DOI: 10.1007/s002670010166

Science, Policy, Stakeholders, and Fish Consumption Advisories: Developing a Fish Fact Sheet for the Savannah River

JOANNA BURGER
Consortium for Risk Evaluation with Stakeholder Participation (CRESP) and
Environmental and Occupational Health Sciences Institute (EOHSI)
Rutgers University
Piscataway, 08854-8082, USA

MICHAEL GOCHFELD
CHARLES W. POWERS
LYNN WAISHWELL
CRESP and EOHSI
UMDNJ-Robert Wood Johnson Medical School
Piscataway, New Jersey 08854, USA

CAMILLA WARREN
US Environmental Protection Agency
100 Alabama Street SW
Atlanta, Georgia 30303, USA

BERNARD D. GOLDSTEIN
CRESP and EOHSI, UMDNJ-Robert Wood Johnson Medical School
Piscataway, New Jersey 08854

ABSTRACT / In recent years there has been a startling rise in the issuance of fish consumption advisories. Unfortunately, compliance by the public is often low. Low compliance can be due to a number of factors, including confusion over the meaning of advisories, conflicting advisories issued by different agencies, controversies involving health benefits versus the risks from consuming fish, and an unwillingness to act on the advisories because of personal beliefs. In some places, such as along the Savannah River, one state (South Carolina) had issued a consumption advisory while the other (Georgia) had not, although at present, both states now issue consumption advisories for the Savannah River. Herein we report on the development of a fish fact sheet to address the confusing and conflicting information available to the public about consuming fish from the Savannah River. The process involved interviewing fishers to ascertain fishing and consumption patterns, evaluating contaminant levels and exposure pathways, discussing common grounds for the provision of information, and consensus-building among different regulatory agencies (US Environmental Protection Agency, South Carolina Department of Health and Environmental Control, Georgia Department of Natural Resources) and the Department of Energy. Consensus, a key ingredient in solving many different types of "commons" problems, was aided by an outside organization, the Consortium for Risk Evaluation with Stakeholder Participation (CRESP). The initial role for CRESP was to offer scientific data as a basis for groups with different assumptions about risks to reach agreement on a regulatory response action. The process was an example of how credible science can be used to implement management and policies and provide a basis for consensus-building on difficult risk communication issues. The paper provides several lessons for improving the risk process from stakeholder conflicts, through risk assessment, to risk management. It also suggests that consensus-building and risk communication are continuing processes that involve assimilation of new information on contaminants and food-chain processes, state and federal law, public policy, and public response.

Hunting and fishing are important activities for many Americans, both for recreation and for food. Public understanding of potential contamination of self-caught food is essential for successful management of exposure and, ultimately, of health effects. Only recently has the scientific community begun to realize that exposure to contaminant levels in some fish are sufficiently high to produce potential adverse health effects, particularly for developing fetuses and young children (Jacobson and others 1989, 1990, Institute of Medicine 1991, Sparks and Shepherd 1994, ATSDR 1995, Jacobson and Jacobson 1996, Schantz 1996). This potential for health effects has led to management of the risk by issuing consumption advisories for some waters and has resulted in cleanup directives from state

KEY WORDS: Fishing; Consumption advisories; Conflict; Consensus-building; Environmental planning; Human health; Risk assessment; Mercury; Cesium; Remediation; Risk communication

*Author to whom correspondence should be addressed.

© 2001 Springer-Verlag New York Inc.

and federal agencies, as well as natural resource damage claims against the responsible parties. The consumption advisories stimulated a flurry of studies to determine the perceptions of risk and compliance by the fishing public.

It is also important to bear in mind that fish and fishing provide many benefits, both nutritional and social (Toth and Brown 1997). For subsistence fishers, fish may be the main affordable source of protein. For others, it may be the healthiest source of protein as well as omega-3 oils, which offer the potential for reduction of cholesterol levels (Hunter and others 1988, Kimbrough 1991, Horn 1992, Anderson and Wiener 1995). Moreover, it is an enjoyable activity that has many social and cultural benefits (Toth and Brown 1997), particularly for Native Americans (Harris and Harper 1997, Burger 1999). The importance of viewing fishing within an integrated context of culture and life-style should not be underestimated.

The US Environmental Protection Agency (EPA 1998a) reported that the number of waterbodies under fishing advisories rose by 9% from 1997 to 1998, and this represents 16% of the nation's total lake acres and 7% of the nation's total river miles. Large portions of US coastal waters, as well as all of the Great Lakes and their connecting waters, are under advisories (EPA 1998a). Mercury accounts for 1931 of the advisories, an increase of 115% from 1993 to 1998; other contaminants with increased numbers of advisories were PCBs, chlordane, dioxins, and DDT. Although the rise in the number of advisories may be due to changes in monitoring or changes in regulatory attention, the sharp rise is cause for concern.

EPA provides guidance both for conducting fish consumption studies and for assessing chemical contaminants data for use in fish advisories (EPA 1998b, 1999). Furthermore, several other regulators have provided insights on the development of plans for fish tissue monitoring, issuance of consumption advisories, and a unified approach to such advisories (Dourson and Clark 1990, Manning 1993).

There is often a gap between the perception of risk by the fish-consuming public and the views on fish consumption expressed by the agencies issuing the advisories (Belton and others 1986, Fiore and others 1989, Reinert and others 1991 Anderson and Wiener 1995, Ebert 1996). The public frequently views eating fish as posing a less serious hazard than does the scientist or environmental manager. People often are aware of advisories, but continue to consume the fish nonetheless (Reinert and others 1991, Burger and Gochfeld 1991, Burger and others 1992, 1993, Velicer and Knuth 1994, May and Burger 1996).

One of the most difficult situations for the fishing public occurs when there is a discrepancy between the information provided by different agencies (Cunningham and others 1994). Such a situation occurs frequently when two or more states are responsible for the same water system, as occurs in the Great Lakes (Foran and VanderPloeg 1989) and along the Savannah River, where for some years, South Carolina issued consumption advisories, but Georgia did not (SCDHEC 1996). In the latter situation, the agencies, along with the US Environmental Protection Agency, recognized the need to provide credible information to local populations to enable effective decision-making when considering the risks and benefits of consuming fish from the Savannah River. The initial discrepancy developed because of different assumptions regarding risk assessment in regard to fish consumption. Although at present both states issue some consumption advisories for the Savannah River, they differ with respect to some of the species of fish covered.

In this paper, we report on the process of developing a fish fact sheet for people fishing along the Savannah River. The overall objective was to produce a one-page fact sheet that all relevant regulatory and compliance agencies could agree on, in terms of content and presentation, distribution, and sources of follow-up information. The process was one of conflict resolution, consensus-building, and overall agreement on a message that was driven and accomplished by a variety of stakeholders. Because of the evolving nature of information on consumption patterns, contaminant levels, and federal and state legislation and regulation (including environmental justice issues), the process is necessarily iterative and on-going. Thus we examine the consensus process to provide insights about a dynamic process.

