Risk Assessment
CLH602
002

Risk Analysis, Vol. 19, No. 2, 1999

Fishing in Urban New Jersey: Ethnicity Affects Information Sources, Perception, and Compliance

Joanna Burger,[1,4] Kerry Kirk Pflugh,[2] Lynette Lurig,[2] Leigh Ann Von Hagen,[2] and Stanley Von Hagen[3]

Recreational and subsistence angling are important aspects of urban culture for much of North America where people are concentrated near the coasts or major rivers. Yet there are fish and shellfish advisories for many estuaries, rivers, and lakes, and these are not always heeded. This paper examines fishing behavior, sources of information, perceptions, and compliance with fishing advisories as a function of ethnicity for people fishing in the Newark Bay Complex of the New York–New Jersey Harbor. We test the null hypothesis that there were no ethnic differences in sources of information, perceptions of the safety of fish consumption, and compliance with advisories. There were ethnic differences in consumption rates, sources of information about fishing, knowledge about the safety of the fish, awareness of fishing advisories or of the correct advisories, and knowledge about risks for increased cancer and to unborn and young children. In general, the knowledge base was much lower for Hispanics, was intermediate for blacks, and was greatest for whites. When presented with a statement about the potential risks from eating fish, there were no differences in their willingness to stop eating fish or to encourage pregnant women to stop. These results indicate a willingness to comply with advisories regardless of ethnicity, but a vast difference in the base knowledge necessary to make informed risk decisions about the safety of fish and shellfish. Although the overall median income level of the population was in the $25,000–34,999 income category, for Hispanics it was on the border between $15,000–24,999 and $25,000–34,999.

KEY WORDS: Risk; fishing; ethnicity; perception; toxics; consumption.

1. INTRODUCTION

The wholesomeness of our commercial food supply is a concern for governmental agencies and the public alike, and methods of assessing its safety are particularly important as reliance on food from foreign lands increases. There are, however, concerns about the safety of consuming noncommercial fish, shellfish, and wildlife,[1,2] and the Institute of Medicine of the National Academy of Science has published a major monograph on Seafood Safety.[3] The U.S. Environmental Protection Agency[4] (EPA) recently reported that the number of water bodies under fishing advisories rose by 14 percent from 1994 to 1995, and this represents 15 percent of the Nation's total lake acres and 4 percent of the Nation's total river miles. All of the Great Lakes and their connecting waters, as well as a large portion of the coastal waters, are also under advisories.[4] Mercury accounted for

[1] Ecology, Evolution, and Natural Resource, Nelson Biological Laboratories, CRESP, and Environmental and Occupational Health Sciences Institute (EOHSI), Rutgers University, Piscataway, New Jersey 08854-8082
[2] Division of Science and Research, New Jersey Department of Environmental Protection, Trenton, New Jersey 08625.
[3] Department of Pharmacology and Toxicity, University of Medicine and Dentistry of New Jersey, Newark, New Jersey.
[4] To whom all correspondence should be addressed

0272-4332/99/0600-0217$16.00/1 © 1999 Society for Risk Analysis

Newark Bay Study Area
NBSA-00063

1308 of the advisories, an increase of 46 percent from 1993; other contaminants with increased numbers of advisories were PCBs, chlordane, dioxins, and DDT.[4]

The increase in advisories clearly reflects a cause for concern, although there are three possible causes of a rise in advisories: (1) a real increase in the number of advisories, (2) an increase in monitoring, or (3) a decrease in the levels of contaminants that generate advisories. Even so, the advisories are real, and apply not only for the general public, but for susceptible populations such as children and pregnant women.[4] Subpopulations that eat the organisms whole or cook them in a manner that maximizes exposure are particularly vulnerable.[5] Most of the recent concern about noncommercial food has concentrated on fish and shellfish, with mercury as the primary contaminant,[6,7] although PCBs are also troublesome,[8,9] and are the contaminant of concern in the Newark Bay Complex. The relationship between fish consumption and PCBs,[10,11] and between fish consumption and mercury, have been examined for a number of countries.[6] Extensive work in the Great Lakes has concentrated on PCBs and fish consumption; prenatal exposure to PCBs was associated with lower full-scale and verbal IQ scores after control for potential confounding variables. Memory and attention were most strongly associated with PCBs, with associated deficits in reading comprehension in 11 year olds.[10]

Recently an extensive series of studies on the relationship between fish consumption, mercury levels, and child neurobehavioral development have been undertaken.[12] Analysis of the developmental neurology literature indicated that the reference dose for methylmercury should be lowered to 0.07 μg/kg/d to protect the developing fetus.[13] Subgroups of the population, particularly fishermen, may consume large quantities of fish (in excess of 350 g/d),[7] particularly where recreational and subsistence fishing is prevalent. It is clear that contaminants in fish that are consumed is a global issue that may require an international effort to understand and solve.

Despite the governmental and scientific concern for the safety of fish, there is often a disconnect between scientific knowledge and fish advisories, and the actions of the public.[14] Either the public does not perceive the danger, they do not believe it, they choose not to heed it, or they find it difficult to follow because of economic considerations. In the latter case, fish may provide a necessary source of protein. The failure of the public to follow fishing advisories, however, may be partially due to the inability of risk communicators to reach the appropriate target audience.[15] Despite extensive studies of the disparity between risk assessments by experts and the public,[16–19] the disparity still exists. Risk communication, as well as targeted risk management, may be required to adequately inform the public and reduce consumption where necessary. Confusion arises because the public has repeatedly been told that fish are a healthier protein source than meat, yet there are warnings about fish safety.

One aspect of fishing behavior and consumption patterns that is critical to enlarging the information base for fishermen (including consumption advisories, health risks, and high-risk individuals) is understanding how these patterns vary within ethnic groups. For example, Fitzgerald *et al.*[20] recently reported that among Mohawk women in New York state there is a higher overall fish consumption rate than others in the region, and a lower percentage stopped eating fish contaminated with PCBs during pregnancy than control women. They concluded that it was critical to understand fishing and consumption behavior of specific ethnic groups for effective communication about the risks of eating fish. Further, Fleming *et al.*,[21] working in the Everglades of Florida, noted that blacks were less likely to know about the health advisories than other ethnic groups examined, again suggesting the importance of understanding differences in the knowledge base before designing a further communication campaign regarding advisories.

Although there is a growing literature on ethnic differences in environmental attitudes and risk, much of this literature deals with environmental hazards (such as hazardous wastes[22–24] rather than the health risks from consuming fish. Studies have indicated that blacks are generally less concerned than whites[22–25] about environmental hazards. Further, a number of studies have shown differences in fishing behavior between blacks and whites, at least with respect to attitudes toward fishing,[26] but little attention has been directed toward Hispanics, either in general environmental attitudes or in fishing and consumption patterns.

