

Community Investigations

Stakeholder participation: experience from the CRESP program

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The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) is an experiment in attempting to mobilize academic-based multi-disciplinary research to be responsive to stakeholders in a manner that allows resolution of complex environmental health issues and leads to enhanced environmental and public health protection. CRESP investigators have carried out projects in which stakeholders are involved in various steps of the project cycle. In this paper, some examples of CRESP's approach to community-based research are presented. Difficulties, challenges, advantages, and methods for performing research with stakeholder involvement in an academic setting are also highlighted. CRESP's experience with community-based research should be viewed as an experiment in progress. Although CRESP has had apparent success as shown with examples in this paper, further analysis is needed to determine whether the central experimental questions have been answered, whether we have truly been able to effectively involve stakeholders in our research, and whether academic researchers effectively respond to stakeholder needs. *Environmental Epidemiology and Toxicology* (2000) 2, 103-111.

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Introduction

The legacy of atom bomb production has contaminated large areas of the United States that had been sequestered for the production of nuclear weapons. These large sites, equaling in total the area of a mid-size state, have been subject to intense environmental restoration and management efforts. Annual expenditures for this mission are now over US\$6 billion dollars yearly, with an eventual cost estimate of over US\$200 billion dollars. Despite these enormous expenditures, relatively little has been accomplished in achieving completed cleanup, especially of the five major sites, although many of the over 100 plus smaller ones have been cleaned up or are well into the process. Monumental environmental management challenges remain and are posed by chemical and radioactive wastes, contaminated soil, groundwater, and ecosystems. One reason for the lack of progress toward

completion has been distrust of the Department of Energy (DOE) by the surrounding community and other stakeholder groups.

Distrust initially was spawned by the necessity of maintaining national defense secrecy. The institutionalized mode of operation tended to minimize public disclosures of worker, public, or environmental risks. With the end of the Cold War and a shift in many DOE locations to a primary emphasis on the cleanup of the Cold War legacy, new standards of openness and transparency were not met.

In 1993, the National Academy of Sciences (NAS) Committee to Review Risk Management in the DOE's Environmental Remediation Program report "Building Consensus" called for an independent, credible, integrating academic program to engage in the provision of information needed for risk-based management of DOE sites (NRC, 1994). NAS also recommended that this externally funded academic group should be tasked to increase the role of stakeholders in defining research needs and in increasing public participation in and acceptance of DOE risk management process. The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) was developed as a

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result of a competitive review of proposals seeking to be responsive to this challenge. The CRESPI consists of the Environmental and Occupational Health Sciences Institute (EOHSI), a joint program of Rutgers University and UMDNJ Robert Wood Johnson Medical School, and the University of Washington School of Public Health and Community Medicine. CRESPI was organized by Dr. Charles Powers, its Executive Director, who has extensive experience in developing innovative organizational approaches to solving environmental pollution problems, including the Health Effects Institute and Clean Sites, Inc. Also involved were Dr. John Moore of the Institute for Evaluating Health Risks and Dr. Arthur Upton, the former head of the National Cancer Institute. CRESPI's faculty was organized in eight Task Groups, each located at the University of Washington and at EOHSI. The Task Groups are Data Characterization, Statistics, and Analysis; Ecological Hazard Identification, Exposure Assessment, Health Hazard Identification, Occupational Safety and Health; Remediation Technology; Social, Land Use, Demographic, and Economic (SLUDGE); and Stakeholder Communication (Goldstein, 1998).

In 1997, the Presidential Commission on Risk Assessment and Risk Management, mandated by Congress in the 1990 Clean Air Act Amendments, published a "Framework for Environmental Health Risk Management" (PCRARM, 1997). The centerpiece of the proposed six-step framework was an ongoing engagement of stakeholders (including the community) at every step of risk assessment and management. The guiding vision was improvement through involvement of stakeholders of the cumbersome and fragmented risk management approach often used by federal and state regulatory agencies. It is not coincidental that both of the initial heads of the two primary academic organizations involved in CRESPI were also members of this commission, including its Chair, Dr. Gilbert Omenn.

In direct contrast to the more traditional, one-way communication of research to communities (and other stakeholders), in which results of research are presented after completion, CRESPI attempted to adopt stakeholder concepts described in the Presidential Commission's six-step risk assessment paradigm. This inclusive approach increases the relevance of research to stakeholder concerns, clarifies objectives of research agenda, and enhances the public acceptance and understanding of research findings. In addition, it involves the community in consideration of environmental management options, decisions, and actions.

