Mercury

Mercury comes in three forms from a toxicological perspective.

- inorganic mercury salts. They are water soluble, are irritating to the gut, and cause severe kidney damage. They are used in industry for teething powders, skin lightening creams, and as preservatives in some medicines such as eye drops. It is highly toxic if ingested, with as little as 0.5 g being lethal.
- organic mercury compounds, which is primarily methyl mercury. It is fat soluble, 90-100% of an oral dose is absorbed, and it is able to cross the blood brain barrier.
- metallic mercury (also known as elemental mercury, liquid mercury, or quicksilver). It can easily vaporize at room pressure and then be inhaled by people which is highly toxic. Ingesting liquid mercury has minimal bioavailability in contrast. It also can be transformed into organic mercury by bacteria such as in lakes and be passed up the food chain. This is what happened in the 1950s in Minamata, Japan when over 800 people were poisoned.

Methyl mercury is the most common form people encounter. Almost all of methyl mercury that people are exposed to comes from seafood contamination. As of 2019 approximately 35,000 pounds of mercury got released into the air in the U.S. which in relative terms is a lot better than a decade earlier (when almost 100K pounds was released in 2009).

Mercury gets into the air, water, and soil from sources such as the manufacture of Portland cement, the burning of oil and wood, electronic devices, light bulbs, batteries, thermometers, etc. that are thrown into the garbage. The burning of iron ore, coke, and limestone to make steel, and use of coal in furnaces also can result in mercury being released; coal-fired power plants are the #1 source of mercury getting into the environment. Car exhaust and especially from diesels also can contain mercury. Cigarette smoke contains mercury. It is involved in the production of chlorine, and it has been used as a fungicide. And one of the more bizarre sources of mercury getting into the environment is from human bodies being cremated.

The most common cause of mercury poisoning comes from eating contaminated seafood especially from fish higher up the food chain that have concentrated it from eating smaller fish. Fish that are higher up the food chain with larger amounts of mercury contamination include tuna, marlin, and king mackerel, along with sharks and swordfish. Smaller fish (e.g. salmon, shrimp, snapper, pollock, grouper, catfish) are thought to be okay to eat 1-2 times/week. Kids and unborn babies are most vulnerable to the effects of mercury poisoning. Methyl mercury gets concentrated in the brain, liver, kidneys, placenta, and the fetus and especially its brain, as well as peripheral nerves and bone marrow.

Metallic mercury can occur from something like a fluorescent bulb or thermometer breaking, and if it is not cleaned up quickly the vapor can be inhaled. Mercury can also be found in barometers, switches, thermostats, and electrical switches. It has been used in dental fillings but that is decreasing over time as substitute materials are employed. There has been some continuing

controversy about the safety of such amalgam fillings. The CDC as of 2001 said they are safe and that for the vast majority of people their health is not compromised by them. Gold mining sometimes uses elemental mercury and the process can be very dangerous for the miners.

Mercury also is in some vaccines, in the form of thimerosal, which is a preservative. A vaccine that contains 0.01% thimerosal would have 50 mcg of thimerosal per 0.5 ml dose which would be about 25 mcg of mercury. That is about how much is found in a 3 oz. can of tuna. The use of thimerosal has been declining in recent years as alternatives have been used. Some years ago there was a large story about thimerosal causing autism. That got debunked when it was learned that a particular doctor had lied.

Another potential source of mercury contamination comes from cosmetics. Such use was banned back in 1974 but as is always the case, there are loopholes and ways to get around the law. Mercury can still be found in skin-lightening creams (e.g. to fade dark spots, sunspots, blemishes, etc.) and especially those made in China.

