Managing Interdisciplinary Research: *Lessons Learned*

Workshop Summary

EPA STAR
Water and Watersheds Research Program

US Environmental Protection Agency
National Center for Environmental Research
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Managing Interdisciplinary Research: Lessons Learned From the EPA STAR Water and Watersheds Research Program

1.0 WHY INTERDISCIPLINARY RESEARCH?

1.1 Environmental Issues Are Broader Than Disciplinary Boundaries

Scientific research has traditionally been conducted by individual scientists addressing one to several testable hypotheses (Popper 1959). This approach has been the foundation not only for scientific research, but also for education of students in the scientific method. Many ecological studies have also been conducted using this model. However, as larger scale ecological studies were conducted, by necessity, these studies became interdisciplinary, including scientists and/or engineers from the natural science disciplines (e.g., physics, hydrology, chemistry, biology, engineering) (Odum and Pigeon 1970; Reichle 1970; RANN 1977). As the scope and scale of environmental problems has expanded, so has the realization that most of these environmental problems have social, economic, and political attributes that are as important as the natural system attributes. Resolving many of these complex, large-scale environmental issues requires that interdisciplinary research also include other scientific disciplines such as economics, sociology, and the behavioral and political sciences.

In recognition of this need for broader interdisciplinary studies to address these 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* 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.

1.2 Watershed Management Requires a Larger Scale Perspective

In recent years, the EPA, other federal agencies, states, and several national organizations have made an integrated watershed approach the cornerstone of their water quality protection programs. While watersheds are useful management units, we do not sufficiently understand how stresses from human activities such as land development, deforestation, stream channelization, pollutant fate and transport, agricultural use, and other stresses affect terrestrial and aquatic ecosystems within these watersheds. Therefore, in 1995 the EPA STAR Program, in partnership with NSF, initiated the Water and Watershed Research Program to conduct interdisciplinary research to understand the important processes and principles for assessing, protecting, managing, and restoring ecological systems at the watershed scale. Although there is no minimum geographic area associated with the definition of a watershed, there was a general recognition that the research and study areas would integrate multiple land use/land cover patterns, different socioeconomic and political sectors, and different types of ecosystems. Watersheds naturally integrate these features within their geographic boundaries.

1.3 Both Natural and Human Dimensions Must Be Considered For Sound Management

The Water and Watersheds Research Program required that interdisciplinary approaches integrate both the natural and the human dimensions. The Water and Watersheds Research Program, and its collaborative agencies, required that these interdisciplinary teams be integrated across the natural sciences (i.e., hydrology, physics, chemistry, biology), engineering, and social sciences (i.e., social, economic, behavioral, political) and that holistic approaches be proposed for conducting research. There was a tendency early in the Program for researchers to propose a multidisciplinary team, and design traditional disciplinary research studies. Integration would be part of the *a posteriori* activities and efforts, rather than an *a priori* requisite of the research. The first solicitation did not propose interdisciplinary studies, where hydrologists, ecologists, sociologists, economists, and political scientists, not only collaborated, but also conducted joint, integrated studies. Initially, this resulted in a large number of single disciplinary proposals being reviewed and a low percentage of the proposed studies funded. The funding agencies subsequently refocused the solicitation, requiring an interdisciplinary approach as a prerequisite for funding. As a consequence, the collaboration among scientists not only within, but also among, institutions increased. The Water and Watersheds Research Program has funded over 60 interdisciplinary projects since its inception in 1995.

1.4 Greater Benefits Accrue From Interdisciplinary Research

The benefits of this research are now becoming evident. It has been 5 years since the Water and Watersheds Research Program initially funded the first research projects. To capture the experiences of the investigators and the lessons learned through the Water and Watersheds Research Program, a workshop was held in October, 2000 to discuss and review these interdisciplinary projects and document the lessons learned over these past 5 years. Many of these lessons extend beyond scientific issues to include personnel, administrative, and institutional issues. These lessons will be used to refine the program, assist scientists conducting other interdisciplinary projects, and increase the efficacy of future interdisciplinary research projects.

The participants at this Lessons Learned Workshop are listed in Appendix A. The Workshop Agenda is included in Appendix B. The Workshop was structured so there was adequate time for interaction among the participants, but also so that each investigator would have the opportunity to describe the attributes of their own research projects. This report documents the results of these discussions.

