# TEACHING AND LEARNING PORTFOLIO

by


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**Overview**

This portfolio contains a collection of my teaching philosophies and teaching experiences which allow me to reflect on my skills as an educator and remain vigilant of the needs of my students.

The remainder of this portfolio is divided into two major parts. Part II consists of my teaching statement which reflects my beliefs about education, how I design and implement lessons in the classroom, and my philosophies regarding teaching, mentoring, and public outreach. Part III of this portfolio contains selected examples of my teaching that elaborate on the principles, techniques, and philosophies mentioned in my teaching statement. This part is divided into two further sections. The first section consists of teaching "artifacts" which are teaching and learning experiences upon which I have reflected. The second section focuses on a teaching-as-research internship that I completed as part of the Delta Program.

The Delta Program was designed to help future faculty members with an interest in teaching develop their instructional skills. The program emphasizes the need to establish learning communities, recognize the influence of diversity on learning, and promotes teaching-as-research as a means to help instructors improve their teaching, remain adaptable and modify educational methods as needed, and assess the progress and needs of their students by applying research methods to teaching.

My internship through Delta consisted of a semester-long project that stressed the need for teachers to continually assess how teaching practices influence student learning. A brief summary of my internship and thoughts on how the experience changed my views about teaching can be found in the "Internship Reflection." The "Internship Report" contains the findings of my teaching-as-research project in the format of a scientific paper.

The Internet Era has dramatically changed the way in which society obtains knowledge and, in doing so, has also changed the role of instructors in higher education. I view the current responsibility of the instructor as not simply transferring information to students, but as impressing upon them unifying concepts and critical thinking skills that demonstrate how to seek out, interpret, apply, and evaluate that information in the context of their discipline and daily lives. In order to achieve this, I adopt a teaching philosophy that uses the concept of backward design to define core goals for student learning, implement teaching strategies that promote active learning, and design assessments that test students on their ability to use higher level thinking as it pertains to the material.

**Defining Goals**

My teaching approach for a given course or class period always begins by defining main goals. I first designate a "ten-year message" – the one thing I want the audience to remember long into the future. The ten-year message is a broad concept, a way of thinking, or a call to action that frames the material and motivates the students to take interest. For example, in a recent lecture on pathogen-induced extinction events, the ten-year message was that anthropogenic activities are the major drivers of disease emergence. This concept was combined with a call for action to help resolve the important issue of emerging diseases. After designating a core message, I develop sub-goals. In the above example, additional learning goals included having the students understand: the characteristics of disease ecology that lead to host extinction; why mitigating the impacts of disease in wildlife is difficult; and how diseases can have ecological impacts not directly related to the host. Finally, I use scientific findings and examples to support and clarify the learning goals, put concepts into context, and serve as an important foundation upon which to build future knowledge. The information I choose to include depends largely on the audience, and I am always conscious of how to reach students by avoiding oversimplification while also ensuring that the material is not overly complex.

**Active Learning in the Classroom**

To help increase student learning and retention of the material and to promote critical thinking, I incorporate active learning into the classroom whenever possible. Active learning requires students to learn through multiple modalities (e.g. seeing, hearing, saying, and physically experiencing the material) and thus reaches students with diverse learning styles. As part of a teaching internship, I recently integrated active learning into an undergraduate wildlife ecology course that previously used only traditional lectures to teach large quantities of natural history information. For this particular exercise, students were required to read a scientific paper in which researchers examined the natural history traits of an animal to determine why the species was declining. Students were also expected to answer a series of higher level thinking questions about the paper (e.g., design a management plan for the species and explain how they would determine the success of that management plan). Students then discussed their responses, shared their thoughts, and critiqued each others' ideas in small groups. I organized the groups such that students with diverse backgrounds and different levels of experience were required to work with one another and thus be forced to think about the material in new ways. The small group discussions were followed by a larger class discussion. By assessing student performance and attitudes, I was able to determine that only two classroom sessions devoted to an active learning exercise resulted in students better understanding the importance of the material and feeling more confident in their ability to read a scientific paper, design a management plan for a rare species, and conduct a research project to test the efficacy of that management plan.

**Assessment of Student Learning**

As part of the process of backward design, I always think carefully about assessments prior to designing lectures and classroom activities and construct assessments to ensure that they

test students on the pre-determined goals for the course. For example, for in-class exams, I use questions that test students' abilities to understand, apply, and analyze what they have been taught. When feasible, I also favor take-home exams and homework assignments because they allow me to gauge the students' abilities to use higher levels of thinking that cannot be tested with in-class exams. In addition, take-home exams allow for student-student and student-instructor dialogues which improve communication and force students (and me) to think in different ways about the material. As part of my previously-described teaching internship, I designed a take-home exam modeled after the in-class discussions. Although students admitted that they found the take-home exam very challenging, they also stated that they felt as though it was a much more accurate assessment of their knowledge and skills than in-class exams. For the majority of students, the take home exam increased their cumulative score for the course and many stated that they appreciated being assessed in a variety of exam formats.

**Improvement of Teaching**

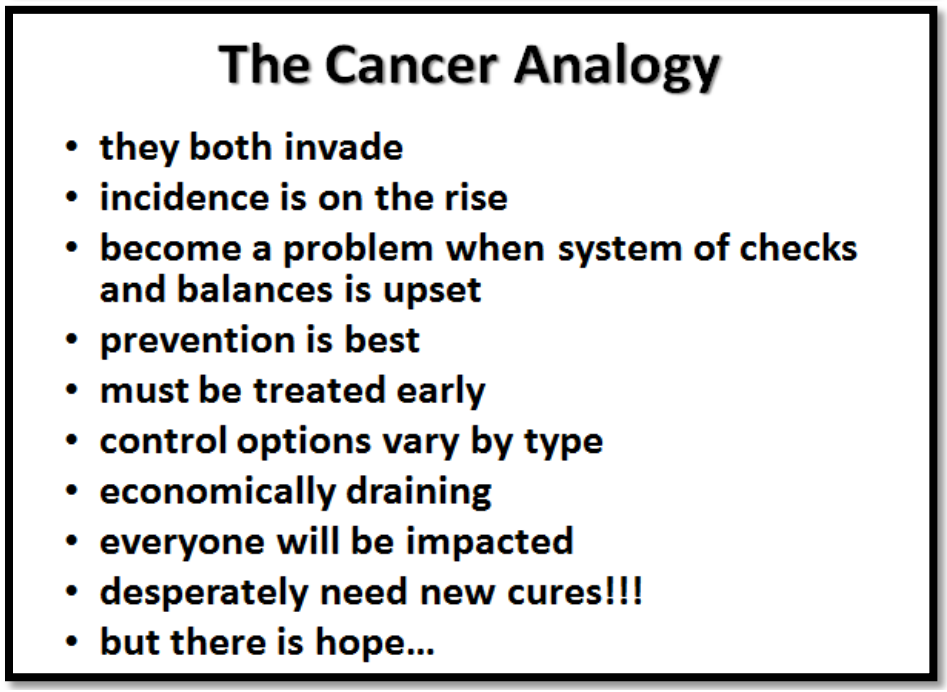
When it comes to instruction, I am a proponent of "teaching-as-research." The idea behind this concept is that instructors assess their own teaching proficiency, the success of different teaching methods, and student learning by using the scientific method to collect and analyze data. This helps the instructor get an unbiased view of what is and is not working in the classroom. For example, the success of the above-mentioned take-home exam was determined by conducting a statistical analysis on student achievement (with and without the exam included in the final grade) and the change in student confidence related to critical thinking skills necessary to address the problems posed by the exam (assessed by comparing surveys distributed before and after the exam). Teaching-as-research has been very important in my growth as an instructor and continues to help me improve my teaching skills (both from the standpoints of effectiveness and time management), remain adaptable and modify methods as needed, and assess the progress and needs of my students. In addition to being able to assess my own instructional effectiveness through teaching-as-research, I also strongly believe that all teachers require a learning community in order to flourish. Learning communities are assemblages of instructors and faculty members that provide a supportive environment in which educators can talk about their teaching experiences, share their successes and failures, and further develop their skills with other faculty members.

Teaching is a multifaceted process that involves the design, implementation, and assessment of curriculum and instructional techniques to reach a variety of students with different learning styles. To date, I have had great success integrating my teaching methods, goals, and philosophy into both large and small classes and public outreach events in multiple disciplines with diverse audiences while still remaining a highly motivated and productive researcher.

## Artifact 1

**Reaching a Diverse Audience through a Relatable Analogy**

Below are selected powerpoint slides from a lecture I presented on invasive species in an environmental studies course. The course consisted of underclassmen that had little background in biology; many of them had never even heard of an invasive species prior to the lecture. In order to reach the diverse audience and impress upon the importance of invasive species, I used an analogy that compared invasive species with something that is relatable to everyone - cancer.

## Artifact 1

When I was asked to give a lecture on invasive species to a large freshmen environmental studies course, I went about planning the lecture in my typical manner of using backward design. Thus, the first thing I needed to do was define my "ten-year message." My first thought as someone that typically interacts with wildlife ecology majors was to make the message: "invasive species are becoming the greatest threat to biodiversity." However, when I talked with the teaching assistant for the environmental studies course, she raised her eyebrows and said "most of these students do not even know what an invasive species *is*." I suddenly felt unsure of what to do. Clearly my "expert blindspot" was a hindrance and I was having a difficult time relating something I knew a lot about to an audience of novices. Not only were the students unfamiliar with the concept of an invasive species, but because of the size of the class, the audience was extremely diverse; many students might never take a science course again. The lecture seemed doomed to be one of the least effective of my career.