In this paper we examine fishing behavior as a function of ethnicity in the Newark Bay Complex of the New York–New Jersey Harbor estuary and its connecting waters. We were interested in differences in behavior, information sources, perceptions, and compliance that might aid in managing and reducing potential risks from angling (herein understood to

What a ridiculous statement!

mean fishing and crabbing). We were also interested in determining whether there is subsistence angling in the Newark Bay Complex. We test the null hypothesis that there is no difference in the angling behavior, information sources, perceptions, and compliance as a function of ethnicity. This is part of a larger study to understand the angling behavior of people in New Jersey, motivated by a desire to reduce the potential risk from contaminated fish and shellfish.[27] As Kraus and Slovic[28] noted, information about the diversity of perceptions within a single group of hazards could provide valuable input to risk management decisions; this is particularly true for fishing or consumption advisories where knowledge of the warnings and potential dangers are essential to making personal choices. In this paper we examine ethnic differences with an aim toward risk reduction by targeting particular groups for information dissemination.

The Newark Bay Complex and the greater New York estuary is one of the most polluted in the United States,[29–31] and there are a number of angling advisories promulgated by both New York and New Jersey.[32,33] Both states have issued advisories for blue crabs (*Callinectes sapidus*), blue fish (*Pomatomus saltatrix*), striped bass (*Morone saxatilis*) and American eel (*Anguilla rostrata*), and New Jersey has advisories for white perch (*Morone americana*) and white catfish (*Ameiurus* [*Ictalurus*] *catus*). The contaminants of concern for the Newark Bay Complex are PCBs and dioxins. Recently Finley *et al.*[34] examined the levels of PCBs in striped bass and other fish from the lower Passaic River (our study area) and reported concentrations that exceeded the NOAA benchmark level, leading to increased cancer risk estimates. Advisories in the Newark Bay Complex range from do not eat, to eat fish no more than once a week or once a month, depending on whether you are a high-risk individual. Pregnant and nursing women, and infants and children up to 15 years of age are considered high-risk individuals.[35] Thus it is of policy and management interest to understand how people fish, what they eat, where they learn about fish and fish safety, and why they do not follow the advisories they do know about.

2. METHODS

From July 20 to October 8, 1995 we interviewed 300 fishermen in the Passaic River, Hackensack River, Newark Bay, Arthur Kill and Kill van Kull in the Newark Bay Complex (Fig. 1). Our protocol was to record some basic information (site, date, day of week, time of day, number of people at site, tides, and weather), and then to approach people who were fishing or crabbing and ask them if they would mind answering some questions.

We asked about sources of information on fish and fishing, what kinds and amounts of fish and blue crabs they caught and ate, whether they gave them away, whether they considered the fish or crabs safe to eat, and whether they thought that eating their catch could increase the risk of cancer or cause problems for an unborn or developing child. We asked whether they had heard any warnings (and what they had heard), sources of information about advisories, whether they believed the warnings, and whether they would modify their behavior if they heard warnings. They were asked specific questions about blue crabs, striped bass, and blue fish, as well as other fish. We also asked them about where they obtained information about their health generally. Questions dealing with demographics included age, sex, education, and income were asked at the end of the survey. Subjects were asked to identify their annual household income as less than $10,000, $10,000–14,999, $15,000–24,999, $25,000–34,999, $35,000–49,999, $50,000–74,999, $75,000–99,999 and over $100,000. The entire interview took about 20 minutes, and 74 percent of the people approached agreed to be interviewed. Refusal was due to language difficulties (4 percent) and outright refusal (22 percent).

For questions about sources of information, people indicated whether or not they used those sources, and they were allowed to have many different sources. For questions of fish safety and health, people answered in four categories: safe, may be safe, unsafe, and do not know. For the awareness of correct warnings, people were asked what the warnings were, and we later evaluated whether their knowledge was correct (within broad limits), with respect to fish species involved in the warning, populations at risk, and consumption limits. We scored it as incorrect if the response they gave was wrong (not if they omitted some of the information).

Contingency tables were used to compare the responses to questions with the demographic data (using the categories white, black, Hispanic, and Asian). Hispanic includes Cuban, Puerto Rican, Mexican, and other latinos. Contingency tables were used to test the null hypothesis of no association with ethnicity, using a chi-squared test. We rejected the null hypothesis of no association when there was a probability of .05 or less.

