CASE

6

RESOLVING SCIENCE-INTENSIVE PUBLIC POLICY DISPUTES

Reflections on the New York Bight Initiative

■ Scott McCreary

The New York Bight Initiative was one of the first studies to explicitly design a collaborative decision-making process to take account of the shortcomings in the way traditional administrative, legislative, and judicial processes handle science-intensive issues. It was carried out from 1986 through 1988 under the auspices of the New York Academy of Sciences (NYAS). The substantive focus of the Bight Initiative was the management of pollutants in what the National Oceanic and Atmospheric Administration called "one of the most stressed marine ecosystems in the United States,"[1] the ocean region adjacent to New York Harbor known as the New York Bight. From a process standpoint, it emphasized the procedures for joint fact-finding, and the linkage between fact-finding and the effective negotiation of a single-text document.

The Bight Initiative consisted of four main phases: a prenegotiation phase devoted to establishing the logic for intervention and framing issues for investigation; a 10-meeting series of mediated negotiations within which the joint fact-finding activity was focused; a postnegotiation ratification phase; and, finally, a documentation phase of the results of the case.[2]

The New York Bight Initiative was built on three key features:

1. Direct dialogue among a panel of scientists and a plenary negotiating group of 22 resource managers, resource users, and other interested parties.
2. An extensive joint fact-finding effort to review and present relevant technical information and evaluate the technical consequences of policy alternatives.
3. Mediated negotiation of an 80-page single-text document through five successive drafts, including five chapters of findings and one chapter of management strategies.

The balance of this case study addresses several topics. First, the logic for intervention is defined and how issues were framed for investigation is explained. The section following that explains how scientists were recruited to participate in the Bight Initiative and details the various roles scientists played. Then, how the joint fact-finding process worked, and how that work supported the development of a single-text agreement, is described. Last, the ratification phase of this single-text process is described.

■ *Framing Issues for Investigation*

The process began at the initiative of the author, then a doctoral candidate at MIT's Department of Urban Studies and Planning, who teamed[3] with the Science and Decision Making Program at the NYAS to prepare a successful proposal to the William and Flora Hewlett Foundation for financial support. The initial period consisted of strategic planning, stakeholder analysis, and issue identification.

We identified 30 key resource agencies and managers and recruited them to provide advice on strategic planning. This core group included representatives from federal, state, and local environmental protection agencies and from the Port Authority of New York and New Jersey, as well as a range of fishing, conservation, and maritime interests. Many of these actors shared responsibility for one or more aspects of resource management, yet have worked in largely separate decision-making venues. Strong, productive working relationships existed among a handful of groups. Other sets of groups had distinctly polarized relationships. For example, representatives of environmental protection organizations and the wastewater treatment agencies had disagreed strongly over the appropriateness of continued dumping of sewage sludge in the New York Harbor region. As well, the environmental interests had joined with the fishing industry in sharp disagreements over how best to dredge and deepen New York Harbor, given the likely resuspension of sediments laden with contaminants. While some strong coalitions existed among small groups of these organizations, there had been few, if any, prior efforts to pull together the full range of agencies with decision-making responsibility into a coherent effort to resolve these management issues.

At the time, citizens groups and resource agencies were in the process of developing specific proposals to restore the bight. The NYAS was concerned that unless these proposals took account of the strong competing interests at stake and were based on the best available science, poorly designed solutions might result. The academy did not seek to push particular models for action. Rather, it hoped to promote agreement by improving communication and cooperation among scientists, policymakers, and the public. In particular, the following issues were to be addressed in the consensus process:

- Is the bight stressed? What are the criteria for making this assessment?
- Is there a need for a bight restoration and management strategy?
- Which issues should be addressed first?
- How can consensus be developed to propose and implement a bight strategy?

COMMENTARY

None of the questions posed in the four bullets has a unique scientific answer. The concept of a stressed ecosystem needs clarification, and the question of the need for restoration and management is one of policy, not science. Science can help set priorities for what to do, once the policy decision is made as to the extent that society wishes to restore an ecosystem. Science may be useful in building a consensus for a bight regional management strategy, but science cannot determine that strategy.

—William Moomaw, *Environmental scientist*

An initial meeting confirmed that there was a high level of conflict and considerable scientific uncertainty inherent in bight management. The more than 30 participants agreed that the bight needed to be managed in a way that went beyond single issues, single disciplines, single interest groups, and single political jurisdictions. Some members of the core group expressed a willingness to fund a broad consensus building effort, but asked the academy to poll bight users and managers extensively to provide greater clarity about the most pressing bight management issues, the obstacles to effective bight decision making, and their level of interest in participating as potential negotiators in the emerging Bight Initiative.

COMMENTARY

Disagreement over facts and interpretation of science is often an impediment to agreement. There are three dimensions of scientific uncertainty that are recognized within the scientific community. The first arises because measurements or observations are insufficient to adequately bound the interpretation. Often, the necessary measurements have simply not been made. The second form of uncertainty may arise because of conflicting measurements, for example, one study finds high levels of PCBs in fish whereas another finds low levels. The third type of uncertainty arises not from issues of adequate data but rather from disagreements over competing or incomplete theoretical frameworks. The resolution of uncertainty within the scientific community may be accomplished through additional research. However, disagreement over uncertainty in developing consensus for policy implementation may not be resolvable since uncertainty is often used in this context to prevent action from being taken.

—William Moomaw, *Environmental scientist*

Over the following autumn and winter, our team conducted a conflict assessment during which we prepared a detailed survey instrument and interviewed close to 100 resource users and managers in the bight. A 10-page interview guide included a mix of open-ended and close-ended questions. Interviews were preceded with a letter explaining the agency's interest in promoting resolution of science-intensive disputes in the New York Bight. Open-ended questions touched on the respective roles in bight management, comments on traditional mechanisms for resolving conflicts between competing uses, and comments on obstacles to effective use of scientific information in bight management.

Perhaps the most important part of our interview guide asked respondents to consider a list of 23 bight management issues and rank order the top five issues. We asked respondents to consider whether (1) the issue was pressing; (2) the issue was characterized by elements of scientific or technical disagreement; and (3) the issue might be clarified or resolved through dialogue among scientists, decision makers, and representatives of key interest groups.

A total of 71 ranked questionnaires were returned to the academy. No single issue emerged as the unanimous choice, but five issues were mentioned by more than half the respondents. The question of assessing risks to the environment posed by contaminants topped the list. Human health risks and a classification of contaminant concentration by source were also major concerns. We established that a focus on the sources, fates, and effects of a class of contaminants would allow us to touch on issues rated high by a very large number of respondents.

The findings discussed above, along with the results of the open-ended interview questions, were described in a document mailed to key stakeholders in June 1986. One part of the report identified and discussed some of the obstacles that respondents perceived as inhibiting effective use of scientific information. They included the following:

- Some data are considered inaccessible to decision makers and the public.
- Parties may be unwilling to consider information that undermines their position.
- Testing protocols and standards are not sufficiently coordinated among agencies.
- Scientific uncertainty and disagreement frustrates effective use of information.
- Data are collected without following an issue-based research agenda.
- Media and elected officials may not make the best use of scientific information.

We reported these findings at a follow-up meeting in July 1986 and were encouraged to develop a formal proposal to submit to potential stakeholders and foundation funders. Through continued interaction of a small steering committee between July 1986 and October 1986, we refined the focus to the sources, fates, and effects of PCBs (polychlorinated biphenyls), a group of chlorinated organic compounds. PCBs were chosen as the focus because of a well-documented persistence in the environment, their tendency to bioaccumulate in fatty tissues, their responsibility for both carcinogenicity and reproductive impairment of a wide variety of marine organisms, and health effects in humans. Of particular concern were the potential risks to people who consume striped bass and bluefish contaminated with PCBs. PCBs enter the New York Bight from a variety of sources. Despite broad agreement over these basic statements, the relative importance of the sources, the extent of the biotic effects, and the real importance of health effects were widely contested and would thus lend themselves to a process devoted to joint fact-finding.

