Integrating on-campus wildlife research projects into the wildlife curriculum

Robert A. McCleery, Roel R. Lopez, Louis A. Harveson, Nova J. Silvy, and R. Douglas Slack

Abstract We propose that creating on-campus wildlife research projects propelled by undergraduate students and interns is a simple way to improve the quality of wildlife education and research. Wildlife educators and natural resource agencies alike have called for wildlife undergraduates to acquire more experience and technical and critical thinking skills before entering the work force. The benefits, especially in the aforementioned skills, from learning by experiencing are well documented. One way to increase learning experience opportunities and to include undergraduates in the research process is through the use of on-campus wildlife research projects. We used 2 on-campus research projects to illustrate the versatility and benefits of this approach. On the urban Texas A&M University (TAMU) campus (≈45,000 students, College Station), we established a fox squirrel (*Sciurus niger*) research project, and on the rural Sul Ross State University (SRSU) campus (≈2,400 students, Alpine, Texas), we established a scaled quail (*Callipepla squamat*) research project. We have incorporated on-campus wildlife research projects into the lesson plans of 4 broad categories of wildlife courses at SRSU and TAMU: wildlife ecology, population dynamics, habitat management, and wildlife management techniques. We have used the projects to provide "hands-on" wildlife experiences, which included capture and handling techniques, radiotelemetry, habitat measurements, population estimation, Geographic Information System (GIS) and Global Positioning System (GPS) technology, and data analysis and presentation. Student workers, interns, and volunteers are the driving force behind the research projects that have proven to be an excellent source of long-term data. Other benefits of on-campus wildlife research projects include a common research theme throughout the wildlife curriculum and less travel time commonly associated with traditional field labs. Additionally, research projects have boosted the profile of both departments on their respective campuses. We believe similar projects on raccoons (*Procyon lotor*), opossums (*Didelphis virginianus*), and feral cats (*Felis catus*) could provide other excellent on-campus research opportunities.

Key words experiential learning, on-campus research, wildlife curriculum

We propose that creating on-campus wildlife research projects driven by undergraduate students and interns is a simple way to improve the quality of wildlife education and research (Kenny and Glaser 1998). The benefits of allowing students to learn by experiencing and participating in their

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subject matter are well documented (Davis 1993, Lewis and Williams 1994, Barr and Tagg 1995) and can provide students with the skills needed by today's wildlife professional (Ryan and Campa 2000). Experiential learning occurs when students learn by coming into contact with the subject mater (Keeton and Tate 1978, Millenbah and Millspaugh 2003). Kolb (1984) presented a 4-step model of experiential learning where knowledge acquisition was accomplished by 1) experiencing concretely, 2) reflective observation, 3) forming abstract concepts, 4) and active experimentation. In this model, concepts, ideas, and techniques are learned by contacts with the subject matter, processing the outcomes of experience, and applying the concepts to new and different situations (Keeton and Tate 1978, Millenbah and Millspaugh 2003).

Students retain information longer and show greater enthusiasm for the subject when they interact with material being taught (Millenbah et al. 2000, Millenbah and Millspaugh 2003). Experiential learning also maximizes opportunities for students with different learning styles (Millenbah et al. 2000), helps advance critical thinking skills, and enhances their ability to apply class lessons to new situations (Barr and Tagg 1995, Kendrick 1996, Millenbah and Millspaugh 2003). In wildlife education experiential learning also captures the enthusiasm of many students to work outside and to work directly with wildlife (Millenbah et al. 2000). Additionally, including undergraduates in the research process helps to stimulate, energize, and increase the learning potential for graduate students and faculty as well as undergraduates (Kenny and Glaser 1998). Only recently have wildlife educators called for an increase in experiential learning, active learning, and other learner-based pedagogies in the undergraduate curriculum (Kessler 1995, Moen et al. 2000, Ryan and Campa 2000, Millenbah and Millspaugh 2003), with less emphasis promoting undergraduate involvement in research projects.

Who advocates experiential learning?

There are 2 groups that have advocated experiential education for wildlife students. Wildlife educators recently have emphasized that participation in the subject is necessary to prepare students for life outside the classroom (Moen et al. 2000, Ryan and Campa 2000, Millenbah and Millspaugh 2003).

Fox squirrel (*Sciurus niger*) eats a candy bar on the Texas A&M University campus.

