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Fish Advisories: Useful or Difficult to Interpret?*

Joanna Burger & Michael Gochfeld**

Introduction

Organic pollutants such as methylmercury and organochlorines are widely distributed through aquatic food chains,¹ allowing for significant exposure to higher vertebrates, including humans. These compounds bioaccumulate readily and are bioamplified through the food chain. Species high on the food chain experience the greatest potential health risk because they consume organisms with the highest concentrations of pollutants. Exposure is particularly great for species that are long-lived because of a longer period for bioaccumulation. The dire consequences for humans of methylmercury exposure from fish first came to light in Minimata and Niigata, Japan in the 1950's.² Although exposure levels were extremely high in Japan, lower levels can also be hazardous. With increasing emphasis on cholesterol intake, fish has become an important source of protein. The recent increase in human consumption of fish and shellfish in the U.S. and elsewhere has

* We thank Helen May for conducting the surveys on the fisherman in a variety of habitats; this research would not have been possible without her help. T. Benson helped with data analysis. This project was partially funded by NIEHS grant ESO 5022 and the Environmental and Occupational Health Sciences Institute. Also, the authors were partially funded by the DOE under the Consortium for Risk Evaluation with Stakeholder Participation (CRESP) during analysis and writing. The overall protocol was approved by the Human Subjects Review Board of Rutgers University, New Brunswick.

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¹ Mark P. Brown et al., *Polychlorinated Biphenyls in the Hudson River*, 19 *Environ. Sci. Technol.* 656 (1985).

² World Health Organization, *Environmental Health Criteria: 1: Mercury* (1976).

resulted in widespread potential exposure.³ Fish may present a major exposure pathway for environmental toxins in urban populations.⁴

Although fish and shellfish may be contaminated by pathogenic organisms, synthetic chemicals and naturally-occurring toxins, they are nonetheless an important and useful source of protein, and benefits must be balanced against both real and perceived risks.⁵ Moreover, fish may be much less likely to contribute to chronic illnesses than the other sources of protein such as meat or poultry.⁶ Thus understanding the relative risks posed by different protein sources is an important part of risk evaluation by consumers. Further, in some cases, the toxic levels reported by scientists are often for entire fish, rather than portions usually consumed, but, in other cases, analysis of only fillets may be inadequate because people consume the entire fish.⁷

Many contaminated environments are being remediated, resulting in lower levels of pollutants in water and biota. Remediation especially applies to Superfund sites, Department of Energy sites and a variety of other contaminated sites. Consumption of fish and shellfish from these sites may increase with public perceptions of improving environments.

One method of risk reduction is to monitor pollutant levels in fish and shellfish stocks and issue advisories when appropriate. Two options are possible: agencies can issue bans prohibiting all fishing, or they can issue advisories concerning which species and sizes of fish to avoid. Advisories fill two different roles: They discourage fishing, and they discourage consumption of fish once caught — providing information that consumers can use to protect themselves.

Some states and the federal government have been quite aggressive in issuing warnings and advisories⁸ based on risk estimates. These

³ U.S. Environmental Protection Agency (EPA), *Assessing Human Health Risks from Chemically Contaminated Fish and Shellfish* (1989).

⁴ Thomas Belton, William Roundy & Neil Weinstein, *Urban Fisherman: Managing the Risks of Toxic Exposure*, 28 *Environ.* 19 (1986); E. Rifkin & J. LaKind, *Dioxin Bioaccumulations: Key to a Sound Risk Assessment Methodology*, 33 *Environ. Health* 103 (1991).

⁵ Renate D. Kimbrough, *Consumption of Fish: Benefits and Perceived Risk*, 33 *J. Toxicol. Environ. Health* 81 (1991).

⁶ L. J. Weddig, *Seafood Safety: An Industry Perspective* (EPA 1990).

⁷ Joanna Burger & Michael Gochfeld, *Fishing a Superfund Site: Dissonance and Risk Perception of Environmental Hazards by Fishermen in Puerto Rico*, 11 *Risk Anal.* 269 (1991).

require accurate estimates of fish consumption rates, itself a difficult task.⁹ Some studies of fish consumption rates have focused only on recreational anglers, while others have examined the general public.¹⁰ To design rational advisories with regard to safe consumption of different kinds of fish, the quantities consumed by different populations must be considered.

