Mercury in Fish

A Global Health Hazard

zero Hg
mercury working group

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Mercury Policy Project

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* The **Zero Mercury Working group** is an international coalition of more than 75 public interest non-governmental organizations from around the world formed in 2005 by the European Environmental Bureau and the Mercury Policy Project/Ban Mercury Working Group. The aim of the group is to continually reduce emissions, demand and supply of mercury, from all sources we can control, with the goal of eliminating mercury in the environment at EU level and globally. Please see www.zeromercury.org

The Mercury Policy Project (MPP) works to promote policies to eliminate mercury uses, reduce the export and trafficking of mercury, and significantly reduce mercury exposures at the local, national, and international levels. We strive to work harmoniously with other groups and individuals who have similar goals and interests. Please see www.mercurypolicy.org

Mercury in Fish: A Global Health Hazard

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Executive Summary

Methylmercury contamination of fish and fish-eating mammals is a global public health concern. The risk is greatest for populations whose per capita fish consumption is high, and in areas where environmental pollution has elevated the average mercury content of fish. But methylmercury hazards also exist where per capita fish consumption and average mercury levels in fish are comparatively low. In cultures where fish-eating marine mammals such as whales and seals are part of the traditional diet, methylmercury in these animals adds to total dietary exposure.

This report presents new test data on mercury levels in fish from three areas of the world: The Indian state of West Bengal, the Manila metropolitan area in the Philippines, and six member countries of the European Union. We also review some published data on methylmercury levels in pilot whales and other marine mammals consumed by Arctic populations, in the Faroe Islands and among the Inuit of northern Canada. Using those data, fish consumption data, and some reasonable assumptions, we examine a variety of plausible exposure scenarios for each region, and compare the consumer exposure estimates thus generated with three established reference standards for acceptable methylmercury exposure.

Our comparisons show that reference levels of methylmercury exposure are exceeded, often by a wide margin, by consumers in each country and area covered in this report. The situation in India is most severe; in that case, average per capita fish intake is high and mercury levels in the locally available fish are often elevated (25 of 56 varieties tested contained more than 0.5 mg/kg mercury). This combination produces doses above accepted international exposure guidelines for the average consumer eating an average amount of the average fish available in most tested locations; even more excessive doses for those who eat above-average amounts of fish, or fish with higher-than-average mercury levels; and very high doses for children, who generally eat adult-sized food portions but whose body weight is smaller, and dosage therefore higher.

In the Philippines, where per capita fish consumption is also very high, and the six EU countries, where fish consumption varies among countries but is sometimes also high, there are two clear risk concerns. Adults and children who eat greater-than-average amounts of fish may get excessive methylmercury exposure even if the average mercury level in their fish is relatively modest; and people who prefer to eat predatory, mercury-accumulating species can easily be exposed to excessive methylmercury doses if they eat those fish often.

Consumption of pilot whale meat is a dominant and excessive source of methylmercury exposure for the Faroese, and mammals from high in the marine food web, especially beluga whale, can contribute substantially to methylmercury exposure among the Inuit.

We briefly review here a recent analysis of reported cases of clinical methylmercury poisoning in the United States, in patients who each ate relatively large amounts of high-mercury fish, such as tuna, swordfish, pike and sea bass. We conclude that similar health effects are likely to occur in each country covered by this report, at least among people with the greatest fish intake overall, and/or the strongest preferences for high-mercury fish varieties.

Even more important than clinically obvious methylmercury poisoning, and more likely to occur, is the risk of developmental neurotoxic effects in babies born to women who eat high-mercury fish, or eat large amounts of moderate-mercury fish, while pregnant. Subclinical but functionally significant neurotoxic effects may also occur in adults and children with methylmercury intake above reference levels, and research suggests that methylmercury exposure increases the risk of cardiovascular disease, as well.

The public health impacts of methylmercury in fish are therefore substantial, and demand an effective response from governments and other affected stakeholders. We present both general and specific recommendations regarding steps that should be taken to acquire better data, support improved risk assessments, choose risk management measures, and improve risk communication on methylmercury problems. Our recommendations apply both to the countries covered in this report and to other areas of the world, where the problem is equally in need of attention.

Background and Introduction

Methylmercury contamination of fish and marine mammals, and exposure of human populations who eat those organisms to methylmercury, has been a public health concern of governments all over the world since mass poisonings in Minamata and Niigata, Japan first called attention to this problem more than 50 years ago.[1] Scientists and health officials still have much to learn about the full dimensions of the problem, however, and about preventing harm from methylmercury. This report offers new information on the scope and significance of methylmercury exposure in six areas of the world, and reinforces the global nature of the challenges this contaminant poses.

The Japanese poisoning incidents of the 1950s resulted from severe industrial pollution of bays from which local populations took the fish they ate. Despite progress in controlling pollution in many countries and regions, mercury discharges into the environment from human activities are still causing harmful accumulation of methylmercury in fish, at least on a local scale. And over the past 20 years or so, research has begun to show that, under some circumstances, the ordinary amounts of mercury in some fish—for example, levels in predatory fish from the open seas, far away from pollution sources—can threaten the health of vulnerable populations.

Methylmercury poisons the nervous system. Health effects of primary concern include damage to babies' developing brains when pregnant women are exposed to methylmercury, with effects on intelligence, learning ability and behavior.[2] Adults and children exposed to excessive doses of methylmercury can also suffer from effects on memory, cognitive and sensory functions, and motor coordination,[3] and some research suggests that the risk of cardiovascular disease increases with methylmercury exposure.[4] In extreme cases, methylmercury poisoning can lead to paralysis, coma and death.

Human exposure to methylmercury comes almost exclusively from eating fish, and also in a few cultures, from eating marine mammals such as whales and seals that themselves eat fish. The risk of excessive exposure to methylmercury is therefore generally highest among populations with the greatest consumption of these foods. Animals from different levels of the food web contain different levels of mercury; predatory fish and mammals atop the food chain generally contain the highest levels. The specific types of fish or marine mammals consumed by a population, or individuals in a population, are also therefore factors in the risk of methylmercury exposure.

Methylmercury exposure has been the subject of extensive risk management efforts by national governments and intergovernmental bodies such as the World Health Organization (WHO). The WHO has established upper limits for tolerable weekly exposure to methylmercury (discussed in a later section), and provides advice to member governments on risk-mitigation measures. The Codex Alimentarius Commission (Codex), a United Nations food safety body, has adopted guidelines on acceptable mercury levels in fish caught commercially around the world, and offers risk-management and risk-communication advice to governments.

Many national governments also have set limits on acceptable mercury concentrations in fish (See **Appendix A**). For its report, the Codex working group on methylmercury assembled test data on mercury in fish of different types that had been collected by the governments of the EU, the US, Canada Japan, and several other countries.[5] Some national databases on mercury levels in fish are available on the internet.[6]

The Codex mercury limits, which are typical of those adopted by many countries, specify 1.0 mg/kg (one milligram per kilogram) as the maximum acceptable methylmercury level in large, predatory fish (See **Appendix E**), and 0.5 mg/kg as the limit for all other fish. These limits are not enforceable regulations, but rather are guidelines; when populations are eating fish with mercury levels near or above these guidelines, health concern is justified.

The risk posed by methylmercury exposure depends on the *dose* of methylmercury that a person consumes (usually expressed in µg/kg/week, or micrograms of methylmercury per kilogram of body weight per week). The dose one gets depends on both the mercury levels in fish and the amounts of various fish consumed. The more fish a population or an individual eats, the lower the average level of methylmercury in those fish that can result in excessive exposure. Indeed, as we will see in later sections, even methylmercury levels below 0.5 mg/kg are not adequately safe for people whose diet is rich in fish.

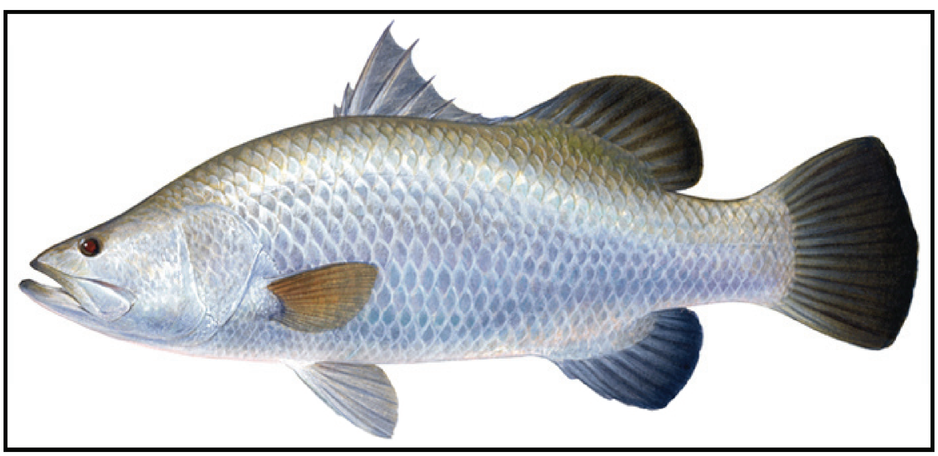
This report presents new data on mercury levels in fish, collected by members of our coalition in six European countries; in the state of West Bengal, India; and in Manila, the Philippines. We also review recent evidence on methylmercury levels in marine mammals included in the diets of two northern populations, the Inuit of Northern Canada and Greenland, and the people of the Faroe Islands. In assessing health implications of these data, we examine cases of methylmercury poisoning among individuals with unusually high intake of high-mercury fish in the United States, and compare exposure levels in those US cases with estimated exposures of populations consuming the fish and mammals on which data are presented here.

New Data on Mercury in Fish

India

Toxics Link, of New Delhi, and DISHA, a Kolkata-based NGO, surveyed mercury levels in fish in the Indian state of West Bengal.[7] They purchased two samples each of six widely consumed fish varieties at five different fish markets in Kolkata, for a total of 60 samples. They also bought fish caught at different sites across the state, collecting an additional 204 samples, which included 56 varieties of locally-harvested fish. Samples were identified as to species and tested for mercury. The results are presented in **Appendix C** and summarized in **Table 1**.

The six fish varieties from Kolkata markets varied in average mercury content. Two types, Bhetki (scientific name *Lates calcarifer*, English name barramundi, a type of sea bass, pictured below), and Aar (*Sperata aor*, long-whiskered catfish) each had an average mercury level of 0.479 mg/kg, while the other four fish sampled contained from 0.280 to 0.384 mg/kg. The overall average across all five fish types and six markets sampled was 0.384 mg/kg.



Fish purchased at the various sites around West Bengal had a higher overall average mercury content, 0.458 mg/kg. Eight of the 56 different fish species tested had average mercury levels above 1.0 mg/kg, while 25 exceeded 0.50 mg/kg, though these averages were often based on just two samples from a single site. Sitapati (*Trichurus sp.*, a type of ribbonfish), averaged 2.355 mg/kg mercury, in two samples. Several fish types tested at more than one location also had relatively low levels of mercury, below 0.20 mg/kg.

The most striking aspect of the results was the very marked difference in average mercury levels in fish of all types taken from different locations. Fish bought in Jharkhali contained on average 1.452 mg/kg of mercury, and 100 percent of the 16 samples (all eight species) from that location exceeded 0.50 mg/kg. Fish from three other locations had average mercury levels of 0.563 to 0.711 mg/kg. The highest average mercury levels were generally found in fish bought in coastal and estuarine areas.

TABLE 1. Mercury Levels in Fish From West Bengal, India

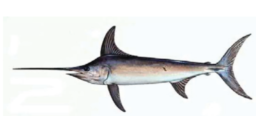
Fish from Markets in Kolkata	No. of Samples	Mean Hg, mg/kg	Range, mg/kg
Fish name			
Rui (Rohu)	10	0.384	<0.20-0.59
Katla (Catla)	10	0.280	<0.20-0.59
Aar (Long-whiskered catfish)	10	0.479	<0.20-1.12
Bhetki (Barramundi)	10	0.479	<0.20-1.27
Tangra (a catfish)	10	0.367	0.20-0.85
Bagda (Tiger prawn)	10	0.317	<0.20-0.57
Averages for Sites in West Bengal	Species Tested	Mean Hg, mg/kg	Range, mg/kg
Place name			
Hugli	8	0.386	0.20-0.55
Budgebudge	9	0.563	0.20-1.03
Jharkhali	8	1.452	0.73-2.66
Haldia	6	0.335	<0.20-0.83
Digha	10	0.577	<0.20-1.99
East Kolkata	3	0.432	0.28-0.76
Kakdwip	8	0.711	0.36-1.09
Mudiali	9	0.241	<0.20-0.64
Farakka	10	0.455	0.20-1.25
North Bengal	12	0.152	<0.20-0.92
Kolaghat	7	0.209	<0.20-0.60
Durgapur	5	0.169	<0.20-0.25
Combined Totals:	56*	0.458	<0.20-2.66

* Some species were purchased at more than one location

In contrast, fish from four locations, two in rural North Bengal and two inland sites, each had average mercury levels close to or below 0.20 mg/kg. The amount of mercury consumers in West Bengal get with their fish thus seems to depend quite heavily on where the fish are caught. It was beyond the scope of the study to determine precisely what might account for the differing levels of mercury contamination, but analysis of the size/age and position in the food chain of the tested fish suggested that these factors alone could not explain differences in mercury content; other, site-specific factors (such as pollution sources) appear to be involved.