While several governmental agencies as well as the public have recognized the importance of stakeholder input (NRC 1993, 1995, Commission on Risk Assessment and Risk Management 1996), there are few published papers detailing the inclusion and importance of stakeholders in the process (see Boiko and others 1996, Jacobson and Marynowski 1997, Harris and Harper 1997). Pittinger (1998) emphasized the importance of involving both risk assessors and risk managers right from the start. For the purposes of this project, we define stakeholders as any individuals, organizations, or agencies that have an interest in the maximization of public health through wise patterns of fish consumption.

Background: Contamination, Conflicts, and Consumption Advisories

The Savannah River originates in the southern Appalachians of North Carolina, passes through South Carolina and Georgia, and flows to the Atlantic Ocean near Savannah. On its winding path it flows through several large reservoirs and past various industrial sites, including chemical factories, nuclear power plants, and the Savannah River Site. The Savannah River Site (SRS) of the Department of Energy is a 780-km^2 nuclear production and research facility. The nuclear reactors were operated from the early 1950s until 1988. Water from the Savannah River was used for cooling the reactors and was deposited in thermal cooling reservoirs on site. Radionuclides were released during this period (Ashley and Zeigler 1980). While there is the potential for contamination of fish from radionuclides (^{90}Sr, ^{137}Cs), mercury is the primary contaminant of concern in fish from the Savannah River (SCDHEC 1996).

The original source of mercury in the Savannah River was from upstream contamination from a chemical plant, although some came from SRS (Kartek and others 1994). However, the problem is of interest to the Department of Energy since they pumped water from the Savannah River to cool their nuclear reactors and so have redistributed and concentrated the mercury both on SRS lands and in the swamplands and streams that run into the Savannah River. DOE is mindful of its economic and social role in the region, since SRS is one of the largest local employers (Greenberg and others 1998). EPA, with a concern both for risk associated with fish consumption patterns and possible equity issues associated with higher consumption rates by minorities, initiated discussions with DOE concerning contaminants in fish, risk from fish consumption, and methods of risk reduction.

The South Carolina Department of Health and Environmental Control (SCDHEC) has issued fish consumption advisories for some time that include the Savannah River from the Augusta Lock and Dam to the Rt. 301 bridge, and includes the river bordering the SRS (SCDHEC 1996, 1999) (Figure 1). The advisories state clearly how much can safely be eaten and what species of fish to avoid. Initially the advisories were driven by mercury contamination; however, radionuclides were also taken into account (SCDHEC 1996, 1999). Georgia did not initially issue advisories, although each year they issued a "Guidelines for Eating Fish from Georgia Waters," which includes a discussion of contaminants, risk, and risk reduction. Georgia now issues recommendations (or advisories) for consumption of some species of fish from the Savannah River (GDNR 1999). At present, there are still discrepancies between the species of fish under advisories and the target population.

EPA, through its regional office in Atlanta, Georgia, provides CERCLA oversight for all federal facilities in the eight-state southeast region. This office had determined significant risk existed for certain populations. However, the coordination among the two states and another powerful federal agency (DOE) required a more thoughtful strategy to ensure better public information regarding risk, without creating other institutional conflicts. The EPA desired that each state maintain its jurisdictional primacy with respect to public health, while insisting that a tangible form of risk communication resulted. EPA is also mandated by a Federal Executive Order 12898 to address environmental justice issues, particularly in regard to its oversight of federal facilities (such as DOE).

When it became apparent that there was confusion regarding the appropriate public response to the consumption advisories and that there may be people eating considerable quantities of fish from the Savannah River, the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) offered to help the EPA regional office, the two states, and DOE by obtaining credible data on fish consumption patterns and by acting as a facilitator to help reach consensus among the state and federal regulators on the appropriate public message concerning the consumption of fish from the Savannah River. This is an on-going process because of the evolving nature of new information on contaminants, consumption patterns, receptor pathways, and public response.

The Role of Science in the Process

Although both South Carolina and Georgia used the same data on levels of contaminants in fish to conduct their human health risk assessment, they arrived at different management strategies. There were several areas of uncertainty about fishing and fish consumption on the Savannah River. One important uncertainty concerned the patterns of consumption of local fishers; there was little information on consumption rates and cooking methods (Burger 1998). Such information is best gathered by interviewing the fishers who are most at risk (Velicer and Knuth 1994)—those actually fishing on the Savannah River.

A key aspect of obtaining information on fish consumption on the Savannah River was the inclusion of a wide range of stakeholders. They were involved in the kinds of information solicited, the design of the questionnaire, the design of the sample, the region and