At the same time, natural resource agencies and wildlife professionals are encouraging universities to better prepare students for the workforce (Bleich and Oehler 2000). Wildlife programs have been criticized by natural resource agencies for their failure to provide undergraduates with field experience, technical skills, and critical thinking skills necessary to be effective in entry-level positions (Kessler 1995, Bleich and Oehler 2000). Kessler (1995), Lopez (2001), and Millenbah and Millspaugh (2003) recently have suggested that increased experiential learning is an excellent way to better prepare undergraduates for jobs with agencies.

Barriers to implementation

Wildlife departments and faculty have developed several ways of increasing experiential learning in the undergraduate curriculum. Wildlife classes often incorporate field trips on which students can engage in actual field work or simulated field experiences. Experiential learning also has been used in and easily incorporated into specialized wildlife classes (e.g., wildlife techniques, Millenbah and Millspaugh 2003) with success. Outside the classroom wildlife students have opportunities to gain valuable field experiences as student workers or volunteers with research projects or working with state and federal agencies (Lopez 2001). Field trips and internship opportunities are steps in the right direction, but they need to be applied to more students and throughout the wildlife curriculum. Students learn and retain material more readily when a common context is used to teach different ideas and theories presented in classes (Berkson 2002). Lessons from class laboratories, field trips, and student internships that offer continuity in the subject are ideal (Millenbah et al. 2000). Historically, experiential learning exercises have been isolated, stand-alone experiences.

There are constraints that prevent a more universal use of experiential learning in wildlife programs. Undergraduate students face a more demanding and compressed curriculum that is increasingly placing a strain on their time (Matter and Steidl 2000, Lopez 2001). Time constraints on students restrict the number of students willing to take field jobs, semesters abroad, intensive field courses, and even field trips (Millenbah et al. 2000). Increasing tuition costs also make it difficult for students to spend extra time or semesters with internships or other volunteer opportunities. Furthermore, faculty usually ask only the best and brightest in their wildlife programs to assist on research projects, which may exclude some students from gaining valuable work experiences. Declining departmental budgets further limit the use of experiential learning in the classroom. Scheduling multiple field trips to research sites with the necessary equipment to accommodate an entire class is an expensive and time-consuming venture. Finally, we do not see more experiential learning in the classroom because it takes substantially more time and effort for instructors to use this pedagogy. Wildlife instructors may cover only a portion of the course material compared to a lecture-based course because of the repetitive and time-consuming nature of experiential learning (Millenbah and Millspaugh 2003).

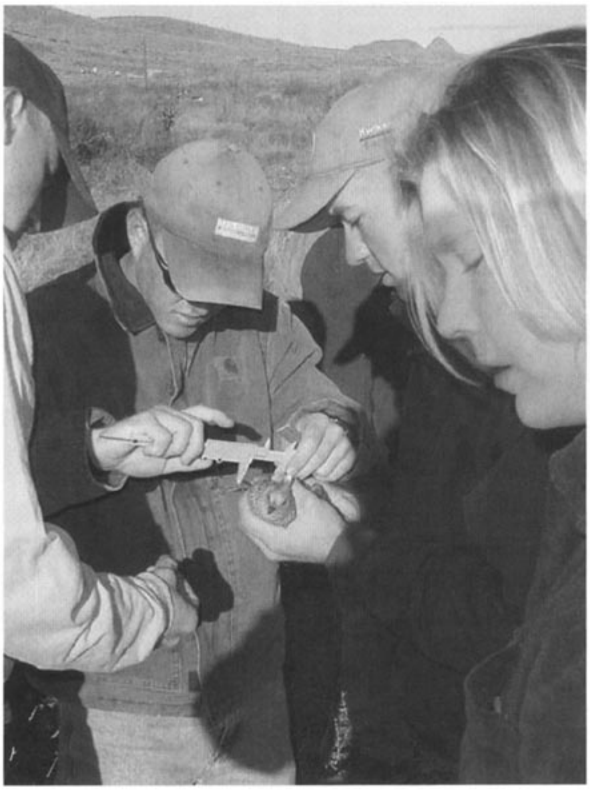
Despite difficulties in implementing experiential learning in the wildlife curriculum, benefits from such approaches warrant finding new opportunities to improve classroom instruction. Herein, we describe how the integration of on-campus wildlife research projects offers unique, alternative opportunities to incorporate experiential learning into the wildlife curriculum. Specifically, we briefly provide a background of our academic institutions (Sul Ross State University [SRSU] and Texas A&M University [TAMU]) and a general overview of the on-campus projects, review our general approach for integrating on-campus projects into our curriculum, and describe the experience gained by student workers, interns, and volunteers. We also will explore the benefits and shortcomings of such research projects and the possibility of other similar projects on other university campuses.

