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Consumption Advisories and Compliance: The Fishing Public and the Deamplification of Risk

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ABSTRACT *Managers and regulators have recognized that the fishing public often ignores fish consumption advisories, and the reasons for non-compliance are explored in this paper. Risk assessors acknowledge that there is a social amplification (intensification) of risk where the public perceive a risk as much more severe than do the 'experts' or scientists, and this social amplification is a function of the interaction of hazards with social, psychological and cultural processes. I propose that non-compliance of consumption advisories occurs because of the deamplification of risk in hazards that are familiar and enjoyed, such as fishing and fish consumption. Although the public are generally aware of consumption advisories, they continue to believe the fish are safe to eat, and a high percentage eat the fish they catch. Unlike the amplification of risk, the deamplification of risk from fishing in the face of consumption advisories is partly legitimized by the actions of some governmental agencies, as well as by society at large. It is suggested that a variety of economic benefits and social institutions lead to a discounting of consumption advisories, and the delayed nature of adverse health effects allows for additional disregard. Further, it is suggested that co-management of the risk from contaminated fish would increase public involvement, and therefore compliance.*

Introduction

Hunting and fishing are enormously popular pastimes in Western civilization, and in many cultures world-wide they play an important role in food acquisition and social status. While both hunting and fishing can be physically dangerous due to accidents, only recently have we begun to realize that the consumption of contaminated fish and game may also be injurious to human health, particularly for developing foetuses and young children (Jacobson *et al.*, 1989, 1990; Institute of Medicine, 1991; Sparks & Shepherd, 1994; Agency for Toxic Substances and Disease Registry, 1995; Jacobson & Jacobson, 1996; Schantz, 1996). This has led to the public policy of issuing consumption advisories for some waters, and a flurry of studies to determine the presence and magnitude of risk and the perceptions of this risk by the fishing public (Institute of Medicine, 1991; Horn, 1992).

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The US Environmental Protection Agency (EPA) (1996, 1998) reported that the number of water bodies under fishing advisories rose by 14% from 1994 to 1995, and that this represented 16% of the nation's total lake acres and 4% of the nation's total river miles. All of the Great Lakes and their connecting waters, as well as a large portion of US coastal waters, are also under advisories (EPA, 1998). Mercury accounts for 1308 of the advisories, an increase of 46% from 1993; other contaminants with increased numbers of advisories were polychlorinated biphenyls (PCBs), chlordane, dioxins and dichlorodiphenyl-trichloroethane (DDT) (EPA, 1996, 1998). Although the increase in advisories could be due to either increases in knowledge or increases in enforcement, there is still cause for concern.

One fact that is clear from the wide range of studies on the perceptions of risk from eating fish is that the public consistently underrate or ignore the risk, and continue to fish in contaminated waters (Belton *et al.*, 1986; Fiore *et al.*, 1989; Anderson & Wiener, 1995; Ebert, 1996; Reinert *et al.*, 1996), although this is partly a function of not communicating to the specific target audience (Connelly & Knuth, 1998). There is a gap between policy and practice. Partly the gap may result from the need for fish as a source of protein for low-income people (Toth & Brown, 1997). Further, the problem is one of discrepancy between consumption and advisories, not fishing, because in some fisheries people catch and release, and do not consume, the fish.

There is a discrepancy between the scientists' and regulators' view of the risk from eating some fish, and that of the general public; the public view the risk of eating such fish less seriously than does the scientist. This is not always the case, as some public health scientists have argued strongly against the threats from contamination of fish and other indigenous foods (see Egeland & Middaugh, 1998; Egeland *et al.*, 1998). Fish continue to be an important source of protein (Jacobs *et al.*, 1998).

Yet for most risk situations, the reverse occurs: the scientist rates the risk from a given hazard much lower than do the general public. This is particularly clear in the case of nuclear power and hazardous waste sites (or the siting of future waste sites). Scientists (and regulators) rank the human health risks from toxic waste sites much lower than do the general public (Kraus *et al.*, 1992; Slovic *et al.*, 1995). Often the issue is one of lack of credibility of the information sources (Mitchell, 1992), coupled with an overwhelming fear or dread of radioactivity (Slovic *et al.*, 1991a, b).

Similarly, there are other voluntary risks, such as smoking, skateboarding, recreational boating and even substance abuse, that result in increased risk to participants (Fischer *et al.*, 1991; Chyou *et al.*, 1997; Mueller & Ciervo, 1998), but since they themselves choose the risk, the perception of the severity of that risk is lessened and people continue to take the risk (Kozlowski, 1986; Murray *et al.*, 1987; Burger & Gochfeld, 1991; Ost, 1995), even when the risk is to unborn children (Schellscheidt *et al.*, 1997). It is a matter of personal control; people accept risks that they themselves have chosen (Slovic, 1987). Thus several factors determine how people perceive risk, including the degree of voluntariness, optimism about susceptibility and other value judgements (Weinstein, 1982; Slovic, 1987; Keeney & von Winterfeldt, 1991).