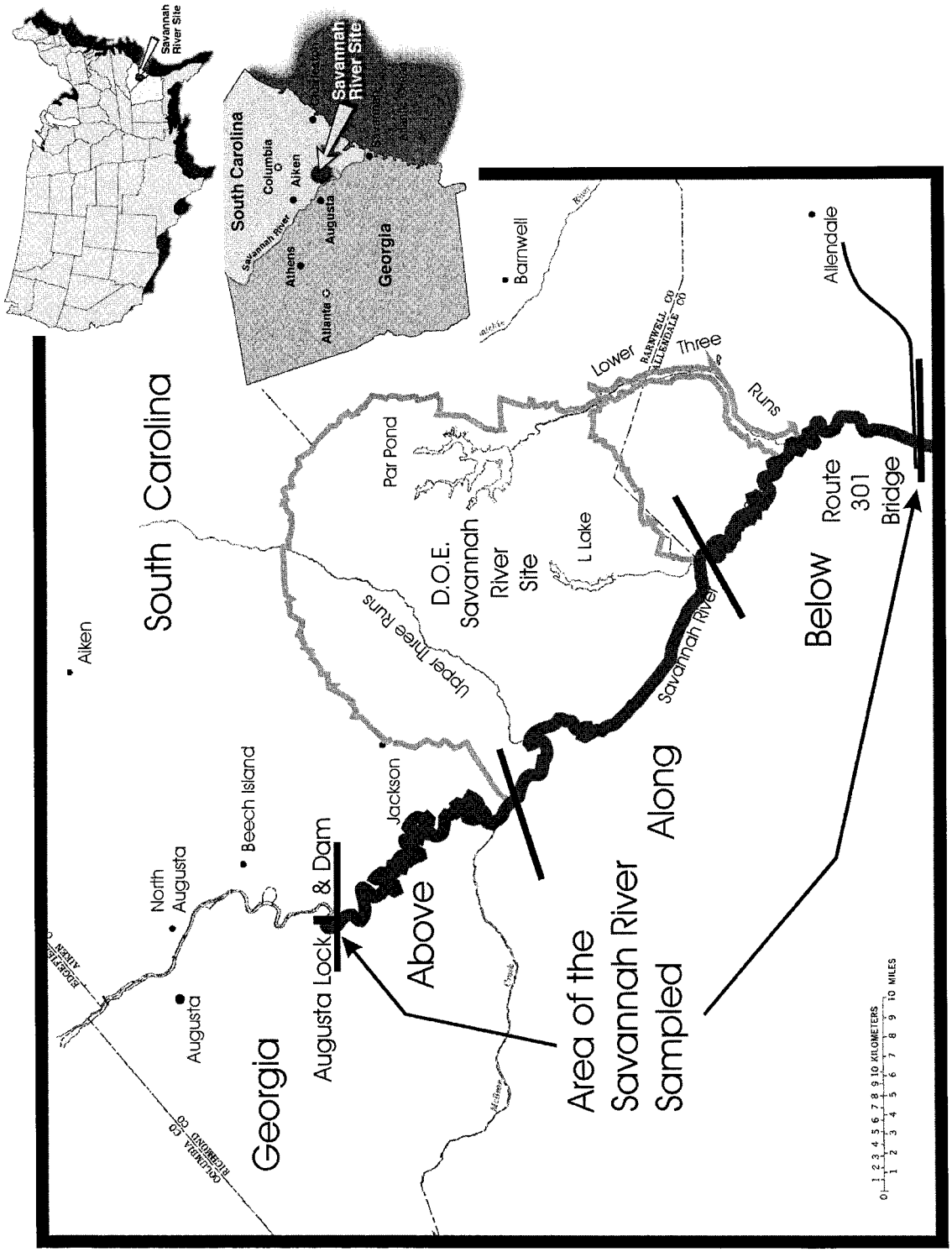


Figure 1. Map of the Savannah River indicating areas where fishermen were surveyed.

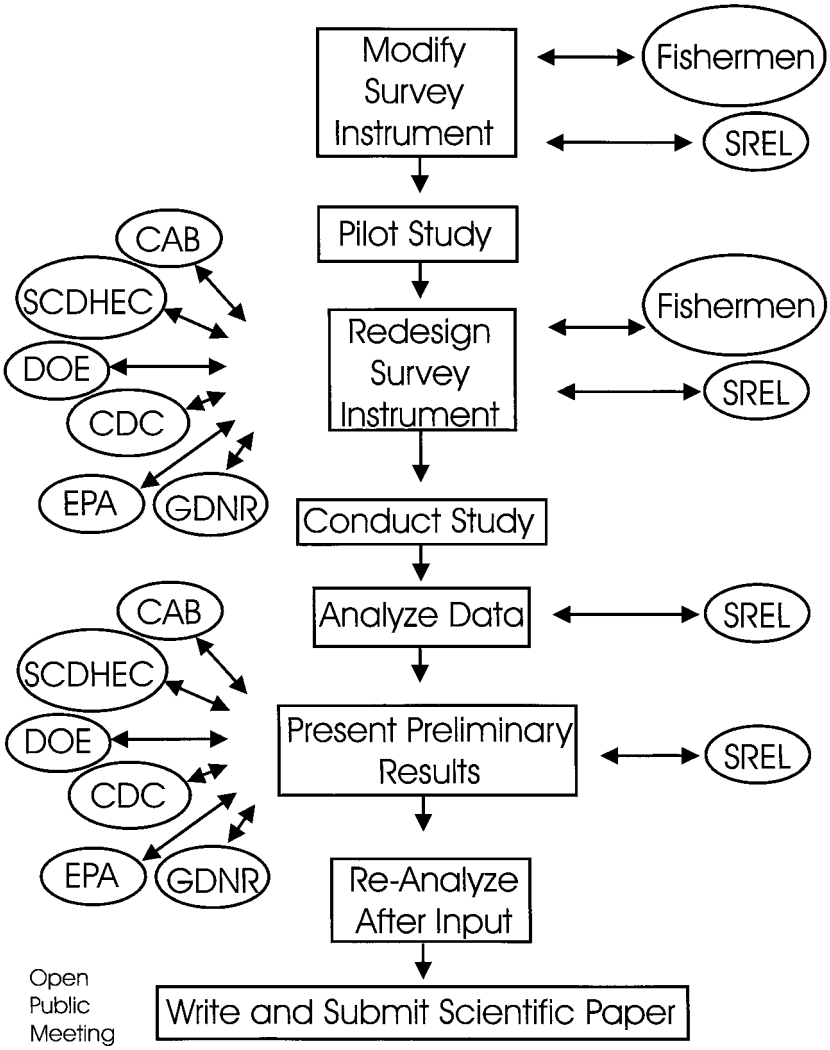


Figure 2. Schematic of the process involved in conducting a stakeholder-driven survey of fishing behavior and consumption patterns for fishermen along the Savannah River by CRESP (Consortium for Risk Evaluation with Stakeholder Participation). EPA = U.S. Environmental Protection Agency, SCDHEC = South Carolina Department of Health and Environmental Control, GDNR = Georgia Department of Natural Resources, DOE = U.S. Department of Energy, CDC = Centers for Disease Control and Prevention: Subcommittee for Health Effects, CAB = Citizens Advisory Board for the Savannah River Site, SREL = Savannah River Ecology Laboratory.

population to be sampled, and the analysis of the data. While the research design is the responsibility of the scientists involved, the information gathered can best inform the regulatory agencies if the data are what they need for appropriate response actions. Since CRESP is committed to undertaking studies with input from a wide variety of stakeholders, consultation was elicited at every stage in the process.

The fishing and consumption survey conducted by CRESP involved the following steps (shown in Figure 2) (Burger 1998, Burger and others 1999):

1. Modifying a previously used and tested questionnaire on fishing and consumption to make it relevant to the Savannah River (after Burger and Gochfeld 1991).
2. Collaborating with the Savannah River Ecology Laboratory (SREL), located on the SRS, concerning all aspects of the research, particularly with regard to the local fish fauna and contaminants.
3. Conducting a pilot study of 40 fishers along the Savannah River to elicit their responses to the survey questions and other reactions and information about fishing that might be critical to understanding fish consumption patterns.
4. Presenting the results of the pilot study to the Centers for Disease Control and Prevention (CDC) Subcommittee for Health Effects for comments, suggestions, and modifications.
5. Soliciting informal comments from members of the Citizens Advisory Board for SRS, and from EPA, DOE, and the relevant state agencies.
6. Redesigning the questionnaire and extending the survey region as a result of the pilot study and the input of various stakeholders.