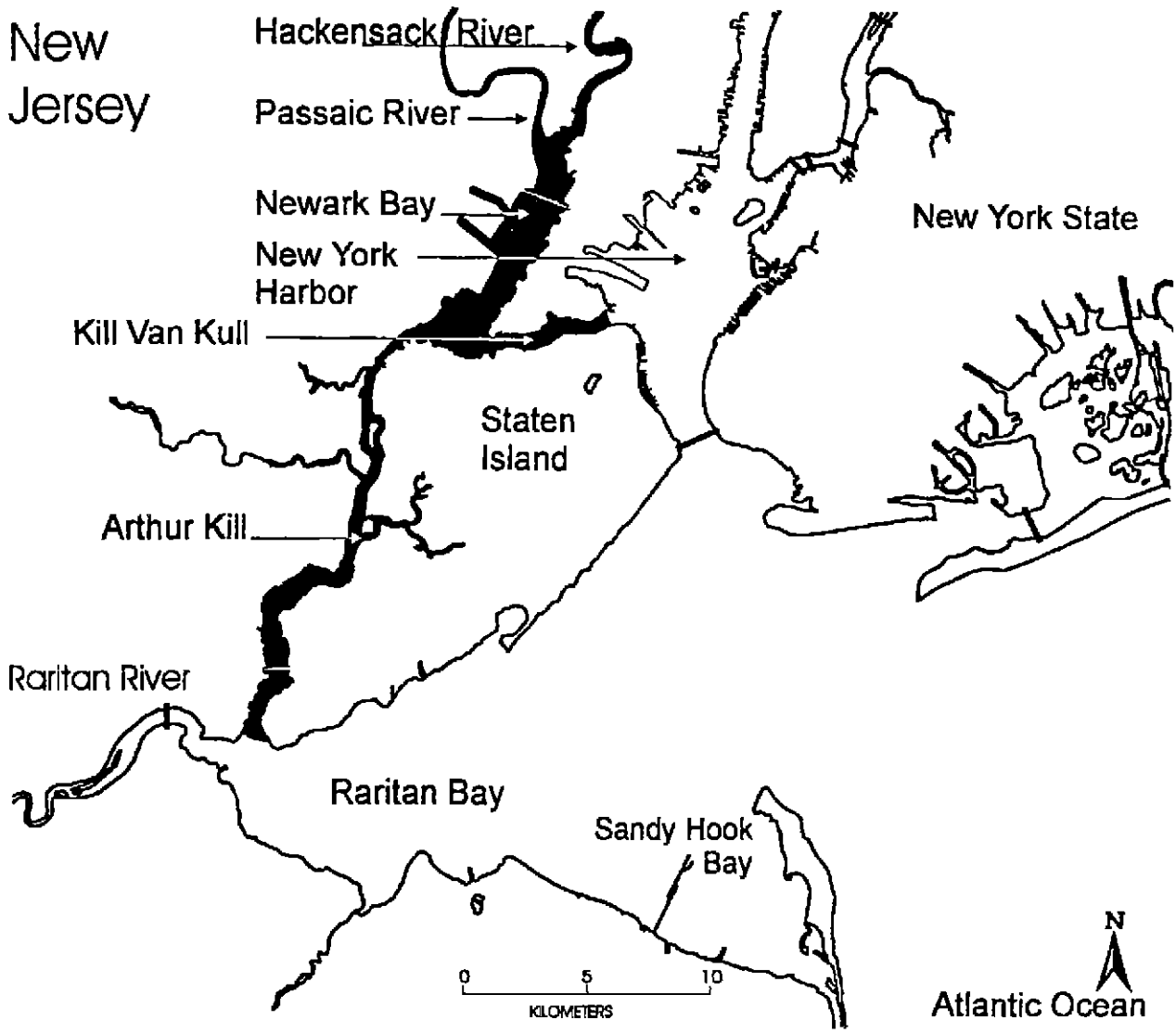


Fig. 1. Map of study area, with survey region shown in black.

3. RESULTS

3.1. Demographics

Most of the people interviewed were male (90 percent), and the population included people who classified themselves as white (55 percent), Hispanic (20 percent), black (17 percent), Asian (3 percent), or other (5 percent). W present the data on Asians in the figures for comparisons, but because of the small sample size, we limit our discussion to white, black, and hispanic. We asked what language they felt most comfortable reading; 83 percent said English, 8 percent said Spanish, and 6 percent said both English and Spanish. Only 28 percent of the people interviewed had not graduated from high school, 45 percent had graduated from high school, and the other 27 percent had attended or graduated from college.

The median household income range, and the range most frequently reported by subjects was between $25,000 and $34,999. Eighteen percent of our sample said their household income was below $15,000, and 11 percent said their household income was over $75,000. Only 11 percent refused to give their income. There were ethnic differences in income, the median and modal income for both black

and white was in the $25,000–34,999 category, whereas for Hispanics it was just on the border between $15,000–24,999 and $25,000–34,999. Similarly, just 11 percent of blacks and whites were in the less than $10,000 income category, whereas nearly 19 percent of Hispanics were.

3.2. Consumption

Despite the issuance of consumption warnings for blue crabs, striped bass, and other fish in all of the areas we surveyed, people continued to eat their catch. There were significant ethnic difference in the percent that ate their catch, with higher percentage of Hispanics eating blue crabs than whites or blacks, and a higher percentage of blacks eating bluefish or striped bass than the other ethnic groups (Fig. 2).

There were no significant differences in whether people fished or crabbed as a function of annual family income.

3.3. Sources of Information

Most of the sample (64 percent) obtained their fish and fishing information from other fishermen or from bait and tackle shops (38 percent), rather than from magazines, radio, television, Department of Environmental Protection newsletters or brochures, the New Jersey Health Department, or their own doctors. Thus, these latter sources are not providing information on fishing to the population fishing in the estuary. There were, however, ethnic differences in whether people obtained information from newspapers (χ^2 = 27.8, df = 4, 295, $p < .0001$), the Department of Environmental Protection Digest (χ^2 = 11.2, df = 4, 295, $p < .02$), and warning signs in the area (χ^2 = 9.4, df = 4, 295, $p < .05$; Fig. 3). Newspapers were providing the most information to whites, followed by black, and hispanics were notably low in this category. On the contrary, warning signs provided more information to whites and hispanics than to blacks. There was no significant difference among ethnic groups in their use of other fishermen, bait and tackle stores, cable television, or magazines as a source of information about fish and fishing.

Fishermen with higher annual family income obtained significantly more information from radio (χ^2 = 16.6, df = 8,293, $p < .03$) and bait and tackle shops (χ^2 = 17.9, df = 8293, $p < .02$) than did people with lower incomes. There were no significant differences as a function of annual family income for the other sources of information.

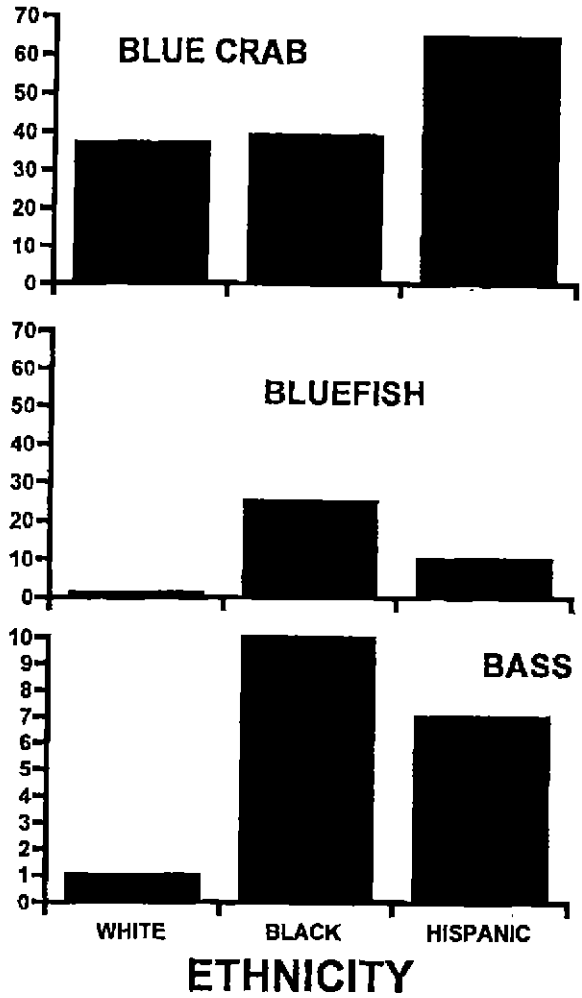


Fig. 2. Percent of people who eat crabs, bluefish or striped bass. Shown is the percent of each ethnic group that consumed crabs, bluefish or striped bass once they caught them. Some people only crabbed, and thus could not be expected to eat the fish

3.4. Fish Safety, Warnings, and Adverse Effects

People were asked about the safety of fish and crabs, possible adverse effects, and their subsequent behavior if they knew that the fish or crabs posed a health hazard. They were asked the questions in that order so as not to prejudice their initial answers. In general, about half of the people believed that it was safe to eat fish more frequently than was advised (Fig. 4), and there were significant ethnic–income