CRESPI has undertaken a range of activities that extend from investigator-initiated projects to those fully dependent upon stakeholder involvement from the beginning. The results have led to close to 200 peer-reviewed publications and many more presentations and other products. Some examples of CRESPI's successes with community-based research and in facilitating community dialogue at different phases of a research project are discussed. But we do not

wish to give the impression that all of our attempts at stakeholder interactions were successful — not at all. We are still learning and still attempting to distill our experiences.

The involvement of academia in community-based research: challenges and methods

Academic scientists are not particularly noted for their sensitivity to community views nor to the views of anyone who does not have peer status in their own field. There is a tendency toward self-absorption among those who have successfully survived the "publish or perish" requirements for academic advancement, and an unwillingness to consider the opinions of those who have not undergone the same trial by intellect. Yet, when managed appropriately, the academic promotion process breeds a fierce and uncompromising dedication to the truth. This extends to an inhibition against reporting of erroneous data or conclusions, which will lead to loss of reputation among peers, and a decreased ability to obtain grant support. This relatively high level of credibility for university-based scientists, which is reflected in public opinion polls, can be of value in providing information that moves contentious community-based issues toward resolution.

Bridging the cultural gap between communities and academia is the central question facing all of us interested in extending academic science to be responsive to community-based issues. The challenge is to show communities that university research can be of value, while at the same time convincing successful academic scientists that community issues represent exciting problems worthy of their time and respect.

The EOHSI scientists involved in CRESPI have had a relatively long history of attempting to be responsive to local community environmental health issues in New Jersey. We have summed up our experience with the claim that we are experts in how not to interact with communities, having made perhaps every mistake possible, but still do not consider ourselves expert in how to interact. Based on this experience and the previous experience at the University of Washington School of Public Health, and now with CRESPI, we suggest that there are two Laws of Community Interaction. The first is never put anything on the table for discussion with the community if you already have decided what you will do. The community will see through your ploy and be able to detect the difference between a dialogue and a dictate. The second law is that there are no laws: every community and every circumstance is different. There are, however, well-described principles that are important to follow when working with communities (Chess et al. 1988; Hance et al., 1991; Covello, 1992, 1993). These principles include honesty, openness, dedication, and commitment.

Table 1. Levels of academic interaction with communities.

Level	Community involvement
1	Inform the community
2	Engage the community
3	Set the research agenda with the community

The CRESP program has attempted to build on this past experience. Its characteristics include research performed primarily by senior investigators at state universities. Our senior investigators have more experience in working with communities, and less at stake from losing the CRESP cooperative agreement through having their findings displease powerful interests. And state land grant colleges have a tradition of service the community particularly in public health and engineering programs which have ample experience demonstrating the value of multi-disciplinary research as a means to approach and solve problems.

Finally, an advantage of academia is the prevailing philosophy that facts are friendly and, if not friendly, useful. A classic approach in dispute resolution is to bring new information to the table. Whether factual or conceptual, the new information needs to be pertinent to the issues of concern. This means that CRESP must be able to listen to the stakeholders in order to understand what may be helpful. It also requires that CRESP's science must maintain the highest credibility with all.

There are a number of theoretical approaches which have identified levels of community involvement in government technical activities, e.g., Arnstein's ladder of Citizen Participation (Arnstein, 1969). We see three levels of academic involvement with communities (see Table 1). The most superficial is simply to inform the community that research relevant to their interests is in progress or has been completed. In the second tier, the researchers also set the agenda and develop the project. But instead of solely communicating their activities and findings after the fact, they also involve the community in the research process, seeking input from the community on the different phases of the research project and, where feasible, engaging the participation of community members in the process. This has been particularly valuable in finding important exposure pathways that were unknown to the investigators, as in the case of the Savannah River fish consumption study described below. The most difficult level of interaction — but which we believe ultimately as the most rewarding to all involved — is to actually develop the research agenda in consultation with the community. This requires listening carefully and respectfully to community interests and concerns. It also requires effective communication about the strengths and weaknesses of the scientific method, particularly so that false hopes will not be raised.

