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Assessment and restoration of a neighborhood wetland invaded by exotic plant species

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Assessment and restoration of a neighborhood wetland invaded by exotic plant species

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ABSTRACT

The University of Arkansas Crop, Soil, and Environmental Sciences (CSES) Club adopted a local wetland in the spring of 2002 through the Fayetteville Parks and Recreation Department. This project has allowed students to interact with local community and governmental organizations as well as other academic departments within the university. Students have gained valuable laboratory and field experience through characterizing hydric soils, identifying bird and plant species, and analyzing water quality, soil nutrients, and microbial biomass. Under the main goal of restoring the wetland, the club has outlined both short and long-term objectives including soil and water assessments; removal of two invasive species—*Lonicera japonica* and *Festuca arundinacea*; revegetation of native species to provide wildlife habitat and forage; establishment of trails and educational signs; and community outreach. To facilitate removal of the invasive species, the club is experimenting with manual removal, implementing physical barriers to prevent plant photosynthesis, and working with city officials to obtain permission for selective use of herbicides. The adoption of the wetland has provided a catalyst for the CSES Club to organize, rebuild itself, and achieve its goals.

* Ryan Neal will graduate in December 2005 with a B.S. in environmental, soil, and water sciences.

† Kimberly R. Payne will graduate in August 2004 with a B.S. in environmental, soil, and water sciences.

§ Lorena Moreno will graduate in December 2005 with a B.S. in environmental, soil, and water sciences.

‡ Graham Duffy will graduate in August 2004 with a B.S. in environmental, soil, and water sciences.

‡‡ Jonathan Peck will graduate in May 2005 with a B.S. in environmental, soil, and water sciences.

§§ Mary C. Savin and Pengyin Chen, faculty mentors and sponsors, are assistant professors in the Department of Crop, Soil, and Environmental Sciences.

MEET THE STUDENT-AUTHORS



Ryan J. Neal, Primary Author

I grew up in Rogers, Ark., graduating from Rogers High School. I began my studies at the University of Arkansas in fall 2001 directly after my senior year and transferred into the Crop, Soil, and Environmental Sciences Department after my sophomore year. Since transferring I have had the opportunity to become involved in many aspects of the department including serving as the president of the CSES Club and attending the American Society of Agronomy annual meeting in Denver, Colo., where I competed as a group in the Student Poster Contest and received second place with a poster titled "Continued Assessment and Rehabilitation in a Neighborhood Wetland."

These opportunities have filled me with great excitement for the future; my plans are to possibly attend graduate school and later focus my attention on issues of sustainable agriculture or water quality. My major is in environmental, soil, and water sciences with a minor in global agriculture. I am currently receiving the Hinkle Scholarship through the department. I plan to study abroad in fall 2004 in New Zealand at Lincoln University, an agricultural college in Canterbury.



Kimberly R. Payne

I graduated in August 2004 with a B.S.A. degree in environmental, soil, and water sciences. I had the privilege of serving as the Crop, Soil, and Environmental Sciences (CSES) Club president during the 2003 calendar year. This experience and conducting independent research under the guidance of Dr. Mary C. Savin have provided me with skills that will serve me throughout the course of my career.

Student authors continue...

MEET THE STUDENT-AUTHORS, CONTINUED...



Lorena Moreno

I am a junior from Santa Cruz, Bolivia. I am majoring in environmental, soil, and water sciences. The Crop, Soil, and Environmental Sciences Club has been a positive experience in my college career. Through the club I have gained experience in team projects, research, and have made good friends.

I was born and raised in Eureka Springs, Ark. I majored in environmental, soil, and water sciences and graduated in summer 2004. I am also an active member of the Crop, Soil, and Environmental Sciences Club.



Graham Duffy

I was born in Little Rock, Ark. I grew up in Morrilton, Ark., where I graduated from high school in 1998. I am an environmental, soil, and water sciences major and my expected graduation is May 2005. I enjoy outdoor activities such as hunting, fishing, and boating.



Jonathan Peck

INTRODUCTION

In the spring of 2002, the Crop, Soil, and Environmental Sciences (CSES) Club at the University of Arkansas adopted the wetland in Bryce-Davis Park through the Fayetteville Parks and Recreation Department. The wetland is located on the west side of Fayetteville in a public park adjacent to a residential subdivision. The east side of the park contains a playground, a sheltered picnic area with park benches, and a basketball court. The west side of the park contains the wetland, which has been overrun with Japanese honeysuckle (*Lonicera japonica*) and tall fescue (*Festuca arundinacea*). The club is working in conjunction with the city to remove the invasive species and restore the wetland with native vegetation.

