written and share that story with a partner. It is okay to add more detail, as this might help determine how to fine tune the statement or come up with ideas not previously thought of. Do not be afraid of pursuing these rabbit holes. Consider recording the session in order to refer back to the tale at a later date. The listening partner should wait until the end of the activity to give feedback but can take notes on the strengths of the story, where it could use development, or clarification (see suggested questions below for aspects to pay attention to). Then switch roles. Repeat a second time with new partners.

Example feedback questions to consider:

- What did you like the most about the story?
- What were its greatest strengths?
- Were there parts of the story that needed more clarity?
- Where did you want to hear more detail?
- Where did you want to hear less detail?
- Were there parts of the story that felt disconnected from the whole? Is there a way to connect them?
- What themes did you notice in the story?
- Did the story have a good pace or were there points where it bogged down? How might they address this?
- Was there a part of the story you felt a strong connection to? If so, what was it and why do you think you felt a connection there?

Finding Research Opportunities

This workshop will feature an invited speaker who will discuss with us how to find various kinds of undergraduate research opportunities. Many students apply for National Science Foundation Research Experiences for Undergraduates (NSF REU). Others find research opportunities from faculty on campus. These can take various forms, such as volunteer, credit-based, or paid experiences.

Preparing Professional Materials Workshop II

This workshop will consist of mock interviews and a Q&A session. Invite faculty in the biodiversity sciences to participate several weeks in advance. The first portion of the class will consist of mock interviews aimed towards an undergraduate research position in a university lab.



Learning to talk with other scientists about research interests and previous experience is a critical professional development skill that will be utilized over and over in a professional career. Source: Photo by Sora Shimazaki

We will visit the offices of two different faculty members as a part of this exercise. The purpose of the mock interview is to experience what the process of interviewing entails so we feel more prepared when undergoing an actual interview. During the interview practice talking about relevant experiences and research interests. Additionally listen to the faculty member describe their research and ask follow-up questions. After the first 20 minutes rotate to another faculty member and conduct a second interview. Following the interviews students and faculty will return to the classroom for an informal panel discussion. This is an opportunity to ask more general questions of the faculty members, such as advice on applying for research opportunities.

Module 4: Research Proposals

Learning Objectives

- Perform biodiversity research through making and translating your observations of the natural world into research questions, hypotheses, and experimental design that are grounded in scientific literature.
- Communicate the research process to your peers in a clear, effective, and engaging manner.

Written Proposal

Writing about research is a primary method scientists use to communicate their work. Thus, this course will involve developing a written research proposal. We will use several drafts to refine the research proposal. The first draft can utilize the template available in Appendix 6. Subsequent drafts should become more refined and start to take the format of a scientific paper. The proposal should include an introductory section providing background on the topic of interest, drawing from several primary research articles. This section also develops the argument for why the research question is worth studying. The research question and hypothesis should also be included in the introduction.

The second section should include the proposed methodology. Describe how the hypothesis will be tested. It should outline the experiments and what will be needed to perform them. Ideas can be supported by referring to previously published research. The third section will address anticipated results. Consider the expected findings and the implications of those findings for the original research question and hypothesis. Consider what it would mean if the results turned out a different way. Finally, be sure to include both in-text citations and a full reference list at the end. The proposal should have good narrative flow and be proofread for proper spelling and grammar. See the rubric in the Appendix 3 for evaluation guidelines.

Oral Presentation

Scientists also frequently share their research findings via presentations, such as at

meetings with other scientists. Developing an oral presentation of the research proposal provides an opportunity to practice communicating science to our peers. The presentation should be ~10 minutes and delivered via a slideshow. The presentation should include the same content as the written portion, but the distinction here the audience will be engaged in a different way. The best presentations tell a good story, so think about how to translate the proposal into a story – typically start with background information so the audience members have some understanding of the context. Then use the background information strategically to build up to the identified research gap and the corresponding research question. The question then leads naturally into the hypothesis or hypotheses to be tested. The final part of the presentation will be the experimental plan – how will the hypothesis be tested? Try to envision all possible outcomes from the experiment and how that will support or refute the hypothesis and inform on the interpretation of the results.

There will be opportunities for questions from peers at the end. It is important to try to ask questions at the end of presentations in order to practice giving this kind of feedback. This is a very common way in which scientists provide feedback to each other on their work. Attending departmental seminars or conferences will enable witnessing this first hand. See the rubric in the Appendix 3 for evaluation guidelines.