I realized that the only way to impress upon the audience the important impacts of invasive species was to create an analogy that every student could relate to no matter what their background, learning style, or interest in the topic. And then it hit me - invasive species parallel cancer in many ways (I subsequently learned that I was not the first to draw this analogy)! Cancer generates a powerful reaction in everyone because it is something that has negatively impacted all of our lives. There was no better way to reach a diverse audience than to make this connection. I designed the lecture around the ten-year message that "invasive impact all of our lives." During the class, I taught students what invasive species are, what kind of impacts they can have, and which traits of invasive species allow them to wreak havoc on the environment. Near the end, I drew the comparison between invasive species and cancer. Based on student feedback, that lecture has been one of the most successful of my teaching career. However, if I could do the lecture again I would start by comparing invasive species to cancer at the beginning of the talk as a means by which to draw in the students early on. Then at the end, I would bring up the analogy again and ask the students to tell me how invasive species and cancer are alike.

This experience taught me how instructors must think carefully about their audience in order to be effective. As experts in specialized fields, it can be difficult to communicate with diverse audiences that have very different backgrounds than our own. When faced with these situations, we need to carefully consider how to create a message that is relatable to everyone. Thinking of analogies that can be universally understood is a great way to accomplish this.

# Artifact 2

**Implementing Active Learning Techniques in Large Classes**

Teaching-as-research (TAR) is an important way in which instructors can assess their own performance and the effectiveness of new instructional techniques. However, TAR can be difficult to employ in situations such as a guest lecture where a teacher may not be able to track students over the course of the semester and therefore does not have the opportunity to receive formal feedback. I learned of a way to get around this when I gave a guest lecture for an introductory Environmental Studies class. Each class period consisted of a 40 minute lecture followed by a 40 minute active learning exercise. The particular lecture I taught was about invasive species and the active learning exercise (that had already been designed by the instructor from a previous year's activity) challenged students to create an invasive species, trade that invasive species with another student's invasive species, and then develop a control strategy for that other student's invasive species. The instructor collected responses from the students and it allowed her to determine whether the students had learned many of the important concepts covered in the lecture.

In this particular active learning exercise, students were also given a bonus question that they could answer at the end of class. The bonus question asked students to formulate a control strategy for a real-life invasive species that I talked about during lecture. The response shown below was from a student that was so interested in the material that he went above and beyond what was expected for the bonus question and wrote an elaborate and well thought-out plan the night after the lecture. The student's plan addressed an example of invasive rabbits in Australia and how they have caused the extinction of several species of Australian wildlife. I had ended my lecture with a call-for-action that let students know that the future of invasive species was in their hands and they would need to find real solutions to deal with this growing problem. This student clearly took the message to heart and let me know that my goals for the lecture were fulfilled!

Email from student to course coordinator:

*"I really enjoyed the presentation on invasive species today and especially had a lot of fun with the Bonus Question for today. I looked at it a little bit in class but I kept thinking about it even after I left. So kudos to you and everyone else today for giving the class something especially interesting to ponder. I just thought I would send you my thoughts to let you all know how much I really enjoyed it; so attached is Group 3's elaborated response to the invasive species bonus question from today's packet.*

*See you next week and have a great weekend.*
*Mike"*

*S.E.R.F. - Suppressing the European Rabbit Fund* *Group 3*
*We picked the European Rabbit to try and control because it is the most easily accessible and identifiable to the common citizen compared to the other invasive species on the list. The beauty of the plan is its simplicity, offer a small cash reward, call it 10 dollars, for any rabbit hide turned into a government collection office. The first step for SERF to be successful is the education of the Australian public regarding the problem and proposed plan. That could simply be done through a little advertising, a quick teaching lesson required in public schools, and word of mouth. Like our presenter this week said, the key is getting enough people involved in the effort. So the education of the plan would also serve as a motivator to get a large number of people involved, by letting them know of the cash reward involved. It would probably be best to make the public aware of safe hunting practices at this time as well. The next step is fundraising to support the plan. By petitioning some of the major farming operations which have been experiencing a good portion of the multi-million dollar losses, SERF could get some donations to support the mean basis of the plan. Lobbying environmental organizations that know of the detrimental*

## Artifact 2

*effects the rabbits are having on the nation's biodiversity could also provide some initial funding. Ultimately a good chunk of the initial funds would probably need to come from government support, which could justify the investment in increased GDP, job creation and less importation of agricultural goods. Another option, that we would discourage, is charging a small one time permit to sell rabbit hides. The reason we would discourage it is we would want to eliminate as many barriers holding the public's participation back as possible. Now any man, woman, or able child that wanted/needed an extra few bucks would have a way to make them, many likely relishing the opportunity in hard economic times. SERF could also provide a small means of income for the nation's poor as well as give bored youth a constructive way to channel any destructive tendencies. The most severely affected plots could advertize the prevalence of the rabbits and lure hunters to come make some money while taking care of their problem. The farmers could even charge a small grounds fee if they saw fit, encouraging them to allow it to take place. The beauty of the plan is its simplicity, but the genius would be its ability to become self sustaining. The government could harvest any fur from the hides and sell them to any businesses that wanted it to help fund the plan. Perhaps a business would even produce rabbit fur-lined hats that said "I support Australia's farmers". You get the idea, new business, that could exploit the cheap resources SERF would provide by the hides from the collection sites, would help replenish the SERF funds. Obviously someone would need to work at the collection site so new jobs would be created, with their salary hopefully provided by these types of business practices. Farmers seeing an increase in productivity would experience a desire to keep the program afloat and donate to SERF. Perhaps the meat could even be utilized, but that would enter its own new batch of complications. New businesses boasting the best and most efficient rabbit hunting equipment could open and bring some new life into the economy. This probably won't eliminate the problem, but it could go a long way in aiding the control of it.*
*Pros: Simply implemented, possible mass participation, hopefully reaches a stage of little government funding after initial capital investment, creates new jobs / business opportunities.*
*Cons: Safety concerns of increased hunting participation, motivation capital would initially have to be provided by government funds.*

The concept of dividing a "power lecture" (two back-to-back lectures) into a lecture and active learning component is an idea that I would like to use in the future. It provides an opportunity to incorporate TAR into every lecture instead of simply assessing methods and student progress at various points over the course of the semester. It also helps break a long class up into manageable units that can hold student interest and keep them engaged for the entire period as well as providing multiple ways in which students can learn and think about the material. However, in the future I would like to know whether responses from individual students such as this one are representative of the class as a whole. Therefore, I would use more formal assessments such as before and after surveys to see how students assess their own learning as a result of the lecture and activity.

# Artifact 3

**Learning by Experience: The Importance of Field Trips in Ecology Courses**

Field trips can provide powerful learning experiences to explain concepts that are difficult to express in a classroom setting. They also allow students with a diversity of learning modalities to take in information through various sensory systems. The pictures below demonstrate how field trips with hands-on experience can help students better appreciate reptile and amphibian ecology and conservation.

## Artifact 3

Different people learn in different ways; this is one of the core concepts of learning-through-diversity. For example, students may take in and process information in different ways as a result of their age, gender, race, ethnicity, cultural heritage, religion, socioeconomic background, past experiences, and/or learning style. One of the ways in which students differ in learning is through the physical means by which they take in information. In most classes, students learn primarily by *seeing* and *hearing* information presented by a lecturer as well as *reading* material in a textbook. Students vary in their abilities to learn through these modalities. However, nearly all students learn well by *experiencing* the material; this is part of the premise behind active learning.

Ecology is one of the most difficult fields of biology to teach because many of the concepts are abstract. Teaching ecology requires an instructor to make their students think in a holistic manner which is contrary to the way most other forms of biology are taught. Famous wildlife ecologist Aldo Leopold referred to it as "thinking like a mountain;" in other words, learning to see the way things interact under the premise that the whole is not always equal to the sum of its parts. Traditionally, students majoring in wildlife ecology came from backgrounds where they already had an ecology mindset. However, in recent years the field of wildlife ecology has been attracting a much more diverse student base and courses that consist solely of traditional lecturing may no longer address the needs of many students.

Getting students to think like ecologists requires more than simply teaching them ecology. It requires having them *experience* ecology, and one of the best ways to get students to experience ecology is to take them into the field. For three semesters I served as a teaching assistant for a terrestrial vertebrate ecology class in the Department of Forest and Wildlife Ecology. The purpose of this course is to teach students about the various mammals, birds, reptiles, and amphibians that inhabit Wisconsin, what they require for survival, and how they interact with one another. The class consists of a lecture and laboratory component, but it is the field trips that allow students to experience the course material firsthand and put the material learned in class into greater perspective.

Originally, the course had a single day-long field trip in spring that involved going to southwest Wisconsin to observe reptiles and amphibians. The instructor was supportive of me adding an additional field trip and so I planned an optional trip that focused on reptiles and amphibians in southeast Wisconsin. These two parts of the state have very different geographies and therefore support very different species of reptiles and amphibians. The field trips allow the students to see how the landscape influences the animal communities and impresses upon them what different animals need to survive and how they interact with one another. These are things that are not easily taught in a traditional classroom setting. Students are also able to see, hear, and touch the animals that they learn about in class (see above photographs). For many, it is their first time experiencing ecology and is fundamental in shaping the way that they think about the subject. Most of the students in the class are pursuing careers in wildlife conservation. Thus, field trips allow them to experience what they are striving to save, allow them to better understand how to go about protecting them, and further instill in them a passion for those natural resources. The benefits of these field trips are not only realized by the instructors; in course evaluations, students repeatedly list the field trips as their favorite part of the class.

By taking part in field trips and following students over the rest of the semester, I have learned how essential hands-on experience can be in facilitating learning. For example, students often refer back to the field trips rather than classroom experiences when relaying information, suggesting that students both understand and remember information better when it is obtained during field trips. Therefore, when it is possible, I will try to structure future field trips to incorporate essential concepts that I want students to understand and carry with them long into the future (i.e., the "ten-year message").

