

Health Consultation

Evaluation of Mercury Concentrations in Fish Collected From
Claremont Area Water Bodies

CLAREMONT, SULLIVAN COUNTY, NEW HAMPSHIRE

**Prepared by the
New Hampshire Department of Environmental Services**

December 16, 2009

Prepared under a Cooperative Agreement with the
U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
Agency for Toxic Substances and Disease Registry
Division of Health Assessment and Consultation
Atlanta, Georgia 30333

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In addition, consultations may recommend additional public health actions, such as conducting health surveillance activities to evaluate exposure or trends in adverse health outcomes; conducting biological indicators of exposure studies to assess exposure; and providing health education for health care providers and community members. This concludes the health consultation process for this site, unless additional information is obtained by ATSDR or ATSDR's Cooperative Agreement Partner which, in the Agency's opinion, indicates a need to revise or append the conclusions previously issued.

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HEALTH CONSULTATION

Evaluation of Mercury Concentrations in Fish Collected
From Claremont Water Bodies

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Prepared By:

New Hampshire Department of Environmental Services
Environmental Health Program
Under Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Summary

The New Hampshire Department of Environmental Services (DES), Air Resources Division, Environmental Health Program (EHP) has completed this environmental data evaluation of mercury concentrations in fish collected from Claremont-area water bodies. In the State of New Hampshire, it is DES's responsibility to ensure that recreational fishermen have the best information possible to safeguard their health and the health of their family.

DES reached two conclusions about eating fish caught from the specific Claremont-area water bodies studied.

1. Eating largemouth bass from Perkins Pond could potentially harm the health of young children and women of child-bearing age (developing fetus). Although this conclusion is based on limited data (one fish 15 inches long), a public health hazard has been identified. Please note that the statewide mercury fish consumption advisory has already placed restricted consumption limits for largemouth and smallmouth bass greater than 12 inches (in length), and mercury concentrations in bass from Perkins Pond are within the normal range for fish of this size (1). Specific details regarding this conclusion are outlined in the "Conclusions" Section.
2. Risk Based Consumption Limits (RBCLs) were calculated for people who eat recreationally-caught fish from Crescent Lake, Eastman Pond, Stocker Pond, Perkins Pond, and Rand Pond. If the RBCLs are followed, harmful health effects from exposure to mercury are not expected. If an individual chooses to eat fish in excess of the recommended RBCL, it is possible that they could consume enough mercury for adverse health effects to develop. Although area specific RBCLs were calculated in this analysis, due to the limited nature of the dataset, people consuming fish from these waters should continue to follow the recommendations in the statewide fish consumption advisory. A DES fish consumption advisory has been developed that provides general safe eating guidelines for freshwater fish in New Hampshire with specific limits on certain fish types and sizes (2).

Next Steps: DES will review additional fish tissue data as it becomes available and provide documents, including follow-up health consultations, if appropriate.

For More Information: If you have concerns about your health, you should contact your healthcare provider. You may also call DES at 603-271-1370 to request further information regarding this health consultation or exposure to mercury from eating New Hampshire freshwater fish.

Background

In May 2006, EHP prepared a public health assessment (PHA) examining the ambient air quality in Claremont, New Hampshire. During the public comment period for the PHA, several citizen concerns were submitted regarding mercury exposure. The evaluation of ambient air mercury revealed that levels were well below health-based exposure thresholds. The PHA noted that, in

contrast to ambient air exposures, the general population is most commonly exposed to mercury from eating fish containing methylmercury in their tissues (3). To address this issue, DES established a program in spring 2008 to collect fish samples from ponds and lakes in the greater Claremont area. The sampling project was aimed to address local residents' concerns by evaluating the mercury exposure risk associated with eating fish from Claremont-area water bodies. This health consultation (HC) presents an area-specific evaluation of fish tissue samples collected during 2008 and the related potential public health implications for local residents who may consume these fish. This scientific evaluation employs health-based benchmarks developed by the US Environmental Protection Agency (EPA).