And then there is high fructose corn syrup (HFCS) which is said to make up 10% of calories that Americans consume, such as in sweetened beverages and processed foods. It can be put into it as an anti-microbial preservative. A 2009 study (Environmental Health, "Mercury from chlor-alkali plants: measured concentrations in food product sugar" Renee Dufault et al, 1/26/09) found levels of mercury in it below detectable levels up to 0.570 mcg/g of HFCS, 9/20 samples did have detectable levels of mercury. Another study by the Institute for Agriculture & Trade Policy found mercury in nearly a third of 55 name-brand foods, most commonly HFCS-containing diary products, dressings, and condiments and that listed HFCS as the first or second ingredient. Average consumption of HFCS is said to be about 50 g/day.

Symptoms of mercury poisoning can include:

- anxiety
- depression (There is some research that has found an association between fish consumption and suicide. One possible explanation is that it may be stemming from mercury contamination in the seafood leading to depression which leads to increased suicidal risk. There was one large study in the American Journal of Epidemiology, "Suicide mortality in relation to dietary intake of n-3 and n-6 polyunsaturated fatty acids and fish: equivocal findings from 3 large US cohort studies", Alexander Tsai, et al. 2014. It looked at over 205,000 people taken from the Nurses Health Study, Nurses Health Study 2, and the Health Professionals Follow-up Study and followed for 14-22 years. Omega-3 intake did not lower the risk of completed suicide, and there was a trend toward higher risk of suicide, but it was below a significant level.)
- irritability
- memory problems
- numbness
- tremors
- hearing and speech difficulties

- lack of coordination
- muscle weakness
- trouble walking
- changes in vision
- nerve loss in the hands and face
- thyroid issues may result because it can accumulate in the gland and it interferes with the conversion of T4 to T3. Some research suggests that Hashimoto's or Graves' disease can result. Whether it is causing such conditions or triggering an autoimmune response that then leads to them is debated, but the end result would still be the same, having such a thyroid state.
- excess mercury has been implicated in the formation of some cataracts
- it also lowers progesterone levels and increases estrogen

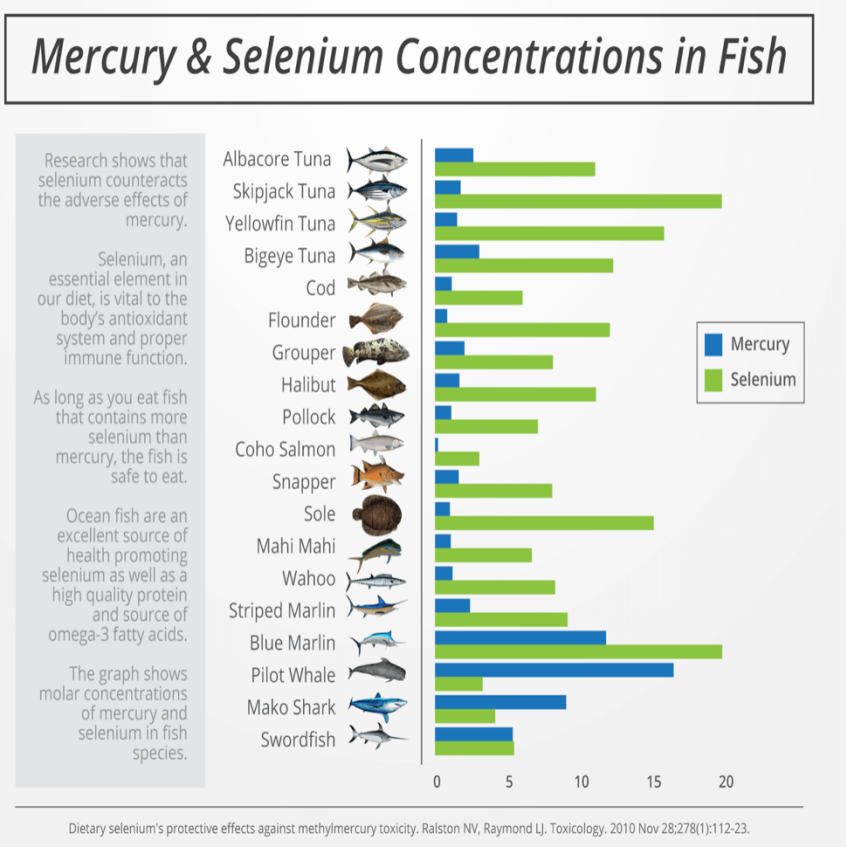
The general guideline for avoiding mercury from seafood consists basically of:

- don't eat fish which is advice often given to women who are pregnant or may become so
- or, eat fish that are lower on the food chain. Big fish eat little fish, and the mercury gets concentrated as it goes up the food chain.