7. Conducting the survey.
8. Analyzing the data.
9. Presenting the preliminary results to regulatory agencies (SCDHEC, Georgia Department of Natural Resources, EPA), DOE, a subcommittee of the Citizen's Advisory Board, and the SRS-CDC health effects subcommittee.
10. Refining the analysis to reflect additional concerns, questions, and information needs of the stakeholders. This aspect of the study is continuing as the state and federal agencies refine their needs.
11. Writing up the study for publication in scientific journals, as well as responding to requests for accounts in the popular press.

While most of the above steps do not need further explanation, several do. Developing a suitable questionnaire on fishing and consumption patterns is critical because site-specific information on exposure is essential for risk assessment, and its relevance is also germane to eliciting cooperation (Velicer and Knuth 1994, Anderson and Wiener 1995). The total design for the project included evaluating the importance and role of fishing and hunting in the local cultures (Burger 1997, 2000, Burger and others 1997).

We feel strongly that the inclusion of a variety of stakeholders in the pilot study and redesign of the questionnaire, while it undoubtedly took more time, was essential to providing the best information, as well as ensuring that the information was later deemed credible by the relevant regulatory agencies and the public.

Two other aspects were essential to the success of the fishing and consumption study: (1) the inclusion of scientists from the SREL in all phases of the research, and (2) the use of local interviewers familiar with the culture and locations. Inclusion of scientists from SREL ensured that local viewpoints and existing local information were incorporated at all stages. The use of local people to conduct the interviews ensured a very high response rate, enabled interpretation of local customs regarding cooking, and ensured more accurate information.

Conducting a pilot study allowed us to determine whether any questions were confusing and what information might be lacking, as well as allowing for a power analysis to determine the sample size necessary for appropriate statistical analysis. Furthermore, results from the pilot were discussed with various stakeholders, allowing them to suggest further questions. For example, following the pilot study, members of the SRS-CDC health effects committee recommended the addition of questions regarding cooking practices and the age at which children first begin eating fish. Other stakeholders suggested adding questions about the sources of information people used in making decisions about fish consumption.

Finally, the presentation of draft results to several stakeholder groups (regulatory agencies, DOE, SRS-CDC health effects subcommittee and the SRS citizen's advisory board subcommittee) allowed us to examine other questions they felt were relevant to decisions about risk management and the fish fact sheet. Recognition of the need to negotiate and reach a consensus is key to conflict resolution (Fisher and Ury 1981, Burkardt and others 1998) and is particularly important where there may be differences in both the methods and assumptions of risk analysis. The assumptions of risk management are, by their very nature, value-laden (Silbergeld 1991), and this also must be taken into account.

The Role of Science: Providing Exposure Assessment Data

The overall results of the fishing and consumption study can be summarized as follows (Burger 1998, Burger and others 1999): Ethnicity and education were the two factors that contributed the most to explaining variations in the number of fish meals per month, serving size, and total quantity of fish consumed per year. Blacks fished more often, ate more fish meals, ate larger serving sizes, and consumed more fish per year than did whites. Although few women were interviewed, their consumption patterns did not differ markedly from the men. Blacks also traveled shorter distances to fish, had significantly lower incomes, and spent fewer years in school than whites. Fishers with incomes below $20,000 ate fish slightly more times per year than those with higher incomes. Although education and income were correlated, education contributed more to explaining differences in fishing and consumption behavior than did income. Fishers who did not graduate from high school ate fish more often, ate more fish per year, ate more whole fish, and had lower incomes than those who graduated from high school. Depending upon the species of fish, children began to eat fish between the ages of 3 and 5 years.

Using the data on meal size and fish consumption rates for each individual indicates that: (1) people who eat fish more often also eat larger portions, (2) a substantial number of people (72 of 258) exceed the fish consumption threshold (19 kg/year) used by the SCDHEC to compute risk to recreational fishers, (3) some people (24 of 258) consume more than the subsistence

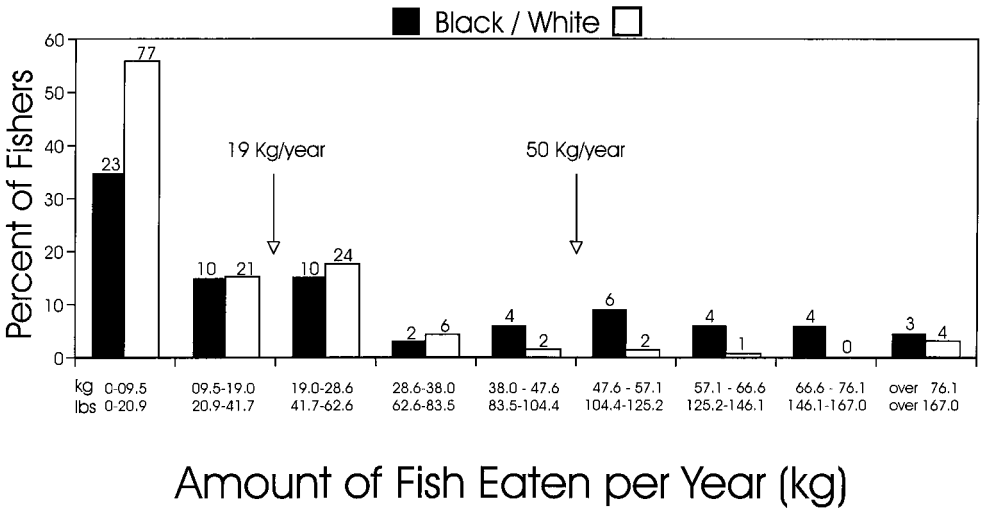


Figure 3. Fish consumption rates of black (black bar) and white (white bar) fishermen interviewed along the Savannah River (after Burger and others 1999).

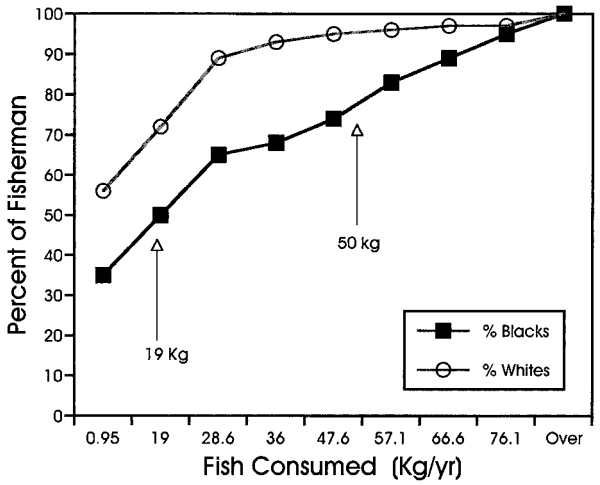


Figure 4. Cumulative percent of people consuming fish as a function of ethnicity.

level default assumption (50 kg/year) used by SCDHEC (1996), and (4) blacks consume more fish per year than whites, putting them at greater risk from potential contaminants in fish (Figure 3). Overall, ethnicity, age, and education (but not income) contributed to variations in fishing behavior and consumption. Clearly, a higher proportion of blacks are consuming more than 19 kg/year, compared to whites (Figure 4).