■ *Involvement of Scientists and Technical Experts*

A central premise of the New York Bight Initiative was to make possible the face-to-face interaction of policymakers and resource users.[4] Accordingly, our team designed and executed a process devoted to joint fact-finding. Our proposal called for a 5-meeting pilot process (which later grew to a 10-meeting series), with particular emphasis on joint discovery and evaluation of the most up-to-date scientific information. We envisioned a panel of scientific advisers working with negotiators in direct dialogue. Our proposal also called for the development of a single negotiating text to sum up the findings of the deliberations. This single text was to note areas of agreement and disagreement and would develop policy recommendations.

Variations on the proposal were sent to 14 prospective funders; of these, 11 agreed to provide support. The Office of Coastal Resources Management agreed to fund the joint proposal of the New York and New Jersey Coastal Programs. Private funders included the Towboat and Harbor Carriers Association, the Monmouth-Ocean Development Council, and the Exxon Foundation. Agency funders included the Port Authority of New York and New Jersey, the New York City Department of Environmental Protection, the Interstate Sanitation Commission, and the Long Island Regional Planning Board. Altogether, the NYAS spent one year raising $85,000 from external sources and agreed to provide matching resources in the form of staff time and space to support the initiative.[5]

Once funding was in place, our team turned to the challenge of recruiting scientists. Identifying and engaging the help of these expert panelists was a two-phase process. In the first phase, as part of the conflict assessment, we assembled a large pool of candidate experts. In our stakeholder interviews, we asked respondents to name scientists whose expertise could conceivably help illuminate technical aspects of major bight issues. This yielded a roster with about 80 individuals (40 academics and 40 agency staff or consultants) with diverse specialties.

The second phase began once PCBs, which persist in the environment and accumulate in biota, were chosen as the focus for attention. Beginning in the 1930s, PCBs were manufactured for industrial uses, especially for electrical equipment because of their heat transfer properties and low combustibility. PCBs were used widely in chemical applications during the 1960s. Later, Monsanto, the original manufacturer, started using PCBs only for electrical equipment and other uses of PCBs were curtailed. General Electric was among the companies that bought the product and manufactured equipment, which used PCBs. Some of this equipment subsequently discharged PCBs into the environment.

We set out to locate scientists who could give an initial briefing to the negotiating group on some of the sources, fates, and effects on the marine ecosystem of PCBs. As work progressed, we redoubled our recruiting efforts for scientists with expertise in toxicology, human health effects, and sedimentology. This effort was iterative as the fact-finding activity continued through the first 8 of the 10 meeting series. By the end of the Bight Initiative, we had enlisted a total of 23 scientists.

We used two overarching selection criteria in recruiting scientists. The first, consistent with the aims of the Bight Initiative and the mission of the academy, was that they be able to generate the best, most up-to-date scientific information. We considered the possibility that negotiators could be given "veto power" over which experts were recruited. However, we rejected that as an inflexible approach that might preclude the best available information from entering the process and stifle an open exchange of views.

The second was to draw on people who would be viewed as credible by the negotiators. We tried to gauge this with a review of recent literature, conversations with negotiators, and, as the fact-finding process progressed, discussions with some of the first scientists recruited. Often, one scientist in a particular specialty was able to lead the academy to colleagues whose expertise could be useful. Several negotiators—both industry officials and environmentalists—also recommended experts who were tapped. Finally, in a few instances, scientific advisers also represented their agencies.[6]

The NYAS used some rather general guidelines to confirm that panelists would be suitable. Our team looked for people with advanced degrees (all but two had doctorates) who had worked and published for several years on their respective subjects. We also asked panelists whether they had previously been involved in "science advising for policy," though we did not expect them to have previous experience in a process with the structure of the Bight Initiative.

COMMENTARY

Adversary science or *advocacy science* is based on the debate model favored by lawyers. It involves having scientists present only the scientific data and theory that bolster a particular side of an argument. This approach has become particularly dominant in environmental debates, and it conflicts with the goal of science to evaluate objectively all evidence before coming to a conclusion concerning cause and effect.

—William Moomaw, *Environmental scientist*

The academy's neutral, nonpartisan standing and its strong scientific reputation[7] helped immeasurably in recruiting panelists for the Bight Initiative. A further element of attraction was the novelty of the process and its potential value for moving the policy debate along. The fact that the academy is housed in the old Woolworth family mansion on the Upper East Side proved to be a draw for some experts, as well. In a few cases, the academy offered to pay a modest per diem and travel expenses,[8] but in most cases this was not necessary.

Eighth Workshop—Text Revision in Working Teams—August 1987

The August workshop will have two major objectives: (1) refining management options developed at the July 26 meeting, and (2) refining sections of the draft text on biological effects. Your greatest contribution will probably be in helping the group refine and critique draft management suggestions, and in offering an overview of efforts to clean up New Bedford Harbor for comparative purposes.

You should be forewarned that the group is a contentious one; in the words of one scientific adviser, members are "a bunch of prima donnas." Some individuals will no doubt take pains to point out how New Bedford and the Hudson/Raritan-Bight are different. But do not let this dissuade you from participating fully.

Figure 6.A. Excerpt from Letters of Invitation to Scientists to Serve as Scientific Advisers for the Bight Initiative in a Later Stage of the Process

COMMENTARY

The question of who funds science or a scientifically based process has become a major issue. Are funders intent on buying a particular outcome, or are they genuinely interested in obtaining the outcome dictated by the scientific findings? The choice of the New York Academy of Sciences as a neutral convenor was critical for attracting scientists to the process and in achieving credibility of the final recommendation.

—William Moomaw, *Environmental scientist*

Once a scientist agreed to serve as a panelist, the NYAS team offered brief guidance in writing, as illustrated in Figure 6.A. These instructions evolved as the focus shifted from initial briefings to in-depth fact-finding, and later to the revision of negotiated language.

As the sequence of mediated negotiations was getting under way, several roles were envisioned for scientists. One was to identify relevant information and comment on its validity. A second was to explain cause-and-effect relationships. This was crucial to the Bight Initiative, since the causal sequence of sources → fates → effects of PCBs was chosen as the frame for analysis. Another important role of scientists was to help evaluate alternate policy recommendations and forecast their implications. Still another key charge was to help clarify the basis of scientific disagreement and uncertainty.

The scientists accomplished these tasks in a variety of ways. One mechanism was to offer scientific briefings and participate in subsequent question-and-answer sessions in which we helped participants to "cross-examine" scientists. Another was to invite scientists to draft initial versions of portions of the negotiated text. Related tasks were to comment on interim drafts summarizing findings, and to join policy makers in deliberating the merits of policy alternatives.

Role of the Mediator in Facilitating the Interaction of Negotiators and Scientific Advisers

The Bight Initiative demonstrated that, to be effective, a mediation team must fulfill a whole series of tasks to facilitate the involvement of scientists and technical advisers. Two of these have already been identified: recruiting scientists and then providing clear "terms of reference" for the briefing or dialogue tasks expected of them.

COMMENTARY

It is extremely important that the tasks of the scientists were clearly stated and that the expectations of their contributions were made clear from the beginning. Many scientists are uncomfortable with questions about what should be done and are often better at assessing the implications of alternative policy recommendations than they are at suggesting appropriate policies.