In this paper I examine the relationship between the public's perception of the risk of eating fish from waters with consumption advisories, and that of the regulators and policy makers, and discuss a conceptual framework for the

deamplification of risk. I discuss both recreational and subsistence fishing. Although there is clearly a need for more information on the economic and cultural factors that influence the way different groups of people interpret fishing advisories, it is important to identify possible new methods of understanding. I suggest that while fisheries biologists are coming to the conclusion that effective management of many fisheries must involve co-management (Jentoft, 1989; Jentoft & McCay, 1995; Sen & Nielson, 1996; Nielsen & Vedsmand, 1997; Kaplan, 1998), information about the consumption of contaminated fish might be equally amenable to the benefits of co-management. The principles and institutions derived for co-management of fish stocks might prove useful in managing the information base for fish consumption advisories, risk assessments and the perception of both the hazards of and risks from consuming fish. The assessment of the risk from consuming contaminated fish, and the management of fish consumption advisories, are now handled by state and federal agencies. Compliance might be improved if the fishing public were involved in these decisions within the framework of co-management.

Background

In a paper entitled 'The social amplification of risk: a conceptual framework', Kasperson *et al.* (1988, p. 177) noted that the social and cultural perceptions of risk could be linked with the understanding of risk perception. They proposed that hazards interact with psychological, social, institutional and cultural processes to "amplify or attenuate" public responses to risk. Much attention has been devoted to the amplification of risk perception, most notably in the case of the public's response to current nuclear power and hazardous waste sites, and to the siting of future facilities (Slovic *et al.*, 1979; Slovic, 1987; Mitchell, 1992). Kasperson *et al.* (1988) noted that amplification occurs at all levels, including the news media, cultural groups, interpersonal networks and others.

Although they mention it in passing, Kasperson *et al.* (1988) did not directly examine the deamplification of risk. I suggest that many of the principles that lead to the social amplification or intensification of risk operate in reverse for other hazards that we undertake voluntarily, and that we enjoy doing; these have policy implications. I use the example of people fishing, where consumption advisories abound. Unlike social amplification examples, however, there are many governmental links in the deamplification process that lend credence to the perceptions of the fishing public. Further, social networks and economic benefits contribute to the process.

The Case of the Fishing Public and Fishing Advisories

I will use data from four published studies (Burger & Gochfeld, 1991; Burger *et al.*, 1992, 1993; May & Burger, 1996) and one ongoing study of fishermen on the Savannah River, South Carolina (Burger, 1998; Burger *et al.*, 1999a), to illustrate the relationship between recreational and subsistence fishing and fish consumption, fish advisories and the perception of fish safety (Figure 1). This is in essence a meta-analysis of previous studies, all of these studies involving personal interviews with fishermen who were actually fishing at the time of the interview. They were asked a number of questions about fishing behaviour, fish consumption, methods of cooking, fish safety and whether they had heard warnings about the safety of the fish.