Even though 62% of the fishers were aware of the advisories issued by SCDHEC, over 80% believed the fish were safe to eat. Fewer blacks, low-income people, and people who had never worked at SRS knew about the consumption advisories, compared to others. Sources of information about the contents of the advisories included newspapers, television, and other people. Few people said they learned about the advisories from doctors, public health officials, or the printed brochures (Burger 1998).

The information provided by the interviews of people fishing along the Savannah River served as a common base for further discussion, and reinforced the mandate of EPA to ensure that affected communities were aware of the risks attendant with fish consumption. EPA's regulatory role in relation to DOE served as a stimulus for further discussion among DOE and the state regulatory agencies.

The Role of Interdisciplinary Information

While information on fishing and consumption patterns was key to providing a solid base for discussions among the agency stakeholders about a common fish consumption message, data and review from many other disciplines were essential to evaluate the potential risk from consuming fish from the Savannah River. This included evaluation of contaminant data on fish and pathways of exposure and involved scientists in exposure assessment and remediation technologies. It was essential to bring several other aspects of risk assessment and management to bear in evaluating the information to use in a fish fact sheet, including aspects of ecological health, public and worker health and safety, data characterization, and outreach and communication.

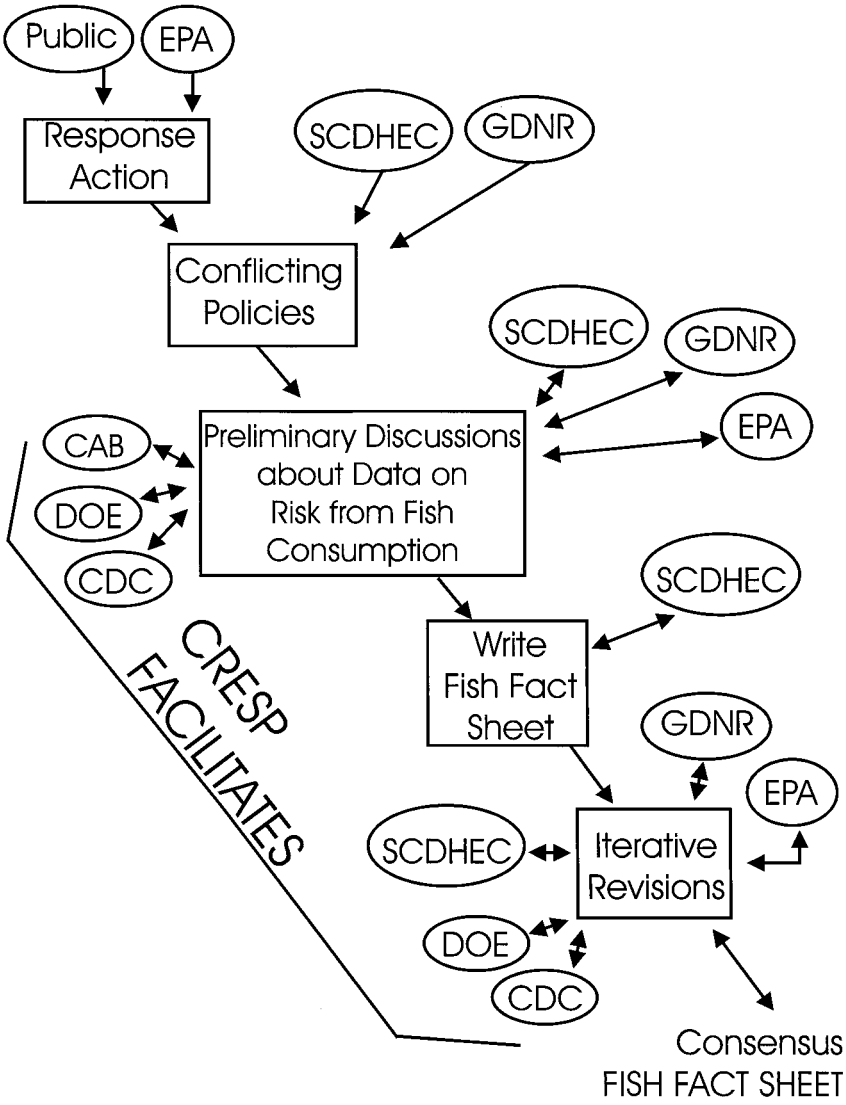


Figure 5. Schematic of the process involved in developing the fish fact sheet. CRESP (Consortium for Risk Evaluation with Stakeholder Participation). EPA = U.S. Environmental Protection Agency, SCDHEC = South Carolina Department of Heath and Environmental Control, GDNR = Georgia Department of Natural Resources, DOE = U.S. Department of Energy, CDC = Centers for Disease Control and Prevention: Subcommittee for Health Effects, CAB = Citizens Advisory Board for the Savannah River Site.

Facilitation Leads to Consensus Among Agency Stakeholders

With the data provided by the fishing and consumption study, it became apparent that it was essential to develop a simple, readable and attractive fish fact sheet that contained information on consuming fish from the Savannah River. While the two state agencies still have differing viewpoints on the issuance of fishing advisories concerning fish species, it was clear that a common message could be developed that would provide necessary information to fishers.

Considerable discussion took place among all the relevant agencies (SCDHEC, GDNR, DOE, EPA) about the kinds of information to present in the fact sheet, EPA provided initial content, and then South Carolina took the lead in writing the initial draft. This was followed by numerous communications concerning the intent and wording of the draft, including conference calls where representatives from all agencies and CRESP were involved. The draft was also reviewed by the relevant citizens advisory board, and the SRS-CDC health effects subcommittee, both for content and presentation. While CRESP facilitated this process, it was the hard work on the part of all involved that resulted in a consensus on the information to provide in the fact sheet, as well as the wording and presentation. This consensus process is shown in Figure 5.

Several principles guided our deliberation, including:

1. Fish are a good source of protein (Hunter and others 1988, Kimbrough 1991, Horn 1992, Anderson and Wiener 1995), and the benefits of fish

consumption must be clear in the fish fact sheet. In addition to direct health benefits of fish consumption, fish also play a key role in social and cultural practices (Toth and Brown 1997).

2. The realization that there was a population of fishers that ate substantially more fish than was previously thought provided justification for the development of the fish fact sheet and motivated the group to reach a consensus.
3. Information on the demographics of the population of fishers and credible sources of information helped outreach and communication specialists design the format and content of the fish fact sheet.
4. Since both radionuclides and mercury are contaminants that can increase the risk of developmental effects, the focus should be on pregnant women and young children.
5. Complete site characterization and extensive knowledge of the sources and pathways is not required to communicate about the potential risks of fish consumption.
6. It should be clear to the public that the fish fact sheet represents consensus among both state regulatory agencies, as well as EPA. This was accomplished by the inclusion of appropriate logos from each agency, with contact numbers where the public can find out more information.