Wetlands serve many functions for the environment such as improving water quality, recharging groundwater, cycling nutrients, sequestering carbon, supporting food production, and providing critical habitat for many wildlife species. The four primary objectives of the club in regard to the wetland in Bryce-Davis Park are: 1) remove invasive species from wetland; 2) provide opportunities for experiential learning; 3) facilitate student research; and 4) encourage outreach by linking students with their community. In order to accomplish these objectives the club has been interacting with many organizations to restore the wetland. After two years of hard work, the club has taken many steps toward accomplishing these goals.

MATERIALS AND METHODS

Experiential Learning

Working in the wetland has given students the chance to experience first-hand many of the principles taught within the CSES Department. This type of experiential learning is made possible through “wetland workdays” held several times throughout the university’s fall and spring semesters. During these workdays, various specialists from within and outside the department have volunteered to share their expertise in a variety of subjects such as wetland delineation, soil and water analysis, weed control, bird identification, and habitat assessment.

Initially, to confirm the area as a wetland, plant, soil, and hydrological characteristics were investigated using Army Corp of Engineers and Natural Resources Conservation Service guidelines. Students evaluated the area and searched for wetland boundaries. Plant and soil scientists from within the CSES Department instructed students to research 1) the presence/absence of hydrophytic vegetation; 2) whether or not the soil had gleyed coloring which would indicate anaerobic conditions or water-logging; 3) any redoxomorphic features in the rhizosphere; and 4) the presence/absence of standing water or hydrologic indicators suggesting previously flooded conditions. Gathering this information allowed students to make reasonable conclusions as to where the transition between the upland and wetland occurred.

Following these initial field sessions, students conducted targeted sampling and lab analysis of soil-quality parameters. Soil samples collected in April 2003 were analyzed for properties including pH (1:10 soil:water ratio), moisture (following oven-drying at 105°C), total carbon and nitrogen (C & N, by combustion), Mehlich III-extractable phosphorus (P, analyzed by inductively coupled plasma spectroscopy), microbial biomass (using the chloroform-fumigation-extraction method), and dissolved organic C (extracted by 0.5 M K₂SO₄ and analyzed on a total organic C analyzer) and inorganic N (extracted at a 1:10 soil:extract ratio in 2M KCl and analyzed colorimetrically on a auto-nutrient analyzer, Table 1). Samples were collected at two-meter intervals on multiple transects within the wetland. Water-quality studies were conducted in the spring of 2002 to determine the nutrient status (N, P) and the possible presence of hydrocarbon contaminants (data not shown).

In order to assess the wetland’s importance as a natural habitat, a graduate student in ornithology at the university joined the club during one of the wetland workdays in April 2003 to catalog the many species of birds using the wetland as a source of forage and habitat (Table 2). The data collected will assist students in mon-

itoring how restoration efforts affect birds using the wetland in Bryce-Davis Park.

RESULTS AND DISCUSSION

Restoration

Restoration is the main goal for working in the wetland, but it is expected to be a long process since manual removal of invasive plants is time consuming. However, the club is proceeding by clearing away invasive species in “sections”. The Parks and Recreation Department has enhanced visibility of the wetland by removing mounds of soil that had been pushed in front of the wetland during the construction of a drainage ditch around the neighborhood. The club has planted native species in these cleared areas (Table 3).

Additionally, several plots have been set aside with the reintroduction of native grasses for the long-term evaluation of restoration on below-ground ecology and nutrient cycling (see related article in this issue of Discovery). In addition to the club’s work, a class in the Landscape Architecture Department constructed an observation deck, allowing the community to observe and appreciate the wetland ecosystem.

Research opportunities

There are many facets of this wetland that provide opportunities for students to conduct individual and group research projects with the help of advisors. Acquiring field and laboratory experience and establishing relationships with professors outside of class are some of the many benefits students receive by performing research. Along with conducting research come opportunities for undergraduate students to present projects at local and national scientific meetings and to publish their findings in scientific journals. Group research projects involve investigating alternative methods of removal for *L. japonica*. In the summer and fall of 2003 the club used a tarp to block sunlight and prevent photosynthesis to the plants of *L. japonica*. Club members have also been interacting with the city to evaluate the benefits and hazards of herbicide use and inquire about the selective use of Rodeo Roundup®. In addition, a controlled burn option was discussed with the Fayetteville Fire Department, the Parks and Recreation Department, Forest Service, and Nature Conservancy. It was concluded that this would not be an economical option. To date, manual removal has been most extensively used, but this method is very labor and time intensive.

Currently the most extensive individual research project involves evaluation of the soil microbial community and the effects of invasive species on the nutrient availability in soil. Initial results were presented in fall

2003 by a student member of the club at the American Society of Agronomy's (ASA) national annual meeting in Denver, Colo. Plans are to continue this project to evaluate long-term effects of revegetation with native grasses on nutrient availability in soil undergoing restoration. Other students who attended the ASA meeting presented a poster entitled "Continued Assessment and Rehabilitation in Neighborhood Wetland" and, for the second consecutive year, received second place in the ASA Student Club Poster Contest. Students were able to attend the meeting thanks to various fundraising events conducted by the club, including the sale of seed kits to local FFA chapters for educational purposes; contributions from the Registered Student Organization for ASA registration fees; and largely thanks to the generosity of the CSES Department.