Below is a chart produced by the Federal government as to its advice on which fish to eat and how often.

Non-governmental sources do not necessarily agree with the list shown above. Some say that shrimp, lobsters, oysters, and other shellfish are a greater risk for mercury contamination. Freshwater fish from lakes and rivers (e.g. trout, largemouth bass) are said to be a larger risk too, and that the 'good choices' shown above are best avoided as well. e.g. White albacore tuna is said to typically have three times as much mercury as chunk light canned tuna. And chunk light tuna is not so safe in that on average it contains 37% more mercury than seafood in general. Canned light tuna is said to be the single largest source of methyl mercury in the American diet. Another issue to be aware of is that not all canned light tuna is the same. There are the major U.S. brands like Star-Kist, Bumblebee, or Chicken of the Sea. But there are also minor brands such as those from Central and South America that have much higher levels. Moreover, even the U.S. brands can have various amounts with some much higher than others. One study from 2010 (Environmental Toxicology & Chemistry, "An evaluation of mercury concentrations in three brands of canned tuna" Shawn Gerstenberger et al), found that 55% of all the canned tuna examined was above the EPA's safety level for human consumption. Moreover, the level of mercury in tuna appears to be getting worse over time, such as there being more than a doubling of mercury between 1993-2010. It should be appreciated that how much mercury is in seafood is dependent on what they eat and how long they live, as well as where they are in the food chain.

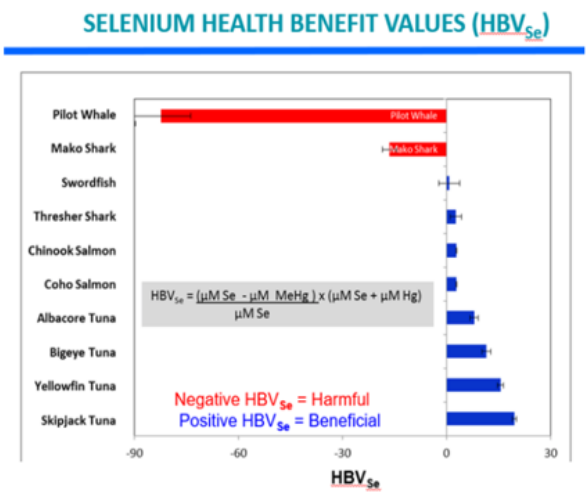
The FDA is also a governmental agency and is subject to political pressures as to protecting the seafood industry. (At a FDA meeting on 12/10/03, "FDA scientist Clark Carrington explained: "In order to keep the market share at a reasonable level, we felt we had to keep light tuna in the low-mercury group." Cited in http://mercuryfactsandfish.org/mercury-facts/mercury-in-tuna-fish/). This same source notes that using FDA data tuna contributes 37% of all the mercury in the US seafood supply vs. 6.5% that comes from swordfish, shark, king mackerel and Gulf tilefish. So tuna is contributing about six times more mercury than the high risk fish collectively do and which people are warned against eating.



https://drjockers.com/selenium-detoxify-mercury/

However, there is a third side to this coin. There is some research that has found that the damage mercury causes to the brain is due to it binding up selenium, which is an important mineral for us, and a deficiency then results. If there is enough selenium maintained by increasing intake of it then brain damage is not an issue. Most ocean fish have high levels of selenium and in relative terms less mercury, and so are said not only to be safe to eat but are healthy in doing so.

