FISH CONSUMPTION ADVISORY PROTOCOL IN IOWA

Developed by the Iowa Department of Public Health

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Background

Since 1980, the State of Iowa has been conducting sampling and monitoring fish within Iowa's water bodies for potentially toxic contaminants. The State of Iowa has historically used the action levels developed by the Food and Drug Administration (FDA) as the basis for determining if levels of contaminants within fish tissue have reached a level of concern to issue consumption advisories. Other states located adjacent to Iowa currently utilize different methodologies and action levels to determine when to issue fish consumption advisories. Several of these states have advisories that include several levels of consumption frequencies that are recommended to consumers of fish. This paper outlines the revised protocol that brings the state of Iowa a little closer to the protocol used by other states, but at the same time maintaining some of the essential elements of the previous Iowa protocol for issuing fish consumption advisories. The revised protocol focuses on three contaminants that can be present in fish tissue and that are of concern nationwide– methylmercury, polychlorinated biphenyls (PCBs), and chlordane.

Previous Iowa Advisory Protocol

As previously stated, Iowa's previous (FDA Action Level-based) protocol for issuing fish consumption advisories was to compare the concentration of chemicals within fish tissue to the FDA action levels. This protocol was used from the early 1980s through 2005. The FDA action levels are 1 ppm for methylmercury, 2 ppm for PCBs, and 0.3 ppm for chlordane within the fish tissue. Fish consumption advisories were issued for water bodies in which the fish sampled exceed these action levels in two consecutive samplings. The recommendation included in the previous advisory was for no consumption of fish covered by the advisory. The Iowa Department of Natural Resources (IDNR) was responsible for issuing fish consumption advisories. The IDNR consulted with the Iowa Department of Public Health (IDPH), to determine if the action levels utilized in the advisories were protective of public health.

In addition to site specific advisories, the IDNR began recommending in 2005 that individuals who make up the more sensitive or vulnerable portion of our population (women who are pregnant and nursing or who are planning to be pregnant, and children up to 16 years old) only consume one meal per week of larger predator fish such as bass or walleye. The reason for this recommendation is that larger predator fish have the greater potential to bioaccumulate toxic chemicals (methylmercury, PCBs, and chlordane) within their tissue. A recommendation to limit consumption of predator fish for this portion of the population provides an additional protection from exposure to these

and other chemicals. This one meal per week recommendation is also included in the revised advisory and is stated on the IDNR web site at the following web address:

http://www.iowadnr.com/fish/news/consump.html

Health Issues

Fish is an important part of a healthy diet. Thus IDPH wishes to encourage the consumption of fish, but at the same time wishes to protect individuals from the consumption of larger quantities of fish that have higher levels of toxic contaminants. The ingestion of fish containing higher levels of chemicals such as methylmercury, PCBs, and chlordane can impact human health. The health impacts of ingestion of methylmercury, PCBs, and chlordane are discussed below.

Methylmercury

Mercury is a naturally occurring element in the environment and is also released into the air through industrial pollution. Mercury that falls from the air can accumulate in streams, rivers, lakes and the ocean. Bacteria in the water cause chemical changes that transform mercury into methylmercury. Fish absorb the methylmercury as they feed in these waters. Methylmercury accumulates more in the muscle tissue of some fish than others depending on what they eat, how long they live, and how high up they are in the food chain.

Methylmercury is a potent neurotoxin that, in cases of high levels of exposure, can cause mental retardation, cerebral palsy, and seizures (1). Individuals that consume fish on a regular basis are exposed to small amounts of methylmercury. Regulatory agencies have attempted to evaluate the toxicity of methylmercury in an attempt to promulgate acceptable oral exposure levels that would be protective to human health.

The FDA action level of 1 ppm methylmercury in fish was designed as a regulatory tool to help ensure that the general population did not exceed the FDA acceptable daily intake (ADI). The ADI for methylmercury is set at 0.43 µg/kg body weight/day. A daily consumption of 30 grams (or about 1 ounce) of fish contaminated with 1 ppm methylmercury would equal the ADI. This is equivalent to about one meal (6-7 ounces) of fish per week at the 1 ppm level.

The Agency for Toxic Substances and Disease Registry (ATSDR) has set a minimum risk level (MRL) for chronic-duration oral exposure to methylmercury at 0.3 µg/kg/day. This MRL is very similar to the ADI set by the FDA. The ATSDR MRL for methylmercury is based on neurodevelopmental outcomes in a study on children exposed in utero to methylmercury from maternal fish ingestion (1). This MRL was based upon a no observed adverse health effect level (NOAEL). There were no adverse health effects observed in this study and the authors noted some positive neurodevelopmental impacts due to most likely the increase consumption of omega-3-fatty acids (fish) at the NOAEL.