Often it is inappropriate for regulatory agencies to issue bans because they have insufficient personnel to enforce them,¹¹ scientific support may not be strong enough or the scientific data does not indicate a ban. Then agencies may rely on advisories, and their efficacy in turn depends upon the knowledge and good will of recreational and commercial harvesters as well as the knowledge of consumers. Exposure and risk can be reduced by the issuance of advisories, only if the public hears and internalizes the message and adheres to the guidelines.

Fish advisories can be issued a variety of ways, e.g., sign postings at fishing sites, television and radio, or newspapers and magazines. In some instances, information is issued directly by the regulatory agency. However, when information is transmitted via secondary sources, problems may occur. For example, health advisories for specific fish or shellfish species may be reported as warnings for all fish from a particular locale or habitat. When New Jersey issued recent warnings for particular species of fish, the news media usually referred to freshwater fish, rather than the species for which data on pollutants were available. For consumers and fishermen to adhere to advisories, they must know which fish are freshwater and which are saltwater. This may not be trivial if a significant proportion of the public cannot distinguish them. Moreover, Glowka¹² has noted that although "fish consumption scares" often affect sportfishing and fish stores along coastlines, the

⁸ Judith E. Foulke, *Mercury in Fish: Cause for Concern*, FDA Consumer 5 (1994).

⁹ E. S. Ebert, P. S. Price & R. E. Keenan, *Selection of Fish Consumption Estimates for Use in the Regulatory Process*, 4 *Expos. Asses. Environ. Epidem.* 372 (1994).

¹⁰ New York Dept. Environmental Conservation, *New York Statewide Anglers Survey* (1994).

¹¹ E. Horn, *Toxics in Seafood*, 3 *Tidal Exchange* 8 (1992).

¹² A. Glowka, *Toxics in Fish Products: A Practical Environmental Perspective*, (EPA 1990).

same fish products may be purchased with no hesitation at stores within 16 km of these same coasts.

Methods

As part of our ongoing studies of exposure, risk assessment and risk perception of fishermen, we explored the level of knowledge about fish among three groups of people: recreational fishermen, college students majoring in biology and university staff. We were also interested in the method of fish preparation and the level of fish consumption by the study groups. We expected that all people could correctly identify well-known or frequently-consumed fish such as shark or tuna, but that knowledge about freshwater fish would be less; that biology majors would be more knowledgeable than university staff; and that fishermen would be more knowledgeable than non-fishermen. Several health advisories and regulations (closed fishing or crabbing areas) in effect in New Jersey and adjacent states cover fish and shellfish of both freshwater and saltwater origin.¹³

To ascertain whether respondents could correctly interpret advisories, we sought to determine:

1. whether they could identify specific fish as freshwater, saltwater or both;
2. their level of consumption by fish type;
3. how many meals of fish or seafood they consumed each week, and how it was prepared; and
4. how often they fished.

Included were fish commonly found in New Jersey supermarkets or of interest to recreational fishermen. University staff and college students were also asked to react to a statement concerning fish consumption during pregnancy.

We collected information on 93 biology majors, 30 university staff and 311 fishermen in face to face interviews. In age, biology majors ranged from 18 to 25 (mean 21), university staff from 23 to 55 (mean 34), and fishermen from 11 to 83 (mean 46). Our sample for fishermen was larger to include those who fish from land, small private boats and large party-boats. Differences among fishermen are discussed elsewhere.¹⁴ We selected these three groups as representative of

¹³ See Horn, *supra* note 11.

¹⁴ Helen May and Joanna Burger, *Fishing in a Polluted Estuary*, Risk. Anal. (*in press*) 1995.

different levels of exposure and information about fish and compared them using Kruskal-Wallis Chi Square tests.¹⁵ Probability levels of $P < 0.05$ were considered significant. We tested the null hypothesis that there were no differences among groups in knowledge about the habitats of fish.