The data reported in Table 1 and elsewhere in this report usually reflect total mercury (inorganic plus methylmercury). In most fish, 90 to 100 percent of the mercury present is methylmercury, and the two are often treated as equivalent. Nevertheless, when we present data as total mercury, it should be kept in mind that the associated methylmercury levels may be slightly lower.

The researchers also conducted a survey of 43 families in Kolkata, asking how much fish households consumed. The results ranged from 250 to 1500 grams per person per week; using a conversion factor of 0.75 to estimate the edible portion of fish purchased, the investigators concluded that typical fish consumption among residents of West Bengal averages about 500 g per person per week, and that at least one person in four eats 750 g/week or more of fish. The combination of this high level of fish consumption with the comparatively high mercury levels detected in fish from Kolkata markets and many locations in West Bengal raises substantial health concerns (see later discussion.)



The Philippines

Ban Toxics!, based in Manila, collected 10 samples of five fish varieties from a single large fresh fish market in Cubao, Quezon City, a major source of fresh fish for the Manila metropolitan area, which sells fish caught in many other parts of the country. Samples were chosen in part based on where they were caught, and came from five different locations. The samples were analyzed for mercury; the results appear in **Appendix D**, and are summarized in **Table 2**.

TABLE 2. Mercury Levels in Fish From Manila, The Philippines

Fish	No. of Samples	Mean Hg, mg/kg
Bluefin Tuna	2	0.13
Swordfish	2	0.92
Mackerel	2	0.16
Shark	2	2.30
Blue Marlin	2	1.26
All Types	10	0.953

The average level in all 10 fish was 0.953 mg/kg; four samples (one swordfish, one marlin, two shark) exceeded the 1.0 mg/kg guideline. Shark had the highest level; marlin and swordfish were also high, while mackerel and bluefin tuna had lower levels. These results are consistent with published data on four of the species; the bluefin tuna results are unexpectedly low, and might reflect the age or size of the individual fish tested, more than the species as a whole.

Europe

For this report, the European Environmental Bureau bought samples of swordfish, shark, fresh and canned tuna, and pike in Germany, Italy, Belgium, France, Spain and the Czech Republic, and tested them for mercury content. Fish varieties chosen were those known to be relatively high in mercury. Results appear in **Appendix B** and are summarized in **Table 3** here.

As shown in the table, swordfish had the highest average mercury level, 0.643 mg/kg; two of the ten samples exceeded 1.0 mg/kg. Shark, frozen and smoked, averaged 0.56 mg/kg, and one of the 5 samples had exactly 1.0 mg/kg. Tuna, canned and fresh, averaged 0.311 mg/kg, with the highest sample, a fresh red tuna from Belgium, at 0.66 mg/kg. Two samples of pike from the Czech Republic averaged 0.44 mg/kg mercury. These results are consistent with data reported by other surveys; in fact, some government data suggest that these fish varieties often contain even more mercury than was evident in this relatively small sampling.

These tests confirm that European consumers who eat these fish are exposed to methylmercury at significant levels, especially if they eat these fish repeatedly. Sampling was too limited to look for differences among the countries, and fish types tested also varied somewhat from country to country. But this survey affirms that high- and moderately high-mercury fish, including some that exceed safety-based guidelines, are available throughout the EU.

TABLE 3: Mercury Levels in Fish From the European Union

Fish Variety	No. of Samples	Mean Hg, mg/kg	Where Purchased
Swordfish (fresh)	10	0.643	Germany, Spain, Italy, Belgium, France
Shark (frozen, smoked)	5	0.560	Germany, Czech Republic
Tuna (fresh & canned)	9	0.311	Germany, Spain, Italy, Belgium, France
Pike (frozen)	2	0.440	Czech Republic
All Fish Combined	26	0.497	Six countries

Arctic Populations: Methylmercury in Marine Mammals

Faroe Islands

The Faroe Islands, an autonomous province of Denmark located in the North Atlantic about halfway between Greenland and Norway, have been the site of a major research project to assess the health effects of methylmercury exposure (see next section). In addition to consuming a diet rich in fish, people of the Faroes have traditionally hunted and eaten pilot whales. As fish-eating predators, these whales accumulate high levels of methylmercury in their tissues. Published data on those mercury levels[8] are summarized in **Table 4**.

The average level in pilot whale meat is about 2 mg/kg—higher than in most fish. Far higher levels are found in the pilot whale liver; however, while most of the mercury in muscle meat is methylmercury, the mercury in the liver is largely in inorganic form, possibly because the liver de-methylates mercury as a detoxification measure.[9]

TABLE 4: Mercury Levels in Pilot Whales, Faroe Islands

Tissue/Organ	Mean Hg, mg/kg	Reference
Muscle	2.30	Caurant et al., 1996
	1.89	Dam and Bloch, 2000
Liver	124	Caurant et al., 1996
Kidney	6.16	Caurant et al., 1996

The Inuit Regions

Inuit live in the Arctic regions of Northeast Russia (Chukotka), Alaska, Canada, and Greenland. Their diverse diet, which varies by region, traditionally includes fish and marine mammals such as whales, seals and walrus.

Inuit generally consume all parts of the animals they hunt, including muscle, organ meats and muktuk (skin and blubber).[10] Recent data on mercury levels in those mammals, collected under the Northern Contaminants Program (NCP) of the Department of Indian and Northern Affairs, Canada,[11] are summarized in **Table 5**.

As the table shows, methylmercury levels in beluga whale meat are similar to those in predatory fish like swordfish, but lower than those in pilot whale, seen in Table 4. Seal meat contains less mercury; most of the total mercury in seal muscle is methylmercury, while most of what is in the liver is the less toxic inorganic mercury.[12]

The Inuit diet also includes fish. While fish from inland waters are sometimes contaminated with methylmercury, sea run char, a dietary staple, tend to have low mercury levels, and provide the Inuit with a less contaminated source of protein.[13]

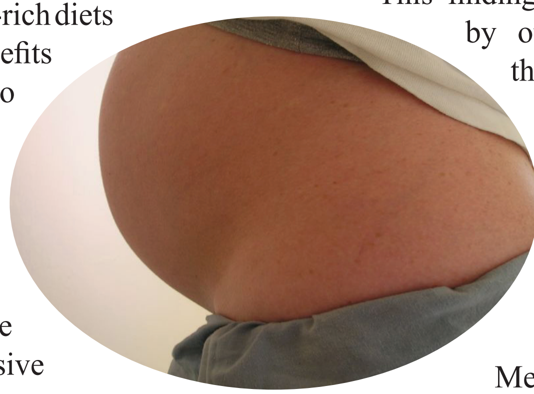
TABLE 5: Methylmercury Levels in Mammals Eaten by the Inuit				
Animal	Tissue	Total Hg, mg/kg	MeHg, mg/kg	Reference
Ringed Seal	Muscle	0.277		AMAP 2002
	Liver	6.640		
Beluga Whale	Muscle		1.030	NCP 06/07
	Muktuk		0.535	Synopsis Report
	Liver		1.048	

Consumer Exposure and Health Risks

Fish in general is a healthy, nutritious and usually a comparatively ecologically sound dietary choice.[14] Fish provides essential nutrients for nervous system development, and diets rich in fish have been associated with reduced risk of death from heart attack and stroke.[15] Many national governments and expert health authorities promote fish consumption for these reasons.

Health Hazards

Unfortunately, the same fish-rich diets that confer nutritional benefits also pose a risk of exposure to methylmercury. In general, the greater the individual's fish consumption, and the larger a role fish and seafood play in a population's diet, the greater the risk of excessive methylmercury ingestion.



When a pregnant woman is exposed to methylmercury during gestation, the mercury can disrupt development of the baby's brain, damaging learning ability, cognitive processes, and other brain functions.[16] The question of what level of exposure to methylmercury is safe for a mother-to-be has received a great deal of attention; see the discussion of "reference levels," below. Despite the adoption of such levels, this question is still far from settled, scientifically. A recent study in the US examined cognitive functions in children at the ages of 6 months and 3 years and found statistically significant beneficial effects and harmful effects in the same population, associated with a fish consumption rate of as little as two meals (about 200 grams) per week.[17] This finding, which needs confirmation by other investigators, suggests that there is no threshold for effects of methylmercury on brain development, and that even modest levels of fish consumption can have both positive and harmful effects on this vital process.

Methylmercury also poses a risk of neurotoxic effects in adults and children who eat a great deal of fish, and whose fish contain sufficient mercury to provide a toxic dose. Such effects (as well as effects of prenatal exposure) were observed in Minamata and other historical poisoning incidents and have occasionally been noted in the medical literature; an analysis of recent cases in the United States is described in a later section here.

The expert community seems to agree that the risk of general neurotoxicity from methylmercury exposure is associated with higher doses than those that can harm the fetus, perhaps doses twice as high (see below). This generalization is subject to an important caveat: Individual people vary widely in sensitivity to toxic effects, and in any large population, some people may experience adverse effects at doses far below those required to cause toxicity in the average person.

Reference Levels for Acceptable Exposure

In 2000, the WHO adopted a Provisional Tolerable Weekly Intake (PTWI) for methylmercury, defining the maximum acceptable dose as 3.3 micrograms per kilogram of body weight (3.3 µg/kg).[18] This limit was applied to the general population, i.e., it is a definition of safe exposure with respect to general neurotoxic effects. In 2003, WHO adopted a revised PTWI of 1.6 µg/kg, to define maximum safe prenatal exposure.[19] Some national governments have also set maximum safe exposure limits for methylmercury; the best known of these was adopted in 2000 by the US Environmental Protection Agency (EPA). Called a Reference Dose (RfD), the US EPA limit is 0.1 µg/kg/day (or 0.7 µg/kg/week). The primary objective of the EPA RfD is to protect the fetus, but the agency also considers it appropriate for the general population.[20]

The existence of different reference levels spanning a range of nearly 5-fold to define maximum acceptable exposure to methylmercury is somewhat confusing. It reflects the uncertainties in the scientific evidence on methylmercury's health hazards, and the consequent role played by expert judgment in recommending the limits. Regardless of the differences among them, these three reference levels are widely recognized as based on good science, and are accepted internationally as describing upper limits of safe exposure to methylmercury. They provide sensible reference points for comparisons to assess the degree of possible risk associated with any particular population's mercury exposure.

Exposure Scenarios for Cases Reviewed Here

Do the mercury levels in fish and marine mammals described earlier in this report represent significant hazards to public health? One way to explore that question is to determine whether individuals or groups of people consuming those foods would get methylmercury doses that exceed one or more of the reference levels just described.

The dose of methylmercury to which a person or population is exposed depends on three factors: The methylmercury *concentration* in the fish or mammals consumed; the *amounts* of fish or mammals consumed; and the *body* *weight* of the consumer. These factors can combine in various ways to create excessive exposure.

For example, someone who eats a food with a high mercury level, such as swordfish or pilot whale meat, can get an excessive mercury dose by eating relatively modest amounts of those foods. On the other hand, among populations with a high rate of fish consumption, such as the people of West Bengal, a relatively low average level of mercury in the fish they consume can still result in excessive exposure. And people with smaller body weights—children, and many adults in Asian societies—get a larger mercury dose from the same meal than would a person with a greater body mass.

In **Table 6**, below, we have created scenarios describing a variety of exposure situations in each country or region covered by this report, using data presented above for methylmercury levels in foods, and some appropriate assumptions about food intake and body weight. Methylmercury doses to which people would be exposed in each scenario were calculated, then compared to the three reference levels. The right-hand columns of the table show the ratios of each scenario's consumer exposure compared to the three reference levels. A number greater than 1.0 in these columns means the indicated standard is exceeded; a number of 4.50 in the column for the WHO Prenatal PTWI, for example, means consumer exposure in that scenario exceeds that reference level by 4.5-fold. Numbers less than 1.0 indicate that the scenario's consumer exposure is within the indicated reference guideline.

The table includes just a few of myriad possible exposure scenarios, particularly for the Indian situation, in which the data in Appendix C show large differences in the average mercury content of fish at a dozen different locations in West Bengal. Scenarios were chosen to span the range of possible exposures, but are not all-inclusive. The assumptions used in each case are explained in our exposure analysis for each country, below.

The overall conclusion of this analysis is that consumers in all geographic areas covered by this report are likely to exceed some or all of the reference levels for methylmercury exposure under many circumstances. The US EPA RfD, the strictest of the three reference levels, is exceeded in 100% of these scenarios. The WHO PTWI for prenatal exposure is exceeded in 26 of the 28 scenarios, and the WHO PTWI for general exposure, the least stringent of the three, is also clearly exceeded in 22 of the 28 scenarios examined here.

