ACS Reform of Introductory Science courses for Non-Majors Course Mini-grants
This program is supported by the W. M. Keck Foundation of Los Angeles

Evaluation of ecosystem services as the objective of field and laboratory activities to be added to an introductory course in Environmental Sciences

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Date of the proposed period of grant: August 2005- May 2006

Summary

This proposal requests funds to develop new and timely field and laboratory activities for an introductory environmental science course for non-science majors. The main objective of these activities will be field-based evaluation of ecosystem services. It is expected that this new lab will connect the classroom to the world outside and will generate a deeper appreciation of "hidden" ecosystem services. Equally important, through the process of collecting and analyzing data, i.e. hands-on experience and critical thinking, the students will develop a greater knowledge and those skills than a lecture-based course cannot foster.

Rhodes College is the perfect place to accomplish the goals of this proposal. Non-science majors have expressed the desire to have field and laboratory activities to complement the lecture-based course in environmental sciences. Overton Park, the field location, is just across the street from the campus and has a significant stand of old growth forest. The Science Departments strongly support course with laboratories for non-science majors and will make their laboratory facilities, including a GIS laboratory, available to the students.

A web site will be created for the course and will provide a space where to share the results of the *ESlab* with other ACS institutions interested in developing similar field and laboratory activities for their students.

Project description

Introduction

A lecture-based environmental science course does not fully bridge the distance between the theoretical content and the application of that information. Students learning, retention, and appreciation is enhanced when they connect with the world around, by making their own observations, performing their own experiments, and drawing their conclusions. As a result of these activities, students develop greater knowledge, skills and attitudes based on critical thinking about their experience and gain a critical understanding of local natural systems and the environmental issues associated with them.

Goals

This proposal requests funds to develop field and laboratory activities to complement the Introduction to Environmental Sciences (ES) course at Rhodes College. Presently, this course is lecture-based and designed for non-science majors to fulfill their science requirement. As an introductory course for a planned ES minor, this course will be offered with field and laboratory activities (*ESla*b) to provide a hands-on experience to non-science majors.

Background and significance

Ecosystem services, such as purification of water and air, regulation of climate, and production and maintenance of biodiversity, are underappreciated and taken for granted, even though they are critical to the survival of all living organisms (Daily et al. 2002). One of the major reasons for our neglect has been the absence of an economic valuation of these services. Ecosystem market goods and services, such as timber or hunting, have easily been quantified. Non-market ecosystem services, however, are intangible and, until recently, they have not been accounted in the cost-benefit analyses of resources utilization. Not everybody agrees that we should and can assign a monetary value to the ecosystem services, but their "free" availability has contributed to our neglect, lack of appreciation, and, often, their destruction.

Recent attempts to estimate the economic value of ecosystem services, however, have brought the "hidden" values of natural system to our attention. Costanza et al. (1997) have estimated the global ecosystem services at $33.3 trillion. A class discussion on Costanza's article can be stimulating but the students are often unable to scale the significance of that valuation down to

the natural ecosystems surrounding them. Like many of us, they take those ecosystem services for granted. Field and laboratory experiences, which guide the students through the process of collecting and analyzing data, can generate not only an economic estimate of local ecosystem services but also a deeper appreciation of these ecosystem's services.

It is anticipated that students will gain, through their field and laboratory experiences, the ability to:

- understand and, to a certain extent, "measure" the economic value of the natural world around them;
- appreciate the challenges and rewards of doing field-based research;
- connect the theory in class with the practice in the field; and
- recognize the complexity of interdisciplinary research.

Description of field experience

The class field site will be Overton Park, a 170 acres of forest located across the street from Rhodes College. Overton Park is the largest green space in urban Memphis. In 2003, this area was designated as a State of Tennessee Dedicated Level I Arboretum. The old forest area is a significant feature of Tennessee forests; indeed, it is of such significance that its existence led to the re-routing of Interstate Highway 40. Currently, faculty and students of Rhodes College are completing a project that involves a GIS inventory of invasive plants and their removal from the park. For the proposed *ESlab* the goal of the students' field and lab experiences will be the economic valuation of selective ecosystem services provided by Overton Forest.

Proposed field and laboratory activities

The lab will be divided into two sections.

Section A. During the first 7 weeks the students will survey the forest. They will collect and analyze data to estimate selected services provided by a forested ecosystem such as:

- Climate regulation: carbon dioxide removal
- Water purification
- Recreation

The funds provided by ACS will be utilized to locate the sites for field work, for purchasing necessary equipment, determining appropriate research methods for data collection, and writing lab exercises.