An alternative solution

We believe there are substantial benefits to establishing on-campus wildlife research projects that increase experiential learning in the wildlife sciences curriculum and undergraduates' involvement in research. We propose that on-campus research projects provide students with a cost- and time-effective means of gaining practical field experience before graduation. On-campus research projects also can be used in varying academic settings (small, rural campus versus large, urban campus), as is illustrated in our paper.

Institutional backgrounds

The Department of Natural Resource Management (NRM) at SRSU was located in Alpine, Texas, a small community (approximately 6,000 people) in west Texas. Total student enrollment for SRSU was 2,400 (1,700 undergraduates, 700 gradu-



Students at Sul Ross University taking morphometric measurements of a scaled quail (*Callipepla squamat*) for an assignment in their Upland Gamebird and Waterfowl Management class.

ates); enrollment in the NRM was 90 students (70 undergraduates, 20 graduates). Approximately 30–40 students/year were served by an on-campus wildlife project. The area surrounding the SRSU campus was characterized as rural and undeveloped, with desert mountains, mesquite (*Prosopis glandulosa*)-desert scrub, and grasslands. Pronghorn (*Antilocapra americana*), mule deer (*Odocoileus hemionus*), javelina (*Pecari tajacu*), gray foxes (*Urocyon cinereoargenteus*), raccoons (*Procyon lotor*), and bobcats (*Lynx rufus*) are all present on campus. In contrast, the Department of Wildlife and Fisheries Sciences (WFSC) at TAMU was located in College Station, a moderate-sized community of approximately 70,000 people in east Texas. The total student enrollment for TAMU was 44,871 (36,590 undergraduates, 8,281 graduates); enrollment in WFSC was 590 (415 undergraduates, 175 graduates). Approximately 200–300 students/year were served by an on-campus wildlife project. The TAMU main campus was an urban area of approximately 300 ha of park-like fields, buildings, and various tree species. Doves (*Zenaida* spp.), feral cats (*Felis catus*), raccoons, opossums (*Didelphis virginianus*), and rabbits (lagomorphs) are abundant in and around campus.

On-campus research projects

In 1998 we initiated a study investigating the dynamics of scaled quail (*Callipepla squamata*) on a 300-ha ranch (SRSU-owned) that was located <100 m from the main campus. We chose scaled quail as the subject of our on-campus project for several reasons. Scaled quail are an important gamebird, locally abundant, and easy to capture. Despite their abundance, Schemnitz (1994) identified several voids in our knowledge of scaled quail. Our research objectives were to 1) monitor long-term demographic changes of scaled quail populations (e.g., sex ratios, age composition, age ratios, survival estimates, densities, productivity), and 2) identify spatial relations of scaled quail (e.g., home range, dispersal, movement rates, habitat use-availability). The scaled quail research project has been ongoing for nearly 6 years.

On the TAMU campus, a study investigating the population dynamics of the urban fox squirrel (*Sciurus niger*) was initiated in 2001. The study area was the central portion of TAMU's main campus. To date, little is known about urban squirrel ecology (McComb 1984, Jodice and Humphrey 1992, Bowers and Breland 1996, Steele and Koprowski 2001). The research objectives were to 1) monitor long-term population demographics (i.e., survival, fecundity, density) of fox squirrels in urban landscapes, and 2) monitor squirrel movements (i.e., ranges, dispersal, and habitat use). Radiotelemetry is central to collecting demographic and movement data. The fox squirrel research project has been ongoing for 3 years.

Courses impacted

We have incorporated on-campus wildlife research projects into the lesson plans of 4 broad categories of wildlife courses at SRSU and TAMU: wildlife ecology, population dynamics, habitat management, and wildlife management techniques. The SRSU quail project has been used in 5 wildlife ecology classes, which students are asked to take in the following order: Wildlife Resources, Upland Gamebird and Waterfowl Management, Wildlife Population Dynamics, Range and Wildlife Habitat Management, and Wildlife Management Techniques. At TAMU the squirrel project has been used in 4 wildlife ecology classes that students take in the following order: Fundamentals of Ecology Laboratory, Animal Ecology, Wildlife Habitat Management and Conservation Biology, and Wildlife Management Techniques. A brief discussion of how students are involved in the research projects and a review of some sample assignments and lesson plans for each of the courses are presented.