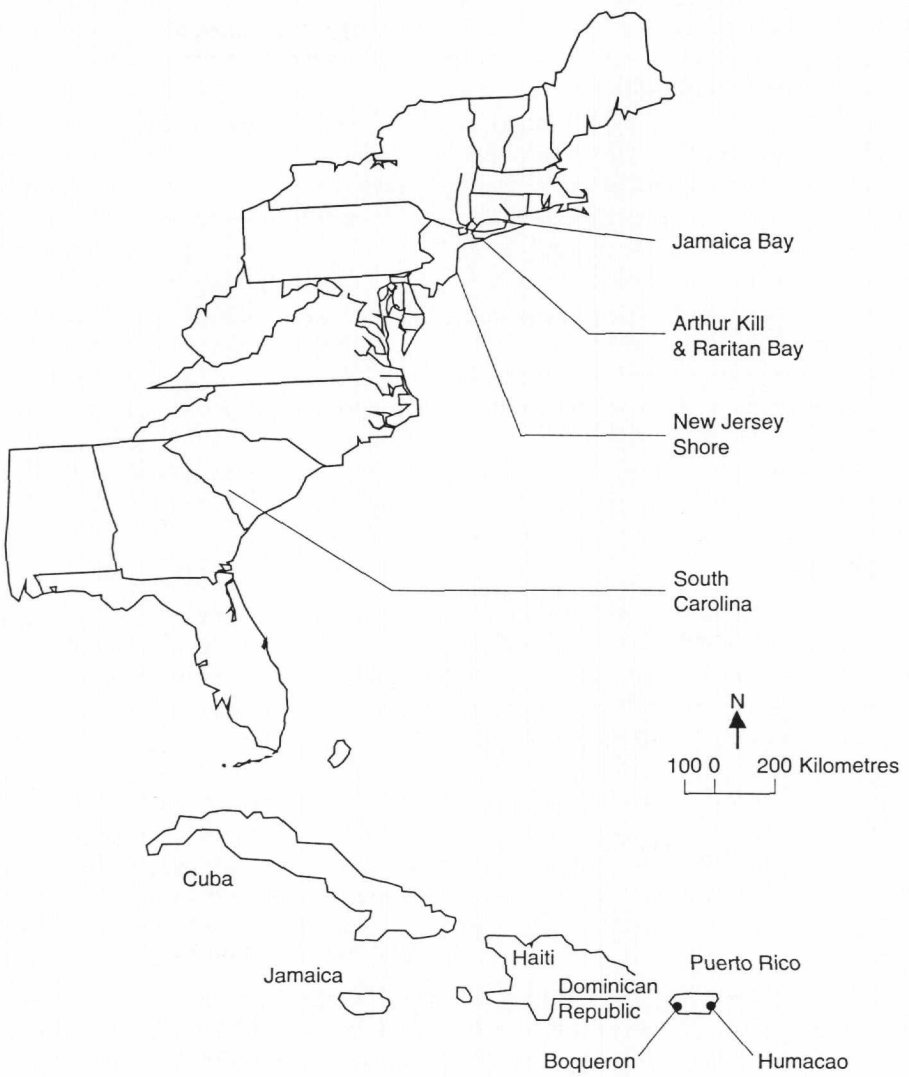

Figure 1. Map showing study sites mentioned in text.

Fish Consumption

In general, people were at the high end of fish consumption compared with the general US public, consuming an average of three or more fish meals a month (Figure 2). Data for the Savannah River illustrate consumption for Black (higher value) and White (lower value) fishermen (Burger *et al.*, 1999a). In all these regions the fishing season is relatively long, and in Savannah River and Puerto Rico people fish for most of the year and freeze fish for later consumption. In South Carolina over a half of the Black men interviewed go fishing on over 90 days a year (Burger, 1997a).

The fish consumption of fishermen examined in Figure 2 is above the average for the general public. For example, a sample representative of all adults in New Jersey (not just the fishing public) indicated that nearly 75% consume two or

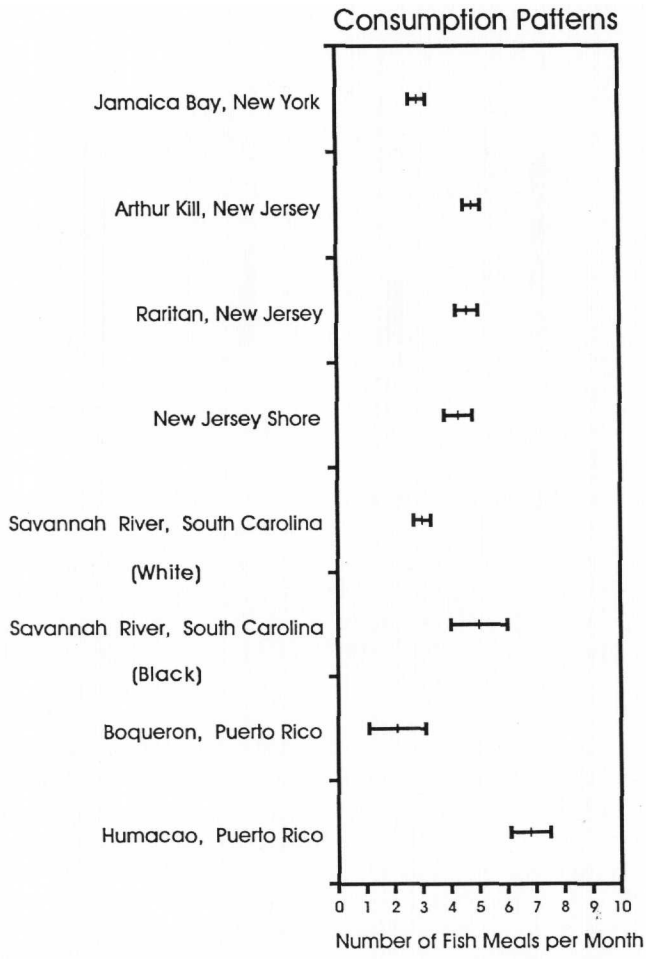

Figure 2. Number of fish meals consumed per month by fishermen surveyed at Jamaica Bay, New York (Burger *et al.*, 1993), Arthur Kill, Raritan Bay and along the New Jersey shore (May & Burger, 1996), Savannah River, South Carolina (Burger, 1998; Burger *et al.*, 1999b) and Humacao and Boqueron, Puerto Rico (Burger & Gochfeld, 1991; Burger *et al.*, 1992). Shown are means ± standard error.

fewer fish meals per month (Stern *et al.*, 1996). The average US citizen eats about 15 g of fish per day (EPA, 1989); given an average meal size of about 200 g this translates into just over two fish meals a month. It must be remembered, however, that both of these latter estimates reflect mostly consumption of commercial fish, and not self-caught fish.

