Public Health Assessment for

PORTLAND HARBOR
MULTNOMAH COUNTY, OREGON
EPA FACILITY ID: OR0001297969
MARCH 22, 2006

U.S. DEPARTMENT OF HEALTH AND HUMAN SERVICES
PUBLIC HEALTH SERVICE
Agency for Toxic Substances and Disease Registry

THE ATSDR PUBLIC HEALTH ASSESSMENT: A NOTE OF EXPLANATION

This Public Health Assessment was prepared by ATSDR pursuant to the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund) section 104 (i)(6) (42 U.S.C. 9604 (i)(6)), and in accordance with our implementing regulations (42 C.F.R. Part 90). In preparing this document, ATSDR has collected relevant health data, environmental data, and community health concerns from the Environmental Protection Agency (EPA), state and local health and environmental agencies, the community, and potentially responsible parties, where appropriate.

In addition, this document has previously been provided to EPA and the affected states in an initial release, as required by CERCLA section 104 (i)(6)(H) for their information and review. The revised document was released for a 30-day public comment period. Subsequent to the public comment period, ATSDR addressed all public comments and revised or appended the document as appropriate. The public health assessment has now been reissued. This concludes the public health assessment process for this site, unless additional information is obtained by ATSDR which, in the agency's opinion, indicates a need to revise or append the conclusions previously issued.

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PUBLIC HEALTH ASSESSMENT

PORTLAND HARBOR

MULTNOMAH COUNTY, OREGON

EPA FACILITY ID: OR0001297969

Prepared by:
Oregon Department of Human Services
Superfund Health Investigation and Education Program

Under Cooperative Agreement with the
U.S. Department of Health and Human Services
Agency for Toxic Substances and Disease Registry

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Purpose and Health Issues:

The Superfund Health Investigation and Education (SHINE) program in the Oregon Department of Human Services developed this public health assessment to address the risk of consuming fish and shellfish caught in Portland Harbor. In 2002, the Agency for Toxic Substances and Disease Registry (ATSDR) developed an initial public health assessment (PHA) that identified the consumption of contaminated fish as the main way that people could be exposed to Portland Harbor site contaminants [1]. At that time, ATSDR was unable to evaluate the possible health consequences from eating contaminated fish from Portland Harbor due to a lack of data on this exposure pathway. Since the release of the initial PHA, several species of fish were sampled in Portland Harbor. This updated public health assessment focuses on the public health implications of consuming fish and shellfish from Portland Harbor based on the results of recent sampling efforts.

Summary:

Children and adults who frequently eat resident fish caught in Portland Harbor have an increased risk of adverse health effects; therefore, the site constitutes a **public health hazard**. The most contaminated fish sampled were carp, bass and bullhead catfish. The primary pollutants of concern are the polychlorinated biphenyls (PCBs). These chemicals are most harmful to the developing fetus and infants.

Children and adults who consume migratory fish, such as salmon, from Portland Harbor are not likely to have adverse health effects as a result of eating these fish.

SHINE recommends that people who eat fish collected from Portland Harbor follow the fish advisory consumption limits developed by the Oregon Department of Human Services (www.healthoregon.org/fishadv) for resident fish caught in Portland Harbor and outlined below.

Women of childbearing age, especially women who are pregnant, thinking about getting pregnant or nursing, infants, children and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor. Examples of resident fish include bass, carp and bullhead catfish.

Healthy adult men and women beyond childbearing age and healthy children may consume one 8-ounce meal of resident fish per month. Fish collected from Portland Harbor should be properly prepared and cooked to reduce exposure to pollutants. The skin, fat, head, eyes, eggs and organs should be removed and discarded. Fish should be cooked by methods that allow the fats to drip off, such as grilling, baking or smoking.

No consumption limits are placed on migratory fish like salmon or steelhead. Research has shown that eating fish has numerous health benefits. It is recommended that people eat a balanced diet of seafood.

Background:

Site Description

Portland Harbor is located in Multnomah County, Oregon, situated along the east and west banks of the lower Willamette River. On December 1, 2000, a portion of Portland Harbor was listed on the National Priorities List (NPL). The exact site boundaries of the Portland Harbor NPL site will be based on the results of the Portland Harbor remedial investigation and feasibility study. The initial study area for the site is a nearly six-mile stretch of the Willamette River, from the southern tip of Sauvie Island [river mile 3.5] to Swan Island [river mile 9.2] (Figure 1). The final site boundaries may be adjusted depending on the findings of the initial investigation. The portion of the river that was placed on the NPL is the most industrialized area of the Willamette River and lies entirely within the city limits of Portland, Oregon.

The Willamette River begins in the Cascade Mountains and flows generally north to its confluence with the Columbia River [2]. The last 26.5 miles of the Willamette River before the confluence is wide and slow moving and affected by tidal reversals resulting in daily fluctuations in water levels. This section of the river was generally shallow historically, but the last 12 miles of the Willamette River has an average depth of 45 feet with a maximum of 140 feet. This greater depth is the result of regular dredging by the U.S. Army Corps of Engineers to allow large ocean-going ships to use Portland Harbor. The portion from river miles 3 to 10 is the principal sediment deposition area of the Willamette River.

History

In 2002, ATSDR identified the consumption of contaminated fish as the major exposure pathway that people could be exposed to Portland Harbor site contaminants, as documented in their initial public health assessment (PHA) document. At that time, a lack of data on contaminants in fish tissue limited the ability of ATSDR to conduct a thorough public health risk assessment. They recommended two large-scale efforts to conduct a complete public health assessment and implement public health actions: a large fish sampling effort and educational outreach to inform the community about the potential health risks from eating fish from Portland Harbor.

In general, the public health assessment process used by ATSDR involves the evaluation of data and information about hazardous substances that have been released into the environment to determine whether there is an impact on public health. The Superfund Health Investigation and Education Program (SHINE) program, housed in Oregon State Public Health (OSPH), is an ATSDR cooperative agreement program. SHINE prepared this PHA as a follow-up to the recommendations made in the initial Portland Harbor PHA prepared by ATSDR.

Thirty-nine species of fish have been identified in Portland Harbor [3]. Migratory fish that inhabit the Willamette River include three Chinook salmon runs, one Coho salmon run, two steelhead runs, shad and Pacific lamprey. White sturgeon is commonly fished within Portland Harbor as well. Resident fish include small and largemouth bass, black and white crappie, walleye, common carp, brown and yellow bullhead, channel catfish, northern pikeminnow, sculpin and others. Crayfish and clams reside in the harbor as well. The species that were analyzed for human public health assessment in this document include small mouth bass, black crappie, brown bullhead, common carp, crayfish, white sturgeon and spring chinook salmon.

Certain contaminants found in sediment, such as PCBs, may be taken up by benthic (bottom-dwelling) organisms. As fish feed on these organisms, the contaminants build up (bioaccumulate) in fish tissue, resulting in greater concentrations than originally present in the sediment. Both subsistence and recreational fishing occur within Portland Harbor, and anglers and their families who eat the fish may be exposed to high levels of contaminants as a result of bioaccumulation. Resident fish, such as bass, carp, and catfish are expected to bioaccumulate far greater amounts of contaminants compared with fish that migrate through the site, such as salmon.

Commercial and industrial activities have occurred in the past and still continue within Portland Harbor. Historical and active sources of pollution have resulted in elevated levels of metals, polycyclic aromatic hydrocarbon (PAHs), polychlorinated biphenyls (PCBs), pesticides, dioxins/furans, petroleum products and other contaminates in the sediment. A group of potentially responsible parties, known as the Lower Willamette Group (LWG), has funded the majority of the remedial investigation/feasibility study to address these contaminants.

The U.S. Environmental Protection Agency (EPA) and the Oregon Department of Environmental Quality (ODEQ) jointly manage the cleanup of the Portland Harbor NPL Site. EPA has the primary responsibility for the in-water portion and ODEQ for the upland sources of contamination. These two agencies are also working closely with nine natural resource trustees. The trustees are designated by law to act on behalf of the public or tribes to protect and manage natural resources, such as land, air, water, fish, and wildlife. Among the trustees are six tribes - the Confederated Tribes and Bands of the Yakama Nation, Confederated Tribes of the Grand Ronde (CTGR), Confederated Tribes of Siletz Indians (CTSI), Confederated Tribes of the Umatilla Indian Reservation (CTUIR), Confederated Tribes of the Warm Springs Reservation of Oregon, and the Nez Perce Tribe. The Oregon Department of Fish and Wildlife (ODFW), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Fish and Wildlife Service (USFWS) are federal government natural resource trustees.

Site Visits

SHINE and ATSDR staff have visited Portland Harbor numerous times beginning in 2002 and throughout 2004 by boat, car and foot. SHINE staff has interviewed numerous individuals about fishing access, transient camp locations, recreational sites and activities, fish and meal preference, consumption and preparation practices and other aspects relevant to this assessment. SHINE has toured Portland Harbor by boat with Willamette Riverkeepers, Multnomah County Vector Control and EPA Region 10.

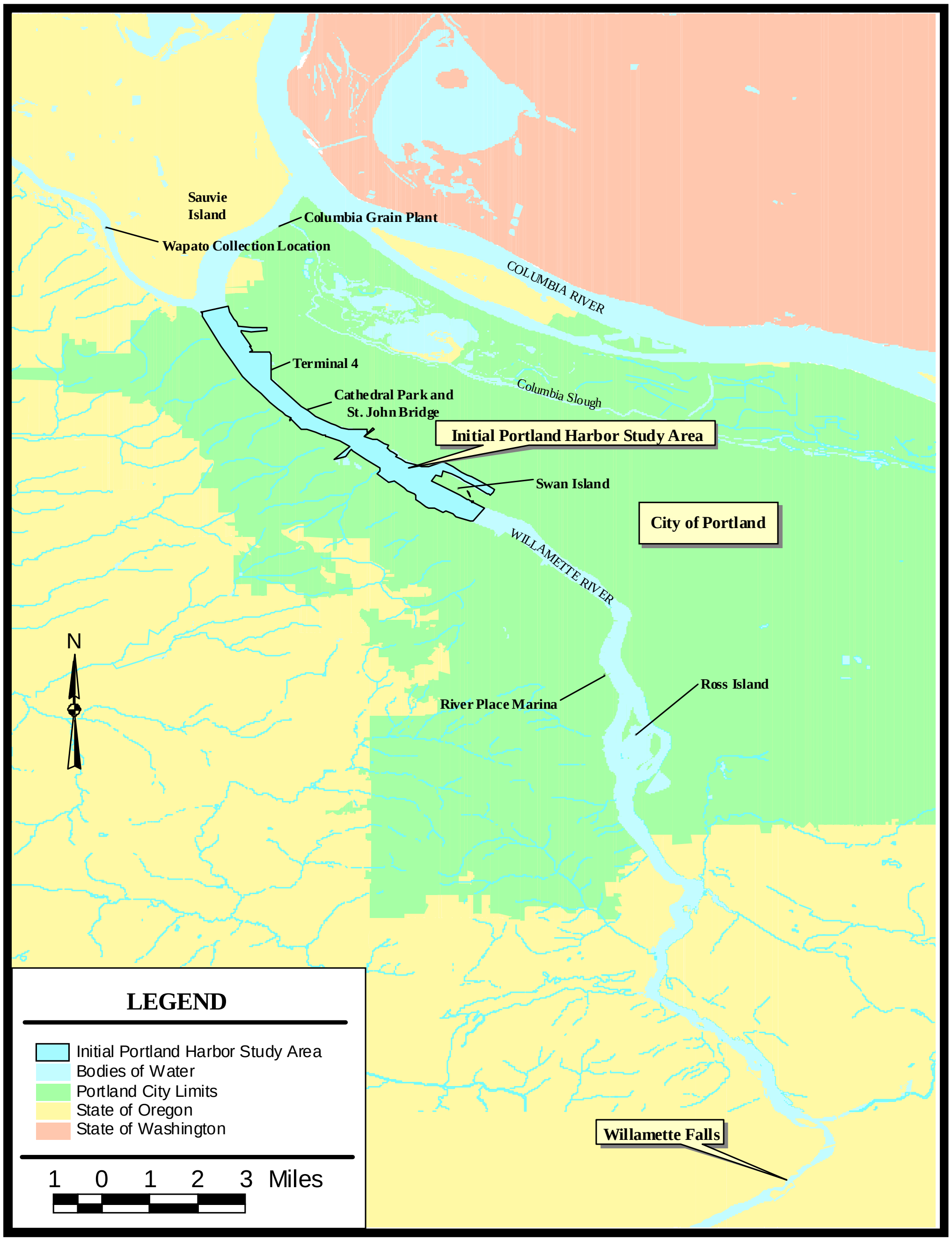


Figure 1 - Portland Harbor NPL Site Area Portland, Oregon

Portland Harbor Public Health Assessment - Initial Release 4 Prepared by John Crellin, Ph.D. - 010802

Demographics

ATSDR's public health assessments usually have a section where the demographic characteristics of the population within a mile of the site are described. This is done because this population includes those individuals most at risk of being exposed to site contaminants. However, at the Portland Harbor site, the individuals most at risk are those who eat fish from the Willamette River. These "at risk individuals" appear to be anglers from specific ethnic and racial groups and recreational boaters and not simply those living near the river. Therefore, the usual demographic evaluation will not be done in this document. Instead there will be descriptions of these "at risk" groups in relevant sections of this public health assessment. Numerous ethnicities fish in Portland Harbor, including Caucasian, African-Americans, Latinos, Asians, Eastern Europeans and Native Americans. In addition, many transient camps have been observed along the banks of Portland Harbor. According to U.S. Census estimates, the city of Portland had 538,544 people in July 2003.

Land and Natural Resource Use

Land Use

The habitat from river miles 3.5 to 9.2 (the initial Portland Harbor site study area) has been substantially altered to accommodate urban development and an extensive shipping industry [4]. Shoreline features include steeply sloped banks covered with riprap or constructed bulkheads, with manmade structures such as piers and wharves extending out over the water. This area of the river is largely devoid of trees and other vegetation along the riverbanks.

The habitat of the rest of the lower Willamette River is not as degraded as the initial study area. This is indicated by the gently sloping, well-vegetated banks at Ross Island, the mouth of Stephens Creek, Powers Marine Park, the mouth and lower reaches of Johnson Creek, Multnomah Channel, Kelly Point Park, and the lower reaches of the Columbia Slough. The first four locations are upstream and the last three are downstream of the initial Portland Harbor site study area.

The site area is heavily industrialized. Some of the historical or current industrial operations along Portland Harbor include: marine construction, bulk petroleum product storage and handling, construction material manufacturing, oil gasification plant operations, pesticide/herbicide manufacturing, agricultural chemical production, battery processing, liquid natural gas plant operations, ship maintenance, repair, and refueling, barge/rail car manufacturing and metal scrapping and recycling. Within or near the initial Portland Harbor study area, there are numerous active investigations or cleanups being performed under oversight by the Oregon Department of Environmental Quality (ODEQ) including the investigation of several City of Portland outfalls.

Residential areas are intermixed with these riverside industries or are close by including the St. John's neighborhood, Overlook Park, the community of Linnton, and University Park. In addition, the lower Willamette River is used for recreational fishing, boating, and water skiing. Cathedral Park and Swan Island serve as boat launches and bank fishing locations [5][6]. During all of our site tours, we observed tents and makeshift dwellings, which provide evidence that people were living along the riverbanks.

Fish and Shellfish

A 1993 survey indicated 39 species of fish residing in the lower Willamette River (river mile 0 to river mile 17) [3]. Four of these resident species are considered major sports fish. They are walleye *(Stizostedion vitreum vitreum*), black crappie *(Pomoxis nigromaculatus)*, white crappie *(Pomoxis annularis*), and smallmouth bass *(Micropterus dolomieui*). The most common non-sports fish are northern pikeminnow *(Ptychicheilus oregonensis*, formerly known as squawfish), yellow bullhead *(Ictalurus natalis*), common carp *(Cyprinis carpio*), and largescale sucker *(Catostomus macrocheilus*). These eight species of fish are abundant and easily caught, and subsistence use by the local population appears to occur, especially use of carp by Asian and Eastern European communities. This conclusion is based on recent observations by a team of investigative reporters [5][6] and conversations SHINE staff has had with numerous community groups and residents.

The Lower Willamette River is both the migratory route and rearing habitat for several anadromous fish species. Anadromous fish are those species which spend the juvenile stage of their life cycle in fresh water and the adult stage in salt water. Three runs of chinook salmon *(Oncorhynchus tshawytscha*), two runs of steelhead trout *(O. mykiss*), and individual runs of coho *(O. kisutch)* and sockeye salmon (*O. nerka*) use the lower Willamette River as their route to locations further up the Willamette River Basin where they will lay their eggs. "Runs" are genetically distinct populations that move up the river at different times of the year. In general, chinook and steelhead populations are the largest and most widespread of the salmonids (i.e., salmon and trout) found in the Willamette River basin.

Other important species which use the Lower Willamette River to migrate from salt to fresh water habitats are the American shad *(Alosa sapidissima*), white sturgeon (*Acipenser transmontanus*), and Pacific lamprey *(Lampetra tridentatus)*. Lamprey are utilized by Native American populations in the area for subsistence, ceremonial and medicinal purposes. A separate health consultation was developed for the Confederated Tribes of Siletz Indians on the risk of ingesting lamprey.

Shellfish known to reside in the lower Willamette River are crayfish *(Pacifasticus lenisculus)* and bivalve *(Corbicula fluminea)* including freshwater mussels. Shellfish can bioaccumulate organic chemicals such as PCBs, pesticides, dioxins, and other fat-soluble compounds.

Discussion:

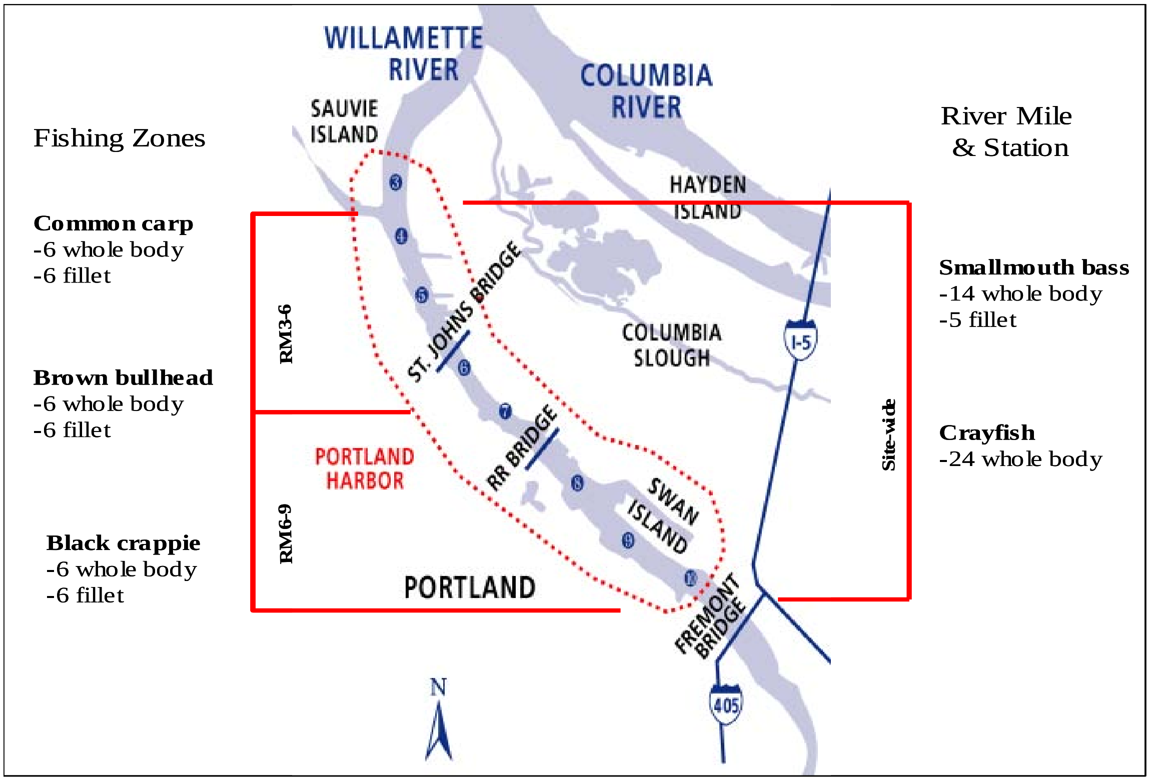
Data Used and Sampling Methods

Two separate sampling efforts were conducted to assess the risk associated with ingesting fish caught in Portland Harbor. The LWG sampled four resident fish and one crayfish species that are likely to spend their entire lifespan within Portland Harbor to determine the potential risk to human health. The resident fish included smallmouth bass, brown bullhead, common carp and black crappie. SHINE, along with ODFW, EPA and the City of Portland, sampled two migratory species, salmon and lamprey, as well as sturgeon. Some studies suggest that sturgeon can show strong site fidelity while other studies indicate that individual sturgeon can have large home ranges.