A researcher at the U. of North Dakota has created a formula that determines the "Health Benefit Value of Selenium" for fish by looking at the ratio of selenium to mercury. Pilot whale and shark are the worst ocean fish to eat according to him, while tuna is beneficial. Based on this idea, "eating fish is especially important for pregnant women and for infants. Professor Ralston's Selenium Healthy Benefit Values for ocean fish provide biochemically based information that supports the FDA/EPA advice for pregnant and breast-feeding women regarding which seafood that should be limited versus the seafood that are beneficial to consume. Maternal consumption of seafood has been shown to benefit the child's neurological development." https://seleniumfacts.com/index.php/mercury



The Selenium Health Benefit Values table shows that salmon and tuna contain enough selenium to bind to methylmercury and permit us to get the good nutrition – lean protein, essential fatty acids, vitamins – from fish meals. Meals of pilot whale and some sharks should be avoided.

As to freshwater fish, this research offers that the relationship of selenium to mercury is very variable from one region to another, and there is a need to look at where such fish are caught to determine the health benefit value. In North America the National Research Council says there are low selenium content in plant and animal food in the following locations:

- the Pacific Northwest of the US
- the south Atlantic seaboard of the US
- the northeastern US
- Arizona and New Mexico
- the Atlantic provinces of Canada
- the interior of British Columbia
- west-central Alberta
- northern Ontario
- the eastern townships and lower St. Lawrence regions of Quebec

<u>What is a safe level of mercury?</u>

There is something called the 'reference dose' (RfD) which was set in 1999. It is not set in concrete and it is likely to be revised over time as more is learned. Currently the RfD is 0.1 mcg/kg of body weight x7 (to convert amount per day to amount per week). For a woman who weighs 132 lbs. (60 kg) that would be 42 mcg of methyl mercury/week. Mercury is a poison and its effects are subtle, and how much damage is being done and how fast is hard to know for sure as one exceeds the RfD.

The EPA also has made calculations of what blood level would correspond to the RfD and doing so came up with 5.8 mcg/liter of blood. This is called the EPA Reference Level. It is a long-term average of mercury in the blood that is "reasonably certain to be without appreciable risk."

There is confusion sown in the process of using these numbers and labels (RfD and Reference Level) by some such as in the seafood industry, such as saying that the RfD is 58 mcg/liter, or that it is 5.8 mcg/deciliter. The numbers cited in this paper are the correct ones.

Another issue to be aware of is that the RfD is based on chronic exposure as to a fairly long period of time. Having a single meal with a lot of mercury is thought to probably not be dangerous, usually. But if a pregnant woman has a high-mercury meal once during the term it might be very foolish to assume that it is so safe. Methyl mercury can pass through the placenta to a fetus. Babies and little kids such as those breastfeeding have rapidly developing brains and mercury can do a lot of damage to that process.

Another issue to be aware of is that current EPA regulations allow mercury levels in fish to be about 10 times higher than the 0.1 mcg/kg of body weight standard would tolerate. Plus there are some researchers who suggest the EPA standard should be cut in half, meaning that fish could be containing 20 times more mercury than is safe.

There is experimental evidence from animal research that short-term exposure to high levels of mercury, such as from a single meal, can cause significant fetal damage, especially if it is occurring in a critical developmental stage. Two studies have measured adverse effects of low-level mercury exposure on human fetuses' brains, as to mercury being at or below the Reference Level. i.e. Ordinary levels of mercury from fish does pose a risk to the developing brain.

One study (Environmental Research, "Cognitive performance of children prenatally exposed to 'safe' levels of methyl mercury" May 1998, P. Grandjean et al) looked at 112 kids who had mothers with hair mercury concentrations of 10-20 mcg/g compared to those kids with exposure below 3 mcg/g. The kids with higher exposure "showed mild decrements, relative to controls, especially in the domains of motor function, language and memory. Subtle effects on brain function therefore seemed to be detectable at prenatal methyl mercury levels currently considered to be safe." Another researcher has stated that "The EPA and National Academy of Science have said that 8-10% of American women have mercury levels that would render any child they gave birth to neurological disorders." (Medical Veritas, "Mercury toxicity: genetic susceptibility and synergistic effects" B.E. Haley, 2005).

