Environmental and Natural Resource Economists, Great Research, and the National Science Foundation

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Environmental and natural resource economists could be more effectively engaged in great research on exciting issues in environmental and natural resource management. After identifying possible obstacles to improved research, the article focuses on opportunities and obstacles associated with obtaining funding from the National Science Foundation. Opportunities abound, both ongoing and in the future, for interdisciplinary work involving environmental and natural resource economists. Keys to exploiting these opportunities for funding include a willingness to face rejection, build teams, contact program officers with specific questions, write detailed research designs, and prepare proposals that promise to go beyond narrow incremental advances.

Key Words: natural resource economists, National Science Foundation, research funding opportunities

Effective environmental and natural resource management integrates knowledge from the social sciences as well as from the natural sciences. This social scientific knowledge comes from the work of anthropologists, communication scholars, geographers, political scientists, psychologists, sociologists, and of course economists. This essay identifies obstacles to great basic research by environmental and natural resource scientists,[1] describes efforts by the National Science Foundation (NSF) to support integrated research that would necessarily often involve environmental and natural resource scientists, and concludes with some suggestions regarding obtaining NSF funding. Although some environmental and natural resource economists are engaged effectively in cutting-edge interdisciplinary research, the community as a whole is not involved as much as it could be and as much as a substantial number of economists would prefer.

As a political scientist who manages NSF's program in decision, risk, and management sciences, and who participates on management teams for interdisciplinary environmental competitions, I am unable to bring an enlightened economic perspective to anything. The contribution of this essay is not to economics, but draws upon my experience at NSF to comment on the role of natural resource economists in the research that NSF funds, to identify present and future opportunities, and to make a few suggestions regarding ways of exploiting these opportunities. This essay argues that natural resource economists have opportunities now (and will increasingly have opportunities in the future) to produce significant new knowledge through interdisciplinary collaborations in environmental and natural resource management. The document concludes with the identification of five keys to obtaining funding from the National Science Foundation.

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[1] Throughout this essay I refer to environmental and natural resource economists and exclude agricultural economists because I am unfamiliar with the latter's work. Many of the questions environmental and natural resource economists ask and the work they do fit well with NSF's mission of supporting basic research. In contrast, my guess is that a good deal of the research of agricultural economists is the application of existing theories and methods to fresh data. This applied research is important, but more appropriately funded by mission agencies such as the U.S. Department of Agriculture. When work by agricultural economists is advancing generalizable theoretical knowledge, then the arguments in this essay apply to agricultural economists too.

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Interdisciplinary Research in Natural Resource Management: Utility and Obstacles

To address fundamental issues of environmental management without the concepts and tools of economists seems foolish. Readers who are professional economists are likely to embrace the utility of economic analysis. Their problem is more likely to be a denial of the utility of anything besides economics. Nevertheless, the multidisciplinary nature of many important environmental and natural resource research questions seems obvious. Understanding air pollution, for example, involves concepts from epidemiology, geography, meteorology, political science, and sociology, as well as economic concepts such as externalities and tradable permits. Addressing the difficult but popular concept of "sustainability" sensibly involves concepts and methods from several fields, and economics is indispensable.

The National Science Board (NSB) and much senior leadership at the National Science Foundation accept the notion that, although research in single disciplines is important, great advances are also likely to come from interdisciplinary enterprises. Since the 1990s, the NSB has supported expensive interdisciplinary initiatives. Although there are widely differing views within NSF regarding what proportion of NSF funds should go into disciplinary or interdisciplinary research, overall support for interdisciplinary research is strong. In the environmental area, NSF's Advisory Committee on Economic Research and Education has focused attention on methods of breaking down barriers to interdisciplinary work.

Obstacles to the involvement of natural resource economists in designing and implementing transformative interdisciplinary research in environmental and natural resource management vary in importance, certainty, and tractability. An overview of the literature and conversations with colleagues identified several possible reasons natural resource economists are not working more frequently with other scholars to produce fundamental new knowledge. These are only hypotheses, not well-researched findings. The readers of this journal are likely to ascribe different degrees of validity to each of eight possible obstacles:

The gilded agricultural college thesis. The argument is that many agricultural or natural resource economists do not pursue exciting basic research because they have easy access to earmarked money from state departments of agriculture and similar sources. Instead of applying for competitive grants from places such as NSF or the competitive programs in the U.S. Department of Agriculture, many economists may be content to work with a more narrowly applied focus.

The ideology of "cornucopian technocentrism" and the paradigm of neoclassical economics.[2] If one assumes that technological solutions to environmental and natural resource dilemmas will emerge as a natural consequence of the operation of market mechanisms, then the scope of legitimate interdisciplinary research narrows considerably. Also, if we know that the answer to most environmental and natural resource problems is to let the market work things out, the role for creative economic thinking seems limited.