For resident fish collection, the sampling design was based on availability and home range of the target fish and shellfish (Figure 2). Resident fish were collected by a variety of methods. Smallmouth bass were collected by river mile in eight different locations between July 23rd and October 17th, 2002. Small mouth bass weighed between 0.4 and 2.6 lbs and were 9-17 inches in length. At three of the locations, three whole body composites were sampled. At the remaining five locations, one whole body and one fillet composite were sampled. For black crappie, brown bullhead and carp, samples were collected and composited along two distinct fishing zones (approximately river mile 3 to 6 and river mile 6 to 9). For bullhead and carp, three whole body and three fillet composites were collected at each of the two fishing zones. Individual crappies weighed between 0.3 and 0.8 pounds and were 8.6 to 10.9 inches in length, bullheads weighed between 0.3 and 0.83 pounds and were 8.7 to 12.2 inches in length, and carp weighted between 3.9 and 9.3 pounds and were 20 to 25.4 inches in length. For black crappie, two whole body and two fillet replicates were sampled within each fishing zone. For crayfish, whole body composites were collected from 24 locations, selected by presence of suitable habitat.

For sturgeon and salmon, sampling methods included dip netting (salmon) and using baited lines (sturgeon). Dip nets were used for collecting chinook salmon at the hatchery holding pond at the Clackamas River. Once a fish was caught, the dip net was pulled to the surface and the fish was removed. Chinook were collected at the Clackamas River Hatchery, which is just upstream from its confluence with the Willamette River, on June 20, 2003. The salmon caught for sampling weighed between 13.4 and 16 pounds. It is estimated that these hatchery spring Chinook salmon have spent a minimum of 1–3 months in the lower Willamette River. Whole body, fillet with skin and fillet without skin composites were analyzed for salmon. To collect sturgeon, three baited lines were set between the St. John's Bridge and the mouth of Swan Island Lagoon. On August 19, 2003, SHINE staff observed ODFW and EPA pulling three lines to retrieve sturgeon from Portland Harbor. Most of the sturgeon were of sub-legal size (<40") and released. Several hooks had sturgeon on them, indicating a large population of white sturgeon in the Lower Willamette River. Five sturgeon collected between September 13th -27th, 2003 around or above 40" in length were kept for analysis.

Figure 2. Sampling design for resident fish and crayfish collected in Portland Harbor.



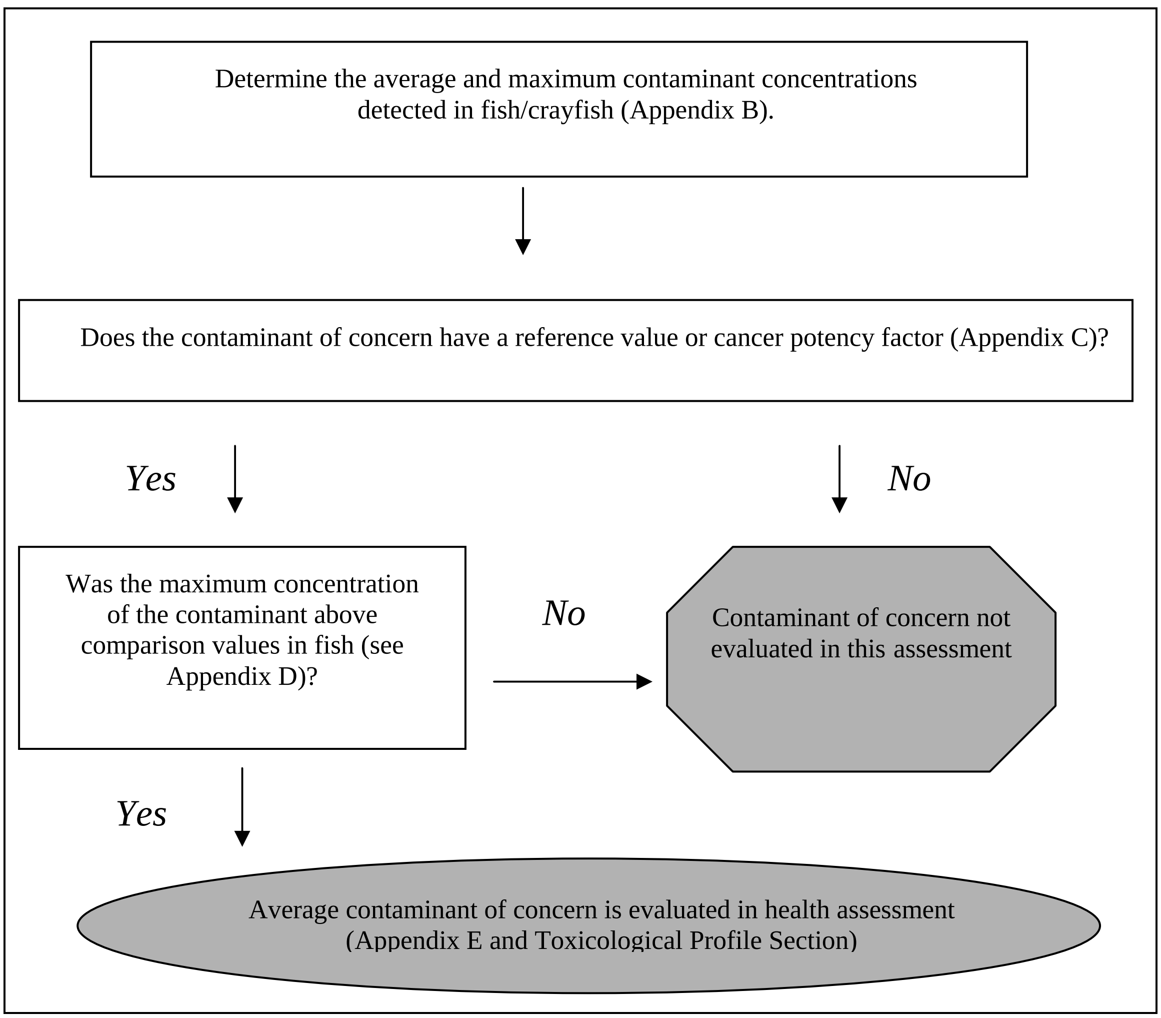
Evaluation Process:

Typically, in public health assessments, environmental data is initially screened using ATSDR comparison values, such as environmental media evaluation guidelines (EMEGs). Since EMEGs do not exist for fish tissue, SHINE calculated alternative comparison values by using default exposure assumptions (Appendix D) and minimum risk levels (MRLs) and reference doses (RfDs) which are described in Appendix A. The MRLs and RfDs were used to calculate acceptable tissue levels for non-carcinogenic endpoints, based on a hazard quotient (or comparison between exposure dose and reference dose; Appendix D) of less than one. Cancer slope factors and an acceptable excess cancer risk of one in 1,000,000 additional lifetime cancers were used to determine acceptable tissue levels for carcinogenic endpoints.

Exceeding criteria for carcinogenic or non-carcinogenic endpoints does not indicate that adverse health outcomes are likely. Rather, if contaminants were found to exceed acceptable tissue criteria (based on a the maximum contaminant concentration) for either carcinogenic or non-carcinogenic endpoints, they were further evaluated in a risk assessment (Figure 3). Polychlorinated biphenyl (PCB) congener data were used to estimate cancer and non-cancer risk as opposed to PCB Aroclor data. A congener is one specific PCB structure whereas PCB Aroclors are mixture of PCB congeners. Using congeners leads to less uncertainty than the use of Aroclors when evaluating risk.

For this public health assessment, average, site-wide contaminant concentrations were used to calculate risk. The use of average, site-wide contaminant concentrations has the potential to mask site-specific areas where the contamination level may be high. This is particularly important in fish that have a limited home-range, such as smallmouth bass. This situation would have potential health implications for someone who fished in a particular part of the Harbor where contamination is high, as opposed to fishing in multiple locations (which may also be mitigated by the incorporation of a high-end fish ingestion rate for the public health assessment).

Figure 3. Flowchart depicting the process for screening and evaluating contaminants found in fish and crayfish tissue.



Portland Harbor Exposure Pathways:

The following section discusses how people may come into contact with contaminants found in Portland Harbor. For a chemical to have a health effect, some degree of exposure must occur. Exposure pathways can be broadly categorized as complete, potential or incomplete. ATSDR categorizes an exposure pathway as complete if five factors are present: 1) a source of contamination, 2) transportation through an environmental medium, 3) a point of exposure, 4) a route of human exposure and 5) a receptor population. The presence of a completed pathway indicates that human exposure to contaminants could have occurred in the past, could be occurring now, or could occur in the future. Potential exposure pathways require that at least one of these five factors is missing, but could be present at some point. An exposure pathway can be eliminated (considered incomplete) if at least one of the five factors will always be absent.

A person can be exposed by more than one pathway and to more than one chemical. Exposure to multiple chemicals would occur if someone ingests fish from Portland Harbor, as more than one contaminant was found in every species sampled. The ability to assess the public health implications of exposure to multiple agents is limited by the vast number of chemicals and possible interactions between chemicals in the environment. Individual cancer risk estimates can be added since they are measures of probability. For non-carcinogenic health outcomes however, similarities in their mode of action must exist between chemicals if the doses are to be added. An example of similar modes of action would be the organochlorine pesticides, DDD, DDE and DDT, on the nervous system. In this case, the hazard quotients for each chemical are summed to give a hazard index.

Hundreds of chemicals were analyzed in the fish collected from Portland Harbor. Only a select few were evaluated for their potential risk to the public. Most were excluded because they were found at levels below their comparison value, or lacked comparison values from which quantitative evaluations could be made. The intent of this document is to focus on the major chemicals of concern.

Completed Biota Exposure Pathways:

The consumption of resident and migratory fish that were collected within Portland Harbor, or after migrating through Portland Harbor, represents a completed exposure pathway.

Fishing locations in or near the initial site study area (river miles 3.5 to 9.2) were identified from discussions with the authors of a series of articles on the topic in the *Oregonian*, other credible sources, and the tours of the area made by ATSDR/SHINE staff [5][6]. Some of the major locations for bank fishing are the River Place Marina, the Swan Island area including the lagoon, St. John's Bridge and Cathedral Park, Terminal 4 (including the coves near this locations), and Willamette Cove. Boat fishing appears to be focused near piers, docks, and other in-water structures from Swan Island to the

Multnomah Channel for warm-water fish [7][8]. Bank fishing is done by a variety of ethnic groups including African-Americans, Vietnamese and other Southeast Asians, and Eastern European immigrants [9][10]. Boat fishing is done mostly by Caucasians and some tribal members.

Average (17.5 grams/day) and high-end (142.4 grams/day) ingestion rates were used to calculate exposure doses for fish caught and consumed in Portland Harbor for adults. These values represent the 90th percentile (17.5 grams/day) and 99th percentile (142.4 grams/day) per capita ingestion rates for people of age 18 or older in the United States, including people that consumed fish and did not consume fish [11]. Although 17.5 grams/day is the 90th percentile fish ingestion rate in EPA guidance, SHINE assigned the term average to this rate, since this assessment is concerned about the risk to fish consumers and not people that avoid consuming fish. For children, an average consumption rate of 7 grams/day and a high-end ingestion rate of 60 grams/day were used. It is important to keep in mind these numbers represent a range of possible fish ingestion rates and do not characterize any individuals or groups consumption rate from eating fish in Portland Harbor.

It is well documented that Native Americans in the Pacific Northwest consumed considerably more fish than the general population; however, four of the tribes in the Columbia Basin have been shown to eat a mixed diet of seafood including a high percentage of salmon and steelhead [12]. Thus, it is assumed that using the high-end ingestion rate for the most contaminated species would result in risk estimates that are protective of tribal members. The risk to health from consuming a balanced diet high in salmon and steelhead would be less than a diet consisting solely of resident fish, such as carp or bass, collected from Portland Harbor. Pacific lamprey, which is consumed by several tribal members after migration through Portland Harbor, was not assessed in this document. A prior health consultation was developed to evaluate the risk of eating lamprey among members of the Confederated Tribes of Siletz Indians [13].

An important consideration when estimating exposure to contaminants in fish from a specific water body concerns the percentage of a particular fish that is consumed. If consumption of a particular species caught in Portland Harbor is only a portion of the total amount of fish consumed, then the overall dose for that species must be considered with the percent contribution of other fish. This can have significant impacts on the risk to an individual. For instance, if someone ingested an average of four ounces of carp per day from Portland Harbor (100% carp diet) versus two ounces of carp and two ounces of sturgeon (50% carp and 50% sturgeon diet) their risk would be different. Since there are numerous possibilities of analyzing dietary mixtures, only the results of individual fish are given below. In addition, the risk would differ depending on what part of the fish is consumed (i.e. fillet versus whole body), how it is cooked (if at all), and who is eating the fish (i.e. infants and children versus adults).

The results analyzed in this document are from uncooked, whole body fish tissue samples. Estimating risk to humans from these results is a health protective approach, since preparation and cooking methods tend to reduce fat-soluble contaminants, such as pesticides and PCBs [14][15]. Removing the skin, head, eyes, organs, and fat will reduce the amount of contaminants as well. In addition, the fillet samples had less organic contaminants, such as PCBs, compared with whole body samples in all the fish tested.

It should be noted that the hazard quotients (HQ) presented for each species below are based on the chemical that was associated with the most risk for consuming a particular species. For non-cancer health effects, a comparison is made between the exposure concentrations (mg/kg/day) and the ATSDR's Minimal Risk Level (MRL) or the EPA's Reference Dose (RfD). This comparison is called a hazard quotient (HQ) and is expressed as:

$$HQ = \frac{\text{Exposure concentration (mg/kg}\cdot\text{day)}}{\text{MRL or RfD}}$$

If the ratio of estimated exposure concentration to the MRL or RfD is greater than one, the potential for adverse health effects needs to be further assessed. The higher the exposure concentration is above the MRL or RfD, the more risk is present. A HQ ratio of greater than one does not mean a health effect will occur.

The summed cancer risk for all chemicals analyzed for this report is presented for each species below. Cancer and non-cancer risk from exposure to hazardous substances are evaluated differently. Detailed information on the calculation and significance of hazard quotients and cancer risk can be found in Appendix A.

Carp

Carp had the highest level of PCB contamination (whole body) of the fish analyzed in this public health assessment and carp are considered to have a significant health risk for consumers. PCB levels were especially high in some of the carp collected between river mile three and river mile six (although carp can move widely throughout the river). The level of PCBs present in the fillet were approximately half of the levels detected in whole body samples.

For average fish consumers (ingestion rate of 17.5 grams carp/day) the hazard quotient for PCBs was 24 and 45 for adults and children, respectively. For high-end consumers (ingestion rate of 142.4 grams carp/day), the hazard quotient was 195 and 348 for adults and children, respectively (Appendix E). These elevated hazard quotients indicate that carp are a significant concern for public health at both average and high-end ingestion rates, especially for infants, children, women of childbearing age and people that eat whole body carp. SHINE considers fetal exposure to PCBs and the effects on neurological development to be a potential critical adverse health effect. The public is strongly urged to follow DHS fish advisory guidelines for resident fish collected in Portland Harbor.

The additional lifetime excess cancer risk from ingesting uncooked, whole body carp at Portland Harbor is three additional lifetime cancers per 10,000 people exposed for average consumers and two additional lifetime cancers per 1,000 people exposed for high-end consumers based. The greatest contribution to cancer risk was based on dioxins, furans and dioxin-like PCBs.

The level of risk posed by ingesting carp from Portland Harbor is a public health hazard. Carp are consumed by numerous ethnicities, including people of Asian and Eastern European descent. SHINE interviews have found that whole body carp is used for soup and making fish paste (which is often fed to infants and children).

Smallmouth Bass

Smallmouth bass had the second highest level of PCB contamination (whole body) among the fish analyzed in this public health assessment and bass are considered to have a significant health risk for consumers. The levels of PCBs were especially high in bass collected from Swan Island Lagoon. The levels of PCBs present in the fillet (measured as Aroclors) were 93% less than the levels detected in whole body samples.

For average consumers, the hazard quotient for PCBs was 11and 21 for adults and children, respectively. For high-end consumers, the hazard quotient was 93 and 182 for adults and children, respectively (Appendix E). These elevated hazard quotients indicate a significant concern for public health at average and high-end ingestion rates, especially for children and women of childbearing age. SHINE considers fetal exposure to PCBs and the effects on neurological development to be a potential critical adverse health effect. The public is strongly urged to follow DHS fish advisory guidelines for resident fish collected in Portland Harbor.

The additional lifetime excess cancer risk from ingesting uncooked, whole body smallmouth bass at Portland Harbor is three additional lifetime cancers per 10,000 people exposed for average consumers and three additional lifetime cancers per 1,000 people exposed for high-end consumers. The greatest contribution to cancer risk was based on a calculated toxicity equivalence factor for dioxins, furans and dioxin-like PCBs.

The level of risk posed by ingesting smallmouth bass from Portland Harbor is a public health hazard, especially if the bass are collected in Swan Island Lagoon. Bass are a popular sportfish and are fished within Portland Harbor, including by a large and active bass and panfish club. Careful preparation and removal of fats and organs from smallmouth bass will reduce the risk posed by PCBs [14][15].

Brown Bullhead

Bullhead had the third highest levels of PCB contamination in their tissue, especially those caught between river miles six through nine and bullhead are considered to have a significant health risk for consumers. The level PCBs present in the fillet (measured as Aroclors) were 13% less than the levels detected in whole body samples.

For average consumers, the hazard quotient for PCBs was 6 and 12 for adults and children, respectively. For high-end consumers, the hazard quotient was 52 and 102 for adults and children, respectively. These elevated hazard quotients indicate a significant concern for public health at average and high-end ingestion rates, especially for children and women of childbearing age. SHINE considers fetal exposure to PCBs and the effects on neurological development to be a potential critical adverse health effect. The public is strongly urged to follow DHS fish advisory guidelines for resident fish collected in Portland Harbor.

The additional lifetime excess cancer risk from ingesting uncooked, whole body bullhead at Portland Harbor is one additional lifetime cancer per 10,000 people exposed for average consumers and one additional lifetime cancer per 1,000 people exposed for high-end consumers. The greatest contribution to cancer risk was based on a calculated toxicity equivalence factor for dioxins, furans and dioxin-like PCBs.

The level of risk posed by ingesting bullhead from Portland Harbor constitutes a public health hazard. Numerous groups catch and consume bullhead from the Willamette River.

Black Crappie

Crappie had elevated levels of PCB contamination in their tissue, but were less than other resident fish tested and crappie constitute a moderate public health concern. The levels of PCBs in fillet (measured as Aroclors) were 82% less than the levels detected in whole body samples.

For average consumers, the hazard quotient for PCBs was 2 and 4 for adults and children, respectively. For high-end consumers, the hazard quotient was 17 and 33 for adults and children, respectively (Appendix E). These hazard quotients indicate a concern for public health at high-end ingestion rates, especially for children and women of childbearing age. SHINE considers fetal exposure to PCBs and the effects on neurological development to be a potential critical adverse health effect. The public is strongly urged to follow DHS fish advisory guidelines for resident fish collected in Portland Harbor.

The additional lifetime excess cancer risk from ingesting uncooked, whole body black crappie at Portland Harbor is seven additional lifetime cancers per 10,000 people exposed for high-end consumers. Average consumption of crappie was below an excess cancer risk of one additional lifetime cancer per 10,000 people exposed. The greatest contribution to cancer risk was based on a calculated toxicity equivalence factor for dioxins, furans and dioxin-like PCBs.

The level of risk posed by ingesting black crappie from Portland Harbor constitutes a public health hazard at the high-end ingestion rates, especially among children. Crappie is a popular sport fish and is fished within Portland Harbor, including a large and active bass and panfish club. Careful preparation and removal of fats and organs from black crappie would greatly reduce the risk posed by PCBs.

White Sturgeon

Sturgeon had elevated levels of PCB contamination in their tissue, and consumption of sturgeon from Portland Harbor constitutes a moderate public health concern. The level of PCBs in sturgeon was highly variable from moderate levels to elevated levels, even though the sturgeon were of similar size. It should be noted that the sturgeon analyzed were at, or just above the legal size limit. There is the potential contamination levels found would have been higher had larger, older sturgeon been caught and analyzed.