Outreach

A final objective for the wetland is to encourage community involvement in the restoration process and enjoyment of the wetland at Bryce-Davis Park. In this effort, students have conducted neighborhood surveys to determine residents' responses to restoration efforts. A trail is being constructed that will provide Fayetteville residents a way to more fully experience this valuable ecosystem. Additionally, a local Boy Scout troop assisted with restoration efforts by revegetating an area adjacent to the observation deck with native grasses. These examples of outreach and the continuation of the restoration process promote connections with the citizenry, city officials, and other organizations to accomplish mutual goals and provide unique opportunities to establish relationships within and beyond the university.

Future Plans

In order to restore the wetland at Bryce-Davis Park, the club plans to continue investigating various removal techniques and revegetating with native plants. Students in the club will also continue to have opportunities to conduct their own individual research projects. Conducting research is a vital component of the adoption of the wetland. Other long-term goals include conducting annual assessments of wildlife populations as the club attempts to promote native plant and wildlife diversity. Outreach goals will be expanded so that this wetland can serve as an outdoor classroom for people of all ages for education on the importance of wetlands in the environment. This may be accomplished by the establishment of a nature trail, with signs along the trail informing visitors of wetland benefits and aiding them in identifying native plants and wildlife.

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- Rob Doster for bird identification.

Table 1. Soil properties of the wetland in Bryce-Davis Park in Fayetteville, Ark. in April, 2003 (n = 11)

Soil property	Mean	Standard deviation
Dissolved organic carbon (C, $\mu\text{g g}^{-1}$)	35.25	18.78
Inorganic nitrogen (N, $\mu\text{g g}^{-1}$)	3.99	2.81
Mehlich-III extractable phosphorus ($\mu\text{g g}^{-1}$)	20.48	8.74
Microbial biomass C ($\mu\text{g g}^{-1}$)	115.50	50.44
Microbial biomass N ($\mu\text{g g}^{-1}$)	12.48	10.00
Microbial biomass C:N	13.04	14.64
Moisture (g g^{-1})	0.44	0.18
pH	6.10	0.60
Soil C:N ratio	12.73	0.38
Total C (%)	2.72	0.75
Total N (%)	0.21	0.06

Table 2. Bird species identified in the Bryce-Davis Park wetland in Fayetteville, Ark., in April 2003

Scientific name	Common name
<i>Actitis macularia</i>	Spotted sandpiper
<i>Agelaius phoeniceus</i>	Red-winged blackbird
<i>Butorides virescens</i>	Green heron
<i>Cardinalis cardinalis</i>	Northern cardinal
<i>Carduelis tristis</i>	American goldfinch
<i>Carpodacus mexicanus</i>	House finch
<i>Cyanocitta cristata</i>	Blue jay
<i>Erithacus rubecula</i>	Robin
<i>Gallinago delicata</i>	Wilson's snipe
<i>Geothlypis trichas</i>	Common yellowthroat
<i>Hirundo rustica</i>	Barn swallow
<i>Poecile carolinensis</i>	Carolina chickadee
<i>Quiscalus quiscula</i>	Common grackle
<i>Seiurus noveboracensis</i>	Northern waterthrush
<i>Thryothorus ludovicianus</i>	Carolina wren

Table 3. Native plant species reintroduced into the wetland at Bryce-Davis Park in Fayetteville, Ark., by the Crop, Soil, and Environmental Sciences Club in 2003

Scientific name	Common name	Plant type	Wetland indicator status
<i>Campsis radicans</i>	Trumpet creeper	Vine	Facultative
<i>Amorpha canescens</i>	Lead plant	Shrub	ND ¹
<i>Callicarpa</i> sp.	Beauty berry	Shrub	ND
<i>Cephalanthus occidentalis</i>	Buttonbush	Shrub	Obligate wetland
<i>Lindera</i>	Spicebush	Shrub	ND
<i>Ilex deciduas.</i>	Possum haw	Shrub	Facultative wetland
<i>Carpinus caroliniana</i>	Blue beech	Tree	ND
<i>Panicum virgatum</i>	Switchgrass	Grass	Facultative
<i>Sorghastrum</i>	Indian grass	Grass	ND
<i>Andropogon gerardii</i>	Big bluestem	Grass	Facultative
<i>Schizachyrium scoparium</i>	Little bluestem	Grass	Facultative upland

¹ ND=wetland indicator status not determined