2.0 WHAT WAS LEARNED FROM MANAGING INTERDISCIPLINARY RESEARCH?

Workshop participants identified four primary, but interactive, areas that need to be considered in conducting interdisciplinary research. These four areas were:

1. Scientific (SL)
2. Personnel (PL)
3. Administrative (AL)
4. Institutional (IL)

The lessons that were learned in each of these four, interacting areas are discussed in the following sections. Each of the specific lessons learned is designated by its respective area. As with interdisciplinary research, it was sometimes difficult to assign the lessons learned to a separate, specific area.

2.1 Scientific Lessons

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

2.1.1 *Interdisciplinary research is changing environmental science.*

Environmental science is, by definition, a holistic arena, but many environmental studies have focused on “natural” interactions and considered humans only as a stressor on the ecosystem. The Water and Watersheds Program has required that interdisciplinary research consider all facets of the ecological system - physical, chemical, biological, sociological and economic attributes and interactions. 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.

Developing sustainable ecosystems requires consideration of the human dimension, socioeconomic drivers, and feedbacks as well as biogeochemical cycles and processes. Every project discussed at the workshop had examples of how socioeconomic and ecological information was being obtained and integrated into their projects. A project in NC, for example, used statistical survey instruments to collect socioeconomic information from landowners to identify constraints on possible wetland restoration sites and approaches. All investigators

indicated that a much greater understanding of the interactions among system components occurred through the interdisciplinary collaboration, which was particularly useful for those projects in urban and urbanizing watersheds.

These new perspectives, however, were not obtained painlessly. Terminology and jargon within disciplines initially created misunderstandings and barriers to communication among disciplines. Identical words can have very different meanings and connotations among different disciplines. However, in many cases, these different meanings were the catalysts for sparking new ideas and insights both into how to study, and how to understand, ecosystem responses to stressors. It has also provided a context for integrating ecological theory and procedure with stakeholder perspective and practice.

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

Explicitly considering 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 their issues. One project, for example, was being conducted jointly with a state Scenic River Commission. The scientific information being generated from the project was being used by the Commission in their decisions on how to protect and manage watersheds and waterways within the state. These projects also provide vital communication links with the public that emphasize the socioeconomic relevance of the research as well as the ecological responses and consequences of socioeconomic drivers such as urban sprawl, transportation corridors, forest fragmentation, and habitat loss and destruction.

While interdisciplinary research is more applied, good, basic disciplinary science is accomplished within the interdisciplinary framework. Every workshop participant also indicated that exciting results were being obtained on fundamental, disciplinary problems within their projects. Interdisciplinary projects contribute the best to both worlds. They spark creativity within disciplines because there are fresh eyes looking at disciplinary problems from a different disciplinary perspective.

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

Watershed management is fundamentally social in nature. Therefore, understanding watershed responses to stressors and management actions requires an understanding of the socioeconomic drivers that produce these stressors and contribute to the implementation of alternative management practices. Virtually every project indicated that the social sciences had 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 to overcome preconceived prejudices and to identify approaches for integrating results from what appear initially to be disparate data sets. However, as the projects developed, there was a better understanding of how various instruments and designs used in the social sciences not only provided useful information for understanding ecological responses, but also provide tools for studying different attributes of ecological systems.

2.1.4 *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 and they are the best liaisons for getting information back to the local, state, or regional communities for addressing the problems or explaining why the research is needed and 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. If stakeholder involvement is part of the project (and this should seriously be considered), the investigators must get "smart" about stakeholder issues before the initial contacts are made. Many of these stakeholders have been involved with studies or efforts in the past that raised expectations and then never delivered. Stakeholder involvement can significantly improve the overall success of the research project, but it will take time and it must be done with the recognition that the stakeholders must receive some benefit from their interactions.

2.2 Personnel Issues

People and their interactions are key to the success of any research project, but particularly interdisciplinary research where it is the interactions that contribute to creativity and innovation. Six lessons related to personnel emerged from the workshop discussions.

2.2.1 *A strong leader (PI) and Lieutenant are 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. Leadership is not necessarily a function of a strong personality, but rather an individual that is comfortable interacting with multiple investigators across multiple disciplines. Effective Project leaders in the Water and Watershed Research Project ranged from gregarious, outgoing individuals to quiet, introspective scientists. Two common characteristics among all the effective Project Leaders were that these individuals were respected by the team members and they 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 PI's is critical in moving the research through any start-up difficulties. This is particularly true for field projects, where prior experience can significantly streamline the project, address QA/QC issues at the start of the project, and ensure that information management systems are designed to accommodate various data types and formats. Senior PI's can also mentor graduate students and younger faculty, encouraging and helping them maintain focus on the overall project goals and objectives.

