2007 Symposium Abstracts – SWS Annual Meeting

Teaching Wetland Ecology

In 2007, Dr. Douglas Wilcox organized and convened a symposium at the annual Society of Wetland Scientists meeting that was held June 10-15 in Sacramento, California, USA. The symposium was well-attended, and the fifteen papers that were presented covered a wide diversity of wetland topics. Details of the symposium and copies of the abstracts are presented below.

Symposium Overview: Wetland ecology is a multidisciplinary field of study, and teaching a Wetland Ecology course requires the instructor to cover widely disparate topics adequately. However, most wetland scientists do not have strong backgrounds in all aspects of the subject matter, which can make teaching difficult and can weaken the course. The purpose of this symposium (and follow-up sessions in future years) is to provide insight on means of presenting various topics in Wetland Ecology courses in an engaging manner that allows students to grasp and retain the key concepts. The symposium should be of value to anyone who teaches a wetland course at the undergraduate or graduate level (and does not already know everything).

Abstracts

TEACHING COLLEGE STUDENTS ABOUT MANAGING WETLANDS FOR WATERBIRDS

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Waterbirds—including waterfowl, shorebirds, and wading birds—are some of the most conspicuous inhabitants of wetland systems. Wetland and wildlife managers spend an enormous amount of time and effort managing wetlands specifically for waterbirds. Students often bring a wide and varied background in waterfowl identification and general outdoor skills and knowledge to the classroom. This disparity in knowledge can make teaching students about wetland management for waterbirds challenging. It is getting increasingly more difficult to effectively teach college students using traditional lecture based classes. Techniques that can be used to reach students include a variety of hands-on demonstrations, discussions, field trips, lab exercises, quizzes, games, and other activities. I will delve into some of the teaching techniques that I have used to simplify principles and enhance student learning, including various strategies that are useful for conveying ideas to students concerning proper water depth, prey availability, response of vegetation to drawdowns, and other management activities. I am hopeful that other teachers will find some of these ideas of value, adapt them for their own classes, and that this will lead to an exchange of ideas among instructors. We must all strive to become better teachers, because the future of our wetlands depends upon it.

Key Words: waterbirds, wetland management, wetland education

WHAT'S BEING TAUGHT IN WETLANDS CLASS?

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Numerous colleges and universities in the United States teach wetland related courses. However, little is known about how wetland courses are instructed across the nation. With increasing pressure on wetlands, there is likewise an increase in the need for quality wetland professionals. We conducted an email survey targeting wetland courses currently being offered at universities within the United States. Various questions were asked of instructors and a syllabus for the course was requested. Our preliminary data, based on 28 courses, indicated that 17 had different titles for their courses, with "Wetland Ecology" being the most common title shared by instructors. The majority of courses were taught by individuals and predominantly through biology departments. Classes were 3 or 4 credits and nearly all were offered to upperclassmen or graduate students. Almost all wetland classes offered a lab session (half met weekly and half met as half-day to full day field trips). The predominant text book used was "Wetlands" by Mitch and Gosselink and most had supplemental readings. Several courses were started in the early 1970s, but the majority of courses have started in the last decade. Subject matter varied among courses

but the most common topics covered included: Definition of a Wetland, Soils, Wetland Function, Hydrology, Restoration and Mitigation, Plants, and Animals. Although there are a lot of similarities among courses, there also are numerous differences in course content and instructional methods. We see several changes on the horizon for university wetland education as the wetland science field continues to develop.