In all of the studies shown in Figure 2, people were fishing in waters where some fish consumption advisories had been issued, and were eating self-caught fish. A sample of the people fishing in Barnegat Bay indicated that they consume fish an average of five times a month (Burger *et al.*, 1998).

Awareness of Warnings

The percentage of people who had heard warnings varied from about 20% for

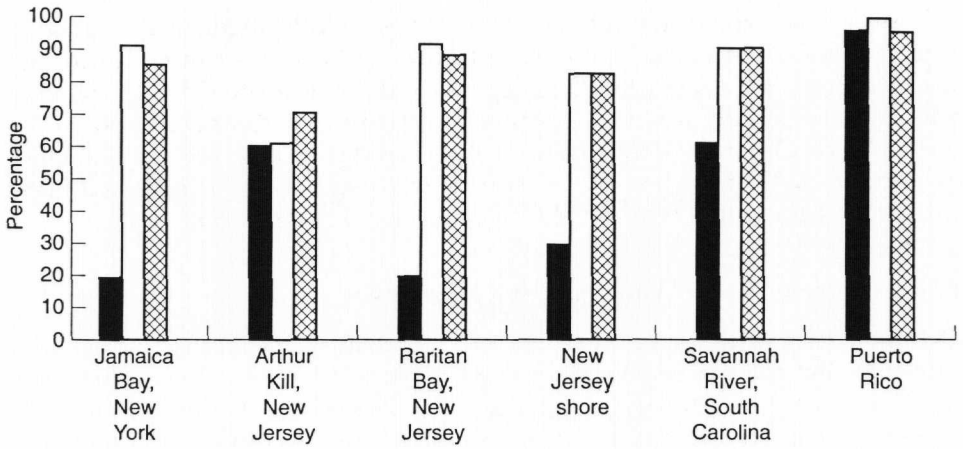

Figure 3. Relationship between knowledge of consumption advisories, perceptions of the safety of eating fish and the percentage that eat the fish they catch for people surveyed at Jamaica Bay, New York (Burger *et al.*, 1993), Arthur Kill, Raritan Bay and along the New Jersey shore (May & Burger, 1996), Savannah River, South Carolina (Burger, 1998) and Humacao and Boqueron, Puerto Rico (Burger & Gochfeld, 1991; Burger *et al.*, 1992). (■) 'Have you heard the warnings?' (□) 'Are the fish safe?' (▨) 'Do you eat the fish?'

Jamaica Bay and Raritan Bay to over 90% for fishermen in Puerto Rico. In all of these locations, over 60% of the fishermen felt that the fish were safe to eat (and did eat them), despite the warnings. There was a significant difference between the number who believed the fish were safe to eat and the number who had heard the warnings, for all sites (X^2 tests, $p < 0.01$) except Arthur Kill and Puerto Rico. The low percentage of people who had heard the warnings in Jamaica Bay and Raritan Bay was largely attributable to the proportion of non-English speakers. In all cases, there was a discrepancy between the percentage of people who had heard safety advisories and the percentage who heeded them. In some cases, the gap was wide, as in Puerto Rico where 96% had heard warnings, but almost none thought the fish were unsafe (and all ate them). In others, the gap was narrower, as in Jamaica Bay, where only about 20% had heard warnings and 9% thought the fish were unsafe to eat.

Awareness of warnings is often ethnically related. In South Carolina only 50% of Blacks had heard warnings, compared with 66% of Whites ($X^2 = 5.5$, $p < 0.02$) (Burger, 1998). In an ongoing study in the Newark Bay complex (Arthur Kill is part of this region), 70% of Whites were aware of consumption warnings, whereas only 60% of Blacks and 35% of Hispanics and Latinos knew about the warnings ($X^2 = 22.6$, $p < 0.001$) (Burger *et al.*, 1999b). There was no gap, however, between the number who believed the fish were safe to eat and the number who ate them (Figure 3).

The examples described above are not unique. There are many studies where fish consumers are exposed to contaminants that exceed levels known to cause adverse effects. Examples include fish consumers from Minamata, Japan (Davies, 1991; Fujiki & Tajima, 1992), and the Great Lakes (Humphrey, 1987; Jacobson & Jacobson, 1996; Lonky *et al.*, 1996) and, to a lesser degree, subsistence fishermen in the Everglades of Florida (Fleming *et al.*, 1995).

The scientists who conducted the risk analyses, and the regulators who issued consumption advisories for these waters, believed there is a risk from consuming fish from these waters, but the fishermen did not evaluate the risks the same way. There is clearly a lack of connection between the risk evaluation by the assessors, the fishermen's awareness of the warnings and the belief that the fish are safe to eat. People who believe the fish are safe to eat do so. In the following discussion I provide a conceptual framework for this discrepancy.

Risk Assessment: Who Loses and Who Benefits?

One aspect of risk assessment and environmental management that is often ignored is the question of who receives the gains and benefits. The relatively low levels of interest in fish consumption advisories shown by the public can partly be explained by the gains that fishermen experience: they enjoy fishing, it gets them outdoors, it is an activity that can be done with every member of the family (regardless of sex or age), it can be done with friends, it can vary seasonally as well as by target fish, equipment and method and, lastly, it provides food.