The arrogance of economists. The argument here is that many economists are so enamored of the traditional economic paradigm that they do not work well with other scholars who work within other traditions. I know of no systematic research into whether economists really are more arrogant than anthropologists, sociologists, or even political scientists, yet the view seems widely held among social scientists.

Inability to attract top-flight graduate students. Research increasingly involves teams that include graduate students. If the graduate students are mediocre, the quality of the research will suffer.

University award structures that discourage interdisciplinary work. If tenure and promotion decisions value disciplinary work over interdisciplinary work, interdisciplinary work will suffer.

U.S. Department of Agriculture and U.S. Environmental Protection Agency research funding priorities. The argument is that the U.S. Department of Agriculture and the U.S. Environmental Protection Agency have largely failed to sustain support for research agendas likely to produce exciting theoretical advances.

NSF's Economics Program. NSF's Economics Program has supported the work of the vast majority of winners of the Nobel Prize in economic science (before they won the award), so the pro-

[2] This notion first appeared in the environmental sociology of Timothy O'Riordan (1981).

gram has had indisputable success in advancing significant theoretical work. With its limited budget, however, the program has a reputation for focusing more on traditional theoretical work within neoclassical economics than on supporting interdisciplinary research, or research in natural resource or environmental economics.

NSF's funding priorities. This argument is that, although NSF leadership often voices the call for interdisciplinary research, the bulk of funding opportunities run through traditionally organized disciplinary programs. Although there is nothing to stop the directors of a program from funding proposals that bring together scholars from vastly different disciplines by using their own program funds (and many such proposals are funded), there is a tendency to want to fund the "home team" first. Although there is nothing to stop the directors of two or more programs from co-reviewing interdisciplinary proposals and then co-funding those awards (and many such co-reviewed proposals are funded), this process is cumbersome and the culture of co-reviewing is not strong everywhere at NSF.

The first three obstacles are under the control of natural resource economists. The next two obstacles are at universities. The final three are governmental. I can provide no useful information about the obstacles that are within the community of environmental and natural resource economists and even less about the external obstacles. I can, however, provide information about the opportunities that exist and that are going to exist at NSF, as well as some perspectives about what differentiates funded proposals from those that are declined.

National Science Foundation

NSF is an Independent Executive Agency whose primary mission is to support basic research. The director and associate director are political appointees who serve 5-year terms, yet the agency has a long tradition of non-partisanship. Everyone else is a civil servant. The annual budget is approximately $5.9 billion, with most of the funds going to universities for research. Last year NSF reviewed approximately 42,000 proposals and made 10,000 new awards.

To make funding decisions, NSF uses a peer review process. Programs in the Social, Behavioral and Economic Sciences Directorate (SBE) use both mail and panel reviewers. Program directors (interchangeably also called "program officers"), informed by those individual reviews and panel recommendations, make the funding decisions, which are extremely rarely overturned. Almost all programs have two "unsolicited" competitions each year. These competitions are called "unsolicited" because there is no specific "request for proposal" or solicitation tied to the competition. There is only a broad program announcement that does not change from competition to competition. The crucial point is that NSF is a "bottom-up" agency that asks the research community, through its proposals, to define where important new discoveries can be found. Rather than program officers determining *a priori* what methods or topics are most likely to produce significant theoretical advancements in a program, the unsolicited program competitions result in funding whichever proposals make the most convincing cases for the intellectual merit and broader impacts of the proposal research.

Besides funding proposals submitted to programs, NSF also supports research centers and funds proposals submitted to special competitions. Although these special competitions involve solicitations that include some specific requirements, the solicitations still are quite broad and even vague, consistent with NSF's "bottom-up" philosophy.

For most scholars at universities, NSF is an advantageous funding source. NSF supports curiosity-driven basic research, and generally pays 2 months of summer salary, all reasonable research costs, and full overhead. Funding is through the grant mechanism that maximizes freedom for scholars. Grantees owe NSF only a brief annual report, as NSF prefers that scholars work on publications and presentations at professional conferences rather than on government reports.