TABLE 6: Comparison of Various Exposure Scenarios With Reference Levels

Country and Food	Amount Eaten per week	Mercury, mg/kg	Consumer & body wt	Consumer dose/wk, µg/kg	Ratio, Consumer Dose to Ref Levels: WHO PTWI, General	WHO PTWI, Prenatal	US EPA RfD
India							
Kolkata, Bhetki	500 g	0.479	50 kg adult	4.79	1.45	2.99	6.84
Kolkata, Catla	500 g	0.280	50 kg adult	2.80	0.84	1.75	4.00
Kolkata, all fish	500 g	0.384	25 kg child	7.68	2.33	4.80	11.0
Jharkhali, all fish	500 g	1.452	50 kg adult	14.5	4.40	9.08	20.7
Jharkhali, all fish	500 g	1.452	25 kg child	29.0	8.80	18.2	41.5
Kakdwip, all fish	500 g	0.711	50 kg adult	7.11	2.15	4.44	10.2
North Bengal, all fish	500 g	0.152	50 kg adult	1.52	0.46	0.95	2.17
North Bengal, all fish	500 g	0.152	25 kg child	3.04	0.92	1.90	4.34
All Fish, average	500 g	0.458	25 kg child	9.16	2.78	5.72	13.1
All fish, average	750 g	0.458	50 kg adult	6.87	2.08	4.29	9.81
Philippines							
Shark	500 g	2.300	50 kg adult	23.0	6.97	14.4	32.9
Blue Marlin	500 g	1.260	50 kg adult	12.6	3.82	7.88	18.0
All Fish, average	500 g	0.953	50 kg adult	9.53	2.89	5.96	13.6
All Fish, average	500g	0.953	25 kg child	19.1	5.78	11.9	27.2
Faroe Islands							
Pilot Whale muscle	100 g	2.000	60 kg adult	3.33	1.01	2.08	4.76
Pilot Whale muscle	100 g	2.000	25 kg child	6.67	2.02	4.17	9.53
Inuit Region, Canada							
Seal muscle	300 g	0.277	60 kg adult	1.39	0.42	0.87	1.99
Seal muscle	300 g	0.277	25 kg child	3.32	1.01	2.08	4.74
Seal liver	300 g	6.640	60 kg adult	32.2	9.76	20.1	46.0
Beluga Whale muscle	300 g	1.030	60 kg adult	5.15	1.56	3.22	7.36
Beluga Whale muscle	300 g	1.030	25 kg child	12.4	3.76	7.75	17.7
European Union							
Swordfish	500 g	0.643	60 kg adult	5.36	1.62	3.35	7.66
Tuna	750 g	0.311	60 kg adult	3.89	1.18	2.43	5.56
Tuna	350 g	0.311	25 kg child	4.35	1.32	2.72	6.21
United States							
Swordfish	500 g	0.976	60 kg adult	8.13	2.46	5.08	11.6
Fresh Tuna	750 g	0.383	60 kg adult	4.78	1.45	2.99	6.83
Canned Albacore Tuna	750 g	0.353	25 kg child	10.6	3.21	6.62	15.1
Chilean Sea Bass	450 g	0.700	70 kg adult	4.50	1.36	2.81	6.43

A basic question is, how many consumers in each country will have exposures represented by the various scenarios? We assess that issue below. Methylmercury in fish and marine mammals appears to pose significant public health hazards in each country and culture examined here. There are, however, important differences in the risk scenarios from the different countries, which have critical risk-management implications in each case. It is therefore worth examining the different risk scenarios in some detail.

INDIA: The people of West Bengal eat a great deal of fish, and based on the test data presented here, most of the fish available in their local markets contain significant levels of methylmercury. These factors combine to produce generally high exposure. All the reference levels are exceeded, often by wide margins, in the majority of Indian exposure scenarios shown in Table 6.

The assumptions used to calculate these exposures are not "worst case" choices. In all but one scenario, we used weekly fish consumption of 500 g, slightly below the median intake shown by the survey of Kolkata households. Our final Indian scenario used an intake of 750 g/week, which represents the 90th percentile intake in that survey. Some West Bengali consumers undoubtedly eat twice or even three times as much fish as the average intake we used in Table 6. Children older than 5 years consume adult-sized portions, according to the survey. Regarding mercury levels in fish, we assumed that people buy a variety of the fish available where they live, and used the average mercury content across all the species tested at each site. It is primarily differences in average mercury levels in fish from different locations that account for most of the differences in calculated exposure.

Overall, our Indian exposure scenarios show that a large majority of consumers in most parts of West Bengal exceed the WHO PTWI for prenatal exposure, because of their high-fish diet and the mercury levels present in the fish they eat. The degree to which this limit is exceeded ranges from slight—a factor of 1.75—to severe, a factor of 9 for an adult, at the site with the highest average mercury levels in fish, Jharkhali. A child eating fish from Jharkhali would exceed the WHO PTWI for general exposure by 8.8 times, and a typical adult's intake exceeds that reference level in half of the locations modeled. Consumers with above-average fish intake, generally not shown in our examples, would exceed safety limits by even wider margins, as could those who had a preference for fish varieties with higher-than-average mercury content, and children with smaller body weights.

THE PHILIPPINES: The people of the Philippines also have a high average rate of fish consumption, estimated at 31 kg per capita per year, or about 600 g per week, on average.[21] Our assumption that a consumer might eat 500 g of the high-mercury tested species in a week is thus slightly below average in terms of typical total fish intake, but seems likely to be far above average in terms of likely consumption of these particular fish varieties.

The fish sold and eaten in the greatest quantities in the Philippines include sardines, roundscad, various types of tuna, mackerel, squid, and anchovies, among others. Based on data from other countries, several of these fish have relatively low mercury levels,[22] while data are unavailable for others. But the high-mercury, predatory species we tested appear to be eaten in smaller total volumes than many other types of fish available there. They are more expensive and thus more likely to be sold in restaurants, or eaten by upscale customers occasionally. They may also be consumed by people in the coastal regions where the fish varieties are caught.[23]

The exposure scenarios for the Philippines shown in Table 6 therefore do not represent average consumers from different areas, as the Indian cases did, but rather relatively unusual consumers, people who either live in the coastal areas or have a personal liking for swordfish, shark, and larger game fish, such as blue marlin, and who eat these fish, singly or in combination, repeatedly. Such individuals may be rare, but even rare scenarios can occur in large numbers among the Philippines' 85 million people. These scenarios suggest that the mercury levels in these fish varieties pose a potential health hazard for Philippine consumers who eat them regularly.

ARCTIC POPULATIONS: The exposure scenarios in Table 6 show the impact for an adult and a child in the Faroe Islands of eating one modest portion of pilot whale muscle in a week, which is probably about an average intake nowadays.[24] The resulting dose of methylmercury still exceeds all safety standards, often by wide margins. Because of the traditional importance of whale meat in their diet, however, some Faroese may eat pilot whale more often than our scenarios suggest (or their health officials advise).[25] A recent study linking methylmercury exposure to the risk of heart disease used Faroese whalers as subjects, and reported that 63 percent of the studied group ate whale meat three or more times per month.[26]

However often it is consumed, pilot whale meat is an intense source of methylmercury exposure for the Faroese. Eating it even occasionally seems likely to exceed safe exposure guidelines; a 60-kg woman, for example, who ate just 21 grams of pilot whale muscle with average mercury content of 2.0 mg/kg per week would exceed the US EPA RfD, and eating 48 grams (half a normal portion) would make her exceed the WHO PTWI for prenatal exposure. Pilot whale meat clearly poses a risk of excessive methylmercury intake for anyone whose diet includes it.

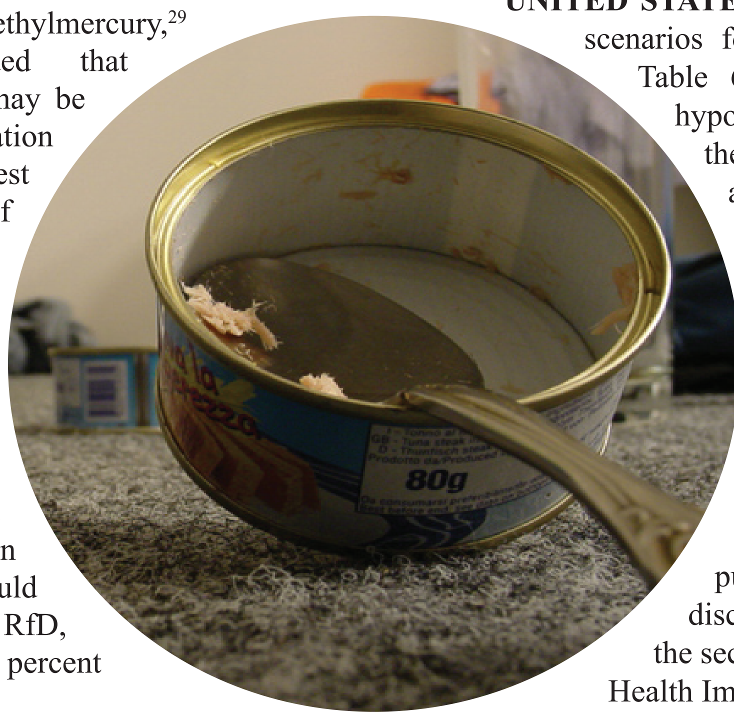
Some trend data suggest that methylmercury exposure among the Inuit has been declining; ironically, the reason for this decline is apparently replacement of the traditional diet with far less nutritious processed foods.[27] The Inuit scenarios in Table 6, based on recent test data for mercury in mammals that are part of the traditional diet, suggest that following that diet can still lead to unacceptably large doses of methylmercury, especially from whale meat.

The largest excess above reference levels shown in the Inuit scenarios involves eating seal liver; as noted, most of the mercury there is in the inorganic, less toxic form. Therefore, the excesses over reference standards associated with eating liver may be

somewhat misleading. It is likely, however, that regular consumption of seal muscle and fat could exceed the standards, if by smaller margins than is the case with beluga.

EUROPE: Fish is an important part of the diet in most European countries, with wide variations in the amounts and types of fish consumed in different regions and countries. The European Food Safety Agency (EFSA) has published a food consumption database that includes fish intake estimates for adults in 16 EU countries, based on a 2006 survey.[28] Average intake of fish ranges from 63 grams/week in Hungary and Slovakia to 441 grams/week in Norway, while consumers at the 95th percentile range from 385 to 2,968 grams/week. In the six countries where fish were purchased for this report, average weekly fish consumption ranges from 133 grams in Germany and the Czech Republic to 300 grams in Italy (data unavailable for Spain); 95th percentile intakes in those same countries range from 400 (Germany) to 1,225 (Belgium and the Czech Republic) grams per week.

EFSA has also carried out a risk assessment for methylmercury,[29] which concluded that young children may be the sub-population at the greatest risk. In terms of consumption per unit of body weight, children 3 to 6 years old eat more fish than adults. EFSA estimated that 44 percent of EU children in this age range would exceed the EPA RfD, compared with 17 percent of adults.[30]



For our scenarios in Table 6, we have chosen some fairly uncommon fish consumers: An adult who likes swordfish and eats two or three medium to large portions in a week; an adult who eats tuna steaks, tuna sushi or canned tuna practically every day; and a child who loves tuna fish sandwiches and eats one daily. These consumers are likely to be in the upper 10 percent or so in terms of overall fish consumption, near the high end of the distribution but not extreme worst cases. They are also unusual in that they repeatedly eat the large, predatory fish species that have comparatively high mercury levels.

The mercury levels in most varieties of fish sold in Europe are low, and eating several fish meals per week is unlikely to pose much risk to the average consumer. However, it is precisely the "non-average" fish consumers—those who eat above-average amounts of fish and choose high-mercury fish varieties repeatedly—who are at risk for excessive methylmercury exposure, in the EU, as was true in the Philippines, and is the case elsewhere.

UNITED STATES: The four exposure scenarios for the US shown in Table 6 are not based on hypothetical assumptions; they are drawn from actual cases of consumers who ate the amounts and types of fish described, and were diagnosed with methylmercury poisoning as a result. These examples are included in Table 6 for comparison purposes; they are discussed in more detail in the section below on "Public Health Implications."

Public Health Implications of Exposure Scenarios

Case Histories of Methylmercury Poisoning in the United States

The Mercury Policy Project (MPP) in the US has recently published a detailed analysis of 24 cases of clinical methylmercury poisoning, diagnosed by physicians, in individuals who ate a great deal of high-mercury fish.[31] The patients were unusual in at least two ways: They ate a great deal of fish; most were probably at or above the 99th percentile in fish consumption for the US, eating fish 5 to 10 times per week. And they all liked and repeatedly ate high- or moderately-high mercury varieties of fish, including tuna, swordfish, sea bass, halibut and pike. Because the amounts of fish some of the patients ate were so large, some obtained toxic mercury doses from fish with mercury levels in the range of 0.20 to 0.40 mg/kg—not considered especially high by most standards.[32]

The cases may also be unusual in a third way: Possibly the individuals were more sensitive than average to toxic effects of methylmercury. That such variation exists is certain; not everyone with high methylmercury exposure will become clinically ill. The fact that these 24 individuals (and quite possibly many others whose cases were not reported publicly) did so, however, is strong evidence that high consumption of fish with high or even moderate mercury levels poses a tangible hazard of methylmercury poisoning for at least a small minority of US consumers.

Methylmercury also can cause health damage that does not produce overt symptoms of illness. Harm to the developing brain is of course the basis for two of the reference levels. The same effects associated with prenatal exposure—performance deficits on cognitive and neuromotor tasks such as word recognition, short-term memory and digital coordination[33]—have also been observed in adults with elevated methylmercury exposure from fish in their diet.[34] Some studies also have linked methylmercury exposure to an increased risk of coronary heart disease.[35] In general, clinical symptoms occur at higher doses than the subtler neurodevelopmental, cognitive or cardiovascular effects. Therefore, wherever there is a risk of overt methylmercury poisoning, there is a larger risk, affecting a greater number of people, of effects that occur at lower doses.

Possible Health Hazards in Other Countries and Cultures

How likely are any of these effects—overt methylmercury toxicity, or subtler functional deficits and cardiovascular effects—to be occurring in the countries and cultures examined in this report? One approach is to examine the situations in each country covered here for similarities and differences with the US conditions that produced cases of methylmercury poisoning.

