Are human consumers potentially at risk from toxic chemicals in Casco Bay fish and shellfish?

Background

Through the process of bioaccumulation (see Chapter 1) toxic metals and organic chemicals present in the sediments and water column can concentrate in the tissues of aquatic organisms. Predators at the top of the food chain, including large, long-lived fish and humans who consume them, are especially at risk of exposure to elevated levels of toxic contaminants. The widespread atmospheric deposition of mercury (see Chapters 2 and 6) has led to bioaccumulation of mercury in the tissues of predatory fish throughout the continental United States. In addition, toxic organic chemicals such as dioxins and PCBs have bioaccumulated in the tissues of some fish.

As of 2004, fish consumption advisories (see box on following page) for freshwater fish had been issued in every state but Alaska and Wyoming, representing 35% of the lake acreage and 24% of the total river miles in the US, plus all of the Great Lakes and their connecting waters. In addition, almost 65% of the US coastline was under advisory for consumption of certain fish (US EPA 2005). This widespread and ongoing problem impacts fish consumers in Casco Bay and across the State of Maine.

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Consumption advisories and consumer guidance have been issued by the Maine Center for Disease Control (Maine CDC) for striped bass (shown above), bluefish, and shark as well as saltwater tilefish, swordfish, king mackerel, halibut, tuna and all fish caught in Maine fresh waters.

Action Levels and Fish Consumption Advisories

State health agencies, including the Maine Center for Disease Control and Prevention, use action levels as a guide to determine whether they should issue a fish consumption advisory warning consumers to limit meals of fish from certain waters (Maine CDC 2001). Action levels are defined as concentrations of a contaminant in fish or shellfish tissue below which there should be negligible risk of deleterious health effects, at a consumption rate of one meal per week (US EPA 1993,1997). An action level takes into account exposure level for a human population, including sensitive subpopulations such as pregnant women and children, body weight, and fish consumption rate. For example, for carcinogens (cancer-causing agents), action levels are based on the assumption that consumption of edible fish tissue at a rate of one 8-ounce meal per week over a 70-year lifetime would result in a 1 in 100,000 incremental lifetime cancer risk (Maine CDC 2001). The tables below provides Maine action levels for PCBs, dioxins, PAHs, pesticides, and metals for both cancer risk and non-cancer risk.

Examples of Maine Fish Tissue Action Levels for Fish Filet (wet weight)

Table 8-1

Organic Chemicals	Non-Cancer Action Level ppb (parts per billion)	Cancer Action Level ppb
PCBs	43	11
Dioxin	0.0019	0.0015
PAHs	**ppb**	**ppb**
Benzo(a)pyrene		3.0
Acenaphthene	130	
Anthracene	648	
Fluoranthene	86	
Fluorene	86	
Biphenyl	108	
Naphthalene	43	
Pyrene	65	
Chlorinated Pesticides	**ppb**	**ppb**
DDT	1080	64
Dieldrin	108	1.4

Source: Maine CDC 2001

Table 8-2

Metals	Non-Cancer Action Level ppm (parts per million)	Cancer Action Level ppm
Arsenic (inorganic)	0.6	0.014
Cadmium	2.2	
Chromium VI	11	7
Lead	*	*
Manganese	302	
Methylmercury - fetal	0.2	
Methylmercury -adult	0.65	
Nickel	43	
Selenium	11	
Silver	11	
Tributyl tin (oxide)	0.6	
Vanadium	6	
Zinc	648	

*The need for advisories based on lead is determined using US EPA's biokinetic model to estimate typical lead exposure given the species and population of interest (Frohmberg 2006)

Consuming Fish from Maine Waters

Elevated levels of mercury in all fresh waters in Maine, including those in the Casco Bay watershed, have resulted in elevated levels of mercury in the tissues of resident fish populations (Maine DEP 2004). Freshwater fish species from some rivers and ponds in Maine also have elevated levels of PCBs, dioxins, and DDT. Both PCBs and dioxins have the potential to cause cancer in humans. Tissue concentrations of PCBs and dioxins that exceed the State action level have been found in some saltwater fish species as well, including striped bass and bluefish. Dioxin has also been found at elevated levels in lobster tomalley, the organ that serves as the lobster's hepatopancreas (pancreas and liver). Monitoring results have led the State of Maine to issue fish consumption advisories since 1994 and to provide consumers with safe-eating guidelines. All advisories are currently undergoing review by the State (Frohmberg 2007). The results of State fish tissue studies and the ongoing Maine DEP Surface Water Ambient Toxic Monitoring Program (SWAT) are also discussed in Chapter 6.