For average consumers, the hazard quotient for PCBs was 3.6 and 6.6 for adults and children, respectively. For high-end consumers, the hazard quotient was 29 and 57 for adults and children, respectively. These hazard quotients indicate a concern for public health at average and high-end ingestion rates, especially for people that frequently consume sturgeon from Portland Harbor, children and women of childbearing age. Sturgeon also had the highest level of mercury compared with other species tested, indicating the need for further caution among children and women of childbearing age. SHINE considers fetal exposure to PCBs and mercury and the effects on neurological development to be a potential critical adverse health effect. The public is strongly urged to follow DHS fish advisory guidelines for resident fish collected in Portland Harbor. Removing the skin, head, eyes, organs, and fat will reduce the amount of PCBs and other fat soluble contaminants

The additional lifetime excess cancer risk from ingesting uncooked sturgeon fillet at Portland Harbor is five additional lifetime cancers per 10,000 people exposed for high-end consumers. Average consumption of sturgeon was below an excess cancer risk of one additional lifetime cancer per 10,000 people exposed. The greatest contribution to cancer risk was based on a calculated toxicity equivalence factor for dioxins, furans and dioxin-like PCBs.

During SHINE site visits to Portland Harbor and interviews with community members, sturgeon fishing was consistently observed or mentioned. Sturgeon were highly variable in their level of PCB contamination. Frequent consumption of sturgeon caught in Portland Harbor may constitute a public health hazard, especially if the consumers are women of childbearing age, infants, children or people with liver, immune system or thyroid problems.

Chinook Salmon

Chinook salmon had the lowest levels of PCBs compared with any other species tested, and consumption of salmon from Portland Harbor is not considered to constitute a public health threat. Chinook salmon had the higher levels of arsenic; however, the risk of adverse health effects from the toxicity and levels of arsenic does not pose a public health threat. A hazard quotient of 1.9 for adults and 3.6 for children was calculated using a high-end ingestion scenario. These hazard quotients were calculated using whole-body samples and an assumed fraction of 10% for inorganic arsenic. Both the assumed fraction of arsenic and the assessment of whole-body salmon are uncertainties that may over-estimate the risk to consumers, as many studies suggest that the majority of arsenic in fish is in the organic form, which was assumed to be less toxic compared with the inorganic form (see Public Health Implications for more information). However, there are several uncertainties in the evaluation of arsenic. The assumption that all organic species of arsenic are non-toxic may underestimate the risk.

With arsenic, the critical health effect of concern is cancer however SHINE does not consider the ingestion of salmon to pose a public health threat. The theoretical additional lifetime excess cancer risk from ingesting uncooked, whole body salmon at Portland Harbor is four additional lifetime cancers per 10,000 people exposed for high-end consumers. Average consumption of salmon was below an excess cancer risk of one additional lifetime cancer per 10,000 people exposed.

Several anglers and tribal members fish for the spring and fall runs of Chinook salmon in Portland Harbor. Based on the low level of PCBs, dioxins and pesticides in salmon tissue, and the assumed fraction of inorganic arsenic, consumption of salmon caught in or near Portland Harbor constitutes a no apparent public health hazard.

Potential Exposure Pathways:

The consumption of crayfish harvested within Portland Harbor represents a potential exposure pathway. It is unknown whether or not crayfish are harvested commercially within Portland Harbor. SHINE was able to determine that the Oregon Department of Fish and Wildlife (ODFW) had issued two permits for commercial collection of crayfish in Multnomah County, which includes all of Portland Harbor. Furthermore, it was found that the licensees had sold the crayfish to commercial seafood distributors for human consumption. Unfortunately, the only location-specific information contained in the ODFW permits is where the boats were taken out of the Willamette River and not where actual collection of crayfish occurs. According to a member of the Oregon Bass and Panfish club, crayfish traps are placed in the Portland Harbor Superfund site boundaries and collected for bait and possibly consumption [7].

Average (3.3 g/day) and high-end (18 g/day) ingestion rates were used to calculate exposure doses for crayfish caught and consumed from Portland Harbor. These values represent the average (3.3 g/day) and 95th percentile (18 g/day) per capita ingestion rates for people of 18 years or older in the United States [11].

Both high-end and average consumption rates of crayfish were below a hazard quotient of one and an excess cancer risk of one additional lifetime cancer per 10,000 people exposed; therefore, adverse health are not anticipated.

Exposure Pathways Not Evaluated:

This document did not evaluate the soil, air, sediment, surface water and groundwater exposure pathways. An evaluation of the risk from exposure to sediment was conducted by the ATSDR in the initial Portland Harbor Public Health Assessment [1] and will be evaluated in future public health assessments as the data from these pathways are completed.

This report did not evaluate the risks from ingesting other wildlife that may be found in Portland Harbor, such as clams, waterfowl, or mammals. Furthermore, no assessment was conducted on vegetation that may be grown in or near Portland Harbor. It is thought that some tribal members may consume wapato *(Sagittaria latifolia)* from a couple of locations near the southern tip of Sauvie Island along the banks of the Multnomah Channel. One of those locations (Wapato Access Area) is maintained by the Oregon Department of Parks and is about 3.5 miles north of the start of Multnomah Channel. Wapato is a tuber that grows in shallow water and, because it is rooted in the sediment, potentially could accumulate contaminants. Known uses of wapato are cooking like a potato or preparing in flour.

Public Health Implications:

Based on the results of the public health assessment in Appendix E, a select group of chemicals were analyzed for their public health impact in the toxicological profile section. For non-carcinogenic effects, contaminants that had a hazard quotient greater than one in any fish tested were included. For carcinogenic effects, contaminants that had a risk of greater than one additional excess cancer per 10,000 people exposed for any fish tested were included in this section. While literature specific to fish consumption was highlighted in this section, a broad overview of the chemical of concern is included as well. For this public health assessment, the contaminant of most concern detected in Portland Harbor fish is PCBs. The adverse health effect associated with PCB exposure of most concern is neurological developmental effects to the fetus. Methylmercury, arsenic and persistent pesticides are discussed since they exceed the criteria for non-carcinogenic and carcinogenic effects described above.

Polychlorinated biphenyls (PCBs)

PCBs were banned from production in the United States in 1977 as a result of concerns for toxicity and persistence in the environment. PCBs were used in several industrial processes, including use as insulating fluids for transformers and capacitors, hydraulic fluids, adhesives, fire retardants and plasticizers. Commercial PCB formulations are known as Aroclors. Aroclors are mixtures of PCB congeners, varying in their degree of chlorination. There are 209 congeners, or structural variations, that are possible for PCBs, although some congeners are more likely to be found in wildlife tissue. In general, PCB persistence increases with increased chlorination in the mixture.

Much of the early literature on harmful effects of PCB exposure were the result of two incidents in which contaminated rice oil was consumed in Japan (Yusho disease) and Taiwan (Yu-Cheng disease). Infants born to women who ate the oil had several neurobehavioral deficits, some of which persisted for many years [16]. In addition, effects on the immune system [17][18] and increased liver cancer [19] were noted. Heating of the rice oil produced relatively high levels of chlorinated dibenzofurans, which may have contributed to adverse health outcomes.

Several studies have examined the developmental effects of PCBs to the fetus as a result of maternal fish consumption. The Michigan Maternal Infant Cohort Study[20][21][22] tested infants that were born to women who consumed Great Lakes fish. Developmental effects and cognitive disorders were noted in children of mothers who had eaten contaminated fish several years preceding pregnancy and throughout gestation. Neurobehavioral effects included impaired visual recognition, depressed response time, and poor short-term memory. Developmental effects included decreased birth weight, gestational age and head circumference. Investigators have found that highly chlorinated PCB congeners were markedly elevated in cord blood in women that ate contaminated Great Lakes fish [23]. Lesser chlorinated PCBs were unrelated to level of fish consumption. High prenatal exposure to the most heavily chlorinated congeners was associated with impaired performance on neonatal behavioral exams [24][25].

Thyroid dysfunction has been associated with PCB exposure and postulated as a mechanism by which PCBs may impair behavioral and neurological development. Thyroid hormones, such as thyroxine, are essential for proper intellectual and nervous system development. Numerous animal and laboratory assays have demonstrated a decrease in thryoxine levels in response to PCB exposure[26][27], including a loss of hearing in rats exposed to Aroclor 1254 [28]. PCBs can have negative impacts on immune system performance as well [29]. ATSDR derived a minimum risk level of 0.00002 µg/kg/day (parts per billion per day) for chronic-duration oral exposure to PCBs based on immunological effects in monkeys (Tryphonas et al, 1989).

Animal studies have suggested that PCBs can cause liver tumors in rats [29]. In epidemiological studies, increased mortality from liver, gall bladder and biliary tract cancers, as well as malignant melanoma, have been reported in capacitor manufacturing workers exposed to a variety of commercial PCB mixtures [30][31]. Epidemiological studies have found associations between non-Hodgkin's lymphoma and PCB concentrations in adipose tissue [32] and serum [33]. Both the EPA and International Agency on Research in Cancer (IARC) classify PCBs as probable human carcinogens [29]. Some PCB congeners have dioxin-like activity, which is thought to contribute to their carcinogenic potency.

Dioxins and furans

Dioxins and furans consist of a family of approximately 210 different compounds with different levels of chlorination. Dioxins and furans occur at very low levels in the environment from naturally occurring sources and can be found in food, water, air and cigarette smoke. Dioxins are primarily released to the environment during the combustion of fossil fuels and wood, during the incineration of municipal, medical and hazardous waste and through certain pulp and paper processes. Dioxins were found in the herbicide 2,4,5-T (currently restricted in the United States), which was used extensively as a defoliant on crops and rangelands, along roadways and during the Vietnam War. Higher chlorinated congeners are found in the wood preservative pentachlorophenol. The most studied and toxic member of the dioxin family is 2,3,7,8-tetrachlorodibenzo-*p*-dioxin (TCDD).

One of the most characteristic effects of exposure to 2,3,7,8-TCDD is a severe skin disease known as chloracne. This condition consists of acne-like lesions, usually found on the face and upper neck. Other skin effects include red rashes, discoloration, and excessive body hair. In addition, liver damage, developmental effects and impaired immune function could result in people exposed to elevated levels of dioxins [34]. These effects would not be anticipated based on exposure to fish consumption. One study assessed the levels of dioxins, furans and dioxin-like PCBs in men with high fish consumption from the Baltic Sea [35]. The mean level of blood dioxins were approximately three-fold higher in fish consumers compared with non-consumers, but was not correlated with a reduction in immune system performance.

Long-term exposure to dioxins and furans could increase the likelihood of developing cancer. Studies in rats and mice exposed to TCDD resulted in thyroid and liver cancer [36]. A number of epidemiological studies have associated exposure to 2,3,7,8-TCDD with cancer mortality [37]. EPA considers 2,3,7,8-TCDD to be a probable human carcinogen and developed a cancer slope factor of 1.5x 10^5 mg/kg/day^{-1} [38][39].

DDT, DDE and DDD:

DDT is an organochlorine insecticide that was widely used in the United States until it was banned in 1972. DDT continues to be used in some parts of the world for control of mosquitoes and other vector-borne diseases. DDE and DDD are breakdown products of DDT and may be found in greater amounts than DDT in the environment. Since the ban of DDT in 1972, levels in the environment have been declining. Today, the primary route of exposure to DDT occurs through the diet especially dairy, fish and meat [40].

DDT, DDE and DDD have high levels of environmental persistence and can biomagnify up the food chain. Most of these chemicals accumulate in fatty tissues. The best-known effect of DDT and its related compounds is the impairment of proper nerve system functioning. Other effects attributed to high exposure or body burdens of DDT, DDE and DDD include adverse liver effects and reproductive effects such as maintenance of pregnancy, fertility and decreased birth weight [40].

Studies in animals have shown that DDT, DDE and DDD can cause cancer, primarily of the liver. Human studies are less conclusive. A study on Canadian women found that plasma levels of DDT and DDE in women with breast cancer were not significantly difference from controls, but that an association was noted between DDE and cancer aggressiveness [41]. EPA considers DDT, DDE and DDD to be probable human carcinogens.

Arsenic

Arsenic is a naturally occurring element found throughout the environment. Arsenic has been used in many products, especially as a wood preservative. Other uses include pesticide formulations, in alloys for lead-acid batteries and in semiconductors. The largest source of arsenic in the typical diet is through the ingestion of fish and shellfish [42][43]. Marine organisms have the ability to accumulate arsenic present in seawater and food items [44]. Most studies indicate that the majority of the arsenic found in fish and shellfish is organic arsenic, which is thought to be less toxic than inorganic arsenic [45]. However, as more information becomes available about organic arsenic toxicity, the assumptions in this public health assessment in regards to arsenic exposure from fish consumption in Portland Harbor may have to be re-evaluated. In this public health assessment, it was assumed that 10% of the total arsenic detected in fish was in the inorganic form. Inorganic arsenic is readily absorbed across the gastrointestinal tract. Inside the body, arsenic is transformed through a methylation process into dimethylarsinous acid (DMA) and monomethylarsonic acid (MMA), both of which can be detected in urine[46].

Numerous non-cancer health effects have been attributed to arsenic ranging from irritation of the gastrointestinal tract to damage to the cardiovascular and nervous systems. One of the most characteristic effects of chronic exposure to arsenic is a pattern of skin changes characterized by the darkening of skin and the appearance of small bumps on the palms, soles and torso [45].

Arsenic was first recognized as a cancer-causing agent over 100 years ago when a number of skin cancers were observed in patients using arsenical treatments[47]. A large study in Taiwan, where villagers consumed water contaminated with high levels of inorganic arsenic, demonstrated increases in bladder, skin, kidney, liver, lung and colon cancers [48]. A study of 26 counties in Argentina revealed increased rates of bladder, lung, kidney and skin cancer with increasing exposure to arsenic contaminated drinking water [49][50]. It should be noted that most skin cancers due to arsenic exposure are not fatal. A large-scale study of the effects of arsenic-contaminated drinking water on a U.S. population did not demonstrate an association between ingestion of inorganic arsenic in drinking water and cancer, although hypertensive heart disease appeared elevated in the exposed group [45]. The International Agency for Research on Cancer, the National Toxicology Program and the Environmental Protection Agency classify inorganic arsenic as a known human carcinogen.

Methylmercury

Mercury is found in the environment from a variety of sources, including the natural off-gassing of the earth's crust, application of fertilizers, pesticides and biosolids, burning of coal, disposal of products containing mercury, mining operations and other sources. As mercury is transported through the environment, certain conditions transform mercury into the organic form, methylmercury. Methylmercury is the predominant form of mercury found in fish and binds to proteins in muscle [51]. Methylmercury can accumulate in the food chain and is often found in the highest amounts among marine and freshwater predatory fish.

Fish consumption constitutes the primary dietary source of mercury for the general public [51]. Since mercury is a developmental neurotoxin [52] special consideration and outreach should be targeted towards women of childbearing age, especially since 8% of women were estimated to have blood mercury levels above the EPA's recommended reference dose of 5.8 ug/L [53]. In the 2000 National Health and Nutrition Examination Survey (NHANES), blood mercury concentrations were seven times higher in women who consumed nine or more seafood meals within the past thirty days versus women who reported no seafood consumption [54].

The first report of widespread neurological toxicity associated with the ingestion of mercury-contaminated fish occurred in Minamata Bay, Japan [55]. More recent studies have found sub-clinical neurological deficits associated with low-level exposure to mercury through fish consumption [56][57]. Recently, methylmercury was demonstrated to affect heart function in children exposed to high seafood diets in the Faroe Islands [58]. ATSDR derived a chronic oral minimum risk level (MRL) of 0.0003 mg/kg/day for mercury exposure in humans based on neurodevelopmental outcomes in children exposed *in utero* to methylmercury [59].

Benefits of Fish Consumption

It is important to consider the health benefits of eating fish. Fish is an excellent source of protein with known benefits to the heart, circulatory system, and diabetic patients [60][61]. A review of epidemiological studies showed that fish consumption reduced the risk of heart attack and stroke mortality in 36 countries [62] and reduced blood pressure [63]. Fish tend to contain a higher proportion of unsaturated fatty acids, such as omega-3 polyunsaturated fats, which have many health benefits. Fish consumption also provides a good source of some vitamins and minerals as well [64]. The American Heart Association recommends two fish meals per week [65].

Evaluation of Health Outcome Data:

The Superfund law requires that health outcome (i.e., mortality and morbidity) data (HOD) be considered in a public public health assessment [66]. This consideration is done using specific guidance in ATSDR's *Public Health Assessment Guidance Manual*

[67]. The main requirements for evaluating HOD are presence of a completed human exposure pathway, great enough contaminant levels to result in measurable health effects, sufficient persons in the completed pathway for health effects to be measured, and a health outcome database in which disease rates for population of concern can be identified [67].

This site does not meet the requirements for including an evaluation of HOD in this public health assessment. Although completed human exposure pathways exist at this site and contaminant levels are high, the exposed population is not sufficiently defined nor is a health outcome database established to permit meaningful measurements of possible site-related health effects as identified in existing HOD.

Child Health Considerations:

SHINE and ATSDR recognize that infants and children may be more vulnerable to exposures than adults in communities faced with contamination of their air, water, soil, or food. This vulnerability is a result of the following factors:

- Children are smaller, resulting in higher doses of chemical exposure per body weight.
- The developing body systems of children can sustain permanent damage if toxic exposures occur during critical growth stages. Infants and children have different absorption, metabolism and excretion rates which can influence how they deal with chemical exposure.
- Infants and children have proportionally larger livers and brains – fatty organs in which PCBs and other organic contaminates preferentially accumulate.
- Infants and children have longer remaining lifespan in which the expression of toxicity (especially cancer) can occur

Because children depend on adults for risk identification and management decisions, SHINE and ATSDR are committed to evaluating their special interests at Portland Harbor.

Infants and children under six should be restricted from eating any resident fish caught in Portland Harbor, especially carp, bass and catfish. Children over the age of six should eat no more than one 8-ounce meal per month of resident fish. The fish should be properly prepared and cooked as described in the recommendations section.

Community Health Concerns:

In the 2002 Portland Harbor Public Health Assessment (PHA) developed by ATSDR, it was determined that the most important exposure pathway at the site was consuming fish. The PHA report recommended that health education and risk communication plans be developed and implemented to inform people of their risk and how they could minimize it. Specifically, it was recommended that programs target the various ethnic groups and sport anglers that catch and consume fish from the lower Willamette River, and that input and cooperation from the targeted groups insure maximum effectiveness.

SHINE conducted an extensive community outreach campaign in response to the recommendations made in the initial PHA report. Because this is a follow-up public health assessment, this section will describe the multi-faceted efforts made by SHINE to perform a needs assessment as well as develop and implement a health education action plan to address the recommendations in the previous public health assessment report.

Overview

SHINE staff developed a plan to address community concerns and provide education to protect and improve public health for communities affected by the Portland Harbor Superfund site that involved significant interaction with community members. Efforts were made to connect with culturally diverse, hard–to-reach communities using outreach methods including public availability sessions, informational mailings, media advertising, mini-grant opportunities and press releases (described in the Public Health Action Plan section).

The staff employed a systematic health education process that included the following steps:

- Needs Assessment: SHINE worked with the community to gather information about their health concerns, knowledge, attitudes and beliefs about exposure to Portland Harbor contaminants, and any practices or behaviors that place them at risk. Methods used to learn about community health concerns included community questionnaires, informal surveying techniques, as well as talking with community leaders and members

- Planning: SHINE identified ways to address health issues found in the assessment and set specific goals for reducing or preventing exposures from consuming Portland Harbor fish. SHINE worked with the community to prioritize needs and included their recommendations in developing the health education action plan.

- Implementation: SHINE worked with community groups to develop health education materials to target their community, address health concerns described in the initial PHA, and present information to communities on how to prevent future exposures. Staff will review the results of the plan and make adjustments as necessary.