Key Words: Wetland Courses, Wetland Education, Wetland Instructors

FIELD EXERCISES IN WETLAND SCIENCE FOR GRADUATE AND UNDERGRADUATE STUDENTS

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Few academic disciplines have opportunities for hands-on educational experiences as rich as those available for teaching wetland science. Because of their widespread distribution and biological, chemical, and physical complexity, wetlands are excellent "living laboratories" for teaching. Field experiences are invaluable for conveying abstract concepts from the classroom and providing experience with methods difficult to describe in a lecture format. The Wetland Ecology class at the University of Maryland is a field-based course that seeks to provide experience in natural and restored wetlands common in the U.S. mid-Atlantic region and field and lab techniques used to describe wetland soils, vegetation, and hydrology. Exercises are designed around fundamental research methods (e.g. quantitative sampling of vegetation composition and structure) or applications of wetland science (e.g., wetland delineation). Plant taxonomy is a strong component of the course, as is data analysis, which includes statistical analysis and hypothesis testing, tabular and graphical presentation, and interpretation. Finally, several lab sessions are set aside for students to work in groups on an applied or fundamental research project of their own design. My experience with this course is that hands-on field experience combined with numerical analysis and presentation is an effective means to address a broad range of learning styles. While classroom teaching delivers the facts and figures, the sights, sounds, smells, and textures of real wetlands drive the points home.

MESHING ECOLOGY, POLICY AND CULTURE: THE MISSISSIPPI DELTAIC PLAIN WETLAND LANDSCAPE AS A CLASSROOM

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The Mississippi Deltaic Plain provides a backdrop for wetland students to explore a wide range of wetland communities, see first-hand the challenges coastal urban centers face with global climate change, and experience a unique culture that has strong ties to surrounding wetlands. Sea level rise and recent hurricanes have thrust this region and its wetlands into the national spotlight, a selling point that can be used to further stimulate student interest and participation. Wetlands visited on the field trip are organized along flooding and salinity gradients and include bottomland hardwood and swamp forests, floating freshwater marshes, and tidal salt marshes. The class is broken into working groups of 3-4 students. Each group establishes a 100 m^2 plot for sampling the plant community at each of the four sites. Students are trained to identify vascular species and quantify abundance of herbaceous and woody species. Soil samples are taken in each plot for analysis of soil texture, organic matter, moisture, and color using Munsell charts. All data are entered into a master dataset for each student to use in preparing his/her lab report. A tour of historic landmarks and hurricane-ravaged parts of New Orleans is also included. During the trip, the class is based at Louisiana Marine Universities Consortium (LUMCON), which has dormitories, classrooms and wet labs for sample processing. This trip is a valuable learning experience that exposes students to coastal wetlands and the impacts of global climate change. It is also a venue for learning standard field and lab procedures.

THE CHALLENGES OF TEACHING WETLAND ECOLOGY TO STUDENTS WITH A DIVERSITY OF INTERESTS AT THE UNIVERSITY OF GEORGIA.

Darold P. Batzer, Rebecca R. Sharitz, and C. Rhett Jackson.

At the University of Georgia, we are tasked with teaching wetland ecology to advanced undergraduate students, entry level graduate students, and advanced Ph.D. students. These students come from Departments as diverse as ecology, forest resources, plant sciences, marine sciences, entomology, environmental design, agricultural engineering, and science education. Our courses must be basic enough to present the foundations of wetland ecology, yet advanced enough to challenge senior students. Course materials must have broad enough coverage to engage students who are focused on a range of taxa and habitat types; as instructors, we cannot simply focus on our personal areas of expertise. In this talk, we describe some of the instructional strategies that we have used from tapping local expertise, laboratory course design, textbook development, and incorporation of student-led activities.

TEACHING A “FIELD LAB” ACROSS THE HGM CONTINUUM TO ILLUSTRATE STRUCTURE AND FUNCTIONS OF WETLAND ECOSYSTEMS

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The abundance of a broad variety of wetlands in coastal plain North Carolina provides an opportunity to demonstrate the relationship between wetland classes and functioning. Available wetlands include tidal marshes, non-tidal sea-level controlled marshes and swamps, forested fens, hardwood flats, pine savannas, organic soil flats (pocosin peatlands), and riverine wetlands ranging from bottomland hardwoods to headwater riparian. Students fill out work sheets during field trips to consolidate data on elevation, water sources, NWI and HGM type, soil series, specific conductance, soil profiles, dominant vegetation, and other distinguishing properties. We use a comparative ecosystem approach to illustrate differences in geologic history and functioning. Hydrologic, biogeochemical, and habitat functions provide the framework for more detailed insight into ecosystem development, adaptations of biota, and natural disturbance regimes and stressors. Students learn to use S-C-T meters, refractometers, sharpshooters, angle gages, soil surveys, topo and NWI maps, Munsell charts, plant keys, indicator species, Macaulay peat samplers, increment borers, and other tools and equipment. An exercise on condition assessment and restoration demonstrates how a “reference system” ranks the effects and intensities of alteration by human activities. Wetland delineation is taught last so that students first understand fundamental principles of wetland science before its application is demonstrated.