Results

Knowledge of Fish Habitats

Table 1
Knowledge about Habitat of Common Fish

<i>Species</i>	<i>Habitat^a</i>	<i>Percent Correct Responses</i>			χ^2 (<i>p</i>) ^b
		<i>Fishermen</i>	<i>Staff</i>	<i>Students</i>	
Shark	S	99	100	92	NS
Bluefish	S	99	86	59	0.006
Flounder	S	97	86	66	0.05
Tuna	S	97	96	80	NS
Swordfish	S	94	96	81	NS
Cod	S	94	86	54	0.003
Snapper	S	93	61	42	0.001
Trout	F	85	86	71	N
Halibut	S	80	68	48	0.02
Catfish	F	78	71	43	0.005
Carp	F	76	61	37	0.001
Pickrel	F	76	33	25	0.001
Haddock	S	75	57	26	0.001
Striped Bass	S/B	72	29	15	0.001
Hake	S	67	36	20	0.001
Tilefish	S	67	43	16	0.001
Sunfish	F	65	64	48	NS
Yellow-fined Tuna	S	65	29	15	0.001
Perch	F	64	43	38	0.02
Bass	F	47	75	60	0.04
Salmon	B	40	61	42	0.06
Tilapia	F	7	25	5	0.001

^a S, F, and B refer respectively to saltwater, freshwater and both.

^b In this and following tables, NS = not significant.

As seen in Table 1, knowledge of habitats was imperfect except for very common fish such as tuna or snapper. Ability to identify fresh or saltwater fish followed the order: fishermen > staff > students. For all,

¹⁵ See, e.g., Sidney Siegel, *Nonparametric Statistics for the Behavioral Sciences* (1956).

freshwater seemed less well-known than saltwater fish, and the habitat of a relatively new commercial fish (tilapia) was misidentified.

Fish Consumption

Table 2
Importance of Fish in Diet and Trophic Level of Fish.

<i>Species</i>	<i>Trophic Level</i>	<i>Consumption on 0-9 scale</i>		<i>Kruskal Wallis X²</i>
		<i>Staff</i>	<i>Students</i>	
Tuna	Carnivore	7.3 ± 0.7	7.5 ± 0.4	NS
Flounder		5.8 ± 0.7	5.0 ± 0.5	NS
Salmon	Carnivore	4.8 ± 0.8	4.6 ± 0.5	NS
Cod		4.1 ± 0.7	2.8 ± 0.5	NS
Trout	Insectivore	3.3 ± 0.7	2.0 ± 0.3	0.07
Swordfish	Carnivore	3.3 ± 0.7	1.9 ± 0.3	0.006
Bluefish	Carnivore	3.2 ± 0.8	1.8 ± 0.3	0.03
Halibut		2.5 ± 0.7	1.4 ± 0.4	0.01
Catfish	Detritivore	2.4 ± 0.6	1.6 ± 0.4	0.03
Snapper	Carnivore	2.2 ± 0.6	2.0 ± 0.4	NS
Shark	Carnivore	2.1 ± 0.6	1.3 ± 0.2	NS
Tilapia	Herbivore	2.2 ± 0.7	0.3 ± 0.1	<0.001
Haddock		1.9 ± 0.6	1.0 ± 0.3	0.04

Table 2 shows consumption relative to fish species on a scale of 0 to 9, with 9 being eaten very often. For the two university groups, it varied by species and group. As might be expected, tuna was most frequently eaten, followed by flounder, salmon and cod (Table 2). Surprisingly, tilapia, a relatively-new commercial fish, was consumed with some regularity, at least by staff.

As shown below in Table 3, all groups consumed fish about the same number of meals per week, but a higher proportion of fishermen's fish was fried compared to others. Students and staff fished an average of fewer than five times per year. Not surprisingly the fishermen fished much more frequently, even though they did not eat fish more often.

Respondents in the two university groups were also asked: "Suppose you or your spouse was pregnant and discovered you were exposed to a toxic." They were then given a series of statements and could respond positively to none or all. Table 4 shows remarkable similarity, although more staff than students said they would try to calculate whether they or their spouse had received a harmful dose.

