Health Consultation

CONTAMINANTS IN KACHEMAK BAY
CRITICAL HABITAT AREA BIVALVES AND
SHIP SANDBLASTING ON
CHUGACHIK ISLAND, ALASKA

Prepared by the
Alaska Department of Health and Social Services

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

Health Consultation: A Note of Explanation

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HEALTH CONSULTATION

CONTAMINANTS IN KACHEMAK BAY CRITICAL HABITAT AREA BIVALVES AND SHIP SANDBLASTING ON CHUGACHIK ISLAND, ALASKA

Prepared By:

The Alaska Department of Health and Social Services
Division of Public Health, Section of Epidemiology
Environmental Public Health Program
Under a Cooperative Agreement with the
Agency for Toxic Substances and Disease Registry

Executive Summary

The Alaska Department of Health and Social Services (ADHSS) was asked to evaluate contaminant levels in mussels and clams collected from Kachemak Bay Critical Habitat Area (KBCHA). ADHSS was asked to evaluate this because of an illegal sandblasting event that occurred in KBCHA. The sandblasting produced metals (chromium, cobalt, copper, lead, nickel, tin, and zinc) that may have been taken into mussels and clams. ADHSS found that clam and mussel metal levels are not a cause for health concern for people that eat them.

I. Purpose and Background

In May of 2008, the Alaska Department of Health and Social Services (ADHSS) was asked by the Alaska Department of Fish and Game (ADFG) to evaluate contaminant levels in shellfish (bivalve) samples collected from Kachemak Bay Critical Habitat Area (KBCHA). This request was in response to an illegal sandblasting event that occurred in May 2006. Sandblasting the vessel hull produced grit and paint chips (Fig. 1) that contained metals. ADFG investigated the amount of metals in grit, paint chip, sediment, and clam and mussel tissues. In writing this health consultation, ADHSS addresses whether contaminants in KBCHA shellfish (clams and mussels) are at levels high enough to cause ill effects in humans who consume them.

Fig. 1. Dust from vessel sandblasting in KBCHA Critical Habitat Area

The sandblasting event occurred on tidal flats near Chugachik Island within Alaska's KBCHA (Fig 2). The waters and tidal flats of KBCHA are used for commercial and recreational shellfish harvesting (1).

The number of people that harvest shellfish from the KBCHA is unknown. People from nearby communities (Homer, Fox River, Fritz Creek, Jakolof Bay, Seldovia, and Seldovia Village) are the most likely to harvest and consume local mussels and clams but day-trippers from other areas may also do so. Based on ADFG data (2), ADHSS estimates that a maximum of 6,000 people may harvest or consume clams and mussels from this area. This number would include actual harvesters (people who collect their own clams and mussels), the people that harvesters share their bivalves with, and people who buy local clams and mussels at seafood shops or restaurants.