—William Moomaw, *Environmental scientist*

Some other tasks are those of a secretariat. These included preparation of detailed agendas and packets containing relevant supporting materials for each day's workshops. These packets typically included short biographies for scientists, memoranda summarizing relevant scientific literature on a topic or an outline of policy options, and copies or excerpts of relevant scientific articles.

Our team accomplished our goal of bringing high-quality, up-to-date information to the deliberations. Moderating those discussions was a major task of the mediation team. Mediators introduced scientists and related their expertise to the task at hand. Then, as scientific advisers proceeded with their presentations, the mediators tried to discern when some presentations were becoming too technical or jargon laden. In other instances, the mediation team asked the experts to clarify their terms: "In other words X." Or, "So that means that Y."

Nevertheless, we had to identify and then work to overcome several obstacles to effective dialogue. In particular, we needed to perform several kinds of coaching and intervention in the preparation and presentations of technical advisers. In particular, we (1) anticipated and restructured overly complex presentations, (2) sought to eliminate unnecessary caveats about expertise, (3) encouraged greater tolerance for nonscientists, and (4) redirected the orientation of the scientists from a focus on research to policy action.

Anticipating and Restructuring Overly Complex Presentations

The mediation team found that scientists often present themselves as though they were addressing a scientific conference of their peers. This is no surprise, since this is the professional norm for most scientists. A recurring problem in the early briefings was that scientists tried to be overly comprehensive, swamping the participants with more information than they could readily handle. For instance, one scientist, when asked for a concise, 20-minute overview of PCB fates, presented 45 slides in 45 minutes. Another scientist, speaking on synergistic effects of PCBs and other contaminants, tried to be concise by packing his remarks with technical terms. We responded by giving ever-more specific instructions and coaching to scientists as the 10-meeting sequence proceeded.

Avoiding Unnecessary Caveats about Preparation or Expertise

In other cases, scientists' self-presentations cast doubts on their expertise or preparation. For example, the NYAS team recruited an aquatic toxicologist to summarize reported effects of PCBs on marine organisms. She prepared an excellent summary in the form of a concise memorandum as requested. But she preceded her professional review of scientific articles by noting, "I didn't really do a literature search." In fact, this investigator did do an informal literature search: She reviewed about 25 scientific articles and summarized them, but may not have turned up and abstracted every conceivable citation. Even though she had a very thorough grasp of her subject, the effect of her rigorous use of the term *literature search* and subsequent disclaimer was to undermine her credibility with the group. The mediator hoped that the panelists would elect to incorporate a summary of her findings in tabular form, listing the effects of PCBs in different aquatic organisms. The panelists instead initially favored including none of her material. Drawing on this lesson, we urged scientific panelists to accurately recount their expertise and level of preparation, but not to denigrate their own experience.

Encouraging Tolerance for Nonscientists or Specialists in Other Disciplines

Some scientists lacked tolerance for laypersons who "ask questions with obvious answers." One scientist, while eager to ensure the scientific accuracy of the discussions, treated a young environmental representative in a condescending style, stating at one point, "I hate it when my students interrupt me before I finish." The unfortunate result was to alienate the negotiator. Two other scientists went further and asserted that fellow scientific panelists with other backgrounds were unqualified to comment on certain subjects. To avoid such incidences, we stressed our fundamental objective of elevating the level of understanding among Bight Initiative negotiators. In instances where scientists appeared to be talking down to negotiators, the mediator tried to get parties to adopt a more conciliatory, collaborative posture.

Redirecting a Preoccupation with Research over Policy Action

Several scientists displayed a tendency to recommend more research rather than commenting on more tangible management options. Scientists varied in their willingness to recommend or propose revisions to policy actions in the face of scientific uncertainty, particularly if the subject matter extended beyond the bounds of their expertise. Our mediation team kept scientists focused on the job of summarizing relevant information and offering prescriptive advice. We repeatedly reminded scientists that while recommendations for new research and analytic tasks were welcome, their charge also included identifying and forging consensus on policy alternatives.

COMMENTARY

When faced with a gap in knowledge, conflicting data, or ambiguous theoretical frameworks, the natural response of the scientist is to ask for more research. After all, this is what they do. On the other hand, it is also important for policymakers to recognize that in some cases, additional measurements or analysis of existing data is necessary to resolve an issue. For example, one contentious issue in PCB-laced sediments is the argument over whether removing these sediments by dredging will stir up the PCBs and increase the amount of biologically available chemicals in the water column. A short-term, carefully monitored test at a limited site could provide a straightforward answer that would guide policymakers as to the relative degree of risk involved in using dredging as a remediation option. To my knowledge, such tests still have not been undertaken, and the "risk from dredging" remains a scientific uncertainty that paralyzes remedial action.

It is extremely difficult for scientists to shift from their role as scientific investigator to that of policy adviser. The rewards in science are for discovering greater complexity and for identifying more subtle effects within a narrowly drawn field of expertise. After all, the more obvious things have already been discovered. Scientific disciplines are deep rather than broad, and the practitioners spend many years mastering the techniques and vocabulary that allow them to practice within their chosen field. Laypeople are clearly seen as incapable of understanding such complex and advanced ideas. Caveats are the norm, and scientists are often loathe to step outside their turf of expertise and greatly resent it when anyone else steps across the boundary into theirs. Maintaining credibility with one's scientific peers is exceedingly important to scientists, and there is often disdain for scientists who either simplify their findings or whose work is used as a basis of policy, because the precision and accuracy of the findings are of necessity diluted or compromised to some degree. By way of contrast, effective policy prescriptions must be simple, at the cost of less precision, and the implications must be transparent and obvious to the nonscientific policymaker and public. The role of a facilitator to clarify the explanations of scientists is essential.

—William Moomaw, *Environmental scientist*

We quickly learned that it was sometimes necessary to allow a scientist a 5- or 10-minute monologue on an arcane subject before he or she was able to focus clearly on policy alternatives. Giving scientists "air time" yielded the dual benefits of establishing the legitimacy of their expertise and allowing them to summarize the key implications of a complex idea. Sometimes, this venting took place in writing: Scientists prepared lengthy briefing papers, which were modified to fit the needs of the participants. For instance, one expert wrote three or four pages on the physical features of the bight; he then worked with other advisers to boil the results down to a one-and-a-half-page document.

The tasks of recording meeting highlights and preparing meeting reports also assisted the exchange of information. Because participants knew they could count on receiving detailed meeting summaries, they were able to focus on the dynamics of the discussion without taking copious notes. The mediation team used both personal computers and large sheets of wallpaper to summarize the deliberations.

Assisting scientists and negotiators with the task of packaging information in an appropriate format was a major task of the mediation team, as detailed in the next section. This involved working closely with technical illustrators as well. The mediators needed to develop strategies for fairly representing information subject to scientific and technical disagreement.

■ *Specific Examples of Joint Fact-Finding and Information Sharing*

Creating a format to enable participants to engage in joint discovery and review of relevant information was a principal feature of the New York Bight Initiative. Joint fact-finding began at the initial meeting in January 1987 and continued through August 1987. This work spanned scientific briefings, group deliberations, and drafting of findings. This section presents several examples of the joint fact-finding activity. The following discussion touches on packaging of information in a useful format, dealing with the burden of proof, and steps to clarify and narrow scientific disagreement and uncertainty. This section concludes with observations on benefits of joint fact-finding.

Packaging Information in a Useful Format

A key finding of the New York Bight Initiative is that the format in which information is presented is as important as the information itself. Organizing information in an appropriate way is crucial to the development of joint understanding of a problem.