# Artifact 4

**Supportive Teaching Environments**

Through teaching highs and lows, I have found unconditional support in the learning communitiy provided by my labmates.

One of the major challenges of being an instructor at the college-level is finding time to balance teaching with other responsibilities. At research-based institutions, this is even more difficult because research may be emphasized over teaching, or at the very least, many individuals' interests fall further on the research end of the spectrum than on the education end. Thus, establishing learning communities can be a challenge. I have been fortunate enough to be part of a lab group in which the members are very concerned about both teaching and research. Our learning community is so successful because we encourage open dialogues about teaching, share our teaching successes and failures, and seek out each other's advice when implementing new techniques.

As individuals with different research interests, career goals, and teaching experiences we each bring something different to the classroom and to our own learning community. During my Delta internship and teaching assistantships, I consulted regularly with my lab group. They are the individuals that provide me with valuable feedback on everything from my research thesis to the active learning activities I have designed to my written teaching statement for job applications. In return, I have been consulted by them to do the same.

My lab group has also helped to push me outside of my normal comfort zone when it comes to teaching. Two of my labmates, Tawnya and Tess, are especially interested in outreach activities for children. Two years ago, they asked if I wanted to help them run a booth at Science Expeditions - a day-long science expo in which parents bring kids ranging in age from 6 to 17 to the University to learn about everything from molecular biology to ecology. As someone that has no experience teaching younger children, this is not something I would normally do on my own. Together we planned activities that centered around the theme "Animal Detectives." The activities taught kids about evolution by demonstrating how an animal's physical characteristics offer clues about where it lives and what it eats. We created a hands-on exhibit with animal pelts, skulls, and a poster of camouflaged animals "hiding" in their native habitats to create a rich active learning environment for the kids. The kids may have learned a lot, but I think I learned even more from Tess and Tawnya about interacting with children of different ages. It is just one example of the great experiences I have had with the learning community formed by the other graduate students in my lab. I know that no matter where we end up, we will always remain an important support group for one another's teaching endeavors. However, I will continue to expand my involvement in other learning communities and aid in the development of new learning communities by seeking out other individuals that are interested in sharing their teaching experiences and providing supportive environments for instructors.

## Internship Reflection

For my internship, I addressed the issue of assessment design and incorporation of active learning exercises into a course that formerly used traditional lectures and exams. First, I designed a take home exam that tested students on their ability to think critically about the material. I then designed two class periods devoted to an active learning activity in which students had to read scientific papers related to the course material and answer questions requiring higher level thinking. During those classes, the students discussed their responses in small groups and then as an entire class. The purpose of these exercises was to prepare students for the take home exam and to help them understand the importance of the material. My goals as an instructor not experienced with implementing active learning in the classroom or designing assessments was to become more comfortable with these techniques and see if my first attempts at them were successful in increasing student learning. Through this internship, I learned much about myself as an educator and the importance of Delta's three pillars: teaching-as-research (TAR), learning communities, and learning-through-diversity.

The internship was particularly beneficial in giving me a better appreciation for the importance of TAR when it comes to assessing the success or failure of certain educational techniques. As a scientist, I appreciate the importance of the scientific method in reducing bias and getting to the "absolute truth." However, applying it in the context of teaching was a foreign concept to me and required much more in-depth thinking than I would have imagined. For example, to understand whether the take home exam and active learning exercises affected student confidence and increased important skills and thought processes related to their future careers, I needed to have the students self-assess themselves before and after the exam and activities. Constructing questions to obtain the information I needed in order to analyze the impact of the exam and learning exercises in an unbiased manner was challenging. However, in the end I felt satisfied with the results and confident that my analysis was really telling me something about my teaching. Given the amount of effort that went into designing and grading the take home exam, I may have not been inclined to use that particular format in my future teaching. However, after seeing its influence on student achievement, skill development, and attitudes, I will certainly try to include a take home exam in my future courses. In short, TAR enlightened me to the fact that instructors cannot always completely rely on their instincts for judging the success of an educational technique, but should try to assess its effectiveness in a more objective way.

The internship also emphasized the importance of learning communities. Throughout this entire process, I found major support by immersing myself into the local learning community provided by Delta. Two classes, the internship discussion, and the "teaching large classes" course were excellent places to learn new things, throw out ideas, get valuable feedback, and commiserate. It was also a great way to feel like I was not alone in dealing with the stress of balancing research, professional development, and teaching. Without a learning community, I would not have had a frame of reference for how much time I should be devoting to class versus other responsibilities. Before this experience I did not fully appreciate how essential learning communities are for developing educators. In addition to support groups, I also experienced how learning communities can change the way instructors approach teaching. I found my mentor to be very interested and open-minded about educational techniques I discussed with her, and I believe that my internship made her reflect on teaching styles. In many academic departments at research-oriented institutions, there is little emphasis on teaching (compared to research) and thus faculty interested in teaching may not know where to turn for advice. I now know that wherever I end up working, I must seek out or establish a new learning community as a means of support and to produce open dialogues between myself and other instructors regarding teaching.

My main reason for wanting to incorporate a take home exam and active learning exercises into a classroom setting was to challenge students to think critically about the material. I was not expecting, however, that the experience would be a good lesson in the importance of learning-through-diversity. When I designed my internship, I thought that students would not like being tested on higher levels of thinking because of the challenging nature of the questions. Yet, in surveys taken after students had

turned in the take home exam, many remarked that they were extremely grateful to have been tested in a format that did not focus on memorization. While I had often thought of diversity related to learning styles, I had not thought much about how diversity related to memorization and student test-taking abilities. In retrospect, it makes sense that not all individuals are equally gifted when it comes to memorization, and exams meant to assess critical thinking skills may provide important opportunities for students who learn and utilize information in different ways. In addition, many students reported that the take home exam was a better reflection of their abilities because they were able to complete it in a stress-free environment. I learned that by providing students with a diversity of assessment formats, an instructor is better able to determine a student's skills and understanding in a more comprehensive manner. Students had variable opinions regarding the active learning exercises. Most surprising was that students seemed to either love or hate the activities. This gave me first-hand experience with understanding how different students learn in different ways. In the future, I plan to use TAR to perfect my teaching such that I can reach diverse audiences.

# Internship Report

**Introduction of a Take Home Exam into a Course where Academic Achievement has been Traditionally Assessed by In Class Exams: Effects on Student Achievement and Attitudes**


## Abstract

As part of a teaching-as-research internship, I incorporated a take home exam designed to test critical thinking skills into a course with traditional in class exams. To help prepare students for the take home exam, two lecture periods were devoted to active learning exercises that reflected the format and expectations of the exam. The impact of the take home exam and active learning activities were assessed by calculating student performance in the course with and without the take home exam grade included. I found that the take home exam significantly increased student achievement in the course and improved the cumulative scores of 87.8% of students. Students also filled out pre-surveys (distributed prior to the active learning exercises and exam) and post-surveys (distributed after the take home exam was turned in) to track how their confidence levels changed for certain knowledge and skill sets as a result of the class. Students reported significant increases in confidence pertaining to critical thinking skills emphasized primarily during the active learning activities and take home exam. Students also reported having favorable opinions of the take home exam; specifically that they enjoyed being tested in an alternative format, that it challenged them in a positive way, and that it was a better indicator of their future career success than the traditional in class exams. Based on student performance and attitudes toward the take home exam, it appeared that devoting only two lecture periods to active learning was sufficient to foster the critical thinking skills necessary for high performance on the take home exam and that take home exams provide a valuable means by which to assess higher level thinking skills related to a particular subject.


## Introduction

Traditional college courses consist primarily of lecturing in order to transfer knowledge to students through passive learning and then assessing students on their ability to recall that information. Despite a great deal of evidence suggesting such methods are less engaging and less effective than active learning exercises in both information retention and in stimulating higher level thinking (Morgado 2010, DeNeve and Heppner 1997), traditional lecturing and traditional exams remain a staple of many American classrooms. One of the main reasons for this is that active learning activities may take a great deal of time for instructors to prepare relative to traditional information-based lectures. They also take up valuable class time that could otherwise be devoted to covering the material that an instructor deems essential for a given course. Knowing whether only occasional class periods devoted to active learning activities can impart critical thinking skills to students would be a great benefit in deciding how to balance lecturing with active learning exercises.

Even when active learning is implemented in the classroom, students sometimes fail to understand how it fosters critical thinking because they are never held accountable for such skills when it comes to assessment. College assessments tend to mirror the traditional teaching style and often focus on lower levels of thinking such as knowledge and recall. Not only are these attributes unlikely predictors of the abilities or future success of the students, but they do little to impress upon students *why* active learning activities are important. Most instructors prefer traditional exams because they can be written, taken, and graded quickly - something that is especially important with large classes or when instructors must balance other commitments with teaching.

Traditional teaching and assessment techniques are especially prevalent in the scientific disciplines where many classes are designed to transfer large quantities of information to students in a short period of time. One such course is Terrestrial Vertebrate Ecology (Forest and Wildlife Ecology 306) offered at the University of Wisconsin-Madison. This course was designed to teach students about the taxonomy, identification, physiology, ecology, and life history traits of birds, mammals, reptiles, and amphibians. To put it into perspective, many universities have at least three courses devoted to covering all of the material that must be packed into this one 3 credit class! Given the amount and type of material that needs to be covered, incorporating active learning and critical thinking assessments into the lecture

periods presents major challenges. However, it also provides an opportunity to make the course material more relevant to the students and assess their ability to use the massive amounts of information in the context of higher level thinking to solve important conservation issues. In this study, we assessed students on their ability to utilize material and concepts learned in class by making them complete a critical thinking exam (hereafter referred to as the take home exam) directly relevant to their future careers. The major goal was to see if as few as two class periods devoted to active learning could provide the students with the higher level thinking skills necessary to perform well on the take home exam. Secondarily, we also wanted to determine whether the take home exam led to improved student academic achievement in the course and how it affected student learning and attitudes.