Americans do not eat a great deal of fish. Per capita consumption of fish in the US has increased steadily for the past decade or so, but is still low by international standards, at 7.5 kg per capita per year, or on average only 144 grams per week.[36]

European fish consumption varies, from roughly the same as in the US in some countries, to two or three times higher in other countries (as discussed above). Per capita consumption in the Philippines is 31 kg/year, based on government fisheries data, and the survey of Kolkata consumers (cited earlier), found a median intake of 700 g/week, or 36 kg/year.

In general, the likelihood of excessive methylmercury exposure and associated risk of adverse health effects increase with average per capita fish consumption. As average fish consumption increases, so does above-average consumption. As the total number of fish-consuming events increases, so should the absolute number of events involving high-mercury fish, even though the latter are just a small fraction of the total supply of fish consumed. And among people who eat greater amounts of fish overall, people who like to eat the higher-mercury predatory species are more likely to consume larger quantities of those fish.

The risk from methylmercury is therefore probably greater, and affects more consumers, in some European countries, in India, and in the Philippines than it is in the US, in two respects. First, consumers who prefer to eat high-mercury fish like swordfish and tuna are likely to eat more of those fish, on average, where overall fish consumption is higher. Second, a far larger fraction of the population in parts of the EU and in Asia has high fish intake, more than 500 grams per week, compared to the US. For people who eat that much fish, even relatively modest average mercury content in their fish is likely to exceed reference levels.

Put another way, for people who eat large amounts of fish, the mercury levels in fish that should trigger concerns about potentially excessive exposure are correspondingly lower. In Asian countries where weekly fish intake for half the population exceeds 500 grams, not only fish varieties with more than 1.0 mg/kg or 0.5 mg/kg of mercury need to be on the "watch list," but additional varieties do as well, those with, say, more than 0.25 mg/kg. The math is inexorable: A person who eats 1200 grams of fish containing 0.25 mg/kg gets the same mercury dose as someone who eats 600 grams containing 0.50 mg/kg, or 300 grams containing 1.0 mg/kg. And in each of these cases the dose ingested by a person of average weight will exceed all reference levels by a wide margin.

If public health monitoring studies were conducted with appropriately sensitive health assays in each country covered by this report, we would therefore expect to see patterns of excessive exposure, broad risks of sub-clinical toxic effects, and occasional cases of clinical methylmercury poisoning, in all the countries. How prevalent these effects are can only be determined by focused research, but it is virtually certain, given the underlying patterns of fish consumption and the availability of high-mercury species, that some adverse health impacts on consumers are occurring.

The situation in India is unusual in several respects, but is clearly the most severe. The test data presented here suggest that nearly half of the 56 varieties of fish tested have average mercury content of 0.5 mg/kg or higher. In a few cases, such as grouper and sea bass, the mercury levels found are consistent with other published data.[37] However, most of the Indian fish tested, although popular aquaculture varieties or commonly caught freshwater, estuarine or marine species, are not well represented in published databases for mercury in fish. It is therefore difficult to determine whether the reported mercury levels are consistent with expectations for those species, or reflect widespread contamination of aquatic environments of West Bengal with mercury. Another possibility should also be acknowledged, and if possible, ruled out. While we have no reason to doubt the accuracy of the test data used here, we strongly urge that the tests be independently repeated and confirmed.

Taking the data in Appendix C and Table 1 at face value, the average consumer in West Bengal, eating 500 grams of fish per week, with average mercury levels detected in all the fish tested, exceeds all the reference levels. The situation is even worse for non-average consumers: Those who eat far more fish than average; those who buy fish from the most contaminated areas; those who like to eat specific fish varieties with higher-than average mercury levels; or children, who get greater mercury doses due to their smaller body weights. Overall, the combination of high fish consumption and elevated mercury levels in fish creates a potential public health impact on an enormous scale, and the situation demands to be urgently addressed.

The situations of the Arctic populations are special cases that each involve substantial risks of excessive methylmercury exposure. The Faroese, of course, are known for high methylmercury exposure, and the health consequences of that exposure have been measured and continue to be measured. While the Faroese have a fish-rich diet, the data presented here reinforce the important contributions of pilot whale meat to exposure and risk.

Inuit populations span four countries going east from Northeastern Russia all the way to Greenland in the Atlantic Ocean, and an equally wide range of habitats, food sources, and dietary patterns. It is not especially feasible to summarize such diversity, and the data for mercury in predatory marine mammals, cited here, represent a small fraction of the information available from extensive, ongoing studies of these populations.[38] As noted, Inuit methylmercury exposure may be declining, but the data presented here show that a traditional Inuit diet can under some conditions still include high doses of methylmercury, from whale meat in particular.

The US EPA has defined 3.5 µg/l as the maternal blood mercury level that is likely to be safe for fetal exposure. As maternal blood mercury rises above 3.5 µg/l, concern about possible toxic effects of prenatal exposure increases.[39] The mean blood mercury level among women of childbearing age in the US is about 1.0 µg/l, and about 10 percent of US women have levels above 3.5 µg/l.[40]

A 2006 survey of 100 Inuit women found their average blood mercury level was 4.013 µg/l, with a range from 0.522 to 28.08 µg/l.[41] A 1999-2005 study in Greenland, where the Inuit diet contains greater amounts of marine mammals, found an average blood mercury level of 23.08 µg/l in women, and 34.81 µg/l in men.[42] Clearly, then, a significant fraction of the population exceeds the EPA reference level by a wide margin. While exposure was lower in the 2006 study than in a baseline survey done in 1996, methylmercury exposure among the Inuit is clearly still unacceptably high. The risk of prenatal neurotoxicity appears significant, and general neurotoxic effects similar to those observed in the US cases cited above might also occur in members of the population with relatively high exposure.

The general conclusion of this discussion is that methylmercury, in fish or in marine mammals, poses important public health hazards to consumers in every region covered by this report.

What Needs to Be Done

The public health challenges posed by methylmercury in fish and marine mammals are complex. While the risk from mercury is undeniable, fish consumption provides undeniable nutritional benefits as well. The solution is certainly *not* for people to stop eating fish; instead, consumers need to learn to consume fish more intelligently, choosing low-mercury varieties as often as possible, and limiting or avoiding consumption of varieties that can lead to excessive mercury exposure, whatever their particular circumstances may be.

This simple-sounding formula is far from simple to execute. Finding workable solutions requires participation by all affected sectors—consumers, scientists, governments, and those who catch, raise and sell fish. The process also requires working in all three phases of risk analysis—risk assessment, risk management, and risk communication.

Risk Assessment Needs

In order to perform an adequate risk assessment on this issue, better data are usually needed on many aspects of the problem. The mercury levels in fish need to be much better characterized in most countries. Sufficient data on mercury content to provide statistically reliable averages and ranges are needed for all varieties of fish consumed in significant amounts in national, regional, or ethnic diets. Data are needed not only to document the high levels of mercury that may occur in some species, but just as importantly, to document *low* levels of mercury that occur in other fish and seafood choices, to show which varieties can safely be consumed in large quantities.

Good fish consumption data are needed. It is essential to know what fish are consumed, and in what quantities, not only on average for countries as a whole, but by subgroups within the overall population. Ideally, the mean per capita consumption and indices of high-end consumption such as 90^{th}, 95^{th} and perhaps 99^{th} percentile intake*, should be characterized, not only for overall fish consumption but also for important individual varieties, such as tuna, swordfish or shrimp.

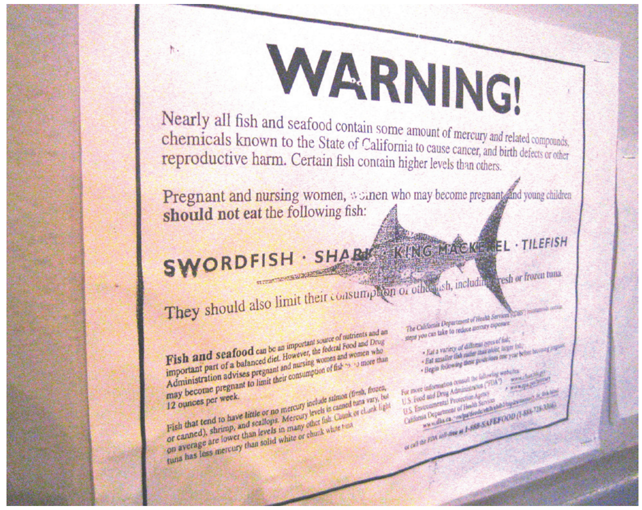
Using fish consumption data, fish mercury levels or both, exposure scenarios can be created (as in this report) to assess the likelihood of exposures in excess of applicable reference levels. Where such potential excessive exposures exist, groups of consumers with high exposure should be identified, and their actual exposure assessed by testing hair or blood samples for mercury levels. Individuals found to have elevated exposure should also be examined for health effects.

<u>Risk Management Needs</u>

When excessive methylmercury exposure is occurring, multiple strategies are generally needed to reduce exposure, depending on what is causing the high exposure in any given case.

Pollution control to reduce mercury levels in fish caught from local contaminated waters may be a critical long-term solution. In the short run, efforts can be made to educate or regulate fish producers and sellers, from the local to the international scale, to reduce the availability of fish (or mammals) with unacceptably high mercury levels. For example, Faroese health authorities have recently recommended that pilot whale meat no longer be used for human consumption,[43] and in many countries, fish that contain more than either 1.0 mg/kg or 0.5 mg/kg of mercury are legally unfit for sale. (As we have seen, though, whether such limits can be enforced or whether it would effectively protect consumers if they were are separate issues.)

The most critical measures, however, and the easiest to implement in a short time period, involve risk communication. Consumers with the greatest risks need to be identified and given advice, and the general amount of information about mercury in fish and seafood choices available to the public needs to be greatly expanded.



<u>Risk Communication Needs</u>

The most important strategies to reduce methylmercury exposure involve educating consumers to choose low-mercury fish, and to limit or avoid consumption of high-mercury varieties. This can be approached by publishing information, in media articles, brochures, on the internet, and in other forms, and by ensuring that facts about the mercury content of different fish are available in fish markets, on labels for packaged fish products, and wherever the consumer may easily find them when deciding what fish to buy.

Risk communication is also needed in the broader sense: That is, risk managers, who are most often government and industry officials, need to communicate with and collaborate with each other, with risk assessors (generally the scientific community), and with other affected parties and stakeholders, including consumers. Without broad-based participation and dialogue among stakeholders, it is likely to be very hard to develop and even harder to implement effective solutions to the problem of excessive methylmercury exposure.

Recommendations

General Recommendations: Risk Assessment

•A collaborative effort should be undertaken by United Nations Environment Program (UNEP) and the World Health Organization (WHO) to expand surveys of mercury levels in fish around the world.

•Governments and international bodies concerned with mercury and health (such as WHO and/or UNEP) should work together to develop a comprehensive, representative fish sampling strategy, conducted in key countries and/or regionally, in order to characterize mercury concentrations in a range of fish species.

•Sufficiently sensitive analytical methods should be employed to document low levels of mercury in many of the tested fish. Emphasis is needed on demonstrating that some fish varieties have low mercury levels and can safely be eaten often, as well as on determining which fish have higher mercury levels and should be eaten in more limited amounts.

•Fish consumption data should be collected, by amounts and species eaten, across a wide range of representative regional, national and ethnic diets.

•Efforts should be made in each area surveyed to find out how often high-mercury fish like shark, tuna and swordfish are consumed, and to identify consumers who eat these varieties often.

•Populations at greatest risk should be identified (e.g., those who consume large amounts of fish, who consume species of fish with high concentrations of mercury, or both).

•Among those at-risk populations, a broad survey of consumer hair mercury levels should be carried out, to determine the distribution of mercury exposure and correlate it with fish consumption data.

•Populations with high and low mercury exposure should be compared in well-designed clinical screenings, to see if adverse health effects are occurring among the former.

▪Finally, the UNEP Governing Council at its February 2009 meeting in Nairobi should specify a near-term mercury program and establish an Intergovernmental Negotiating Committee (INC) to negotiate a free-standing, legally binding instrument on mercury, one that enables implementation of the recommendations presented here, among others.

General Recommendations: Risk Management and Risk Communication

•Countries should adopt a global legally binding instrument on mercury pollution to control the major sources of mercury emissions, reduce or phase out intentional uses of mercury in products and processes, and restrict or phase out mercury supply and trade.

•Measures are urgently needed to control emissions of mercury from coal-fired power plants, ore processing, cement manufacturing and other sources, and to phase out the intentional uses of mercury in products and processes. Collaborative international action is needed to achieve these goals.

•Using risk assessments based on appropriate national and regional data, countries should review the lists of fish that are now exempt from meeting the widely applied general limit of 0.5 mg/kg in fish sold, with a view towards reducing the number of species allowed to contain higher mercury levels.

•WHO, UNEP and member governments should provide capacity building assistance as needed and work with affected stakeholders to develop effective risk communication programs, to teach consumers in all countries which fish contain significant levels of mercury, and which contain the lowest levels and can safely be eaten most often.

•A particular focus should be on warning consumers who like swordfish, tuna and shark that these varieties (and other high-mercury fish, if such are determined to be important by the surveys called for above) should be eaten infrequently or not at all.

•UNEP, the Food and Agriculture Organization (FAO) and member governments should work together to increase awareness of methylmercury contamination as an issue in fisheries management and in aquaculture development, and to engage officials in those disciplines with other stakeholders in the effort to mitigate mercury risks.