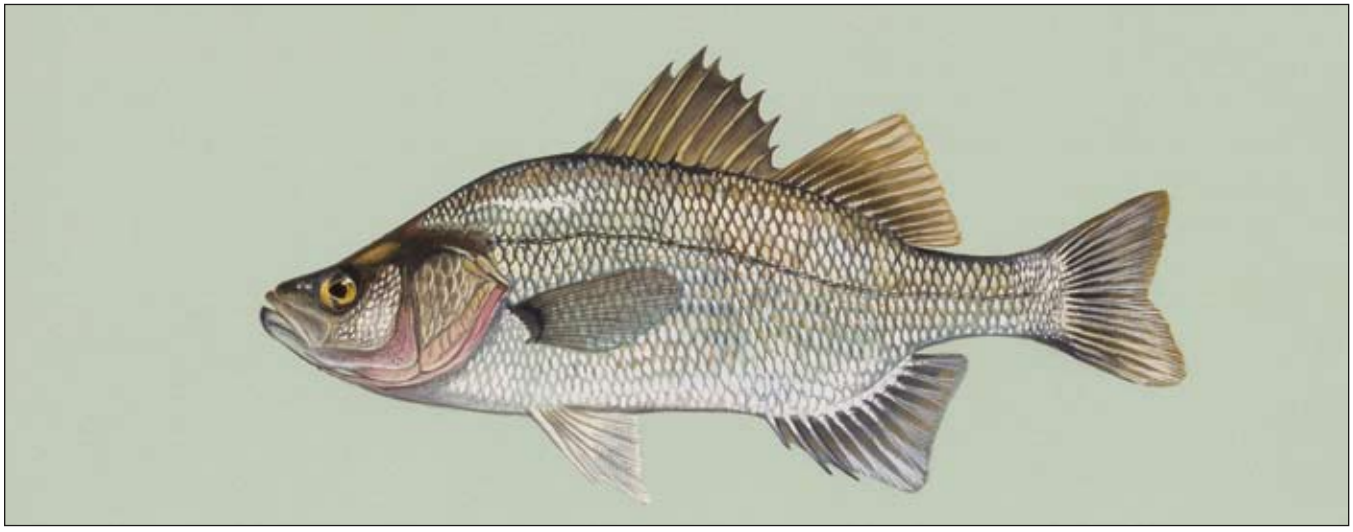
State Guidance on Eating Freshwater Fish from the Casco Bay Watershed

Because mercury has the potential to harm forming or growing brain tissue, unborn babies, infants and young children are at greatest risk of harm from exposure to small amounts of mercury. In higher dosages, older children and adults can also experience neurological damage (Maine CDC 2006a). State consumer guidance on fish consumption for adults and children over 8 is based on an 8-ounce meal (an upper estimate of fish consumption). Four ounces is the amount promoted by dietary organizations and the Maine Family Fish Guide as an appropriate serving size (Maine CDC 2006b, Frohmberg 2007).

- **Pregnant and nursing women, women who may get pregnant, and children under 8:** Consumers in this high risk category are advised not to eat any freshwater fish from Maine's inland waters. The only exceptions are freshwater smelt, brook trout and landlocked salmon, for which the guidance suggests a limit of 1 meal per week.

- **Adults and children older than 8:** Consumers are advised to eat no more than 2 meals per week of freshwater fish from Maine's inland waters, with a limit of 1 meal per week for freshwater smelt, brook trout and landlocked salmon.