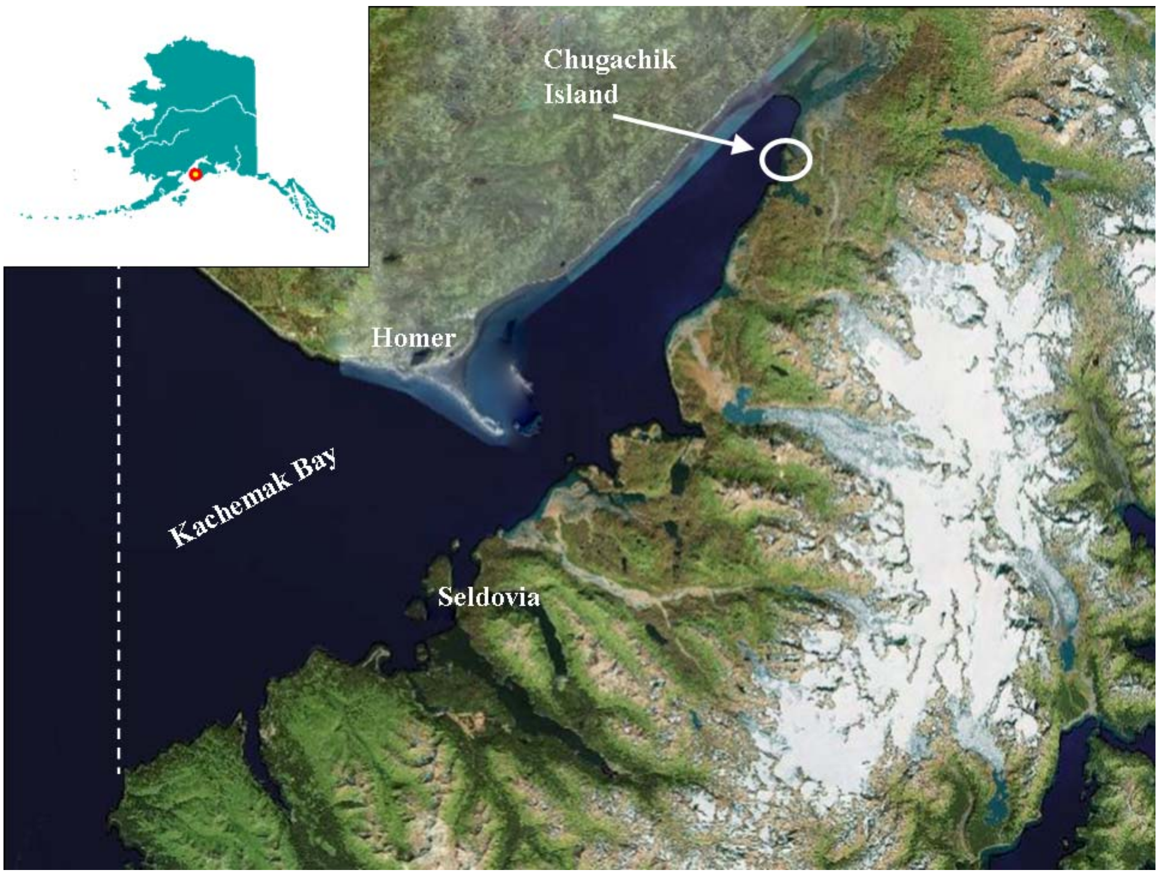

Fig. 2. KBCHA within Alaska. Red dot is area of detail.
Sandblasting occurred on Chugachik Island (white circle)

II. Methods

A. Sample Collection and Analysis

Alaska State Troopers collected paint/grit samples from the flats a week after the sandblasting event (~May 29, 2006). The Alaska Department of Environmental Conservation's (ADEC) Environmental Health Laboratory (EHL) analyzed the paint/grit samples. These samples were determined to have the metals of chromium, cobalt, copper, lead, nickel, tin, and zinc.

ADFG personnel collected shellfish and sediment samples at four different sites (Fig. 3) approximately fifteen months (September 2007) after the sandblasting event. Site 1 was the discharge location and site 2 was on the northeast side of Chugachik Island. Sites 3 and 4 were control sites, near Bear Cove. A control site is an area thought to resemble a contaminated area but be outside its influence, to use for comparative purposes. Control sites are used to distinguish whether contaminants/contaminant levels are natural or caused by man. Multiple (4 to 8) samples of ten to 20 bivalves were taken by bivalve type (mussels, littleneck, or butter clams) and/or site. For example, there were 8 mussel samples and 5 samples each of littleneck and butter clams collected at site 2. Similar bivalves types were composited (mixed together) for analysis. ADEC-EHL analyzed the samples for chromium, cobalt, copper, lead, nickel, tin, and zinc elements. These elements were chosen because they were in the previously collected paint/grit samples. The analysis was completed by a standard Environmental Protection Agency (EPA) method (6020A) using Inductively Coupled Plasma-Mass Spectrometry.

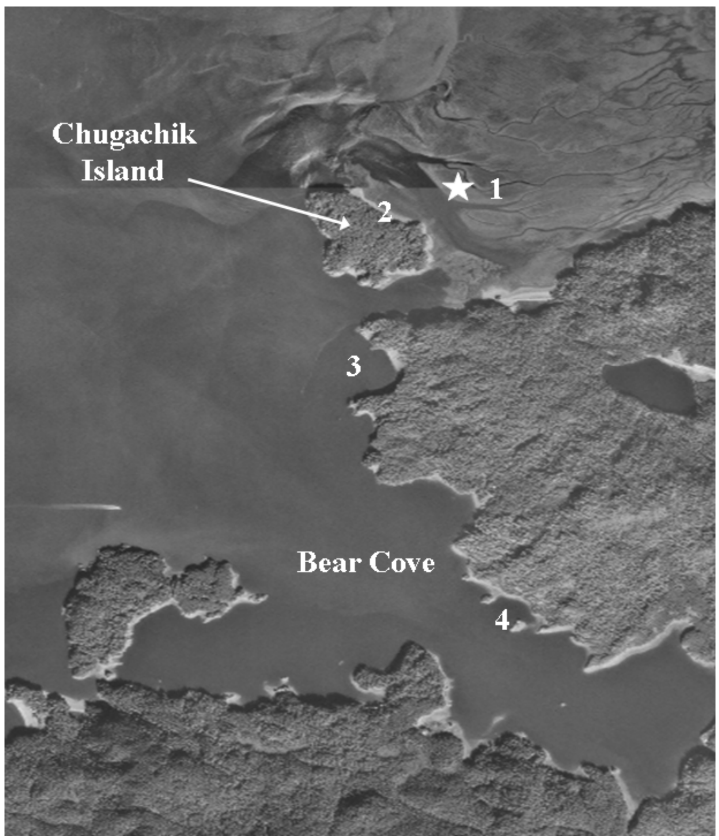

Fig 3. Mussel and clam sampling locations.
White star is sandblasting location.