Scientists can help provide the essential content, but providing the context or frame of the information became the responsibility of the mediation team. Simply stated, scientists (or any technical experts) working alone cannot always furnish the information in the most useful format. "Packaging" information in a clear, appropriate format required the joint effort of scientists, the mediation team, and negotiators. Appropriate packaging of information in a single text also requires careful attention to phrasing and sequence of prose.

Example 1: Defining, Documenting, and Illustrating PCB Movement through the Ecosystem

One issue we tackled in the joint fact-finding phase of the Bight Initiative was to document PCB sources and movement through the ecosystem. The starting point was a briefing by Dr. Joel O'Connor of the National Oceanic and Atmospheric Administration in which he described approximate quantities of PCBs in the Upper Hudson River, the Lower Hudson River, and the Hudson-Raritan Estuary, as well as the changes in these volumes over time. Negotiators urged the NYAS to continue synthesizing available information on this subject. To comply with this request, the NYAS mediation team and Dr. O'Connor jointly assembled the PCB Sources Subcommittee to be drawn from a mix of Bight Initiative negotiators and an expanded group of scientific advisers. ➡

COMMENTARY

Task-specific groups like the PCB Sources Subcommittee are narrowly focused scientifically. Developing such groups fits better with many scientists' comfort level than organizational structures that are more broadly based.

—William Moomaw, *Environmental scientist*

In getting the PCB Sources Subcommittee under way, Dr. O'Connor circulated a modified draft of the summary table he had presented at the initial briefing to about a dozen colleagues who had published peer-reviewed articles, Ph.D. dissertations, or technical reports on PCB sources in the Hudson-Raritan ecosystem. Based on comments and corrections from these experts, a third version of the table was compiled. Subsequently, these scientists were invited to attend a PCB Sources Subcommittee meeting. The purpose of this gathering was to prepare an up-to-date synthesis and answer questions of the nonscientist negotiators.

Our mediation team proposed several ground rules, which the PCB Sources Subcommittee accepted. These included the following: (1) The group would focus specifically on sources; (2) scientific experts would serve as nonpartisan advisers—they would not represent one particular view over another; (3) interaction between scientific advisers and Bight Initiative negotiators was strongly encouraged; and (4) the group would move as far toward consensus as possible. In addition, the subcommittee established the important principle that information included in the summary table must be linked to a specific published article, technical report, or personal communication of data from the scientist who gathered it.

COMMENTARY

It is extremely important to scientists to base findings on securely documented information, of which peer-reviewed scientific articles are the most respected. Insisting that all references in the tables be linked to specific articles, technical reports, or identified scientists not only satisfies scientific credibility criteria for scientists but also ensures policy makers that they are using credible scientific input and not just opinions of individual scientists. The public is also well served by this transparent approach in that individuals, corporations, and public-interest organizations who were not involved directly in the process can have access to the information that was used in the policy-making process and make their own judgments as to its appropriateness or credibility.

—William Moomaw, *Environmental scientist*

We structured the agenda to begin with the creation of a joint working vocabulary. This involved drafting and revising working definitions of key terms—such as *source, flux,*[9] and *volatization*[10]—used to describe sources of PCBs and their movement through the ecosystem. Building this list of key terms in itself was a single-text negotiation exercise: One scientists would propose a definition, we would write it on flip chart paper, and another would propose a revision, which in turn would be subject to further change.

Reaching agreement on these working definitions gave the subcommittee not only a common language but also an important sense of momentum. It was determined that information on resources and fluxes be listed for two time periods: 1959-1979 and 1980 to the present (this break point was appropriate because flux of PCBs declined markedly after 1980). More important, the subcommittee undertook to prepare a "PCB budget": a table that showed sources, reservoirs (resting points), and fluxes (movements) of PCBs through the system. The subcommittee also agreed that each possible source of PCBs should be listed for each segment of the river, even if some data were missing. The next draft result was a 12-page table with many gaps.

At the negotiators' request, Dr. O'Connor joined with Dr. John Sanders, a sedimentologist based at Columbia University, to prepare a more concise version of the table, and together they boiled it down to four pages. In all, 25 scientific studies were referenced in the PCB budget.

The PCB Sources Subcommittee agreed that the four-page table should be included in the single-text document, but pointed out the need to present information on PCB sources in other formats. To more clearly communicate the nature of the problem, the subcommittee developed several paragraphs of text to summarize the key findings. Included were the following:

- Land disposal sites and electrical equipment are almost certainly the largest PCB reservoirs. Sediments of the Hudson River and estuary system are probably the next largest reservoirs.
- PCB levels in the system are dynamic. Available information indicates that PCB transport in sediment down the Hudson River has declined considerably between 1970 and the early 1980s and has since leveled off.
- The most obvious features of PCB flux in the region are that they are dominated by historic discharges of the General Electric Company. Although GE discharges of PCBs declined dramatically and have virtually ceased, flux of PCBs continued.
- Potentially significant loadings—such as industrial discharge, sewage treatment plant (STP) effluent, combined sewer overflow, and urban runoff—are not adequately measured.

The New York Bight Initiative demonstrated that technical information needs to be presented in multiple formats to make it accessible and understandable. For example, negotiators agreed that a figure was needed to show how PCBs move through the system.

COMMENTARY

It is useful to present information in multiple formats even within the scientific community. Hence, data tables, graphs, and diagrams can play an essential role in clarifying the basis for decision making to all constituencies.

—William Moomaw, *Environmental scientist*

Some negotiators suggested creating a flow diagram. In struggling to make a flow diagram geographically precise, they arrived at the idea of creating a series of block diagrams keyed to specific reaches of the river and estuary. The negotiators began sketching illustrations, but soon found that they lacked the patience and skills to implement their suggestions. Our mediation team offered to pass on the task to a technical illustrator who was on the staff at the NYAS. Figure 6.B shows excerpts of the figure in its final form.

Example 2: Summarizing the Existing Regulatory Framework for PCBs

The NYAS team and the negotiators completed a similar sequence of tasks to put information on PCB regulations into a useful format. In brainstorming text on PCB management, negotiators suggested that a matrix be prepared to summarize regulations that pertain to each PCB source.

The NYAS team sought help from the attorneys who edit *Environmental Regulation Reporter,* an authoritative periodical on environmental law and regulations. The editors produced a dense, 12-page manuscript and obligingly traveled to a Bight Initiative negotiation session to present their analysis. Despite the mediators' efforts to portray the work in a favorable light, the Bureau of National Affairs (BNA) editors met with a rude reception from some negotiators, who rejected the lengthy prose format as inappropriate and reaffirmed their desire to see information summarized in a tabular format.

Negotiators wanted to see regulations grouped according to several subjects:

- the ban on uses;
- standards involving drinking water, fish consumption, and allowable PCBs in navigable waters;
- regulations pertaining to specific PCB inputs or reservoirs;
- laws guiding the cleanup of spills; and
- laws guiding the cleanup of in situ PCBs.

With the help of the NYAS team, the negotiators' needs were related to the BNA attorneys, who responded with a revised matrix.

COMMENTARY

Agreeing on data to put into a table is often an arduous task. Science is not so much a democracy of ideas but rather a consensus as to what is established and what is not. As critics are often keen to point out, just because the scientific community "agrees" on a set of facts or on a particular interpretation does not make it so. It is always possible that the lone dissenting scientist is correct after all. Having said this, it is still important to recognize that the lone dissenter has available to him or her a peer-reviewed process for presenting the alternative view. This process subjects the dissenter's view to testing by others to determine whether or not it should become the new paradigm.