Challenges of community outreach and engagement

Bridging the gap between the academic researcher and the community must start with an understanding of the problems inherent in community outreach and engagement. Any bonafide effort to reach the public and special interest groups in a given location will encounter three realities. One is that people vary enormously in their desire and ability to keep abreast of the quality of their environment and engage in protecting it. This has been especially true for DOE activities as site issues are extraordinarily complex with many technical meetings and documents, and are fraught with post-security secrecy legacy. From as little as 10% to as large as half of the people in neighborhoods do not want to be informed and do not want to engage (Greenberg, 1998; Williams and Suen, 1998; Williams et al., 1999, 2000). Indeed, some become angry when you try to get them to participate. Having noted that it is not possible to reach everyone, people we have studied at DOE sites, the DOD's chemical weapons sites, and environmentally stressed industrial neighborhoods tend to fit into three groups. One group only wants the organization's information given to them *via* one-way communication. The second group wants information, but also wants to express their needs, values, and views. The third group wants to be kept abreast, wants to express their views, and wants to be actively engaged in decision making.

If the goal is to reach as many people as possible, the second reality is that those who want to engage the community must be prepared to try a wide variety of outreach methods (Booz et al., 1998; Chess and Purcell, 1999). Those who want to be informed can be reached with newspapers, radio, television, videos, mailings, a booth at the county fair, a speaker's bureau, news conferences, employee briefings, and other one-way forms of communication. Those who want some engagement and to be kept informed will also need opportunities such as public meetings, a telephone line, systems that permit feedback, workshops, open houses, facility tours, community round tables. Additional opportunities include participation in surveys and focus groups. The timeliness of these interactions is also important since the expectation of this group is that they will participate in decision making; these interactions need to occur throughout the process and not as a final stage for reacting to decisions.

Thus, for researchers, the most difficult demand to meet is for participation in decision making. The difficulty arises from determining who represents the public, when their views should be solicited in the decision making process, and how can this be done with the organization, such as the DOE or DOD, retaining its statutory responsibility for making the decision. Formal citizen advisory groups appointed by a governor or a site official are a common method of gaining input on decision making. But a single

citizens group cannot hope to satisfy the needs of the 5–15% of the people in a neighborhood that really wants to participate (Pew Research Center for People and Press, 1999).

Another reality is that all of the above efforts can lead to confusing results, unless an evaluation component such as a “lessons learned program” is built into the program. That is, every method to reach and engage the community must be evaluated for effectiveness. Those that are not working should be modified or replaced by others that are working. Furthermore, it is absolutely critical that all the results be examined for common patterns. It makes no sense to independently do surveys, focus groups, evaluation of newspaper articles, and keep registries of phone calls and inquiries unless a process is in place to evaluate such information and use it as a feedback to modify or augment active practices. This requires regular examination of all of the collected data to extract the key policy implications.

Study of risk perceptions at Savannah River Site (SRS) — a community-based survey

A large cross-sectional population survey was conducted of residents living near the DOE's SRS in Georgia and South Carolina. SRS delivers the nation's tritium-filled reservoirs to the DOD. It also plays a major role in nuclear weapons stockpile stewardship with the construction and operation of a new facility to extract tritium. Additionally, SRS has been selected as the site for disposition of the surplus plutonium materials in support of the nation's nuclear nonproliferation effort. In recent years, SRS's missions have expanded from primarily a defense mission to comprise environmental cleanup and the stabilization, storage, and preparation for final disposition of nuclear materials (SRS, 2000).

The study aimed at identifying determinants of perceptions of environmental risk and institutional trust among site residents. It was conducted with the specific intent of gathering information that could be used to enhance risk communication efforts. Before conducting the study, a research partnership was established between CRESPP researchers and two local universities (Williams et al., 1999).

Residents were surveyed using a computer-assisted telephone interviewing (CATI) system. The use of a quantitative assessment approach allowed researchers to identify and limit potential sources of systematic measurement error. Additionally, population surveys permit researchers to reliably measure broad perceptual areas and to assess large numbers of subjects, thus yielding generalizable findings. In contrast, the generalizability of findings and the precision of measurement are compromised when using more qualitative approaches to assessment (i.e., focus

groups). Given the “high stakes” of this study, a formal quantitative assessment approach was warranted (Williams and Suen, 1998). Additionally, previous studies have implied that assessment of risk perceptions should be more rigorous methodologically (Paternoster et al., 1982; van der Pligt, 1996; Fromme et al., 1997; Frewer et al., 1998).