2.2.2 *Everyone needs 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 PI's can lead by example. The senior PI's can raise the ego issue without appearing arrogant and ask that all individuals respect the comments, opinions, and ideas of others. Senior PI's can ask the younger faculty to both adopt this perspective and to provide examples for others to emulate. 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. Interdisciplinary research can not be conducted without open dialogue and exchange of information.

2.2.3 *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 PI's on a project can get too large. While more PI's 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 PI's. Most individuals, appropriately, will prioritize their time on projects in which they have a major role. Including individuals on a project simply for their name or reputation neither enhances the chances for funding nor success, if funded.

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. This is an area where the senior PI's can provide leadership. It may be necessary to remove individuals from the project team if they continue to create morale problems.

2.2.4 *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 PI's must also commit to these rules of inclusiveness and be both a part of the team and attend the team meetings. This helps set the tenor and example for all team members to follow.

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. This maximizes the synergy that occurs among interdisciplinary team members because everyone has the opportunity to review and analyze information from their disciplinary perspective.

2.2.5 *Younger faculty 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.

Publications are important for all project team personnel. It is critical that the rules of authorship be established at the outset of the project, not after data and results are being produced, and manuscripts are being prepared. The specific rules of authorship are up to the individual project team, but these rules must be established and agreed upon at the beginning of the project. This will minimize conflicts and morale problems later in the project.

2.2.6 *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. It is only through continued interaction and discussion that these differences are appreciated, resolved, and begin to stimulate new ideas. The next generation of scientists and engineers working on interdisciplinary projects will be versed in the language of other disciplines as well as knowledgeable about the techniques, procedures, and methods that are not only used in these disciplines, but also those that are applicable to problems in their disciplinary field. Information transfer will not only be more efficient, it will be more effective in communicating with stakeholders and other sciences.

2.3 Administrative Lessons

Administration and management of the interdisciplinary projects received considerable discussion at the workshop. Interdisciplinary research requires greater attention to administration, coordination, and management than disciplinary research. Four lessons were identified during the workshop.

2.3.1 *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, and, in some cases, agencies and organizations. This requires greater attention to how the project will be managed so that it can achieve its goals and objectives. Management style is much less important that management structure. A management structure and approach need to be in place at the outset of the project. Projects that do not

indicate how budgets will be developed, funds allocated, overhead distributed, personnel interactions maintained, and research efforts coordinated are much less likely to be successful.

The management plan should also consider contingencies that might arise during the project. In several projects, senior PI's left during the project, which created problems in leadership, disciplinary expertise, and interdisciplinary interactions. It is difficult to replace someone during interdisciplinary projects because of terminology, perspective, understanding, and similar issues. Thinking about alternatives and options before the situation arises is a useful exercise during proposal development. Given that interdisciplinary projects run from 3 to possibly 5 years, the likelihood is much greater that team members will leave, rather than all stay with the project for its duration. The plan should include ideas on how to augment or replace expertise when individuals leave.

2.3.2 *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. Each PI indicated they either had, or strongly recommended, that an administrative assistant or lieutenant help administer the project. Learning the administrative procedures and protocols used by different departments, colleges, institutions, and agencies/organizations requires considerable time. The amount of time required to administer interdisciplinary projects is considerable and needs to be budgeted in the project. Time management is crucial. It is worthwhile to provide seminars or training in time management for project team personnel.

Ensuring good communication and interaction among different scientists and engineers in different departments, colleges, institutions, and agencies is critical for project success. Initially, these lines of communication are not well established and it requires considerable effort at the start of the project to get these lines of communication and interaction established. It also requires constant attention to sustain these interactions.

2.3.3 *3 years is short for interdisciplinary research projects.*

There are at least three elements of interdisciplinary research that require sufficient time to satisfactorily develop: stakeholder involvement; communication; and field efforts or sequential studies.

Stakeholder development takes time and is built on trust. Nearly every stakeholder group has had some negative interactions with groups who promise solutions to their problems,

consume their time and resources, and then either do not produce results or do not communicate the results to them. Establishing these lines of communication takes time, but the benefits are immeasurable. Stakeholder support not only contributes to a better, more focused project, it also generates community and public support for projects, which translates into support for the institution.