Because some field trips require several hours of driving time, the lab is taught on Saturdays (all day, but only 6 meetings for 1 hour of credit per semester).

INTEGRATING RESEARCH AND UNDERGRADUATE TEACHING

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One of the axioms of student-active science education is that students should "learn science as science is done." One means of exposing students to the scientific process is the incorporation of actual research into laboratory exercises. Using this approach, I enhanced the coverage of species invasion, vegetative propagation, and wetlands bioassessment during my Aquatic and Wetland Plant Ecology class. This was accomplished in part through a series of complementary laboratory activities that built, sequentially, from basic biology & growth form to comparative investigations of regeneration ability and finally application of biology and ecology to wetlands assessment. The latter two activities included hands-on application of research methods, including an experimental test of vegetative regeneration ability among native and non-native plant species. The progression from basic to applied topics reinforced the cumulative knowledge students gained by providing them the opportunity to apply their knowledge in an experiential learning environment. An advantage of this approach to laboratory design was the overlap with ongoing research, which reduced the investment of time and money needed to design successful laboratory exercises. From the student perspective, this approach integrated students into the research process from experimental design to preparation of a final scientific report – all as part of an interdisciplinary, campus-wide research effort.

TEACHING NITROGEN BIOGEOCHEMISTRY IN WETLAND ECOLOGY COURSES

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The movement and transformation of elements in wetlands is dictated by a complex array of chemical, physical and biological processes, making wetland biogeochemistry one of the most interesting aspects of wetland ecology but also a challenging one to convey to students. We use an ecosystem approach in lecture and field classes to teach the fundamentals of nutrient cycling. The stoichiometry of nitrogen and carbon are used to investigate linkages in these cycles and illustrate how human alterations to the nitrogen cycle disrupt ecosystem processes. In the classroom we emphasize nitrogen transformations in riparian wetlands, particularly subsurface processes and the value of riparian buffers for control of agricultural runoff. Field exercises take advantage of a long-term experiment established in a riparian sedge meadow undergoing restoration. A series of plots running perpendicular to the stream channel receive treatments of ammonium nitrate fertilizer several times each year. Students collect data in both fertilized and unfertilised plots on plant species diversity, soil carbon content (using the loss on ignition method), and groundwater levels using monitoring wells that have been established. Using this baseline information students can devise and test hypotheses by collecting additional data such as nitrate and ammonium concentrations in groundwater, or soil nitrogen concentrations in order to calculate C:N ratios. Upper level students can collect data on soil respiration to evaluate the response of the microbial community to nitrogen enrichment. Providing this experimental framework allows students to participate in a long-term, collaborative research project and illustrates the challenges of field-based research.

INTEGRATING WILDLIFE ECOLOGY INTO WETLANDS ECOLOGY COURSES

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Integrating wildlife ecology into wetlands ecology courses is challenging because of the diverse academic backgrounds of the students. Students often have little field experience in wetlands, cannot identify many wetland plants and animals, and/or they are from traditional wildlife backgrounds with little understanding of wetland ecosystem processes. At LSU, we incorporate wetland ecology in undergraduate wildlife courses so that undergraduates understand processes such as denitrification and marsh vertical accretion. At the graduate level, we use a field intensive, system-based approach to teach wetlands ecology. We conduct at least 6 field trips, including 2 overnight field trips and a 4-day field trip from east Texas to the Mexico border. Students are encouraged to learn common wetland plants, birds, invertebrates, and other wetland dependent organisms so that they can more fully understand observed wildlife responses to local and landscape processes. We visit with site managers at dozens of refuges, wildlife management areas, and preserves in a variety of habitats and discuss basic ecosystem processes as well as the goals and objectives of wetland restoration and management and the socioeconomic constraints limiting management options. Our goal is to develop an appreciation of wetland ecosystem processes in wildlife students and to develop an interest in wildlife ecology among other wetland students. We believe this field-based approach, integrated with key principles in lecture, provides students with a diverse array of experiences to draw from, thereby facilitating their understanding of wetland processes and enhancing their ability to critically analyze wetland management and restoration techniques.

