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A Perspective on Interdisciplinary Science

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This has proven to be a difficult piece to write. It not only challenges my ability to fundamentally communicate how good science is formulated, but it also challenges my ability to communicate how a variety of personal skills is blended into a special way of viewing the world. Successful interdisciplinary research demands good science as much as it demands personal values related to patience, trust, responsibility, and honesty, all the attributes related to being a respected citizen (Naiman and others 1998). Nearly everyone seems inherently to know these attributes are important, but putting them into practice is another matter altogether.

The editors have asked that several issues be addressed concerning interdisciplinary research, and I have added a brief preamble. I address each issue while at the same time interjecting personal lessons and observations that have either been learned or developed over my professional career. My only objective is to share experiences in the hope that, by doing so, it will make a difference to ecosystem science.

A Preamble

In the current debate over the scope of watershed and ecosystem management (Christensen and others 1996; Dale and others 2000), it is widely recognized that there are significant technical and cultural constraints to effective implementation. These constraints are related to such important issues as identifying appropriate spatial and temporal scales, monitoring and assessment, developing an adaptive management process, and developing cultural values and philosophies that allow management to be successful (Levin 1993), none of which can be resolved by a single discipline. The ability of a rapidly increasing human population to dramatically impact local, regional, and global ecosystems requires an interdisciplinary perspective for understanding and management if there is to be a healthy resource base for future generations.

It is now recognized that in human-dominated regions, the land mosaics (that is, patches and boundaries) are created by a mixture of cultural practices, traditions, myths, and institutions. The spatial extent and temporal duration of each patch and boundary type are ultimately determined by laws, regulations, taxation, technologies, cultural values and beliefs, and traditional land-use practices that pertain to the use of natural resources (Dale and others 2000). Understanding this situation and reliably predicting its implications demand an interdisciplinary perspective, and that is one of the greatest challenges facing the next generation of ecosystem researchers.

Developing an integrated socioenvironmental perspective means confronting and resolving several important issues. For example, how does one address social and ecological literacy, the accommodation of changing cultural values, the increasing migration of peoples away from traditional homelands and cultures (that is, cultural mixing), the balancing of consumption rates with population growth, the weathering of political change, and the establishment of knowledge-based cooperative institutions (Lee 1993). These issues are closely interrelated and cannot be resolved separately, and collectively they have an enormous impact on the environment. Because these issues are outside of traditional ecological science, they require a broad-based research team that has experience working

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together and that includes members from outside the traditional academic setting (Naiman and others 1998).

How to implement an integrated program that addresses these and related issues may not be immediately apparent because each situation has a unique set of issues to resolve. Designing research efforts that will actually be used by the sectors of society that make and implement higher order decisions requires an understanding of the workings of the decision-making system that is at least as insightful and fully developed as the corresponding understanding of system ecological behavior. Unfortunately, this is beyond the training and skills of most physical and biological scientists. There are, however, basic principles and practical approaches to guide the development of effective interdisciplinary research that are included below in my responses to the editors' questions.

What Are the Benefits and Pitfalls of Conducting Interdisciplinary Research?

Perhaps the greatest benefit is the opportunity to view issues from many and often very different perspectives. This means having to understand issues and their causes, to temper one's viewpoint with those from other disciplines, and to build a response that will produce a satisfactory solution for now and the future. What could be more challenging? Today the rapidly changing intersection of science, society, and management provides a persistent intellectual challenge at one of the most dynamic times in the history of the world. This means conducting *good* science that is not only *useful* but is also *used* to resolve current and emerging issues. In my experience one's greatest intellectual growth occurs when presented with challenges. Understanding the causes and consequences of emerging problems and finding ways to resolve them is a laudable challenge.

There are pitfalls, however, but they are not without rewards if they are resolved. Major pitfalls include the (a) time necessary to learn about other disciplines and their vocabulary. It can take a year or more to get team members to use the same definition for the same words. (b) Not all team members are of the same intellectual caliber or have the same commitment to team-oriented research. This means that team leadership must be willing to shoulder more of the load and, at times, make tough decisions about the continuation of support or membership. (c) Research results take longer to publish because of the number of people and personal styles involved, and there can only be one first author. This latter consideration often is of concern to younger researchers, but it does not have to be so. (d) The challenge of actually organizing and performing the work (as hard as that is) is often subordinate to the challenge of incorporating social and political insights into the form the science takes. This can be a major problem in dealing with some team members who refuse to address broader issues. (e) Finally, the commitment of time and energy into understanding other disciplines invariably detracts from the time and commitment put into maximizing one's own mastery of a single discipline. The result is a perception that interdisciplinary scientists are less competent or accomplished, and that interdisciplinary science is less exacting.