Pathways of Exposure

Environmental contamination cannot affect a person’s health unless there is a “completed exposure pathway.” A completed exposure pathway exists when all of the following five elements are present: 1) a source of contamination; 2) transport through an environmental medium; 3) a point of exposure; 4) a route of human exposure; and 5) an exposed population. These five elements do not define exposure; rather they contribute to determining the probability of exposure (4).

The only completed exposure pathway in this HC is the ingestion of fish contaminated with mercury. All water bodies throughout the northeastern United States are subject to mercury pollution from local, regional, and distant industrial emissions (sources of contamination). Mercury is transported through ambient air and deposited into water bodies including those in the Claremont area (transport). This mercury is ingested by fish which, in turn, are caught and consumed by people who recreationally fish (point of exposure, route of human exposure & receptor population). This is the pathway by which mercury becomes a potential human health risk.

People who eat recreationally-caught fish have been exposed and are currently exposed to the mercury in those fish. The potential for future exposures also exists. This completed exposure pathway is illustrated below.

Pathway Analysis

Source	Environmental Transport And Media	Exposure Point	Exposure Route	Exposed Population	Time Frame	Status
Food (Fish)	Air Emissions to Lakes/Ponds to Fish	Dinner Table	Ingestion	Recreational Fishermen	Past	Completed
					Present	Completed
					Future	Completed

Fish Sampling

In 2008, EHP worked in collaboration with the DES Voluntary Lake Assessment Program (VLAP) to collect fish samples from ponds and lakes in the greater Claremont area for subsequent mercury analysis. The fish collection efforts specifically focused on lakes and ponds within a 15-mile radius of center Claremont. EHP disseminated letters to individual VLAP volunteers to solicit their assistance. Signs were also posted at water body access points to notify recreational anglers of how to participate in the DES fish sampling study. In addition, informational e-mails were sent to local angler groups and clubs requesting their assistance.

DES specifically targeted five species of edible-sized fish: yellow perch, large and smallmouth bass, black crappie, and horned pout (a.k.a. brown bullhead). These species were chosen because they are commonly caught and consumed by local residents. VLAP volunteers and other recreational angler participants were requested to place individual fish in plastic bags, record/label the date and location of the catch, and freeze before delivery to the DES Laboratory. Anglers were also instructed to utilize a clean container (e.g., ice chest) for sample storage and delivery, and to avoid cross contamination from unclean or painted surfaces. DES confirmed that this fish collection protocol was followed prior to laboratory analysis.

During the 2008 fishing season, twenty-five individual samples were delivered to the DES laboratory for analysis (5). The fish samples were collected from five water bodies located within the 15-mile radius of center Claremont including:

1. Crescent Lake located in the northeastern area of Acworth, NH; approximately 9 miles to the southeast;
2. Eastman Pond located in northwest Grantham, NH; approximately 15 miles to the northeast;
3. Stocker Pond located in the southeastern area of Grantham; approximately 14 miles to the east-north-east;
4. Perkins Pond located in west central Sunapee; approximately 12 miles to the east; and
5. Rand Pond located in the northeastern area of Goshen approximately 12 miles to the east-south-east.

A map showing the location of the aforementioned water bodies is available in Appendix A

Fish-Specific Information

This section provides a brief overview of the fish species that were delivered to the DES Laboratory for mercury analysis.

The smallmouth bass (*Micropterus dolomieu*) is a predator game fish species that lives in cool, clear, waters where the bottom is rock or gravel. The species is a good indicator of persistent pollutants such as mercury that can increase in concentration from one link in a food chain to

another (biomagnification). Young smallmouth bass feed upon aquatic insects such as mayflies and dragonflies. Fingerlings and adults feed on insects, crayfish, and other smaller fishes (6).

The yellow perch (*perca flavescens*) is a game fish that prefers relatively shallow waters near shore. They travel in schools and remain active during the winter; hence they are popular target for ice fisherman. Adult perch (4-10 inches) primarily eat immature insects, larger invertebrates such as crayfish, other small fish and fish eggs (7).