SWAMP: THE USE OF AN OUTDOOR WETLANDS LABORATORY TO TEACH PRINCIPLES OF WETLAND ECOLOGY AND RESTORATION

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It has becoming increasingly evident that the future of wetland science requires the integration of technology, research and restoration skills from various disciplinary approaches in-order-to solve complex environmental problems. Opportunities for graduate and undergraduate students to participate in state-of-the-art research and teaching experiences in wetlands are not often thought of as being available on college campuses today, although they are often just outside window if one views the campus as just another development needing water quality improvements and habitat enhancement. The development of an outdoor wetlands laboratory called SWAMP (Stream Wetland Assessment Management Park) to teach the principles of wetland ecology and restoration is our new approach to enhancing the development and teaching of wetland science and restoration. The parks development over the past 7 years on the Duke campus utilized students at all stages. It continues to provide teaching and integrated research opportunities to more fully develop the potential of our students and faculty as well as make available a regional training center for high school and science museum students as well as staff from state and federal agencies. SWAMP has become a key part of Duke Universities plan to "green" the campus, provide flood and water quality improvements, but more importantly act as a student outdoor laboratory. This has been accomplished through allowing students to aid in the design, planning and site restorations as well as work on the monitoring teams. Examples of student projects, classroom exercises and teaching approaches that have enhanced the teaching of wetland principles and restoration design will be presented.

INQUIRY-BASED LABORATORY EXERCISES IN ECOLOGY

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I teach ecology using an inquiry-based approach. In each of our labs, students develop a hypothesis and then design and carry out a study to test it. Students are given a field observation as a staring point. For example, students are told that several years of high water can eliminate emergent species from local wetlands, but that the emergents quickly becomes re-established after the next drawdown. This observation begins students thinking about how plant species get to wetlands and under what conditions they become (re-)established. A discussion of the very rapid rate of recovery of emergents eventually results in the students hypothesizing that the seeds of these species must be in the wetland's soil (seed bank) even when these species are absent from the vegetation. The students then have to decide how to test their hypothesis. As part of their experimental design planning, they choose where to collect soil samples, how many to collect, and how to estimate the number of seeds of emergent species in these soil samples. Because greenhouse space is available, a seedling assay is normally done in which soil is placed in shallow trays for 6-8 weeks under various moisture regimes to see if the seeds of any emergent species germinate. An-inquiry-based approach teaches students how to use the scientific method to investigate ecologically interesting questions, in this case about succession, and it gives them an appreciation of the realities of setting up and conducting even a simple scientific study.

VISUALIZING SOIL REDOX PROCESSES

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Oxidation-reduction (redox) chemical reactions create anaerobic conditions in wetlands and form the mottled color patterns of hydric soils. Despite their importance, students frequently have trouble relating the chemical reactions they study in class to soil colors seen in the field. Redox processes can be easily visualized when oxidation and reduction processes are viewed separately.

Oxidation occurs when bacteria “eat” organic tissues and essentially excrete an electron and a proton. Reduction occurs when the electrons and protons are added to other atoms such as oxygen, iron, or sulfur. Adding electrons and protons to molecular oxygen is a major process in upland soils and has no impact on soil color. However, in saturated soils reduction creates anaerobic conditions. Iron oxides form the reddish colors in upland soils, and when iron is reduced gray colors will form. The reduction of sulfur produces hydrogen sulfur gas which is detected by its rotten egg odor. Creation of anaerobic conditions requires that four conditions be met in soils: organic matter must be present, bacteria must be active, soils must be saturated, and the water should be stagnant. The same conditions are needed for iron reduction to occur and for hydrogen sulfide to be produced. Gray colors in hydric soil occur where the four conditions were met. When one of the conditions is missing, then the soils generally will not become anaerobic nor have gray colors. Examples will illustrate how redox processes change soil colors, and how to visualize where specific redox reactions occur in soils.