With these in mind, it was possible to provide a message that focused risk reduction for fish consumers overall, on a sensitive target group (pregnant or soon-to-be pregnant women), and to recommend switching to fish species with lower contaminant levels.

Efficacy of the Fish Fact Sheet and Risk Communication

One commitment made by the researchers in their survey protocol, approved by Rutgers University Human Subjects Review Board, was to provide information to the original subjects of the study. The mechanism selected was to distribute the fish fact sheet to people fishing along the Savannah River, ask them some risk communication questions about the sheet, and provide answers to their questions regarding fish consumption (Burger and Waishwell, unpublished data). Nearly everyone we approached agreed to answer our questions, and 90 of 93 people took the fact sheet home. Over 40% of those interviewed correctly identified the target audience, and over 80% understood that they could reduce their risk from eating fish by limiting fish intake in some way. When asked whether they had other comments or would like other information, 50% of black people interviewed asked where they could get the fish fact sheet or when more would be available, indicating an interest in such information. White fishers asked about the levels of contaminants in fish (50%), and both groups asked who was going to clean up the river. These interviews indicated the importance of continuing to refine the fish fact sheet as information becomes available and documented the interest of the fishers in receiving such information.

Lessons for the Future

State agencies have a clear responsibility to provide information to the public about the safety of self-caught foods, including fish (Manning 1993, EPA 1999). While the US EPA provides general information on national consumption rates of fish, contaminant levels of concern, and summaries of water bodies with consumption advisories (EPA 1999), it is still the responsibility of individual states to obtain site-specific information on consumption rates and contaminant levels and to issue advisories where appropriate.

Where there is disagreement between two or more states about the issuance of advisories, the suitable levels of consumption, or the fish species of interest, the development of a fish fact sheet aimed at providing the public with consensus information may be the best solution. It removes the discussion from the necessity to agree on the exact risk methodologies used, and the assumption used, to reaching consensus on the key points the fishing public should be aware of in making their own decisions about how much fish to consume. In contrast, a fish advisory is driven by specific risk assessments, which may involve a number of disputed assumptions.

It is important to stress both the benefits and the risks of consuming fish. Fish clearly provide a good and healthy source of protein (Hunter and others 1988, Kimbrough 1991, Horn 1992, Anderson and Wiener 1995), although some chemicals in contaminated fish have the potential to cause adverse developmental effects (see Jacobson and others 1989, 1990, Institute of Medicine 1991, Sparks and Shepherd 1994, ATSDR 1995, Jacobson and Jacobson 1996, Schantz 1996). The importance of providing both types of information should not be underestimated because the public is surely aware of it (Egeland and Middaugh 1997).

The input of stakeholders was essential to the consensus necessary to produce the fish fact sheet. Many different agencies have recognized the importance of including stakeholders at an early stage in the decision-

Eating Fish from the Savannah River

Did you know...

- Some fish from the Savannah River have chemicals in them that can cause health problems.
- Fish caught in the Savannah River may contain mercury.
- Fish caught in Steel Creek, Lower Three Runs Creek, and Fourmile Branch may also contain cesium and strontium.
- Fish that contain these chemicals do not look, smell, or taste different.

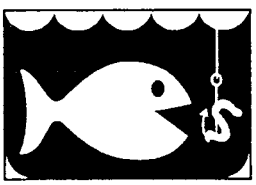
Why is this important to me?

Eating fish with mercury, cesium, and strontium will not make you sick right away. But as you eat more and more, they may build up in your body.

Mercury is more harmful to babies and children than adults. Unborn babies and children have nervous systems that are still forming. Pregnant women can pass mercury to their unborn babies. Mothers can pass it to their babies through breast milk.

Can I still eat fish?

Fish is a healthy, low-fat source of protein. There is no way to clean or cook the fish to get rid of mercury and cesium. This is because they are stored mostly in the meat of the fish, and not in the fat or skin. You can reduce strontium by removing the scales and bones before cooking. You can further reduce health risks from eating fish by doing these things:



- Follow the advice in this fact sheet.
- Eat smaller fish.
- Eat smaller amounts of fish.
- Eat fish from places like markets and restaurants, and from lakes and rivers without fish advisories.
- Eat crappie, pickerel, and sunfish which have lower levels of chemicals.

How much fish can I eat?

Most people should not eat more than one meal a week of largemouth bass or bowfin from the Savannah River. Unborn babies, infants, and children can be more easily harmed by mercury. If you are pregnant, planning a pregnancy, breast-feeding, or have young children, please call one of the telephone numbers on the back of this page for more information.

Remember...

- Mercury is more harmful to babies and children.
- Pregnant women and women with young children should call for more information before eating fish.
- Most people can still eat up to one meal a week of largemouth bass or bowfin.
- The Savannah River is safe for boating and swimming.

Figure 6. The fish fact sheet developed through the process described in this paper.

Will eating fish affect my health?

If large amounts of mercury, cesium, or strontium get into your body, they may cause health problems.

Mercury collects in fish meat and may build up in people who eat fish. It is harmful to the kidneys and nervous system (brain, spinal cord, and nerves). In most cases, health effects from mercury in adults go away as the body gets rid of it.

Cesium collects in fish meat and, when eaten, may build up in your muscles. Cesium is a radioactive substance which can injure cells. It may increase the risk of developing cancer.

Strontium collects in the scales and bones of fish and, when eaten, may build up in your bones. Strontium is a radioactive substance which can injure cells. It may increase the risk of developing cancer.

Is catching and releasing O.K.?

People who want to continue to enjoy fishing, but also want to avoid any risks from eating fish containing the chemicals, should consider catching and releasing. Catching and releasing is a good way to preserve your local fishery.

How can I get more information?