Ongoing NSF Opportunities for Environmental and Natural Resource Economists

In 2007 NSF created its first multi-directorate permanent program: Dynamics of Coupled Natu-

ral and Human Systems (CNH). Originally part of a multi-year initiative, Biocomplexity in the Environment, CNH receives support from the SBE, Biological Sciences, and Geosciences directorates. Successful CNH proposals must examine both the dynamic impacts of humans on the environment and the dynamic impacts of the environment on humans. As such, projects must involve both natural scientists and social scientists. For example, one CNH award in FY 2007 couples economic, social network, and hydrologic models to study surface water/groundwater interactions for the protection of in-stream flows. Another CNH award looks at economic, regulatory, environmental, and ecological linkages of fisheries. To get a good sense of the research that the CNH Program—or any NSF program—is funding, one can peruse the abstracts of awards. These abstracts are available on the NSF website (www.NSF.gov) and are searchable by program, key word, etc.

The Decision, Risk and Management Sciences Program (DRMS) in SBE has a long tradition of supporting research on adaptive environmental management and other topics that involve environmental and natural resource economists. Currently active awards include "An Experimental Examination of the Economics and Psychology of Stigma" (to Bill Schulze, Kent Messer, and Brian Wansink) and "Improving the Valuation of Risk Reduction" (to Trudy Cameron, J.R. Shazo, and Paul Slovic).

Although the Economics Program has not been focusing its support on natural resource economics or interdisciplinary work, it will fund proposals from environmental or natural resource economists when those proposals have particularly strong theoretical or methodological innovation. The good news for principal investigators (PIs) is that they do not have to decide between the Economics Program and other programs such as DRMS. Principal investigators can select the program whose literature the proposal advances most significantly and also request a co-review from a second or even a third program. The review process is double opportunity, not double jeopardy, in funding decisions. In other words, one program may decide that the proposal makes only a trivial contribution to its discipline, while a second program may find the proposal highly meritorious of funding. That second program will typically fund the proposal.

The Geography and Regional Science Program (GRS) has a long tradition of supporting interdisciplinary work, albeit proposals with a spatial component. GRS also has a strong affinity toward research involving environmental and natural resource concerns, perhaps as a reflection of the spatial components of much of that research.

Future NSF Opportunities for Environmental and Natural Resource Economists

Funding opportunities are likely to emerge from the ashes of expiring solicitations, from the desire of natural scientists to add social scientists to their projects, and from SBE's own initiatives.

The final competition of the five competitions of the Human and Social Dynamics Priority Area (HSD) had a winter 2008 deadline. In an effort to foster interdisciplinary work among social scientists (and especially among social scientists and non-social scientists), this special competition required that each proposal include at least three principal investigators from at least two or more disciplines. In previous HSD competitions, NSF has funded several environmental projects involving economists. Despite the widespread view that HSD has begun to nurture impressive interdisciplinary collaborations, HSD is ending because NSF rules require that "priority area" competitions cease after 5 years. My point in mentioning HSD is that some sort of interdisciplinary solicitation is likely to emerge for FY 2009 or FY 2010. When this happens, the SBE webpage on the NSF website will publicize the new solicitation.

Similar to HSD, funding for Decision Making under Uncertainty for Climate Change is ending. This solicitation funds centers (at Columbia, Carnegie Mellon, and Arizona State Universities) and smaller teams (at the University of Colorado and RAND) that study how to incorporate climate change into decisions. NSF may decide to continue to fund these centers for a period of time before devising a new competition.

The leaders of NSF's actual and future networks of observatories are indicating a strong desire to involve social scientists. The Long-Term Ecological Research Network (LTR) has been collecting ecological data at over 20 sites for over 25 years. The two urban sites, Baltimore and Phoenix, are particularly likely to initiate signifi-

cant social science projects. The National Ecological Observatory Network (NEON) is a continental-scale research instrument with laboratory and field instruments collecting data at sites linked via a computational network. As NEON will become operational in the next couple of years, there is an effort to identify what social science information should be collected at these sites. The Water and Environmental Research Systems Network (WATERS Network) is the hydrological counterpart to NEON. WATERS will provide networked sensors focused on the water cycle. Two years or so behind NEON in design and implementation, the WATERS leadership is initiating an effort similar to the NEON effort to identify what social science information should be collected at these sites.

There are three possible new NSF investments in environmental and natural resource management wherein SBE has the primary role. Most certain is the development of a joint solicitation on hurricane warnings funded by SBE, the Engineering Directorate at NSF, and the National Oceanic and Atmospheric Administration (NOAA) in 2008. The purpose is to advance basic knowledge about how people and organizations respond to warnings, using hurricanes as the testbed.

More long-term is the preliminary discussion underway involving the U.S. Geological Survey, NOAA, and SBE regarding the creation of an observatory system of sites that would serve as resilience observatories. Unlike the other observatories, SBE would have a major role in the planning of these resilience observatories from the beginning. The sites presumably would be chosen to reflect different sorts of threats (e.g., earthquakes, hurricanes, tornadoes).