—William Moomaw, *Environmental scientist*

In the end, four different tables were created: General Regulatory Framework (for an excerpt from this table, see Table 6.A), Restrictions on Industry Discharge, Con-

The question of who should bear the burden of proof arose repeatedly in the fact-finding phase of the Bight Initiative. Port and chemical industry representatives repeatedly pressed regulators and environmental interest groups to point to conclusive evidence linking PCBs to environmental damage. Conversely, environmental groups pressed for aggressive action in the cleanup and remediation arena. Although negotiators did not arrive at any overarching principle, they did address the issue in several ways. Through the work of scientific advisers and the active mediation of the NYAS team, the tone of the final text reflected an evenhanded approach. Neither cluster of interests succeeded in shifting the burden wholly to the "other side."

The following pages present an example of our efforts to help negotiators confront the burden-of-proof question as it bore on the important challenge of determining whether laboratory studies of biological effects are relevant to real effects in the field and, more generally, how to characterize plausible environmental effects based on circumstantial evidence.

Determining Whether Laboratory Studies of Biological Effects Are Relevant to Effects Observed in the Field

The joint fact-finding phase of the Bight Initiative involved negotiators and scientific advisers in the consideration of available data. As a result, one of the tasks for negotiators was to determine whether laboratory studies of effects of contaminants are relevant to effects observed in the real environment. This variation on the burden-of-proof question arose during the negotiation of language summarizing biological effects of PCBs on fish and other biota.

COMMENTARY

The difficulty of extrapolating laboratory findings to the field is extremely vexing. In the laboratory, the researcher has control of many variables and can therefore identify specific factors and their influence when other conditions are held constant. In the natural environment, exposure is to multiple natural and man-made chemicals under a variety of conditions. Some of these other chemicals may act synergistically to produce enhanced adverse health effects, while others may act antagonistically to diminish or obscure adverse health effects. Even if a chemical in the environment is potentially harmful, humans may not be exposed to it because it is sequestered in some way. Sorting out the effects of a particular chemical or set of chemicals and determining their exposure route are often very expensive, and relatively few comprehensive studies are undertaken. Often, those opposing action will state that "despite laboratory studies, there is no evidence of harm to humans or to wildlife under real-world conditions, and hence no action is needed." Scientifically, the lack of a study is not a reason to assume that no risk exists, especially if there is laboratory evidence to the contrary. The compromise wording in the report is a rare example of a statement that is scientifically accurate as well as being politically acceptable.

—William Moomaw, *Environmental scientist*

TABLE 6.A A Product of Joint Fact-Finding: Excerpts from PCB Regulations Tables—General Regulatory Framework

Action	*Effective Date*	*Regulation/Legal Authority*
Manufacture, processing, distribution banned	Jan. 1, 1979	40 CFR 761/Toxic Substances Control Act (TSCA)
Ban on uses	Phaseout began Oct. 1, 1984; final Oct. 1, 1990	40 CFR 761/TSCA
Designated as hazardous substances	March 13, 1978	40 CFR 116/Federal Water Pollution Control Act (Clean Water Act); Sections 311 (b)(2)(A) and 501(1)
Proposed recommended maximum for drinking water set at 0	50 FR 46936	Would amend 40 CFR 141.50/ Safe Drinking Water Act
Limit of 2 ppm set for fish intended for human consumption	August 20, 1984	FDA
Listed as hazardous substances that may subject applicants for NPDES permits to additional requirements	July 18, 1980	40 CFR 122, Table 2D-4, Clean Water Act
Ambient water criterion for PCBs in navigable waters set at 0.001 micrograms per liter	Jan. 12, 1977 (compliance date Jan. 12, 1978)	40 CFR 129.105(a)(3)/ Clean Water Act

Dealing with the Burden of Proof

The outcomes of many technically intensive disputes hinge on the question of which side should bear the burden of proof (Brooks, 1984). In other words, in the context of the Bight Initiative, does one need to produce a "smoking gun" linking PCBs to effects observed in the field, or is "circumstantial evidence" sufficient to motivate action?

COMMENTARY

The question of who should bear the burden of proof has been addressed in recent years by appealing to the precautionary principle and the reduction of risk in the face of uncertainty. Those responsible for the creation of the alleged problem often argue that unless there is proof of harm (the definition of which they must approve), they should not be held liable for any costs associated with remediation or compensation. Those who perceive a risk to themselves or to the environment argue that if there is evidence of risk (by their definition), then prudent action must be taken to reduce that risk. Scientists drawn into such debates, and beyond their initial presentation of evidence, usually play only an ineffective role in resolving the burden-of-proof argument.

—William Moomaw, *Environmental scientist*

Negotiators recognized that isolating the effects of PCBs from those of other contaminants in urban water bodies is almost impossible. How, then, should the text summarize laboratory studies that show damage caused by PCBs at very low concentrations and may mirror the effects thought to exist in the field?

NYAS mediators asked Dr. Judith Weis, an aquatic toxicologist from Rutgers University, to review articles she had compiled on the subject and to brief negotiators on her findings. In the preparatory briefing packet, the mediation team asked whether some version of the data summarized by her should be included in the single-text document. Dr. Weis suggested that the following wording might be appropriate: "In laboratory studies, deleterious effects of PCBs on reproductive habits have occurred at levels of 1 ppb [parts per billion] or less. European field studies of flatfish and seals strongly suggest that PCBs are responsible for reproductive impairment. However, in the Hudson River, there are no data that conclusively relate PCBs to reproductive impairment."

To avoid incorporating findings in the text that ran contrary to their values and interests, some negotiators insisted on a stricter standard. Geraldine Cox of the Chemical Manufacturers Association and Dan Curll of the Towboat and Harbor Carriers Association took a strong position against including any version of Weis's summary. They initially argued that if the studies did not show a causal linkage between PCBs and damage to fish in the Hudson River and the bight, then no version of the material should be included. Nick Stevens of the Interstate Sanitation Commission and George Lutzic of the New York City Department of Environmental Protection retorted that excluding the material would constitute suppression of information.

Dr. Joseph O'Connor (not Dr. Joel O'Connor, mentioned earlier), another scientific adviser, tried to help the group out of the jam by suggesting some alternate language, although Weis took exception to portions of his wording, as is evident from the following exchange:

O'Connor: Consider an excerpt from the recent NOAA report on PCBs in Atlantic bluefish: "Despite laboratory evidence describing PCBs as highly toxic at low concentrations there are few published data showing evidence of ecological effects due to PCBs in natural systems. However, some studies provide evidence that PCB effects in natural systems may be subtle and difficult to isolate from the effects of other environmental contaminants." The NOAA report continued: "We know of no data demonstrating that PCBs in natural environments are the direct cause of chronic or acute toxicity."

Weis: I must take issue with this last statement. That assertion makes light of good correlations between some of the lab studies and European field studies of flatfish and the study of seals. A fair, evenhanded treatment must mention these items. Then, the text should note that these effects were not shown in the Hudson. I could live with that.

In the end, parties agreed to include a shortened version of Weis's summary, citing the most important studies and listing the major biological effects. After some further consideration, the parties also agreed to incorporate a more general conclusion from O'Connor's language in the text:

> Lack of evidence conclusively linking adverse environmental or ecological impacts with PCBs is not proof that PCBs are toxicologically benign. Adequate studies have not been conducted in the Hudson/Raritan-Bight to rigorously establish whether observed ecological effects can be specifically attributed to PCBs, or to synergistic effects of PCBs with other contaminants, or to other causes.

Finally, negotiators came to agreement around two high-priority research items to help deal with technical uncertainty: to conduct a tiered study of PCB movement through the sediment and water column of the Hudson/Raritan-Bight system, and to document congener-specific research on the movement of PCBs through various environmental compartments, including edible seafood and other selected biota.