Specific Recommendations for Particular Countries and Populations

•In the Faroe Islands, with due respect to the historical and cultural importance of pilot whale in the Faroese diet, the proposal to abstain from human consumption of pilot whale should be adopted, in the interest of protecting public health.

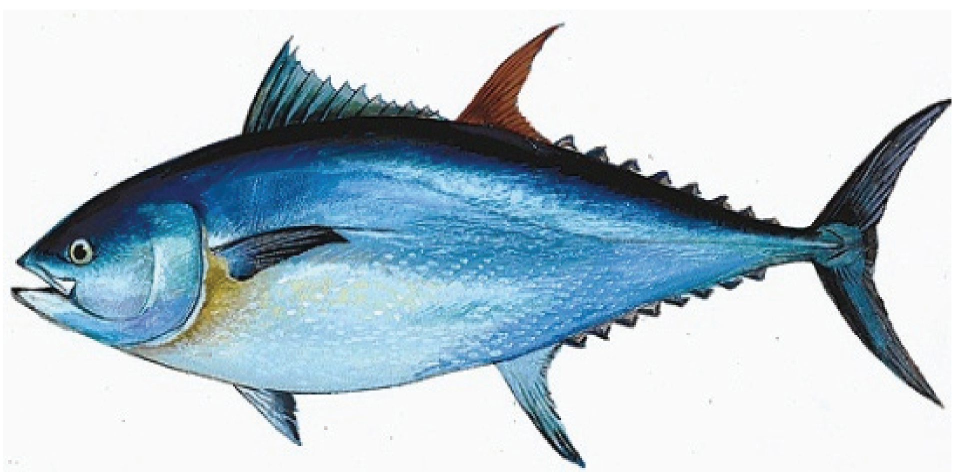
•More extensive data should be collected on mercury levels in the muscle meat of marine mammals eaten by the Inuit, especially seals.

•Collaborative international research efforts such as the Arctic Monitoring Assessment Program (AMAP) should continue to be supported, and additional countries should become engaged, to the extent feasible.

•The proposed European Union regulation for labeling foodstuff, currently being considered by the European Parliament, should include advice for vulnerable groups about the mercury content of fish and seafood. The regulation should be finalized, adopted and implemented.

•The survey of mercury in fish conducted in West Bengal should be confirmed by further testing, and replicated in other Indian states.

•Since methylmercury in fish is truly a global problem, any nation not named in this report but where fish is an important part of the diet should pursue the generic recommendations listed above.



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23 Personal communication from Richard Gutierrez, Ban Toxics!, 21 January 2009.

24 Personal communication From Philippe Grandjean, Adjunct Professor, Environmental Health, Harvard School of Public Health, and Professor and Chair of Environmental Medicine, University of Southern Denmark, January 2009.

25 Since 1998 Faroese health authorities have recommended that men should eat pilot whale meat no more often than one to two times per month, and women should avoid eating it. As noted later in this report, the health ministries are now proposing that pilot whale meat not be used at all for human consumption. (See Note 45, below).

26 Choi, A.L., P. Weihe, E. Budtz-Jørgensen, P.J. Jørgensen, J.T. Salonen, T. P. Tuomainen, K. Murata, H.PP. Nielsen, M.S. Petersen, J. Askham and P. Grandjean (2008), Methylmercury exposure and adverse cardiovascular effects in Faroese whalingmen. *Environmental Health Perspectives* doi:10.1289/ehp.11608.

27 AMAP 2002 Health Assessment, Note 10, above.

28 EFSA, European Food Safety Agency (2008), Guidance Document for the use of the Concise European Food Consumption Database in Exposure Assessment. Available at http://www.efsa.europa.eu/EFSA/General/Concise_database_guidance_document_and_annexes.pdf

29 EFSA, European Food Safety Agency (2004) Opinion of the Scientific Panel on Contaminants in the Food Chain on a request from the Commission related to mercury and methylmercury in food. EFSA Journal 34:1-14.

30 Ibid., page 7.

31 Mercury Policy Project (2008), Over The Limit: Eating Too Much High-Mercury Fish, available at http://mercurypolicy.org/wp-content/uploads/2008/12/mppoverthelimit.pdf

32 For example, one or more types of tuna fish were involved in 86 percent of the cases of methylmercury poisoning. FDA data show average mercury levels of 0.383 mg/kg in fresh and frozen tuna; 0.353 mg/kg in canned Albacore tuna; and 0.118 mg/kg in canned "light" tuna (usually Skipjack).

33 See Oken et al., Note 17, above.

34 Carta, P., C. Flore, R. Alinovi, A. Ibba, M.G. Tocco, G. Aru, R. Carta, E. Girei, A. Mutti, R. Lucchini, and F.S. Randaccio (2003), Sub-clinical neurobehavioral abnormalities associated with low level of mercury exposure through fish consumption. *Neurotoxicology* 24(4-5):617-623. Also, Yokoo, E.M., J.G. Valente, L. Grattan, S.L. Schmidt, I. Platt and E.K. Silbergeld (2003), Low level methylmercury exposure affects neuropsychological function in adults. *Environmental Health: A Global Access Science Source* **2**:8. http://www.ehjournal.net/content/2/1/8.

35 See Stern's review, cited in Note 4, above.

36 National Marine Fisheries Service (2007), Fisheries of the Unites States, 2006. Silver Spring, MD: National Oceanic and Atmospheric Administration.

37 For example, the US FDA database reports an average mercury level of 0.465 mg/kg in Grouper, 0.386 mg/kg in Chilean Sea Bass, 0.072 mg/kg in Croaker, 0.049 mg/kg in Catfish (although there are several different kinds of catfish in the Indian test data, and it is not clear which if any of them might be analogous to catfish consumed in the US); and 0.14 mg/kg for carp.

38 AMAP and NCP reports, Notes 11 and 12, above.

39 Mahaffey, K.R., R.P. Clickner and R.A. Jeffries (2009), Adult Women's Blood Mercury Concentrations Vary Regionally in the United States: Association with Patterns of Fish Consumption (NHANES 1999-2004). *Environmental Health Perspectives* **117**(1):47-53.

40 Ibid.

41 Blanchet, C. and L. Rochette (2008), Nutrition and Food Consumption Among the Inuit of Nunavik. National Institute of Public Health, Quebec, and Nunavik Regional Board of Health and Social Services.

42 Deutch et al., 2007, Science of the Total Environment 327:486-496.

43 Recommendations from the Chief Physician and Chief medical Officer of the Faroe Islands, to the Government, concerning the pilot whale. 7 August 2008; English Translation 1 December 2008. Landslægen, Chief medical Officer, Faroe Islands.

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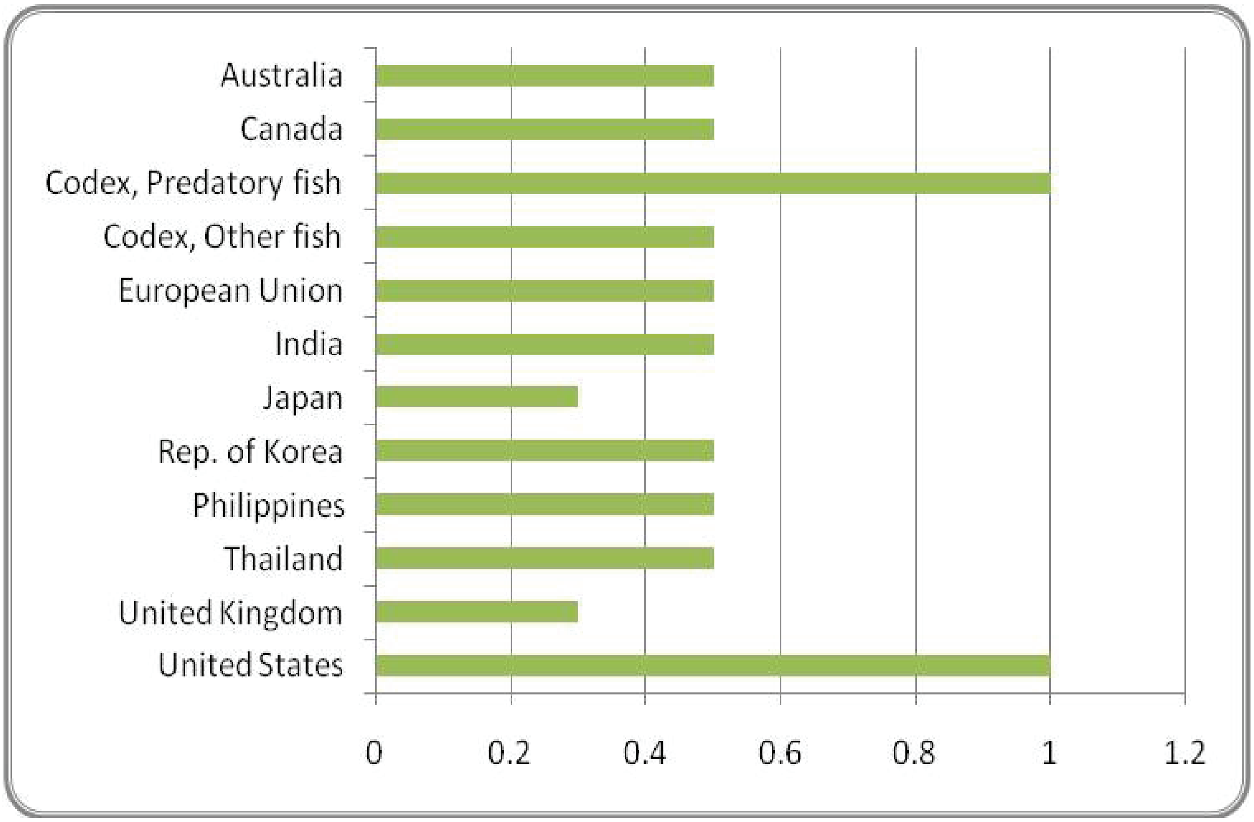
Elena Lyberidi -- European Environmental Bureau (EEB) - pp. 11a, 16, 31

Eric Loring, Inuit Tapiriit Kanatami (ITK) - p. 8

Dr. Philippe Grandjean pp. 14a, 19

APPENDIX A:
National/International Standards for Mercury Levels in Fish



APPENDIX B:
Test Data on Fish from the European Union

Country	Type of fish	Latin Name	Origin	Market	Mercury Test Result (Hg mg/ kg)	Technology Used
Germany	Swordfish, fresh		Indian Ocean		**0.12**	AFS with cold vapour technique
	Shark, Spiny Dogfish smoked		West Atlantic		**1.00**	AFS with cold vapour technique
	Shark, Spiny Dogfish smoked		Unknown		**0.27**	AFS with cold vapour technique
	Swordfish, frozen		Western Indian Ocean		**0.57**	AFS with cold vapour technique
	Shark, frozen		Pacific Ocean		**0.69**	AFS with cold vapour technique
	Swordfish, frozen		East Central Atlantic, Spain		**0.39**	AFS with cold vapour technique
Spain	Swordfish	Xiphias Gladius	North-East Atlantic	Carrefour Sevilla	**0.58**	AFS with cold vapour technique
	Tuna	Thunnus alalunga	Mediterranean Sea	Carrefour Sevilla	**0.25**	AFS with cold vapour technique
	Swordfish	Xiphias Gladius	South West Atlantic	Carrefour Dos Hermanas, Sevilla	**0.29**	AFS with cold vapour technique
	Tuna	Thunnus thynnus	CenterEast Atlantic	Carrefour Dos Hermanas, Sevilla	**0.40**	AFS with cold vapour technique
Czech Republic	Shark (frozen)		Panama	CIPA-Cash and Carry, Prague	**0.38**	AFS with cold vapour technique
	Shark (frozen)		Panama	CIPA-Cash and Carry, Prague	**0.46**	AFS with cold vapour technique

(cont.,)

Country	Type of fish	Latin Name	Origin	Market	Mercury Test Result (Hg mg/kg)	Technology Used
Czech Republic (cont.)	Pike (frozen)		Hungary	CIPA-Cash and Carry, Prague	**0.52**	AFS with cold vapour technique
	Pike (frozen)		Hungary	CIPA-Cash and Carry, Prague	**0.36**	AFS with cold vapour technique
Belgium	Red Tuna (fresh)	Thunnus	Indian Ocean	Delhaize	**0.20**	AFS with cold vapour technique
	Swordfish (fresh)	Xephias Gladius	Pacific Ocean	Delhaize	**0.74**	AFS with cold vapour technique
	Yellowfin Tuna – Imperial (canned)		Packed by SA Sopralex & Vosmarques NV- Bruge	Delhaize	**0.33**	
	Red Tuna (fresh)	Thunnus	Indian Ocean	Carrefour GB	**0.66**	AFS with cold vapour technique
	Swordfish (fresh)	Xephias Gladius	Atlantic Ocean	Carrefour GB	**0.61**	AFS with cold vapour technique
Italy	Tuna (fresh)		Sicilian Channel		**0.56**	AFS with cold vapour technique
	Swordfish (fresh)		Sicilian Channel		**1.60**	AFS with cold vapour technique
	Swordfish		Indian Ocean	Super-market, Rome	**0.33**	AFS with cold vapour technique
	Tuna fish		North-East Atlantic Ocean	Super-market, Rome	**0.17**	
France	Albacore Tuna		North Atlantic	Carrefour France	**0.092**	AFS with cold vapour technique
	Swordfish		North Ocean	Carrefour France	**1.20**	AFS with cold vapour technique
	Albacore Tuna		North Atlantic	Carrefour France	**0.14**	AFS with cold vapour technique

APPENDIX C:
Test Data on Mercury in Fish From West Bengal, India

Analytical method: ICP-OES (hydride generation), instrument model iCAP 6300, AOAC Official Method 977.15.