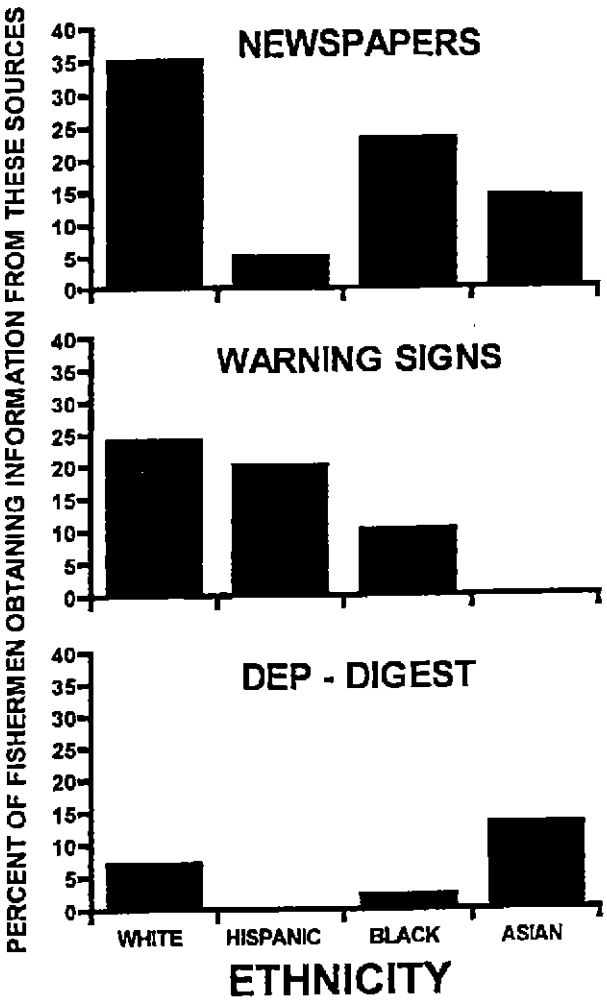


Fig. 3. Percent of respondents obtaining information on fishing from different sources as a function of ethnicity.

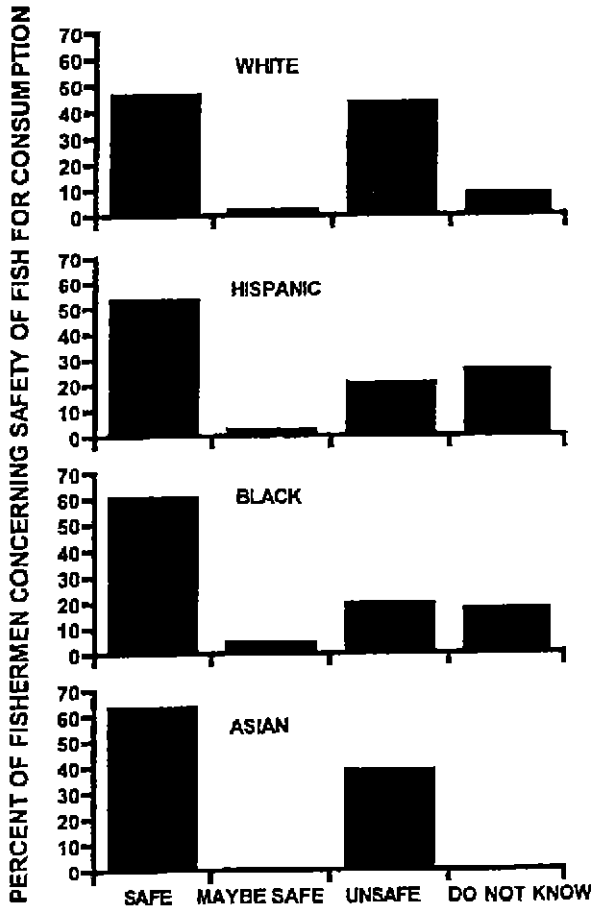


Fig. 4. Percent of respondents thinking the fish and crabs were safe to eat as a function of ethnicity.

differences (Table I), although income was the stronger effect. Blacks and Hispanics generally felt the fish were safer to eat than did whites.

They were then asked whether eating locally caught fish or crabs over their lifetime would increase their risk of cancer, harm the growth of unborn children, or harm the growth and development of young children (Fig. 5). In general there were ethnic differences with respect to their perception of increased risk of cancer, harm to their unborn children, and harm to developing children (see Table I). In general, whites thought the risks were greater, blacks were intermediate, and Hispanics thought the risks were lower (see Fig. 5). There were significant differences as a function of income for increased risk of cancer, and harm to their unborn children (see Table I); in general whites with medium incomes were more concerned about the risks.

The percentage of people who had heard warnings about the fish and crabs varied ethnically (see Table I), as did the percent aware of the correct advisories ($\chi^2 = 27.8, p < .0005$) and the percent that thought the fish were safe to eat (Fig. 6). In general, whites and blacks were more aware of the warnings, and of the correct warnings, than were Hispanics.

They were then told that there was a state public health advisory about crabs and striped bass, and were asked again if they thought they were safe to eat (Fig. 7). Over 44 percent of blacks, Hispanics, and whites still believed they were safe to eat. There were no significant differences among ethnic groups in the way they responded ($\chi^2 = 29.0$, df = 4292, $p < 0.02$). The next questions had similar wording, but dealt with bluefish, white catfish, American eel, and white perch. These questions elicited no ethnic

Table I. Responses to Questions About Fish Safety by Income and Race

	<$15k very low	$15–35K low	$35–75K medium	>$75k high	Total	Column percent	
Black	9	17	12	8	46	18.6%	
Hispanic	17	21	13	1	52	21.1%	
White	24	52	52	21	149	60.3%	
Total	50	90	77	30	247	100.0%	
Row %	20.2%	36.4%	31.2%	12.1%	100.0%		
						Chi square	P
Fish are safe for consumption (n = 112)							
Black	5	13	6	2	25		
Hispanic	12	9	6	0	27		
White	12	22	19	6	59		
Total	29	44	31	8	112		
Interaction of race × income (df = 6)						9.91	NS
Differences by race for all incomes (df = 3)						5.21	NS
Differences by income for all races (df = 2)						8.71	<.02
Excess: medium income, white							
Fish might increase cancer risk (n = 83)							
Black	0	6	2	4	12		
Hispanic	2	5	4	0	11		
White	5	19	31	5	60		
Total	7	30	37	9	83		
Interaction of race × income (df = 6)						20.4	<.01
Differences by race for all incomes (df = 3)						7.74	<.055
Differences by income for all race (df = 2)						16.0	<.001
Excess: medium income, white							
Deficit: very low income, Hispanic							
Fish might pose risk to unborn child (n = 76)							
Black	0	3	3	3	9		
Hispanic	2	3	2	0	7		
White	7	17	31	5	60		
Total	9	23	36	8	76		
Interaction of race × income (df = 6)						23.6	<.001
Differences by race for all incomes (df = 3)						16.3	<.001
Differences by income for all races (df = 2)						14.4	<.001
Excess: medium income, white							
Deficit: very low income, Black, Hispanic							
Aware of warnings regarding fish (n = 119)							
Black	2	11	2	5	20		
Hispanic	4	3	4	0	11		
White	19	28	33	8	88		
Total	25	42	39	13	119		
Interaction of race × income (df = 6)						21.6	<.001
Differences by race for all income (df = 3)						22.6	<.001
Differences by income for all races (df = 2)						0.62	NS
Excess: white							
Deficit: Hispanic							

