A Blueprint for Universities: Interdisciplinary Approaches to Biodiversity Challenges

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Threats to biodiversity and natural resources are widespread and pervasive among countries and regions, and these threats are complex. Universities have long played three prominent roles in addressing past resource issues: instruction, research, and outreach are the three primary missions for most universities, and certainly are the core missions of land-grant universities.

Past approaches to organization of administrative units within universities have fallen along disciplinary lines. Colleges of engineering, agriculture, fine arts, and social and behavioral sciences are found at many campuses. Within these, more narrowly focused departments reside with even more specialized faculty within them. Past rewards for academic success were driven by excellence in teaching disciplinary courses, publishing in disciplinary journals, and attending disciplinary conferences. Granting of indefinite tenure that allowed the academic community to express views freely was the ultimate reward for disciplinary success.

These aspects of the history of our academic culture persist on many campuses in this and other countries, but significant changes are occurring. Many campuses now have developed mechanisms for interdisciplinary programs that span multiple disciplines. Curricula are becoming less rigid and more responsive to the needs of future employers faced with complex interdisciplinary problems.

The distinctions among instruction, research, and outreach are becoming blurred as students and faculty work together on complex problems in their own communities. Indeed, as these changes occur,4 campuses are faced with finding a balance that allows maintenance of disciplinary strengths while having the capacity to address interdisciplinary issues and opportunities. This balance is all the more difficult to achieve because university support from state funds is restricted, resulting in the need to refocus faculty interests or force campuses to collaborate, or both.

Curricular Changes

Many natural resources curricula are being revised to establish a balance between adequate depth in a discipline and breadth among disciplines. Curricula often require general education courses to ensure breadth, as well as courses in communication skills, computer skills, and emerging techniques. In addition, new courses have been developed that purposefully place students from different majors in the same course and require students to work together to solve an interdisciplinary problem in group settings (e.g., ecosystem management).

Repeated opportunities for teamwork are offered at various stages of a student’s tenure in a program, so that a final capstone course is truly the final polished session in preparation for work on an interdisciplinary team with an agency, NGO, industry, or a research project as a graduate student.

These changes in curricula are the result of a number of changes that have occurred in workforce planning within agencies as well as an evolving interest in interdisciplinary research among some university faculty and agency scientists. Indeed, even the names of departments and undergraduate majors have changed recently at a number of campuses to reflect a broader focus. And new majors have been developed in response to these interests (e.g., conservation biology, environmental sciences, environmental studies, etc.).

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Disciplinary expertise remains important to employers, but university programs are recognizing that a broad suite of skills are needed by employers that go beyond traditional disciplinary lines. With both tighter budgets and greater demands by employers for broad skill sets, teaching priorities must be set within programs. Not all past courses can remain as new courses are developed. This has led to a greater recognition that programs must collaborate to offer courses across campuses, often using distance education technologies. Web-based and compressed video technologies are not suited to education of students in all courses, but identification of key courses that offer courses on one campus could benefit students on many other campuses expands opportunities among campuses.

This approach is being taken among northeast universities at this time and is being facilitated by a USDA Higher Education Challenge Grant. As faculty and administrators see the benefit of intercampus collaboration, then campus ownership of particular disciplinary strengths become blurred and intercampus research and outreach opportunities may emerge.

In summary, natural resources instructional goals are designed to produce graduates who can communicate and work effectively with others on teams to resolve complex natural resource problems. Students realize that to be a successful team member requires a breadth of knowledge, understanding of specialized areas of expertise, effective communication, and especially trust among team members. The measure of success in achieving those goals will be not through simply offering a smorgasbord of courses and assuming that students have skills necessary upon graduation, but rather through real-world problem solving and contributing to local complex problems. Indeed, community service learning is becoming a component of many courses to ensure that students walk into the workplace prepared to address real world problems.

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Research
University research initiatives traditionally have been categorized conveniently as basic and applied. Federal formula funds provided through congressionally appropriated have been in response to research needs in forestry (McIntire-Stennis) and agriculture (Hatch Act). National Science Foundation programs traditionally have been focused more on basic research in the sciences and technology. These sources of funds result important to funding both short- and long-term research to address key issues and theories in natural systems. Past funding programs largely have been disciplinary in nature because scientists tended to be disciplinary and the university programs within which they worked were disciplinary. Information gained from these research programs did indeed contribute to a better understanding of states and processes within natural and managed systems, and in so doing contributed to the information base needed to even conceptional interdisciplinary solutions to contemporary problems.

Recently, new initiatives have been developed to enhance opportunities for interdisciplinary work to address threats to biodiversity and human health and welfare. The NSF Bio-complexity program, the Ecosystems program within USDA Competitive Grants, and recent USEPA collaborative have provided funds to encourage team approaches to research on complex issues. In addition, grassroots efforts by scientists have led to collaborative approaches. Policy research initiatives such as the Coastal Landscape Analysis and Modeling Systems Project was developed within the U.S. Forest Service Research Station and includes university and agency scientists as well as managers and stakeholders from throughout coastal Oregon (Spies et al. 2002). Funding for this project came from a variety of sources, but began from scientist initiatives and support within the agency (Spies et al. 2002). In efforts such as these, teams of students, scientists, researchers, managers, and decision-makers work together to understand the changes in spatial patterns of resources over large multi-ownership areas over time.

The socioeconomic and biophysical resources resulting from current and alternative policies can be compared among alternative futures to make informed changes in policy. In this manner, all components of the system encompassing the problem are represented on the team and the solutions to the problem represent the synergy from the team's collaboration. This is quite different from having a multi-disciplinary approach where individual scientists work on the various components individually, and then try to assemble the solution after the disciplinary pieces are understood. The interdisciplinary, teamwork approach takes more time, effort, and communication, but can produce a store comprehensive and credible result.