TEACHING HYDROLOGY IN WETLAND ECOLOGY COURSES: EMPHASIS ON GROUND WATER

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As a foundation for learning about wetland hydrology, students must develop an understanding of hydroperiods and water budgets. Input/output variables of precipitation, evapotranspiration, surface water, and tides are relatively easy to understand. Ground water poses a greater challenge because it requires three-dimensional thinking to grasp thoroughly. Coupled with Darcy’s Law, USGS Circular 1139 (Ground Water and Surface Water: a Single Resource) provides an excellent teaching resource. Three figures use a plan view to demonstrate construction of iso-potential lines and flow lines from water-table-well data. Students understand this quickly if they picture the well data as land-surface elevations, the iso-potential lines as elevation contours, and the flow lines as surface-water flows downhill – topics familiar from delineating watershed boundaries. Another figure provides a cross-sectional view of a similar setting, allowing introduction of the third dimension. This figure shows the land surface, water-table surface, and iso-potential lines that meet the water table, demonstrating that the hydraulic heads of the iso-potential lines support the water-table elevations. It is necessary to explain that each iso-potential line is actually a plane that extends out from the figure. Flow lines are shown perpendicular to the iso-potential lines. Water-table wells and nested piezometers shown in the figure provide an opportunity to explain the differences in their construction and in what they measure. Nested piezometers can also be used to explain vertical flow patterns in the cross-sectional diagram and introduce confining layers and flowing wells. Other figures demonstrate focused recharge, cones of depression, and landscape settings in which ground water interacts with wetlands.

Key Words: wetland education, hydrology, ground water

PROPOSAL FOR AN ACCREDITED MAJOR IN WETLAND SCIENCE AND MANAGEMENT

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Wetland science emerged as a distinct discipline in the 1980s. In response, courses addressing various aspects of wetland science and management were developed by universities, government agencies, and private firms. Professional certification of wetland scientists began in the mid-1990s to provide confirmation of the quality of education and experience of persons involved in regulatory, management, restoration/construction, and research involving wetland resources. The education requirements for certification and the need for persons with specific wetland training to fill an increasing number of wetland-related positions identified a critical need to develop curriculum guidelines for an undergraduate wetland science and management major for potential accreditation by the Society of Wetland Scientists. That proposed major contains options directed toward either wetland science or management. Both options include required basic courses to meet the general education requirements of many universities, required upper-level specialized courses that address critical aspects of physical and biological sciences applicable to wetlands, and a minimum of four additional upper-level specialized courses that can be used to tailor a degree to students' interests. The program would be administered by an independent review board that would develop guidelines and evaluate university applications for accreditation. Students that complete the required coursework will fulfill the education requirements for professional wetland scientist certification and possess qualifications that make them attractive candidates for graduate school or entry-level positions in wetland science or management. Universities that offer this degree program could gain an advantage in recruiting highly qualified students with an interest in natural resources.

Key Words: accredited wetland science and management major, education, training

USING A CONSTRUCTED WETLAND TO TEACH REAL-WORLD SCIENCE: DOES PEDAGOGICAL CONTEXT INFLUENCE STUDENT LEARNING AND MOTIVATION?

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The preparation students receive in typical college laboratory courses is often disconnected from the practice of science in academia and industry. To students, laboratory activities often have no clear relevance to social issues, each investigates a different topic, generates small amounts of data that address a limited set of questions, and allows only superficial quantitative treatment. We will present preliminary results from an NSF-funded Course, Curriculum, and Laboratory Improvement project meant to better prepare science students for the complex, real-world problems they will encounter in academia, government, or industry; problems that require strong quantitative skills and a thorough, realistic understanding of scientific inquiry. Our project involves classes in four disciplines (geography, biology, chemistry, and geology) studying Radford University's on-campus stormwater remediation wetland. We expected that studying a real-world problem, to which students themselves contribute (stormwater drains from student

parking lots), would engage and motivate students, resulting in greater student achievement and interest across disciplines. Moreover, confronting the quantitative complexity of a large, heterogeneous, and relatively long-term dataset would provide opportunities for students to gain real analytical skills and perhaps impress upon them the need for those skills. We will present preliminary data both on student's retention of specific course content and on student's attitudes and perceptions. We will also present some ideas for how this approach can be used in courses that are not part of a multidisciplinary project and at schools without an on-campus field site.