## Methods

**Course Description and Traditional Exams:** This study took place during the spring semester of 2011 in Terrestrial Vertebrate Ecology (Forest and Wildlife Ecology 306), a required course for students majoring in Wildlife Ecology at the University of Wisconsin-Madison. Since prerequisites are required, most students enroll in the course as juniors or seniors. The class size was 51 students. The class consists of three 50 minute lectures and one 1.5 hour lab per week, and is divided into four units to cover the four taxonomic groups of terrestrial vertebrates: mammals, birds, reptiles, and amphibians. In lecture, students are provided with information on the physiology, distribution, life history, evolution, and ecology of representative members of these groups. The laboratory focuses more heavily on taxonomy and identification of the different taxa; an emphasis is placed on species that occur in Wisconsin. The laboratory component and a mandatory field trip at the end of the semester provide interactive experiences, but the lecture relies mostly on passive learning. The course was originally designed to help students identify terrestrial vertebrates and provide them with life history and background knowledge that is vital to a career in wildlife management.

Traditionally, students were assessed on the basis of 6 exams (3 lecture exams and 3 laboratory exams) which test mostly at the lower levels of Bloom's taxonomy (i.e., the exams predominantly test *knowledge* with a few questions on the laboratory exams testing *comprehension* and *application*). The first lecture and lab midterm exams were each worth 10% of the final grade; the second and third midterms for the lecture and laboratory exams each accounted for 15% of the final grade. The remaining 20% of the final grade was determined by the take home exam (15% - see below) and participation (5%). The traditional exams contained mostly short answer and fill-in-the-blank type questions and were graded on a standard scale.

**Class Discussions:** Excluding the laboratory component, class time had previously been devoted solely to lecturing. However, in the spring 2011 semester, two class periods were devoted to an active learning exercise. Students were assigned to read a research paper or research proposal outside of class and answer questions about it. The readings were related to material that the students were currently learning about in lecture, and linked the subject matter to wildlife management scenarios. In other words, the papers showed how the natural history of a species is critical to its conservation and demonstrated how the students might use the material taught in class in their future careers. Responses to the questions were due at the beginning of the active learning class period to ensure that the students completed the reading prior to attending class. The active learning class was structured as follows: a 15-20 minute lecture on material relevant to the paper followed by a brief overview of the paper, a 20 minute small group discussion, and a 10-15 minute class discussion. After the initial mini-lecture, students were broken up into groups of 5-6 (predetermined such that groups contained both high and low-achieving students) and assigned 3 or 4 questions to discuss as a group. Some questions were the same as the ones they had answered for the homework assignment while others were new questions. Most questions required critical thinking skills in order to formulate a response. Examples included asking the students to apply the information they learned in class and from the paper to develop management strategies or to design an experiment to address a new hypothesis proposed by the authors of the papers. After the small groups had discussed the questions, we reconvened as a class and the groups shared their responses during which

time we openly discussed the answers, including potential insights or flaws in thinking processes that led to a given answer. To encourage participation during the session, students were given points for attendance. After class, answers to the discussion questions were posted on the course website. Part of the purpose of the class discussions was to help prepare students for the critical thinking processes that would be required to complete the take home exam.

**Take Home Exam:** The take home exam was assigned immediately after the second active learning session and contained material related to that discussion. Students were given one week to complete the exam which represented 15% of their final grade. The take home exam contained 10 questions (see Appendix A) that revolved around a hypothetical situation in which a species of snake was experiencing a population decline. The students were asked to fill the role of researcher/wildlife manager and interpret data in order to determine why the snake was declining. They were then asked to develop and defend a management plan based on their findings. The questions were designed to test students at the *application*, *analysis*, and *synthesis* levels of Bloom's taxonomy. Students were free to consult any resources they deemed appropriate – including their classmates – but were required to write up their answers individually. The exams were graded using a rubric (see Appendix B) to ensure consistency. Open office hours were held twice between the time the exam was assigned and the due date, and an online forum was set up so that students had ample opportunities to seek assistance.

**Changes in Student Academic Achievement:** Given that students differ in their critical thinking skills and ability to memorize information, we were interested in examining how the take home exam influenced student academic achievement in the course; in particular, whether being tested in a different format and at higher levels of thinking caused overall student scores to increase or decrease. To test this, we compared the final cumulative score for each student in the class with the calculated score that the student would have received should the take home exam have been excluded from the course using a paired t-test (significance at $p<0.05$). In this scenario, the 15% of the grade accounted for by the take home exam was equally divided among the remaining in class examinations. All personal identifying information was stripped from the class dataset before conducting these analyses.

**Changes in Student Confidence:** Examining changes in student achievement alone reveals little about how the incorporation of the class discussions and take home exam impacted learning in the course. For example, the take home exam might increase grades if students did not find it challenging enough; alternatively, if the exam was too challenging and grades decreased, students might have still learned a great deal from the experience. To help determine how the discussions and the take home exam might have influenced student learning, we distributed a voluntary survey (during the class period) prior to the first class discussion and a second survey after the take home exam was due but before it was graded to reduce student bias (hereafter referred to as pre-survey and post-survey, respectively). These served as a self-assessment for the students. The pre- and post-surveys asked students to rank their ability or confidence level for being able to perform a specific task. For example, one question asked "How confident are you in your ability to design, implement, and evaluate a wildlife management plan?" Since the discussions and take home exam were the predominant component of the course that addressed such a topic, we believed that changes in confidence for a question such as this would be related to these specific learning activities. We also included questions in which learning would have predominately occurred during the lecture or laboratory components of the course such as "How confident are you in your ability to identify any given terrestrial vertebrate species that you observe in Wisconsin?" Finally, to ensure that students were consistent in their responses between the pre- and post-surveys we included questions for which we believed that student responses should not change over the duration of the semester; for example "How often do you expect to design, implement, and/or evaluate wildlife management plans in your career?" For each question, students were asked to quantify their expectations or confidence level on a scale of 1 to 4 with 1 being the least often/least confident and 4 being the most often/most confident. The surveys were linked so that changes in responses could be determined for each individual. This was

done by having students use non-traceable identifiers. The pre- and post-survey results were compared using paired t-tests (significance at $p<0.05$); data was only used from respondents that filled out both a pre- and post-survey. The actual pre- and post-surveys can be found in Appendices C and D, respectively.

**Student Attitudes Toward the Take Home Exam and In-Class Discussions:** The post-survey (Appendix D) described above also contained several questions designed to help better understand what student attitudes were toward the take home exam and in-class discussions. Some of these questions asked students to choose the test format (i.e. lecture exam, laboratory exam, or take home exam) that best addressed a given question. Examples included "Which assessment type do you feel was the most accurate indicator of your future success in a wildlife ecology-related career?" and "[If I could remove one assessment type for this course,] I would REPLACE the removed assessment with what type of exam?" The post-survey also contained various questions asking the students to rate their level of agreement /disagreement (on a scale of 1 to 4) with how valuable the in-class discussion periods were, whether they found the take home exam to be challenging, and whether they appreciated being tested in the format of the take home exam. In addition, students were given the opportunity to write out responses regarding what they liked and did not like as well as what they found to be valuable experiences. We were also interested in knowing how much of a time commitment the take home exam was relative to the other assessment types. To examine this, we asked students to indicate which type of exams they spent the most time preparing for/completing and how many hours they spent on the take home exam.

**Results**

**Take Home Exam:** Of the 51 students enrolled in the course, 50 completed the take home exam. For the purposes of comparing overall student achievement in the course, exam scores for the student who did not complete the take home exam were excluded from the dataset because a score of 0 was assigned when in fact designating the exam as "incomplete" would be more appropriate for the purposes of this analysis. Similarly, exam scores were excluded for a student that did not take one of the lecture exams for the same reason. Student scores on the take home exam ranged from 58.4-99.0 (out of 100 possible points) with an average score of 89.1 (±8.5).

Students were given one week to complete the take home exam during which two 4-5 hour open office hour periods were held. The first office hour period was held 4 days before the exam was due and the second period was held 2 days before the exam was due. No students made use of the first open office hour period and less than 20% of the students sought assistance during the second period. Students reported spending from 2.5-15 hours on the take home exam, with the average reported time spent being 6.3 hours (±3.1 hours).

**Changes in Student Academic Achievement:** When the take home exam was not included in the cumulative course grade, the average achievement score of students was 81.3 (±10.5) (out of a total of 100 possible points). When the take home exam was included in the final grade, the achievement score increased to 82.5 (±9.6). A paired t-test showed that this increase in cumulative score was highly significant ($p=0.000003$).

Of the 49 students included in the analysis, 43 (87.8%) demonstrated an increase in their cumulative score for the course when the take home exam was included in the total point value. Nine of these students (18.4% of the class) actually improved their overall performance in the class by one whole letter grade. However, 6 students (12.2% of the class) experienced a decrease in their cumulative score due to the take home exam. Two of these six individuals (or 4.1% of the class) saw a decrease of one letter grade.

**Changes in Student Confidence:** To examine whether students felt that they had learned specific skills and concepts over the semester, we distributed pre- and post-surveys asking the students to rate their expectations and confidence levels on a scale of 1 to 4 (with 1 being the least often/least confident and 4

being the most often/most confident). Responses that were not integers were rounded up to the next whole number (e.g. 1.5 rounded up to 2). Of the 51 students enrolled in the course, we received 44 responses to the pre-survey and 34 responses to the post-survey; 30 responses were obtained that included both a pre- and post-survey. For the purposes of assessing changes in student confidence, only these 30 respondents could be included in the analysis.