Wildlife ecology. Students are first introduced to the on-campus research projects in introductory-level ecology courses (Wildlife Resources, Upland Gamebird and Waterfowl Management, Fundamentals of Ecology Laboratory), which are offered to majors and nonmajors. Course enrollment for these courses varies from 25–200 students/semester. On-campus research projects are used to complement and reinforce general ecological principles and terminology learned in the classroom. For example, students are introduced to the basics of radiotelemetry and Geographic Information System (GIS) and Global Positioning System (GPS) technology. Following a general introduction to the topic, students then use radiotelemetry and hand-held GPS receivers to find and map radiotagged squirrels or quail for their weekly lab assignment. Experiences like these exemplify the ability of on-campus research projects to provide the "concrete experiences" that start the experiential learning process (Step 1, Kolb's [1984] model).

Population dynamics. After initial exposure, undergraduates are fully immersed into the research projects when they take their upper-level courses. In fact, by the time wildlife students are classified as a junior or senior, they have already had 2 (Wildlife Resources and Upland Gamebird and Waterfowl Management or Fundamentals of Ecology Laboratory and Animal Ecology) courses introducing them to the research projects. For example, in the senior-level Wildlife Population courses, students conduct various exercises from data they helped collect 2–3 years prior to the course. Before working with data, students are asked to recall some of problems, potential flaws, and advantages to the data they collected. Having students work on the same project throughout their undergraduate experience makes incorporation of reflective observations (Step 2, Kolb's [1984] model) of their previous experience a natural fit, allowing students to build on their earlier experiences in a classroom setting. Several laboratories emphasize quantitative analysis of collected field data (i.e., telemetry locations, density estimates, nest-box observations) and the formation of abstract concepts (Step 3, Kolb's [1984] model). In these labs students calculate ranges and estimate squirrel or quail population demographics (i.e., survival, fecundity, density). With their population estimates, students learn to construct population models using spreadsheets or advanced software to understand population processes. Students use the models to test hypothesis and experiment (Step 4, Kolb's [1984] model) with various management scenarios (e.g., removal of habitat, hunting, introductions). By incorporating reflective observations, formations of abstract concepts, and experimentation in upper-level classes, the experiential learning model has come full course from the first concrete experiences of underclassmen. This 4-step process (Kolb's [1984] model) also is continued in both our habitat management and wildlife techniques classes.

Habitat management. In our Wildlife Habitat Management courses, students experience various habitat sampling methodologies commonly used in wildlife studies and reflect on their advantages and disadvantages. For the scaled quail project, students create habitat maps using remote sensing and GIS techniques and quantify vegetative characteristics (e.g., species composition, screening and canopy cover, plant dominance). For the squirrel project, students sample potential nest trees (e.g., species, diameter at breast height, tree height, number of squirrel nests, trees/ha) on campus and estimate mast production using various methods (e.g., quadrats, sampling funnels). For both studies students generate hypotheses explaining how changes in vegetation relate to life-history information covered in previous courses and test their hypotheses with current and historic population trend data from the projects.

Wildlife management techniques. In Wildlife Management Techniques courses students experience several applications of commonly used techniques. First, students are involved in the trapping and marking of quail and squirrels on campus. In the radiotelemetry lab, students acquire radiotelemetry locations using hand-held antennas and receivers. We then give telemetry data to the entire class and students use home-range software (Animal Movement Extension in ArcView, Hooge and Eichenlaub 1999) to calculate annual and seasonal ranges and movements. Throughout the semester, several population estimators are employed (e.g., line transects, time-area counts, mark–recapture methods, distance sampling; Hein 1997, Krebs 1998). After participating in fieldwork, students compare and reflect on these different methods and population models. We then ask students to apply skills and information they learned to new situations. For example, one assignment might ask the students to design the best possible population estimates (considering time and money) for a species other than squirrels or quail. Such assignments emphasize the "real-world" application of concepts to undergraduates in their career preparation.

Other experiences

We required (TAMU) or encouraged (SRSU) wildlife undergraduates to complete $\geq$1 semester or a summer of internship work with a wildlife-related project prior to their graduation. The on-campus research projects currently provide opportunities for 2–10 students/semester to complete their internships and gain professional experience working on an actual wildlife research project. Student internships are designed to expose interns to and familiarize them with the many different aspects of the research projects during the semester. Similar to concepts and techniques learned in class, student interns collect quail or squirrel data at a greater intensity and with less supervision than in the classroom. Student interns take part in monthly trapping sessions during the semester in which they are responsible for pre-baiting, baiting, and setting traps. Interns gain experience handling animals, administering passive integrated transponders (PIT), attaching ear tags or leg bands, and affixing radiotelemetry backpacks or collars. Throughout the semester interns also gain considerable telemetry experience. They normally track radiotagged animals 2-3 times during the week (random time intervals) where they collect relevant habitat, movement, nesting, and weather data. Interns also participate in the collection of monthly population estimation data. All data collected by student interns are entered into databases and ArcView GIS (Environmental Systems Research Institute, Version 3.3) software. Prior to completion of their internship, we require students to analyze data and write a report that follows styles of scientific manuscript or agency report. Upon completion of their internships, students are better prepared for work opportunities that are available to them and they have the advantage of having worked with faculty and graduate students on comprehensive research projects. Another advantage of the on-campus research projects is that students do not have to leave campus for a semester and have no travel-time constraints, so they can easily fit field work into their classroom schedule.