Clarifying and Narrowing Areas of Disagreement and Uncertainty

The most complex and controversial element of the joint fact-finding effort dealt with representing the evidence linking PCBs and health effects in humans, a subject on which there has been broad disagreement in the scientific community.

COMMENTARY

The difficulty of coming to consensus over health effects is often tied as much to the legal and motivational effects of such findings as it is to scientific uncertainty. Once human health effects are established, defection from within the industry group is likely to occur, and regulatory action by government becomes a much more likely outcome. Since health effects are the one factor that can swing support for an issue to one side or the other, there is much less willingness to give ground on any single piece of information that would undercut one's position or undermine one's interest.

—William Moomaw, *Environmental scientist*

Accordingly, the NYAS team did not expect to settle this high-stakes public health debate in the context of a dialogue on coastal water quality. Nevertheless, the NYAS mediation team was determined that the text should accurately portray existing information and the specific extent and basis of scientific disagreement over the interpretation of available data. Together, the negotiators and advisers tackled a litany of contested subjects: carcinogenicity of PCBs and pathways to humans, mechanisms of carcinogenic action, developmental toxicity, human absorption and metabolism, epidemiology, and accidental poisoning.

Our mediation team helped negotiators address this problem by arranging briefings from three scientific panelists who could offer different perspectives on the issue. Stephen Safe of Texas A&M University discussed noncancer health effects and commented on some of the uncertainties inherent in attributing health effects to PCBs. James Cogliano of the Environmental Protection Agency's (EPA's) Cancer Assessment Group discussed the elements of cancer risk assessment. Michael Connor of Battelle Laboratories helped place PCBs in the larger context of other contaminants.[11]

Stephen Safe's presentation summarized some of the noncancer health effects attributed to direct ingestion of or contact with PCBs, including chloracne, changes in liver functions, and impairment of visual functions. This information seemed to be readily accepted by most negotiators. Safe's briefing also explained that one basis of existing PCB regulations that classify PCBs as suspected environmental carcinogens is the Yusho poisoning incident, in which Japanese families ate rice oil accidentally contaminated with PCBs and dibenzofurans, another suspected carcinogen. In addressing the links between PCBs and cancer, Safe emphasized the synergistic effect of PCBs and dibenzofurans, and he suggested that dibenzofurans, rather than PCBs, may have been the true "bad actor."

Cogliano emphasized that the Yusho incident was only one piece of evidence considered. His talk and associated briefing paper explained that PCBs are classified by the EPA as probable human carcinogens based on a series of key studies on animals; they are not classified as known human carcinogens. Cogliano's briefing also touched on developmental effects of PCB exposure. Cogliano constructed his calculations of cancer risk in step-by-step fashion on an overhead projector for all negotiators to see. He fielded aggressive questions by chemical industry and Port Authority representatives, who harped on the uncertainty inherent in forecasting cancer risks. Still, it was evident that this candid presentation of the reasoning behind the agency's determinations was very much appreciated even by negotiators such as a senior Port Authority official, who exclaimed, "This is great!" Geraldine Cox was adamant that the conservative assumptions embedded in the EPA's methods be clearly expressed in the single text. Port interests wanted risks of PCBs placed in the context of relative risk. As detailed below, the NYAS mediators used several strategies to deal with these concerns.

The dialogue over health effects of PCBs in humans differed from less controversial discussions of PCB sources and regulations in several ways. No amount of discussion was able to produce a single version of the "facts" that all negotiators could agree was accurate. Rather, the give-and-take in the briefings and deliberations of negotiators revealed the presence of substantial technical disagreement and uncertainty on the question of health effects of PCBs. Negotiators from the chemical industry sought to share information from studies other than those summarized by the scientific advisers with the intent of including this material in the text.

At this juncture, the NYAS team discussed with other negotiators how to handle this "volunteered" information. We worked with negotiators to adopt several protocols to avoid freezing development of the single text in its tracks. First, negotiators agreed that findings had to be documented in published literature (preferably peer-reviewed journals) to be included in the negotiated text. (Participants agreed to make an exception to this ground rule for the comments of two scientifically trained negotiators, Geraldine Cox and Ellen Silbergeld.)

Three other drafting strategies were used:

1. express the assumptions or rationales used to support a particular forecast of health risk,
2. identify specific uncertainties inherent in health risk assessment, and
3. express the range of interpretations associated with specific data sets.

Express the rationales or assumptions in support of an estimate of health risk:

[Finding 9, Carcinogenicity and Pathways to Humans]

"EPA's methods reflect the consensus view of several respected scientists in the regulatory and scientific communities. They are consistent with recent findings of the Office of Science and Technology Policy, which stated that when the precise mechanism of cancer induction is not known as with PCBs, then a straight-line projection is a reasonable and prudent method to use. The rationale—that it is reasonable, for practical purposes, to regard an agent for which there is sufficient evidence of carcinogenicity in animals as presenting a carcinogenic risk to humans—reflects the views of the International Agency for Research on Cancer (IARC), World Health Organization."

Express uncertainties associated with the forecast of risks:

[Finding 10, Carcinogenicity and Pathways to Humans]

"Critics of EPA's methods, including many respected health professionals, point out that extrapolating linearly (as in EPA models) may be much too conservative. Specifically, they criticize extrapolating from very high doses—such as the maximum tolerated doses—to low dose human exposure even for those carcinogens that are mutagens. Such analysts suggest that the agency should present an array of slopes to show maximum, most probable, and minimum risks for PCBs. In this way, a sensitivity analysis on their data could be provided (Cox, 1988). However, EPA counters that at present, no methods are available to enable this sort of sensitivity analysis."

Express the range of interpretations associated with scientific observations:

[Finding 13, Carcinogenicity and Pathways to Humans]

"A range of professional opinion exists as to appropriate interpretation of published data on occupational exposure, additional poisonings, and animals studies.

"In a recent article (1987) Renate Kimbrough, when at the Centers for Disease Control, reviewed about 120 published articles on occupational exposure, accidental poisonings, and animal studies. She concluded that 'no conclusive evidence thus far reported shows that occupational exposure to PCBs causes an increased incidence of cancer.'

"Staff of EPA's Cancer Assessment Group generally concur with this finding but also notes that existing human data are not sufficient to allow conclusions to be drawn about the presence or absence of carcinogenic effects of PCBs (James Cogliano, personal communication).

"EDF's staff toxicologist Ellen Silbergeld (personal communication) dissents from Kimbrough's conclusion. In her view, existing evidence strongly suggests a link between PCBs and cancer in humans. Moreover, she believes that since PCBs and dibenzofurans are the empirical mix, they should be considered together in health risk assessment."

Figure 6.C. Drafting Strategies to Clarify and Narrow Areas of Scientific Disagreement

Judicious use of each drafting technique helped produce a balanced and technically sound discussion of human health effects. Examples of each approach are given in Figure 6.C.

These strategies were used several times over the 10-meeting process in which five successive drafts were produced, culminating in the final ratified agreement (although most of the 220 or so findings incorporated in the single-text agreement were less controversial and therefore less time-consuming to negotiate).

Using Joint Fact-Finding to Build a Single-Text Document

At the third meeting of the series, we asked negotiators to split into two groups and to develop a draft outline, or table of contents, for the ultimate work product. With minor differences, the two groups both envisioned a logical sequence of sources, fates, and effects of PCBs and wanted to include a chapter of policy recommendations. Thus, a decision was reached early in the process that the final text should include both findings and recommendations. (As discussed below, an alternative strategy would have been to produce two separate, but cross-referenced, documents and to seek ratification of only the policy recommendations.)