A. *Example of methods of data analysis for carbon sequestration by Overton Park, Memphis, TN*

Four plots will be randomly selected in the forest to be representative of the entire site. In each of the four plots, species composition, diameter at breast height (dbh), and tree cores will be collected and measured. This field collection and available biomass regression equations will provide average annual growth for the tree species. Annual carbon sequestration will be calculated based on known carbon composition for tree species.

B. *Example of method of data analysis for water purification*.

The same approach to measuring carbon sequestration will be used to determining the water purification services provided by Overton Park. Sources of water input, i.e. urban runoff, into the forest and output, i.e. stream, will be located. Using the Hydrolab multiprobe for monitoring water quality in the environment, change in water chemistry will be measured. The Biology Department has this instrument available for research.

C. *Example of method of data analysis for recreational values*

Recreation values will be calculated by using the Contingency Valuation Method (CVM). The CVM is described by Portney (1994) as “the use of sample surveys (questionnaires) to

elicit the willingness of respondents to pay for (generally) hypothetical projects or programs. The name of the method refers to the fact that the values revealed by respondents are contingent upon the constructed or simulated market presented in the survey." As part of planning for the new laboratories, available surveys in this field will be researched and assessed.

Section B. During the last weeks of the semester the students, in addition to the CVM, will learn and apply an additional method to estimate the economic values of the forest ecosystem services, the Replacement Cost Method (RCM). RCM estimate how much we pay for market and technological services, such as carbon sequestration technologies that are not any longer provided by natural systems.

For this reason, the class will visit two sites: *Memphis Power Plant* to learn about carbon capture technologies, and *Water Waste Treatment Plant*. The students will calculate the costs of building and maintaining those facilities and, by using the RCM, will estimate the economic value of ecosystem services such as water purification and carbon sequestration. An additional exercise might be the evaluation of ecosystem services lost to urban sprawl in Memphis.

Timeline

Planning of these new laboratories will start during the Summer 2005, and will continue during the academic year 2005-2006. Revision of the course will be completed by the Summer 2006, and the new revised course will be offered in the Fall 2006.

By the end of September 2005, the forested area at Overton Park will be surveyed by the faculty and the plot's location will be identified. During the fall semester, the faculty, with the

assistance of the undergraduate intern, will research appropriate research methods for data collection, and write the lab exercises. At the same time the website will be developed, so that the laboratories will be ready to go by the end of spring semester.

Impact on the Institution, including number of students per year

Introduction to Environmental Sciences, a non-major class with an enrollment of 20/25 has been in the past few years consistently filled. Rhodes College is developing a minor in Environmental Science, open to non-major and major science students. *ESlab* will have the unique distinction of attracting both non-science majors and science majors, and fulfill their respective college degree requirements for science and social sciences. In addition the website will offer the opportunity to share the results of the *ESlab* with other ACS institutions that might be interested in developing similar field and laboratory activities for their students.

Evidence of Institutional support

The Biology Department and its chair, Dr. Chuck Stinemetz, support the development of these field and laboratory experiences. As a result of this commitment, the *ESlab* students will have access to the facilities available in the Science Departments., such as laboratories with computers, and a GIS laboratory updated with the latest GIS software and plotter.

Evaluation and dissemination

The primary goal of developing laboratories for the ES introductory class is to provide non-science majors with the opportunity to experience how data are generated and interpreted in

environmental sciences. Dissemination will occur through the creation of a website and the integration of the Science Values Inventory (SVI) assessment tool developed by faculty at Drury University.

The course website will make all information about field and laboratories activities available to any interested faculty and student. Comments and suggestions will be actively requested and shared to generate discussion on the selection and content of the laboratories. Ultimately, from other ecosystems studies could be added to the website to offer a more complete estimate of the diverse "hidden" values of our natural ecosystems.

The Science Values Inventory (SVI) tool (ACS, 2003) will be adopted in the revised course, to assess the science learning of on-science majors and the need for improvements. To learn as to best integrate this tool in the course, the teaching faculty will study the results of tryouts conducted by Drury University since Spring 2004. Meetings and workshops on this topic will be an additional avenue available to the faculty to best contribute to the ACS efforts to improve the teaching of science to non-science majors.

Literature Cited

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