Consumption of one meal per week of fish contaminated with approximately 0.7 ppm methylmercury would equal the MRL of 0.3 µg/kg/day.

The Environmental Protection Agency (EPA) has developed an oral reference dose (RfD) for methylmercury of 0.1 µg/kg/day. The RfD was based on developmental neurological abnormalities in human infants (2). In this study neurological impairments were noted in infants whose mothers were exposed to a benchmark dose that corresponded to range of maternal consumption rate of methylmercury from 0.857 to 1.472 µg/kg/day. An uncertainty factor of 10 was applied to this benchmark consumption rate to account for variability and uncertainty in estimating an ingested methylmercury dose from cord-blood methylmercury concentration and other uncertainties. Consumption of one meal per week of fish contaminated with approximately 0.2 ppm methylmercury would equal the RfD of 0.1 µg/kg/day.

PCBs

PCBs are a family of more than 200 chemical compounds. The differing varieties of PCBs are called congeners. PCBs were discovered over 100 years ago, but their production and commercial use began in 1929. Because of their remarkable insulating capacity and their flame-retardant nature, PCBs gained widespread use as coolants and lubricants in transformers and other electrical equipment. Manufacture and use of PCBs was banned in 1979; however, PCBs are extremely persistent in the environment and biomagnify within the food chain. As with methylmercury, fish absorb PCBs as they feed in water containing PCBs; and the PCBs accumulate more in the fatty tissue of some fish than others depending on what they eat, how long they live, and how high up they are in the food chain.

PCBs can cause skin conditions, such as acne and rashes, in individuals exposed to high levels (3). Studies have been completed in an attempt to determine health effects from exposure to low levels of PCBs such as the low levels that may be contained in fish tissue. As with methylmercury, regulatory agencies have promulgated acceptable oral exposure levels of PCBs that would be protective of human health.

The FDA tolerance of 2 ppm PCBs in fish was developed considering health studies, average levels of consumption of fish by the general public, and the economic impact to the fish industry. It was concluded by the FDA that an action level of 2 ppm PCBs in fish would be protective of health to the majority of consumers and would not be overly economically harmful to the fishing industry (4). According to the FDA, this action level applies to fish that are sold on a commercial basis. The FDA also concluded that the 2 ppm tolerance level may not adequately protect atypical sport fishers who consume large quantities of fish contaminated with PCBs. The FDA encourages State authorities to consider how they can adequately protect these consumers of recreationally caught fish that may contain high levels of PCBs.

ATSDR has set a MRL for chronic-duration oral exposure to PCBs at 0.02 µg/kg/day based upon a lowest observed adverse effect level (LOAEL) of 5 µg/kg/day for immunological effects in adult monkeys from exposure to Aroclor 1254, one of the many congeners of PCBs (3). The EPA has developed an RfD of 0.02 µg/kg/day for Aroclor 1254 based on dermal/ocular and immunological effect in monkeys, and an RfD of 0.07 µg/kg/day for Aroclor 1016 based on reduced birth weight in monkeys (5). Consumption of one meal per week of fish contaminated with approximately 0.05 ppm PCBs would equal the oral MRL or RfD of 0.02 µg/kg/day.

The Uniform Great Lakes Sport Fish Consumption (Great Lakes) advisory utilizes a health protection value (HPL) of 0.05 µg/kg/day which was derived by a weight-of-evidence evaluation of health effect levels (6). The following Border States to Iowa utilize the Great Lakes advisory protocol: Minnesota, Wisconsin, and Illinois. Consumption of one meal per week of fish contaminated with approximately 0.12 ppm PCBs would equal the Great Lakes HPL of 0.05 µg/kg/day.

Chlordane

Chlordane is a man-made chemical that was used as a pesticide in the United States from 1948 to 1988. Prior to 1978 chlordane was used as a pesticide on agricultural crops, lawns, and gardens and as a fumigating agent. From 1983 to 1988 chlordane was only approved to be used to control termites in homes. As with PCBs, chlordane is extremely persistent in the environment and biomagnify with the food chain. Fish absorb chlordane as they feed in water containing chlordane; and the chlordane accumulates more in the fatty tissue of some fish than others depending on what they eat, how long they live, and how high up they are in the food chain.

Chlordane can cause effects to the central nervous system, the digestive system, and the liver for individuals who swallow chlordane mixtures (7). As with methylmercury and PCBs, regulatory agencies have promulgated acceptable oral exposure levels of chlordane that would be protective of human health.