The largemouth bass (*Micropterus salmoides*) is a predator game fish species that lives in warm, shallow water habitats, among reeds, waterlilies, and other vegetation. Like smallmouth bass, the species is a good indicator of persistent pollutants. Young largemouth bass feed on microscopic animals and small crustaceans such as crayfish. Fingerling bass feed on insects, crayfish, minnows, and smaller fishes. Adult bass will eat any available fish (including their own), crayfish, frogs, salamanders, snakes, mice, turtles and birds (8).

The brown bullhead (*Ameiurus nebulosus*) is a nocturnal bottom-feeding fish. They live in shallow bays, on or near a soft bottom with lots of vegetation. Unlike predator fish such as bass, brown bullheads consume mostly algae, plants and mollusks, and occasionally fish eggs. The public doesn't always hold brown bullheads in the highest regard, but nevertheless they are fun to catch and have delicious flesh (9). Brown bullhead are also known as horned pout.

The rock bass (*Ambloplites rupestris*) is a member of the sunfish family. Rock bass live in groups near shallow, rocky areas. They associate and compete with smallmouth bass for food such as aquatic insects, crayfish, and small fish. Rock bass are lively fighters when hooked and have firm, delectable flesh (10).

Laboratory Sample Preparation and Analyses

The DES Limnology Center Laboratory manual *Standard Operating Procedures - Fish Tissue Preparation and Total Mercury Analysis* outlines the procedure for fish tissue preparation and analysis. Incoming fish samples were identified by species, weighed and measured. Samples of skinless portions from the right side of each upper-back fillet were assayed in duplicate using a Direct Mercury Analysis (DMA-80) unit to measure the mercury levels. Individual fish were analyzed separately, which provides specific information on the mercury body burden of each fish. The DMA-80 unit essentially vaporizes the tissue samples in a small furnace, reads the spectrum of wavelengths given off by vaporization, and calculates the amount of mercury in the sample. DES calibrated the DMA-80 unit, conducted Quality Assurance/Quality Control (QA/QC) (i.e., verified method detection levels, samples run), analyzed samples (including spikes and duplicates), and downloaded/imported data according to written DES protocol (11).

Summary of Analytical Results

Table 1 summarizes the species, length, weight, and mercury level of the twenty-five fish collected from each respective water body. Sixteen of the twenty-five fish samples were received from Perkins Pond in Sunapee. Smallmouth bass and yellow perch were the most numerous fish species collected (22 of 25). Analytical results indicated concentrations of total mercury ranging

from 0.1135 parts-per-million (ppm) found in a yellow perch fillet caught in Perkins Pond in Sunapee, to 0.9410 ppm found in a smallmouth bass fillet from Eastman Pond in Grantham. Levels of mercury were generally higher in largemouth and smallmouth bass than in any other species sampled, most likely due to their diet of smaller fish, thus concentrating mercury in their tissue (5).

Table 1. Claremont-area water body fish tissue sampling results (5).