Interdisciplinary research also requires more time because there are communication and language barriers to initially overcome among disciplines. 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. Once developed, the modules need to be integrated into a single model, calibrated, and confirmed before they are applied to address specific management alternatives. It is difficult to accomplish most projects within 3 years.

A 5 year time frame would be a more realistic duration for Water and Watershed projects.

2.3.4 *PI's must interact routinely with team members.*

Establishing trust and communication applies not only to stakeholders, but also to the relationships among PI's and team members. It is important that PI's 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. It is through the interactions of team members that synergy of ideas and approaches occurs. The more opportunities for these interactions, the greater the likelihood for success in the project.

2.4 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.

2.4.1 *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. This dividend, however, occurred only because of the investment that occurred throughout the project.

The increased publicity can also contribute to changing the perception of interdisciplinary research within departments and institutions. Clearly, institutional support for the project diminishes when the funding stops, so developing a support base both within departments and colleges and external to the institutions is important.

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

Younger faculty 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.

2.4.3 *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 can not be satisfactorily resolved can seriously jeopardize project success. There were multiple examples of successful multi-institutional projects being conducted,

but each of them addressed these issues before the contract was awarded. Several projects encountered problems when negotiations were required after the project was funded.

2.4.4 *Institution benefits by the quality of grad students and subsequent positions*.

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.

Interdisciplinary projects build support for institutions both through the research products and through continued demand for graduates with an interdisciplinary background. With the transition from the information to the knowledge age, individuals conversant in multiple technical areas are in demand. Those institutions producing these students will benefit from continued support and demand for programs providing this interdisciplinary background.

3.0 ANY RECOMMENDATIONS?

3.1 Improving Interactions and Enhancing Communication

Regardless of the project, program, organization or agency, communication is always a critical area raised for improvement. This is particularly true for interdisciplinary projects because different disciplines use similar words, phrases, and terms, but with different disciplinary definitions. Several recommendations were made for improving and enhancing interactions and communication, both within the project team, and among Water and Watershed Projects. These recommendations included:

1. Prepare a concordance of terms, by discipline, with the differences in definitions and make this available to new Water and Watershed Projects. This can help to emphasize that communication problems will arise because of different terminology and jargon.
2. Continue the biannual meetings for all Water and Watershed Project PI’s.
    a. Target hot topics for these meetings from professional society symposia and conferences that have interdisciplinary themes.
    b. Provide explicit guidance on the desired outcome and issues that need to be addressed and resolved at these meetings

1. Fund interdisciplinary workshops that would increase communication within the broader scientific community
2. Prepare and publish approaches for effective communication related to specific themes and build on the experiences of the Water and Watersheds Program.
3. Develop Guidance Documents with the lessons learned for conducting Interdisciplinary Projects. Include some of the pitfalls as well as the successes.
4. Continue to encourage professional societies to publish and conduct special symposia on interdisciplinary projects.

3.2 Minimizing Administrative Burdens

Administering interdisciplinary programs requires greater effort than traditional disciplinary projects. This message was conveyed by all the workshop participants. To help reduce the administrative burdens, the following actions were recommended:

1. Include a second in command, lieutenant or similar individual to help coordinate and administer the project. The time required should not be underestimated.
2. Make sure everyone knows what they have for a budget, that it is tracked, and that there are no additional funds unless a contingency was established as part of the project. This is particularly important for field projects, where cost overruns can occur very quickly.
3. Include a management plan as part of the proposal. A management structure should be considered before contract award, not after. Make sure you know how budgets will be prepared, funds transferred, overhead distributed, and similar requirements among departments and/or institutions before the contract is awarded. This will save time, embarrassment, and budget adjustments if the contract is awarded. Formulate contingency approaches for augmenting or replacing expertise as team members leave.
4. Consider an administrative assistant to handle budgetary issues - tracking, expenditures, planning. It is critical that any problems with budgets are addressed early, efficiently, and professionally.
5. Establish a secure project website, conduct periodic team meetings, and establish lines of communication among project team members early in the project.