Initial Assessment of Community Needs

Early in the process of identifying the Portland Harbor as a Superfund site, DEQ, EPA and ATSDR performed some initial assessment of needs. In 1999 and 2000, the Oregon Department of Environmental Quality (DEQ) performed extensive investigation into community concerns and communications. In 2001, the Environmental Protection

Agency (EPA) united efforts with DEQ to continue collecting and responding to community concerns. Jointly, they conducted over 30 interviews and performed a series of four focus groups with representatives from concerned communities (business, neighborhoods, recreational users, and environmental groups). The following are some of the main concerns they identified (Portland Harbor Community Involvement Plan, February 2002, Memo to discussion group participants, May 2002):

- Cleanup should be coordinated with efforts to prevent recontamination of the harbor
- Dredging as a means to clean up contamination in the harbor
- The manner that contaminated sediments get cleaned up and disposed of
- The continued economic viability of Portland Harbor
- The operation of businesses during the cleanup
- Safety of fish to consume
- Involvements of agencies and tribal governments slowing down the cleanup process
- Posting and advertising of unsafe conditions
- The effect on water quality of contaminated sediments
- The extent of the harbor's contamination

In preparing the initial version of this document, ATSDR met with or contacted a variety of groups and individuals to identify health concerns the community might have about exposure to contaminants from the Portland Harbor site. These groups included the Urban League of Portland, OCEH, OSPIRG, Willamette Riverkeepers, IRCO, DEQ, DHS and EPA. ATSDR met with tribal representatives from the Confederated Tribes of the Siletz Indians and the Grand Ronde as well.

In spring of 2002, EPA initiated a meeting to determine if members of the affected communities would be interested in developing a community advisory group around the Portland Harbor Superfund site. A group of interested community members established the Portland Harbor Community Advisory Group and has continued to meet monthly to discuss issues pertaining to the cleanup, human health and the environment. In its third year, the CAG members are largely represented by neighborhood associations, business, environmental organizations and at-large community members, but are interested in reaching out to all affected communities to include racial and ethnic groups.

Needs Assessment

In early 2003, SHINE began a health education needs assessment. SHINE reviewed existing health concerns and health education materials and performed a more detailed public health assessment. This information was used to develop the health education action plan.

SHINE attended community events, neighborhood association meetings and approached community members to administer a community health education needs assessment questionnaire (in English and Spanish). Participants at a University Park Neighborhood Association meeting, a community health fair at Clarendon Elementary School in North

Portland, a public meeting on the McCormick & Baxter Superfund site cleanup, the Portland Harbor fish advisory public availability meeting and the Kenton Neighborhood Festival responded to the questionnaire throughout the spring and summer of 2003. A total of fifty persons were approached to share their top concerns and health issues about Portland Harbor, preferred ways to receive information, whether they were aware of the fish advisory, locations along the river that they have seen people fish or engage in other behaviors that may pose a health threat along the river, as well as information about fish consumption from the Portland Harbor. Besides indicating the most popular sites along the river to recreate, respondents provided ideas and listed venues for performing education outreach. Almost all of the community members listed posting signs as the most important way to publicize the fish advisory. Other frequent concerns that people had included were:

- concerns about future health effects
- community use of sites, such as McCormick and Baxter
- obtaining correct health information
- concerns about current health effects

SHINE conducted one-on-one interviews with community leaders, involved agencies and groups to learn about the people that fish Portland Harbor and previous health education efforts. The purpose of these interviews was to obtain information on concerns from the site, opinions on the best way to keep the community informed, recommended contacts, important venues for health education, and knowledge about fishing populations. In addition to community leaders, SHINE interviewed Department of Environmental Quality staff, EPA Community Involvement staff, potentially responsible parties, environmental activists, CAG members, neighborhood associations, and representatives of several community organizations. The needs assessment interviews provided insight on historical outreach programs and future needs.

SHINE attended community events with an interactive display that encouraged event-goers to participate in an informal survey about issues related to the Portland Harbor in an effort to engage people in the display. The informal surveying of people attending three events in 2003 was designed to engage people in talking about fishing from the Portland Harbor and fish consumption behaviors. Booth participants received three beads to vote where fish advisory signs should be placed. There were six jars with known fishing spots and a map with colorful dots placed at each spot. Participants were encouraged to place beads in up to three locations where they have fished or seen community members fishing before. The booth was set up at the Festival Latino, the Kenton Neighborhood Festival, and the African American Wellness.

SHINE also attended two events in 2004, as well as one event in 2005, and informally surveyed the community's greatest concerns about the Portland Harbor cleanup and contamination. Over 600 booth participants at the African American Wellness Village, the Portland Harbor Superfund Field Day, and the Northwest Sportsmen's Show voted on the top three concerns they had relating to the site out of six known community concerns. Participants were encouraged to place beads in up to three jars or weight it according to their level of concern. The two most frequent concerns were obtaining correct health information on chemicals and health effects, and the impact of the clean up on swimming and/or fishing in Portland Harbor.

Based on the efforts described above, SHINE prepared a Needs Assessment Summary document to summarize the findings of the needs assessment efforts. This document was used to guide the development of a comprehensive plan to address community concerns and health education needs (described in the Public Health Action Plan section). The focus of the Public Health Education Action Plan was to engage community partners in developing culturally appropriate health education materials and activities as a mechanism to reach communities that catch and consume fish from the harbor.

Document Release

SHINE released this public health assessment for public review and comment on July 15, 2005 until October 14, 2005. A press release was developed to notify the public of the document release and public comment period. SHINE staff conducted extensive outreach to educate about the findings and recommendations of this public health assessment, and the current fish advisory through a series of eight neighborhood association and community meeting presentations. The document and summary fact sheet (see Appendix H) were made available at the presentations that were given in conjunction with staff from the EPA and DEQ throughout the summer and fall of 2005. The document was also available on the web at http://www.healthoregon.org/superfund. Comments on the draft version of the Portland Harbor Public Health Assessment were received and addressed in Appendix A.

Conclusions:

Consumption of resident fish caught in Portland Harbor represents a **public health hazard** for children and adults. The most contaminated fish are carp, bass and bullhead catfish. The primary pollutants of concern are polychlorinated biphenyls (PCBs). These chemicals are most harmful to the developing fetus via maternal fish consumption.

Children and adults who consume migratory fish, such as salmon, from Portland Harbor are not likely to have adverse health effects as a result of eating these fish.

Outreach and educational activities for people and groups that consume resident fish in Portland Harbor needs to be a continuous and cooperative effort as long as PCBs continue to be detected at levels of public health concern.

Recommendations:

SHINE recommends that people who eat fish collected from Portland Harbor follow the fish advisory consumption limits developed by the Oregon Department of Human Services (www.healthoregon.org/fishadv) for resident fish caught in Portland Harbor outlined below.

Women of childbearing age, especially women who are pregnant, thinking about getting pregnant or nursing, infants and children and people with weak immune systems, thyroid or liver problems, should avoid eating resident fish from Portland Harbor. Examples of resident fish include bass, carp and bullhead catfish.

Healthy adult men and women beyond childbearing age and healthy children should limit their consumption to one 8-ounce meal of resident fish per month. Fish collected from Portland Harbor should be properly prepared and cooked to reduce exposure to pollutants. The skin, fat, head, eyes, eggs and organs should be removed and discarded. Fish should be cooked by methods that allow the fats to drip off, such as grilling, baking, broiling or smoking.

Public Health Action Plan:

The Public Health Action Plan for the site contains a description of actions that have been or will be taken by SHINE and other government agencies at the site. The purpose of the Public Health Action Plan is to ensure that this public health assessment not only identifies public health hazards, but also provides a plan of action designed to mitigate and prevent adverse human health effects resulting from exposure to hazardous substances in the environment. Included is a commitment on the part of ODHS to follow up on this plan to ensure that it is implemented.

In the 2002 initial Portland Harbor Public Health Assessment (PHA) developed by ATSDR [1], it was determined that the most important exposure pathway at the site was consuming fish. The PHA report recommended that health education and risk communication plans be developed and implemented to inform people of their risk and how they could minimize it. Specifically, it was recommended that programs target the various ethnic groups and sport anglers that catch and consume fish from the lower Willamette River, and that input and cooperation from the targeted groups insure maximum effectiveness. Much of this Public Health Action plan details activities that have been implemented or are planned to accomplish risk communication about consuming fish from the Portland Harbor.

Actions Completed

- SHINE initiated and completed an interagency exposure investigation to examine the level of contaminants in salmon, sturgeon and lamprey, in response to concerns raised by community groups, tribes and the public. This effort involved drafting a quality assurance project plan implementing a sampling protocol, interpreting tissue results and making public health recommendations. The agencies involved included DHS, ATSDR, EPA Region X, ODF&W, and the City of Portland.
- SHINE created the Portland Harbor health education action plan based on the findings of the needs assessment conducted throughout the spring and summer of 2003. The plan details specific goals and objectives around providing outreach to

communities affected by Portland Harbor, with an emphasis on reaching communities that catch and consume fish in the affected area.

- SHINE created messages to communicate risk based on the goals and objectives outlined in the health education action plan.
- SHINE developed community-based mini-grant opportunities for community organizations that serve hard-to-reach communities that catch and consume fish from Portland Harbor. The primary goal of the mini-grant projects were to develop and implement culturally appropriate health education materials and outreach activities. In the first year, five groups were awarded grants to reach their communities including the Confederated Tribes of Siletz Indians, Benson High School health occupations program, the Asian Health and Services Center, the Linnton Community Center, and the Asian Pacific Consortium on Substance Abuse. Health education activities ranged from training Tribal workers to incorporate fish consumption activities in diabetes classes and breastfeeding circles to holding interactive booths at cultural events, such as a Chinese New Year celebration. A number of workshops with safe fish preparation method demonstrations were performed throughout the Chinese and Vietnamese communities and in the Tribal train-the-trainer workshop. In the second year, the Immigrant and Refugee Community Organization (IRCO) received a small grant to incorporate a fish consumption curriculum in pre-employment classes for immigrant and refugee communities.
- SHINE worked with the community organizations that received mini-grants to create and pretest materials with messages about safe fish eating techniques and the Portland Harbor fish advisory. Materials that were developed included seven brochures that targeted tribal, Chinese, Vietnamese, Laotian, African American, recreational and Russian anglers, a coloring book for tribal youth, and power point presentations. Materials were translated into Spanish, Russian, Vietnamese, Chinese, and Laotian and printed, along with English materials, to be disseminated throughout the affected communities.
- Information from the fish sampling events in 2002 and 2003 required SHINE to release a fish advisory for the Portland Harbor area between Sauvie Island (RM 3) and the Fremont Bridge (RM 9). This advisory is more restrictive on the recommended amount of fish meals compared with the mainstem Willamette River advisory. The advisory was initially communicated through a press release followed by a media availability session, held in conjunction with Multnomah County Health Department (MCHD), on June 16, 2004, and community meeting at the St. John's Community Center on June 29, 2004. The health education and fish advisory efforts were covered through several media outlets. Newspaper coverage included *El Hispanic News, The Chinese Times*, *The Oregonian,* and *The Portland Tribune*. Additional coverage of the fish advisory was through television and radio reports.
- SHINE worked with the Multnomah County Health Department, Willamette Riverkeepers, the City of Portland, ODEQ, community members and other stakeholders to develop a fish advisory sign for Portland Harbor. In the needs assessment questionnaire, community members responded that posting signs was the most important venue for performing outreach about the fish advisory. MCHD

staff conducted three focus groups to identify what primary languages should be included in the sign to reach the majority of communities that catch and consume fish from the harbor. MCHD staff pretested the signs and translations with numerous community members

- SHINE and MCHD staff toured the river with a knowledgeable representative from the Sheriff's Office to share anecdotal information of preferred fishing spots for different ethnic communities along the river in order to identify appropriate sites to post the signs. The primary sites identified for posting were Cathedral Park and the Swan Island boat ramp. MCHD staff were instrumental in contacting landowners and municipalities to place the signs at the designated locations. The fish advisory sign is posted in English, Russian, Spanish, Vietnamese, Chinese and Laotion (See Appendix F).
- SHINE developed and presented information on public health, fish and Portland Harbor to a number of community organizations, tribes, agencies and other groups, including the following:
    - St. John's Community Meeting: *Fish and Health*, September 25, 2002
    - Portland Harbor Citizens Advisory Group: *Fish Consumption and Portland Harbor*, December 11, 2002
    - ATSDR Regional Conference: *Mega-Sites: Portland Harbor,* January 30, 2003
    - Portland Harbor Community Advisory Group, *SHINE Overview and Fish Consumption Outreach for the Portland Harbor Superfund Site*, August 13, 2003
    - Portland Harbor Community Advisory Group, *Fish Contamination in Portland Harbor*, March 10, 2004
    - Confederated Tribes of Siletz Indians health forum: *Fish and Your Health*, March 15, 2004
    - ATSDR Annual Partners Meeting: *Contamination of Migratory and Non-Migratory Fish in Portland Harbor*, March 29, 2004
    - Western Region Epidemiological Network annual meeting: *Fish and Portland Harbor*, May 13, 2004
    - Public Availability Meeting: *Portland Harbor, Fish and Public Health*, June 29, 2004
    - Women-Infant-Children program training: *About Fish and Your Health*, September 16, 2004
    - Umatilla Tribal Fish Health Forum: *Salmon, sturgeon and lamprey*, November 16, 2004
    - Society of Environmental Toxicology and Chemistry World Congress: *Persistent Organic Pollutants in Fish from Portland Harbor,* November 19, 2004
    - Oregon Bass and Panfish Club: *Fish and Health for Oregonians*, November 23, 2004
    - El Programa Hispano Promatoras: *Safe Fish Consumption for the Portland Harbor*, January 7, 2005
    - Immigrant and Refugee Community Organization Staff Training: *Safe Fish Consumption for the Portland Harbor*, May 15, 2005

    - Environmental Educators Conference: *Portland Harbor Superfund Site: Successful Strategies in Cross Cultural Community Outreach*, June 24 2005
    - Russian Women's Delegation: *Portland Harbor Superfund Site: Successful Strategies in Cross Cultural Community Outreach*, June 28, 2005.
    - Minigrant Educational Luncheon: *Portland Harbor Safe Fish Consumption Health Education Projects*, February 15, 2006.
- SHINE assisted in the development of a segment targeted for Spanish speaking populations on the popular *Cita Con Nelly* television show that was broadcast on a local Spanish channel. This piece highlighted the updated fish advisory information, the populations of concern, and ways to reduce contaminants by proper preparation and cooking of fish.
- SHINE participated in several events with other agencies and community groups including advisory groups and neighborhood association meetings, the Portland Harbor Superfund Field Day, McCormick & Baxter Tree Planting Celebration, community festivals, tribal forums and the 2005 Northwest Sportsmen's Show to communicate our message.
- SHINE developed a summary fact sheet that will summarize information from this public health assessment and translated it into Spanish, Russian, Vietnamese, Chinese, and Laotian.
- SHINE conducted extensive outreach to educate about the findings and recommendations of this public health assessment, and the current fish advisory.

Actions Ongoing

- SHINE has awarded mini-grants to three community organization that provides services to Asian-Pacific Islander and Latino populations to conduct fish consumption education and outreach activities pertaining to Portland Harbor.
- SHINE continues to participate in community and agency-sponsored events.

Actions Planned

- SHINE will continue to partner with other agencies and organizations in their efforts to identify communities that catch and consume fish from the Portland Harbor, and to create and distribute targeted health education materials.
- SHINE will update the health education action plan on a regular basis to incorporate changes and identify new activities to accomplish outreach and education goals.
- SHINE will address other pathways, such as dermal exposure to sediment or oral ingestion of water, in separate, future public health consultations when data are available.

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The authors of this report would like to dedicate the Portland Harbor Public Health Assessment in memory of John Crellin, PhD.

John Crellin was the ATSDR project officer for the SHINE program from 2002-2005. His passion, knowledge and character were an integral part of SHINE's success. John was a dedicated champion of public health and a mentor to his colleagues. He came to Oregon to learn about Portland Harbor from the many groups of people impacted by the contamination. John grew to love the Willamette River and the communities it serves.

John, you are missed and this document is a tribute to you.

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Appendix A. Comments and Responses

The public comment period for the draft version of the Portland Harbor Public Health Assessment was open from July 15, 2005, through October 14, 2005. ATSDR received a total of 41 comments from a community group and two environmental agencies. Comments and SHINE's responses are below. All page references below refer the public comment version of this public health assessment.

Comment 1: In response to your invitation to comment on the report Public Health Assessment for the Portland Harbor, we find this report a beginning as a public health assessment for the Portland Harbor Superfund site. However, we have serious concerns with the methodology and conclusions drawn in this report and would like to see further study to address other pathways for contamination concerning human exposure.

Response: The Superfund Health Investigation and Education (SHINE) program within the Oregon Department of Human Services (DHS) appreciates these comments. Overall, it is appropriate to describe this public health assessment as a "beginning." The focus of this Portland Harbor Public Health Assessment (PHA), as identified in the initial PHA from 2002, is to assess the primary exposure pathway and risk to humans, which is the consumption of fish and shellfish. We plan to address other pathways, such as dermal exposure to sediment or oral ingestion of water, in separate, future public health consultations.

Comment 2: Specifically, we would like information on the effects of swimming, boating, sediment contact, and other forms of contact. The "Draft Report" of 2002 included a discussion regarding the exposure of children in a recreational setting while this final report did not refer to that issue.

Response: Other exposure pathways will be evaluated in future documents. We are waiting for additional incoming data to better evaluate these other pathways. In the "Draft Report", or the Initial Portland Harbor Public Health Assessment, referenced above, ATSDR determined fish ingestion to be the primary exposure pathway of concern for humans and recommended that it should be the focus of further assessments. SHINE fully endorses this finding, based on exposure potential and risk from fish ingestion versus other activities such as sediment contact, boating and swimming. The potential impact of fish ingestion will remain the focus in the current PHA and, as stated above, other pathways or activities will be evaluated in future health consultations.

Comment 3: We are also concerned that this report does not include a comprehensive sampling of fish tissue. We believe a larger sampling of crayfish and other species needs to be sampled. For example, the report states that the small mouth bass in Swan Island lagoon were highly contaminated, but the report does not indicate the time of year sampled, how high the water was, or the size of the fish sampled. It did not recognize that the data would vary if samples were drawn during spring run-off when the small-mouth bass from other parts of the river migrate into Swan Island lagoon to spawn. These migrating fish are not the same as the fish that are native to Swan Island lagoon. Bullhead catfish were also omitted from the Swan Island sampling.

Response: It should be noted that SHINE did not fund or direct the sampling for the resident fish or crayfish collected and analyzed in Portland Harbor. SHINE did receive the funding and led the collection of sturgeon, lamprey and salmon for this report. While the resident and migratory fish database is by far the most fish tissue SHINE has analyzed at any site in Oregon, additional samples in such a large and complex site would further contribute to our evaluation of public health risks. Information regarding time of year collected and target size of fish has been included in the final version of the PHA. While interesting, information regarding high-water mark, and the failure to note whether the bass from Swan Island had migrated in the spring season or were resident populations, is outside the scope of a public health document.

Comment 4: We would like the report to include information about the location of sampling for the crayfish. For example, was it taken from the International Slip, from the ARKEMA site, the GASCO site, or the Gunderson site? Was the sampling from the bank of the river or the middle, and was it from the upstream or downstream portion of the Superfund site? We need other similar details to understand the foundation of the report.

Response: Additional information on sampling locations for crayfish collected in Portland Harbor has been included in the final version of the PHA.

Comment 5: We also question statements in the report that the crayfish in the Superfund site are safe to eat. We know this is not true for we have seen data for fish tissue samples within the Superfund site, including crayfish, that show these crayfish are highly contaminated.

Response: The data that SHINE used to assess the health risk of crayfish consumption show no evidence of a health concern. Table 7 lists the contaminants found in crayfish collected in Portland Harbor, including mean and maximum levels. Table 10 shows the screening process of contaminants of concern in crayfish tissue. Table 13 shows the calculated average and high-end exposure doses and corresponding cancer risk. The sum of cancer risks from the high-end ingestion of crayfish was significantly less than what would be considered a health concern by SHINE. These analyses were conducted with established health assessment methodologies, identical to those used for the resident and migratory fish. “Seeing” the data and determining a risk is present is perception and is not suitable to determine public health risks without further analysis.

Comment 6: In Appendix B, the page titled: Contaminant concentrations in fish and crayfish, page 39, the numbers used for "non-detect" levels were omitted which would indicate some of the scope of analysis.

Response: Based on SHINE's understanding of this comment, the use of a "-" instead of "0" in the non-detect columns for PCB, dioxin/furan, TEQ and other total or congener analysis, signifies that some congeners (or one of the many variants of the chemical structure, for example PCBs have 209 different forms or cogeners) may have been detected in some or all of the analysis and other congeners may have been absent in some or all of the analyses. A "0" descriptor would not accurately reflect the complexities of congeners found in fish tissue.

Comment 7: Because of the serious omissions and lack of scientific rigor, we recommend that the agency address these concerns in a reworking of the report using methods similar to other studies by the Oregon Department of Human Services, the USGS and Lower Willamette Group. Until that is done, this report simply lacks credibility with the public.