Under the Federal Food, Drug and Cosmetic Act the EPA is authorized to establish a tolerance for the maximum amount of a pesticide residue that may be legally present in or on a raw agricultural commodity as well as to exempt a pesticide residue from the requirement of a tolerance. A tolerance or tolerance exemption is required when EPA grants registration for the use of a pesticide in food and feed production. FDA is responsible for the enforcement of these tolerances established by EPA. An action level specifies the level below which FDA exercises its discretion not to take enforcement action. The FDA action level of 0.3 ppm for chlordane currently in effect is an unavoidable pesticide residue concentration in fish (8).

ATSDR has set a MRL for chronic-duration oral exposure to chlordane at 0.6 µg/kg/day based upon a NOAEL of 0.055 mg/kg/day for hepatic (liver) effects in rats in a 30-month study (7). A safety factor of 100 was utilized in the determination of the oral MRL.

Consumption of one meal per week of fish contaminated with 1.4 ppm chlordane would equal the oral MRL of 0.6 µg/kg/day.

The EPA has developed an oral RfD for chlordane of 0.5 µg/kg/day based upon a NOAEL of 0.15 mg/kg/day for hepatic effects in mice in a 104-week study (9). A safety factor of 300 was utilized in the determination of the oral RfD. Consumption of one meal per week of fish contaminated with 1.2 ppm chlordane would equal the RfD of 0.5 µg/kg/day.

A HPL of 0.15 µg/kg/day has been establish by the state of Illinois based upon a weight-of-evidence evaluation of health effect levels (10). They have incorporated this level into their version of the Great Lakes advisory. Consumption of one meal per week of fish contaminated with approximately 0.35 ppm chlordane would equal the Illinois HPL of 0.15 µg/kg/day.

Comfort Level with Published Health Effect Levels

The safety factors utilized to develop the published health effect levels discussed above were evaluated. In most cases the published health effect levels were at least several orders of magnitude greater than the NOAEL of LOAEL in any particular study. It is the conclusion of the IDPH that the published health effect levels are protective of human health within several orders of magnitude of safety.

Revised Advisory Protocol

The revised advisory protocol currently utilized by the State of Iowa modified the previous (FDA-based) advisory protocol by adding an additional recommended level of consumption to the previous two levels of recommended consumption of fish to make three recommended levels of consumption – unrestricted consumption, consumption of one meal per week, and no consumption.

The revised levels of contaminants in fish and corresponding recommended consumption levels are as follows:

Methylmercury:	0 to <0.3 ppm*	ð unrestricted consumption
	0.3 to <1.0 ppm	ð one meal per week
	1.0 ppm and over	ð do not eat
PCBs:	0 to <0.2 ppm	ð unrestricted consumption
	0.2 to <2.0 ppm	ð one meal per week
	2.0 ppm and over	ð do not eat
Chlordane:	0 to <0.6 ppm	ð unrestricted consumption
	0.6 to <5.0 ppm	ð one meal per week
	5.0 ppm and over	ð do not eat

* The level of 0.3 ppm methylmercury in fish tissue is the also the EPA recommended fish tissue residue criteria to be utilized in the determination of impaired waters (11).

As with the previous advisory protocol, the revised advisory protocol includes a state-wide recommendation to nursing mothers, women planning on being pregnant, and children up to 16 years of age to consume only one meal per week of predator fish (i.e., bass, walleye).

The revised levels for recommending no consumption of fish are the same as the previous levels for methylmercury and PCBs, but the level of chlordane for recommending no consumption of fish in the revised protocol is higher than the previous level of 0.3 ppm chlordane in fish. The previous level of 0.3 ppm chlordane is based upon the FDA tolerance level of an unavoidable amount chlordane in the fish, not based upon health study data. Basing the no consumption recommendation upon health study data and risk-based calculations will produce an action level of chlordane in fish of about 5 ppm.

Similar to the previous protocol, consumption advisories are issued following two consecutive samples that contain levels of a mercury, PCBs, or chlordane above an advisory trigger level. Information on Iowa's statewide fish contaminant monitoring program is available at *http://wqm.igsb.uiowa.edu/wqa/raft.html*. An advisory will not be rescinded until two consecutive samplings show that contaminant levels are below advisory trigger levels. Although IDNR remains responsible for issuing consumption advisories, decisions to issue advisories under the revised protocol are coordinated with IDPH.