Water Body	Town	Species	Length (inches)	Weight (grams)	Total Mercury (*ppm)
Crescent Lake	Acworth	Yellow perch	7.3	71	0.2247
Crescent Lake	Acworth	Yellow perch	11.4	248	0.519
Eastman Pond	Grantham	Smallmouth bass	17.9	1057	0.941
Eastman Pond	Grantham	Smallmouth bass	12.6	448	0.3117
Eastman Pond	Grantham	Smallmouth bass	13.8	622	0.2773
Eastman Pond	Grantham	Yellow perch	10.4	285	0.2447
Perkins Pond	Sunapee	Largemouth bass	15.2	758	0.8602
Perkins Pond	Sunapee	Smallmouth bass	12.6	460	0.3885
Perkins Pond	Sunapee	Smallmouth bass	10.6	285	0.3204
Perkins Pond	Sunapee	Smallmouth bass	14.0	622	0.6463
Perkins Pond	Sunapee	Smallmouth bass	13.8	568	0.5507
Perkins Pond	Sunapee	Smallmouth bass	14.4	684	0.6131
Perkins Pond	Sunapee	Smallmouth bass	12.0	370	0.4057
Perkins Pond	Sunapee	Smallmouth bass	13.0	485	0.5173
Perkins Pond	Sunapee	Yellow perch	9.1	108	0.2624
Perkins Pond	Sunapee	Yellow perch	10.0	185	0.4212
Perkins Pond	Sunapee	Yellow perch	9.1	143	0.1518
Perkins Pond	Sunapee	Yellow perch	10.0	184	0.1135
Perkins Pond	Sunapee	Yellow perch	11.8	262	0.5547
Perkins Pond	Sunapee	Yellow perch	8.5	91	0.2077
Perkins Pond	Sunapee	Yellow perch	9.4	118	0.3516
Perkins Pond	Sunapee	Yellow perch	8.5	92	0.219
Rand Pond	Goshen	Brown bullhead	13.4	551	0.2047
Rand Pond	Goshen	Yellow perch	8.9	111	0.2338
Stocker Pond	Grantham	Rock bass	8.9	224	0.272

*ppm – parts per million

Laboratory Data Analysis

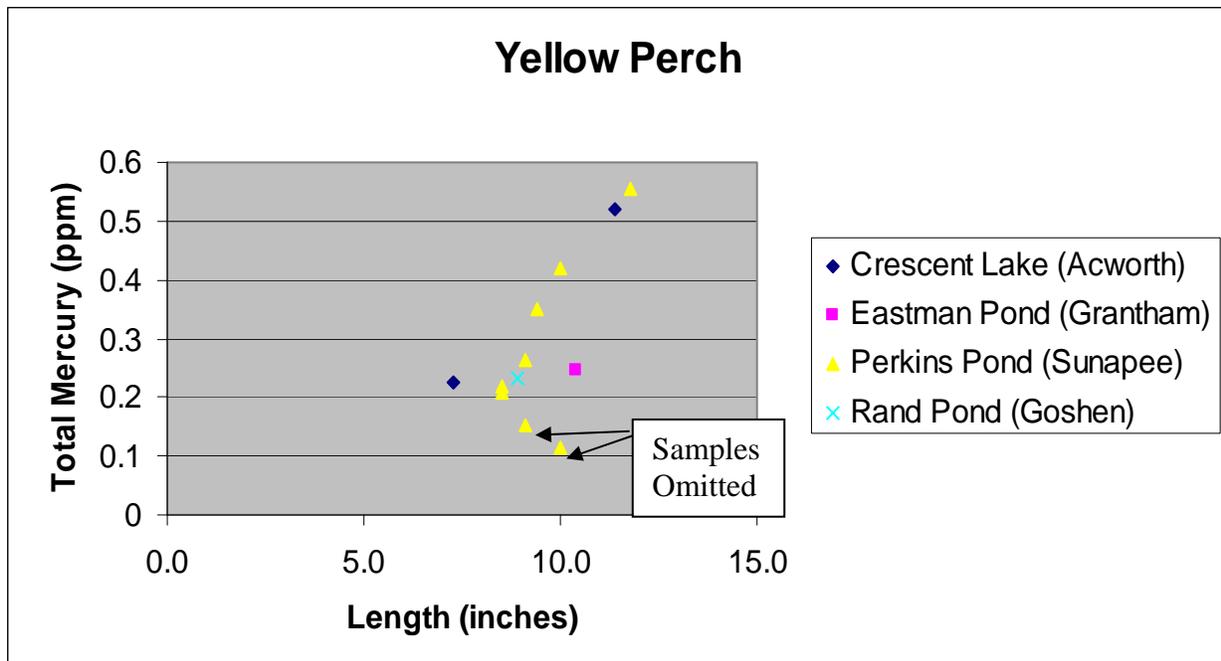
An analysis of the laboratory results revealed that some fish that were matched for species, size, and water body, had dissimilar mercury tissue levels. As seen in Table 2, there were two cases where yellow perch of the same size from Perkins Pond had dissimilar levels of mercury.