Response: SHINE regrets that you feel this report contains serious omissions and lack of scientific rigor. The statement that the this report should be reworked using methods similar to other Oregon Department of Human Services studies, might imply that the commenter is unclear about the source of this report. This report was developed by the SHINE Program within the Oregon Department of Human Services, using the same methods and scientific rigor that were employed in prior documents and efforts at the Portland Harbor site. A discussion on the intent and scope of a public health assessment has been added to the document. A brief mention of SHINE's cooperative agreement program with ATSDR was also added that explains their involvement at Portland Harbor.

Comment 8: Page 3, third paragraph. This is the first use of the acronyms EPA and ODEQ, so they should be defined here. ODEQ is defined on page 5.

Response: These changes have been made in the final version of the Public Health Assessment.

Comment 9: Page 9, Figure 3. There is an error with the shaded boxes.

Response: This has been changed in the final version of the Public Health Assessment.

Comment 10: Page 10, second paragraph. To avoid possible confusion with the use of "analyzed" in the first sentence to mean chemical analysis, I suggest that the word "analyzed" in the second sentence be replaced with "evaluated."

Response: This has been changed in the final version of the Public Health Assessment.

Comment 11: Page 11, third paragraph. For clarity, consider replacing the word "exponential" with "many" or "numerous."

Response: The word "exponential" has been replaced with "numerous" in the final version of the Public Health Assessment.

Comment 12: Page 11, last paragraph. Hazard quotient is defined later on page 53, but it would be helpful to include a brief definition here.

Response: A brief definition of hazard quotient has been included on page 11.

Comment 13: Page 16, public health implications, and page 55, evaluating cancer risk. In Table 13 (page 55), excess lifetime cancer risks that exceed $1x10^{-4}$ are highlighted, and the selected chemicals are discussed in the text beginning on page 16. This may be appropriate for focusing the assessment on the most important chemicals. Note, however, that when DEQ reviews the risk assessment performed for this site, we will make comparisons with Oregon's acceptable excess lifetime cancer risk limit of $1x10^{-6}$ for individual chemicals.

Response: This comment is noted.

Comment 14: Appendices C, D and E. The tables should be modified so that the headers to the columns are repeated if the table continues on an additional page.

Response: Headers to columns have been repeated if the tables continue to other pages.

Comment 15: Pages 49 and 50, Appendix D, Tables 9 and 10. To avoid implying that analyses for inorganic arsenic were performed, include a footnote explaining that the concentration of inorganic arsenic was estimated by taking 10 percent of the concentration of total arsenic (as discussed in the text).

Response: Footnotes have been included with these tables to clearly indicate that inorganic arsenic was an estimated fraction of total arsenic measured.

Comment 16: Page 55, first paragraph. It is not appropriate to state that "an estimate of the number of expected additional lifetime cancers was estimated." Rather, the calculations result in an excess of lifetime cancer risk, or rate of excess cancer.

Response: This statement has been changed to "From these calculations, an excess of lifetime cancer risk can be estimated."

Comment 17: Page 55, Table 13. Excess cancer risks are provided for dioxins/PCB TEQ, but not for total Aroclors or total PCB congeners. The reason for this omission is not provided. Cancer comparison values for total Aroclors and total PCB congeners are provided in Table 9. It is likely that excess cancer risks calculated for total Aroclors or total PCB congeners would be similar to excess cancer risks calculated for the PCB TEQs. We are aware that EPA considers the excess cancer risks calculated from total PCBs to be separate from the excess risks calculated for PCB dioxin-like congeners, although it is possible that the risks are equivalent and therefore not additive. Regardless, a discussion of the issue would be helpful. This will not change the conclusions of the report.

Response: The commentary on how to assess Aroclors, dioxin-like PCBs and total PCB congeners highlights the complexities of this issue, which are not relevant to a public health assessment intended for public consumption. While the reviewers agree with the comment above, since this document is intended for the general public and the conclusions of the report will not be affected, no further language about this topic will be included in the final version of the PHA.

Comment 18: Appendix G. Glossary. I expect that these are standard plain language definitions used by ATSDR, but I have some suggestions for you to consider.
CERCLA. This can be omitted because it is covered by the definition for Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).
Concern. I don't think a definition for this term is necessary.
Environmental Contaminant. This definition can replace the definition for Contaminant. In this context, the modifier "environmental" is not necessary.
Malignancy. The term is not defined except by reference to cancer. I suggest either defining it as "a cancerous tumor" or omitting it.
Plume. The term "line" is probably inappropriate. The term column should be sufficient.
Point of Exposure. Replace "dirt" with "soil."
Route of Exposure. For precision, I would say "there are three main exposure routes." There are other atypical routes (such as injection) that do not need to be mentioned.
Sample Size. I don't think this definition is necessary.
Sample. I don't think this definition is necessary, and could be confused with environmental (e.g., soil or water) samples collected during a site investigation.

Response: The **CERCLA** definition will be omitted. The **Concern** definition will be omitted. The **Environmental Contamination** definition will replace the definition for Contaminant. The **Malignancy** definition will be omitted. In the **Plume** definition, the term "line" will be omitted. In the **Point of Exposure** definition, "dirt" will replace "soil." In the **Route of Exposure** definition, the language will remain as written. Only three exposure routes are relevant to environmental contaminants. The definition for **Sample Size** will be omitted. The definition for **Sample** will be omitted.

Comment 19: Thank-you for the opportunity to comment on the Public Health Assessment (PHA) for Portland Harbor, dated July 15, 2005. This document was prepared by the Oregon Department of Human Services under a cooperative agreement with ATSDR.

Overall, this PHA was very well organized and presented the potential health impacts of consuming fish from the Portland Harbor in a clear and concise manner. Most of my comments are minor editorial suggestions that will not change the conclusions of this PHA.

Response: Thank you for your comments on this public health assessment.

Comment 20: My only major criticism of this PHA is that the methods used for evaluating PCBs and the rationale for using these methods are not very clear in the document.

In this PHA, the data used for calculating PCB non-cancer hazards and cancer risks (Tables 11, 12, and 13) are from congener analysis of fish tissue, not Aroclor analysis. This is not clear in the report but it is important because it reduces the uncertainty in the estimate of the total PCB concentrations in fish tissue using Aroclors.

Response: A statement in the section entitled “Evaluation Process” has been included to state that PCBs congeners were used to estimate cancer and non-cancer risk as opposed to Aroclors. An additional statement has been added to highlight that congeners are associated with less uncertainty compared with Aroclors.

Comment 21: For the estimation of non-cancer hazards, total PCB concentrations (total of all PCB congeners) were used with the Aroclor RfD (Table 11 and 12). However, for the evaluation of cancer risks (Table 13), total PCB data were not used with the Aroclor cancer slope factor. Rather, cancer risk was evaluated using only those PCB congeners that exhibit dioxin-like toxicity (those congeners for which the World Health Organization has developed 2,3,7,8 TCDD Toxicity Equivalency Factors (TEFs)). Use of this method may result in an underestimate of risks from PCBs because some PCB congeners may cause cancer by mechanisms other than through binding to the dioxin (Ah) receptor.

Response: The point that PCBs may exhibit carcinogenicity beyond mechanisms associated with Ah receptor activity has been noted. Given the cancer risk assessment for the dioxin-like PCBs and the uncertainty in other cancer mechanisms associated with non-dioxin-like PCBs, is unlikely that including non-dioxin-like PCBs would affect the conclusions and recommendations of the report in any way.

Comment 22: The PHA did not discuss why the decision was made to use only the dioxin-like PCB TEQs to evaluate cancer risks, even though both were used for screening (in Table 9). Also there is no discussion as to what TEQ are or how they are calculated. It would be useful to add these to the document. The inclusion of risks from both dioxin-like PCBs (using the 2,3,7,8, TCDD cancer slope factor) and total PCBs (using the Aroclor cancer slope factor) would result in higher cancer risks from PCBs. However, it will not impact the conclusion of the report (i.e., that the primary pollutants of concern are PCBs). Therefore, at a minimum, I recommend that the uncertainties in cancer risk that may result from evaluating only the dioxin-like PCBs be discussed in the PHA.

Response: The discussion of uncertainty in cancer risk, as a result of the evaluation of only the dioxin-like PCBs along with the potential to underestimate theoretical cancer risk from total PCBs that may have cancer activity not associated with the Ah receptor has been noted. These points will not be added since the document is intended for public consumption and this language is quite technical.

Comment 23: Page 2 – Add crayfish as a species that were analyzed in this PHA.

Response: The term crayfish has been added to page 2

Comment 24: Page 3 – The purpose of the RI/FS at the PH site is to investigate the nature and extent of contamination for the in-water portion of the Site, to assess the potential risk to human health and the environment, to develop and evaluate potential remedial alternatives, and to recommend a preferred alternative. Work is not focused on sediments alone but all media of concern. Therefore, it would be more appropriate to use the words "EPA has the primary responsibility for the in-water portion and ODEQ….".

Response: This section of page 3 has been changed to "EPA has the primary responsibility for the in-water portion and ODEQ…."

Comment 25: Page 5 - There are portions of the PH site that have gently sloping and/or vegetated banks. Some of these areas are parks and others are used for bank fishing and recreation and by the homeless. Therefore, it might be best to add the words "Large parts of the" before the words "Shoreline features include" in the second paragraph.

Response: The language in page 5 will remain as written. The land use description is intended to be generic.

Comment 26: Page 6 - Freshwater mussels are found in the PH site and should be added to the last paragraph.

Response: Freshwater mussels have been included in the last paragraph.

Comment 27: Page 7 – There has been much discussion with the tribes involved in the PH site as to the home range of sturgeon. The tribes have cited studies that suggest that some sturgeon may spend most of their lifespan in one area. Therefore, I recommend that the language in the first paragraph of this page be modified to:

"SHINE, along with ODFW, EPA, and the City of Portland sampled two migratory species, salmon and lamprey, as well as sturgeon. Some studies suggest that sturgeon can show strong site fidelity while other studies indicate that individual sturgeon can have large home ranges."

Response: The language has been changed on page 7 to read "SHINE, along with ODFW, EPA, and the City of Portland sampled two migratory species, salmon and lamprey, as well as sturgeon. Some studies suggest that sturgeon can show strong site fidelity while other studies indicate that individual sturgeon can have large home ranges."

Comment 28: Page 8 – In the last paragraph on this page, it is stated that for this PHA, average site-wide contaminant concentrations were used to calculate non-cancer hazards and cancer risks and that this has the potential to mask site-specific areas where the contamination levels may be higher. I strongly concur with this statement. A review of the bass data shows that there are higher concentrations for PCBs and DDT/DDE/DDD in certain river miles than the average calculated here. Therefore, the risks from consuming bass in these river miles would also be higher than those calculated here.

Response: Comment has been noted.

Comment 29: Page 12 – In the last sentence of the fourth paragraph, "feed" should be "fed". In the fifth paragraph, second sentence, it should read "The levels of PCBs".

Response: On page 12, fourth paragraph, "feed" has been changed to "fed." In the fifth paragraph, the language has been changed to "The levels of PCBs."

Comment 30: Page 13 – Need a space before the first full paragraph.

Response: A space has been added before the first full paragraph.

Comment 31: Page 14 – Remove the extra period after second sentence on the page.

Response: The extra period has been removed.

Comment 32: The white sturgeon that were caught and analyzed were just at or slightly above the legal limit. It is very likely that larger sturgeon could have had higher levels of contaminants. It would be useful to mention this as an uncertainty in this section.

Response: A statement that acknowledges this probability has been added in the last paragraph in the section entitled "White Sturgeon."

Comment 33: The last sentence might be qualified with "Removing the skin, head, eyes, organs, and fat would reduce the amount of PCBs and other fat soluble contaminants." It will not reduce the levels of mercury in sturgeon, which is the species with the highest mercury concentrations.

Response: The last sentence has been changed to read, "Removing the skin, head, eyes, organs, and fat would reduce the amount of PCBs and other fat soluble contaminants."

Comment 34: Page 15 – There are many forms of organic arsenic in fish. Some may be non-toxic (e.g. arsenobetaine) while others (e.g. dimethyl arsenic or DMA) are likely toxic. For example, some research suggests that DMA, which is often found in fish tissue and can be formed in the body by methlyation of inorganic arsenic, may be the active toxic metabolite of arsenic in vivo. EPA's pesticide program has in fact developed a cancer potency factor for DMA. On the other hand, some fish species (especially marine) often have levels of inorganic arsenic that are less than 10% of total arsenic. And finally, I don't think there are data that show that there are differences in the amounts of inorganic arsenic in whole body versus filleted fish. Given these uncertainties, it might be useful to modify the last sentence to read, "There are several uncertainties in the evaluation of arsenic. Some of these uncertainties, such as the fact that some fish species may have inorganic arsenic levels that are less than 10%, may overestimate the risk to consumers. The assumption that all organic species are non-toxic may underestimate the risk."

Response: The first paragraph of the section entitled "Chinook Salmon" has been changed to include this language: "Both the assumed fraction of arsenic and the assessment of whole-body salmon are uncertainties that may over-estimate the risk to consumers, as many studies suggest that the majority of arsenic in fish is in the organic form, which was assumed to be less toxic compared with the inorganic form (see Public Health Implications for more information). However, there are several uncertainties in the evaluation of arsenic. The assumption that all organic species of arsenic are non-toxic may underestimate the risk.

Comment 35: Page 16 and Table 13 – In Table 13, chemicals with excess cancer risks above 10^{-5} are highlighted and these same chemicals are discussed in the Public Health Implications Section. While this may be appropriate for focusing on the chemicals of most concern, based upon both EPA guidance and Oregon regulation, individual chemicals with risks above 10^{-6} will be included in the evaluation of chemicals of potential concern in the RI baseline risk assessment.

Response: Comment has been noted.

Comment 36: Bottom of page 16 and top of page 17- I recommend that the statement in the parenthesis (begins with "although it is unlikely…") be removed. The hazard quotient (HQ) for PCBs for carp for the high-end consumption rate for children is 348 and for adults are 195. Also, the RfD used to calculate this (HQ) is quite old and was not developed using the more recent data showing developmental neurotoxicity in children born to mothers who ate contaminated fish. Therefore, HQs this high may be of concern – it is not so clear that consumers are unlikely to experience adverse health effects under the exposure assumptions used.

Response: This statement has been omitted. Reviewers agree with the comment that the HQs are quite high and that the RfD for mercury is dated.

Comment 37: Page 17 and 18 – It would be very helpful for the reader if this section were expanded to include more discussion on the methods used to calculate non-cancer hazards and cancer risks for PCBs. This should include a discussion of what TEFs and TEQs are and how they were developed.

Response: See response to comment 21 above.

Comment 38: Page 19 – Under arsenic, the uncertainties that result from the fact that some organo arsenic species are toxic is not discussed (see response for comment 34).

Response: Language has been added to the document that mentions information on how organo arsenic toxicity may change at which point, assumptions made in this public health assessment may need to be re-evaluated.

Comment 39: Page 26 and 27- The last bullet on page 26 is repeated on the top of page 27.

Response: The repeated bullet will be omitted on page 27.

Comment 40: Page 38 – EPA's definition of its RfD is, "An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime." The use of safety factors is separate from the "uncertainty spanning an order of magnitude".

Response: The RfD definition will be changed to read ""An estimate (with uncertainty spanning perhaps an order of magnitude) of a daily oral exposure to the human population (including sensitive subgroups) that is likely to be without an appreciable risk of deleterious effects during a lifetime."

Comment 41: Table 13 – Several of the numbers for individual contaminants that should be "bold" are not.

Response: These numbers have been rechecked and placed in bold if appropriate.

Appendix B. Evaluation Process

Screening Process

In evaluating the fish tissue data from Portland Harbor, SHINE used comparison values (CVs) to determine which chemicals to examine more closely. CVs are the contaminant concentrations found in a specific media (such as tissue or soil) and are used to select contaminants for further evaluation. CVs incorporate assumptions of daily exposure to the chemical and a standard amount of air, water, and soil that someone could inhale or ingest each day. Since comparison values such as environmental media evaluation guidelines (EMEGs) and cancer risk evaluation guidelines (CREGs) are not available for fish tissue, minimum risk levels (MRLs) and references doses (RfDs) were used as surrogates to develop the comparison values.

As health-based thresholds, CVs are set at a concentration below which no known or anticipated adverse human health effects are expected to occur. Different CVs are developed for cancer and non-cancer health effects. Non-cancer levels are based on valid toxicological studies for a chemical, with appropriate safety factors included. They are also based on the assumption that small children and adults are exposed every day. Non-carcinogenic endpoints were developed using the maximum contaminant concentration for the high-end childhood ingestion scenario (60 grams/day of fish). Cancer risk was screened at concentrations in which there could be no more than one additional lifetime cancer per 1,000,000 people exposed over 30 years. For this assessment, a high-end adult ingestion of 142.4 grams of Portland Harbor fish per day was used to screen chemicals for carcinogenic effects. Also, exceeding a CV does not mean that health effects will occur—just that more evaluation is needed.

Evaluation of Public Health Implications

Estimation of Exposure Dose

The next step is to take those contaminants that are above the CVs and further identify which chemicals and exposure situations are likely to be a health hazard. Child and adult exposure doses are calculated for the site-specific exposure scenario, using assumptions outlined in Appendix E. The exposure dose is the amount of a contaminant that gets into a person's body.

Non-cancer Health Effects

The calculated exposure doses are then compared to an appropriate health guideline for that chemical. Health guideline values are considered safe doses; that is, health effects are unlikely below this level. The health guideline value is based on valid toxicological studies for a chemical, with appropriate safety factors built in to account for human variation, animal-to-human differences, the use of the lowest adverse effect level, or a combination of all three. For non-cancer health effects, the following comparison values were used:

Minimal Risk Level (MRLs) - developed by ATSDR
An estimate of daily human exposure—by a specified route and length of time—to a dose of chemical that is likely to be without a measurable risk of adverse, non-cancerous effects. An MRL should not be used as a predictor of adverse health effects. A list of MRLs can be found at http://www.atsdr.cdc.gov/mrls.html.

Reference Dose (RfD) - developed by EPA
An estimate (with uncertainty spanning perhaps an order of magnitude) of daily oral exposure to the human population (including sensitive subgroups) that is likely to be without appreciable risk of deleterious effects during a lifetime. The RfDs can be found at http://www.epa.gov/iris/.

If the estimated exposure dose for a chemical is less than the comparison value, then the exposure is unlikely to cause a non-carcinogenic health effect in that specific situation. If the exposure dose for a chemical is greater than the comparison value, then a public health assessment is performed. These toxicological values are doses derived from human and animal studies summarized in the ATSDR toxicological profiles.

Risk of Carcinogenic Effects

The estimated risk of developing cancer from exposure to the contaminants was calculated by multiplying the site-specific adult exposure dose by EPA's corresponding Cancer Slope Factor (which can be found at http://www.epa.gov/iris/). The results estimate the maximum increase in risk of developing cancer after 30 years of exposure to the contaminant. If someone where to spend their lifetime (70 years) eating fish collected from Portland Harbor on a daily basis, their cancer risk would be approximately double the results presented in Appendix E.

Because of uncertainties involved in estimating carcinogenic risk, ATSDR employs a weight-of-evidence approach in evaluating all relevant data. Therefore, the carcinogenic risk is described in words (qualitatively) as well as a numerical risk estimate. A numerical risk estimate must be considered in the context of the variables and assumptions involved in their derivation and in the broader context of biomedical opinion, host factors, and actual exposure conditions. The actual parameters of environmental exposures must be given careful consideration in evaluating the assumptions and variables relating to both toxicity and exposure.