Review of draft findings and tentative formulations of policy options continued at Meetings 4 through 8. By Meeting 8, we had a complete draft of all chapters. Over the months of September and October, we then developed three successive drafts. Our team served as the secretariat, producing and revising the drafts. We brought a pair of portable computers and laser printers to the negotiating sessions, and we were able to develop several important sections in real time as negotiators pressed ahead with their work.

Often, information presented in scientific briefings constituted "raw material" for a negotiated single text. A table showing PCB levels in fish, for example, was included almost verbatim. In this way, joint fact-finding set the stage for negotiation over policy options. Time and again, negotiators made reference to key findings in framing their arguments about management options. It was apparent that our joint fact-finding efforts had helped create a more "even playing field" for participants who ordinarily have unequal access to technical expertise or scientific information.[12] The process had helped participants build their understanding of complex issues in manageable, stepwise fashion. Organizing the deliberations of the negotiators around sources and effects of PCBs, followed by effects on biota, and, finally, effects on human health created a logical structure for the single-text document.

The final single-text document had the following structure: The document begins with a ratification page listing the signatures of the heads of 18 participating organizations.[13] Next, an executive summary recaps about 30 key findings and management recommendations. The next five chapters report the negotiators' findings. Recommended management strategies are reported in the sixth chapter. Seven appendixes present more detailed information. Presented in a desktop published format, the body of the text is 47 pages, and there are 28 pages of appendixes.

Chapter 1 of the text presents an overview of the Hudson/Raritan Estuary and the New York Bight and explains the chemistry and historical use of PCBs. The second chapter, on biological effects, reports on both human health and biota. The human health discussion reviews the links between PCBs and cancer in humans, the development of toxicity, and reports of some important epidemiological studies. The discussion of the effects on biota summarizes PCB levels in fish reported by three government agencies; reproductive impairment and other effects on biota are also reviewed.

Chapter 3 of the text summarizes sources and movements of PCBs. This chapter includes the tabular presentation of inputs, reservoirs, and losses of PCBs. Chapter 3 of the negotiated text also reviews the fates of PCBs—their transformation by physical, chemical, or biological processes. Chapter 4 briefly discusses socioeconomic effects of PCBs on fisheries, port operations, and tourism. Chapter 5 presents an overview and comment on the existing management structure. The chapter includes a detailed summary of the regulatory framework, restrictions on industry discharge, control on specific PCB inputs and reservoirs, and spill notification requirements. Also included in Chapter 5 is a comparison of the respective methods used by the states of New York and New Jersey to sample, analyze, and interpret PCB levels in species of edible fish.

The recommended management strategies that follow are organized into management principles, management options (sorted by high and medium priority, and options that face major obstacles), and suggestions for public education. Specific recommendations are included for source reduction, more consistent monitoring of environmental trends, and coordinated issuance of health advisories to warn people about consuming PCB-contaminated fish. Promising new decontamination technologies were identified—including UV/ozone, naturally adapted microbes process, and supercritical water oxidation—that merit investigation as alternatives to more traditional methods of PCB decontamination, such as incineration.

COMMENTARY

Disagreements over appropriate recommended actions reflect the parties' interests. Agreeing even to source reduction may not only be expensive for the releasers of chemicals but may also be seen as acknowledging that the release of the chemicals is dangerous. Similarly, not insisting on removal undermines an environmentalist position that the chemicals are dangerous.

—William Moomaw, *Environmental scientist*

Challenges in Ratification of the Single-Text Agreement

From the inception of the Bight Initiative, we envisioned that negotiators would have to "sell the agreement back home" and demonstrate that they were truly speaking for their organization when they acceded to the document. Unfortunately, we did not think through in detail the mechanics of moving this ratification process along. As a result, we did not anticipate or emphasize the eventual ratification of the document in the ground rules we wrote to structure the process. By the fifth meeting of the process, negotiators agreed that they wanted to press for ratification of the final work product, but this commitment was a bit soft, and, as a result, proved difficult to enforce later in the process.

Our mediation team continued explicit discussion of ratification at the October 10, 1987 meeting when we brought forward the second complete draft of the text. We specifically asked negotiators how close they were to being able to recommend ratification to their respective organizations, and what specific changes they would need to make this recommendation. Several detailed responses were received, and we distributed two subsequent versions of the document to all parties. Based on a number of conference calls in which negotiators expressed their intent to ratify the final document, we envisioned a definitive response within 90 days, and we felt confident that most groups would ratify in 45 days when we mailed out the final text for review and ratification in December 1987.

In fact, the ratification process for the New York Bight Initiative stretched over a very long period of time—six months—and consumed several weeks of time on the author's part. By April 1, 1988, over half the groups had ratified the document, and by the end of April 1988, there were 16 ratifiers. The ultimate result of this process was to bring forward signatures of 18 of the 22 members. Signatories included all of the initial core group: the EPA, New Jersey Department of Environmental Protection, New York State Department of Environmental Conservation, and the city of New York, as well as a range of port, fishing, and environmental groups. Interestingly, although the port organizations had sometimes aligned themselves with the chemical industry, they all ratified the final document. Similarly, all of the local and regional environmental groups signed the document. Four groups did not ratify the document, however: the Environmental Defense Fund (EDF) and the coalition from the chemical industry.

COMMENTARY

It is interesting to note that the nonsigners were all interests that have been and are in the future likely to be legal protagonists in court over this and other similar issues.

—William Moomaw, *Environmental scientist*

In hindsight, the factor that had the greatest bearing on ratification was the decision to recruit to the negotiating table representatives of the industry that manufactured and used PCBs. These parties—GE, Monsanto, and the Chemical Manufacturers Association—were not members of the original core group of the Bight Initiative but were invited to join our group after PCBs were chosen as the focus for attention. These organizations were (and still are 10 years later; see Revkin, 1998[14]) involved in high-stakes discussions and litigation about redemption of PCB spills in the Upper Hudson River. They were concerned that findings in the single-text document might be used in courts and other forums. This was true even though we had spent 10 months trying to accurately represent a range of opinions about the most contentious issues. Perhaps we could have structured the ground rules to deal with the use of information in other forums, but even with such assurances, it is not at all clear that the recalcitrant parties would have signed the document. Again, we did not anticipate this late-inning hesitancy because the parties were so cooperative during the early work of the Bight Initiative. EDF's comments were twofold. First, a concern was expressed that the final single text understated the linkage between PCBs and cancer in humans—notwithstanding the fact that the final text clearly stated divergent views on this matter. The second concern was that the document did not "read" like the proceedings of a scientific panel—that its findings were somehow not crafted in a sufficiently scholarly manner, or that the disparate topics were treated in too fragmented a fashion.

As the series of 10 full plenary sessions of the Bight Initiative wound up, we set in motion a process to secure ratification of the document. A final drafting subcommittee meeting was convened in Washington, D.C. on October 26, 1987 among the four dissenting organizations: EDF, GE, Chemical Manufacturers Association, and Monsanto. The intent was to undertake a selective rewriting of the portion of the document dealing with carcinogenicity and pathways to humans. At this stage, we already had agreement on some 200 specific findings; it did not seem overreaching to hope we might close this last gap between recalcitrance and ratification if a few key parties could "agree to disagree." Recognizing the divergent views that would be represented around the table, the mediation team anticipated that a greater effort to fully characterize the professional views of the negotiators—that is, to fully disclose the degree of disagreement on this particular issue—might move the parties closer to ratification of the overall document. The result of this rewriting was to more clearly state certain findings, link findings more explicitly to cited literature, and explain key assumptions associated with specific studies. Although parties expressed appreciation for the final effort by the mediator, this final meeting did not move the parties from their views that they did not want to ratify the final document.