  Additional State fish consumption limits are suggested for fresh waters where fish have elevated levels of PCBs, dioxins or DDT. Fortunately, none of these waters is in the Casco Bay watershed (Maine CDC 2006a). The Maine DEP SWAT program continues to monitor fish in the Casco Bay watershed, including recent dioxin and coplanar PCB sampling in fish from the Presumpscot River at Westbrook and Windham. The sampling was funded with assistance from the CBEP.



Duane Raver

Consumption advisories and consumer guidance have been issued by the Maine CDC for all fish caught in Maine fresh waters, including white perch, pictured above.

State Guidance on Eating Saltwater Fish

Consumption advisories for saltwater species cover all marine waters in Maine, including Casco Bay.

- **Pregnant and nursing women, women who may get pregnant, and children under 8**: These high risk consumers should not eat the following fish due to elevated mercury levels:

  Swordfish
  Shark
  King Mackerel
  Tilefish

  The following marine fish should be limited to one meal per week:

  Tuna steak
  Canned white tuna
  Halibut steak

  These consumers should limit meals of other ocean fish and shellfish (including canned light tuna), to 2 per week (Maine CDC 2006c). The exceptions are bluefish and striped bass which have elevated levels of PCBs and should be limited to 2 meals per month by all consumers (Maine CDC 2006c).

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Saltwater fish that are low in mercury include fresh and canned salmon (Atlantic salmon is shown above), sardines and herring, smelt, Atlantic mackerel, mussels, scallops and clams, flounder and sole, shrimp, haddock, hake, Pollock, cod, and lobster (Maine CDC 2006b).

The current advice for striped bass and bluefish is under review by the Maine CDC. New advice will be released by spring of 2007 (Frohmberg 2007). A review of the data can be found at http://www.maine.gov/dhhs/eohp/fish/PCBSTBhome.htm (Maine CDC 2006d).

- **Adults and Children Older Than 8:** The State guidance advises no more than 2 meals per month of:

  Swordfish
  Shark
  King Mackerel
  Tilefish
  Bluefish
  Striped Bass (Maine CDC 2006c)

Maine DEP

Consumers are advised to avoid eating the greenish tomalley (shown above) due to elevated levels of dioxin.

State Guidance on Eating Lobster Tomalley

While lobster meat is low in mercury and other toxics and safe to eat, the lobster tomalley (the soft, green substance found in the lobster's body cavity) has been shown to contain elevated levels of dioxin. The tomalley functions as the lobster's liver and pancreas, concentrating lipophilic (fat-soluble) organic contaminants. The State guidance advises that no one consume lobster tomalley (Maine CDC 2006c).

Casco Bay Mussel Toxics Study

Chapter 5 describes the Maine DEP's mussel sampling program, which uses the shellfish *Mytilus edulis* as an indicator organism to assess the health of the Casco Bay ecosystem. In the decade from 1987 to 1997, the DEP mussel sampling program found that only the metals mercury and lead exceeded State action levels for toxics at a few stations in Maine. Since 1996, CBEP has been supplementing the DEP blue mussel monitoring program by periodically collecting samples at additional sites in Casco Bay. Selection of sites for testing takes into consideration the results of CBEP sediment contamination studies (see Chapter 4), the intensity of local land use, and past history of pollution, focusing on areas where the mussels might have maximum exposure to elevated concentrations of toxics.

To assess the potential human health impacts from mussel contamination, the results of the 1996 and 1998 CBEP sampling were submitted to the Maine CDC, Environmental and Occupational Health Program, previously called the Maine Bureau of Health, Environmental Toxicology Program. The samples were collected at eight sites, which were selected for the following reasons:

- Back Cove in Portland was selected because of its historically elevated levels of PAHs and metals in the sediments, the result of CSO overflows into the Cove
- Harraseeket River in Freeport was selected because of the recent huge increases in impervious surface in the watershed and the heavy vehicle traffic.
- Quahog Bay in Harpswell was selected because the sediments have high levels of cadmium.
- Falmouth was selected due to its close proximity to boating and boat yards.
- Middle Bay was selected because of potential PAH and other chemical contamination from the Naval Airbase.
- The Wolfe's Neck site in Freeport was selected because there is an air deposition monitoring site there.
- Jewell Island in Outer Casco Bay and the Basin in the New Meadows River were selected as potential reference sites, because they had no known local sources of toxics.