Benefits

The benefits of creating on-campus wildlife research projects that emphasize undergraduate participation are numerous and varied. On-campus wildlife research projects increase the quality of education by providing more experience and experiential learning opportunities for undergraduates. We believe the experiential learning from these projects helps students get more out of their class work and prepares them for wildlife careers following graduation. On-campus research projects also have provided a common context for semester-long courses and within the wildlife curriculum, allowing students to become intimately involved in the research process. Still, undoubtedly the greatest benefit of on-campus research projects is the removal of time and travel constraints. By moving the field just outside the classroom doors, on-campus research projects make it substantially easier to transition from classroom to field. Reduction of travel costs, use of equipment based in the department, and the ample base of eager student volunteers also have reduced the research costs in implementing the squirrel and scaled quail research projects. We estimated 30-60% savings from these projects compared to similar research projects at remote field sites. Additionally, most funds for the 2 projects were generated from internal teaching and research funds. Funding projects in such a manner makes it possible for even the smallest of wildlife programs to incorporate on-campus wildlife projects. Additionally, we have found it easier to receive external grants for the projects due to their close association with classroom teaching (e.g., $22,500 in external funding received for squirrel project).

The projects serve to develop student-mentor relationships between underclassmen, faculty, graduate students, and upperclassmen. They also have provided a means to achieve a goal of major research institutions. They include undergraduates, graduate students, and faculty members in the acquisition of knowledge through research (Kenny and Glaser 1998). The projects are excellent sources of long-term, quality data sets. The scaled quail and fox squirrel projects have been ongoing for nearly 6 and 3 years, respectively. Continued research of these 2 projects eventually can provide a comprehensive understanding of these 2 species.

In the implementation of these projects, we also have seen some benefits to on-campus research that were not expected. The projects have increased the visibility and exposure of our departments on campus (university newspaper articles), with alumni (newsletters), and with the general public (area newspapers articles and local television stories). They have become excellent for departmental public relations. The projects have even been used as a recruiting tool by undergraduate advisors within our departments and universities. We believe potential students will be attracted to the departments based on the learning atmosphere provided from on-campus research projects.

Limitations

We are aware of some of the limitations of our on-campus teaching projects. When we designed the projects, it was important to ensure that skills and knowledge necessary to collect data were simple and easy to understand so undergraduates with little training could comprehend and contribute to the project. On-campus research projects to enhance the undergraduate curriculum are not conducive to the use of intricate equipment or data-collection methods. Additionally, the high rate of turnover of student workers and classes that work on the project introduces a considerable risk to observer bias. We have addressed these problems by placing either a faculty member or full-time graduate student in charge of training students, data collection, and ensuring continuity and direction in the research of the on-campus projects. Another limitation to implementing on-campus projects is the amount of time required for initial set-up; however, the time required decreased to approximately 10 hours/week in supervising projects.

Conclusions and recommendations

Educators have underutilized experiential learning in the wildlife curriculum to better prepare students for careers in wildlife. Previously cited reasons for not using experiential learning in the classroom include the time constraints for students and faculty, travel requirements, expense, and difficulty in accommodating a large numbers of students. We believe the integration of on-campus wildlife projects overcomes many of these limitations and makes experiential learning more accessible to students and faculty. We illustrated how these types of projects can work in a variety of university campus settings and can be easily incorporated into the wildlife curriculum. Not only have our on-campus projects provided more learning opportunities for our students but they also have yielded more continuity across the wildlife curriculum. Additionally, our departments have benefited from the inclusion of undergraduates in cost-effective long-term research projects and the positive public exposure of our departments to local and university communities. We propose that similar research projects can be implemented on almost every campus, which may include deer (*Odocoileus* sp.), doves, feral cats, raccoons, opossums, and rabbits. On-campus research project can provide excellent teaching and research opportunities that ultimately can improve wildlife education.

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