Benefits of Fishing

Scientists interested in leisure sciences have recently started to examine not only the meanings of why people participate in recreational activities such as fishing, but also both gender and racial differences in meanings. Toth & Brown (1997) noted that there are many reasons for engaging in fishing besides obtaining fish to eat, including enjoying the outdoors, family recreation, relaxing, getting away from demands, enjoying friends, sport and obtaining fish to give away to friends and family and for swapping. Many of these involve complicated social dimensions that may far exceed merely obtaining fish for consumption. The added benefit of supplementing the family food with fish is particularly important for some groups, including Blacks (Toth & Brown, 1997). Risk scientists, in contrast, often concentrate only on the latter benefit when computing risk and issuing advisories, spending most of their time with probability and magnitude (Kasperson *et al.*, 1988) rather than including the more complex issues that people may use in evaluating risk. Recreational activities do not occur in a vacuum, but clearly involve a web of social factors that allow the fisherman to meet their social needs (Toth & Brown, 1997).

Many of the benefits listed above are obtained in fishing, and it is not necessary to eat the fish. For example, in many freshwater fisheries, catch-and-release is the norm. Catch-and-release is particularly encouraged where fish stocks are depleted or declining drastically, such as with striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) (Soldwedel, 1999). However, for many people, fish is a source of protein and they eat their catch. In the studies examined above (Burger, *et al.*, 1992; Burger *et al.*, 1993; May & Burger, 1996; Burger, 1998; Burger *et al.*, 1999a), from 70% (Arthur Kill) to 96% (Puerto Rico) of the people ate the fish they caught (Figure 3). Thus, although the benefits can be derived from catch-and-release, people are clearly eating the fish they catch, even though there are consumption advisories for many of these waters. Further, in these populations, frying fish was an important method of cooking: Savannah River, 88%; Jamaica Bay, 82%; Arthur Kill, 72%; Puerto Rico, 66%; Raritan Bay,

48%; and the New Jersey shore, 34% (Burger *et al.*, 1992; Burger *et al.*, 1993; May & Burger, 1996; Burger, 1998). Frying is a method of cooking that ensures maximum exposure to some contaminants, since the oils with contaminants are retained (Ebert, 1996).

The benefits of fishing are clear for the fishermen, but there are also secondary benefits for a wide range of businesses, such as fishing tackle stores, bait stores, boating stores and marinas. There are also tertiary benefits for an even wider range of businesses, including restaurants and hotels, tourist boutiques (particularly in small European fishing villages or along the Atlantic coast) and travel agencies (for fishermen who travel far for good fishing). Finally, there are a number of governmental bureaus that are involved with fishing and hunting activities. In short, there are many people who derive benefits from fishing, and who are directly hurt if the consumption advisories are really true, and are followed. Freshwater and saltwater recreational fisheries in 1991, for example, supported 924 600 jobs, provided $19.8 billion in earnings (all prices in US dollars), resulted in $24 billion in expenditures and contributed $1.1 billion in state sales taxes in the USA, $227 million in state income taxes and $2.1 billion in federal income taxes (Stedman & Hanson, 1997).

Costs of Fishing

In marked contrast, the only cost from eating fish from waters with advisories are the potential, uncertain, long-term health effects that might result from eating fish contaminated with PCBs, mercury, radionuclides or other contaminants. For example, people who consume self-caught fish from contaminated waters may have serum PCB levels up to 30 times greater than those who do not eat these fish (Humphrey, 1987). The major ill-health effects from fish consumption have been attributed to methylmercury and PCBs (Jacobson & Jacobson, 1996; Weiss & Elsner, 1996), which are the contaminants of concern for the studies depicted in Figures 2 and 3. For both methylmercury and PCBs, the primary population at risk are pregnant women and children. Effects of these contaminants on developing foetuses often involve neurobehavioural development and cognitive function (Jacobson & Jacobson, 1996; Schantz, 1996; Weiss & Elsner, 1996), and are therefore often difficult for women to observe in their children and relate to their own fish consumption many months or years before.

Aside from the fact that the benefits listed above are immediate and the costs appear to be delayed, the fisherman is usually faced with the fact that no one he (she) knows ever gets ill or dies from eating fish (Burger *et al.*, 1993). There is an imbalance not only in the number of people that gain or lose from eating potentially contaminated fish, but also in the timing of the damage, and this leads to a devaluation of the risk from fish consumption because the harm is not immediate.