Comparison to the Great Lakes Advisory Protocol

Three border states to Iowa (Minnesota, Wisconsin, and Illinois) utilize the Great Lakes advisory protocol and have recommended consumption levels for varying concentration of methylmercury, PCBs, and chlordane found in recreationally caught fish. The following is a summary of their recommended levels of consumption for varying concentrations of methylmercury, PCBs, and chlordane:

Methylmercury:	0-0.05 ppm	ð unrestricted consumption
(child)	>0.05-0.2 ppm	ð one meal per week
	>0.2-1.0 ppm	ð one meal per month
	NA	ð one meal per two months
	>1.0 ppm	ð do not eat
PCBs:	0-0.05 ppm	ð unrestricted consumption
	>0.05-0.2 ppm	ð one meal per week
	>0.2-1.0 ppm	ð one meal per month
	>1.0-1.9 ppm	ð one meal per two months

	>1.9 ppm	ð do not eat
Chlordane:	0-0.15 ppm	ð unrestricted consumption
	>0.15-0.65 ppm	ð one meal per week
	>0.65-2.8 ppm	ð one meal per month
	>2.8-5.6 ppm	ð one meal per two months
	>5.6 ppm	ð do not eat

If we compare the Great Lakes advisory protocol to the revised Iowa advisory protocol we will find the following differences. The revised Iowa advisory protocol eliminates the "one meal per month" and "one meal per two months" categories for fish consumption. The upper level of contaminants used in the one meal per week category of the Great Lakes advisory protocol are roughly equal to the upper level of contaminants in the unrestricted consumption category of the revised Iowa advisory protocol. And the upper level of contaminants used in the one meal per month category of the Great Lakes advisory protocol are roughly equal to the upper level of contaminants in the one meal per week category of the revised Iowa advisory protocol. The levels of a "do not eat" recommendation for consumption of fish using the Great Lakes advisory protocol are essentially the same as the revised Iowa advisory protocol.

Justification

The purpose of the revised Iowa advisory protocol is to provide for a mechanism to adequately protect individuals that may be consuming fish contaminated with methylmercury, PCBs, and chlordane while at the same time realizing the importance of including fish in every person's diet, and not discouraging fishing as a sport and family activity. The IDPH believes that the health of the average Iowan would benefit by increasing their consumption of fish. The revised Iowa advisory protocol is more protective to human health that the previous protocol, but does not overly discourage people from including fish in their diet.

The revised Iowa protocol is not over complicated; it has only three recommended consumption levels as compared to the 5 recommended consumption levels utilized in the Great Lakes advisory protocol. It is believed that people can easily understand and implement limiting their fish consumption to one meal per week or no consumption if these levels were recommended in a fish advisory.

It is believed that the one meal per week or no consumption recommendations included in the revised Iowa advisory protocol will adequately protect the health of Iowans if properly followed. The health effect levels promulgated by ATSDR and EPA that are utilized in the Great Lake advisory protocol include, in most cases, several orders of magnitude of safety (safety factors between 10 and 300). The revised Iowa advisory protocol is between 6 to 10 times less restrictive than the Great Lakes advisory protocol, but still within the safety factors utilized in the development of ATSDR and EPA health effect levels for methylmercury, PCBs, and chlordane.

References

1. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Mercury. Atlanta: US Department of Health and Human Services; March 1999.

2. United States Environmental Protection Agency, Integrated Risk Information System. EPA Web Site Link: *http://www.epa.gov/iris/subst/0073.htm#reforal*

3. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Polychlorinated Biphenyls. Atlanta: US Department of Health and Human Service; November 2000.

4. Federal Register, Vol. 44, No. 127, Friday, June 29, 1979.

5. United States Environmental Protection Agency, Integrated Risk Information System. EPA Web Site Link: *http://www.epa.gov/iris/subst/0389.htm#reforal*

6. Great Lakes Sport Fish Advisory Task Force. Protocol for a Uniform Great Lakes Sport Fish Consumption Advisory; September 1993.

7. Agency for Toxic Substances and Disease Registry. Toxicological Profile for Chlordane. Atlanta: US Department of Health and Human Service; May 1994.

8. United States Food and Drug Administration, Office of Regulatory Affairs. FDA Web Site Link: *http://www.fda.gov/ora/compliance_ref/cpg/cpgfod/cpg575-100.html*

9. United States Environmental Protection Agency, Integrated Risk Information System. EPA Web Site Link: *http://www.epa.gov/iris/subst/0142.htm#reforal*

10. Illinois Environmental Protection Agency. Discussion Paper for Chlordane HPV; July 2003.

11. United States Environmental Protection Agency, Water Quality Criteria. EPA Web Site Link: *http://www.epa.gov/waterscience/criteria/methylmercury/document.html*