There is also the time and effort involved in putting the research program together. One must realize that the time, effort, and costs associated with building the team and conducting the research will exceed the institutional attention span of most funding agencies and decision makers. It takes significantly longer due to the travel and meetings needed to reach agreement on a central theme, to decide on specific activities and other logistical details (such as experimental designs and budgets), and then to cooperate. Everyone needs to share the same general vision but have specific parts of the overall project that they, as individuals, have "ownership." And then comes the proposal review. As with any other proposal, the work plan needs to be concise, seamless, and well crafted to be successful. This requires special leadership by one person or a small group to assemble the final product.

Obstacles to Publication of Interdisciplinary Research

Most of the serious problems arise within the group. (a) A lack of patience, understanding, trust and respect, or unspoken jealousies and perceived threats to someone's position or authority can be devastating. These are people skills, and it is essential to recognize and deal with such maladies as early as possible. (b) Individual variations in depth of commitment to the project often slow the synthesis. Everyone is busy and individuals have different priorities. Explicit recognition of this helps minimize any disruptions. (c) Disagreements over ownership of ideas and data will arise, and unless the guidelines are agreed to in advance, there will be strife. (d) Invalidation of individual initiative will occur if the leadership is too controlling or does not seek out the views of others in a way that is nonthreatening.

Personally, I think there are very few obstacles to publication that are external to the research team. Fortunately, there is an increasing number of journals and reviewers competent to judge manuscripts. Occasionally, one encounters a reviewer that may not understand the entire article, but a good editor will recognize this problem and seek an additional review. In any case, if the manuscript is well written and tells a coherent story, it will communicate the results in an understandable manner, not only within a discipline but among disciplines. This can be accomplished by having a lead author who writes well enough to weave the messages from team members into a coherent whole.

Strategies for Overcoming These Obstacles

I continue to believe that the best means to overcome obstacles internal to the group is regular, informal communication. There are several approaches: (a) Encourage everyone to express how they see their role in the larger project. If another person feels uncomfortable about someone else's role, then make it clear that it is their responsibility to say so in a respectful and tactful manner. (b) Try to work toward consensus, making sure everyone knows the guidelines for building a consensus. This is often done in a generative atmosphere where everyone contributes to the solution. (c) Decide on the "currency" or type of information that will be delivered from one discipline to another, its scope, and when it will be delivered. The Land-Use Change Analysis System (LUCAS) provides a good example (Figure 1) where economists, sociologists, and ecologists built an integrated model that respected the types of information generated by each subgroup (Berry and others 1996; Turner and others 1996).

Suggestions for Improving Cross-Disciplinary Review

Review continues to be a major problem, more at the proposal than publication stage, I believe. My only suggestion is rather weak. It is for program managers and editors to actively encourage the development of a cadre of younger reviewers with an explicit interest in interdisciplinary research. Of course, these reviews will need to be blended with those from more disciplinary reviewers that have the ability to comment on the veracity of techniques and approaches.

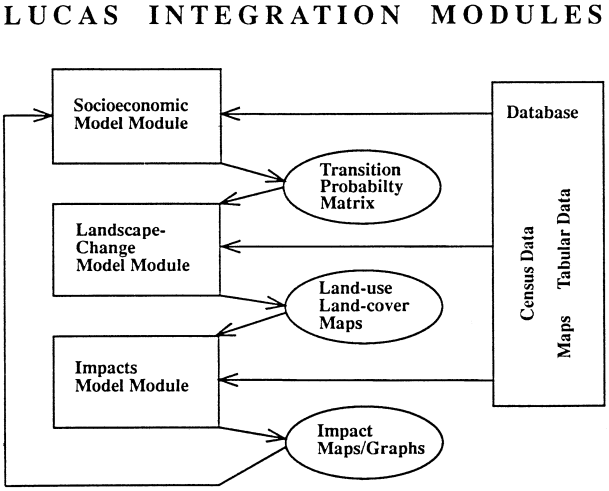

Figure 1. Integration of social, economic, and environmental aspects of watershed management can be accomplished with the use of the Land-Use Change Analysis System (LUCAS) modeling environment [from Berry and others (1996)].

