Managing Interdisciplinary Research: Lessons Learned from the EPA-STAR /NSF/USDA Water and Watersheds Research Program

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Abstract

As environmental problems became more complex, interdisciplinary research teams were recognized as key elements needed to solve environmental problems. With the recognition that interdisciplinary research was essential to laying the scientific foundation for solving complex watershed problems the U.S. EPA's *Science to Achieve Results (STAR)* program in partnership with the NSF initiated the Water and Watersheds research program in 1995. In 1998, the USDA joined the partnership. A major goal of the program was to promote integration across the biological, physical, and social sciences in the area of watershed management. In October 2000, the EPA sponsored a workshop comprised of 10 of the Principal Investigators (PIs) to investigate the issues of managing interdisciplinary research teams. The output of the workshop was a *Lessons Learned* document that reviews the scientific, personnel, administrative issues of managing complex grants.

Keywords: watershed, research management, interdisciplinary

Introduction

Over the last few decades, approaches to environmental management have significantly changed. Traditional approaches to watershed research have focused on individual scientists testing hypotheses within single disciplines (Popper 1959). As environmental problems have become more complex, interdisciplinary research teams, including engineers and social scientists, have become the preferred approach to solving problems at multiple scales (Odum and Pigeon 1970; Reichle 1970).

In recognition of this need for broader interdisciplinary studies to address larger-scale environmental issues, the US Environmental Protection Agency (EPA) *Science To Achieve Results* (STAR) program, in partnership with the National Science Foundation (NSF), initiated the *Water and Watersheds Program* in 1995 to competitively fund large, interdisciplinary teams of scientists from the natural, socioeconomic, and engineering sciences. In 1998, the US Department of Agriculture joined the partnership.

Methods

By 2000, the Water and Watersheds Research Program had funded 87 projects. It was clear that the time had come to assess the progress of these grants, not only from a scientific perspective but also from a managerial perspective. In order to do so, EPA convened a "lessons learned" workshop. Ten Principal Investigators were brought together to discuss the scientific, personnel, administrative, and institutional issues associated with managing large interdisciplinary grants. The focus of this paper is to translate their insight into useful lessons for the future interdisciplinary research manager.

Conclusions

Scientific lessons

Four primary scientific lessons were distilled from the presentations by the Principal Investigators and the ensuing discussion. These four lessons were:

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① ***Interdisciplinary research is changing environmental science***.

There was consensus among workshop participants that these interdisciplinary interactions sharpened the research questions and focus, brought a freshness of perspectives to the research, provided a better appreciation of the complexity of the issues, provided new tools and techniques for studying ecological systems, and contributed to integrated conceptual models that better framed critical pathways and watershed processes. Scientists and engineers from different disciplines taught each other new ways and approaches for investigating problems that each thought they had previously understood.

② ***Interdisciplinary science is more applied and management/policy more relevant than in disciplinary research.***

Emphasizing the integration of socioeconomic and political attributes, conditions, and consequences in these projects brings interdisciplinary research into the policy and management realm. While the Water and Watershed research project investigators are not making policy and management decisions, the results and information from these projects are being injected into the decision making process. In addition, as science becomes more accountable to the public, these interdisciplinary projects are involving stakeholders in the process, demonstrating why the information is needed, and how it contributes to addressing stakeholder issues. While interdisciplinary research is more applied, good, basic, disciplinary science is accomplished within the interdisciplinary framework.

③ ***Social sciences contributions are a major strength of the program.***

Watershed management is fundamentally social in nature. Virtually every Principal Investigator (PI) indicated that the social sciences made major contributions to the natural sciences, both in providing analytical techniques and tools, and in providing insight into why various issues arise and how they can be addressed. Initially, differences in study designs (e.g., experimental versus survey), qualitative versus quantitative analytical procedures, and interpretations based on "hard" versus "soft" science required discussion. The discussions lead to overcoming preconceived prejudices and to identifying approaches for integrating results from what appear initially to be disparate data sets.