Finally, SBE is considering a solicitation or a program that would fund interdisciplinary research within the social sciences in environmental and natural resource management. The CNH Program, co-funded by SBE and the directorates of the Biological Sciences and Geosciences, covers research that explores how people influence the environment and how the environment influences humans and their institutions. Research that is interdisciplinary, yet within the social sciences, does not fit into CNH. This sort of research—for example, a project that would bring together economists, geographers, and political scientists—has difficulty finding a home in SBE. The project could be funded after co-reviews by the three disciplinary programs, yet the process is cumbersome and is not likely to contribute to the development of an ongoing community of interdisciplinary scholars. This sort of project has been funded recently through the HSD priority area, but HSD is expiring.

How to Win an NSF Grant[3]

All of these opportunities may seem a sort of cruel mirage to scholars who believe that they have no chance of funding because NSF supports only superstar professors at elite institutions. I have five suggestions for potential applicants:

First, *learn to love rejection*. The key to obtaining NSF funding is applying for NSF funding. Persistence is important as NSF often funds proposals that are revisions. The key is to distinguish declined proposals that are like bad poker hands (they may improve, but never enough to become awards) from proposals whose improvement can result in awards. Some proposals have reviews that identify in the research design a fatal flaw or other weaknesses that cannot be addressed. Other proposals have weaknesses that can be addressed. If you are not certain from the panel summary or the program officer's comments into which category your proposal falls, contacting a program officer for clarification is a good idea. E-mail usually works better than a phone call for the initial contact.

NSF funds superstar professors, but NSF also supports large numbers of junior faculty and scholars at less distinguished colleges. Because information on proposals is private, many people would be surprised if they knew how frequently superstar scholars submit proposals that NSF declines to fund. One of the reasons well-known scholars receive so much NSF support is that they are often relentless.

Second, *team up*. Principal investigators need to convince reviewers that the research team has the appropriate expertise to do the work described in the proposal. If a proposal involves a survey,

[3] These suggestions arise from my experience in participating in management teams of interdisciplinary NSF competitions as well as directing the Decision, Risk and Management Sciences Program in SBE since 2001. One particularly trustworthy and useful guide for obtaining funding is the book by Paul Chapin (2004), who was an NSF program officer for 25 years.

for example, the team should include someone whose résumé demonstrates competence in survey design and implementation. Nobody ever wins an NSF award by low-balling on cost at the expense of the resources needed to do the work.

The NSF electronic Fastlane system for proposals makes submitting proposed projects from more than one institution administratively easy. If you want to work with scholars at three institutions, there are two options. One is for one institution to submit a proposed project with subcontracts to the other two. The second option is to submit a collaborative project which involves three linked proposals. Each institution submits its own proposed budget, but the rest of the proposal (i.e., project summary, project description, etc.) is exactly the same on all three submissions.

Third, *contact your program officer if you have specific questions*. Often principal investigators have questions, including whether the idea for a research project is appropriate for NSF funding and, if so, in which program. Contacting a program officer, identifiable through the NSF website, is wise. Encouraging strong proposals is part of the job of program officers. Responding to questions from PIs who have done their homework regarding a solicitation is a pleasure.

I have heard statements that principal investigators need to "get to know" their program officer in order to be funded. This is patently false as, for example in my own experience, I have managed many proposals that were funded when I not only did not know the PI personally, but had never heard of the PI's work prior to submission of the proposal. Calling a program officer to talk to "get to know" the program officer is likely to annoy the program officer.

Fourth, *provide as much detail as possible* in the 15-page project description. "Trust-me" proposals lay out the importance of the research problem, but leave out crucial details of exactly how the PI intends to implement the research design. NSF usually declines to fund these "trust-me" proposals that, despite an intriguing and significant idea and a strong research team, fail to describe adequately the research plan.

Finally, *avoid proposing narrowly incremental research.* Unfortunately, SBE's budget is inadequate to support every meritorious proposal. In any competition, a small number of proposals will promise transformation effects that challenge traditional paradigms and methods. Other proposals will promise significant theoretical or methodological advances beyond the current theoretical understanding or methods. Finally, a third group of proposals seem to be incremental advances to well understood traditional theories. NSF is less likely to fund proposals in this third group, even if well designed, than well-designed proposals in the other two groups. NSF leadership encourages program officers to take more risks in funding decisions.

Winning NSF funding is a process that is neither quick nor easy. Although the road to funding often involves episodes of frustration, the process inherently involves learning and building relationships, which have their own joys beyond the satisfaction of receiving a congratulatory e-mail message from a program officer. It would be beneficial to both the community of environmental and natural resource economists and to science for NSF to send more of those congratulatory e-mail messages.

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