Mixed Messages and Consumption Advisories

Jardine & Hrudey (1997) have suggested that many environmental risk decisions on the part of the public are based on differences either in the understanding or in the interpretation of many of the words or phrases used by risk communicators. They note that many people equate safety with zero risk, thus assuming that nothing is safe because there is no activity that has zero risk. In the case of

fishing and fish consumption, I suggest that fishermen may err in the opposite direction, equating 'limited risk' with 'no risk worth worrying about'. To avoid alarming the public unduly, some fishing advisories are written in sufficiently vague terms to allow the public to interpret them broadly, or to misunderstand the importance of the warning to some groups (such as pregnant women and young children). Although some misunderstandings occur with respect to the meaning of risk from fish consumption, these may be minor compared to the deamplification that occurs because of social considerations and governmental complicity.

Another arena of mixed messages occurs in places where there are different consumption advisories issued by two or more states that share a water resource. Here the policy makers have not achieved unanimity, making it difficult for the public to make environmental decisions. This has happened in the Great Lakes and in rivers whose borders are shared by two states (Cunningham *et al.*, 1994; Reinert *et al.*, 1991; Burger *et al.*, 1999a, b). In some cases, the limits for safe consumption differ, while in others, one state may issue a consumption advisory while the adjoining state does not. Since the risk assessment methodologies are often not transparent to the public (or to the risk assessors for that matter), it is difficult for the public to decide which to follow. In other cases, advisories may mention 'freshwater' or 'saltwater' fish, while the public may not be aware which fish are which (Burger & Gochfeld, 1996).

Economic Benefits

For all segments of society there are economic benefits from consuming self-caught fish, although these benefits may increase as annual family income decreases (Toth & Brown, 1997). Fishing costs can be very low, and may involve only a string and a hook, well within the budgets of even young children. In urban areas, such as the New York Harbor or Puerto Rico, people can catch a large number of crabs quickly with an old chicken bone tied to a string. Although most states require fishing licences, the costs of these licences are usually minimal for in-state residents. For most marine habitats, fishing licences are not required, and thus no licence costs are associated with fishing there.

The benefits of consuming self-caught fish are especially important for subsistence fishermen who may derive a substantial proportion of their protein from fish. Benefits are particularly great for local fishermen where there is a low cost to fishing (the resource is close by and does not involve travel costs). Economic benefits of consuming self-caught fish have long been recognized, and therefore will not be examined in detail here. The social benefits, however, have often been ignored.

Social and Cultural Discounting

There are powerful social and cultural aspects to fishing. Fishing is an enjoyable pastime, engaged in by a wide range of people. In different parts of the USA there are 'runs' of spawning fish that attract large numbers of fishermen of all ages, and these runs are often part of the local culture, forming the basis for festivals. These include smelt runs in Minnesota, shad runs in the east and salmon runs in the north-west.

In some parts of the USA people fish for 6 months or more a year (Burger *et*

al., 1997; Burger, 1998), and they fish in the same place for their entire lives (Burger *et al.*, 1999a). There may be, to some extent, an unconscious conspiracy among fishermen who want to believe that eating their catch is healthy, even when they consume large quantities of fish from waters posted with consumption advisories (see Figure 3). This social discounting is not an optimistic bias (Weinstein, 1989) but rather an overall optimism on the part of fishermen that the fish are indeed safe for everyone to eat. The data (Figure 3) show that the fishermen believe the fish are safe to eat despite the consumption advisories.

Fish and fishing are integral parts of some cultures, such as those of American Indians, and thus have even more import (Murphy & Murphy, 1960; Callicott, 1985; Cornell, 1994; Harris & Harper, 1998; Burger, 1999). Fishing is deeply rooted in these cultures, and extends from the past to the future. Exposure scenarios from fish should include not only consumption of the fish themselves, but other uses, such as use for medicinal and ceremonial purposes, making risk assessments from fish difficult (Callicott, 1985).

The social benefits of fishing are not only deeply rooted in American Indian culture, but also involve an important temporal element in many cultures. Compliance with fishing advisories is often negatively correlated with a tradition of fishing (Diana *et al.*, 1993). Books and magazines for children often deal with fishing, including *The Adventures of Tom Sawyer*, *The Adventures of Huckleberry Finn* and the *Hardy Boys* series. There are many films with a romantic or adventure theme that deal with fishing, such as *A River Runs Through It*. Even today, there are badges for fishing (or angling) in Boy Scouts. There is no badge for hazardous waste sites or risk assessment, and magazines do not encourage young adults to visit hazardous waste sites.

Conflicting Governmental Messages

While the EPA and state health departments (or environmental protection agencies) are issuing consumption advisories, other state agencies are promoting tourism and recreational activities within these same jurisdictions. The public, therefore, see conflicting policies. Often fishing and boating activities are illustrated in brochures for lakes with fishing advisories. Many states have bureaus or agencies that deal specifically with promoting fishing within the state.

I have watched local residents, as well as municipal and city employees, remove fish consumption warning signs only days after they were posted by state officials. Most municipal and city officials do not want residents or tourists to be afraid to come to their towns to fish, largely because it brings in activity and business. This discrepancy does not occur with hazardous waste sites: no other governmental agency is interested in increasing human use of these sites (at least in their present state).