The results of the data analysis are presented below:

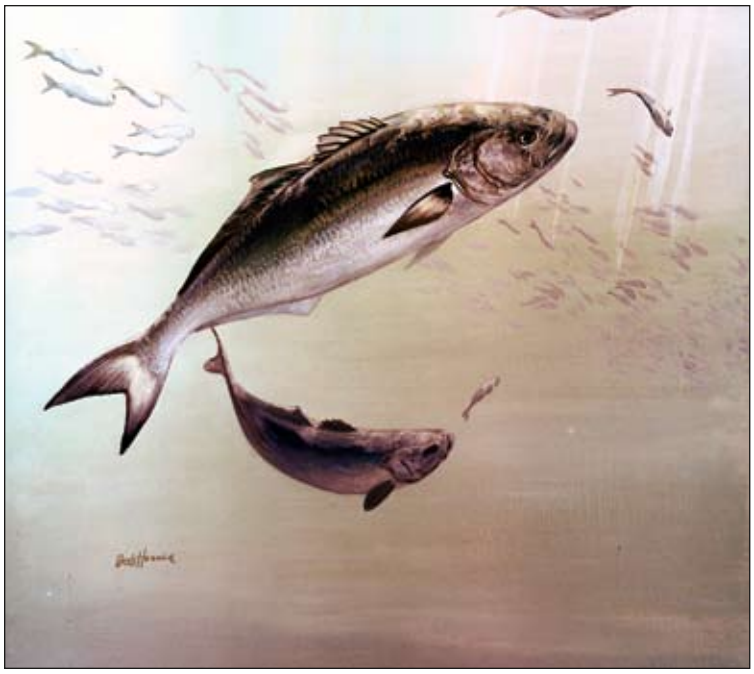
- Levels of lead in samples from Back Cove were slightly elevated above the action level for this neurotoxin. Since lead is a serious concern for young children, regular consumption of mussels from Back Cove could pose a risk. Back Cove is currently closed for all shellfishing.
- Total PCB levels were elevated in mussels from Back Cove and Quahog Bay and somewhat elevated in mussels from Falmouth.
- For the PAH compounds evaluated for their potential to cause cancer, levels indicated an incremental cancer risk for frequent consumers of mussels of less than 2 in 100,000. Of the compounds evaluated for non-carcinogenic effects, none approached levels of concern.
- Arsenic was elevated above the action level at Falmouth and Jewell Island. The report noted that most of the arsenic found in seafood tends to be in a relatively non-toxic form (Maine CDC, 1999).

Because mussels are widely harvested in Casco Bay, the risk associated with human consumption is of great interest to the Maine CDC. There is, however, no licensing program for recreational mussel harvesting in the Bay and no data available on the frequency of harvesting or the quantities of wild mussels consumed in a typical meal (Maine DHHS, 1999). In 2002, field studies conducted by CBEP determined that recreational harvesting is taking place in the Bay in a few mussel beds where elevated levels of pollutants have been observed. Further studies would be needed to determine whether local harvesters and their families are consuming enough mussel meals from polluted beds to pose a public health risk (CBEP 2002).

Maine DEP also periodically samples soft-shell clams *(Mya arenaria)* for toxic chemicals and makes the data available to the Maine CDC for risk analysis. No advisories for clam consumption have been issued by the Maine CDC.

Summary/Conclusions

While many species of saltwater fish remain safe for all consumers to eat, inputs of mercury and organic chemicals generated by human activities have resulted in fish consumption advisories in Maine and all across the United States. The good news is that the levels of mercury, PCBs and dioxins (as well as many pesticides) entering the aquatic environment across the country have greatly declined over the past two decades. Chapter 9 discusses some of the ways federal, state and local governments and citizens are helping to reduce the loading of toxic chemicals to our environment.



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