Workshops

Proposal Workshop I

Proposing research ideas is a key element of working in the biodiversity science field. Thus this first workshop will be focused on sharing and expanding upon initial ideas for a research proposal. It will take a lab meeting format with a round table discussion where each student has the opportunity to share their research proposal ideas. Peers will then ask follow-up questions to help support idea development. Incidentally, this also serves as an opportunity to practice communicating science to peers. It takes practice to clearly articulate ideas. Following the workshop, begin exploring some literature related to the topic of interest and start putting ideas down on paper – they will not be polished yet, but it will help to develop the initial draft of the research proposal. See the Appendix 6 for a proposal first draft template.

Proposal Workshop II

This workshop will continue to develop the research question, hypothesis, and experimental design. We will discuss developing ideas in pairs with both the course instructor and classmates. We will work to develop ideas into excellent proposal material by digging into the following questions.

Research Question

- What is your research question?
- Is your question clearly stated and focused? If not, how might you tailor it?
- Why are you interested in this question? What makes you curious about it? What have you learned from previous studies that lead you to want to ask this question?

Hypotheses/predictions

- What are your hypotheses/predictions?
- Are they stated clearly? If not, what needs to be adjusted?
- Are they aligned with the question you are asking?
- Why are you interested in this hypothesis?

Experimental Plan

- What is your experimental plan?
- Does the design fit with your hypothesis?
- Are there things that still need to be considered? If so, what are they?

Proposal Workshop III

This workshop is an opportunity to polish. Use this time to solicit final feedback from peers, test out design ideas for the final presentation, or practice delivering the presentation in front of an audience.

Appendix 1: Example Schedule

Date	Details – unless otherwise stated assignments are due the following week
Week 1	<p>Course logistics and first field trip</p> <p>Location: Classroom + Field Site</p> <p>Assignments: pre-course survey + field notebook entry #1</p>
Week 2	<p>Field Trip: Plant specimen collection</p> <p>Location: Classroom + Field Site</p> <p>Assignments: field notebook entry #2</p>
Week 3	<p>Field Trip: Prepare herbarium specimens</p> <p>Location: Classroom + Ada Hayden Herbarium</p> <p>Assignments: field notebook entry #3 + reflective writing #1</p>
Week 4	<p>Field Trip: Data Collection</p> <p>Location: Classroom + Field Site</p> <p>Assignments: field notebook entry #4 + peer review #1</p>
Week 5	<p>Field Trip: Data Analysis</p> <p>Location: Classroom</p> <p>Assignments: field notebook entry #5</p>
Week 6	<p>Weekend Field Trip</p> <p>Location: Lakeside Laboratory</p> <p>Assignments: field notebook entry #6 + reflective writing #2 + paper reading #1 + first draft of professional materials (due week 10)</p>
Week 7	<p>Field Trip: Local Site and Paper</p>

Date	Details – unless otherwise stated assignments are due the following week
	Location: Classroom + Field Site Assignments: field notebook entry #7 + peer review #2 + paper reading #2
Week 8	Field Trip: Virtual Discussion and Paper Location: Classroom Assignments: field notebook entry #8 + paper reading #3
Week 9	Field Trip: Local Site and Paper Location: Classroom + ISU Horticulture Farm Assignments: field notebook entry #9 + turn in field notebook + REMINDER: first draft of professional materials
Week 10	Workshop on Proposals I Location: Classroom Assignments: peer review #3 + proposal #1 (due week 12)
Week 11	Finding research opportunities – invited speaker Location: Classroom Assignments: revision #1
Week 12	Workshop on Proposals II Location: Classroom Assignments: peer review #4 + proposal #2 (due week 14)
Week 13	Preparing Professional Materials Workshop I Location: Classroom Assignments: revision #2 (due week 15)
	<i>Thanksgiving Break – Class does not meet</i>
Week 14	Workshop on Proposals III Location: Classroom Assignments: proposal #3

Date	Details – unless otherwise stated assignments are due the following week
Week 15	Professional Materials Workshop II Location: Classroom Assignments: reflective writing #3 + post-course survey + final presentation
Week 16	<i>Finals Week</i> – Present Research Proposals Location: Classroom End of Semester Celebration