Advice You Can Offer from Your Own Experience to Those Embarking Upon Interdisciplinary Research Projects

As I write this perspective, I am just finishing an interdisciplinary work plan with eight other team members from the United States and South Africa. We are embarking on an 8-year program investigating the role of riparian corridors in the savanna landscape of Kruger National Park. In addition to nearly 5 years of formal and informal contact, it has taken three meetings over 6 months, numerous trips to visit local sites, and (most recently) nearly 2 weeks of intense discussion, writing, disagreeing (yes, and even arguing at times), revising work plans, compromise, building shared budgets, and establishing priorities. At the same time, this group (which has not worked together as a team before) is building trust, respect, cultural understanding, and patience. Although, for the most part, we are comfortable with each other, I estimate it will take another year or so before most activities will be moving relatively smoothly. Why? First, we are individuals with our own histories and biases. We are coming together voluntarily with similar yet unique professional interests. Second, we are somewhat divided by a common language. Even though we use the same words (such as ecosystem, habitat, flux, and so forth), they have slightly different meanings within our own institutional and disciplinary settings. It will take some time before individual

definitions merge into a common lexicon. These lessons are not new. I, as well as others, have faced them over and over again as we attempt to bring groups together to tackle large and increasingly complex issues. As one can imagine, it becomes even more challenging when there are two or more languages and cultures involved.

So what are the lessons learned over the years as well as in this most recent endeavor? Surprisingly, they are simple to write down but hard to put into consistent practice. And I freely admit that I have not mastered them. They are:

1. Make a conscious commitment to cooperate and, as you do this, visualize and acknowledge the personal and professional sacrifices as well as the rewards.
2. Cooperate with colleagues who have a similar level of commitment to team research. Team research is freely sharing ideas, a commitment to excellence, being honest, and having an arena of mutual respect in which to work.
3. Choose people that are willing to assume, and share, leadership and responsibility. And, as a team leader, be willing to share them without remorse or resentment.
4. Take the time to educate new team members and to ensure their ownership of a significant aspect of the project. Build confidence as well as ownership.
5. Find ways to encourage continuous communication of new results and ideas; even though one may not always agree, do validate the person as well as his/her willingness to share.
6. Never forget that we are all individuals with our own strengths and weaknesses. Value everyone in the group, not just those with the "best" work habits or ideas.
7. Learn how to continue *learning* in an ever-changing world (Michael 1995). Practice tact and patience; demonstrate respect.

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REFERENCES

Berry M, Flamm R, Hazen B, MacIntyre R. 1996. LUCAS: a system for modeling land-use change. IEEE Computational Sci Eng 3:24–35.

Christensen NL, Bartuska AM, Brown JH, Carpenter S, D'Antonio C, Francis R, Franklin JF, MacMahon JA, Noss RF, Parsons DJ, Peterson CH, Turner MG, Woodmansee RG. 1996. The report of the Ecological Society of America committee on the scientific basis for ecosystem management. Ecol Appl 6:665–91.

Dale VH, Brown S, Haeuber RA, Hobbs NT, Huntly N, Naiman RJ, Riebsame WE, Turner MG, Valone TJ. 2000. Ecological principles and guidelines for managing the use of land. Ecol Appl, in press.

Lee KN. 1993. Compass and gyroscope. Island Press, Washington, D.C.

Levin SA, editor. 1993. Science and sustainability. Ecol Appl 3:550–89.

Michael DN. 1995. Barriers and bridges to learning in a turbulent human ecology. In: Gunderson LH, Holling CS, Light SS, editors. Barriers and bridges to the renewal of ecosystems and institutions. New York: Columbia University Press, p 461–85.

Naiman RJ, Bisson PA, Lee RG, Turner MG. 1998. Watershed management. In: Naiman RJ, Bilby RE, editors. River ecology and management: lessons from the Pacific coastal ecoregion. New York: Springer-Verlag. p 642–61.

Turner MG, Wear DN, Flamm RO. 1996. Land ownership and land-cover change in the Southern Appalachian Highlands and the Olympic Peninsula. Ecol Appl 6:1150–72.