④ ***Stakeholder input and communication is invaluable to good science.***

Stakeholders provide more than just local perspective on issues and problems. They understand the community fabric that contributes to these problems. They are also the best liaisons for getting information back to the local, state, or regional communities for addressing the problems. The stakeholders can explain why the research is needed and how it will eventually contribute to resolutions of issues. Many stakeholders also bring skills and expertise that can contribute to better research question formulation, experimental design, and implementation of management alternatives.

Stakeholder involvement, however, takes time. A time frame of 3-5 years to develop trust and a good working relationship with stakeholders is not uncommon.

Personnel issues

People and their interactions are key to the success of any research project. They are particularly important in interdisciplinary research where these interactions contribute to creativity and innovation. Six lessons related to personnel emerged from the workshop discussions.

① ***A strong project leader (PI) is needed to oversee the research project.***

Given the different personalities, disciplines, departments, and institutions that are involved in many interdisciplinary projects, a strong leader is essential for overseeing the research project. Two characteristics common to all the effective Project Leaders were that they were respected by the team members and were effective communicators. Senior principal investigators also play a critical role in interdisciplinary research and must be part of a project team. Not only is their leadership experience needed to work through some of the initial communication issues, but the stabilizing influence of senior PIs is critical in moving the research through any start-up difficulties. Senior PIs can also mentor graduate students and younger faculty, encouraging and helping them maintain focus on the overall project goals and objectives.

② ***All investigators need to park their egos at the door.***

This is a critical lesson that must be infused in any interdisciplinary project. This is also an area where senior PIs can lead by example. The senior PIs can raise the ego issue without appearing arrogant and ask that all individuals respect the comments, opinions, and ideas of others. Insecurities should be parked in the space next to egos. There must be mutual respect for each others' opinions, information sources, and efforts if interdisciplinary research is to succeed. This means interactive discussions, analyses, and joint authorship on publications.

③ ***People must be committed to the project.***

Commitment to the project is essential if it is to succeed. There are several corollaries to this statement. First, the number of PIs on a project can get too large. While more PIs might seem advantageous, the greater the number of individuals, the smaller the role for each. In general, the degree of individual commitment to the project is inversely proportional to the number of PIs. Most individuals, appropriately, will prioritize their time on projects in which they have a major role. Attitude is an integral part of commitment, and it is critical that project morale be maintained. One "bad apple" can demoralize a team, whether it is a scientific or athletic team. Maintaining a positive attitude during those periods when studies must be redesigned or interactions among team members is strained is a challenge.

④ ***A Rule of Inclusiveness must be established and sustained***.

Teams function effectively only when everyone feels part of the team. It is important that rules of inclusiveness be established at the onset of the research and that these rules be sustained throughout the project. Everyone must have an opportunity to have their ideas, thoughts, and suggestions aired and objectively discussed. The Senior PIs must also commit to these rules of inclusiveness and be both a part of the team and attend the team meetings.

Inclusivity means that everyone also has access to the same information and that information is shared among all team members via email, teleconferences, meeting minutes, team meetings, and other forms of communication.

⑤ ***Younger faculty members need to maintain disciplinary expertise.***

It is important that younger faculty maintain a strong disciplinary focus because their career development and promotion comes from publications in recognized and respected disciplinary journals. As was stated above, sound disciplinary research is conducted within interdisciplinary projects and contributes to the overall project success. Most of the younger faculty will be rewarded and promoted within disciplinary, rather than interdisciplinary, departments. Therefore, it is important that they retain that focus while expanding their knowledge and vocabulary in other disciplines that can contribute to them becoming better scientists and engineers.

⑥ ***Interdisciplinary programs are developing the next generation of scientists and engineers.***

One of the major obstacles to interdisciplinary research has been disciplinary jargon and terminology. Different disciplines use the same words, but with different meanings and definitions. Initially, these differences interfere with effective communication. The next generation of scientists and engineers working on interdisciplinary projects will be versed in the language of other disciplines. They will also be knowledgeable about the techniques, procedures, and methods in other disciplines, as well. Information transfer will not only be more efficient, it will be more effective in communicating with stakeholders and other sciences.

Administrative lessons

Interdisciplinary research requires greater attention to administration, coordination, and management than disciplinary research. Four lessons were identified during the workshop.