Given that research into human babies and mercury poisoning is very difficult beyond observational studies, there is a lot that is not known about short term spikes in mercury levels. But the safe advice is for pregnant and breast-feeding women to avoid mercury as much as possible.

One study found that for every microgram of mercury found in the hair the risk of acute coronary events increased by an average of 11% and cardiovascular disease death rate by 10% (Journal of

Nutritional Biochemistry, "Mercury as a risk factor for cardiovascular disease", Jyrki Virtanen et al, Feb. 2007).

Having made a case to avoid mercury as much as possible, one national study (NHANES, 1999-2002) found that for women of child-bearing age the average mercury level was 0.92 mcg/liter and that for kids ages 1-5 years it was 0.33 mcg/l. For women ages 16-49 5.66% were above the 5.8 mcg/l level. The number of kids at or above that level was too small to calculate a reliable estimate. (Cited from the CDC, "Blood mercury levels in young children and childbearing-aged women - U.S., 1999-2002, MMWR weekly, 11/5/04).

Other research looked at umbilical cord blood and its mercury level and found that it was about 70% higher in mercury concentration than maternal blood. If a lower RfD of 3.5 mcg/l is used to compensate for this issue, then the number of women of child-bearing age with that mercury level or higher in the U.S. would result in 600,000 newborns/year who receive "in utero mercury exposure that is associated with increased risk of neurodevelopmental effects." (Transactions of the American Clinical and Climatological Association, "Mercury exposure: medical and public health issues", Kathryn Mahaffey, 2005).

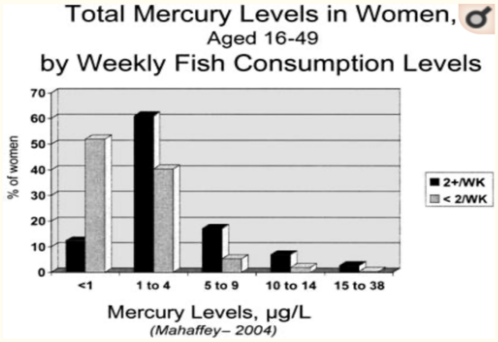


Fig. 2

Blood mercury (total in µg/L) for adult women aged 16 to 49 years examinees who participated in NHANES 1999/2000 by weekly fish consumption.

This was taken from the NHANES study of 1999-2000, and it basically shows that eating fish 2+ times/week leads to higher levels of mercury in these women.

How much mercury is in your body?

There are different types of testing that can be done to determine how much mercury you may have in your body. These include:

- a blood test. This is measuring what you may have been exposed to, typically from seafood. If methylmercury from seafood is not an issue, elevated blood levels may reflect ongoing inorganic mercury exposure. If the levels decrease rapidly it may mean that the inorganic exposure has ended. Metallic and inorganic mercury can be detected in the blood too but the half-life is about 3 days in that it moves into organs like the brain and kidneys. Consequently, testing needs to be done within days or suspected exposure. A blood level above 10 mcg/L indicates an unusual exposure for someone who does not regularly work with mercury.

- urine test, which tests for metallic and inorganic forms of mercury, but not methyl mercury. Small amounts may be found from dental amalgam fillings. Elevated levels in the urine may indicate a chronic, high level exposure such as from a workplace. Normal urine samples are typically less than 10 mcg/L for those without occupational exposure.
- hair testing can assess for methyl mercury exposure that has occurred over time such as the past several months. It can be impacted by various factors such as dyes, bleach, shampoo, etc. Some research has found that elevated levels of methyl mercury in maternal hair may be associated with harmful effects on the neurological development of babies. Other forms of mercury exposure have not been clearly or consistently shown to be reflected in hair levels.