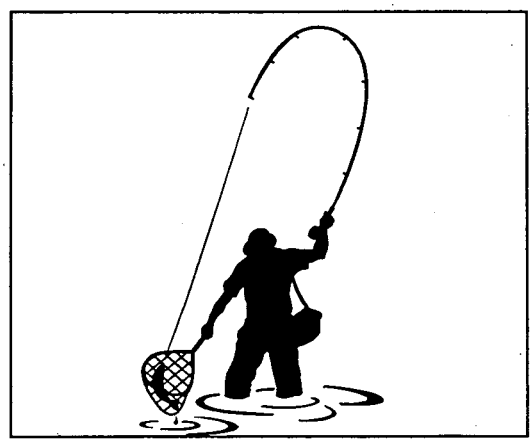
If you have questions or need more information, please call:

(803) 641-7670
Local DHEC Office in Aiken

(888) 849-7241 (toll-free)
DHEC Division of Health Hazard Evaluation

(706) 369-6376 or (404) 656-4713
Georgia Department of Natural Resources

(800) 241-1754
U.S. Environmental Protection Agency



D H E C
PROMOTE PROTECT PROSPER
South Carolina Department of Health and Environmental Control

DEPT. OF NATURAL RESOURCES
GEORGIA

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

Eating Fish from the Savannah River

making process (NRC 1993, Commission on Risk Assessment and Risk Management 1996), particularly for agencies such as the DOE (NRC 1995, Jacobson and Marynowski 1997) where the magnitude and costs of the decisions are so great. While the creation of citizens advisory boards was an excellent first step (Boiko and others 1996), inclusion of an even broader range of stakeholders was an important part of the process of consensus-building about the fish fact sheet. We note in passing that two groups that were not involved in the process were downstream residents and local elected officials, who are particularly important in addressing environmental equity issues (Greenberg and Cidon 1997).

In the development of the fish fact sheet reported here, we found several things to be essential: (1) the acquisition of credible data on fishing and consumption patterns, (2) the inclusion of a wide range of stakeholders in the study design and development, (3) the willingness of all agencies to reach consensus on a message about fish consumption, and (4) the presence of an outside entity (CRESP) that could facilitate the process, while not being previously or directly related to the local situation. Further, evolving information on fishing and consumption patterns (which may change over time), contaminant levels, food-chain effects, federal and state regulations and laws, and environmental justice concerns will force the process to be dynamic and iterative. Because of their commitment to providing appropriate risk information and developing sound public policy, all parties are willing to continue the dialog, based on sound science and equity concerns. Willingness to reach a consensus is a key ingredient of conflict resolution (Fisher and Ury 1981, Kriesberg and Thorson 1991, Burkardt and others 1998). All of these aspects played a critical role in our ability to reach consensus on both the fish fact sheet itself and on a suitable distribution plan and public outreach. Evaluation of the impact of fish fact sheet is a necessary follow-up to a public outreach approach.

Acknowledgments

The authors acknowledge the help of several other members of CRESP for valuable discussions about risk and exposure assessment, including D. Kosson, P. Lioy, A. Roy, P. Georgopoulos, S. Boring, J. Snodgrass, and A. Upton, as well as R. Ramos for help with graphics. J. W. Gibbons, I. L. Brisbin Jr., and K. F. Gaines of SREL participated in discussions about fishing and the fish consumption survey, and we thank them for participation and advice. We are particularly grateful to the following agency representatives for working on this process and contributing to writing the fish fact sheet: Tracey Shelly and Robert Marino (South Carolina Department of Health and Environmental Control: Randy Manning and Robert Hardeman (Georgia Department of Natural Resources): John Stockwell (US Environmental Protection Agency and US Public Health Service): Jerry Nelsen, Thomas Johnson, and Wade Whitaker (US Department of Energy): M. Flora (Westinghouse): and Joan Morrissey and Paul Renard (SRS-CDC subcommittee and staff). The manuscript was enhanced greatly by the comments of P. A. Cunningham and N. Burkhardt. This research was funded by the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) under a cooperative agreement with the Department of Energy (AI DE-FC01-95EW55084), NIEHS (ESO 5022), and EOHSI, and by DOE contract DE-AC09-76SR00819 with the University of Georgia (J.W.G).

Literature Cited

Anderson, P. D., and J. B. Wiener. 1995. Eating fish. Pages 104–123 *in* J. D. Graham and J. B. Wiener (eds.), Risk versus risk: Tradeoffs in protecting health and the environment. Harvard University Press, Cambridge, Massachusetts.

Ashley, C., and C. C. Zeigler. 1980. Releases of radioactivity at the Savannah River Plant, 1954–1978. E. I. DuPont de Nemours and Company, Aiken, South Carolina. Report DPSPU 75-25-1.

ATSDR (Agency for Toxic Substances and Disease Registry). 1995. States issue a record number of health advisories. *Hazardous Substances and Public Health* 6:1–2.

Belton, T., R. Roundy, R. and N. Weinstein. 1986. Urban fishermen: Managing the risks of toxic exposure. *Environment* 28:19–37.

Boiko, P. E., R. L. Morrill, J. Flynn, E. Faustman, G. van Belle, and G. S. Omenn. 1996. Who holds the stakes? A case study of stakeholder identification at two nuclear weapons production sites. *Risk Analysis* 16: 237–249.

Burger, J. 1997. Recreation and risk: Potential exposure. *Journal of Toxicology and Environmental Health* 52:269–284.

Burger, J. 1998. Fishing and risk along the Savannah River: Possible intervention. *Journal of Toxicology and Environmental Health* 55:405–419.

Burger, J. 1999. American Indians, hunting and fishing rates, risk and the Idaho National Engineering and Environmental Laboratory. *Environmental Research* 80: 317–329.

Burger, J. 2000. Gender differences in meal patterns: Role of self-caught fish and wild game in meat and fish diets. *Environmental Research* (in press).

Burger, J., and M. Gochfeld. 1991. Fishing a Superfund site: Dissonance and risk perception of environmental hazards by fishermen in Puerto Rico. *Risk Analysis* 11:269–277.

Burger, J., K. Cooper, and M. Gochfeld. 1992. Exposure assessment for heavy metal ingestion from a sport fish in

Puerto Rico: Estimating risk for local fishermen. *Journal of Toxicology and Environmental Health* 36:355–365.

Burger, J., K. Staine, and M. Gochfeld. 1993. Fishing in contaminated waters: Knowledge and risk perception of hazards by fishermen in New York City. *Journal of Toxicology and Environmental Health* 9:95–105.

Burger, J., J. Sanchez, J. W. Gibbons and M. Gochfeld. 1997. Risk perception, federal spending, and the Savannah River Site: Attitudes of hunters and fishermen. *Risk Analysis* 17: 313–320.

Burger, J, W. Stephens, C. S. Boring, M. Kuklinski, J. W. Gibbons and M. Gochfeld. 1999. Ethnicity and risk: Fishing and consumption in people fishing along the Savannah River. *Risk Analysis* 19:427–438.

Burkardt, N., B. L. Lamb, and J. G. Taylor. 1998. Desire to bargain and negotiation success: Lessons about the need to negotiate from six hydropower disputes. *Environmental Management* 22:877–886.

Commission on Risk Assessment and Risk Management. 1996. Report of the Commission on Risk Assessment and Risk Management. US Congress, Washington, DC.

Cunningham, P., S. Smith, J. Tippett, and A. Greene. 1994. A national fish consumption advisory data base: A step toward consistency. *Fisheries* 19:14–23.