To ensure that students self-assessed themselves consistently, we included three questions in which we believed a given student's response should not have changed over time unless they changed their career goals during the course of the semester. As predicted, comparisons between how the students rated their expectations for these 3 questions in the pre- and post-surveys were not significantly different (Q1: $p=0.20$; Q5: $p=0.63$; Q7: $p=0.070$). Students were also asked three questions that were meant to assess how traditional lecture and lab material increased their knowledge or skills over the semester. Responses to these questions indicated that students felt that they significantly increased their knowledge and confidence levels with respect to the material covered in lecture and lab (Q2: $p=7.4 \times 10^{-10}$; Q3: $p=2.2 \times 10^{-6}$; Q4: $p=3.7 \times 10^{-13}$). Similarly, the students were asked three questions to assess how the two discussion periods and take home exam increased their skills over time. Comparisons of student responses to these questions before and after the discussions and take home exam indicated that students significantly increased their confidence when it came to performing these tasks (Q6: $p=0.026$; Q8: $p=4.0 \times 10^{-8}$; Q9: $p=3.8 \times 10^{-5}$). To look at how much confidence levels increased for these three questions, respondents that had rated their confidence at the maximum level in the pre-survey were excluded since it was impossible for their confidence level to increase.

**Student Attitudes Toward the Take Home Exam and In-Class Discussions:** To investigate how students viewed the take home exam relative to the lecture and laboratory exams, we asked students a series of questions in which they were to select the exam format that best answered the question. These questions (Q10-Q14 in Appendix D) were contained within the post-survey, and all 34 respondents were included in the analysis. Since a few students did not respond to all of the questions and some chose more than one test format per question, the percentages displayed are calculated from the total number of responses to a given question. While students (44.7%) felt the laboratory exam best tested their knowledge of the material presented during the course of the semester, the majority (68.8%) believed that it was the take home exam that best indicated their future career success. The majority of respondents also reported that if one exam format type could be removed from the course, they would elect to remove the lecture exams. When asked to explain their reasoning for this, most students (51.5%) indicated that the lecture exams were overwhelming in the breadth of material that they covered and tested them mostly on memorization; representative comments included:

> "lecture exams were overwhelming because of [the] volume of material"
> "the lecture is just memorizing things which we would be able to look up"
> "lecture and lab exams stressed memorization and did not really help me address conservation issues"
> "lab and lecture exams examined my ability to regurgitate info and not to assimilate knowledge or synthesize the material"

Most respondents (63.6%) preferred that the exam format they suggested for removal from the course be replaced by additional take home exams. A large number of students had positive feelings toward the take home exam in general, indicating that it required critical thinking, was more applicable to their future careers, and provided a good alternative way of testing their abilities; example comments included:

> "the take home exam helped me better understand the material and think more critically than the lecture exams; I also found the take home exam material more interesting due to the applied example"

"the take home exam was better because it required thought and demonstrated what you really know and not just what can be produced in an exam setting"
"…I also think that our success on the take-home exam will best indicate our success in careers"
"the take home was the most beneficial because it seems like something I will actually do in the future and pushed me to think harder and more creatively"
"the lecture exam is so much memorization, but I forgot a lot of it afterwards whereas the take home exam makes you use critical thinking and use what we have learned so it is more applicable to real life"
"the take home helped us use information we knew and apply it in new ways"
"it was refreshing to have an exam that expected us to think; for those of us with learning disabilities, straight memorization without correlation to real-world importance is very difficult"
"glad we had the exam! It really is nice to be tested in multiple formats"

These comments were in agreement with the way students responded to questions in which they were asked to evaluate the take home exam on a scale of 1 to 4 (1=disagree and 4=agree). For example, when asked whether they found the take home exam challenging (Q19), the average response was a score of 3.32 (±0.84); when asked whether they appreciated being tested in the format of a take home exam (Q20), the average response was a score of 3.79 (±0.48).

It is important to note that despite these trends, there were also a number of students (~18%) that liked the lecture and lab exams better than the take home exam. For example, some students commented that the take home exam was difficult to interpret or was not relevant to the course material:

"I found the take home exam to be difficult to conceptualize; I did not know what the questions were looking for sometimes"
"the take home exam did not seem 100% relevant to the material in class"
"the take home required us to look up a lot of information that we didn't learn in class; should be on material covered in lecture"

The post-survey also included three questions (using the same scoring system described above: 1=disagree and 4=agree) designed to determine whether the in-class discussions were valuable experiences and helped the students prepare for the take home exam. Students tended to agree that the discussions helped them to better understand the relevance of the course material (Q16), prepare them for the take home exam (Q17), and provided them with a valuable experience (Q18) (average scores of 3.35 [±0.85], 3.62 [±0.65], and 3.06 [±0.95] respectively), but there was considerable variation in responses. Looking more specifically into which aspects the students liked/disliked most about the discussions suggested that while most students enjoyed interacting with their peers, they were divided regarding how stimulating they found the discussion. Some students reported that the questions were remedial and disliked having to answer the questions both on their own as well as in the group while others found the questions to be too challenging and reported that they learned a lot by having their peers share their ideas.

**Discussion**

The main goal of this project was to determine whether a small number of active learning exercises introduced into a traditional lecture-based course would be sufficient to help students think about the course material in a higher context. We found that dedicating only two 50 minute class periods to an active learning activity was adequate for students to learn how to apply their critical thinking skills to the subject matter and perform well on a take home exam requiring higher level thinking. In fact, the take home exam was able to increase overall achievement in the course for most students. The difficulty of the take home exam did not appear to play a role in this as students reported finding the take home exam challenging.

Over 18% of students improved their cumulative score by one letter grade due to the inclusion of the take home exam. These students did not show significant increases in their final in-class exam scores relative to the in-class midterm exam scores such that increased motivation in an attempt to improve their cumulative score did not sufficiently explain their high performance on the take home exam. Instead, we believe that students that increased their grade due to high achievement on the take home exam did so because they had difficulties with memory-based exams or because the take home exam tested a different type of skill set and thinking process. For example, all instructors have encountered the student that appears to be highly capable, highly motivated, and very knowledgeable yet consistently performs poorly on traditional exams. Such students may suffer at the hands of traditional exams due to anxiety created by the time constraint of an in-class exam, difficulty in memorizing large quantities of information, lack of motivation to memorize material, other learning disabilities, or a combination of these. Take home exams are a great way to better assess these individuals because the length of time in which students have to work on them reduces stress and anxiety, attenuates the negative effects of certain learning disabilities, and tests students on higher levels of thinking which allows the instructor to fully understand the students' true capabilities and mastery of the subject matter. In addition, a take home exam designed to be challenging and requiring problem-solving can motivate some students because it allows them to see the relevance of the material and view the exam as a test of their future success in the field.

In addition to student achievement, students also were asked to respond to pre- and post-surveys in which they indicated their level of knowledge or confidence in performing specific tasks. To rule out the possibility for inconsistencies in the student self-assessments, we included three questions that were career based and that we did not anticipate students to change their responses to over the course of the semester. As expected, comparisons of pre- and post-survey responses indicated that there was no significant change in the responses to these questions. However, we did observe significant increases in self-reported knowledge and skill confidence levels for questions relating to material covered in the lecture and laboratory components of the course. We also saw significant increases in confidence for skills that were emphasized primarily during the in-class discussions and take home exam. While these changes could have occurred from external factors, we believe that the take home exam and discussions did influence this due to a large amount of positive feedback left by the students that indicated the usefulness of the take home exam and discussions. This suggests that the take home exam not only served as an assessment of whether students can think critically about the material, but that the exam itself also acted as an important learning tool for the students.

Instructors often believe that there is a discrepancy between the types of exams that students prefer versus the types of exams that best assess the students' capabilities. As stated previously, students reported that they found the take home exam challenging which might imply that they did not view it favorably. However, the results of the post-survey overwhelmingly demonstrated that the majority of students viewed the take home exam in a positive light. Students rated the take home exam as being the best indicator of their future success and the majority said that they would like to replace one of the other exam formats (lecture or laboratory exams) with additional take home exams. Students also directly stated that they appreciated the ability to be tested on their critical thinking skills in a format that was not as stressful and time-limited as the lecture and laboratory exams and that the take home exam provided them with an opportunity to truly demonstrate their mastery of the subject matter. Bias in these responses as a result of the high grades students received on the take home exam was an unlikely issue because students had not yet received their grade for the exam prior to filling out the survey. A few students viewed the exam negatively, but such complaints were far outweighed by the large numbers of positive comments received in regards to the take home exam, many of which contradicted the complaints.

Student viewpoints on the value of the in-class discussions were more polarized. While most students agreed that the discussions were useful in helping them to prepare for the take home exam, some found the overall experience of the discussion to not be particularly valuable. Several respondents wrote that the discussions were helpful because they were able to hear new ideas from their peers that made them think about the problems differently. However, nearly an equal number of respondents found the discussions to be remedial. They especially disliked having to discuss the same questions in their group

as they had already answered on their own. These contrasting views were actually anticipated and were the reason the groups were organized such that each group contained both high and low-achieving students. Our goal for the discussion groups was to have the students learn from each other. The students that found the discussions most useful were likely the students that were having a harder time understanding and thinking critically about the material. While this may seem to hold little value for the students that were already more advanced, we suspect the experience helped them to better develop their communication skills and solidify the concepts they were trying to impart onto their peers. Teaching a class that includes students at various experience levels is always a complicated task. Finding ways of challenging advanced students while not overwhelming the less advanced students is something that could be improved upon for future discussion sessions.