A random sample of 1671 of Georgia and South Carolina residents was drawn from a 14-county region within about a 90-mile radius of the SRS site. The estimated total population for the 14 counties was 841,128 (U.S. Bureau of the Census, 1994). The demographic characteristics (e.g., ethnic distribution) of the sample were comparable to that of the study region (Williams et al., 1999).

The findings of this study indicate that determinants of environmental risk perceptions and institutional trust are constructed both psychologically and socially. In terms of risk perceptions, heightened concern was found to be most commonly associated with educational, economic, psychological, and geographic factors. Overall, heightened environmental risk perception was most often associated with the following respondent characteristics: “Not being economically dependent on SRS (e.g., not being a site employee)”; “Living downriver from SRS”; “Not being willing to accept additional hazardous waste at SRS”; “Not being willing to accept public health risks for economic gain”; “Distrust of facility operation and regulation”; and “Having a low-income level and being poorly educated.” The determinants of institutional trust were similar to that of risk perceptions. Low trust was associated with residents who live downriver from the site, who are not economically dependent on SRS, who have a low level of environmental stress in their neighborhood, and who believe that external factors control their personal fate.

Study of risk perceptions at SRS — newspapers content analysis

Understanding how stakeholders formulate risk perceptions and information is an essential component of stakeholder interaction. Another approach to understanding how local stakeholders form perceptions of risk related to SRS was an analysis of local newspapers' characterization of hazards and risk and their impacts on local communities (Lowrie et al., 2000). Literature frequently cites newspapers as a credible and frequently used source of information that provides a significant contribution to perception and knowledge about hazards and risk (McCallum et al., 1991). According to Witt (1983), most of what Americans know come from television and newspapers. As DOE sites have both a mandate for cleanup and a mandate to solicit stakeholder participation in determining cleanup priorities, the examination of how local newspapers report environmental risks and their impacts provides insight into

community dynamics and perceptions related to site activities. CRESPI investigators examined how newspapers in two different regions of the United States report news about nuclear weapons facilities in their areas. Five newspapers based near SRS in rural South Carolina or near the Rocky Flats Environmental Technology Site in the Denver, Colorado area were searched for articles about an event, process, or activity (past or future) at the site between July 1, 1996 and June 30, 1997. Articles ($N=188$) were coded for their main subject. Within all articles, each paragraph was coded for the source of information, ways that environmental hazards or risks were characterized, and the resulting impacts. Two thirds of all paragraphs ($N=2661$) had no hazard or risk information (Waishwell and Lowrie, 1998). About a quarter of all paragraphs referred to a specific hazard, but less than 5% mentioned risk in any context. The resulting impacts of hazards and risks identified in the paragraphs were identified and categorized. Cost-effectiveness, economic, environmental, human, or occupational health and the effect on stakeholder involvement were mentioned. Economic impacts of site events were most often mentioned by SRS newspapers while environmental impacts were more prominent in Rocky Flats newspapers. Human health impacts were rarely mentioned in any article. This study points to a need for involvement of the media in promoting accurate and reliable information about potential health risks.

The identified sources of information in the newspaper articles included DOE officials, contractors, other governmental officials, business and industry officials, workers, environmental organizations or other citizen groups, and technical experts. Newspaper reporting of an issue often includes alternative or counterpoint perspectives. Over half of all paragraphs identified a specific source of information provided. The most frequently used sources of information were a local site official (either DOE or the local contractor) and DOE Headquarters in Washington, DC. Although the press is often accused of sensationalizing environmental risks by seeking extreme opposing views, this study found that reporters overwhelmingly utilize site officials and DOE Headquarters as the most frequent and often the sole sources for their information. There were few business and industry, union, expert, or environmental organization sources identified as a source of information.

Experience at the Hanford site — Hanford Openness Workshops (HOWs)

Secrecy was a way of life during the Cold War at DOE sites and activities at the Hanford Site located in southeastern Washington State were not exceptions. National security was used as a rationale for hiding from the public

environmental, health, and safety documentation that had little connection to genuine national security concerns. However, government officials did become concerned about public reaction if the environmental impacts of weapons production were disclosed (Parker, 1948; Gordon et al., 1973).