One company (QuicksilverScientific.com) offers a 'tri-test' which encompasses all three of these approaches, along with a 'free' 30-minute consultation upon completion of the results. It looks at both methyl as well as inorganic mercury.

According to the Mayo Clinic blood levels of mercury 0-9 ng/ml of blood is not a concern. Blood levels of 10-15 ng/ml is a mild exposure. Levels over 50 ng/ml is heavy. Levels above 15 ng/ml are considered to be the point where a detox is needed, and below that your kidneys and liver are thought capable of filtering it out.

Detoxing from mercury

Mercury gets removed from the human body on its own to some extent. The half-life is approximately 100 days (others say 70 days), meaning that if you stop ingesting it after 100 days the blood level will be cut in half. After 200 days the blood level should be down to one-fourth it had been at its peak, etc. BUT mercury does not just go into the blood. It also can get into the brain and autopsy findings have included the half-life of mercury then being over 27 years. That has ramifications especially to women who want to be or are pregnant, or are breast feeding. Up to 20% of methyl mercury is thought to be excreted in breast milk, with the bulk of the rest eliminated through stool.

There is some research that has found that the only way to produce a significant impact on kids' exposure "required mothers to eliminate fish from their diets for 5 years before their children were conceived." (Environmental Health Perspectives, "Fish consumption caveat: advisories may not help with long-lived contaminants" Feb. 2014).

One approach to removing mercury, as well as lead and cadmium, from the human body, is through use of a lactovegetarian diet. One study found that mercury levels dropped by 25%, lead by 47%, and cadmium by 24% after three months on the diet. When the subjects went off the diet, their levels of these poisons returned to about their baseline although lead was actually 13% higher after a three-year period.

Other approaches to removing mercury is by eating more fiber which moves everything through your bowel more regularly and in the process the mercury too. Drinking more water can help, in that mercury is eliminated somewhat through the urine.

There are claims that can be found on the internet about various foods and spices that may help with detoxing from mercury. These include garlic, cilantro, and Brazil nuts. There is little research on such stuff and it tends to be done on rats or other animals. The downside is usually limited but eating something like too many Brazil nuts could lead to a toxic level of selenium. Sulfur-rich foods (e.g. garlic, onions, broccoli) may be helpful. Glutathione which is a powerful anti-oxidant in the body might also help remove it, and Brewer's and nutritional yeast have glutathione building nutrients. Saunas may help with its removal through sweat.

Zinc, iron, and sulfur may also be helpful in combatting and preventing the adverse effects of mercury. That does not mean you should start gulping down such supplements by the handful. They can impact other nutrients (e.g. zinc and copper need to be kept in balance to each other). And the human body likes 'Goldilocks' levels of everything, not too much, not too little, but just right. Assessing your nutritional status for such minerals relative to your mercury level and then talking to an appropriate professional for nutritional advice about supplements or obtaining such minerals through your diet is advised.

There are also any number of products that can be found on the internet, but the amount of research on them is generally sparse as to just how effective they are.

Some experts voice concern that if you try to flush out toxic elements like mercury too fast, what might happen is that it goes from being locked up in your body to suddenly flushed into your blood stream and hits with you a more serious and acute poisoning. Consequently, they recommend that you first strengthen yourself nutritionally such as by looking at mineral and vitamin levels and getting them up to snuff, before you flush anything out of your system.

There is also chelation therapy that medical doctors can do, which bind up mercury and help it be eliminated from the body, such as a through use of a chemical called DMPS, DMSA, or through DPCN or BAL. They can exist in pill or IV form. Talk to a doctor for details. Such chelating agents do have risks. Side effects might include dehydration, low calcium levels, kidney damage, elevated liver enzymes, allergic reactions, lower levels of some nutrients like zinc, and even death.