In addition to benefiting students, take home exams and in class discussions can also be advantageous for instructors. While traditional exams can reveal much about what information students are retaining, they are largely incapable of divulging whether students have learned how to utilize that knowledge in a higher context. Take home exams have the unique ability to allow students to demonstrate their full potential and inform the instructor as to how students are interpreting the information presented, thereby being better indicators of how well students comprehend the material. Furthermore, the role of the instructor often goes beyond simply transferring knowledge. Students inevitably approach instructors seeking career guidance and support as references. However, an instructor may not be able to offer adequate guidance or may be able to say little about students' capabilities based off of their performance on traditional exams. Take home exams and class discussions are able to demonstrate the maturity of an individual's thinking processes as they relate to the material and allow instructors to better know their students, thus allowing instructors to better advise and more accurately portray the abilities of their students.

While this study shows that take home exams and in-class discussions have many benefits for students and instructors alike, inclusion of such an exam format and class activities into a course is not without its drawbacks. Designing exams that test students on their ability to interpret, apply, analyze, and synthesize material is challenging and requires a large time commitment. Additionally, grading such an exam is an exhaustive process. For faculty expected to balance teaching with other responsibilities, incorporating a large number of such activities into a course seems like a daunting task. This project demonstrates that the inclusion of very limited amounts of active learning exercises and a single exam that tests critical thinking skills can greatly improve student learning and the instructor's ability to assess his or her students.

**Literature Cited**

DeNeve, K.M. and Heppner, M.J. 1997. Role play simulations: the assessment of an active learning technique and comparisons with traditional lectures. *Innovative Higher Education* 21: 231-246.

Morgado, P. 2010. From passive to active learners: implementing the pedagogy of "learning by doing" in a large-sized design foundation class. *Transformative Dialogues: Teaching and Learning Journal* 4: 1-12.

## Internship Report Appendix A: Take Home Exam

The take home exam described in the internship report (see page 15) can be found on the following nine pages. This exam was designed to test higher levels of thinking than are typically tested by in class exams and consists of questions that require students to apply the information they had learned in lecture as well as to analyze and synthesize new information.

## Forest and Wildlife Ecology 306 Take-Home Exam

**Due Date:** The exam will be due on **Wednesday, April 20th**. You will submit the exam via the dropbox function at Learn@UW. The time stamp for the submission must occur **on or before 11:59 PM (midnight) on April 20th.** No excuses for late work will be accepted (including computer or personal issues). To avoid problems, get started early and do not wait until the last minute to turn your exam in. Also, after submitting, make sure that you get a "dropbox receipt." Late submissions will automatically be docked 50% for each day that it is late.

**Expectations and Grading:** This exam will test your ability to apply what you have learned in class to a hypothetical research and management situation that you might encounter as a wildlife ecology professional. You may use notes, textbooks, and other resources (including your classmates) to aid you in your thinking process, but your work must be written in your own words; any evidence of plagiarism - including plagiarizing other students - will not be tolerated (see "Academic Honesty" below). Your exam should be easy to read: typed, double-spaced, saved as a .doc or .docx file, and in a format that indicates which question you are answering. There are no length restrictions, but keep your answers concise and on topic. When in doubt about how much to write, consider the number of points a question is worth. The take home exam will be worth 15% of your final grade. You will be graded on 1.) the correctness and validity of your responses (25%), 2.) your ability to illustrate your thought process and rationalize or explain your logic (60%), and 3.) grammar and clarity of your writing (15%). Keep in mind that there may be numerous correct responses for a given question, but you must explain and justify your thinking for full credit!

**Assistance:** The take-home exam will require you to think critically about what you have learned in class. Because it will be challenging, we strongly suggest that you start the exam early so that you have plenty of time to think about the questions. If you have quick inquiries, you are free to ask them before and after class. We will not answer questions during scheduled class time (including lab). In addition, there will be two opportunities to seek assistance from the teaching assistant during the following times: Saturday April 16th from 2:00PM-7:00PM in Room 240 Steenbock Library AND Monday April 18th from 5:00PM-9:00PM in Room 340 Steenbock. Please note that the room numbers are different for the different days. We will not respond to questions in the 24 hour period before the exam is due. This is to encourage you to start working on the exam early and to prevent a flood of last minute questions that we may not have time to respond to.

**Academic Honesty:** For the take-home exam, you should feel free to work in pairs or small groups to discuss the test and to share knowledge and ideas. Interacting with your peers can be a powerful learning experience. However, it is NOT okay to work in a group with a divide and conquer approach. In other words, you cannot divide the workload of the exam between different people and then exchange or copy

each others' answers. Academic honesty requires that the course work a student presents to an instructor honestly and accurately indicates the student's own academic efforts. If you are going to work in a group, it is okay to go over each question together and jot down notes, but you must write up your answers *on your own*. If you cannot restate the answer in your own words, then it means that you do not fully understand it, and you should ask your group mates to explain the concept again. Sharing your own responses for another person to copy, or copying another student's responses (written or oral) is strictly forbidden. If two or more exams show evidence of copying, both students will automatically receive a zero on the exam and may be subject to further penalization as indicated in the course syllabus. Aside from other students, you will probably want to utilize other outside resources such as books, websites, journal articles, etc. Remember that you must restate information that you pull from such sources in your own words. Failure to do so constitutes plagiarism and is also subject to the same penalties described above. Finally, you are expected to refrain from other acts of academic dishonesty which include, but are not limited to, cheating, deception, and fabrication. If you have questions about what constitutes academic dishonesty, you should contact the professor or TA.

## Internship Report Appendix A: Take Home Exam

**Background Information:** The plains gartersnake (*Thamnophis radix*) was once an abundant snake across the southern one-third of Wisconsin with records indicating that it was relatively common into the 1970's and 80's. In the proposal discussed in class on April 13th, you saw that populations of *T. radix* in southeast Wisconsin are hybridizing with *T. butleri* (Butler's gartersnake) where their ranges overlap. During the course of that work, attempts were made to obtain *T. radix* samples from well outside the known range of *T. butleri* to serve as a positive control (i.e. to determine the genetics of "purebred" *T. radix*). Several sites in south-central and southwest Wisconsin that formerly harbored *T. radix* were resampled in the early 2000's, but not a single specimen of *T. radix* was captured. Prompted by fears that "purebred" *T. radix* might have become extirpated in Wisconsin, the Department of Natural Resources (DNR) implemented additional surveys. To date, only three populations of *T. radix* have been found outside of the hybrid zone, and two of these contain so few individuals that they are not likely to persist. The remaining site consists of grassland within a very open landscape, implicating natural succession (encroachment of trees and shrubs into open areas) as the ultimate factor in the snake's decline. The proximate factor has not been determined.

As a wildlife ecology professional, you have just received funding from the Wisconsin Department of Natural Resources to conduct a research project to help determine the proximate factor responsible for the near extirpation of *T. radix* from Wisconsin. You believe that the proximate factor could be related to one or more of the following that might have changed as a result of natural succession:

1.) changes in predator abundance
2.) changes in food abundance
3.) changes in the abundance of competitors
4.) increase in the abundance of one or more species of *Thamnophis* that hybridize with *T. radix.*

Before moving forward, you design a study to determine which of the preceding four factors to research in more detail. You select six sites of equal size (A, B, C, D, E, and F) in south central and southwest Wisconsin (see Fig. 1) where *T. radix* was formerly known to occur and place cover boards in upland grasslands at those sites. You capture *Thamnophis* at all six sites, but only find *T. radix* at three sites. You collect data from all six sites to analyze (see the attached tables and graphs). Answer the following questions based on the data and on your knowledge of the life history and ecology of relevant terrestrial vertebrate species.

# Internship Report Appendix A: Take Home Exam

**If applicable, list the names of other students that you worked with during the exam:**

**List any outside resources that you used to aid you in the exam:**

**Questions**

1.) You just hired new technicians for this project and are concerned that they may not be able to distinguish between *T. radix* and other species of *Thamnophis* (they have not taken FWE 306 yet!). Create a dichotomous key that your technicians could use to differentiate the different species of *Thamnophis* found in Wisconsin. (10 pts)

2.) Do the results of your study support the suspected ultimate factor causing the decline of *T. radix* in Wisconsin? Why or why not? (5 pts)

3.) To test the first proximate factor, you had your technicians document the abundance of red-tailed hawks at each site. The results are summarized in graph 1.

a.) While red-tailed hawks are important predators of *T. radix*, what other predators might you want to consider in your study? List at least 5. (5 pts)

b.) How is hawk abundance related to the presence/absence of *T. radix* according to the data? (2 pts)

c.) Which other variables that you have measured does hawk abundance appear to be correlated with? (2 pts)

d.) Why is your response to part c important? With this in mind, what can you conclude about whether hawk densities affect *T. radix* populations? (8 pts)

4.) To test the second proximate factor, you had your field technicians determine leopard frog densities at each site. The results are summarized in graph 2.

a.) Does the presence of *T. radix* appear to be influenced by leopard frog abundance? (2 pts)

b.) Would you feel comfortable extrapolating your response from part a to make conclusions about the second proximate factor? Why or why not? (5 pts)

5.) For the third proximate factor, you are especially concerned with potential competition between *T. radix* and other species of *Thamnophis*. Your technicians use mark and recapture to estimate the population of other *Thamnophis* at each site. The results are summarized in table 1.

a.) What does the data from table 1 show? Why can't you conclude that other *Thamnophis* are outcompeting *T. radix*? (8 pts)

b.) Design an experiment to test whether other *Thamnophis* are capable of outcompeting *T. radix* (do not worry about the financial feasibility of the experiment). Explain the experiment and how it would answer the question. Also, make sure that your experiment has a valid control. (10 pts)

6.) To test the fourth proximate factor, you will use genetics to determine if hybridization is occurring. However, you have limited funds and can only test to see if genes from one other species of *Thamnophis* are entering the *T. radix* population.