Table 2. Comparison of same-size yellow perch with much different mercury levels, caught in Perkins Pond (5).

Water Body	Town	Species	Length (inches)	Total Mercury (ppm)
Perkins Pond	Sunapee	Yellow perch	9.1	0.2624
<i>Perkins Pond</i>	<i>Sunapee</i>	<i>Yellow perch</i>	<i>9.1</i>	<i>0.1518</i>
Perkins Pond	Sunapee	Yellow perch	10.0	0.4212
<i>Perkins Pond</i>	<i>Sunapee</i>	<i>Yellow perch</i>	<i>10.0</i>	<i>0.1135</i>

After a statistical review of the Perkins Pond yellow perch data (standardization and correlation), EHP determined that the two low-mercury samples (Table 2 *italics*) should be eliminated from the data set and subsequent review. As shown in Figure 1, mercury levels in fish collected from the same water body typically increase with size. Omitting these low-mercury samples (indicated by arrows in Figure 1) provides a more protective approach to assessing fish consumption risk for recreational fisherman who keep their fish for consumption (5).

Figure 1. Mercury levels detected in yellow perch tissue by fish length in four area water bodies (5).



Health Risk Assessment Methods

Mercury was found in the tissue of twenty-five fish caught in five Claremont-area water bodies. Fish plays a vital role in maintaining a healthy, well-balanced diet and is a valuable source of omega-3 fatty acids. People who eat these fish, however, are exposed to varying amounts of mercury (based on species, amount eaten, and the water body where the fish was caught). The

primary effect of methylmercury exposure in humans is neurotoxicity (affects the nerve cells within the brain and spinal cord). Using EPA's protective estimate for methylmercury toxicity, DES has determined area and species-specific eating guidelines (RBCLs) whereby residents can safely enjoy the benefits of eating fish while protecting against the harmful effects of mercury exposure.

DES calculated mercury-specific RBCLs for three receptor groups; women of child-bearing age, young children (ages 1-6), and other adults and children according to EPA guidance. RBCLs are determined using an estimate of mercury intake from eating fish, as well an estimate of mercury intake that may present an increased risk of adverse health effects (EPA Reference Dose or RfD). Several safety factors are incorporated into EPA RfDs to account for variability and uncertainty. The RBCL calculations included an **adult fish portion size of eight ounces** and a **child portion of three ounces** (uncooked weight). These portion sizes are consistent with those of the *Technical background for the 2008 Update to the New Hampshire Statewide Mercury Fish Consumption Advisory*. The RBCLs presented in this health consultation allow for fish consumption at a rate that will prevent the development of adverse health effects from exposure to mercury. For clarity, RBCLs were rounded to the closest whole meal per month. If an individual chooses to eat fish in excess of the recommended RBCL, it is possible that they could consume enough mercury for adverse health effects to develop. The most sensitive known adverse health effect from mercury exposure is on the nervous system. It is not possible to predict how much mercury consumption in excess of the EPA RfD will result in the development of symptoms in any individual (1).

Results

Analysis of Claremont-area fish tissue data revealed that all fish, **except largemouth bass from Perkins Pond**, could safely be eaten at least one time per month by all receptor groups (Table 3) (5). For largemouth bass from Perkins Pond, DES recommends that women of child-bearing age and young children (ages 1-6) not consume these fish. This recommendation, however, is based on the analysis of a single largemouth bass (15+ inches in length) caught in Perkins Pond, with a mercury concentration of 0.8602 ppm. According to the DES *Technical Background for the 2008 Update to the New Hampshire Statewide Mercury Fish Consumption Advisory* document, largemouth bass generally increase in mercury concentration with fish length. For example, largemouth bass caught in New Hampshire averaging 14.2 inches in length have a mean mercury level of 0.730 ppm (263 samples 1992 -2007). By comparison, typical 8 to 12-inch largemouth bass caught in New Hampshire have an average mercury level of 0.38 ppm (131 samples 1992 - 2007). Without additional area-specific fish tissue data, however, DES is unable to definitively state whether smaller-sized largemouth bass from Perkins Pond could be eaten by residents (1).