Table 3
Fish Consumption and Fishing Frequency (Mean \pm SE)

	<i>Fishermen</i> ^a	<i>University Staff</i>	<i>Students</i>	X^2 (<i>p</i>) ^b
• Fish Consumption				
Mean number of fish meals per week	1.2 \pm 0.3	1.29 \pm 0.20	1.48 \pm 0.15	NS
Days since last fish meal	—	7.95 \pm 1.85	9.44 \pm 1.52	NS
Days since last other seafood meal	—	6.47 \pm 1.66	14.47 \pm 4.2	NS
Fish preparation (by percent)				
Fried:	51%	19%	19%	0.001
Tuna Sandwich	—	19%	48%	0.001
• Fishing Activities				
Frequency of fishing (%)				
Never	—	27.6	37.1	NS
Rarely	—	55.2	47.4	NS
Occasionally	—	10.3	8.3	NS
Often	—	6.9	7.2	NS
Times fishing in last year				
Freshwater	—	1.05 \pm 0.74	1.93 \pm 0.71	0.05
Saltwater	33.5 \pm 2.4 ^c	3.43 \pm 3.08	2.77 \pm 1.11	0.001

^a See May and Burger, 1995; also, all fished occasionally or often.

^b Comparison of University staff and students only.

^c Based on 5.6–8.8 times per month for summer months.

Table 4
Effect of Pregnancy on Response to Consuming Contaminated Fish

<i>N</i>	<i>University Staff</i> 39	<i>College Students</i> 98	X^2 (<i>p</i>)
<i>Response</i>			
<i>Percent Answering*</i>			
• Ignore notice	0	1	NS
• Hope, pray or cross fingers	24	22	NS
• Consult expert	93	88	NS
• Try to calculate whether dose was harmful	62	33	0.003
• Seek diagnostic procedures	72	61	NS
• Consider an abortion	45	26	0.02

* Respondents could select more than one response.

Discussion

Policy, Regulation and Risk

Risk of exposure to mercury, PCBs and other pollutants may be reduced by advisories and bans. As a matter of public policy, these depend on each individual's trust in authority and on voluntary compliance. Risk reduction occurs only if individuals adhere to advisories or bans regularly. If they do not, e.g., for lack of knowledge of the advisories, then mechanisms for reducing the risk to the public from consuming pollutants in fish are insufficient.

Permanent regulations, restrictions or outright bans on fishing at some locations are familiar to U.S. fishermen. They must have licenses, adhere to fishing seasons and follow size and catch limits. Fishermen are also accustomed to bans (closed areas or other legal restrictions) because of contamination. Non-fishermen, however, are not required to follow these regulations and indeed may be unaware of them.

Fishermen can also choose to ignore bans and closed areas even when they are posted.¹⁶ Thus they may choose to ignore bans on areas closed for short times or on favorite fishing areas the use of which is deeply entrenched. This is often true in Northern New Jersey and in other areas of the New York-New Jersey coast where families have fished or crabbed for many years.¹⁷ Under such circumstances, regulations have little effect unless rigorously enforced, and even so, consumption may not change.¹⁸ Moreover, fishermen may place a lower negative value on the risk from toxicants in fish compared with other risks or with perceived benefits — nutritional, economic or recreational.¹⁹ The general public, however, is generally less aware of

¹⁶ Ricard W. Stoffle et al., *Urban Sports Anglers and Lake Michigan Fishery Policies*, 10 *Coastal Zone Manage.* 407 (1983); Joanna Burger et al., *Exposure Assessment for Heavy Metal Ingestion from a Sport Fish in Puerto Rico: Estimating Risk for Local Fisherman*, 36 *J. Toxicol. Environ. Health.* 355 (1992). See also, Belton, Roundy & Weinstein and Rifkin & LaKind, *supra* note 4 and Burger & Gochfeld, *supra* note 7.

¹⁷ Joanna Burger, Kevin Staine & Michael Gochfeld, *Fishing in Contaminated Waters: Knowledge and Risk Perception of Hazards by Fishermen in New York City*, 39 *J. Toxicol. Environ. Health* 95 (1993).

¹⁸ Diane M. Samdahl & Robert Robertson, *Social Determinants of Environmental Concern: Specification and Test of the Model*, 21 *Environ. Behav.* 57 (1989). See also, Belton, Roundy & Weinstein and Rifkin & LaKind, *supra* note 4.

¹⁹ Michael Stewart Connor, *Comparison of the Carcinogenic Risks from Fish vs Groundwater Contamination by Organic Compounds*, 18 *Environ. Science Technol.*

fishing bans and advisories because they usually obtain their fish from the market. Current regulation fails to inform the general public about bans and advisories or risks of consuming store-bought fish. Perhaps relevant agencies, with media help, should make a concerted effort to educate the public not only about the existence of advisories, but also about factors that contribute to risk, including how and why toxic chemicals are in some fish but not others.