Appendix 2: Lakeside Laboratory Itinerary

Accommodations: Lakeside Motel

Friday

- 3:20 Meet in classroom
- 3:30 Depart Ames
- 6:30 Arrive at Lakeside Laboratory
- 6:45 – 7:45 Dinner
- 7:45 – 10:00 Firepit and s'mores (bad weather location: loft above dining hall)

Saturday

- 7:00 – 8:00 Breakfast
- 8:00 – 10:00 Kettle Hole Prairie
- 10:00 – 12:00 Time on own (view collections, go kayaking, hike in nearby areas, work on field notebook)
- 12:00 – 1:00 Lunch
- 1:00 – 3:00 Pontoon GLEON Buoy
- 3:00 – 4:30 Professional Materials Workshop (Mahan Hall)
- 4:30 – 5:00 Break
- 5:00 – 6:00 Read a Scientific Paper (Mahan Hall)
- 6:00 – 7:00 Dinner
- 7:00 – 10:00 Firepit and smores (bad weather location: loft above dining hall)

Sunday

- 7:00 – 8:00 Breakfast
- 8:00 – 10:00 Silver Lake Fen
- 10:00 – 12:00 Time on own (view collections, go kayaking, hike in nearby areas, work on field notebook)
- 12:00 – 1:00 Lunch
- 1:00 – 2:00 Pack up

- 2:00 Depart Lakeside
- *Possible pitstop at Liska-Staneck Prairie*
- 6:00 Arrive in Ames

Appendix 3: Rubrics

Peer Review

- **Course Learning Objective:** Practice peer-review by providing regular, constructive feedback through comments and questions on the work of your fellow students.

Peer review is challenging, but an excellent opportunity to learn how to critically and constructively evaluate the work of others. In the processes of this, you will also learn to think more deeply about your own work and its strengths and weaknesses. Additionally, it models transparency which is an important value to practice in an effort to build a healthy and robust scientific community.

Reading for peer review is distinct from reading for spelling and grammar errors. If you notice these, you can certainly point them out, but they should not be your focus. We will conduct two types of peer review in this course: on field notebooks and on professional materials.

Field Notebook

For the peer review on field notebooks focus on the following:

- **Robustness of observations.** At the end of the day when looking back at a record of observations, we never regret the extra detail. Quantity and quality both matter here. Are your peers making only a few, simple observations or are they making multiple kinds of observations and in great detail?
- **Approach to observations.** There is no right or wrong approach, but consider the various possibilities and their effectiveness. These could include written descriptions, sketches, creative responses to observations such as poems, etc. Ask, what kind of approach(es) are your peers taking and are these approaches effective at representing field observations?
- **Evidence of scientific thinking.** The field notebook is by no means a formal research document, but it is a tool to help us think like scientists. Has your peer begun to frame questions and consider hypotheses to those questions? What about ideas for

experiments?

- **Depth of reflective thinking.** A component of the field notebook is the reflective writing exercise. These are an opportunity for meta-cognition (thinking about thinking). Is your peer making connections across field observations? Is there evidence of their ideas developing from simple, amorphous themes to more clearly developed concepts?

Assess each of these four areas and type up a response to your peer that discusses with concrete examples areas where they are accomplishing the above well as well as areas that could use greater development. If applicable, make suggestions for how they might consider improving.

Professional Materials

The professional materials include an inquiry email, CV, and personal statement. For the peer review on professional materials focus on the following:

- **Clarity and completeness.** Is all relevant information included? Is the information presented clear?
- **Cohesiveness and connection between elements.** Is the information presented in a consistent way across each component? Do they tell a cohesive story about the applicant?
- **Compelling story.** Does the applicant clearly communicate their motivations and goals? Do they convey why they are interested in a particular path and how they have come to that path?
- **Professionalism and design.** Are components formatted in a pleasing way? Are they designed in a way that aids in the communication of their information? Is material provided professional in appearance and content?

For each peer review activity assess the relevant areas and type up a response to your peer that discusses with concrete examples areas where they are accomplishing the above well as well as areas that could use greater development. If applicable, make suggestions for how they might consider improving.

Written Proposal

- **Course Learning Objectives:** Perform biodiversity research through making and translating your observations of the natural world into research questions, hypotheses, and experimental design that are grounded in scientific literature. Communicate the research process to your peers in a clear, effective, and engaging

manner.