Appendix C. Contaminant concentrations in fish and crayfish

Table 1. Site-wide contaminant concentrations for smallmouth bass (whole body). Data were provided by the Lower Willamette Group.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	14	5.38	11
Antimony	mg/kg	12	14	0	0.001
Arsenic, total	mg/kg	0	14	0.272	0.39
Arsenic, inorganic	mg/kg	0	14	0.0272	0.039
Cadmium	mg/kg	4	14	0.006	0.024
Chromium	mg/kg	2	14	0.388	1.14
Copper	mg/kg	0	14	0.665	1.29
Lead	mg/kg	0	14	0.028	0.303
Manganese	mg/kg	0	14	1.26	2.65
Mercury	mg/kg	0	14	0.087	0.114
Nickel	mg/kg	7	14	0.064	0.2
Selenium	mg/kg	11	14	0.073	0.4
Thallium	mg/kg	0	14	0.004	0.009
Zinc	mg/kg	0	14	14.9	16.3
2-Methylnaphthalene	ug/kg	10	14	9.38	59
Acenaphthene	ug/kg	10	14	13.7	95
Fluoranthene	ug/kg	13	14	2.77	36
Fluorene	ug/kg	11	14	9.31	69
Naphthalene	ug/kg	12	14	6.40	86
Phenanthrene	ug/kg	12	14	6.10	85
Pyrene	ug/kg	13	14	2.90	39
Dieldrin	ug/kg	13	14	0.913	7.3
Bis(2-ethylhexyl) phthalate	ug/kg	12	14	4,973	87,000
Di-n-octyl phthalate	ug/kg	11	14	250	2,100
Dibenzofuran	ug/kg	12	14	4.73	52
Total DDD	ug/kg	0	14	36.9	89.8
Total DDE	ug/kg	0	14	129	177
Total DDT	ug/kg	0	14	26.6	104
Total Chlordane	ug/kg	0	14	0.542	4.33
Total Endosulfan	ug/kg	0	14	0.975	7.8
Total Aroclors	ug/kg	-	14	914	2,933
Total PCB congeners	ug/kg	-	14	911	3,025
Total dioxin-like PCB Congeners	ug/kg	-	14	54.2	84.8
Total Dioxin TEQ†	ng/kg	-	14	3.36	8.6
Total PCB TEQ	ng/kg	-	14	15.2	24.7
Total TEQ	ng/kg	-	14	18.56	28.4

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion
†TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxin, furan and dioxin-like PCBs

Table 2. Site-wide contaminant concentrations for carp (whole body). Data were provided by the Lower Willamette Group.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	6	96.8	134
Arsenic, total	mg/kg	0	6	0.166	0.22
Arsenic, inorganic	mg/kg	0	6	0.0166	0.022
Cadmium	mg/kg	0	6	0.069	0.108
Chromium	mg/kg	0	6	1.09	2.02
Copper	mg/kg	0	6	1.16	1.42
Lead	mg/kg	0	6	0.151	0.202
Manganese	mg/kg	0	6	6.22	8.53
Mercury	mg/kg	0	6	0.04	0.047
Nickel	mg/kg	0	6	0.745	1.37
Selenium	mg/kg	0	6	0.317	0.4
Silver	mg/kg	2	6	0.01	0.017
Thallium	mg/kg	0	6	0.003	0.005
Zinc	mg/kg	0	6	99.3	112
2-Methylnaphthalene	ug/kg†	5	6	19.8	38
Acenaphthene	ug/kg	4	6	34.1	75
Fluorene	ug/kg	5	6	22.3	53
Naphthalene	ug/kg	4	6	27.8	56
Methoxychlor	ug/kg	5	6	2.63	4.2
Total DDD	ug/kg	0	6	68.8	171
Total DDE	ug/kg	0	6	135	260
Total DDT	ug/kg	0	6	13.3	47
Total Chlordane	ug/kg	0	6	14.3	25.5
Total Endosulfan	ug/kg	0	6	3.12	10
Total Aroclors	ug/kg	-	6	1,728	6,865
Total PCB congeners	ug/kg	-	6	1,920	8,154
Total dioxin-like PCB congeners	ug/kg	-	6	47.0	150
Total Dioxin TEQ†	ng/kg	-	6	4.79	11.1
Total PCB TEQ	ng/kg	-	6	13.2	38.8
Total TEQ	ng/kg	-	6	18	49.9

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion
†TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxin, furan and dioxin-like PCBs

Table 3. Site-wide contaminant concentrations for brown bullhead (whole body). Data were provided by the Lower Willamette Group.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	6	9.8	31.7
Arsenic, total	mg/kg	0	6	0.056	0.08
Arsenic, inorganic	mg/kg	0	6	0.0056	0.008
Cadmium	mg/kg	0	6	0.012	0.014
Chromium	mg/kg	0	6	0.73	1.32
Copper	mg/kg	0	6	0.69	0.798
Lead	mg/kg	1	6	0.025	0.044
Manganese	mg/kg	0	6	5.09	10.8
Mercury	mg/kg	0	6	0.037	0.054
Nickel	mg/kg	1	6	0.248	0.321
Selenium	mg/kg	4	6	0.175	0.3
Silver	mg/kg	5	6	0.002	0.004
Thallium	mg/kg	2	6	0.002	0.004
Zinc	mg/kg	0	6	14.1	15.6
Fluoranthene	ug/kg	5	6	20.4	40
Phenanthrene	ug/kg	5	6	23.8	60
Dieldrin	ug/kg	4	6	2.48	2.6
gamma-Hexachlorocyclohexane	ug/kg	3	6	2.02	1.9
Methoxychlor	ug/kg	5	6	1.18	1.1
Bis(2-ethylhexyl) phthalate	ug/kg	5	6	491	2,700
Total DDD	ug/kg	0	6	12.9	25
Total DDE	ug/kg	0	6	47.4	70
Total DDT	ug/kg	0	6	27.9	58
Total Chlordane	ug/kg	0	6	18.0	67
Total Endosulfan	ug/kg	0	6	3.9	8.6
Total Aroclors	ug/kg	-	6	415	1,719
Total PCB congeners	ug/kg	-	6	511	1,950
Total dioxin-like PCB congeners	ug/kg	-	6	22.8	56.4
Total Dioxin TEQ†	ng/kg	-	6	1.75	2.43
Total PCB TEQ	ng/kg	-	6	6.82	16.5
Total TEQ	ng/kg	-	6	8.57	18.93

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion
†TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Table 4. Site-wide contaminant concentrations for black crappie (whole body). Data were provided by the Lower Willamette Group.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	4	22.4	68.9
Arsenic, total	mg/kg	0	4	0.279	0.42
Arsenic, inorganic	mg/kg	0	4	0.0279	0.042
Cadmium	mg/kg	0	4	0.004	0.006
Copper	mg/kg	0	4	0.82	0.946
Lead	mg/kg	3	4	0.007	0.019
Manganese	mg/kg	0	4	3.12	3.41
Mercury	mg/kg	0	4	0.039	0.044
Nickel	mg/kg	0	4	0.343	0.357
Thallium	mg/kg	0	4	0.011	0.017
Zinc	mg/kg	0	4	15.4	16.8
alpha-Hexachlorocyclohexane	ug/kg	3	4	0.725	1.4
delta-Hexachlorocyclohexane	ug/kg	3	4	1.74	2.3
Dieldrin	ug/kg	3	4	2.84	2.5
Heptachlor	ug/kg	3	4	0.863	1.8
Hexachlorobenzene	ug/kg	2	4	3.71	8.1
Hexachlorobutadiene	ug/kg	1	4	1.38	2.3
Total DDD	ug/kg	0	4	12.1	18.5
Total DDE	ug/kg	0	4	55.6	80.5
Total DDT	ug/kg	0	4	14.1	21.6
Total Chlordane	ug/kg	0	4	7.5	9.7
Total Endosulfan	ug/kg	0	4	2.03	6
Total Aroclors	ug/kg	-	4	134	250
Total PCB congeners	ug/kg	-	4	164	301
Total dioxin-like PCB congeners	ug/kg	-	4	12.2	21.0
Total Dioxin TEQ†	ng/kg	-	4	1.24	1.33
Total PCB TEQ	ng/kg	-	4	3.37	5.26
Total TEQ	ng/kg	-	4	4.61	6.5

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion
†TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxin, furan and dioxin-like PCBs

Table 5. Site-wide contaminant concentrations for chinook salmon (whole body). Data were provided by DHS and ATSDR.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	4	14.6	16.3
Arsenic, total	mg/kg	0	4	2.73	2.99
Arsenic, inorganic	mg/kg	0	4	0.273	0.299
Copper	mg/kg	0	4	4.38	4.62
Manganese	mg/kg	0	4	0.9	1.02
Mercury	mg/kg	0	4	0.057	0.062
Nickel	mg/kg	0	4	0.376	0.655
Zinc	mg/kg	0	4	83.1	112
Heptachlor	ug/kg	3	4	0.779	1.7
Total DDE	ug/kg	-	4	6.4	7.9
Total DDT	ug/kg	-	4	0.9	1.35
Total Chlordane	ug/kg	-	4	1.26	1.95
Total Endosulfan	ug/kg	-	4	2.03	6
Total Aroclors	ug/kg	-	4	16.8	19
Total PCB congeners	ug/kg	-	4	15.4	17.2
Total dioxin-like PCB congeners	ug/kg	-	4	0.959	1.1
Total Dioxin TEQ†	ng/kg	-	4	0.233	0.295
Total PCB TEQ	ng/kg	-	4	0.306	0.334
Total TEQ	ng/kg	-	4	0.538	0.628

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion
†TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Table 6. Site-wide contaminant levels for sturgeon (fillet). Data were provided by DHS and ATSDR.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	4	5	5.14	11
Arsenic, total	mg/kg	0	5	1.4	2.76
Arsenic, inorganic†	mg/kg	0	5	0.14	0.276
Copper	mg/kg	0	5	0.767	1.2
Lead	mg/kg	4	5	0.028	0.071
Manganese	mg/kg	0	5	2.09	4.97
Mercury	mg/kg	0	5	0.201	0.318
Nickel	mg/kg	0	5	2.82	7.31
Zinc	mg/kg	0	5	10.5	13.7
Dieldrin	ug/kg	3	5	0.7	1.4
Hexachlorobenzene	ug/kg	2	5	1.43	1.95
Total DDE	ug/kg	0	5	50.3	94
Total DDT	ug/kg	0	5	27.4	74
Total Chlordane	ug/kg	0	5	3.26	5.6
Total Endosulfan	ug/kg	0	5	0.597	1.1
Total Aroclors	ug/kg	-	5	132.5	430
Total PCB congeners	ug/kg	-	5	285	946
Total dioxin-like PCB congeners	ug/kg	-	5	6.4	14.1
Total Dioxin TEQ‡	ng/kg	-	5	0.624	1.43
Total PCB TEQ	ng/kg	-	5	1.68	4.04
Total TEQ	ng/kg	-	5	2.3	5.47

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion

† The inorganic arsenic concentration was assumed to be 10 percent of total arsenic

‡ TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Table 7. Site-wide contaminant concentrations for crayfish (whole body). Data were provided by the Lower Willamette Group.

Chemical	Units*	Non-detects	Total Samples	Mean	Maximum
Aluminum	mg/kg	0	27	94.0	203
Antimony	mg/kg	11	27	0.008	0.02
Arsenic, total	mg/kg	0	27	0.353	0.5
Arsenic, inorganic†	mg/kg	0	27	0.0353	0.05
Cadmium	mg/kg	0	27	0.018	0.036
Chromium	mg/kg	0	27	0.489	0.9
Copper	mg/kg	0	27	14.1	17.6
Lead	mg/kg	0	27	0.153	1.3
Manganese	mg/kg	0	27	138	213
Mercury	mg/kg	0	27	0.028	0.041
Nickel	mg/kg	15	27	0.383	0.83
Silver	mg/kg	4	27	0.029	0.047
Thallium	mg/kg	0	27	0.003	0.008
Zinc	mg/kg	0	27	16.7	20.3
Benz(a)anthracene	ug/kg	26	27	2.01	80
Chrysene	ug/kg	26	27	2.16	87
Fluoranthene	ug/kg	24	27	10.2	130
Phenanthrene	ug/kg	26	27	2.37	97
Pyrene	ug/kg	25	27	4.02	83
Endrin	ug/kg	22	27	0.342	2.8
4-Methylphenol	ug/kg	25	27	9.29	190
Pentachlorophenol	ug/kg	26	27	5.42	130
Phenol	ug/kg	26	27	21.7	520
Total DDD	ug/kg	0	27	1.33	21.3
Total DDE	ug/kg	0	27	6.78	51
Total DDT	ug/kg	0	27	4.13	17.5
Total Chlordane	ug/kg	0	27	0.288	1.9
Total Endosulfan	ug/kg	0	27	0.767	3.1
Total Aroclors	ug/kg	-	27	29.8	280
Total PCB congeners	ug/kg	-	-	65.6	207
Total dioxin-like PCB congeners	ug/kg	-	-	6.03	15.1
Total Dioxin TEQ‡	ng/kg	-	-	3.4	22.7
Total PCB TEQ	ng/kg	-	-	1.92	4.55
Total TEQ	ng/kg	-	-	5.32	27.25

*units: mg/kg = parts per million; ug/kg = parts per billion; ng/kg = parts per trillion

† The inorganic arsenic concentration was assumed to be 10 percent of total arsenic

‡ TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Appendix D: Toxicity Values

A list of reference doses and cancer slope factors are provided below (table 8). These toxicity values were used to calculated comparison values for contaminant screening (appendix D) and to estimate risk for fish consumers (appendix E).

Table 8. Toxicity Values to screen contaminants and determine risk for cancer and non-cancer causing contaminants.

Chemical	Cancer SFo* $(mg/kg/day)^{-1}$	Cancer SFo source	RfD† (mg/kg/day)	RfD/MRL source	Comments
Aluminum	-		1	PPRTV‡	
Antimony			0.0004	IRIS§	
Arsenic, inorganic	1.5	IRIS	0.0003	IRIS	Inorganic
Cadmium			0.001	IRIS	
Chromium			0.003	IRIS	Hexavalent
Copper			0.04	HEAST¶	
Lead			NA		
Manganese			0.14	IRIS	
Mercury			0.0003	ATSDR MRL**	ATSDR
Nickel			0.02	IRIS	
Selenium			0.005	IRIS	
Silver			0.005	IRIS	
Thallium			0.000066	IRIS	
Zinc			0.3	IRIS	
2-Methylnaphthalene			0.004	IRIS	
Acenaphthene			0.06	IRIS	
Benz(a)anthracene	0.73	calculated	-		using benzo(a)pyrene relative potency factors
Chrysene	0.0073	calculated	-		using benzo(a)pyrene relative potency factors
Fluoranthene			0.04	IRIS	
Naphthalene			0.02	IRIS	
Phenanthrene			0.03	IRIS	surrogate: pyrene
Pyrene			0.03	IRIS	
4-Methylphenol			0.05	IRIS	surrogate: 2-methylphenol
Pentachlorophenol	0.12	IRIS	0.03	IRIS	
Bis(2-ethylhexyl) phthalate (DEHP)	0.014	IRIS	0.02	IRIS	
Di-n-octyl phthalate			0.04	PPRTV	
Methoxychlor			0.005	IRIS	
Gamma-hexachloro-cyclohexane	1.3	HEAST	0.0003	IRIS	
Alpha-Hexachloro-cyclohexane	6.3	IRIS	0.008	ATSDR MRL	
Dibenzofuran	0.004	HEAST			
Hepatachlor	4.5	IRIS	0.0005	IRIS	
Hexachlorobenzene	1.6	IRIS	0.0008	IRIS	
Hexachlorobutadiene	0.078	IRIS	0.0002	HEAST	
Total DDD	0.24	IRIS	0.0005	IRIS	

Chemical	Cancer SFo* (mg/kg/day)-1	Cancer SFo source	RfD† (mg/kg/day)	RfD/MRL source	Comments
Total DDE	0.34	IRIS	0.0005	IRIS	
Total DDT	0.34	IRIS	0.0005	IRIS	
Total Chlordane	0.35	IRIS	0.0005	IRIS	
Dieldrin	16	IRIS	0.00005	IRIS	
Endrin			0.0003	IRIS	
Total Endosulfan			0.006	IRIS	
Total Aroclors	2	IRIS	0.00002	IRIS	RfD for Aroclor 1254
Total PCB congeners			0.00002	IRIS	RfD for Aroclor 1254
Total PCB TEQ	150000	HEAST			TEQ based on 2,3,7,8-TCDD toxicity
Total Dioxin TEQ	150000	HEAST			TEQ based on 2,3,7,8-TCDD toxicity

*SFo = oral cancer slope factor
†RfD = reference dose; exposure below this dose is not anticipated to result in adverse health effects
‡PPRTV=Provisional Peer Reviewed Toxicity Value
§IRIS = Environmental Protection Agency's Integrated Risk Information System
¶HEAST = Health Effects Assessment Summary Tables
**ATSDR MRL = Agency for Toxic Substances and Disease Registry's Minimum Risk Level (similar to RfD)

Appendix E. Comparison Values and Contaminant Screening

The first step used to calculate the risk posed from eating fish and crayfish collected from Portland Harbor was to develop comparison values to screen contaminants. The acceptable risk level to screen contaminants was a risk of no more than one excess lifetime cancer per 1,000,000 (10^{-6}) people exposed for carcinogenic endpoints and a hazard quotient equal to one.

Comparison values were calculated using the formulas below:

$$CV_{cancer} = \frac{ARLc \times BW \times AT_{cancer} \times 1000\ g/kg \times 1000\ ug/mg}{SFo \times IR \times ED}$$

$$CV_{non\text{-}cancer} = \frac{ARLnc \times (RfD\ or\ MRL) \times BW * AT_{non\text{-}cancer} \times 1000\ g/kg \times 1000\ ug/mg}{IR \times ED}$$

Where,

Parameter	Group		Units	Comments
	Adult	Child		
CV = comparison value	---	---	µg/kg	Used to screen contaminants prior to risk assessment
SFo = oral slope factor (mg/kg/day)-1	---	---	(mg/kg/day)-1	Chemical specific
Ingestion Rate (IR) – average	17.5	7	g/day	
Ingestion Rate (IR) – high end	142.4	60	g/day	
Body weight (BW)	70	15	Kg	Assumed weight of adult and child
Exposure Duration (ED)	30	6	Years	Estimated residence time spent eating fish/shellfish
Averaging Time ($AT_{non\text{-}cancer}$)	30	6	Years	
Averaging Time (AT_{cancer})	70	-	Years	70 year lifetime
Acceptable Risk Level, cancer (ARLc)	10^{-6}	-	unitless	One in a million cancer risk
Acceptable Risk Level, noncancer (ARLnc)	1	1	unitless	Hazard quotient of one

Carcinogenic endpoints were assessed for adults only, assuming 30 years of exposure. If an individual lives their entire lifetime and consumes fish from Portland Harbor throughout this period, the carcinogenic risk would be approximately double the values estimated in this assessment.

Contaminants were screened using the maximum concentration for a given contaminant for each species tested (Table 9). Non-carcinogenic health effects were screened using a childhood exposure scenario and ingestion of 60 grams fish per day. Carcinogenic endpoints were screened using an adult exposure scenario and ingestion of 142.4 grams of fish per day. Comparison values were calculated using established reference doses or minimum risk levels for non-carcinogenic effects and oral slope factors for carcinogenic effects (Appendix C).

Table 9. Carcinogenic and non-carcinogenic risk screening for contaminants found in fish collected in Portland Harbor. Values highlighted in bold indicate a concentration greater than the comparison value. Dashes indicate the chemical was not detected.