Overall n = 247, n signifies number responding either "yes" or "no" to each question ("don't know" and "no opinion" are excluded)

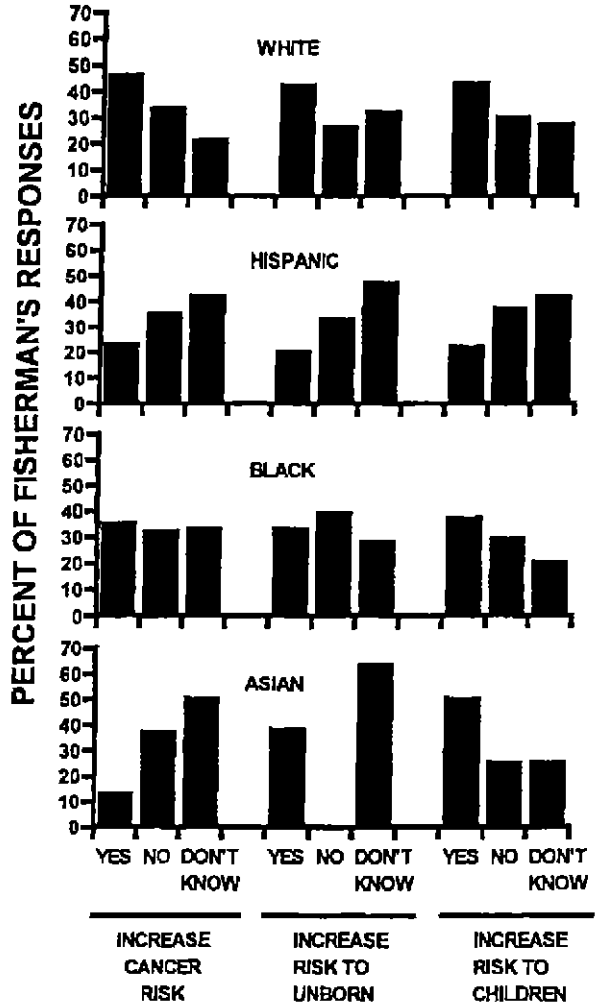


Fig. 5. Percent of respondents that thought there was an increased cancer risk, increased risk to the unborn, or an increased risk to children from consuming fish with contaminants as a function of ethnicity.

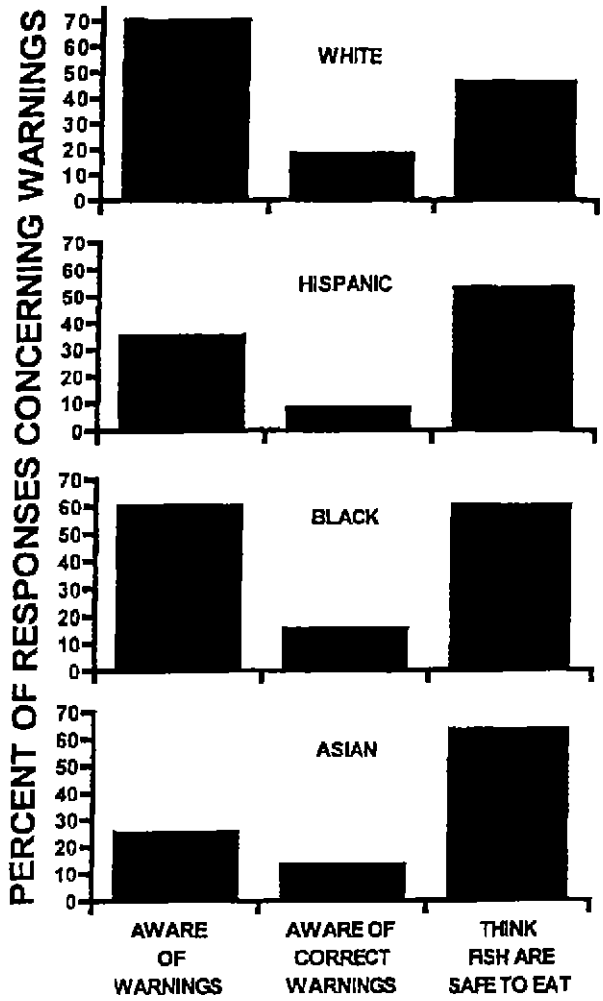


Fig. 6. Percent of respondents aware of the warnings, aware of the correct warnings, and who still thought the fish were safe to eat as a function of ethnicity.

differences, but only 24 percent said they felt that these fish were safe to eat more often than the recommendations.

When asked whether they thought it would be easy to follow the instructions in the consumption advisory (about limits for the general public of not more than one fish meal a week of locally caught bluefish, catfish, eel, and white perch, and for pregnant and nursing women, and children), 83 percent said yes, but only 72 percent said they intended to follow the recommendations. Many people said they would stop eating locally caught fish if it increased their cancer risk (85 percent), and would encourage women in their households to stop eating fish if it increased the risk to unborn children (96 percent) or developing children (97 percent). There were no ethnic differences in these responses.

4. DISCUSSION

4.1. Sources of information

This study clearly indicated that most people learned about fishing and crabbing from other fishermen and bait and tackle shops, while they learned about warnings from newspapers. These data indicate that for this urban population there are no good, reliable, highly used sources for information about

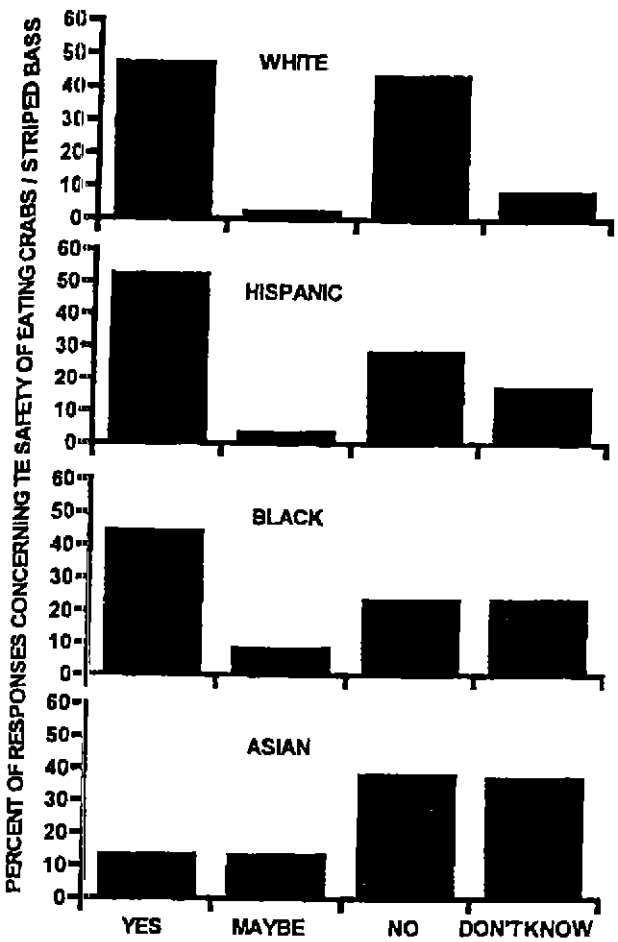


Fig. 7. Percent of people who though is was safe to eat crabs or bluefish after being told there was a New Jersey Department of Environmental Protection state advisory about consumption, as a function of ethnicity.

fishing that can be easily used to transmit health advisory information. Overall 60 percent of the people interviewed said that they had heard warnings, although when asked to state them, only 15 percent could correctly recall them.