Knowledge and Risk

Fishermen, and non-fishermen alike, cannot respond appropriately to risks posed by contaminants in fish if information is inaccurate or inconsistent, or if their knowledge is inadequate. Consumers have little control over how the media choose to report information about health hazards. If warnings or advisories about specific species of fish are reported as applying to “freshwater fish,” then consumers must determine whether such warnings apply to the fish they normally buy in supermarkets or restaurants. Media advisories should always indicate the species and location. Supermarket labels provide various nutritional data including whether fish are farm-raised or previously frozen, but not whether they are freshwater. In any case, consumers must know whether the fish come from fresh or salt water before knowing the risk.

Further, without knowledge of whether a given fish species is a predator or merely eats vegetation, consumers may be unable to generalize about levels of pollutants in fish. This poses several problems:

1. Consumers cannot decide whether it would be prudent to consider a warning about a specific freshwater fish as applying to other freshwater fish from the same location.
2. Consumers cannot decide whether warnings about a specific fish from a given location should be generalized to all locations.
3. Consumers cannot decide whether warnings about specific fish from a given location should be generalized to all freshwater fish in all locations.

Clearly pollutants are not evenly distributed in all species — even those from the same lake, stream or estuary. Levels depend upon both uptake and accumulation. Uptake depends upon trophic level: species that eat other animals are exposed to higher levels of pollutants than plant-eating fish, and fish that eat larger animals are exposed to higher

levels than those that eat smaller animals. Moreover, accumulation depends to some extent on size (age): larger, carnivorous fish accumulate higher concentrations than smaller fish of the same species.²⁰ Toxins are likely to be lowest in small, fast-growing herbivores such as tilapia (commercial) and perch (recreational). Yet, this is often not known by consumers. The two university groups we examined did not preferentially select herbivores.

This study indicates that the general public can not clearly identify whether a number of commercial and recreational fish are freshwater or saltwater. Although fishermen are more knowledgeable than students or staff, they nonetheless cannot clearly classify all common species. Students are less knowledgeable than either fishermen or staff. The most commonly eaten fish (tuna) was correctly identified, but the next most commonly-eaten (flounder, salmon) were not always correctly identified as to habitat (at least by non-fishermen).

Risk and Pregnancy

University groups were given a scenario that involved their (or their spouse's) exposure to a pollutant while pregnant and asked to respond. A relatively high percentage (over 88% for both groups) stated they would consult an expert about the exposure, but far fewer indicated they would try to calculate whether they had received a harmful dose. Despite warnings about fish consumption and food safety, many would not try to calculate the risk to themselves (or spouses). This indicates to us that the message of examining our world in terms of environmental risks has not been generalized.

Risk and the Media

The results of this study clearly indicate that knowledge about the habitats of fish is not perfect, and is quite imperfect for a number of readily-available commercial and recreational fish. It should be noted that recreational fish are also available to consumers at small fishing stores along the coasts and at local docks and markets.

²⁰ See Burger et al., *supra* note 17.

Conclusions

One important method of managing risk to the public from eating contaminated fish is for the media to provide more ecological information so that the public can be aware of factors that contribute to increased toxic loads in fish in general. Such information would include increasing the public's understanding of the relative importance of size and age of the fish, trophic level of the fish, habitat of various commercial and recreational fish, and the fate of pollutants within fish (i.e. PCBs tend to be in the fat). In general, toxic loads are higher in fish that are carnivorous and in fish that are older or larger. Big carnivorous fish, such as tuna, shark and bluefish usually have the highest levels of pollutants such as mercury. Older (larger) fish have had longer to accumulate pollutants and thus should be avoided.

Risk can be reduced by eating smaller fish and avoiding the skin or fatty tissue. It can be reduced to almost zero by eating fish that feed on only vegetation. This message should be conveyed and reinforced to the public by the media throughout the U.S. It is particularly important for people in coastal areas and in recently-remediated places, such as Superfund, Department of Energy or other previously-contaminated sites. As such sites are perceived to be improving environmentally, the potential for exposure from consumption of fish and other wildlife increases, unless loads are monitored and the public is kept informed.



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