Table 3. Average size, mercury concentration and Recommended Risk-Based Consumption Limits (RBCLs) for Claremont-area fish (5).

Water Body	Fish Species	Average Fish Length (inches)	Mercury Concentration ^a (ppm)	Human Receptor	RBCL (meals/month)
Crescent Lake	Yellow Perch	9.4	0.3719 (n=2)	Women	2
				Young Children	1
				Other	7
Eastman Pond	Yellow Perch	10.4	0.2447 (n=1)	Women	3
				Young Children	2
				Other	11
	Smallmouth Bass	14.8	0.5100 (n=3)	Women	1
				Young Children	1
				Other	5
Stocker Pond	Rock Bass	8.9	0.2720 (n=1)	Women	3
				Young Children	2
				Other	10
Perkins Pond	Yellow Perch	9.6	0.3361 (n=6)	Women	2
				Young Children	1
				Other	8
	Smallmouth Bass	12.9	0.4917 (n=7)	Women	1
				Young Children	1
				Other	5
	Largemouth Bass	15.1	0.8602 (n=1)	Women	0
				Young Children	0
				Other	3
Rand Pond	Yellow Perch	8.9	0.2338 (n=1)	Women	3
				Young Children	2
				Other	12
	Brown Bullhead	13.4	0.2047 (n=1)	Women	4
				Young Children	2
				Other	13

a- Average calculated mercury concentration, when n=1 the actual measured value is presented.

“Women” - Women of child-bearing age

n - Number of Samples

“Young Children” - Children 1 to 6 years of age

“Other” – Older children and other adults

NOTE: For ease of communication, the calculated “Risk-Based Consumption Limits” were rounded to the lowest whole meal per month (i.e. 1.7 meals = 1 meal)

Limitations

This health consultation was conducted using a limited amount of available fish tissue data. The data evaluation, however, represents a foundation whereby additional fish tissue samples could be added in the future. Additional samples would enable DES to more accurately ascertain risks associated with eating fish from a particular water body, but would also facilitate analysis of size thresholds for consumption. For instance, consumption of smaller-sized largemouth bass from Perkins Pond could possibly be acceptable if further data were presented. RBCLs from the remaining water bodies could also be modified pending the addition to the respective data sets.

DES was unable to calculate RBCLs for fish species not represented in the data (i.e., largemouth bass from water bodies other than Perkins Pond). Consequently, the risk associated with eating these fish remains unknown. Given these circumstances, DES suggests that anglers follow the protective recommendations outlined in the existing *New Hampshire Fish Consumption Guidelines 2009* available at:

<http://des.nh.gov/organization/commissioner/pip/factsheets/ard/documents/ard-ehp-25.pdf> (1).

Public Health Implications

Fish is an excellent source of protein, minerals, and vitamins, and plays a vital role in maintaining a healthy, well-balanced diet. Fish is also a valuable source of omega-3 fatty acids, which are essential for proper fetal development (12). Conversely, the general population is most commonly exposed to mercury from eating fish tissue containing methylmercury. After inorganic mercury compounds are released into the environment and deposited in water and sediment (washed out of the air by precipitation & discharged to the water), microorganisms such as bacteria and fungi convert inorganic mercury to methylmercury. In aquatic environments, methylmercury subsequently accumulates in fish to levels that are many times greater than levels in the surrounding water. The primary effect of methylmercury exposure in humans is neurotoxicity (affects the nerve cells within the brain and spinal cord). Methylmercury can cause adverse effects in young children because it can interfere with critical processes in the developing brain. Methylmercury can accumulate in an unborn baby's blood, at concentrations higher than in the mother, and can be passed from a mother's breast milk to a nursing infant. Over time, the bodies of children and adults can also build-up harmful levels of methylmercury (13). DES accounted for these sensitive populations (prospective mothers and young children) when calculating risk-based consumption limits (RBCLs). Specifically, it is considered to be protective to use the EPA RfD, or amount that is thought to be without risk of adverse health effects for risk based calculations. EPA derived its RfD from epidemiological studies of: 1) mother-infant pairs from fish-eating populations; and 2) children of mothers with higher mercury levels matched with children whose mothers had lower mercury levels. This focus was deemed as the appropriate strategy for protecting public health (14).