There were ethnic differences in the sources of information, in their knowledge about fishing advisories, and in their knowledge of the correct advisories. In general, whites took advantage of written sources of information a higher percentage of times than did blacks, and both used written sources of information more than Hispanics. There was even an ethnic difference in the perception of the presence of advisory signs near the fishing and crabbing locations.

These data appear to suggest that the techniques that authorities are using to inform the public about fishing and crabbing, of the dangers from consuming contaminated fish, and of the possible developmental defects that can result from consuming such fish, are not effective. However, in the year prior to this study, the New Jersey Department of Environmental Protection initiated an extensive public information program that included brochures and flyers in both English and Spanish. Signs were posted in many locations, press releases were issued, and public meetings were held. Part of our motivation to conduct this study was to learn the barriers to effective communication so that a more effective outreach program could be developed.

These data on a lack of information suggest the need for a more targeted information program aimed at subpopulations that do not have access to traditional channels used by the government. Although this may be difficult, the awareness by some segments of the population of warnings provided by newspapers and warning signs suggests that more time and energy should be invested in these modes of communication. Also, the fact that fishermen and bait and tackle shops are sources of information about fish and fishing suggests that these modes of communication be integrated into a communication strategy.

May and Burger[9] interviewed urban fisherman from the Arthur Kill, Raritan Bay, and the New Jersey shore and found that a higher percentage of the fisherman overall (70 percent) had heard about the advisories. Although these differences may relate to language differences, this is unlikely; more than 80 percent of the people interviewed in our survey gave English as the language they were most comfortable with. However, a significant number of the people interviewed in the May and Burger study were recreational fishermen who had sufficient time and money to travel to the Jersey shore to fish along the beach or to go out in party boats.

The New Jersey Department of Environmental Protection first issued consumption advisories in 1982,[35] and owing to recent media attention about mercury in freshwater fish, and the media campaign about PCBs, we hoped that everyone would be aware of the warnings. The ethnic difference in knowledge of advisories suggests that targeted methods should be developed for different ethnic groups.[15] Velicer and Knuth[15] also found differences in knowledge about fish safety, with migrant workers being less aware of advisories than were others. Although, in their study, the transient nature of the workers may be partly to blame, this is not the case with the fishermen interviewed in this study.

4.2. Exposure, Catch Safety, and Risk

Consumption rates varied, but up to 65 percent of the people ate blue crabs, and up to 25 percent ate bluefish. Because the majority of people are engaged in crabbing, it is not surprising that a lower percentage eat the fish (because they are not fishing). There were several interesting aspects of the perception of advisories and catch safety:

1. There was a discrepancy between their perception of warnings and their perception of the safety of fish.
2. There was another discrepancy between their perception of warnings and their knowledge of the correct warnings for their fishing site.
3. There was a general lack of knowledge about the potential health risks.
4. There were ethnic differences in all these aspects.

Despite hearing warnings about the safety of fish and crabs, on average, 47 percent still felt the fish were safe to eat. The perception of the safety of fish varied ethnically, with blacks being more sure fish and crabs were safe than were Hispanics or whites. Ethnic differences have generally not been examined for risk perceptions, but Flynn *et al.*[36] found that white men thought a variety of environmental health risks were less severe than did white females, or black men and women. In this case, Hispanics were more sure the fish and crabs were safe than were blacks and whites.

The overall finding of a discrepancy between information from state-issued advisories and the perception that the fish were safe to eat agrees with previous findings of Belton *et al.*,[37] Burger *et al.*,[14] and May and Burger[9] for the Newark Bay Complex. What is different is the relatively low knowledge of advisories, and the ethnic differences in information sources and perception about fish safety.

Moreover, there was another discrepancy not previously reported: although many people knew about the fishing advisories, most were not aware of the correct warnings for the waters where they were fishing. People perceived that there were some warnings, but were not aware of the exact warnings. This may partially account for their failure to heed them. The warnings are either so generalized, or the people generalize them, and thereby may discount their importance. It is also possible that people perceive that the warnings apply elsewhere, and not to their favorite fishing place. Anecdotally, people reported that they discounted warnings because people "are not getting sick" and "are not throwing up."

Only 38 percent of all people interviewed agreed that fish posed an increased cancer risk to themselves, or an increased risk to unborn or young children; for blacks and Hispanics, the percentage of people aware was even lower. In most cases, both ethnicity and income contributed to differences in the perceptions. Clearly, the information about developmental deficits from toxins such as dioxins and PCBs is not general knowledge, at least in the population interviewed. Gregory and Mendelsohn[38] noted that perceptions of effects on future generations have a significant effect on the perception of risk, suggesting that this aspect should be used in future risk communication about the risks from eating contaminated fish, especially for pregnant women.

When initially presented with a statement that the State of New Jersey had issued advisories about consuming striped bass and crabs, nearly half the people still felt it was safe to eat them. When presented with a second such scenario about the cancer risks to themselves and unborn children, the percentage that felt it was safe to eat then decreased for all ethnic groups. The percentage that said they would stop eating such fish (or would encourage pregnant women to do so) if they knew it would increase the cancer risk, or increase problems for unborn children or young children, increased to 85 percent or more. We believe that this indicates that providing specific, detailed information about who is at risk, including unborn children, makes the risk more real and pertinent to themselves. Providing such information to individuals through a trusted information source could have some benefit.

The importance of trusting the information source was not examined in this study, but could be important. In this study, the interviewers were not perceived as officials, suggesting that the answers may have been more reliable than when confronted by "state officals." Further, after completition of the interview, the interviewers spent considerable time with each person, answering questions about fish and consumption advisories. This procedure in itself is a valuable information transfer mechanism about fish consumption and human health effects.