a.) Which other species' genetic material will you test for? What is your justification for this decision (i.e. for each species, give a brief explanation for why you would or would not test for its genetic material)? (8 pts)

b.) Is it necessary to also screen the species you chose in part a for *T. radix* genetic material? Why or why not? (hint: look at graph 3). (2 pts)

c.) The results of your genetic screening are shown in graph 3. Is hybridization occurring? What is your conclusion about the fourth proximate factor? (5 pts)

Now that your study has concluded, apply your findings to a management situation by answering the following questions:

7.) Based on your findings from questions 3-6 and the information you have, which proximate factor do you think is **most likely** (you must select one) responsible for the decline of *T. radix* (i.e. for which factor is there the strongest evidence given the data you have)? Explain why you chose the one you did and why you feel the others are less likely to be responsible. (15 points)

8.) The Department of Natural Resources would like to immediately implement management strategies to protect the remaining populations of *T. radix*. The three sites in your study that contain *T. radix* are on public property.

a.) Develop a management plan to protect the populations that addresses the suspected **ultimate** cause of the decline. Make sure to explain how this would remedy the problem (5 pts)

b.) Now develop a management plan to protect the populations that addresses the **proximate** cause of the decline that you chose in question 7. Make sure to explain how this would remedy the problem (5 pts)

c.) Which of the two above plans would be the easiest to implement and why (consider cost, labor, probability of success, and feasibility)? (5 pts)

9.) A wildlife manager from southwest Wisconsin performs habitat restoration work for bullsnakes and tells you that after management efforts had been implemented, the populations recovered very slowly. Do you believe that *T. radix* populations will recover more quickly, at the same rate, or more slowly than bullsnake populations? Justify your response. (5 pts)

10.) Management activities that benefit one species will almost always be detrimental to another.

a.) List 3 other species of Wisconsin vertebrates (excluding red-tailed hawk, northern leopard frog, and all species of *Thamnophis*) that are likely to decline at the sites if you implement your management strategy from question 8a. Explain why their populations would decline. What groups of people might object to the loss or decline of these species at the sites? (8 pts)

b.) To continue with your management strategy from question 8a, you will need to justify the benefits of your plan. Since most people do not care about snakes, list 3 other species of Wisconsin vertebrates (excluding red-tailed hawk, northern leopard frog, and all species of *Thamnophis*) that would also benefit from your proposed management plan. Include at least two species that are listed as endangered, threatened, or special concern in Wisconsin. Explain why each species you listed would benefit. (6 pts)

# Internship Report Appendix A: Take Home Exam

**Supporting Materials**

**Fig 1:** Location of study sites.

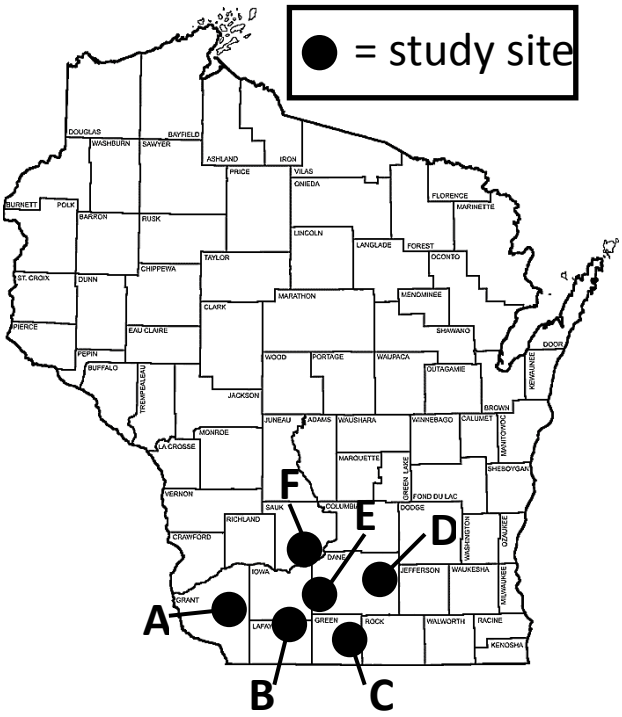


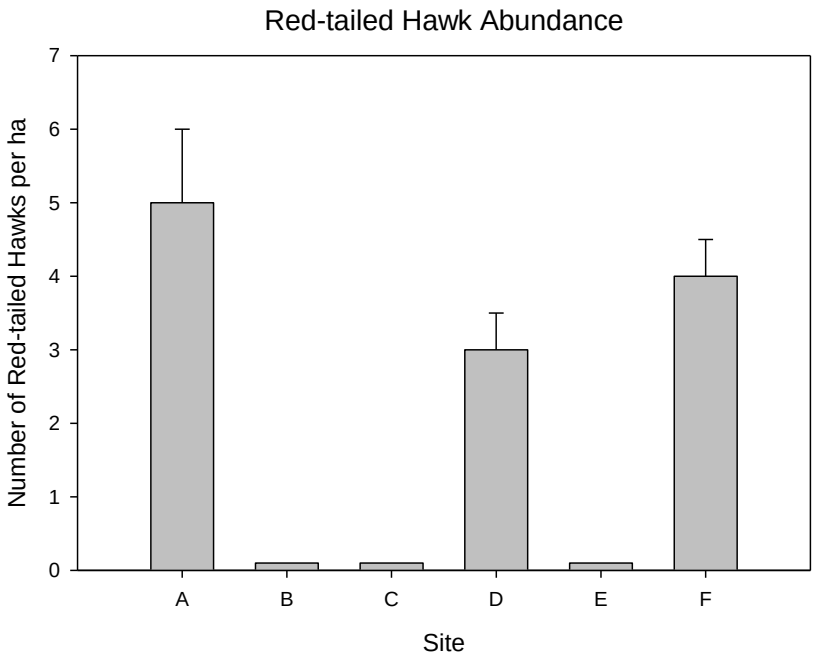

**Table 1:** Number of *T. radix* and other species of *Thamnophis* captured during coverboard surveys by site.

| | Site | | | | | |
|---|---|---|---|---|---|---|
| | A | B | C | D | E | F |
| *T. radix* | 0 | 35 | 172 | 0 | 87 | 0 |
| other *Thamnophis* | 136 | 10 | 0 | 206 | 3 | 183 |
| **Total** | **136** | **45** | **172** | **206** | **90** | **183** |

**Table 2:** Percentage of groundcover consisting of woody plants by site.

| Site | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| % Woody Cover | 5 | 0.8 | 0.2 | 4 | 0.4 | 4.5 |

**Graph 1:** Predator abundance by site as indicated by red-tailed hawk density.



**Graph 2:** Prey abundance by site as indicated by northern leopard frog density.

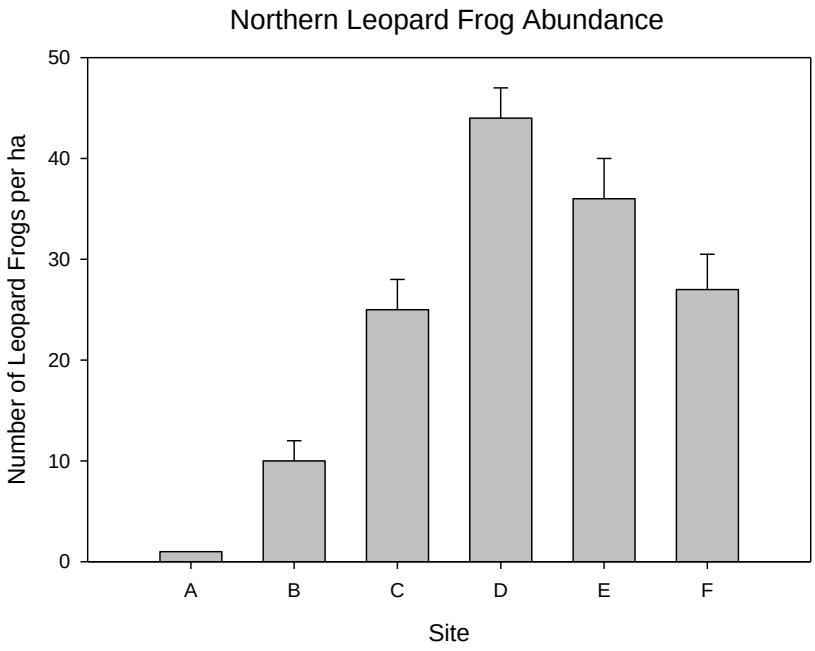
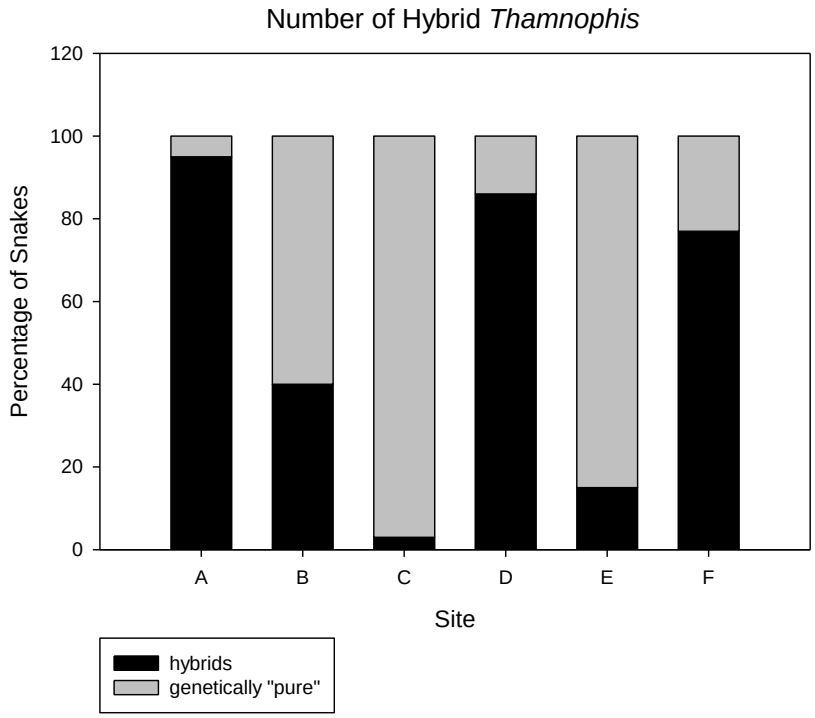



**Fig 3:** Genetic makeup of populations of *Thamnophis* at each site.



## Internship Report Appendix B: Grading Rubric

The rubric employed to grade exams can be found on the following three pages. A grading rubric was used to ensure fairness and accuracy in the grading process. To provide students with feedback, the completed rubric was given to the students when graded exams were returned. Prior to completing the take home exam, students were notified of the grading criteria (see page 22).