Conclusions

DES reached two important conclusions about eating fish caught from the five Claremont-area water bodies studied:

1. Residents who eat recreationally-caught fish from Crescent Lake, Eastman Pond, Stocker Pond, Perkins Pond, and Rand Pond should observe the recommended species-specific RBCLs outlined in Table 3. If the RBCLs are followed, harmful health effects from exposure to mercury are not expected. If an individual chooses to eat fish in excess of the recommended RBCL, it is possible that they could consume enough mercury for adverse health effects to develop.
2. DES concludes that eating **largemouth bass caught in Perkins Pond** could harm the health of young children and women of child-bearing age (developing fetus). This is a public health hazard. This DES public health conclusion is based on limited fish tissue data (one 15-inch fish sample). Data from other New Hampshire locations, however, shows that mercury levels are lower in smaller-sized largemouth bass (8-10 inches in length). Therefore, it is possible that smaller largemouth bass caught in Perkins Pond may be safe for limited consumption. In the absence of additional fish tissue data, however, DES is unable to determine this.

Recommendations

1. Residents can minimize their exposure while obtaining the health benefits associated with fish consumption by reducing serving sizes, the frequency of fish consumption, eating smaller-sized fish, and substituting lower mercury-containing species (e.g., panfish).
2. The small number of available fish tissue samples limited the DES data analysis. In order to produce a more statistically-sound and comprehensive review of mercury levels in fish tissue, additional samples are required. If possible, eight edible-sized tissue samples from each water body, of the same species would facilitate the most valid RBCLs.

Public Health Action Plan

The purpose of the Public Health Action Plan is to ensure that the current document not only identifies exposure potentials and possible health risks, but also provides a plan of action to mitigate and prevent adverse human health effects resulting from exposures to mercury in fish tissue. The first section of the Public Health Action Plan contains a description of completed and ongoing actions taken to collect fish tissue samples for subsequent mercury analysis. The second section presents a list of public health actions planned for the future.

Actions Completed

1. In 2008, EHP worked in collaboration with the DES Voluntary Lake Assessment Program (VLAP) to collect fish samples from ponds and lakes in the greater Claremont area for subsequent mercury analysis.

2. In spring 2009, EHP posted signs at Claremont-area water body access points to notify recreational anglers of how to participate in the DES fish sampling study.
3. In spring 2009, informational e-mails were sent to local angler groups and clubs requesting their assistance in the DES fish sampling study.

Actions Planned

1. DES will continue to provide health outreach and education to the community as needed. This includes disseminating this health consultation and the existing DES fish consumption advisory to the local community and applicable lake associations.
2. DES will review additional fish tissue data as it becomes available and provide documents, including follow-up health consultations, if appropriate.

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Certification

The Health Consultation evaluating fish samples from water bodies located near Claremont, New Hampshire was prepared by the New Hampshire Department of Environmental Services, Environmental Health Program, under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It is in accordance with approved methodologies and procedures existing at the time this health consultation was initiated. Editorial review was completed by the cooperative agreement partner.



Technical Project Officer, CAT, CAPEB, DHAC, ATSDR

The Division of Health Assessment and Consultation (DHAC), ATSDR, has reviewed this health consultation and concurs with its findings.



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Appendix A