4.3. Risk Reduction

People have always been intuitive toxicologists in their choice of food, often relying on their senses

of taste and smell to warn them of harmful or unsafe foods.[39] Yet this is not possible with toxic chemicals that do not taste or smell bad. Thus, the dangers from fishing are not always apparent. Moreover, fishing is an enjoyable pastime, and for many, fish may provide an important source of protein. In addition to providing an important source of protein that may aid in cholesterol reduction,[40] for some people fishing may provide an affordable source of protein. Determining whether there were subsistence fishermen in the Newark Bay Complex was one of our initial objectives. However, the median household income of fishermen in this study was $25,000–34,999, well above the average poverty threshold for a family of four ($15,569).[41] This does not rule out, however, the importance of economic pressures in compliance with the suggested consumption advisories, particularly for the 18 percent who said their income was below the poverty level. This applies particularly to the Hispanic community, where 19 percent reported a household income of less than $ 10,000, in contrast to blacks and whites (both at 11 percent).

Because fishing is voluntary, and the public will accept risks a thousand times greater for voluntary compared to involuntary activities,[17,42] it may be difficult to influence people to change their consumption rates of fish. Moreover, Weinstein[43,44] has noted the tendency for people to be unrealistically optimistic about their own susceptibility. Optimistic biases may also arise because no acute effects are experienced, or no one routinely gets sick. Nonetheless, strategies must be developed to inform the public about the risks of consuming blue crabs and particular species of fish.

Another important aspect of fishing behavior is the underlying meaning of fshing within a social context. Toth and Brown[26] evaluated racial and gender meanings of why people fish along the Upper Mississippi Delta, noting that there were important social relations involved with fishing, and that there were ethnic differences. Blacks in the region approached recreational fishing from a different cultural framework (they fished for consumption) than whites, who fished as a diversion between work shifts or lunch breaks.[45] Blacks also viewed fishing holistically (allowing them to be outdoors, relax, visit with friends), and as part of a social network (being able to provide fish for fish fries or to give them away), and as subsistence.[26] Whites in contrast, did not view fish in a subsistence framework, but instead viewed fishing as family leisure, sport, sociability, and as part of a social network. The social meaning of fishing to the people interviewed in our study was not examined, but it may be an important contributor to differences in compliance with advisories.

We contend that the results of this study suggest that risk-reduction strategies must take into account ethnic differences in information sources, perceptions about safety and health risks, and consumption patterns. Newspapers and warning signs seem to be the information source where people heard about fish consumption advisories. With adequate resources, both culd be utilized more frequently. Brighter signs with pictures of the offending species, and less verbiage to explain the message, might be more effective. The major problem, however, may be that there are not enough signs, and those that are put up are sometimes removed. Regular sign replacement might be a chore that could be undertaken by a community group or official.

We were impressed with the relative change in attitudes that occurred within the period of the interview. That is, when presented with a statement about state health advisories, and when the significance was explained (increased cancer risk, increased risk to unborn and young children), nearly everyone responded by saying that they would heed the warnings. People view risks in terms of how they affect their lives,[38] and when faced with a direct statement that the health department had issued advisories about fish because of potential cancer risks and developmental risks, people changed their perception of the safety of the fish (at least for the survey). This change in perception also indicates a degree of rationality in making their choices.[46,47] This suggests that a campaign that included hiring students, interns, or local residents to talk to fishermen about the hazards from fish and crab consumption might be effective. Further, such people should be fluent in Spanish in the Newark Bay Complex, and comfortable with the Hispanic culture.

Finally, we note that fish are an important source of protein, particularly for subsistence or supplemental fishermen, and that fishing need not be discouraged. Instead, alternate cooking methods or other risk-reduction methods can be encouraged, as well as "catch and release" strategies. Fish may be good because of the potential for reduction of cholesterol.[48] We suggest that additional information about risk reduction from eating certain kinds of fish, eating smaller fish, and cooking to eliminate rather than retain all contaminants should be a part of any educational program. This additional information might help people understand that they can reduce risk

while not necessarily decreasing the amount of fish eaten.

This study indicates that the dissemination of risk information has had less of an impact than authorities would like to believe, and that the differences between expert risk assessments and the perceptions of the public are still great.[18] They are greater for Hispanics and blacks than for whites, and this difference must be addressed if risk reduction is to occur.

ACKNOWLEDGMENTS

We thank M. Gochfeld and A. Stern for comments on the manuscript; B. Johnson, R. Prince, B. Ruppel, and J. Shaw for technical aid; B. Longstretch, B. Neyenhouse, C. Pak, K. Rothrock, Captain B. Sheehan, E. Yacovelli, and A. Wilner for help with the survey work. This project was funded by U.S. Environmental Protection Agency, Region II, and the Division of Science and Research of the New Jersey Department of Environmental Protection; and by the following for JB: the Consortium for Risk Evaluation with Stakeholder Participation (CRESP, through the Department of Energy Cooperative Agreement, AI # DE-FC01-95EW55084), NIEHS grant ESO 5022, and the Environmental and Occupational Health Sciences Institute.