TABLE 1. Kolkata Markets

1	2	3	4	5	6	7	8	9	10
Sl. No.	Location	DISHA Code	Lab Code	Hg mg/kg	Species Local Name	Species/ Variety average	Species Scientific Name	Sample Weight (Kg)	Sample Length (cm)
1	Gariahat	MG1A	7120018807	0.51	Rui		*Labeo rohita*	1.400	49.5
2	Gariahat	MG1B	7120018808	0.48	Rui	0.495	*Labeo rohita*	1.450	50.0
3	Gariahat	MG2A	7120018809	0.59	Katla		*Catla catla*	2.450	54.0
4	Gariahat	MG2B	7120018810	0.39	Katla	0.49	*Catla catla*	1.990	50.0
5	Gariahat	MG3A	7120018811	0.84	Aar		*Sperata aor*	1.125	60.0
6	Gariahat	MG3B	7120018812	1.12	Aar	0.98	*Sperata aor*	1.070	55.0
7	Gariahat	MG4A	7120018813	1.27	Bhetki		*Lates calcarifer*	1.100	43.0
8	Gariahat	MG4B	7120018814	0.88	Bhetki	1.075	*Lates calcarifer*	1.200	43.5
9	Gariahat	MG5A	7120018815	0.45	Tangra		*Mystus gulio*	0.075	19.5
10	Gariahat	MG5B	7120018816	0.44	Tangra	0.445	*Mystus gulio*	0.070	18.0
11	Gariahat	MG6A	7120018817	0.21	Bagda		*Penaeus monodon*	0.060	19.5
12	Gariahat	MG6B	7120018818	0.23	Bagda	0.22	*Penaeus monodon*	0.055	19.0
13	Sahababu	MSa1A	7120018819	0.24	Rui		*Labeo rohita*	1.275	48.5
14	Sahababu	MSa1B	7120018820	<0.20	Rui	0.12	*Labeo rohita*	1.325	48.0
15	Sahababu	MSa2A	7120018821	<0.20	Katla		*Catla catla*	1.075	43.0
16	Sahababu	MSa2B	7120018822	<0.20	Katla	0	*Catla catla*	1.025	42.0
17	Sahababu	MSa3A	7120018823	0.32	Aar		*Sperata aor*	0.520	46.0
18	Sahababu	MSa3B	7120018824	<0.20	Aar	0.16	*Sperata aor*	0.670	47.0
19	Sahababu	MSa4A	7120018825	<0.20	Bhetki		*Lates calcarifer*	0.670	36.0

20	Sahababu	MSa4B	7120018826	0.29	Bhetki	0.145	*Lates calcarifer*	0.690	37.0
21	Sahababu	MSa5A	7120018827	0.22	Tangra		*Mystus gulio*	0.054	17.0
22	Sahababu	MSa5B	7120018828	0.30	Tangra	0.26	*Mystus gulio*	0.064	17.0
23	Sahababu	MSa6A	7120018829	0.34	Bagda		*Penaeus monodon*	0.048	18.0
24	Sahababu	MSa6B	7120018830	0.50	Bagda	0.42	*Penaeus monodon*	0.045	17.5
25	Sealdah	MSd1A	7120019547	0.50	Rui		*Labeo rohita*	1.130	46.0
26	Sealdah	MSd1B	7120019548	0.20	Rui	0.35	*Labeo rohita*	1.140	46.5
27	Sealdah	MSd2A	7120019549	0.20	Katla		*Catla catla*	1.820	49.0
28	Sealdah	MSd2B	7120019550	<0.20	Katla	0.1	*Catla catla*	2.085	52.5
29	Sealdah	MSd3A	7120019551	0.20	Aar		*Sperata aor*	0.920	57.0
30	Sealdah	MSd3B	7120019552	0.22	Aar	0.21	*Sperata aor*	0.770	52.0
31	Sealdah	MSd4A	7120019553	0.65	Bhetki		*Lates calcarifer*	0.690	39.0
32	Sealdah	MSd4B	7120019554	0.70	Bhetki	0.675	*Lates calcarifer*	0.775	38.5
33	Sealdah	MSd5A	7120019555	0.47	Tangra		*Mystus gulio*	0.050	16.8
34	Sealdah	MSd5B	7120019556	0.85	Tangra	0.66	*Mystus gulio*	0.080	19.5
35	Sealdah	MSd6A	7120019557	0.57	Bagda		*Penaeus monodon*	0.030	16.2
36	Sealdah	MSd6B	7120019558	0.39	Bagda	0.48	*Penaeus monodon*	0.035	17.5
37	Maniktala	MMn1A	7120019559	0.24	Rui		*Labeo rohita*	1.360	48.5
38	Maniktala	MMn1B	7120019560	0.46	Rui	0.35	*Labeo rohita*	1.330	46.5
39	Maniktala	MMn2A	7120019561	0.52	Katla		*Catla catla*	1.790	49.5
40	Maniktala	MMn2B	7120019562	0.20	Katla	0.36	*Catla catla*	2.050	54.0
41	Maniktala	MMn3A	7120019563	0.58	Aar		*Sperata aor*	0.755	44.0
42	Maniktala	MMn3B	7120019564	0.54	Aar	0.56	*Sperata aor*	0.735	48.0
43	Maniktala	MMn4A	7120019565	0.22	Bhetki		*Lates calcarifer*	0.600	34.3
44	Maniktala	MMn4B	7120019566	0.24	Bhetki	0.23	*Lates calcarifer*	0.665	36.5
45	Maniktala	MMn5A	7120019567	0.22	Tangra		*Mystus gulio*	0.065	17.6
46	Maniktala	MMn5B	7120019568	0.31	Tangra	0.265	*Mystus gulio*	0.055	18.4
47	Maniktala	MMn6A	7120019569	<0.20	Bagda		*Penaeus monodon*	0.040	18.2

48	Maniktala	MMn6B	7120019570	0.38	Bagda	0.19	*Penaeus monodon*	0.035	17.0
49	Behala	MBe1A	7120019571	0.59	Rui		*Labeo rohita*	1.100	45.5
50	Behala	MBe1B	7120019572	0.52	Rui	0.555	*Labeo rohita*	1.010	45.3
51	Behala	MBe2A	7120019573	0.38	Katla		*Catla catla*	1.735	48.4
52	Behala	MBe2B	7120019574	0.22	Katla	0.3	*Catla catla*	1.670	49.0
53	Behala	MBe3A	7120019575	0.56	Aar		*Sperata aor*	0.955	57.5
54	Behala	MBe3B	7120019576	0.31	Aar	0.435	*Sperata aor*	0.870	52.0
55	Behala	MBe4A	7120019577	0.24	Bhetki		*Lates calcarifer*	0.970	39.7
56	Behala	MBe4B	7120019578	0.20	Bhetki	0.22	*Lates calcarifer*	1.280	42.5
57	Behala	MBe5A	7120019579	0.21	Tangra		*Mystus gulio*	0.075	18.0
58	Behala	MBe5B	7120019580	0.20	Tangra	0.205	*Mystus gulio*	0.075	18.2
59	Behala	MBe6A	7120019581	0.35	Bagda		*Penaeus monodon*	0.045	18.0
60	Behala	MBe6B	7120019582	<0.20	Bagda	0.175	*Penaeus monodon*	0.065	22.0

APPENDIX C (cont.) **TABLE 2.**
The Various Fishing Locations in West Bengal

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
1	Hugli	HG1A	7120019835	0.36	Rui		*Labeo rohita*	0.490	34.5
2	Hugli	HG1B	7120019836	0.20	Rui	0.28	*Labeo rohita*	0.530	36.5
3	Hugli	HG2A	7120019837	0.33	Katla		*Catla catla*	0.425	31.4
4	Hugli	HG2B	7120019838	0.33	Katla	0.33	*Catla catla*	0.480	30.6
5	Hugli	HG3A	7120019839	0.55	Magur		*Clarias batrachus*	0.267	32.0
6	Hugli	HG3B	7120019840	0.41	Magur	0.48	*Clarias batrachus*	0.160	28.0
7	Hugli	HG4A	7120019841	0.36	Shingi		*Heteropneustes fossilis*	0.055	22.5
8	Hugli	HG4B	7120019842	0.47	Shingi	0.415	*Heteropneustes fossilis*	0.048	21.1
9	Hugli	HG5A	7120019843	0.52	Pangash		*Pangasius pangasius*	0.810	46.1
10	Hugli	HG5B	7120019844	0.36	Pangash	0.44	*Pangasius pangasius*	0.870	46.9
11	Hugli	HG6A	7120019845	0.28	Koi		*Anabas testudineus*	0.072	15.0
12	Hugli	HG6B	7120019846	0.40	Koi	0.34	*Anabas testudineus*	0.085	16.5
13	Hugli	HG7A	7120019847	0.47	Lyata		*Chanos chanos*	0.093	20.4
14	Hugli	HG7B	7120019848	0.40	Lyata	0.435	*Chanos chanos*	0.105	22.5
15	Hugli	HG8A	7120019849	0.42	American Rui		*Cyprinus carpio*	0.935	34.0
16	Hugli	HG8B	7120019850	0.32	American Rui	0.37	*Cyprinus carpio*	1.050	38.0
17	Budgebudge	BJ1A	8120000295	0.20	Pabda		*Ompok pabda*	0.100	26.0
18	Budgebudge	BJ1B	8120000296	0.20	Pabda	0.2	*Ompok pabda*	0.098	25.0
19	Budgebudge	BJ2A	8120000297	0.37	Bele		*Sillago sihama*	0.180	33.0
20	Budgebudge	BJ2B	8120000298	0.56	Bele	0.465	*Sillago sihama*	0.195	32.5
21	Budgebudge	BJ3A	8120000299	0.70	Ilish		*Tenualosa ilisha*	0.172	25.0

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
22	Budgebudge	BJ3B	8120000300	0.58	Ilish	0.64	*Tenualosa ilisha*	0.170	26.0
23	Budgebudge	BJ4A	8120000301	0.56	Gurjaoli		*Eleutheronema tetradactylum*	0.178	28.0
24	Budgebudge	BJ4B	8120000302	0.82	Gurjaoli	0.69	*Eleutheronema tetradactylum*	0.160	27.0
25	Budgebudge	BJ5A	8120000303	0.69	Topshe		*Polydactylus sexfilis*	0.043	20.5
26	Budgebudge	BJ5B	8120000304	0.59	Topshe	0.64	*Polydactylus sexfilis*	0.055	21.0
27	Budgebudge	BJ6A	8120000305	0.45	Nihere		*Harpadon nehereus*	0.045	20.0
28	Budgebudge	BJ6B	8120000306	0.42	Nihere	0.435	*Harpadon nehereus*	0.050	21.5
29	Budgebudge	BJ7A	8120000307	0.61	Norke Bhola		*Panna microdon*	0.048	19.0
30	Budgebudge	BJ7B	8120000308	0.44	Norke Bhola	0.525	*Panna microdon*	0.040	18.0
31	Budgebudge	BJ8A	8120000309	1.03	Madhu Bhola		*Otolithoides sp.*	0.085	22.5
32	Budgebudge	BJ8B	8120000310	0.46	Madhu Bhola	0.745	*Otolithoides sp.*	0.080	21.0
33	Budgebudge	BJ9A	8120000311	0.83	Bhetki Bhola		*Nibea soldado*	0.065	18.0
34	Budgebudge	BJ9B	8120000312	0.63	Bhetki Bhola	0.73	*Nibea soldado*	0.075	19.5
35	Jharkhali	JHK1A	8120000850	2.66	Sitapati		*Trichurus sp.*	0.080	41
36	Jharkhali	JHK1B	8120000851	2.05	Sitapati	2.355	*Trichurus sp.*	0.070	41
37	Jharkhali	JHK2A	8120000852	1.36	Amudi		*Coilia sp.*	0.035	21
38	Jharkhali	JHK2B	8120000853	0.92	Amudi	1.14	*Coilia sp.*	0.040	21.2
39	Jharkhali	JHK3A	8120000854	1.72	Lote/ Nihere		*Harpadon nehereus*	0.100	25
40	Jharkhali	JHK3B	8120000855	0.59	Lote/ Nihere	1.155	*Harpadon nehereus*	0.100	24.2
41	Jharkhali	JHK4A	8120000856	1.31	Mocha Galda		*Macrobrachium rosenbergii*	0.240	29.5
42	Jharkhali	JHK4B	8120000857	1.52	Mocha Galda	1.415	*Macrobrachium rosenbergii*	0.130	25.5
43	Jharkhali	JHK5A	8120000858	2.08	Baul		*Pampus chinesis*	0.270	23.5
44	Jharkhali	JHK5B	8120000859	2.03	Baul	2.055	*Pampus chinesis*	0.300	24