Chemical (ug/kg)*	SM Bass maximum conc.	Carp maximum conc.	Bullhead maximum conc.	Crappie maximum conc.	Salmon maximum conc.	Sturgeon maximum conc.	Non-cancer Comparison Value	Cancer Comparison Value
Aluminum	11000	134000	31700	68900	16300	11000	250000	-
Antimony	1	-	-	-	-	-	100	-
Arsenic, total	390	220	80	420	3000	2760	-	-
Arsenic, inorganic†	**39**	**22**	**8**	**42**	**300**	**276**	75	0.8
Cadmium	24	108	14	6	-	-	125	-
Chromium	1140	2020	1320	-	-	-	375000	-
Copper	1290	1420	798	946	4620	1200	5000	-
Lead	303	202	44	19	-	71	-	-
Manganese	26500	8530	10800	34100	1000	4970	35000	-
Mercury	**114**	47	54	44	62	**318**	75	-
Nickel	200	1370	321	357	655	7310	5000	-
Selenium	400	400	300	-	-	-	12500	-
Silver	-	17	4	-	-	-	12500	-
Thallium	9	5	4	17	-	-	17	-
Zinc	16300	**112000**	15600	16800	**112000**	13700	75000	-
2-Methylnaphthalene	59	38	-	-	-	-	1000	-
Acenaphthene	95	75	-	-	-	-	15000	-
Fluoranthene	36	-	40	-	-	-	10000	-
Fluorene	69	53	-	-	-	-	10000	-
Naphthalene	86	56	-	-	-	-	5000	-
Phenanthrene	85	-	60	-	-	-	7500	-
Pyrene	39	-	-	-	-	-	7500	-
Dieldrin	**7.3**	**-**	**2.6**	**2.5**	-	**1.4**	13	.07
Bis(2-ethylhexyl) phthalate (DEHP)	**87,000**	-	2700	-	-	-	5000	82
Di-n-octyl phthalate	2,100	-	-	-	-	-	10000	-
Methoxychlor		4.2	1.1	-	-	-	-	-

Chemical (ug/kg)*	SM Bass maximum conc.	Carp maximum conc.	Bullhead maximum conc.	Crappie maximum conc.	Salmon maximum conc.	Sturgeon maximum conc.	Non-cancer Comparison Value	Cancer Comparison Value
Gamma-hexachloro-cyclohexane	-	-	**1.9**	-	-	-	75	0.9
Alpha-Hexachloro-cyclohexane	-	-	-	**1.4**	-	-	125	0.2
Delta-Hexachloro-cyclohexane	-	-	-	**2.3**	-	-	50	0.6
Dibenzofuran	52	-	-	-	-	-	1000	-
Hepatachlor	-	-	-	**1.8**	1.7	-	125	0.3
Hexachlorobenzene	-	-	-	**8.1**	-	**2**	200	0.7
Hexachlorobutadiene	-	-	-	2.3	-	-	75	15
Total DDD	**89.8**	**171**	**25**	**18.5**	-	-	125	4.8
Total DDE	**177**	**260**	**70**	**80.5**	**7.9**	**94**	125	3.4
Total DDT	**104**	**47**	**58**	**21.6**	1.35	**74**	125	3.4
Total Chlordane	**4.33**	**25.5**	**67**	**9.7**	1.95	**5.6**	125	3.3
Total Endosulfan	7.8	10	8.6	6	6	1.1	1500	-
Total Aroclors	**2,933**	**6865**	**1719**	**250**	**19**	**430**	5	0.6
Total PCB congeners	**3,025**	**8154**	**1950**	**301**	**17.2**	**946**	5	0.6
Total dioxin-like PCB Congeners	**84.8**	**150**	**56.4**	**21**	**1.1**	**14.1**	-	-
Total Dioxin TEQ‡	**0.009**	**0.01**	**0.002**	**0.001**	**0.0003**	**0.001**	-	0.0000076
Total PCB TEQ	**0.02**	**0.04**	**0.02**	**0.005**	**0.0003**	**0.004**	-	0.0000076
Total TEQ	**0.03**	**0.05**	**0.02**	**0.007**	**0.0006**	**0.006**	-	0.0000076

*ug/kg = parts per billion

† The inorganic arsenic concentration was assumed to be 10 percent of total arsenic

‡ TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Contaminants were screened using the maximum exposure point concentration for a given contaminant. Non-carcinogenic health effects were screened using an adult exposure scenario and consumption of 18 grams of crayfish per day (Table 10). Comparison values were calculated using established reference doses or minimum risk levels for non-carcinogenic effects and oral slope factors for carcinogenic effects (Appendix C).

Table 10. Carcinogenic and non-carcinogenic risk screening for contaminants found in crayfish collected in Portland Harbor. Dashes indicate that these chemicals are not carcinogenic.

Chemical (ug/kg)*	Crayfish maximum conc.	Non-cancer Comparison Value	Cancer Comparison Value
Aluminum	203000	3,888,889	-
Antimony	20	1,556	-
Arsenic, total	500	-	-
Arsenic, inorganic†	**50**	1,167	6
Cadmium	36	1,944	-
Chromium	900	5,833,333	-
Copper	17600	77,778	-
Lead	1300	-	-
Manganese	213000	544,444	-
Mercury	41	1167	-
Nickel	830	77,778	-
Silver	47	194,444	-
Thallium	8	257	-
Zinc	20300	1,166,667	-
Benz(a)anthracene	**80**	-	12
Chrysene	87	-	1243
Fluoranthene	130	155,556	-
Phenanthrene	97	116,667	-
Pyrene	83	116,667	-
Endrin	2.8	1,167	-
4-Methylphenol	190	194,444	-
Pentachlorophenol	**130**	116,667	76
Phenol	520	116,667	-
Total DDD	21.3	1,944	38
Total DDE	**51**	1,944	27
Total DDT	17.5	1,944	27
Total Chlordane	1.9	1,944	26
Total Endosulfan	3.1	23,333	-
Total Aroclors	**280**	78	4.5
Total PCB congeners	**207**	78	4.5
Total dioxin-like PCB Congeners	15.1	-	-
Total Dioxin TEQ‡	**0.0227**	-	0.00006
Total PCB TEQ	**0.00455**	-	0.00006
Total TEQ	**0.0238**	-	0.00006

*ug/kg = parts per billion

† The inorganic arsenic concentration was assumed to be 10 percent of total arsenic

‡ TEQ = toxicity equivalency quotient based on relative potency to 2,3,7,8-TCDD for dioxins, furan and dioxin-like PCBs

Appendix F: Exposure Doses and Risk Assessment

To estimate risk, the level of exposure to a contaminant must be calculated. For both carcinogenic and non-carcinogenic end-points, exposure dose (i.e. the amount of a substance that one contacts per kg of body weight per day) was calculated using the formulas below:

$$\text{Dose}_{(\text{cancer, mg/kg/day})} = \frac{C \times C_1 \times IR \times C_2 \times EF \times ED}{BW \times AT_{cancer}}$$

$$\text{Dose}_{(\text{non-cancer, mg/kg/day})} = \frac{C \times C_1 \times IR \times C_2 \times EF \times ED}{BW \times AT_{non\text{-}cancer}}$$

Where,

Parameter	Group		Units	Comments
	Adult	Child		
Concentration (C)	---	---	µg/kg	Average concentration of chemical in fish/shellfish (site-wide)
Conversion Factor (C_1)	0.001	0.001	mg/µg	Converts fish concentration (µg) to mg
Ingestion Rate (IR) – average	17.5	7	g/day	
Ingestion Rate (IR) – high end	142.4	60	g/day	
Body weight (BW)	70	15	kg	Assumed weight of adult and child
Conversion Factor (C_2)	0.001	0.001	kg/g	Converts g → kg
Exposure Frequency (EF)	365	365	days/ year	Assumes daily exposure
Exposure Duration (ED)	30	6	years	90^{th} percentile of time spent living in one residence
Averaging Time ($AT_{non\text{-}cancer}$)	10950	2190	days	Number of days in 70 years
Averaging Time (AT_{cancer})	25550	-	days	70 year lifetime

For crayfish ingestion, the exposure dose can be calculated using the same formulas described above with different ingestion rates. For crayfish, an adult high-end ingestion rate of 18 grams crayfish per day and an average rate of 3.3 grams crayfish per day were utilized.

Evaluating non-cancer risk:

The following section describes how risk is assessed from the exposure doses calculated above. For non-cancer health effects, a comparison is made between the exposure concentrations (mg/kg/day) and the ATSDR's Minimal Risk Level (MRL) or the EPA's Reference Dose (RfD). If the ratio of estimated exposure concentration to the MRL or RfD (i.e. greater than one), the potential for adverse health effects needs to be further assessed. The higher the exposure concentration is above the MRL or RfD, the more risk is present. This comparison is called a hazard quotient (HQ) and is expressed as:

$$HQ = \frac{\text{Exposure concentration (mg/kg·day)}}{\text{MRL or RfD}}$$

Non-cancer dose and risk calculations for adult consumption of fish from Portland Harbor (using the average, site-wide exposure concentration for a chemical) for chemicals that exceeded screening values (Table 11). Contaminants that exceeded a hazard quotient (HQ) of one are marked in bold and discussed in the toxicology profile in the main text of the public health assessment.

Table 11. Exposure dose and non-cancer risk for adults ingesting fish collected from Portland Harbor.

		Estimated Dose			Hazard Quotient	
Species	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	RfD/MRL (mg/kg/day)	Average	High-End
Smallmouth Bass	Mercury	0.00002	0.0002	0.0003	0.07	0.6
	Total PCBs	0.0002	0.002	0.00002	**11.4**	**92.5**
	DEHP	0.0012	0.01	0.02	0.1	0.5
	Total DDD	0.000007	0.00005	0.0005	0.01	0.1
	Total DDT	0.000009	0.00008	0.0005	0.02	0.2
	Total DDE	0.00003	0.0003	0.0005	0.06	0.5
	Hazard Index (DDT, DDE + DDD)				0.09	0.8
Carp	Mercury	0.00001	0.000081	0.0003	0.03	0.3
	Total PCBs	0.0005	0.004	0.00002	**24**	**195**
	Zinc	0.03	0.2	0.3	0.08	0.7
	Total DDD	0.00002	0.0001	0.0005	0.03	0.3
	Total DDT	0.000003	0.00003	0.0005	0.007	0.05
	Total DDE	0.00003	0.0003	0.0005	0.07	0.5
	Hazard Index (DDT, DDE + DDD)				0.1	0.9
Brown Bullhead	Mercury	0.00001	0.00008	0.0003	0.01	0.08
	Total PCBs	0.0001	0.001	0.00002	**6.4**	**51.9**
	Total DDD	0.000003	0.00003	0.0005	0.006	0.05
	Total DDT	0.000007	0.00006	0.0005	0.01	0.1
	Total DDE	0.00001	0.0001	0.0005	0.02	0.2
	Hazard Index (DDT, DDE + DDD)				0.04	0.4

		Estimated Dose			Hazard Quotient	
Species	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	RfD/MRL (mg/kg/day)	Average	High-End
Black Crappie	Mercury	0.00001	0.00008	0.0003	0.03	0.3
	Total PCBs	0.00004	0.0003	0.00002	**2**	**16.7**
	Total DDD	0.000003	0.00003	0.0005	0.006	0.05
	Total DDT	0.000004	0.00003	0.0005	0.007	0.06
	Total DDE	0.00001	0.0001	0.0005	0.03	0.2
	Hazard Index (DDT, DDE + DDT)				0.04	0.3
Salmon	Arsenic	0.00007	0.0006	0.0003	0.2	**1.85**
	Mercury	0.00001	0.0001	0.0003	0.05	0.4
	Zinc	0.02	0.17	0.3	0.07	0.6
	Total PCBs	0.000004	0.00003	0.00002	0.19	**1.56**
	Total DDT	0.0000002	0.000002	0.0005	0.0005	0.004
	Total DDE	0.000002	0.00001	0.0005	0.003	0.03
	Hazard Index (DDE + DDT)				0.004	0.03
Sturgeon	Arsenic	0.00004	0.0003	0.0003	0.1	0.9
	Mercury	0.00005	0.0004	0.0003	0.2	**1.4**
	Total PCBs	0.00007	0.0006	0.00002	**3.5**	**28.9**
	Total DDT	0.000007	0.00006	0.0005	0.01	0.1
	Total DDE	0.00001	0.0001	0.0005	0.03	0.2
	Hazard Index (DDE + DDT)				0.04	0.3

Non-cancer dose and risk calculations for childhood consumption of fish from Portland Harbor (using the average, site-wide exposure concentration for a chemical) for chemicals that exceeded screening values (Table 12). Contaminants that exceeded a hazard quotient (HQ) of one are marked in bold and discussed in the toxicology profile in the main text of the public health assessment. Hazard indices are the combined hazard quotients of chemicals that have similar modes of action or health outcomes.

Table 12. Exposure dose and non-cancer risk for children ingesting fish collected from Portland Harbor.

		Estimated Dose			Hazard Quotient	
Fish Species	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	RfD (mg/kg/day)	Average	High-End
Smallmouth Bass	Mercury	0.00004	0.0003	0.0003	0.14	**1.2**
	Total PCBs	0.0004	0.003	0.00002	**21.3**	**182.2**
	Total DDD	0.00002	0.0002	0.0005	0.03	0.3
	Total DDT	0.00001	0.0001	0.0005	0.03	0.2
	Total DDE	0.00006	0.0005	0.0005	0.1	**1**
	Hazard Index (DDT, DDE + DDD)				0.2	**1.5**
Carp	Mercury	0.00002	0.0002	0.0003	0.06	0.5
	Total PCBs	0.0009	0.008	0.00002	**44.8**	**348**
	Total DDD	0.00003	0.0003	0.0005	0.06	0.55
	Total DDT	0.000006	0.00005	0.0005	0.01	0.1
	Total DDE	0.00006	0.0005	0.0005	0.1	**1.1**
	Hazard Index (DDT, DDE + DDD)				0.1	**1.75**
Brown Bullhead	Mercury	0.00002	0.0002	0.0003	0.06	0.5
	Total PCBs	0.0002	0.002	0.00002	**11.9**	**102.2**
	Total DDD	0.000006	0.00005	0.0005	0.01	0.1
	Total DDT	0.00001	0.0001	0.0005	0.03	0.2

Brown Bullhead		Estimated Dose			Hazard Quotient	
	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	RfD (mg/kg/day)	Average	High-End
	Total DDE	0.00002	0.0002	0.0005	0.04	0.4
	Hazard Index (DDT, DDE + DDD)				0.08	0.7
Black Crappie	Mercury	0.00002	0.0002	0.0003	0.06	0.5
	Total PCBs	0.00008	0.0007	0.00002	**3.8**	**32.8**
	Total DDD	0.000006	0.00005	0.0005	0.01	0.09
	Total DDT	0.000007	0.00006	0.0005	0.01	0.1
	Total DDE	0.00003	0.0002	0.0005	0.05	0.4
	Hazard Index (DDT, DDE + DDD)				0.08	0.6
Salmon	Arsenic	0.0001	0.001	0.0003	0.4	**3.6**
	Mercury	0.00003	0.0002	0.0003	0.09	0.8
	Zinc	0.04	0.3	0.3	0.13	1
	Total PCBs	0.000007	0.00006	0.00002	0.4	**3.1**
	Total DDT	0.0000004	0.000004	0.0005	0.0008	0.007
	Total DDE	0.000003	0.00003	0.0005	0.006	0.05
	Hazard Index (DDE + DDT)				0.01	0.06
Sturgeon	Arsenic	0.00007	0.0006	0.0003	0.22	**1.9**
	Mercury	0.00009	0.0008	0.0003	0.3	**2.7**
	Total PCBs	0.0001	0.001	0.00002	**6.7**	**57**
	Total DDT	0.00001	0.0001	0.0005	0.03	0.2
	Total DDE	0.00002	0.0002	0.0005	0.05	0.4
	Hazard Index (DDE + DDT)				0.08	0.6

Evaluating cancer risk:

Some chemicals are considered to be carcinogenic, or cancer causing. Cancer risk is assessed by determining a dose (as detailed above) and multiplying this dose by a cancer slope factor for that chemical (see Appendix A). From these calculations, an estimate of lifetime cancer risk can be estimated. This approach has a large degree of uncertainty. There are many reasons for cancer, many of which are not linked to environmental contaminants.

Cancer risk calculations for adult consumption of fish and crayfish from Portland Harbor (using the average, site-wide exposure concentration for a chemical) for chemicals that exceeded screening values (Table 13). Contaminants that are equal to or exceeded a cancer risk of one excess cancer in 10,000 people exposed (0.0001) are marked in bold and discussed in the toxicology profile in the main text of the public health assessment.

Table 13. Exposure dose and cancer risk for adults ingesting fish collected from Portland Harbor.

		Estimated Dose			Excess Cancer Risk	
Species	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	Cancer Slope Factor $(mg/kg/day)^{-1}$	Average	High-End
Smallmouth Bass	Arsenic	0.000003	0.00002	1.5	0.000005	0.00004
	Dieldrin	0.0000001	0.0000008	16	0.000002	0.00001
	DEHP	0.0005	0.004	0.014	0.00001	0.00009
		Estimated Dose			Excess Cancer Risk	

Smallmouth Bass	Contaminant	Average (mg/kg/day)	High End (mg/kg/day)	Cancer Slope Factor $(mg/kg/day)^{-1}$	Average	High-End
	Total DDTs (DDT+DDD+DDE)	0.00002	0.0002	0.24/0.34*	0.000004	0.00004
	Chlordane	0.00000006	0.0000005	0.35	0.00000002	0.0000002
	Dioxin/PCB TEQ	0.000000002	0.00000002	150000	**0.0003**	**0.002**
	Sum of cancer risks				**0.0003**	**0.003**
Carp	Arsenic	0.000002	0.00001	1.5	0.000003	0.00002
	Total DDTs (DDT+DDD+DDE)	0.00002	0.00008	0.24/0.34*	0.000004	0.00004
	Chlordane	0.000002	0.00001	0.35	0.0000005	0.000004
	Dioxin/PCB TEQ	0.000000002	0.00000002	150000	**0.0003**	**0.002**
	Sum of cancer risks				**0.0003**	**0.002**
Brown Bullhead	Arsenic	0.0000006	0.000005	1.5	0.0000009	0.000007
	Dieldrin	0.0000003	0.000002	16	0.000004	0.00003
	DEHP	0.00005	0.0004	0.014	0.0000007	0.000006
	Total DDTs (DDT+DDD+DDE)	0.000009	0.00008	0.24/0.34*	0.000003	0.00003
	Chlordane	0.000002	0.00002	0.35	0.0000007	0.000006
	Dioxin/PCB TEQ	0.0000000009	0.000000007	150000	**0.0001**	**0.001**
	Sum of cancer risks				**0.0001**	**0.001**
Black Crappie	Arsenic	0.000003	0.00002	1.5	0.000004	0.00004
	Dieldrin	0.0000003	0.000002	16	0.000004	0.00004
	Total DDTs (DDT+DDD+DDE)	0.000009	0.00007	0.24/0.34*	0.000003	0.00002
	Chlordane	0.0000008	0.000007	0.35	0.0000003	0.000002
	Dioxin/PCB TEQ	0.0000000005	0.000000004	150000	0.00007	**0.0006**
	Sum of cancer risks				0.00009	**0.0007**
Salmon	Arsenic	0.00003	0.0002	1.5	0.00004	0.0004
	Total DDTs (DDT+DDD+DDE)	0.0000002	0.000001	0.24/0.34*	0.0000003	0.000002
	Chlordane	0.0000001	0.000001	0.35	0.00000004	0.0000004
	Dioxin/PCB TEQ	0.00000000006	0.0000000005	150000	0.000009	0.00007
	Sum of cancer risks				0.00005	**0.0005**
Sturgeon	Arsenic	0.00002	0.0001	1.5	0.00002	**0.0002**
	Dieldrin	0.00000008	0.0000006	16	0.0000001	0.000001
	Total DDTs (DDT+DDD+DDE)	0.000008	0.00007	0.24/0.34*	0.000003	0.00003
	Chlordane	0.0000003	0.000003	0.35	0.0000001	0.0000009
	Dioxin/PCB TEQ	0.0000000002	0.000000002	150000	0.00004	0.0003
	Sum of cancer risks				0.00006	**0.0005**
Crayfish	Arsenic	0.0000006	0.000004	1.5	0.0000001	0.000006
	Total DDTs (DDT+DDD+DDE)	0.0000002	0.000001	0.24/0.34*	0.00000006	0.0000003
	Benz(a)anthracene	0.00000004	0.0000002	0.73	0.00000002	0.0000002
	Pentachlorophenol	0.0000001	0.0000006	0.12	0.00000001	0.0000001
	Dioxin/PCB TEQ	0.0000000001	0.0000000006	150000	0.00001	0.00009
	Sum of cancer risks				0.00002	0.00009

* A slope factor of 0.24 was used for DDD and 0.34 for DDT and DDE.

Appendix G. Fish Advisory Sign

NOTICE!

DHS Oregon Department of Human Services

Multnomah County Health Department

OREGON FISH ADVISORY

Fish from these waters may be harmful to eat, especially for children and pregnant or nursing women.

For more information, call DHS at 503-731-4012.

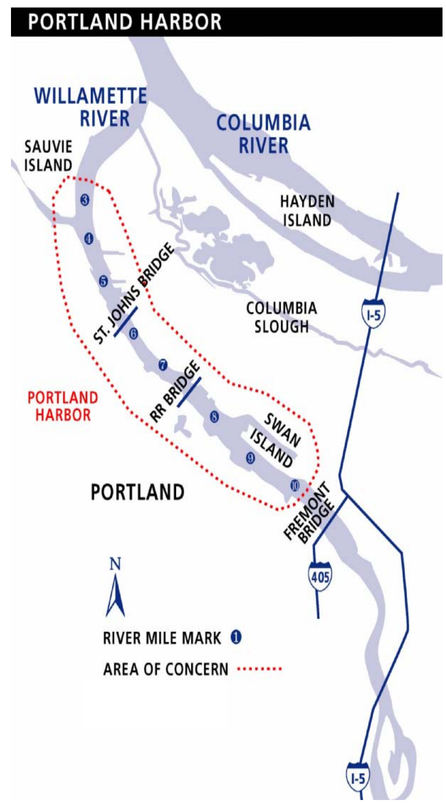
Atención: Los peces de estas aguas pueden ser dañinos al comerlos, especialmente a mujeres embarazadas, mujeres que están lactando (amamantando) y a niños.