Writing is one of the primary ways scientists communicate their work. Thus being able to clearly communicate through your writing is an essential ability to develop as you continue your path in science.

The written proposal should be approximately 500-1000 words. One of the purposes of the writing assignment is to help you clarify your thinking on the topic before putting together a presentation. Thus, it will be due one week before the presentation takes place. It should include an introduction to the topic along with any of your own relevant field observations, your research question along with reasoning for the question, research hypotheses, explanation of proposed experimental design including methodologies, types of data collected, and a general explanation of how you will interpret those data depending on the result. The assignment should include references to primary research articles to support the proposal. These can include background context, ideas for methodological implementation, or other supporting information as you see fit. The proposal should have good narrative flow and a logical argument. Think of a proposal as a prequel to a research paper – you have figured out your rationale, research question, and approach – you just do not have the results yet. Consequently, the proposal should be written in a way that is stylistically similar to a research article.

- **Background.** This section should give your reader a basic grasp of what it is you are studying. If your proposal deals with a particular animal or plant or groups of animals or plants, you will want to provide relevant information about the organismal biology and how it relates to your research question. You will likely also want to address similar research on your topic of interest to help show how your proposal fits into the broader field as well as any novelty it might add. These are some examples, as there may be other information you deem relevant to include – part of the process is learning how to make that assessment.
- **Research question.** This is the question you are interested in answering. It should be clearly stated and also clearly rationalized. You want to convince the reader of why it is an interesting and important question worth addressing. Your background information should also help to justify this research question and ground it in larger body of scientific research.
- **Hypothesis.** What hypothesis are you testing in an effort to answer your research question? What predictions does that hypothesis lead you to make? These should be clearly stated in your proposal. They should also be supported to show why they logically follow the question you are asking.
- **Experimental design.** How will you test your hypothesis? What do you propose to do

and how do you propose to go about doing it? This section should be sufficiently detailed so that the experiment could be carried out; however, it should be written in a narrative way and not a list or a step-by-step format.

- **Anticipated results and interpretation.** What do you expect to find and what are the potential implications of those findings? Consider both results that would support or refute your hypothesis.
- Writing has good narrative flow; ideas are organized; grammar, punctuation, and spelling are correct.
- References cited properly in the format shown below. Include both in-text citations and full citations at the end of the proposal.

In-text citation:

- One author: (Last Name, Year)
- Two authors: (Last Name and Last Name, Year)
- Three or more authors: (Last Name *et al.*, Year)

Full citation:

Author Last Name, Author Initials. Year. Title. *Journal Name*. Volume #(Issue #): page numbers.

Be sure to include all author names.

Proposal Presentation

- **Course Learning Objectives:** Perform biodiversity research through making and translating your observations of the natural world into research questions, hypotheses, and experimental design that are grounded in scientific literature. Communicate the research process to your peers in a clear, effective, and engaging manner.

Presentations offer an alternative and equally important way to communicate scientific information. They often contain a lot of similar information to their written counterparts, however as they are presented in a different format it can be helpful to keep in mind that you are telling a story of research to your audience. Making your story compelling will help keep your audience engaged with your presentation. Thus it can be helpful to think about common elements of a narrative arc: exposition (background), rising action (question, hypothesis, and methods), climax (results), and falling action (further directions, acknowledgements, etc.).

- Background is concise and provides enough relevant detail to orient the audience.
- Research question is clearly stated and justified.
- Hypothesis follows research question and has clear, testable predictions.
- Experimental Design – student explains the methodology in a clear and understandable fashion, indicating conceptual grasp, and the methods are appropriate for addressing the question and hypothesis.
- Anticipated results, interpretation, and potential impact are described and related back to the original question and hypothesis.
- Delivery is engaging. Student presents a cohesive research story to the audience.
- Design of slideshow is not distracting and aids audience in processing information. Text is kept to the essentials to emphasize key points. Figures and photos are used and are thoughtfully explained and related to the content of the presentation.
- References cited properly and acknowledgements provided at the end if applicable.
- Q&A handled professionally.

Professional Materials

- **Course Learning Objective:** Access future research opportunities through the preparation of professional materials that communicate your skills and interest in research opportunities.