1	2	3	4	5	6	7	8	9	10
Sl. No.	Location	Our Code	Lab Code	Hg mg/ kg	Species Local Name	Species/ Variety average	Species Scientific Name	Sample Weight (Kg)	Sample Length (cm)
45	Jharkhali	JHK6A	8120000860	1.42	Bagda		*Penaeus monodon*	0.040	19
46	Jharkhali	JHK6B	8120000861	1.29	Bagda	1.355	*Penaeus monodon*	0.070	22
47	Jharkhali	JHK7A	8120000862	1.09	Lathi Bhola		*Panna microdon*	0.600	45.5
48	Jharkhali	JHK7B	8120000863	1.61	Lathi Bhola	1.35	*Panna microdon*	0.560	44.5
49	Jharkhali	JHK8A	8120000864	0.85	Koibol		*Epinephelous sp.*	1.450	48
50	Jharkhali	JHK8B	8120000865	0.73	Koibol	0.79	*Epinephelous sp.*	0.950	43
51	Haldia	HD1A	8120002271	0.83	Ilish		*Tenualosa ilisha*	0.830	42.0
52	Haldia	HD1B	8120002272	0.55	Ilish	0.69	*Tenualosa ilisha*	0.850	42.5
53	Haldia	HD2A	8120002273	0.37	Tul / Karrma		*Sillaginopsis panijus*	0.250	33.0
54	Haldia	HD2B	8120002274	0.26	Tul / Karrma	0.315	*Sillaginopsis panijus*	0.240	33.0
55	Haldia	HD3A	8120002275	0.20	Banspata		*Devario devario*	0.095	32.0
56	Haldia	HD3B	8120002276	0.22	Banspata	0.21	*Devario devario*	0.078	29.0
57	Haldia	HD4A	8120002277	0.29	Topshe		*Polydactylus sexfilis*	0.068	22.5
58	Haldia	HD4B	8120002278	0.53	Topshe	0.41	*Polydactylus sexfilis*	0.065	20.5
59	Haldia	HD5A	8120002279	0.25	Tarui		*Rhinomugil corsula*	0.033	15.5
60	Haldia	HD5B	8120002280	0.21	Tarui	0.23	*Rhinomugil corsula*	0.035	15.0
61	Haldia	HD6A	8120002281	0.21	Tampra		*Setipinna phasa*	0.190	31.5
62	Haldia	HD6B	8120002282	<0.20	Tampra	0.105	*Setipinna phasa*	0.135	28.0
63	Digha	DIG1A	8120002577	0.63	Bhola		*Otolithoides sp.*	0.180	30.0
64	Digha	DIG1B	8120002578	0.39	Bhola	0.51	*Otolithoides sp.*	0.160	25.0
65	Digha	DIG2A	8120002579	0.40	Baul		*Apolectus niger*	0.160	20.5
66	Digha	DIG2B	8120002580	0.42	Baul	0.41	*Apolectus niger*	0.135	19.5
67	Digha	DIG3A	8120002581	<0.20	Padre		*Pellona sp.*	0.140	27.0

1	2	3	4	5	6	7	8	9	10
Sl. No.	Location	Our Code	Lab Code	Hg mg/ kg	Species Local Name	Species/ Variety average	Species Scientific Name	Sample Weight (Kg)	Sample Length (cm)
68	Digha	DIG3B	8120002582	<0.20	Padre	0	*Pellona sp.*	0.140	26.5
69	Digha	DIG4A	8120002583	0.60	Banspata		*Devario devario*	0.070	21.5
70	Digha	DIG4B	8120002584	0.72	Banspata	0.66	*Devario devario*	0.068	21.0
71	Digha	DIG5A	8120002585	0.26	Karrma		*Sillago sihama*	0.060	21.5
72	Digha	DIG5B	8120002586	0.24	Karrma	0.25	*Sillago sihama*	0.043	18.0
73	Digha	DIG6A	8120002587	0.26	Parshe		*Liza parsia*	0.045	16.0
74	Digha	DIG6B	8120002588	0.29	Parshe	0.275	*Liza parsia*	0.040	15.0
75	Digha	DIG7A	8120002589	0.50	Samudra Kankra		*Portunus pelagicus*	0.320	16.5
76	Digha	DIG7B	8120002590	0.48	Samudra Kankra	0.49	*Portunus pelagicus*	0.305	17.0
77	Digha	DIG8A	8120002591	1.14	Gurjaoli		*Eleutheronema tetradactylum*	0.070	22.0
78	Digha	DIG8B	8120002592	1.10	Gurjaoli	1.12	*Eleutheronema tetradactylum*	0.065	21.5
79	Digha	DIG9A	8120002593	1.39	Motka Chingri		*Penaeus sp.*	0.035	17.0
80	Digha	DIG9B	8120002594	1.99	Motka Chingri	1.69	*Penaeus sp.*	0.030	17.0
81	Digha	DIG10A	8120002595	0.43	Phitemaach		*Trichurus lepturus*	0.040	35.0
82	Digha	DIG10B	8120002596	<0.20	Phitemaach	0.215	*Trichurus lepturus*	0.080	38
83	East Kolkata	EKO1A	8120004162	0.45	American Rui		*Cyprinus carpio*	1.000	36.0
84	East Kolkata	EKO1B	8120004163	0.28	American Rui	0.365	*Cyprinus carpio*	0.750	35.5
85	East Kolkata	EKO2A	8120004164	0.76	Lilentika		*Oreochromis nilotica*	0.300	27.0
86	East Kolkata	EKO2B	8120004165	0.40	Lilentika	0.58	*Oreochromis nilotica*	0.195	24.0
87	East Kolkata	EKO3A	8120004166	0.30	Chara Pona (Fingerling)		*Labeo rohita*	0.125	24.0
88	East Kolkata	EKO3B	8120004167	0.40	Chara Pona (Fingerling)	0.35	*Labeo rohita*	0.070	20.5
89	Kakdwip	KAK1A	8120004168	0.45	Bhola		*Otolithoides sp.*	0.525	38.0
90	Kakdwip	KAK1B	8120004169	0.50	Bhola	0.475	*Otolithoides sp.*	0.425	36.0

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
91	Kakdwip	KAK2A	8120004170	0.42	Tul		*Sillaginopsis panijus*	0.205	32.0
92	Kakdwip	KAK2B	8120004171	0.36	Tul	0.39	*Sillaginopsis panijus*	0.135	28.5
93	Kakdwip	KAK3A	8120004172	0.48	Bele		*Platycephalous sp.*	0.525	41.0
94	Kakdwip	KAK3B	8120004173	0.69	Bele	0.585	*Platycephalous sp.*	0.065	23.0
95	Kakdwip	KAK4A	8120004174	0.60	Tangra		*Arius sp.*	0.195	29.0
96	Kakdwip	KAK4B	8120004175	0.58	Tangra	0.59	*Arius sp.*	0.130	24.0
97	Kakdwip	KAK5A	8120004176	0.83	Shadapata		*Raconda russiliana*	0.030	18.0
98	Kakdwip	KAK5B	8120004177	0.71	Shadapata	0.77	*Raconda russiliana*	0.030	18.0
99	Kakdwip	KAK6A	8120004178	0.96	Phyasa		*Setipinna phasa*	0.078	23.5
100	Kakdwip	KAK6B	8120004179	1.09	Phyasa	1.025	*Setipinna phasa*	0.080	24.0
101	Kakdwip	KAK7A	8120004180	0.84	Banspata		*Devario devario*	0.060	21.5
102	Kakdwip	KAK7B	8120004181	0.96	Banspata	0.9	*Devario devario*	0.055	20.0
103	Kakdwip	KAK8A	8120004182	0.96	Parshe		*Liza parsia*	0.070	18.0
104	Kakdwip	KAK8B	8120004183	0.94	Parshe	0.95	*Liza parsia*	0.070	18.5
105	Mudiali	MUD1A	8120006419	<0.20	Rui		*Labeo rohita*	0.480	34.0
106	Mudiali	MUD1B	8120006420	0.20	Rui	0.1	*Labeo rohita*	0.520	34.5
107	Mudiali	MUD2A	8120006421	<0.20	Katla		*Catla catla*	0.560	33.0
108	Mudiali	MUD2B	8120006422	0.20	Katla	0.1	*Catla catla*	0.575	31.5
109	Mudiali	MUD3A	8120006423	0.25	Mrigel		*Cirrhinus cirrhosus*	0.495	35.5
110	Mudiali	MUD3B	8120006424	<0.20	Mrigel	0.125	*Cirrhinus cirrhosus*	0.475	36.0
111	Mudiali	MUD4A	8120006425	<0.20	Bata		*Labeo bata*	0.170	25.5
112	Mudiali	MUD4B	8120006426	<0.20	Bata	0	*Labeo bata*	0.140	24.0
113	Mudiali	MUD5A	8120006427	0.24	Lilentika		*Oreochromis nilotica*	0.750	35.5

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
114	Mudiali	MUD5B	8120006428	<0.20	Lilentika	0.12	*Oreochromis nilotica*	0.650	32.0
115	Mudiali	MUD6A	8120006429	<0.20	Silver Carp		*Hypophthalmichthys molitrix*	0.465	33.5
116	Mudiali	MUD6B	8120006430	0.32	Silver Carp	0.16	*Hypophthalmichthys molitrix*	0.425	32.0
117	Mudiali	MUD7A	8120006431	0.21	American Rui		*Cyprinus carpio*	0.840	35.5
118	Mudiali	MUD7B	8120006433	0.36	American Rui	0.285	*Cyprinus carpio*	0.800	35.0
119	Mudiali	MUD8A	8120006434	0.64	Pholi		*Notopterus notopterus*	0.220	30.0
120	Mudiali	MUD8B	8120006435	0.42	Pholi	0.53	*Notopterus notopterus*	0.150	26.0
121	Mudiali	MUD9A	8120006436	0.32	Grass Carp		*Ctenopharyngodon idella*	0.660	37.5
122	Mudiali	MUD9B	8120006437	0.47	Grass Carp	0.395	*Ctenopharyngodon idella*	0.660	38.0
123	Farakka	FKF1A	8120006725	0.27	Katla		*Catla catla*	1.080	40.0
124	Farakka	FKF1B	8120006726	0.20	Katla	0.235	*Catla catla*	1.530	44.5
125	Farakka	FKF2A	8120006727	0.24	Mrigel		*Cirrhinus cirrhosus*	1.500	50.0
126	Farakka	FKF2B	8120006728	0.23	Mrigel	0.235	*Cirrhinus cirrhosus*	1.400	51.0
127	Farakka	FKF3A	8120006729	0.79	Shol		*Channa striatus*	0.500	38.0
128	Farakka	FKF3B	8120006730	0.52	Shol	0.655	*Channa striatus*	0.470	38.5
129	Farakka	FKF4A	8120006731	0.27	Bacha		*Eutropichthys vacha*	0.120	25.0
130	Farakka	FKF4B	8120006732	0.41	Bacha	0.34	*Eutropichthys vacha*	0.090	24.5
131	Farakka	FKF5A	8120006733	0.24	Ghere		*Silonia silondia*	0.070	22.0
132	Farakka	FKF5B	8120006734	0.29	Ghere	0.265	*Silonia silondia*	0.050	19.0
133	Farakka	FKF6A	8120006735	0.37	Aar		*Sperata aor*	0.530	48.0
134	Farakka	FKF6B	8120006736	0.26	Aar	0.315	*Sperata aor*	0.450	43.0
135	Farakka	FKF7A	8120006737	0.24	Tel Ghagra		*Mystus sp.*	0.220	29.0
136	Farakka	FKF7B	8120006738	0.30	Tel Ghagra	0.27	*Mystus sp.*	0.120	23.5

1	2	3	4	5	6	7	8	9	10
Sl. No.	Location	Our Code	Lab Code	Hg mg/ kg	Species Local Name	Species/ Variety average	Species Scientific Name	Sample Weight (Kg)	Sample Length (cm)
137	Farakka	FKF8A	8120006739	0.48	Sarpnuti		*Puntius sarana*	0.085	17.5
138	Farakka	FKF8B	8120006740	0.60	Sarpnuti	0.54	*Puntius sarana*	0.080	17.0
139	Farakka	FKG9A	8120006741	0.39	Pholi		*Notopterus notopterus*	0.250	31.0
140	Farakka	FKG9B	8120006742	0.83	Pholi	0.61	*Notopterus notopterus*	0.140	25.5
141	Farakka	FKG10A	8120006743	0.39	Bam		*Mastacembelus armatus*	0.320	48.0
142	Farakka	FKG10B	8120006744	0.83	Bam	0.61	*Mastacembelus armatus*	0.095	33.5
143	Farakka	FKG11A	8120006745	0.62	Shol		*Channa stiatus*	0.700	43.5
144	Farakka	FKG11B	8120006746	1.25	Shol	0.935	*Channa stiatus*	0.570	40.5
145	North Bengal	NBB1A	8120007652	<0.20	Bata		*Labeo bata*	0.155	26.0
146	North Bengal	NBB1B	8120007653	<0.20	Bata	0	*Labeo bata*	0.110	22.5
147	North Bengal	NBB2A	8120007654	<0.20	Shingi		*Heteropneustes fossilis*	0.040	17.0
148	North Bengal	NBB2B	8120007655	<0.20	Shingi	0	*Heteropneustes fossilis*	0.030	16.0
149	North Bengal	NBB3A	8120007656	<0.20	Tangra		*Mystus bleekeri*	0.022	12.0
150	North Bengal	NBB3B	8120007657	<0.20	Tangra	0	*Mystus bleekeri*	0.025	12.5
151	North Bengal	NBB4A	8120007658	<0.20	Bacha		*Eutropichthys vacha*	0.090	24.0
152	North Bengal	NBB4B	8120007659	<0.20	Bacha	0	*Eutropichthys vacha*	0.065	20.0
153	North Bengal	NBB6A	8120007662	<0.20	Baan		*Ophisternon bengalense*	0.070	31.0
154	North Bengal	NBB6B	8120007663	<0.20	Baan	0	*Ophisternon bengalense*	0.040	23.0
155	North Bengal	NBB7A	8120007664	<0.20	Lyata*		*Channa punctatus*	0.070	19.5
156	North Bengal	NBB7B	8120007665	<0.20	Lyata*		*Channa punctatus*	0.080	18.5
157	North Bengal	NBB8A	8120007666	<0.20	Taki*		*Channa punctatus*	0.055	16.0
158	North Bengal	NBB8B	8120007667	<0.20	Taki*	0	*Channa punctatus*	0.045	15.0
159	North Bengal	NBPB9A	8120007668	<0.20	American Rui		*Cyprinus carpio*	1.140	38.0