Chú ý: Ăn cá từ những vùng nước này có thể sinh nguy hại, nhất là cho trẻ em, phụ-nữ đang mang thai hoặc cho con bú.

注意: 食用這些水域的魚類，可能會使健康受損，尤其對兒童、懷孕婦女、或正在用母奶哺乳的母親影響更大。

Внимание: Рыба из этой воды может быть вредной для употребления, особенно для детей, беременных и кормящих женщин.

ໂປດຊາບ: ການກິນປາໃນນ້ຳເຫຼົ່ານີ້ ອາດເປັນອັນຕະລາຍ, ໂດຍສະເພາະສຳລັບ ເດັກນ້ອຍແລະແມ່ຍິງທີ່ຖືພາ ຫຼືແມ່ຍິງທີ່ລ້ຽງລູກດ້ວຍນົມຕົນເອງ



AVOID **Evite comer** **Tránh** **避免** **ИЗБЕГАЙТЕ** **ຫລີກເວັ້ນ**

Carp

Bass

Catfish

Appendix H. Portland Harbor PHA Summary Fact Sheet

SHINE Program
Oregon Department of Human Services
Superfund Health Investigation and Education
Portland Harbor Health Assessment Findings

August 2005

Portland Harbor Superfund Site

Health Assessment findings

This fact sheet contains information about:

- The Portland Harbor health assessment findings
- Health risk of eating Portland Harbor fish
- Selecting less contaminated fish from Portland Harbor
- Recommendations for sensitive populations
- How to reduce PCBs in fish
- SHINE's action plan at Portland Harbor

Health Assessment completed

SHINE has finished a second public health assessment to determine the risk of eating fish from the Portland Harbor. SHINE worked with agencies and the Lower Willamette Group to collect fish tissue samples to determine which contaminants were present and at what levels. Based on the results of these tests, SHINE has concluded that frequent consumption of resident fish, such as carp, bass, and bullhead, from the Portland Harbor could result in health problems. This fact sheet explains the results of the public health assessment in further detail.

Site background

The Portland Harbor Superfund site is a six-mile stretch of the Willamette River (see map on p. 4) starting from the southern tip of Sauvie Island [river mile 3.5] to Swan Island [river mile 9.2]. The site is heavily industrialized and considerable amounts of chemicals have been released into the river over many years.

Contaminants of concern

The primary contaminants of concern in Portland Harbor fish are polychlorinated biphenyls (PCBs). PCBs are known to cause developmental problems in infants and children. Other contaminants found in Portland Harbor fish include dioxins and furans, persistent pesticides like DDT, arsenic, and methylmercury.

Community concerns

SHINE gathered information about health concerns from community members at public events and meetings. Frequent concerns expressed were:

- Safety of eating fish from the river.
- Current and future health effects of fish consumption.
- Safety of recreational use or other uses of the site.
- Need for signs warning the community which areas and activities are unsafe.
- How to obtain correct health information.

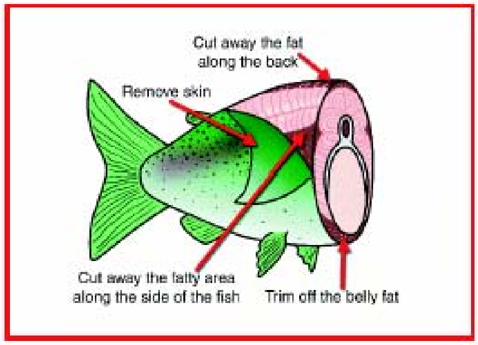
Conclusions

- People are advised to avoid eating resident fish caught in Portland Harbor, such as carp, bass, and bullhead catfish, because it could lead to health problems.
- The primary pollutants of concern are polychlorinated biphenyls (PCBs), which are most harmful to the developing fetus and infants.
- Eating migratory fish, such as salmon, from Portland Harbor is not likely to result in adverse effects.

Portland Harbor Fish Advisory

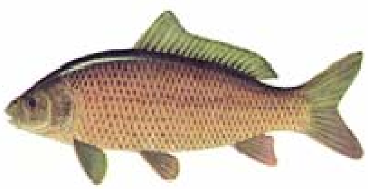
Based on the conclusions of the health assessment, SHINE recommends that people limit their consumption of resident fish from the Portland Harbor.

1. Avoid eating resident fish (see below) from the Portland Harbor if you are:
   - Pregnant, thinking of getting pregnant,
   - Nursing an infant,
   - A woman of childbearing age,
   - A child,
   - A person with a weak immune system, thyroid or liver problems.
2. Healthy adult men and women beyond childbearing age may consume one 8-ounce meal of resident fish per month. (An 8-ounce serving is about the size of two decks of cards).
3. Fish collected from Portland Harbor should be properly prepared and cooked to reduce your exposure to pollutants.
   - Remove and discard the skin, fat, head, eyes, eggs and organs.
   - Cook fish by methods that allow the fats to drip off, such as grilling, baking or smoking.

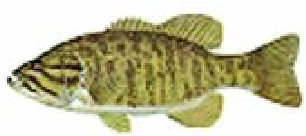


Resident fish in Portland Harbor are more contaminated than other fish.

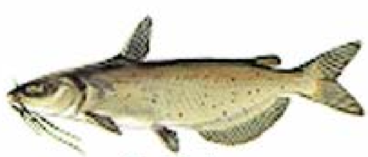
AVOID OR LIMIT INTAKE



Carp



Bass



Catfish

NO LIMITS IN PLACE

No limits have been placed on eating migratory fish like salmon or steelhead. Research has shown that eating fish has numerous health benefits. It is recommended that people eat a balanced diet including seafood.

Salmon

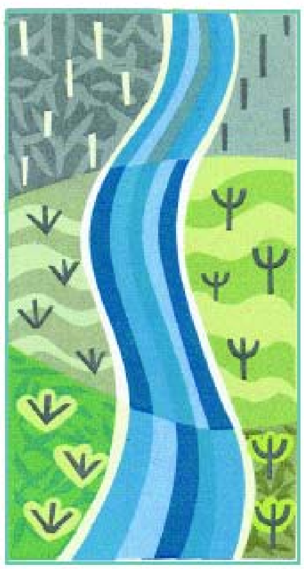
Steelhead

SHINE's Action Plan for Portland Harbor

In addition to conducting public health assessments, SHINE creates a *Public Health Action Plan* to ensure that the public health assessment not only identifies public health hazards but also provides a plan of action to reduce and prevent health problems caused by exposure to hazardous substances.

SHINE's past actions:

- Initiated an exposure investigation to look at the level of contaminants in three kinds of resident fish.
- Released a fish advisory based on results of the fish sampling.
- Carried out a needs assessment and created a public health education action plan to meet those needs.
- Developed community-based mini-grant opportunities for community organizations that serve hard-to-reach communities that catch and consume fish from Portland Harbor. SHINE worked with tribal, Chinese, Vietnamese, Pacific Islander and transient communities to develop their own materials and outreach activities.
- Worked with agencies, community members and other stakeholders to develop and post fish advisory signs for Portland Harbor.
- Developed and presented information about public health, fish and Portland Harbor to community organizations, tribes, agencies and other groups.



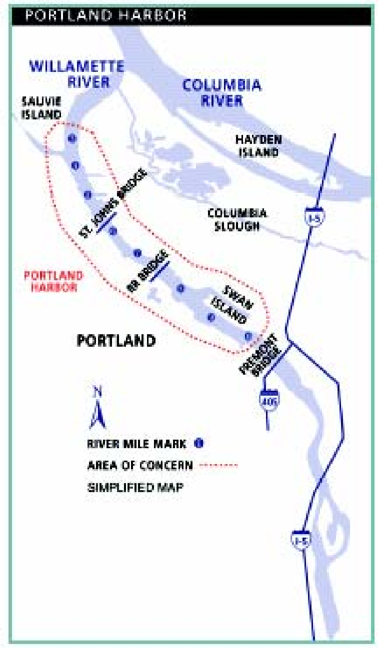
SHINE's current and future actions:

- SHINE has awarded a mini-grant to IRCO, a community organization that provides services to the immigrant and refugee population, to conduct fish consumption education and outreach activities pertaining to Portland Harbor.
- SHINE will continue to work with other agencies and organizations to identify communities that catch and consume fish from the Portland Harbor, and to create and distribute targeted health education and materials.
- SHINE will conduct extensive outreach to communicate our health assessment findings and recommendations.
- SHINE will update the health education action plan on a regular basis to incorporate changes and identify new activities to accomplish outreach and education goals.

Public Health's Involvement at the Portland Harbor

Oregon's SHINE Program, or Superfund Health Investigation and Education, within the Oregon Department of Human Services (DHS), was established in 2001 through a cooperative agreement with the Agency for Toxic Substances and Disease Registry (ATSDR), a national public health service agency. The DHS SHINE Program works to assess and prevent human exposure to contamination at Oregon sites listed on the National Priority List (or Superfund sites) and at other hazardous waste sites that impact communities at the request of concerned individuals and organizations.

SHINE is involved in determining the adverse human health effects of exposure to contaminants in both in-water and upland portions of the Portland Harbor Superfund site and educating the community on how to reduce or prevent exposures to these contaminants.



Web site: www.oregonhealth.org/superfund
Phone: 503-731-4025

Superfund Health Investigation and Education (SHINE)
Oregon Department of Human Services
800 NE Oregon St., #827
Portland, OR 97232

Appendix I. ATSDR Plain Language Glossary of Environmental Health Terms

Absorption: How a chemical enters a person's blood after the chemical has been swallowed, has come into contact with the skin, or has been breathed in.

Acute Exposure: Contact with a chemical that happens once or only for a limited period of time. ATSDR defines acute exposures as those that might last up to 14 days.

Additive Effect: A response to a chemical mixture, or combination of substances, that might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

Adverse Health Effect: A change in body function or the structures of cells that can lead to disease or health problems.

Antagonistic Effect: A response to a mixture of chemicals or combination of substances that is **less** than might be expected if the known effects of individual chemicals, seen at specific doses, were added together.

ATSDR: The **A**gency for **T**oxic **S**ubstances and **D**isease **R**egistry. ATSDR is a federal health agency in Atlanta, Georgia that deals with hazardous substance and waste site issues. ATSDR gives people information about harmful chemicals in their environment and tells people how to protect themselves from coming into contact with chemicals.

Background Level: An average or expected amount of a chemical in a specific environment. Or, amounts of chemicals that occur naturally in a specific environment.

Bioavailability: See **Relative Bioavailability**.

Biota: Used in public health, things that humans would eat – including animals, fish and plants.

CAP: See **C**ommunity **A**ssistance **P**anel.

Cancer: A group of diseases which occur when cells in the body become abnormal and grow, or multiply, out of control

Carcinogen: Any substance shown to cause tumors or cancer in experimental studies.

CERCLA: See **C**omprehensive **E**nvironmental **R**esponse, **C**ompensation, and **L**iability **A**ct.

Chronic Exposure:	A contact with a substance or chemical that happens over a long period of time. ATSDR considers exposures of more than one year to be *chronic*.
Completed Exposure Pathway:	See **Exposure Pathway**.
Community Assistance Panel (CAP):	A group of people from the community and health and environmental agencies who work together on issues and problems at hazardous waste sites.
Comparison Value: **(CVs)**	Concentrations of substances in air, water, food, and soil that are unlikely, upon exposure, to cause adverse health effects. Comparison values are used by health assessors to select which substances and environmental media (air, water, food and soil) need additional evaluation while health concerns or effects are investigated.
Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA):	**CERCLA** was put into place in 1980. It is also known as **Superfund**. This act concerns releases of hazardous substances into the environment, and the cleanup of these substances and hazardous waste sites. This act created ATSDR and gave it the responsibility to look into health issues related to hazardous waste sites.
Concern:	A belief or worry that chemicals in the environment might cause harm to people.
Concentration:	How much or the amount of a substance present in a certain amount of soil, water, air, or food.
Contaminant:	See **Environmental Contaminant**.
Delayed Health Effect:	A disease or injury that happens as a result of exposures that may have occurred far in the past.
Dermal Contact:	A chemical getting onto your skin. (see **Route of Exposure**).
Dose:	The amount of a substance to which a person may be exposed, usually on a daily basis. Dose is often explained as “amount of substance(s) per body weight per day”.
Dose / Response:	The relationship between the amount of exposure (dose) and the change in body function or health that result.

Duration:	The amount of time (days, months, years) that a person is exposed to a chemical.
Environmental Contaminant:	A substance (chemical) that gets into a system (person, animal, or the environment) in amounts higher than the **Background Level**, or what would be expected.
Environmental Media:	Usually refers to the air, water, and soil in which chemicals of interest are found. Sometimes refers to the plants and animals that are eaten by humans. **Environmental Media** is the second part of an **Exposure Pathway**.
U.S. Environmental Protection Agency (EPA):	The federal agency that develops and enforces environmental laws to protect the environment and the public's health.
Epidemiology:	The study of the different factors that determine how often, in how many people, and in which people will disease occur.
Exposure:	Coming into contact with a chemical substance.(For the three ways people can come in contact with substances, see **Route of Exposure**.)
Exposure Assessment:	The process of finding the ways people come in contact with chemicals, how often and how long they come in contact with chemicals, and the amounts of chemicals with which they come in contact.
Exposure Pathway:	A description of the way that a chemical moves from its source (where it began) to where and how people can come into contact with (or get exposed to) the chemical. ATSDR defines an exposure pathway as having 5 parts: 1. Source of Contamination, 2. Environmental Media and Transport Mechanism, 3. Point of Exposure, 4. Route of Exposure, and 5. Receptor Population. When all 5 parts of an exposure pathway are present, it is called a **Completed Exposure Pathway**. Each of these 5 terms is defined in this Glossary.

Frequency: How often a person is exposed to a chemical over time; for example, every day, once a week, twice a month.

Hazardous Waste: Substances that have been released or thrown away into the environment and, under certain conditions, could be harmful to people who come into contact with them.

Health Effect: ATSDR deals only with **Adverse Health Effects** (see definition in this Glossary).

Indeterminate Public Health Hazard: The category is used in Public Health Assessment documents for sites where important information is lacking (missing or has not yet been gathered) about site-related chemical exposures.

Ingestion: Swallowing something, as in eating or drinking. It is a way a chemical can enter your body (See **Route of Exposure**).

Inhalation: Breathing. It is a way a chemical can enter your body (See **Route of Exposure**).

LOAEL: **L**owest **O**bserved **A**dverse **E**ffect **L**evel. The lowest dose of a chemical in a study, or group of studies, that has caused harmful health effects in people or animals.

Malignancy: See **Cancer**.

MRL: **M**inimal **R**isk **L**evel. An estimate of daily human exposure – by a specified route and length of time -- to a dose of chemical that is likely to be without a measurable risk of adverse, noncancerous effects. An MRL should not be used as a predictor of adverse health effects.

NPL: The **N**ational **P**riorities **L**ist. (Which is part of **Superfund**.) A list kept by the U.S. Environmental Protection Agency (EPA) of the most serious uncontrolled or abandoned hazardous waste sites in the country. An NPL site needs to be cleaned up or is being looked at to see if people can be exposed to chemicals from the site.

NOAEL: **N**o **O**bserved **A**dverse **E**ffect **L**evel. The highest dose of a chemical in a study, or group of studies, that did not cause harmful health effects in people or animals.

No Apparent Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where exposure to site-related chemicals may have occurred in the past or is still occurring but the exposures are not at levels expected to cause adverse health effects.

No Public Health Hazard: The category is used in ATSDR's Public Health Assessment documents for sites where there is evidence of an absence of exposure to site-related chemicals.

PHA: **P**ublic **H**ealth **A**ssessment. A report or document that looks at chemicals at a hazardous waste site and tells if people could be harmed from coming into contact with those chemicals. The PHA also tells if possible further public health actions are needed.

Plume: A line or column of air or water containing chemicals moving from the source to areas further away. A plume can be a column or clouds of smoke from a chimney or contaminated underground water sources or contaminated surface water (such as lakes, ponds and streams).

Point of Exposure: The place where someone can come into contact with a contaminated environmental medium (air, water, food or soil). Some examples include: the area of a playground that has contaminated dirt, a contaminated spring used for drinking water, or the backyard area where someone might breathe contaminated air.

Population: A group of people living in a certain area; or the number of people in a certain area.

PRP: **P**otentially **R**esponsible **P**arty. A company, government or person that is responsible for causing the pollution at a hazardous waste site. PRP's are expected to help pay for the clean up of a site.

Public Health Assessment(s): See **PHA**.

Public Health Hazard: The category is used in PHAs for sites that have certain physical features or evidence of chronic, site-related chemical exposure that could result in adverse health effects.

Public Health Hazard Criteria: PHA categories given to a site which tell whether people could be harmed by conditions present at the site. Each are defined in the Glossary. The categories are:
– Urgent Public Health Hazard
– Public Health Hazard
– Indeterminate Public Health Hazard
– No Apparent Public Health Hazard
– No Public Health Hazard

Receptor Population: People who live or work in the path of one or more chemicals, and who could come into contact with them (See **Exposure Pathway**).

Reference Dose (RfD):	An estimate, with safety factors (see **safety factor**) built in, of the daily, life-time exposure of human populations to a possible hazard that is not likely to cause harm to the person.
Relative Bioavailability:	The amount of a compound that can be absorbed from a particular medium (such as soil) compared to the amount absorbed from a reference material (such as water). Expressed in percentage form.
Route of Exposure:	The way a chemical can get into a person's body. There are three exposure routes: – breathing (also called inhalation), – eating or drinking (also called ingestion), and – getting something on the skin (also called dermal contact).
Safety Factor:	Also called **Uncertainty Factor**. When scientists don't have enough information to decide if an exposure will cause harm to people, they use "safety factors" and formulas in place of the information that is not known. These factors and formulas can help determine the amount of a chemical that is not likely to cause harm to people.
SARA:	The **S**uperfund **A**mendments and **R**eauthorization **A**ct in 1986 amended CERCLA and expanded the health-related responsibilities of ATSDR. CERCLA and SARA direct ATSDR to look into the health effects resulting from chemical exposures at hazardous waste sites.
Sample Size:	The number of people that are needed for a health study.
Sample:	A small number of people chosen from a larger population (See **Population**).
Source (of Contamination):	The place where a chemical comes from, such as a landfill, pond, creek, incinerator, tank, or drum. Contaminant source is the first part of an **Exposure Pathway**.
Special Populations:	People who may be more sensitive to chemical exposures because of certain factors such as age, a disease they already have, occupation, sex, or certain behaviors (like cigarette smoking). Children, pregnant women, and older people are often considered special populations.
Statistics:	A branch of the math process of collecting, looking at, and summarizing data or information.
Superfund Site:	See **NPL**.

Survey: A way to collect information or data from a group of people (**population**). Surveys can be done by phone, mail, or in person. ATSDR cannot do surveys of more than nine people without approval from the U.S. Department of Health and Human Services.

Synergistic effect: A health effect from an exposure to more than one chemical, where one of the chemicals worsens the effect of another chemical. The combined effect of the chemicals acting together are greater than the effects of the chemicals acting by themselves.

Toxic: Harmful. Any substance or chemical can be toxic at a certain dose (amount). The dose is what determines the potential harm of a chemical and whether it would cause someone to get sick.

Toxicology: The study of the harmful effects of chemicals on humans or animals.

Tumor: Abnormal growth of tissue or cells that have formed a lump or mass.

Uncertainty Factor: See **Safety Factor**.

Urgent Public Health Hazard: This category is used in ATSDR's Public Health Assessment documents for sites that have certain physical features or evidence of short-term (less than 1 year), site-related chemical exposure that could result in adverse health effects and require quick intervention to stop people from being exposed.

Certification

The Superfund Health Investigation and Education Program of the Oregon Department of Human Services prepared the Portland Harbor site under a cooperative agreement with the Agency for Toxic Substances and Disease Registry. This document is in accordance with approved methodology and procedures. Editorial review was performed by the cooperative agreement partner.

Gregory Ulirsch, Ph.D.
Technical Project Officer for Oregon, SSAB, DHAC

I have reviewed this health consultation, as the designated representative of the Agency for Toxic Substances and Disease Registry and concur with its findings.

Alan Yarbrough, M.S.
Leader, Cooperative Agreement Team, SSAB, DHAC