Dourson, M. L., and J. M. Clark. 1990. Fish consumption advisories: Toward a unified, scientifically credible approach. *Regulatory Toxicology and Pharmacology* 12:161–178.

Ebert, E. S. 1996. Fish consumption and human health: Developing partnerships between risk assessors and resource managers. *American Fisheries Society Symposium* 16:261–270.

Egeland, G. M., and J. P. Middaugh. 1997. Balancing fish consumption benefits with mercury exposure. *Science* 278: 1904–1905.

EPA (Environmental Protection Agency). 1989. Assessing human health risks from chemically contaminated fish and shellfish: A guidance manual. EPA-503/8-89-002, Appendix F. US EPA, Washington, DC.

EPA (Environmental Protection Agency). 1998a. Update: National listing of fish and wildlife consumption advisories. US EPA, Cincinnati, Ohio). http://www.epa.gov/ost.fish

EPA (Environmental Protection Agency). 1998b. Guidance for conducting fish and wildlife consumption surveys. EPA-823-B-98-007. Office of Water, Washington, DC.

EPA (Environmental Protection Agency). 1999. Guidance for assessing chemical contaminant data for use in fish advisories. Volume 2: Risk assessment and fish consumption limits. EPA-823-R-99-008. Office of Water, Washington DC.

Fiore, B. J., H. A. Anderson, L. P. Hanrahan, L. J. Olson, and W. G. Sonzogni. 1989. Sport fish consumption and body burden levels of chlorinated hydrocarbons: A study of Wisconsin anglers. *Archives of Environmental Health* 44:82–88.

Fisher, R., and W. Ury. 1981. Getting to yes: Negotiating agreement without giving in. Houghton-Mifflin, Boston.

Foran, J. A., and D. VanderPloeg. 1989. Consumption advisories for sport fish in the Great Lakes Basin: Jurisdictional inconsistencies. *Journal of Great Lakes Research* 15:476–485.

GDNR (Georgia Department of Natural Resources). 1999. Guidelines for eating fish from Georgia waters. GDNR, Atlanta, Georgia.

Greenberg, M., and M. Cidon. 1997. Broadening the definition of environmental equity: A framework for states and local government. *Population Research and Policy Review* 16: 397–413.

Greenberg, M., D. Krueckeberg, K. Lowrie, H. Mayer, D. Simon, A. Isserman, and D. Sorenson. 1998. Socioeconomic impacts of US nuclear weapons facilities: A local-scale analysis of Savannah River, 1950–1993. *Applied Geographyw* 18: 101–116.

Harris, S. G., and B. L. Harper. 1997. A Native American exposure scenario. *Risk Analysis* 17:789–795.

Horn, E. 1992. Toxics in seafood *Tidal Exchange* 3:6–7.

Hunter, D. J., I. Kazda, A. Chockalingam, and J. G. Fodor. 1988. Fish consumption and cardiovascular mortality in Canada: An inter-regional comparison. *American Journal of Preventive Medicine* 4:5–11.

Institute of Medicine. 1991. *Seafood safety.* National Academy Press, Washington, DC.

Jacobson, J. L., and S. W. Jacobson. 1996. Intellectual impairment in children exposed to polychlorinated biphenyls in utero. *New England Journal of Medicine* 335:783–789.

Jacobson, J. L., H. E. B. Humphrey, S. W. Jacobson, S. L. Schwartz, M. D. Mullin, and R. Welch 1989. Determinants of polychlorinated biphenyls (PCBs), polybrominated biphenyls (PBBs), and dichlorodiphenyl trichloroethane (DDT) levels in the sera of young children. *American Journal of Public Health* 79:1410–1404.

Jacobson, J. L., S. W. Jacobson, and J. B.Humphrey. 1990. Effects of in utero exposure to polychlorinated biphenyls and related contaminants on cognitive functioning in young children. *Journal of Pediatrics* 116:38–45.

Jacobson, S. W., and S. B. Marynowski. 1997. Public attitudes and knowledge about ecosystem management on department of Defense land in Florida. *Conservation Biology* 11: 770–781.

Kartek, E. J., W. H. Carlton, M. Denham, L. Eldridge, and M. C. Newman. 1994. Assessment of mercury in the Savannah River Environment. Westinghouse Savannah River Company, TR-94-0218ET.

Kimbrough, R. D. 1991. Consumption of fish: Benefits and perceived risks. *Journal of Toxicology and Environmental Health* 33:81–91.

Kriesberg, L., and S. J. Thorson (eds.). 1991. Timing and the deescalation of international conflicts. Syracuse University Press, Syracuse, New York.

May, H., and J. Burger, J. 1996. Fishing in a polluted estuary: Fishing behavior, fish consumption, and potential risk. *Risk Analysis* 16:459–471.

Manning, R. O. 1993. Development of a plan for fish tissue monitoring and issuance of consumption advisories. In Proceedings of the 1993 Georgia Water Resources Conference K. J. Hatcher (ed.), University of Georgia, Athens, Georgia.

NRC (National Research Council). 1993. Issues in risk assessment. National Academy Press, Washington, DC.

NRC (National Research Council). 1995. Improving the envi-

ronment: An evaluation of DOE's environmental management program. National Academy Press, Washington, DC.

Pittinger, C. A. (ed.). 1998. A multi-stakeholder framework for ecological management: Summary of a SETAC technical workshop. Society of Environmental Toxicology and Chemistry, Pensacola, Florida.

Reinert, R. E., B. A. Knuth, M. A. Kamrin, and Q. J. Stober. 1991. Risk assessment, risk management, and fish consumption advisories in the United States. *Fisheries* 16:5–12.

Schantz, S. L. 1996. Developmental neurotoxicity of PCBs in humans: What do we know and where do we go from here?. *Neurotoxicology and Teratology* 18:217–227.

Silbergeld, E. K. 1991. Risk assessment and risk management: An uneasy divorce. Pages 99–114 *in* D. G. Mayo and R. D. Hollander (eds.), Acceptable evidence. Oxford University Press, New York.

SCDHEC (South Carolina Department of Health and Environmental Control). 1996. Public health evaluation: Cesium-137 and strontium-90 in fish. Attachment to the fish consumption advisory for the Savannah River. #3–5/14/96.

SCDHEC (South Carolina Department of Health and Environmental Control). 1999. Attachment to the fish consumption advisory for the Savannah River.

Sparks, P., and R. Shepherd. 1994. Public perceptions of the potential hazards associated with food production: An empirical study. *Risk Analysis* 14:799–803.

Toth, J. F., Jr., and R. B. Brown. 1997. Racial and gender meanings of why people participate in recreational fishing. *Leisure Science* 19:129–136.

Velicer, C. M., and B. A. Knuth. 1994. Communicating contaminant risks from sport-caught fish: The importance of target audience assessment. *Risk Analysis* 14:833–841.