DOE took several sporadic efforts toward openness at this site during the 1980s, including development of the Tri-Party Agreement (TPA, 1989) which committed DOE to clean up Hanford and to abide by federal and state environmental laws. Other efforts toward openness occurred as a result of DOE administrative changes. Assistant Secretary Grumbly helped set the tone by stating:

Public involvement in decision making is perhaps the single most important thing the Department of Energy can do... DOE needs broad-based support and participation... DOE's activities directly affect public health and safety and the environment for which DOE must exercise stewardship and be responsive to the public interest. Citizens must have the right to influence decisions about matters that affect them (U.S. Department of Energy, 1995).

In 1994, at a meeting called Hanford Summit II, DOE Richland took steps toward meeting the challenge by proposing a Hanford openness panel. The panel's mission would be to increase public access to documents, transparent decision making, accountability and openness, and the elimination of reprisals against employees for "whistleblowing." For more than 2 years, Northwest stakeholders and Tribal Nations aggressively pursued this commitment to Hanford openness, but could not agree to a format acceptable to DOE. In 1997, the logjam was broken when the Oregon Office of Energy and the Washington State Department of Ecology facilitated the creation of the HOWs by developing an implementation plan with CRESPI.

Taking advantage of a workshop format, CRESPI organized a series of meetings to address issues of openness at the Hanford site. The HOWs are a collaborative partnership among the DOE Richland Operations Office, regional tribal and public interest organizations, the Oregon Office of Energy, Washington State Department of Ecology, and CRESPI. The HOW mission is to resolve issues impeding the availability of information important to public health, the environment, understanding, and decision making at Hanford. Since 1977, 10 workshops have produced eight fact sheets and two major documents with recommendations as well as workshop summaries.

In keeping with the concept of openness, materials produced by the workshops have been posted on their web

site, www.hanford.gov/boards/openness. These materials include fact sheets on openness-related topics (DOE declassification and document access processes; Internet openness resources; openness and security), summaries of workshops, and two major documents with recommendations: a report on the 1997–1998 series of workshops (Hanford Openness Workshops, 1998) and *Is Openness Working? A Progress Report* (Hanford Openness Workshops, 1999). The workshop participants developed a broad definition of openness to include not only declassification issues but also openness and transparency of decision making processes at DOE. Smaller working groups to address specific issues have included Employee Concerns, Information Tools, Declassification, Public Involvement, Performance Measures, and Tribal Concerns. Perhaps most importantly, these workshops have facilitated two-way dialogues between site managers and interested parties. The HOW has taken significant steps toward meeting the intent of former Energy Secretary Hazel O'Leary's definition of openness: "Open, ongoing, two-way communication, both formal and informal, between the Department of Energy and its stakeholders" (O'Leary, 1994). For example, HOW workshop participants met with DOE outreach specialists and discussed approaches for improving the evaluation component of DOE's outreach activities. Discussions from these HOW dialogues allowed the workshop participants to identify "good" examples of DOE outreach and communication efforts as well as those activities that needed improvement. Participants also developed specific recommendations for improving evaluation and encouraged use of "performance metrics" to emphasize the DOE's commitment to openness by their actions and their subcontractors efforts.

Another example of an openness issue identified during the openness workshops was that of raising awareness of the unique openness concerns and priority needs of Tribes and Tribal Nations. The second HOW workshop series had a specific meeting organized on this topic. This brought DOE declassifiers to a workshop organized by the tribal openness working group including representation from three "Hanford-affected" federally recognized tribes. The workshop highlighted the need for DOE declassifiers to meet directly with Tribes in order to improve the appropriateness or sensitivity of declassification of information (e.g., salmon and cultural risk issues) of interest to the Tribes.

Workshop outcomes have had national implications and have been shared with Chairs of DOE Site-Specific Advisory Boards (SSAB). In addition, the Secretary of Energy Advisory Board has established an Openness Advisory Panel (OAP) concerning the status and strategic direction for DOE's classification and declassification policies. A member of the OAP attended a HOW and reported back to the OAP a very favorable impression of HOW's activities during the OAP's first ever field meeting

in February 1998 (Openness Advisory Panel of the Secretary of Energy Advisory Board, 1998).