# Internship Report Appendix B: Grading Rubric

**Name:**

**Grading Rubric**

| Correctness/Validity of Response | Explanation/Thought Processes | Grammar/Clarity |
|---|---|---|
| 5 = completely correct/valid | 5 = substantially developed | 5 = exemplary |
| 4 = mostly correct/valid | 4 = mostly developed | 4 = proficient |
| 3 = partially correct/valid | 3 = somewhat developed | 3 = acceptable |
| 2 = mostly incorrect/invalid | 2 = underdeveloped | 2 = substandard |
| 1 = entirely incorrect/invalid | 1 = completely undeveloped | 1 = unacceptable |

| **Question #1** | | | | | | **Score:** | **/10 pts** |
|---|---|---|---|---|---|---|---|
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |

| **Question #2** | | | | | | **Score:** | **/5 pts** |
|---|---|---|---|---|---|---|---|
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |

| **Question #3** | | | | | | **Score:** | **/17 pts** |
|---|---|---|---|---|---|---|---|
| **#3a** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#3b** | | | | | | **Score:** | **/2 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#3c** | | | | | | **Score:** | **/2 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#3d** | | | | | | **Score:** | **/8 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |

## Internship Report Appendix B: Grading Rubric

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Question #4** | | | | | | **Score:** | **/7 pts** |
| **#4a** | | | | | | **Score:** | **/2 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#4b** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **Question #5** | | | | | | **Score:** | **/18 pts** |
| **#5a** | | | | | | **Score:** | **/8 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#5b** | | | | | | **Score:** | **/10 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **Question #6** | | | | | | **Score:** | **/15 pts** |
| **#6a** | | | | | | **Score:** | **/8 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#6b** | | | | | | **Score:** | **/2 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#6c** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **Question #7** | | | | | | **Score:** | **/15 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |

## Internship Report Appendix B: Grading Rubric

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **Question #8** | | | | | | **Score:** | **/15 pts** |
| **#8a** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#8b** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#8c** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **Question #9** | | | | | | **Score:** | **/5 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **Question #10** | | | | | | **Score:** | **/14 pts** |
| **#10a** | | | | | | **Score:** | **/8 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |
| **#10b** | | | | | | **Score:** | **/6 pts** |
| Correctness/Validity of Response | 1 | 2 | 3 | 4 | 5 | | |
| Explanation/Thought Processes | 1 | 2 | 3 | 4 | 5 | | |
| Grammar/Clarity | 1 | 2 | 3 | 4 | 5 | | |

**Total Score: /121 = ____%**

## Internship Report Appendix C: Pre-Survey

To help determine how the discussions and the take home exam might have influenced student learning, a voluntary "pre-survey" was distributed prior to the first class discussion. The pre-survey served as a source of baseline data in which to compare the post-survey (see page 37) results. The pre-survey contained questions that asked students to rank their expectations for using certain skill sets in the future or their level of confidence in performing a particular task that we believed could change as a result of the subsequent class discussions or take home exam. The pre-survey that the students were asked to fill out can be found on the following page.

## Internship Report Appendix C: Pre-Survey

**Identifier (first 3 letters of the month you were born and the last two digits of your cell #):_____**

**Year in School (circle one):** Freshman Sophomore Junior Senior Graduate Special Student

**Which of the following best describe your future career goals? (check all that apply)**

____ Wildlife Management/Conservation

____ Medical Science (including Veterinary Medicine)

____ Education

____ Law

____ Research

____ Other Biology/Environmental Science-related Career

____ Non-biology-related Career

**Please indicate your expectations or confidence level for the following questions on a scale of 1 to 4 (with 1 being the least often/least confident and 4 being the most often/most confident)**

| | **Least** | | | **Most** |
|---|---|---|---|---|
| Q1: How often do you expect to utilize the information that you learn in this course in your future career? | 1 | 2 | 3 | 4 |
| Q2: What is your current knowledge level of the distributions, habitats, and life history traits of Wisconsin's terrestrial vertebrate species? | 1 | 2 | 3 | 4 |
| Q3: How confident are you in your ability to identify any given terrestrial vertebrate species that you observe in Wisconsin? | 1 | 2 | 3 | 4 |
| Q4: How likely would you be to know which Wisconsin vertebrate species someone was speaking of if they were to use only its scientific name? | 1 | 2 | 3 | 4 |
| Q5: How often do you expect to consult scientific literature (i.e. research papers) that pertains to wildlife ecology in your career? | 1 | 2 | 3 | 4 |
| Q6: How confident are you in your ability to read through and comprehend scientific literature (i.e. research papers) that pertains to wildlife ecology? | 1 | 2 | 3 | 4 |
| Q7: How often do you expect to design, implement, and/or evaluate wildlife management plans in your career? | 1 | 2 | 3 | 4 |
| Q8: How confident are you in your ability to design, implement, and evaluate a wildlife management plan? | 1 | 2 | 3 | 4 |
| Q9: How confident are you in your ability to go about identifying and addressing the factors limiting the recovery of an endangered species? | 1 | 2 | 3 | 4 |

## Internship Report Appendix D: Post-Survey

To help determine how the discussions and the take home exam might have influenced student learning, a voluntary "post-survey" was distributed after the take home exam was due. Students used unique identifiers such that responses from the pre- and post-surveys could be linked. Thus, data related to students' expectations for using certain skill sets in the future or their level of confidence in performing a particular task from the post-survey were compared with the results of the pre-survey. Additionally, the post-survey contained questions that assessed student attitudes toward the class discussions and take home exam. The post-survey questions are found on the next two pages.

## Internship Report Appendix D: Post-Survey

**Identifier (first 3 letters of the month you were born and the last two digits of your cell #):_____**

**Please indicate your expectations or confidence level for the following questions on a scale of 1 to 5 (with 1 being the least often/least confident and 5 being the most often/most confident)**

| | **Least** | | | **Most** |
|---|---|---|---|---|
| Q1: How often do you expect to utilize the information that you learn in this course in your future career? | 1 | 2 | 3 | 4 |
| Q2: What is your current knowledge level of the distributions, habitats, and life history traits of Wisconsin's terrestrial vertebrate species? | 1 | 2 | 3 | 4 |
| Q3: How confident are you in your ability to identify any given terrestrial vertebrate species that you observe in Wisconsin? | 1 | 2 | 3 | 4 |
| Q4: How likely would you be to know which Wisconsin vertebrate species someone was speaking of if they were to use only its scientific name? | 1 | 2 | 3 | 4 |
| Q5: How often do you expect to consult scientific literature (i.e. research papers) that pertains to wildlife ecology in your career? | 1 | 2 | 3 | 4 |
| Q6: How confident are you in your ability to read through and comprehend scientific literature (i.e. research papers) that pertains to wildlife ecology? | 1 | 2 | 3 | 4 |
| Q7: How often do you expect to design, implement, and/or evaluate wildlife management plans in your career? | 1 | 2 | 3 | 4 |
| Q8: How confident are you in your ability to design, implement, and evaluate a wildlife management plan? | 1 | 2 | 3 | 4 |
| Q9: How confident are you in your ability to go about identifying and addressing the factors limiting the recovery of an endangered species? | 1 | 2 | 3 | 4 |

**Please circle the assessment format type that you feel most appropriately addresses the questions below.**

Q10: Which assessment type best tested your knowledge of the material? Lecture Lab Take Home

Q11: Which assessment type did you spend the most time preparing for/working on? Lecture Lab Take Home

Q12: Which assessment type do you feel was the most accurate indicator of your future success in a wildlife ecology-related career? Lecture Lab Take Home

Q13: If one assessment type had to be eliminated from the course, I would REMOVE Lecture Lab Take Home

Q14: In the above question, I would REPLACE the removed assessment with what type of exam..... Lecture Lab Take Home

## Internship Report Appendix D: Post-Survey

Please explain your response to the previous two questions about which exam format to replace.

Q15: How much time (in hours) did it take you to complete the take home exam? _____

**Please evaluate the following statements regarding the two discussion-based class periods and take-home exam.**

| | **Disagree** | | | **Agree** |
|---|---|---|---|---|
| Q16: The two discussion-based class periods helped me to better understand the importance of the course material | 1 | 2 | 3 | 4 |
| Q17: The two discussion-based class periods prepared me for the take-home exam | 1 | 2 | 3 | 4 |
| Q18: I found the discussion-based class periods to be valuable experiences | 1 | 2 | 3 | 4 |
| Q19: I found the take home exam to be challenging | 1 | 2 | 3 | 4 |
| Q20: I appreciated the opportunity to be tested in a format different from in-class exams | 1 | 2 | 3 | 4 |

Q21: What aspects of the discussion-based class period were:

the most useful? Please explain.

the least useful? Why? Please explain.

Q22: Any additional comments or suggestions for the discussions or take home exam?