I will provide one other example of governmental agencies giving out different messages. In 1996 there was an oil spill on the New Jersey beaches just before Memorial Day weekend (Burger, 1997b, c)—one of the biggest money makers for tourist businesses along the New Jersey shore. People come to the shore to fish, swim or just sunbathe. While local municipalities and the state government were anxious that the oil spill should be cleaned up along the beaches, they were more concerned that the travelling public should not be afraid to come to the shore over the long weekend. This led to some state officials making statements on television to the effect that the beaches were cleaned of oil, while the state

emergency response and contractor teams were out in full force in white protective suits, cleaning up beaches. Meanwhile, the agencies responsible for protecting fish and wildlife were busy documenting the damage to sensitive species. Children playing on the beaches had blotches of oil on their feet, and an oil odour was present. Fish caught from these waters would surely have contained some oil, and would have been tainted by an oil odour (Burger, 1997c). Local residents were aware of the beach clean-up, but people living farther from the shore received only television and radio messages stating that the beaches were clean. They arrived to find some tar balls still on the beaches, and an oil sheen on the waters.

The role of government has a direct, as well as an indirect, economic incentive. Most states issue fishing licences, and these licences are an important source of revenue for fish, game and wildlife departments. It is thus not in the best interest of these departments to discourage fishing within state waters. Advisories, on the other hand, are often issued by state health departments, rather than parks and recreation departments. At the local level, municipalities sell park or beach permits to fishermen, providing a source of local revenue.

Thus, I suggest that some governmental agencies within the same state often enable fishermen to discount the warnings and consumption advisories that are issued by another state agency. The apparent willingness of other state and local agencies to encourage fishing suggests to the public that 'it must really be all right'. This is a classic case of mixed messages in risk communication, wherein different messages are received from different sources, both at the same level (government agency versus government agency) and at different levels (agency versus friends, friends versus doctors). It is not merely that mixed messages are transmitted because of differences in the understanding or interpretation of words or terminology (after Jardine & Hrudey, 1997); different messages are given by different information sources. This aspect can be remedied only by closer collaboration between those responsible for human health and those responsible for resource management (Ebert, 1996).

Media Synergism

The role of government agencies in promoting fishing on the one hand, but warning of the adverse effects from consuming fish on the other, is abetted by the press. Stories and pictures abound of the pleasures derived from fishing with one's family in idyllic waters. Many newspapers feature regular fishing columns. Television coverage of fishing, in contrast to that provided about hazardous waste sites, is usually filled with attractive pictures and happy people.

Thus, there are three ways in which the media influences the public about risk and fishing: (1) information about fishing and fish; (2) information about contaminants in fish; and (3) information about the positive benefits of eating fish with respect to blood cholesterol. The role of the press in influencing perceptions about the environment and risk is well known (Sandman *et al.*, 1987), but bears remembering nonetheless.

Possible Solutions

As Kimbrough (1991) and others (e.g. Phillipson *et al.*, 1985) have noted, eating fish has health benefits, providing that the fish are not unduly contaminated.

Diets that contain high levels of fish oils probably contribute to lowered cardiovascular disease through reduced plasma cholesterol (Simonsen & Nordoy, 1989; Wahlqvist *et al.*, 1989).

Targeting Populations at Risk

Since fishing is such an enjoyable pastime and provides a beneficial source of protein, it may be unreasonable to post consumption advisories that are broad (with respect to the target population at risk, the fish species or the sizes and ages of fish). It seems much more reasonable to concentrate a risk communication strategy on the segments of the population that are most at risk (Velicer & Knuth, 1994), and to suggest that there are ways in which people can reduce their exposure to chemicals by selection of the fish species (low on the food chain), selection of the size (smaller and younger fish) (Bull *et al.*, 1981), selection of the part of the fish to consume (avoiding the skin, bones and fat) (Dellinger *et al.*, 1995) and selection of the cooking methods (avoiding frying or stewing) (Clarkson, 1990). Jacobson & Jacobson (1996) and others (e.g. Rogan & Gladen, 1991) have demonstrated that the developing human foetus is most at risk from contaminants in fish, and this risk message must be communicated clearly to the fishing public.

Catch and Release

Another method of reducing the risk from consuming fish, while not reducing the pleasure from fishing, is to encourage catch-and-release within regions where people are not engaged in subsistence fishing. Even where subsistence fishing predominates, risk can be reduced either by selection of the fish species or size or by selection of the cooking methods.

While the immediate solution may be to try and reduce the consumption of contaminated fish by populations at risk, the long-term solution is to reduce the level of contaminants in fish. Taking the longer, intergenerational viewpoint, risk reduction should involve reduction at the source. It is this solution that American Indians and others are proposing for highly contaminated sites (Harris & Harper, 1998; Burger, 1999).