REFERENCES

1. P. Sparks and R. Shepherd, "Public Perceptions of the Potential Hazards Associated With Food Production: An Empirical Study," *Risk Anal* **14,** 799–808 (1994).
2. Agency for Toxic Substances and Disease Registry (ATSDR), "States Issue a Record Number of Health Advisories," *Hazardous Substance Public Health* **6,** 1–2 (1996).
3. Institute of Medicine. *Seafood Safety* (National Academy Press, Washington, DC, 1991).
4. Environmental Protection Agency (EPA), Update· National Listing of Fish and Wildlife Consumption Advisories (Cincinnati, Ohio, U.S. Environmental Protection Agency, 1996).
5. J. N. Morgan, M. R. Berry, and R. L. Graves, "Effects of Commonly Used Cooking Practices on Total Mercury Concentration in Fish and Their Impact on Exposure Assessments," *J. Exposure Anal. Environ. Epidemiol.* **7,** 119–134 (1996).
6. D. Airey, "Total Mercury Concentrations in Human Hair From 13 Countries in Relation to Fish Consumption and Location," *Sci. Total Environ* **31,** 157–180 (1983).
7. J. Burger, K. Cooper, and M. Gochfeld, "Exposure Assessment for Heavy Metal Ingestion From a Sport Fish in Puerto Rico: Estimating Risk for Local Fishermen," *J. Toxicol. Environ. Health* **36,** 355–365 (1992).
8. P. Weihe, P. Grandjean, F. Debes, and R. White, "Health Implications for Faroe Islanders of Heavy Metals and PCBs From Pilot Whales," *Sci. Total Environ.* **186,** 141–148 (1996).
9. H. May and J. Burger, "Fishing in a Polluted Estuary: Fishing Behavior, Fish Consumption, and Potential Risk," *Risk Anal.* **16,** 459–471 (1996).
10. J. L. Jacobson and S. W. Jacobson, "Intellectual Impairment in Children Exposed to Polychlorinated Biphenyls in Utero," *N. Engl J Med.* **335,** 783–789 (1996).
11. S. L. Schantz, "Developmental Neurotoxicity of PCBs in Humans: What Do We Know and Where Do We Go From Here?" *Neurotoxicol. Teratol.* **18,** 217–227 (1996).
12. B. Weiss and J. Elsner, "Risk Assessment for Neurobehavioral Toxicity," *Environ. Health Perspectives* **104**(supl), 171–413 (1996).
13. A. H. Stern, "Re-evaluation of the Reference Dose for Methylmercury and Assessment of Current Exposure Levels." *Risk Anal.* **13,** 355–364 (1993).
14. J. Burger, K. Staine, and M. Gochfeld, "Fishing in Contaminated Waters: Knowledge and Risk Perception of Hazards by Fishermen in New York City," *J. Toxicol. Environ. Health,* **39,** 95–105 (1993)
15. C. M. Velicer and B. A. Knuth, "Communicating Contaminant Risks from Sport-Caught Fish. The Importance of Target Audience Assessment," *Risk Anal.* **14,** 833–841 (1994).
16. P. Slovic, B. Fischoff, and S. Lichtenstein, "Rating the Risks," *Environment* **21,** 14–20 (1979).
17. P Slovic, "Perception of Risk," *Science* **236,** 280–285 (1987).
18. P. Slovic, "Perceived Risk, Trust, and Democracy," *Risk Anal.* **13,** 675–682 (1993).
19. R. E. Kasperson, O. Renn, P. Slovic, H. S. Brown, J. Emel, R. Goble, J. S. Kasperson, and S. Ratick, "The Social Amplification of Risk: A Conceptual Framework," *Risk Anal.* **8,** 177–187 (1988).
20. E F. Fitzgerald, S. Hwang, K. A. Brix, B. Bush, K. Cook and P. Worswick, "Fish PCB Concentrations and Consumption Patterns Among Mohawk Women at Akwesasne," *J. Exposure Anal. Environ. Epidemiol* **5,** 1–19 (1995).
21. L. E. Fleming, S. Watkins, R. Kaderman, B. Levin, D. R. Ayyar, M. Bizzio, D. Stephens, and J. A. Bean, "Mercury Exposure in Humans Through Food Consumption From the Everglades of Florida," *Water Air Soil Pollution* **80,** 41–48 (1995)
22. D. E. Taylor, "Blacks and the Environment: Toward an Explanation of the Concern and Action Gap Between Blacks and Whites," *Environ. Behavior* **21,** 175–205 (1989).
23. J. Flynn, P. Slovic, and C. K. Mertz, "Gender, Race, and Perception of Environmental Health Risks," *Risk Anal.* **14,** 1101–1108 (1994).
24. W. Arp III and C. Kenny, "Black Environmentalism in the Local Community Context," *Environ. Behavior* **28,** 267–282 (1996).
25. R. D. Bullard and B. H. Wright, "The Politics of Pollution· Implications for the Black Community," *Phylon* **47,** 71–78 (1986).
26. J F Toth Jr and R. B. Brown, "Racial and Gender Meanings of Why People Participate in Recreational Fishing," *Leisure Sci.* **19,** 129–146 (1997).
27. K. Kirk Pflugh, L. Lurig, L. A. VonHagen, S. VonHagen, and J. Burger, "Urban Anglers' Perception of Risk From Contaminated Fish," *Science Total Environment* **228,** 203–218 (1999).
28. N N. Kraus and Paul Slovic, "Taxonomic Analysis of Perceived Risk: Modeling Individual and Group Perceptions Within Homogeneous Hazard Domains," *Risk Anal.* **8,** 435–455 (1993).
29. R. U. Ayres and S. R. Rod, "Patterns of Pollution in the Hudson-Raritan Basin," *Environment* **28,** 14–43 (1986).
30. T P. O' Connor and C. N Ehler, "Results from the NOAA National Status and Trends Program on Distribution and Effects of Chemical Contamination in the Coastal and Estuarine United States," *Environ. Monit. Assess.* **17,** 33–49 (1991).

31. K. S. Squibb, "Overview of Toxics in the Harbor Estuary," *Tidal Exchange*, **3**, 1–2 (1992).
32. New York State Department of Health (NYSDOH), *1994–1995 Health Advisories: Chemicals in Sportfish or Game* (New York State Department of Health, Bureau of Toxic Substance Assessment, New York, 1994).
33. New Jersey Department of Environmental Protection, Division of Science and Research (NJDEP), *A Guide to Health Advisories for Eating Fish and Crabs in New Jersey* (New Jersey Department of Environmental Protection, Division of Science and Research, Trenton, New Jersey, 1994).
34. B. L. Finley, K. R. Trowbridge, S. Burton, D. M Proctor, J. M. Panko, and D. J. Paustenbach, "Preliminary Assessment of PCB Risks to Human and Ecological Health in the Lower Passaic River," *J. Toxico. Environ. Health* **52**, 95–118 (1997).
35. P. Hauge, *Polychlorinated Biphenyls (PCBs), Chlordane, and DDTs in Selected Fish and Shellfish from New Jersey Waters, 1988–1991: Results from New Jersey's Toxics in Biota Monitoring Program* (New Jersey Department of Environmental Protection, Division of Science and Research, Trenton, New Jersey, 1993).
36. J Flynn, P. Slovic, and C. K. Mertz. "Gender, Race, and Perception of Environmental Health Risks," *Risk Anal.* **14**, 1101–1108 (1994).
37. T. Belton, R. Roundy, and N. Weinstein, "Urban Fishermen: Managing the Risks of Toxic Exposure," *Environment*, **28**, 19–37 (1986).
38. R. Gregory and R. Mendelsohn, "Perceived Risk, Dread, and Benefits," *Risk Anal.* **13**, 259–264 (1993).
39. N. Kraus, T. Malmfors, and P. Slovic, "Intuitive Toxicology: Expert and Lay Judgements of Chemical risks," *Risk Anal.* **12** 215–232 (1992).
40. P. D. Anderson and J. B. Wiener, "Eating Fish," In J. D. Graham and J. B. Weiner, eds, *Risk versus Risk: Tradeoffs in Protecting Health and the Environment* (Harvard University Press, Cambridge, MA, 1995).
41. Federal Census Bureau, *U. S. Census* (U.S. Government Printing Office, Washington DC, 1995).
42. C. Starr, "Social Benefits Versus Technological Risk," *Science* **165**, 1232–1238 (1969).
43. N. D. Weinstein, "Unrealistic Optimism About Susceptibility to Health Problems," *J. Behav. Med.* **5**, 441–460 (1982).
44. N. D. Weinstein, "Optimistic Biases About Personal Risks," *Science* **246**, 1232–1233 (1989)
45. M. B. Campbell, "Fishing Lore: The Construction of the 'Sportsmen'," *Annals of Tourism Research* **16**, 76–88 (1989).
46. H. Otway and B. Wynne, "Risk Communication: Paradigm and Paradox," *Risk Anal.* **9**, 141–145 (1989).
47. A. Tversky and D. Kahneman, "The Framing of Decisions and the Psychology of Choice," *Science* **211**, 452–458 (1981).
48. E. Horn, "Toxics in Seafond," *Tidal Exchange*, **3**, 6–7 (1992).