The HOW makes recommendations not only to DOE Richland, but also to DOE Headquarters. In the 1998 HOW report, 33 recommendations were directed to DOE Headquarters. A response from DOE Headquarters to these recommendations was received in 1999 and the HOW began a dialogue with DOE Headquarters on the recommendations. The regional DOE office has also responded specifically to the HOW recommendations and, in many cases, implemented suggested changes. The workshops have provided a forum in which the parties can begin to develop the trust necessary to work together toward common goals. In the context of DOE in general, and Hanford in particular, simply providing such a forum has been an important step for public participation. CRESPE, as a facilitator of this process, has been able to use a workshop format comfortable for participants but which maintained a focus on technical issues and a products-driven approach.

Community ecological issues for effective risk characterization

Traditional ecological risk assessment usually involves comparing the levels of a stressor in organisms with the levels known to cause adverse effects in those organisms or ecosystems. Using this definition, protection of the ecosystem is thus maintained by keeping levels of a stressor below those levels causing adverse effects in those organisms evaluated. This method of risk assessment normally involves only directly interested parties such as developers or polluters, and not the general public or other stakeholders.

With chemical and radiological stressors, the levels known to cause effects are often determined in laboratory tests with a small range of specific aquatic species, and with haphazard data derived from adverse incidents in nature. In this assessment, there is neither room nor a role for stakeholders. However, true protection, maintenance, and/or restoration of ecological health is a far broader concept requiring a much more demanding series of assessments and inputs. Such breadth of evaluation can be especially appreciated when ecological risk assessments are developed for evaluating potential effects on terrestrial species and their ecosystems. For assessment of large land holdings, such as those of the DOE, a more broad-scale food web approach is necessary if the wide range of receptors is to be protected. Such receptors include the top trophic level, such as humans. In this broader approach to ecological risk, a wide range of stakeholders should be included because their input is essential in identifying the receptors of concern, exposure conditions, and scenarios. In accordance with this

holistic framework for ecological health, CRESP researchers have established and maintained a two-way dialogue with the public, on-site scientists, and regulators (Burger, 1999) in the development of an effective risk management plan for the DOE sites.

While traditional methods of ecological risk assessment may be useful as a filter to identify areas within any given site that pose an immediate danger, designing a holistic plan that includes measures at different ecological levels is critical to preservation of functioning ecosystems (Burger, 1999). Such a plan should ideally include measures and endpoints at the individual species, population, community, ecosystem, and landscape scale. It is at this initial stage that a variety of stakeholders can have the greatest input, assuring that local and more regional concerns can be incorporated.

Measures at the landscape scale to evaluate ecological risk at regional levels are the most useful to resource managers, policy makers, and the general public in a variety of decisions about cleanup, remediation and restoration, and future land use of complex hazardous waste sites. However, it is this stage that is the most difficult to include a variety of stakeholders because the methods for regional and landscape evaluation are more poorly developed than the methods at the species or population level. Yet, CRESP and others can have the greatest effect at this stage in increasing the awareness of stakeholders of the importance of landscape scale measures.

Bioindicators and measures used for ecological risk can often be selected to serve multiple goals. Both the goals and the indicators should be influenced by a variety of stakeholders in an iterative design. That is, bioindicators can be used to assess ecological risk to the organisms themselves and to higher trophic levels that consume them, including humans. Thus, some fish can be used as indicators of the individual population, the health of the ecosystem, and the health risk to human consumers.

In order to shed light on the controversy about the relative risks from consuming fish from the Savannah River, particularly near the Savannah River Plant, CRESP researchers designed a holistic study that assessed the exposure of, and risk to, people fishing along the river (Burger et al., 1999). The levels of mercury, strontium, and cesium in fish collected from the area were quantified, and the risk from consuming these fish to receptors, including other fish and humans, was comprehensively evaluated. A survey to determine whether people understood fish consumption advisories for the river was also conducted.

This study of people fishing along the Savannah River, along and below the SRS, indicated that people consumed higher levels of fish than previously assumed by the respective state agencies (SCDHEC, 1996, 1999) and that blacks consumed significantly more fish than whites, putting them potentially at higher health risk (Burger et al., 1999).

These data indicate the importance of obtaining site-specific risk information for more realistic and representative risk characterization by constructing population-specific exposure scenarios and site-specific contaminant levels.