One tactic that might have increased the odds of full ratification would have been to segment the single text into two documents: a summary of technical findings and a section on management options. After all, the latter were negotiated through five successive drafts; represented a balanced mix of analytic, environmental management, and research tasks; and were carefully structured to convey order of priority and to acknowledge opportunities and obstacles for implementation. In the end, they were not particularly controversial.

Similarly, the vast majority of the 220 findings were not controversial. The "big ticket items" on which substantial divergence of views persisted, even with the extensive fact-finding effort, were (1) the links between PCBs and cancer in humans, and (2) the proper stance toward decontamination and remediation technologies, particularly whether to endorse continued on-site containment versus dredging and application of new remediation technologies.

As our mediation team was readying the final report for distribution, some of the dissenters contacted Heinz Pagels, executive director of the NYAS, and suggested that because the document was "flawed," the academy should not publish it. Dr. Pagels countered that the report was a sound piece of work, and published it on the academy's letterhead.

■ *Epilogue*

Retrospective interviews with former NYAS colleagues, Bight Initiative negotiators, and scientific advisers suggest that the Bight Initiative has had four sets of significant implications:

1. A rich process model was established and documented to guide subsequent intervention in science-intensive environmental policy disputes.

2. An information base was established for use in subsequent bight environment decision making.
3. Policy recommendations were stated to create a foundation for both immediate implementation and for further refinement and development of policy options for subsequent resource management decisions.
4. Important professional relationships and networks were established.

Process Model

First, the Bight Initiative established a valuable process to guide subsequent intervention in science-intensive environmental policy disputes. The Bight Initiative has particularly informed CONCUR's[15] model of practice in the design of joint fact-finding processes to resolve about 20 complex, science-intensive disputes. Examples include projects involving comparative risk assessment, regional flood protection and habitat restoration, hydropower relicensing, and remediation of contaminated sites (Crane Valley Project Committee, 1997; Guadalupe River Flood Control Project Collaborative, 1998; Louisiana Department of Environmental Quality, 1991; McCreary, 1995; Thompson, Templet, Gamman, McCreary, & Reams, 1994). The Bight Initiative has also informed the subsequent practice of several of the negotiators and technical advisers. For example, Joseph O'Connor, one of the scientific advisers to the Bight Initiative, brought some of his experience as a scientific adviser to later work at the Aquatic Habitat Institute in California, which focused on assembling technical information in support of management decisions for San Francisco Bay.

Use of Information Gathered and Synthesized

The compilations of stakeholder groups and the synthesis of technical information produced by the Bight Initiative have been used in several ways, primarily in conjunction with the policy recommendations of the Bight Initiative. The kickoff of the Bight Initiative anticipated by two years the National Estuary Program, created by the 1987 amendment to the Clean Water Act. The National Estuary Program's purpose was to promote the development of comprehensive management plans for estuaries of national significance threatened by pollution, development, or overuse. Responding to the request of the governors of New York and New Jersey, the New York Harbor was accepted into the program in 1988. In 1987, Congress also required the EPA to prepare a restoration plan for the bight. Because the harbor and the bight are linked in so many ways, the EPA and the Management Conference agreed to make the Bight Restoration Plan a product of the Harbor Estuary Program.

Recommendations Implemented as the Basis of Subsequent Management Actions

The recommendations of the Bight Initiative have been pursued in various ways. Recommendations concerning unified testing of PCB levels in fish were pursued by the respective agencies from New York, New Jersey, and the National Marine Fisheries Service. Other recommendations created the foundation of further policy development through the New York-New Jersey Harbor Estuary Program, a multiagency consortium, which in turn produced the *Final Comprehensive Conservation and*

Management Plan (1996). The *Plan* includes seven elements, which address broad policy areas, including management of toxic contamination. The management of toxics element, the longest portion of the *Plan*, gives considerable weight and emphasis to management of PCBs. This *Plan* element includes 13 specific objectives, of which 5 address PCBs specifically and another 4 apply directly to PCBs. Many contain recommendations quite similar to those stated in the Bight Initiative's single text: developing unified testing protocols for PCBs in fish, conducting congener-specific analyses of PCBs, updating mass balances to track the movement and volume of PCBs in the river system, and reducing down-river transport of PCBs.

Personal Networks and Relationships

The Bight Initiative established and cemented numerous personal networks and relationships. As the New York-New Jersey Harbor Estuary Program was getting under way, the New York State Department of Environmental Conservation contacted the author to obtain a summary of the stakeholders identified through the Bight Initiative, as well as our analysis of these stakeholders. Many of the participants active in the New York Bight Initiative still remain very active in management matters in 1999. From the author's perspective, important long-term professional relationships were begun with both Marc David Block and—when Marc left the team due to health reasons—John Gamman, then a fellow MIT doctoral student. This marked the beginning of a collaboration that has grown into the foundation of our present firm. I have subsequently called on several members of the scientific panel in some of my later work on estuarine and water quality issues. The NYAS has also continued its institutional sponsorship of scientific dialogues pertaining to the estuary, and several of the scientific advisers active in the Bight Initiative have recently contributed to these programs.

■ *Notes*

1. Cited in a letter of invitation by Heinz Pagels, executive director of the New York Academy of Sciences, to stakeholders invited to a first organizational meeting in June 1985.

2. The results were submitted, along with an analysis of four other cases, as the author's doctoral dissertation to MIT's Department of Urban Studies and Planning (McCreary, 1989).

3. Members of the team initially included the author, Dr. Janice Perlman, Marc David Block, and Marlene Mallner. Later, Perlman left the academy and Block became less active in the project, and the author recruited MIT colleague John Gamman to join him in the final mediated sessions.

4. This model stands in contrast to two other prevalent models for injecting scientific advising into environmental decision making: the

blue ribbon panel and the adversary science model prevalent in litigation and traditional public review and comment processes.

5. The one-year gap is unusually long, and reflected the need to raise funds to support continued work.

6. Thomas Belton of the New Jersey Department of Environmental Protection's Office of Science and Research also served as a second negotiator behind Lawrence Schmidt, head of the Planning Office.

7. The NYAS was founded in 1838, has members in 80 nations and all 50 states, publishes *The Sciences* and its own *Annals of the New York Academy of Sciences*, and has taken very few positions on public policy issues.

8. About three-quarters of the scientists had home institutions in the New York metropolitan area, although the NYAS also invited experts from Woods Hole Oceanographic Institution and Battelle Laboratories in Massachusetts, Texas A&M University, the Environmental Protection Agency, and the Bureau of National Affairs in Washington, D.C.

9. Movement of PCBs at some rate; mass of PCBs that passes a given rate per unit of time.

10. Conversion from liquid or solid to gas; process by which PCBs enter the atmosphere.

11. The actions of two negotiators—Geraldine Cox of the Chemical Manufacturers Association and Ellen Silbergeld of the Environmental Defense Fund—though not formal scientific advisers, also had a major impact on this section of the document as will be shown below.

12. However, it should be stressed that while a resource pool helps give groups equal access to information, it cannot completely compensate for differences in professional training, preparation, or access to staff assistants.

13. Ratification is briefly discussed in the next section.

14. In addition to the Revkin article, 49 other articles were published in 1998 in the *New York Times* on PCBs in the Hudson River or the Hudson-Raritan Estuary/New York Bight.

15. CONCUR was cofounded by myself and John Gamman. The firm provides services in environmental policy analysis, mediation, and negotiation training.

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