① ***A management plan should be part of the research plan.***

Every research plan submitted to the Water and Watersheds Program should include a management section. Interdisciplinary projects are being conducted by personnel in different departments, colleges, institutions, agencies and organizations. This requires greater attention to how the project will be managed so that it can achieve its goals and objectives. The management plan should also consider contingencies that might arise during the project. In several projects,

senior PIs left during the project, which created problems in leadership, disciplinary expertise, and interdisciplinary interactions.

② ***Project management takes considerable time.***

Every Water and Watersheds Program PI indicated they grossly underestimated the amount of time required to administer and manage interdisciplinary projects. Managing these projects is a major commitment of time and resources. Learning the administrative procedures and protocols used by different departments, colleges, institutions, and agencies/organizations requires considerable time. Each PI indicated they either had, or strongly recommended, that an administrative assistant or lieutenant help administer the project.

③ ***Three years is short for interdisciplinary research projects.***

Interdisciplinary research requires more time because there are communication and language barriers to initially overcome among disciplines and with stakeholders. The first year can be frustrating because of differences in definitions and semantics among project members. This improves through time, but effective lines of communication and understanding can take 3 years, or longer, to fully develop. Many of these projects also have field studies or phased research efforts with precursor research results used to refine the design of subsequent research efforts. For example, hydrodynamic models or modules might be required before water quality or biological modules are developed. A 5-year time frame would be a more realistic duration for the projects.

④ ***PIs must interact routinely with team members***.

Establishing trust and communication applies not only to stakeholders, but also to the relationships among PIs and team members. It is important that PIs have regular interactions among themselves and team members. These interactions should not just be professional, but also social through parties, get-togethers, and similar events so that team building can occur. A social gathering is strongly recommended at project initiation so that people begin to feel comfortable with team members from different departments or institutions and in expressing their ideas and thoughts in an open forum. One multi-institutional project was initiated by having a 3-day workshop at the Iowa field site. This contributed to shared, place-based knowledge about the site and established strong lines of communication early in the project.

Institutional lessons

Institutional administrators, in general, are skeptical about the benefits of interdisciplinary research. Four lessons that emerged from the workshop relate both to this skepticism and to the reality of functioning within institutional constraints.

① ***It pays to promote projects in your institution***.

Publicity pays. Several Water and Watershed projects received publicity through their interactions with stakeholder groups. This publicity had a positive influence on institutional support for the project. The support of the stakeholder group also contributed to public support of the projects and greater acceptance of the results and proposed management actions. This support was generated because the stakeholders were part of the project team. Team building, including T-shirts, joint field sampling, and similar approaches, was one of the major focuses of the interdisciplinary research project. Stakeholder involvement paid dividends in getting the project results considered and enacted in natural resource management decisions.

② ***Departments still prevail, and younger faculty members need departments for advancement.***

Younger faculty members need to focus on publishing and participating in disciplinary journals and professional societies, respectively. As indicated above, however, sound disciplinary research is conducted within interdisciplinary projects. The interdisciplinary projects also contribute to the professional and career development of the faculty by increasing their awareness of other analytical techniques and procedures that are applicable to their research, increasing their vocabulary, perspective and insight into interdisciplinary problems, identifying additional research areas, and establishing the linkages between their research and other environmental or societal problems or issues.

③ ***Multi-institution projects can work, but this requires pre-planning***.

The time to consider the intricacies of working among institutions is during proposal preparation, not after

award of the contract. Budget administration, transfer of funds, distribution of overhead, administrative procedures and protocols, and personnel procedures can all create significant contractual and administrative problems for the project. Problems arising after the contract is awarded that cannot be satisfactorily resolved can seriously jeopardize project success.

④ ***The quality of graduate students and subsequent positions benefits the institution***.

Institutional benefits accrued both through the quality of the students produced from interdisciplinary programs, employers hiring these students, and the support from stakeholders using the results. Employers have been proponents of interdisciplinary projects because the students from these programs are not only sound in their respective disciplines, but also have greater breadth, being conversant and knowledgeable in other disciplines. Breadth, in addition to depth, is critical in many agency and private sector positions. Institutions producing these students will benefit from continued support and demand for programs providing this interdisciplinary background.

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