Table 1. Mercury levels in 51 varieties of fish and shellfish

Fish/Shellfish Variety	Mercury, µg/g			
	Mean	Min	Max	No. Samples
Tilefish, Gulf of Mexico	1.450	0.65	3.73	60
Shark, all varieties	0.988	ND	4.54	351
Swordfish	0.976	ND	3.22	618
Mackerel, king	0.730	0.23	1.67	213
Orange roughy	0.550	0.30	0.86	49
Marlin	0.489	0.10	0.92	16
Grouper, all varieties	0.460	0.05	1.21	43
Tuna, fresh/frozen	0.384	ND	1.30	228
Mackerel, Spanish	0.368	0.05	1.56	109
Tuna, canned albacore	0.353	ND	0.85	399
Bluefish	0.340	0.14	0.63	52
Bass, freshwater	0.318	NA	NA	NA
Lobster, American	0.310	0.05	1.31	88
Croaker, Pacific	0.303	0.18	0.41	15
Bass, saltwater	0.301	ND	2.18	87
Lingcod & scorpionfish	0.286	0.02	1.34	78
Sablefish	0.273	ND	0.70	102
Trout, saltwater	0.269	ND	0.74	39
Halibut	0.220	ND	1.52	46
Carp & buffalofish	0.203	0.01	0.43	6
Haddock, hake & monkfish	0.170	ND	1.02	94
Perch, freshwater	0.162	ND	0.31	6
Skate	0.137	0.04	0.36	56
Snapper, porgy & sheepshead	0.137	ND	1.37	102
Lobster, spiny	0.121	ND	0.27	9
Tuna, canned light	0.118	ND	0.85	347
Cod	0.115	ND	0.42	39
Tilefish, Atlantic	0.111	0.04	0.53	32
Smelt	0.092	0.04	0.50	16
Mackerel, Pacific (Chub)	0.088	0.03	0.19	30
Whitefish	0.075	ND	0.31	28
Croaker, Atlantic	0.073	0.01	0.15	35
Squid	0.070	ND	0.40	200
Catfish	0.068	ND	0.31	23
Butterfish	0.058	ND	0.36	89
Pike	0.056	NA	NA	NA

Anchovies, herring & shad	**0.050**	**ND**	**0.34**	**137**
Flatfish (flounder, sole & plaic	**0.050**	**ND**	**0.18**	**23**
Crabs, all varieties	**0.050**	**ND**	**0.61**	**63**
Mackerel, Atlantic	**0.049**	**0.02**	**0.16**	**80**
Pollock	**0.049**	**ND**	**0.78**	**62**
Perch, saltwater & mullet	**0.040**	**ND**	**0.13**	**197**
Trout, freshwater	**0.037**	**ND**	**0.68**	**34**
Crayfish	**0.033**	**ND**	**0.05**	**44**
Salmon	**0.028**	**ND**	**0.19**	**57**
Oysters & mussels	**0.023**	**ND**	**0.25**	**38**
Clams	**0.023**	**ND**	**ND**	**6**
Scallops	**0.023**	**ND**	**0.22**	**66**
Tilapia	**0.020**	**ND**	**0.07**	**9**
Sardines	**0.016**	**ND**	**0.04**	**29**
Shrimp	**0.012**	**ND**	**0.05**	**24**

Data are for total mercury and/or methylmercury; in most cases the two are nearly equivalent (i.e. 90-95 percent of mercury in most fish is methylated).
Data are from USFDA (2009), Tables AA-2 and AA-3. Also available online at http://www.fda.gov/Food/FoodSafety/Product-SpecificInformation/Seafood/
ND = Not detected (Limit of Detection 0.01 µg/g).
NA = Data not available; FDA has removed freshwater bass and pike from its published database because they are not sold commercially.
http://mercuryfactsandfish.org/wp-content/uploads/2010/02/FDADataMercuryLevelsFishAndShellfish.pdf