3.3 Reducing Institutional Constraints

Many of the projects were being conducted among institutions as well as among departments. There were a number of recommendations suggested to reduce some of the institutional constraints:

1. Negotiate contract terms prior to award of the contract so there are no delays in starting the project, or misunderstandings on disbursement of funds.
2. The PI should visit other participating institutions are the initiation of the contract and meet the grant administrators at those institutions so lines of communication are established early in the project before any issues arise.
3. Consider stakeholders as part of the project**.** However, this should not be entered into lightly. This can be a significant commitment if done properly, or bad public relations, if done poorly.
4. Keep administrators informed of the project status, particularly with respect to stakeholder involvement. Publicize findings relevant to the community.

3.4 Measuring Success

The workshop participants discussed some the attributes of the Water and Watershed Program that they considered measures of success of the program. Having quantifiable measurement criteria for any program is advantageous. With the Government Performance Review Act, this also becomes a requirement of many federal projects. Some of the measures of success that were identified and recommended by workshop participants included:

1. Next generation of interdisciplinary scientists, as measured by the number of:
    a. PhD and Masters students
    b. Post-doctoral students
    c. Undergraduate courses
    d. Departments or Centers in universities.
2. Employment in interdisciplinary fields
    a. Number of students employed by state or federal agencies
    b. Number of students employed by private sector
    c. Number of students employed in non-profit or other organizations needing interdisciplinary expertise.
3. Outreach activities in the interdisciplinary arena
    a. Speciality conferences
    b. Publications
    c. Articles in popular press
4. Use of project results
    a. Influence environmental management decisions

b. Influence policy decisions on multimedia issues.

5. Track incremental project funding

a. Make next years funding contingent on demonstrating progress and results during the previous year.

3.5 Future Water/Watershed Projects

Workshop participants strongly encouraged EPA to continue emphasizing interdisciplinary research through the Water and Watersheds Research Program. Interdisciplinary research and management at the watershed scale is the future of ecology and environmental management. The progress that has been made, and the lessons learned, clearly indicate that the Program is filling a needed niche and is *Science That's Achieving Results*.

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Managing Interdisciplinary Research Projects
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Managing Interdisciplinary Research Projects
Lessons Learned Workshop
Agenda
11-12 October 2000
Hotel Washington - Washington, D.C.

Time	Topic	Responsible Individual
Wednesday, 11 October		
0830	**Welcome, Introductions** **Workshop Purpose:** **1. Discuss the advantages/disadvantages associated with conducting interdisciplinary research projects.** **2. Identify the Lessons Learned from conducting interdisciplinary research.** **3. Provide examples and documentation for each Lesson Learned.** **4. Discuss/decide on a journal article describing the Lessons Learned.** **5. Other Issues?**	**B. Levinson**
0845	**Workshop Goals and Objectives,** **Interactive Workshop Format**	**B. Levinson**
0900	**Research Project Background** **1. Research Project Objectives and Approaches** **2. Project Team - Disciplines, Departments, Universities** **3. Positive Experiences** **4. Negative Aspects** **5. Possible Resolution of Negative Aspects**	**Each PI (15 min. each)**
1000	**BREAK**	
1015	**Research Project Background (Continued)**	**Each PI**
1145	**LUNCH**	
1300	**Formalizing the Lessons Learned (Brainstorming Session)** **1. Scientific Issues** **2. Personnel Issues** **3. Administrative Issues** **4 Institutional Issues** **5. Things To Do** **6. Things Not To Do** **7. Team Building Approaches**	**K. Thornton**

Time	Topic	Responsible Individual
1500	**BREAK**	
1515	**Formalizing Lessons Learned (Continued)**	**K. Thornton**
1700	**Summary of Day's Discussion, Action Items** **Review Thursday's Agenda**	**K. Thornton**
1900	**DINNER**	
Thursday, 12 October		
0830	**Things That Went Bump In The Night**	**K. Thornton**
0845	**Recommendations** **1. Enhancing Interdisciplinary Communication** **2. Improving Interdisciplinary Interactions** **3. Reducing Institutional Constraints** **4. Minimizing Administrative Burdens** **5. Other Issues**	**ALL**
1000	**BREAK**	
1015	**Recommendations (Continued)**	**ALL**
1045	**Tentative Report Outline** **1. Sections** **2. Content** **3. Format**	**K. Thornton**
1100	**Journal Manuscript** **1. Yes/No** **2. Authorship** **3. Tentative Journals**	**ALL**
1130	**Other Issues**	**ALL**
1145	**Meeting Summary, Action Items, Schedule**	**K. Thornton**
1200	**ADJOURN**	