Merely doing a 'better job' of informing the public (Reinert *et al.*, 1996) will not ameliorate the problem of compliance with fishing consumption advisories if we do not consider the social and cultural context of fishing and the deamplification of the risk message when managing the risk from consuming fish. There needs to be a greater emphasis placed on understanding community and cultural aspects of fishing and the risk from fish consumption (Hance *et al.*, 1989). Further, public health officials must consider the countervailing benefits of eating fish with the risks of fish consumption when issuing advisories, because the public surely will, in the absence of direct reference to these benefits. Telling most people to eat more fish to lower blood cholesterol clearly pits the words of doctors against those of public health officials who are warning about the risks of consuming contaminated fish.

Finally, the importance of fish as a source of protein for economically deprived individuals (Toth & Brown, 1997) must be taken into account in any management solution. Other sources of protein may need to be provided to low-income people. Thus, the problem of high fish consumption may not be just a problem of communication, but one created by poverty.

Co-management as a Possible Solution

I suggest that the failure of the present system for risk assessment and environmental management to prevent recreational or subsistence fishermen from consuming contaminated fish might be partially ameliorated by adopting co-management principles. Participatory management, or co-management, has largely evolved in resources that are difficult to manage, such as fisheries (Pinkerton, 1989). While society interacts with the environment through social institutions (Ostrom, 1995), the formation of the rules governing resources such as fisheries is a social process involving people who have different social power and different interests (McCay & Acheson, 1987). Scientists interested in managing fisheries have recognized the importance of bringing all parties to the table to participate in the making of the governing institutions, many of which involve shared cultural knowledge (McCay & Jentoft, 1996). Some of the governing mechanisms that allow institutions to function include rational communication, influence, prestige, authority and money (Habermas, 1987; Hackett *et al.*, 1994; Wilson & McCay, 1998).

While the rules and incentives that govern the management of resources, such as fisheries, are critical, the key is the participation of stakeholders in management. Stakeholder participation is commonplace in fisheries management in a wide variety of Western countries (McCay & Jentoft, 1996), although participation may often involve struggles between classes, ethnic groups, sectors of industry or commerce and governments (Baily, 1986; Barrett, 1991). Globalization provides additional problems of social justice and environmental quality for fisheries (Stonich *et al.*, 1997). While traditional fisheries management by government agencies was based on the 'tragedy of the commons' (Hardin, 1968), more recent work has centred on the range of common property regimes where ownership of the resource involves a variety of stakeholders (Feeny *et al.*, 1990; Burger & Gochfeld, 1998; Ostrom *et al.*, 1999).

I suggest that borrowing some of the governing principles from fisheries co-management provides a useful paradigm for moving forward with risk assessment of and risk communication about the hazards from consuming fish. The mechanisms for the development of co-management of fish stocks are equally applicable to risk assessment and risk management. Rational communication, influence, prestige, authority and money can all be used effectively to develop stakeholder-driven risk communication that may be more effective than communication driven only by scientists and regulators. While risk assessors have often noted that community concerns and involvement should be important aspects of risk management (Hance *et al.*, 1989), true co-management has not evolved, particularly for risk management of the hazards and risks from eating contaminated fish.

Compliance among recreational and subsistence fishermen might be higher if they were involved in risk assessment and management. However, the methods of compliance might differ between recreational and subsistence fishermen: recreational fishermen might increase the percentage of fish that they release, thereby reducing their intake, while subsistence fishermen might change the size or species of fish, or the method of cooking. For example, in a study of fishermen in the Newark Bay complex of New Jersey, Burger *et al.* (1999b) found that most people (85%) said they would stop eating locally caught fish if it increased their cancer risk, and 96% said they would encourage women in their households to

stop eating some species of fish if doing so increased the risk to babies. This information was elicited after the standard questionnaire about fishing advisories, and after they were told about the state public health advisories and potential risks from eating contaminated fish (*Morone saxatilis* and *Pomatomus saltatrix*) and crabs (*Callinectes sapidus*) from these waters.

Conclusions

With co-management, affected fishermen could provide information needed for all phases of the risk assessment and management plan, possibly contributing to better risk assessments, and they could contribute important social and cultural information to the management process. Moreover, the potential management of risk assessments and information about fish would benefit greatly from a more regional or local perspective, rather than taking place at a state or federal level. As with other aspects of fisheries management, fishermen would like to be involved *during* the policy-making process, not at the end (McCay & Jentoft, 1996). If fishermen, whether they are recreational, subsistence or commercial, feel that they have not been involved in the process of risk assessment, policy making and the issuing of consumption advisories, they will be less likely to comply. Regardless of the strength or value of consumption advisories, the effectiveness of the advisories will be compromised if fishermen do not comply. As with fisheries co-management (Jentoft & McCay, 1995; Sen & Nielson, 1996; Nielsen & Vedsmand, 1997), there will be greater incentives to comply if the fishermen themselves have been involved in the risk assessment and risk management (i.e. the issuing of consumption advisories) phases. While there is no 'resource', in the usual sense of the term, that needs managing, co-management would improve all aspects of the relationship between toxicological risk assessors, policy makers and the fish-consuming public.

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