The basic design of all three aspects of this study was aided by several meetings with local fishermen, the Citizen's Advisory Board, the CDC Health Effects Subcommittee, state and federal regulators, DOE, and CRESP which improved all aspects of the study design. By presenting both survey instruments and proposed methodologies to a variety of stakeholders both before and after data collection, CRESP was able to modify the questions asked and the methodologies used, and to analyze the data in ways that were helpful to a broad range of stakeholders. The inclusion of stakeholders before and after each research step insured that the results were relevant to public, governmental, and regulatory concerns. The inclusion of stakeholders at several points in the research effort was advantageous because more relevant questions were asked about fish consumption and cooking methods. This resulted in collection of appropriate fish and tissue types for analysis, and identification of more realistic consumption patterns (by ethnicity, gender and age) in order to better characterize risks for receptors of concern.

While the use of fish as a bioindicator is obvious because of the potential impact on the fishing and consuming public, other receptors of concern are less obvious to identify. From local surveys (Burger, 2000), CRESP determined that some people hunt and consume raccoons. Raccoons are omnivores whose feeding habits integrate exposure over a broader spatial scale than point source measures of soil or water, and can provide a measure of potential risk to both themselves and other organisms, including human consumers. CRESP determined the levels of radiocesium, mercury, and other metals in the tissues of raccoons to assess the potential health hazards to higher trophic level consumers, including humans (Gaines et al., 2000).

It is equally important to assess how species, including humans, will use ecosystems if unrestricted access is provided. CRESP researchers in various disciplines (e.g., health hazard identification, ecological health, economic, and social sciences) have consulted with a wide range of stakeholders to understand their concerns and to design and conduct research that not only contributes to scientific discovery but also addresses stakeholder concerns. Understanding the perceptions and attitudes of stakeholders concerning the value of ecological services is an important aspect of ecological risk assessment. CRESP interviewed people who hunted on the SRS, lived adjacent to the site, or lived in the region. We found a surprising agreement that using the site as a National Environmental Research Park and for recreation (hunting, fishing, camping, hiking) were the preferred future land uses, and that using SRS for

building homes and factories and for additional nuclear waste storage ranked the lowest.

Since recreation-related activities are often important exposure pathways for communities, both through direct on-site exposure and from indirect exposure (e.g., consumption of contaminated biota), it is important to develop an integrated and holistic ecological risk assessment that includes site-specific data concerning exposure (exposure pathways, concentration in biota, receptors of concern, consumption rate) and population-specific data about potentially exposed populations. Both the direct inclusion of stakeholders by CRESP in the design phase of the traditional ecological risk assessments and understanding the values and perceptions of community members around DOE sites are critical to understanding and conducting meaningful ecological risk assessments.

Conclusions

CRESP is an ongoing experiment. It attempts to mobilize academic-based multi-disciplinary research to be responsive to stakeholders in a manner that permits resolution of complex environmental health issues and leads to enhanced environmental protection. We have presented a few examples of this research which provide insight into the challenges and advantages of this mode of operation. Judged by usual academic data concerning research productivity, including close to 200 peer-reviewed publications, CRESP has been a success. Although we have been less than perfect in our relation with stakeholders and not everyone agrees with our interpretation of our findings, we take great pride in the fact that we are unaware of anyone who has challenged the scientific integrity or credibility of our research. We believe that CRESP also has readily met the test of being an effective use of taxpayer funds; in fact, we believe that the outcome of our research may well save literally hundreds of millions of dollars that can be used for effective response to DOE's environmental problems. DOE and the broad range of stakeholders that impact on the DOE budget process apparently believe that CRESP has been useful in that CRESP has been recently renewed for another 5 years at a somewhat increased funding level and with the addition of Vanderbilt University as a full partner and of scientists from Columbia University and the University of Arizona as well as others. But further analysis is needed to determine whether the central experimental questions have been answered: whether we have truly been able to effectively involve stakeholders in our research and whether academic researchers can be responsive to stakeholder needs.

The DOE — and other federal agencies whose mission extends beyond that of science and technology — in essence has three potential sources of science and

technology independent of its regulated community. These are its in-house scientists, in the case of DOE primarily the National Laboratories; the contract community; and academia. We believe that CRESP demonstrates that the addition of the credibility provided by academia in situations in which academics truly have relevant expertise and in which this expertise is filtered through stakeholder interaction before turning into research helps provide a rationale for involving universities in site-specific stakeholder-related research.

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