Email – This will be an email template you can use in the future to inquire about potential research opportunities.

- Introduce yourself – who are you and what is your career stage (e.g., year in college).
- Explain why you are emailing. Is there a particular position you are applying for or are you inquiring about possible openings? Maybe you would just like to talk with them some more about their research.
- Demonstrate your interest. Why are you interested in this particular position? Consider reviewing the lab website to have a basic understanding of what they investigate. You could also take a look at some papers published from the lab. This demonstrates your curiosity and initiative. Consider explaining why you find their research to be particularly interesting (e.g., I would like to better understand how social relationships are translated into gene expression patterns in fish with social sex determination).
- Provide a brief description of your relevant qualifications for the position you are inquiring about. Do you have previous research experience from an internship or lab course? Do you have relevant course work? How about experiencing working with or leading others? These are just some examples. Reflect on your experiences and how

they help make you a strong candidate.

- Sign off politely.

CV – The curriculum vita or CV is a curated list of your accomplishments.

- Name and contact information provided
- Educational information provided (e.g., College/University Name, start/end years, major, minor, honors, GPA)
- Other experience organized by type. Examples include work experience, leadership experience, scholarships won, relevant coursework, mentoring experience, service activities, other involvement demonstrating your well roundedness. You can include relevant dates for when these took place or were achieved. If something is not intuitive to understand, you may provide a short description.

Personal Statement – The story of who you are.

- Catchy opening sentence.
- Good narrative flow with proper grammar and spelling.
- Tell a compelling story that keeps the reader engaged. For example:
- Funny anecdotes that show your personal development.
- Pivotal moments in your life that helped you to learn about yourself, your values, or your interests.
- Examples of professional experience that taught you what you were capable of or revealed new interests.
- Choose a theme and weave that theme throughout the different elements of your statement.
- Sense of who you are as a person. Be honest, a little vulnerable, and open to feedback.

Appendix 4: Survey

Pre- and Post-Course Survey Questions to Assess Effectiveness

Please rate the following questions honestly on a scale of 1 to 10. **1 = not at all comfortable/familiar with the concept. 10 = extremely familiar and comfortable with the concept.** Responses will be used to evaluate the effectiveness of this course – thus the best answer is the most accurate one. All responses are anonymous.

I know what biodiversity research involves.

1 2 3 4 5 6 7 8 9 10

I know how to find and apply for research experiences.

1 2 3 4 5 6 7 8 9 10

I feel I could belong in the community of biodiversity researchers at ISU.

1 2 3 4 5 6 7 8 9 10

I know how to apply the scientific method to biodiversity research.

1 2 3 4 5 6 7 8 9 10

I am comfortable communicating my scholarship to my peers.

1 2 3 4 5 6 7 8 9 10

I know how to provide thoughtful, constructive feedback to my peers.

1 2 3 4 5 6 7 8 9 10

I am comfortable exploring scientific literature to support biodiversity research

1 2 3 4 5 6 7 8 9 10

I am comfortable building observations of the natural world into research questions.

1 2 3 4 5 6 7 8 9 10

Appendix 5: Reading a Scientific Paper

Reading papers takes practice and a development of scientific literacy, so don't be discouraged if this feels really challenging – it should feel that way. Here are some questions to consider as you read:

- What was the rationale and how did the author(s) come to it?
- What did the author(s) do in this paper? Try to provide a succinct summary of the approach.
- How do the techniques work?
- What were the results? Nitty-gritty patterns in the data and whether they support the hypothesis.
- Why do the results matter? What is their broader application?
- How might you adapt their research?
- What was most interesting and why? What did you learn?
- What was the main idea – or the big picture finding?
- What unanswered questions do you have about the paper? These can be about the paper, or these can be new questions inspired by the paper.

Take notes as you read the paper and try to form answers to most of these questions. You can also write down other thoughts or questions that arise as you are reading the paper. If there are terms you are unfamiliar with, try to find a definition of them if you can. Bring these notes with you to the group discussion.

Example Reading Guide

Here is an example reading guide for a paper by Meissen *et al.*, 2020¹. Many of the questions can be easily repurposed for alternative paper readings.