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Further, the interdisciplinary approach provides a conceptual framework that directs research to meet the needs of the group, and allows researchers to prioritize research efforts to fill specific information needs relative to the issue at hand. There are many excellent approaches to testing hypotheses that advance disciplinary knowledge, and these should be explored. Working within an interdisciplinary setting allows scientists to focus on the key questions needed by the group.

Given the growing interest and support for interdisciplinary research, why do we not see this area growing more rapidly? Two factors probably limit the proliferation of interdisciplinary research approaches to advancing knowledge. First, the reward structure for university advancement focuses on senior-authored publications and principal investigators on outside grants and contracts. This must change, especially for junior faculty members involved in team efforts. Recognition of the time and effort needed to advance a successful team effort is key to continuation, and proliferation of these efforts.

Second, only now is a new generation of scientists who have received graduate training within these team research projects entering the workforce. There is a strong cultural imprint on students moving into research positions. Most of the current scientists in the natural resources have received training and positive reinforcement for disciplinary work. Changes to interdisciplinary work in mid-career can be difficult for some individuals. Mentoring of undergraduates and graduate students through involvement in team research efforts can lead to a new generation of scientists who begin their careers with a team philosophy.

In summary, research approaches to complex natural resources problems require new approaches to developing and synthesizing knowledge. Universities should train students to work within this framework as educators, politicians, managers, and/or researchers. Past models of the requirements to be a successful scientist may not always be appropriate, and reward systems must be adaptable to these new approaches. Participation on grant proposal development, data collection, and publications resulting from team efforts must be viewed highly by university administration when considering scientists for promotion. Further, students involved in these efforts should be recognized for their contributions to a collective solution that requires communication, knowledge, and trust.

Threats to biodiversity conservation and human health and welfare should be addressed by integrating teaching, research, and outreach when finding solutions to these problems.

Outreach

Providing the information to managers, policy makers, affected cultures, and other scientists who are addressing complex natural resources problems should be an integral component of university teaching and research. Funding for some USDA Competitive Grant funds requires an outreach component. Capstone courses within a community service/learning framework provide information to managers that can be applied to current problems. The distinction among teaching and research faculty and extension specialists at land grant universities is not as clear as it once was. Threats to biodiversity conservation and human health and welfare should be addressed by integrating teaching, research, and outreach when finding solutions to these problems. The challenge is to make outreach efforts effective given the complexity of the issues and the numbers of stakeholders.

For instance, consider a project that addresses threats to biodiversity from continued parcelization and development of eastern hardwood forests in the U.S. Massachusetts alone has 235,000 forest landowners. How do we provide information in a manner that will produce changes in land management decisions beneficial to a suite of human values? Clearly, new and innovative approaches must be considered. Although web-based and media-based information can be important to information transfer, it only will be effective if people look for it. With large complex issues, one-on-one contact may seem impossible. One possibility is to engage community leaders in intensive training and involvement in research programs. These community leaders then are expected to interact with key politicians, landowners, and interest groups in their communities. This approach has been taken in Massachusetts and Connecticut within the Converis programs run by Dave Kirttredge and Steve Broderick. They have demonstrated significant effects on land management decisions on thousands of acres of private land in the northeastern U.S.

In order to facilitate the effectiveness of the research (active, e.g., Covets) and passive (e.g., web-based) outreach, we should be developing new technologies (e.g., data visualization, remote sensing, and bioinformatics) to facilitate transfer of complex information to the public. Use of tools such as GIS, stand and landscape visualization, and movies of landscape change over time can provide a quick understanding of contemporary issues and solutions with-
Outreach also occurs among disciplines and among interdisciplinary groups. Open source problem solving that involves participation among scientists in web-based advancement toward solutions to complex problems is similar to LINUX-based computer programming approaches. Anyone can contribute to advancing knowledge and approaching a solution to a given problem, so long as they freely post their information and solution to the problem for others to see and evaluate. With many brains focused on a problem, conceivably an acceptable solution can be found more quickly than using traditional research and outreach approaches.

Finally, one component of outreach that needs additional attention is management of existing information. The web has advanced us tremendously in this regard. However, there is a tremendous amount of information that simply is unavailable to others because it is not archived and accessible (either openly accessible or password protected). Development of data banks where data can be archived as a pre-requisite to peer-review publication can facilitate the use of meta-analysis and other data-mining techniques to address future problems. Imagine the wealth of readily accessible information if authors were required to archive data and metadata in a data bank as a prerequisite to publication in peer-review journals. If we started now, then 20 years from now these meta analyses will not only be possible, they could help direct future research by allowing scientists to quickly determine if additional studies in a particular area will likely change our understanding of a state or process. These sorts of outreach efforts enhance research and teaching opportunities and advance our ability to address new and emerging issues with more efficiency.

Summary

Contemporary threats to biodiversity conservation and sustainable use of natural resources are complex and require individuals trained to be effective team members developing new information that can be integrated to produce acceptable solutions to problems. Solutions viewed as acceptable now may be unacceptable in the future or in a different location or culture. Hence, individuals trained at universities need to be able to communicate effectively and realize that solutions to natural resources problems will evolve as human values and policies evolve. Conversely, those same students, through their effectiveness as team members can influence human values and natural resources policies by offering alternative solutions to contemporary problems. The university challenge is to be an active and adaptable participant in training team members and finding solutions and then disseminating information to the affected public. Changes in the university reward system and other engrained attributes of university culture will be necessary to ensure that we continue to advance toward meeting that challenge.

Literature Cited