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
160	North Bengal	NBPB9B	8120007669	<0.20	American Rui	0	*Cyprinus carpio*	0.050	15.0
161	North Bengal	NBPB10A	8120007670	<0.20	Lyata	‡	*Channa striatus*	0.100	24.0
162	North Bengal	NBPB10B	8120007671	<0.20	Lyata	‡	*Channa punctatus*	0.080	20.5
163	North Bengal	NBPB11A	8120007672	0.22	Mrigel		*Cirrhinus cirrhosus*	0.150	26.5
164	North Bengal	NBPB11B	8120007673	<0.20	Mrigel	0.11	*Cirrhinus cirrhosus*	0.140	26.0
165	North Bengal	NBPR12A	8120007674	0.26	Silver Carp		*Hypophthalmichthys molitrix*	0.230	27.5
166	North Bengal	NBPR12B	8120007675	<0.20	Silver Carp	0.13	*Hypophthalmichthys molitrix*	0.160	26.0
167	North Bengal	NBPR13A	8120007676	<0.20	American Rui		*Cyprinus carpio*	0.135	19.5
168	North Bengal	NBPR13B	8120007677	<0.20	American Rui	0	*Cyprinus carpio*	0.140	19.0
169	North Bengal	NBPR14A	8120007678	<0.20	Mrigel		*Cirrhinus cirrhosus*	0.060	18.0
170	North Bengal	NBPR14B	8120007679	<0.20	Mrigel	0	*Cirrhinus cirrhosus*	0.050	17.5
171	North Bengal	NBPK15A	8120007680	<0.20	Shingi		*Heteropneustes fossilis*	0.050	19.5
172	North Bengal	NBPK15B	8120007681	<0.20	Shingi	0	*Heteropneustes fossilis*	0.040	18.0
173	North Bengal	NBPK16A	8120007682	<0.20	Koi		*Anabas testudineus*	0.100	17.0
174	North Bengal	NBPK16B	8120007683	<0.20	Koi	0	*Anabas testudineus*	0.080	16.5
175	North Bengal	NBPK17A	8120007684	0.71	Taki†		*Channa punctatus*	0.055	17.0
176	North Bengal	NBPK17B	8120007685	0.25	Taki†	0.48	*Channa punctatus*	0.050	16.0
177	North Bengal	NBPD18A	8120007686	0.92	Lyata†		*Channa punctatus*	0.100	21.0
178	North Bengal	NBPD18B	8120007687	<0.20	Lyata†	0.46	*Channa punctatus*	0.080	19.0
179	North Bengal	NBRC19A	8120007688	<0.20	Baan		*Mastacembelus sp.*	0.090	35.5
180	North Bengal	NBRC19B	8120007689	<0.20	Baan	0	*Mastacembelus sp.*	0.080	34.0
181	Kolaghat	KOG1A	8120007284	0.41	Pangash		*Pangasius pangasius*	1.250	50.0
182	Kolaghat	KOG1B	8120007285	0.22	Pangash	0.315	*Pangasius pangasius*	1.530	54.0

1	2	3	4	5	6	7	8	9	10
Sl. No.	**Location**	**Our Code**	**Lab Code**	**Hg mg/ kg**	**Species Local Name**	**Species/ Variety average**	**Species Scientific Name**	**Sample Weight (Kg)**	**Sample Length (cm)**
183	Kolaghat	KOG2A	8120007286	0.60	Katla		*Catla catla*	0.800	37.0
184	Kolaghat	KOG2B	8120007287	<0.20	Katla	0.3	*Catla catla*	1.000	39.5
185	Kolaghat	KOG3A	8120007288	<0.20	Silver Carp		*Hypophthalmichthys molitrix*	1.100	46.0
186	Kolaghat	KOG3B	8120007289	0.20	Silver Carp	0.1	*Hypophthalmichthys molitrix*	0.880	42.0
187	Kolaghat	KOG4A	8120007290	0.27	Mrigel		*Cirrhinus cirrhosus*	0.270	30.0
188	Kolaghat	KOG4B	8120007291	<0.20	Mrigel	0.135	*Cirrhinus cirrhosus*	0.250	30.5
189	Kolaghat	KOG5A	8120007292	0.24	Bata		*Labeo bata*	0.130	24.0
190	Kolaghat	KOG5B	8120007293	<0.20	Bata	0.12	*Labeo bata*	0.135	23.5
191	Kolaghat	KOG6A	8120007294	<0.20	Galda Chingdi		*Macrobrachium rosenbergii*	0.100	23.0
192	Kolaghat	KOG6B	8120007295	<0.20	Galda Chingdi	0	*Macrobrachium rosenbergii*	0.900	22.0
193	Kolaghat	KOG7A	8120007296	<0.20	Lilentika		*Oreochromis nilotica*	0.190	22.5
194	Kolaghat	KOG7B	8120007297	0.29	Lilentika	0.145	*Oreochromis nilotica*	0.200	22.0
195	Durgapur	DGP1A	8120008653	0.25	Boal		*Wallagonia attu*	1.040	58.0
196	Durgapur	DGP1B	8120008654	0.21	Boal	0.23	*Wallagonia attu*	0.915	55.0
197	Durgapur	DGP2A	8120008655	<0.20	Aar		*Sperata aor*	0.550	48.0
198	Durgapur	DGP2B	8120008656	0.22	Aar	0.11	*Sperata aor*	0.450	46.0
199	Durgapur	DGP3A	8120008657	0.20	Baan		*Ophisternon bengalense*	0.140	38.0
200	Durgapur	DGP3B	8120008658	0.21	Baan	0.205	*Ophisternon bengalense*	0.125	37.0
201	Durgapur	DGP4A	8120008659	<0.20	American Rui		*Cyprinus carpio*	0.640	29.5
202	Durgapur	DGP4B	8120008660	<0.20	American Rui	0	*Cyprinus carpio*	0.575	27.5
203	Durgapur	DGP5A	8120008661	<0.20	Bacha		*Eutropichthys vacha*	0.160	28.0
204	Durgapur	DGP5B	8120008662	0.20	Bacha	0.1	*Eutropichthys vacha*	0.100	23.0

APPENDIX C (cont.) **TABLE 3:**
Common and Scientific Names of Fish Listed in Table 1 and 2

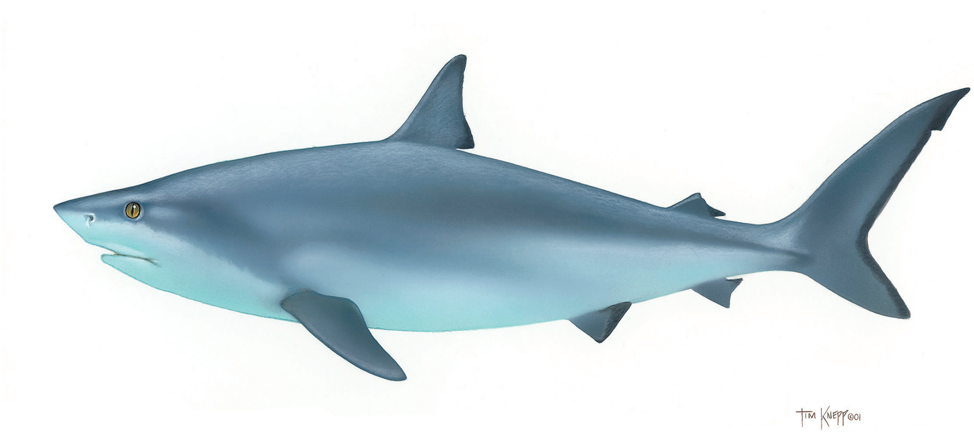
Species /Kind Scientific Name	Species /Kind English Common Name
Anabas testudineus	Climbing perch
Apolectus niger	Black Pomfret or Brown Pomfret
Arius sp.	A variety of catfish
Catla catla	Catla
Channa punctatus	Spotted snakehead
Channa stiatus	Snakehead murrel
Chanos chanos	Milkfish
Cirrhinus cirrhosus	Mrigal
Clarias batrachus	Walking catfish
Coilia sp.	A variety of anchovy
Ctenopharyngodon idella	Grass carp
Cyprinus carpio	Common carp
Devario devario	Sind danio
Eleutheronema tetradactylum	Fourfinger threadfin
Epinephelous sp.	A variety of grouper
Eutropichthys vacha	Vacha catfish
Harpadon nehereus	Bombay-duck

Species /Kind Scientific Name	Species /Kind English Common Name
Heteropneustes fossilis	Stinging catfish
Hypophthalmichthys molitrix	Silver carp
Labeo bata	Bata
Labeo rohita	Rohu
Lates calcarifer	Barramundi
Liza parsia	Gold-spot mullet
Macrobrachium rosenbergii	Giant freshwater prawn
Mastacembelus armatus	Zig-zag eel
Mastacembelus sp.	A variety of eel
Mystus bleekeri	Day's mystus
Mystus sp.	A variety of mysus
Mystus gulio	Long whiskers catfish
Nibea soldado	Soldier croaker
Notopterus notopterus	Bronze featherback
Ompok pabda	Pabdah catfish
Ophisternon bengalense	Bengal eel
Oreochromis nilotica	Nile tilapia
Otolithoides sp.	A variety of Croaker
Pampus chinesis	Chinese silver pomfret
Pangasius pangasius	Yellowtail catfish

Species /Kind Scientific Name	Species /Kind English Common Name
Panna microdon	Panna croaker
Pellona sp.	Pellona
Penaeus monodon	Tiger prawn
Penaeus sp.	A local variety of prawn
Platycephalous sp.	Name uncertain
Polydactylus sexfilis	Sixfinger threadfin
Portunus pelagicus	A certain kind of crab
Puntius sarana	Olive barb
Raconda russiliana	Raconda
Rhinomugil corsula	Corsula
Setipinna phasa	Gangetic hairfin anchovy
Sillaginopsis panijus	Flathead sillago
Sillago sihama	Silver sillago
Silonia silondia	Silond catfish
Sperata aor	Long-whiskered catfish
Tenualosa ilisha	Hilsa shad
Trichurus lepturus	Largehead hairtail
Trichurus sp.	A variety of ribbonfish or cutlassfish
Wallagonia attu	Wallago

APPENDIX D:
Test Data on Mercury in Fish
Manila, Philippines

FISH SAMPLE	TEST RESULTS MERCURY PPM	LOCATION WHERE SAMPLE WAS CAUGHT
1. Bluefin Tuna	0.09	Gen. Santos (Southern Mindanao)
2. Bluefin Tuna	0.17	Zamboanga (Southern Mindanao)
3. Swordfish	1.20	Dumaguete (Visayas)
4. Swordfish	0.64	Quezon Province (Southern Luzon)
5. Mackerel	0.15	Quezon Province (Southern Luzon)
6. Mackerel	0.16	Zambales (Western Luzon)
7. Blue Marlin	0.92	Gen. Santos (Southern Mindanao)
8. Blue Marlin	1.60	Gen. Santos (Southern Mindanao)
9. Shark	2.30	Quezon Province (Southern Luzon)
10. Shark	2.30	Quezon Province (Southern Luzon)



APPENDIX E:
Fish Listed as Large Predatory Species
Codex Alimentarius Committee

Product	Codex guidance level (mg/kg wet weight)
Predatory fish*:	
alfonsino (*Beryx species*) anglerfish (*Lophius species*) atlantic catfish (*Anarhichas lupus*) barracuda (*Sphyraenidae*) barramundi (*Lates calcarifer*) bonito (*Sarda sarda*) dogfish (*Squalus acanthias*) eel (*Anguilla species*) emperor, orange roughy, rosy soldierfish (*Hoplostethus species*) grenadier (*Coryphaenoides rupestris*) grouper (*Serranidae species*) halibut (*Hippoglossus hippoglossus*) ling (*Molva species*) king mackerel (*Scomberomorous cavalla*) marlin (*Makaira species*) megrim (*Lepidorhombus species*) mullet (*Mullus species*) pike (*Esox lucius*) plain bonito (*Orcynopsis unicolor*) poor cod (*Tricopterus minutes*) portuguese dogfish (*Centroscymnes coelolepis*) rays (*Raja species*) redfish (*Sebastes marinus, S. mentella, S. viviparus*) sail fish (*Istiophorus platypterus*) scabbard fish (*Lepidopus caudatus, Aphanopus carbo*) seabream, pandora (*Pagellus species*) shark (*all species*) snake mackerel, butterfish, escolar (*Lepidocybium flavobrunneum, Ruvettus pretiosus, Gempylus serpens*) sturgeon (*Acipenser species*) swordfish/ broadbill (*Xiphias gladius*) tilefish (*Lopholatilus, Caulolatilus, Hoplolatilus, Malacanthus*) tuna (*Thunnus species, Euthynnus species, Katsuwonus pelamis*)	1.0 mg/ kg