1. Meissen, JC *et al.* 2020. Seed mix design and first year management influence multifunctionality and cost-effectiveness in prairie reconstruction. *Restoration Ecology*. 28(4):807-816. <https://doi.org/10.1111/rec.13013>

Introduction

- What is the research problem they identified?
- Where do they propose implementing a solution to this research problem? Why do they propose implementing it in this particular location?
- What is the research gap they are addressing?
- What are their ideas for addressing this research gap?
- What do they test specifically?

Methods

- Provide a short description of their research methodology.
- How did they assess ecosystem services and was their assessment justified? Why or why not?

Results

- What were their main findings?
- Look at each figure and summarize the information communicated by that figure. Do this for figures 1-4.

Discussion

- What was the primary finding they identified in the discussion section? What were some of the results they highlighted that supported this finding?
- What are some future research directions they identify?
- What is the broader scope of their research? Consider what the implications of their research are for informing future conservation investments.
- What questions or critiques do you have for this paper?

Appendix 6: Starting Research Proposals

Proposal First Draft Template

Eventually your proposal will be written formally with background on your topic, clearly stated questions and hypotheses, and a detailed description of your proposed experimental procedure. Initially, the goal is to get ideas onto paper. Use this template to start gathering your ideas for your research proposal.

- What are some general biodiversity-related topics you would be interested in learning more about? List them here.
- What are some questions that come to mind when you think about these topics? Draft them here.
- Now that you have identified some topics you might be interested in, find some sources that provide background information that will help you learn more. Write the citations for these sources here using the format below. Include at least three sources.

Last name, Initials. Year. Title. Journal Name. Volume(issue number): page numbers.

- Identify some content from these papers that may seem useful. Put direct quotes here that seem useful:
- Paraphrase the information in those quotes here (put it in your own words). Being able to properly paraphrase shows that you understand the information you are reading and not just regurgitating it.
- What are some of the methodologies used in these papers? Describe them to the best of your ability. If you have further questions about how they work, put those questions here for future follow up.
- Would you like to do something different or use a similar method? Why or why not?
- What are some hypotheses you would like to test? What are your predictions for those hypotheses? How would you test those hypotheses?
- Put any other thoughts or notes that don't fit into the categories above here:

Appendix 7: Table of Assignments

Assignment	Description
Pre-course Survey	Survey to assess baseline of student understanding
Reflective Writing #1	First reflective writing assignment considering field trips and observations
Peer Review #1	Peer review of field notebook
Paper Reading #1	Paper reading paired with field trip
Reflective Writing #2	Second reflective writing assignment considering field trips and observations
Paper Reading #2	Paper reading paired with field trip
Peer Review #2	Peer review of field notebook
Paper Reading #3	Paper reading paired with field trip
Field Notebook	Entire field notebook consisting of an entry for each field trip
Professional Materials #1	First draft of personal statement, CV, and email template
Peer Review #3	Peer review of professional materials
Proposal #1	First draft of research proposal – use template
Professional Materials #2	Second draft of personal statement, CV, and email template
Peer Review #4	Peer review of professional materials

Assignment	Description
Proposal #2	Second draft of research proposal
Professional Materials #3	Final draft of personal statement, CV, and email template
Proposal #3	Final version of research proposal with proper formatting
Reflective Writing #3	Final reflective writing assignment considering course as a whole
Final Presentation	Final presentation of research proposal, based on written proposal
Post-course Survey	Survey to assess change in student understanding

Appendix 8: Personal Statement Brainstorming Questions

What areas of research do you find interesting and why? How did you come to be interested in this research area?

Do you have career goals, yet? If so, what are they? What about this career path is interesting to you? What kind of experiences do you think would be beneficial to help prepare you for this goal?

If you don't have career goals, what kind of experiences would you like to seek out to help find what you might be interested in?

What have been your favorite classes (both high school and college classes are okay to discuss) and what did you like about them? What topics did you find yourself thinking about outside of class? What experiences have you had in them that felt particularly formative?

What have been your favorite extracurricular activities (these could include: volunteering, work experience, outreach activities, service activities, other activities of interest)? What did you like the most about them? Where there any challenges you have faced in this experience? What responsibilities did you have as a part of it? What skills have you learned from these experiences that you have found to be valuable?

What accomplishment are you most proud of and why? What did that experience teach you about yourself? Was there anything you learned from that experience that you can take with you into other areas of your life?

Do you have any personal challenges that you have overcome along your path? If so, how did you overcome them? What did you learn from the experience?