B. Identifying Contaminants of Potential Concern

This report evaluates the mussel and clam samples from KBCHA. The first step in this process is to identify contaminants of potential concern. A substance is a contaminant if it is present where it does not belong. A contaminant of concern is a substance that is present at levels that might cause harmful health effects. If site-specific concentrations (levels) are higher than environmental Comparison Values (CVs) then the contaminant may be of concern. CVs are values that are below levels known or expected to cause harmful health effects. CVs include large safety factors (3 to 1,000) to protect people from the potential of an ill health effect. There are no established environmental CVs to screen bivalve samples for contaminants of potential concern, so all detectable elements were further evaluated (Table 1, bold).

The maximum level (concentration) of each bivalve contaminant at each site was used to calculate child and adult doses. For instance, butter clams from site 2 had copper concentrations from 1.91 to 3.38 parts per million (ppm) but only the highest concentration (3.38 ppm) of these five butter clam samples is reported in Table 1 and used in calculations. A dose range was calculated using the highest and lowest maximal contaminant level among bivalve species and sites. As an example, the maximal dose range would be calculated from Table 1 copper concentrations of 3.38 ppm (in butter clams from site 2) and 0.98 ppm (in littlenecks from site 4). The ADHSS and the Agency for Toxic Substances and Disease Registry (ATSDR) screening process utilizes the maximum contaminant concentration when making comparisons, to represent a worst case scenario for contact with contaminants. Large volumes of data are rapidly screened by using this method. However, a contaminant that is above screening levels does not necessarily mean that it will cause harmful health effects; rather, it requires further evaluation.

Doses in micrograms per kilogram per day (µg/kg-day) are then compared to health-based guidelines. Health guidelines include, but are not limited to, Minimal Risk Levels (MRLs), Reference Doses (RfDs), and Dietary Reference Intake Tolerable Upper Intake Level (DRI-UL). All of the health guidelines indicate a level at which the contaminant poses no risk of harmful (adverse) health effects for almost all individuals. If no health guidelines are available, then the No Observable Adverse Effect Level (NOAEL) or Lowest Observable Adverse Effect Level (LOAEL) from toxicological experiments is used for comparison to the site-specific dose.

The contaminants of potential concern for this health consultation are: chromium, cobalt, copper, lead, nickel, tin, and zinc. A complete contact pathway occurs when people eat KBCHA bivalves. Therefore, doses were calculated and compared to available toxicological information to determine whether ill effects may result from eating mussels and clams from this area.

III. Completed Contact Pathway

This report is organized by contact pathway and the pathway is eating of KBCHA clams and mussels. A contact pathway is used to describe conditions and circumstances by which a contaminant travels from its source to the human body. Contaminants may come from nature or human activity. Contaminants may travel from dusts, soils, or sediments into water where clams and mussels may take up the contaminant. People that eat clams and mussels that have contaminants make a completed contact pathway. Contact with contaminants are likely ongoing (present and future) and may have also occurred in the past because people harvest and eat KBCHA mussels and clams.

IV. Health Considerations

The likelihood of ill effects from a contaminant is dependent upon the contaminant amount, the amount a person eats, and how often a person eats a food with the contaminant. How much a person eats often varies and has to be assumed. For instance, one assumption is how many clams a person would normally eat. This is important for calculating a dose. For this evaluation, ADHSS assumed that a typical meal portion of clams would be an 8-ounce (227,000 mg) meal portion or about 5 to 10 clams, depending on clam size. Children from 1 to 6 years were estimated to eat 1.2 ounces per meal. Seven to 19 year olds were estimated to eat 7.2 ounces of clams/mussels per meal. Site-specific doses and rates were calculated as described in Appendix A.

Estimates of theoretical cancer risk are largely dependent on the contaminant amount, the amount a person is exposed to, and how often a person is exposed to the contaminant. Most cancer studies use daily contact to a substance to see if it will produce cancer. However, contact to the contaminants in KBCHA bivalves is not occurring on a daily basis. People normally do not undertake clamming activities during periods of extreme weather (cold or storms). The amount of contact with contaminants is significantly reduced by not eating mussels and clams daily.

V. Toxicological Evaluation

The requestor asked whether consuming the contaminants in KBCHA clams or mussels might cause an ill effect. Comparisons between sandblasting and control sites were not possible because of the time (15 months) that passed between sandblasting and sampling. With time, biological and other environmental factors may have influenced the contaminant results.

Estimated doses for potential contaminants of concern are located in Table 2. KBCHA bivalves were considered to be eaten for 14 days or less for evaluation of acute contact toxicity, or eaten for a lifetime for carcinogenic risk evaluation purposes. Lead and tin exceeded a health CV when eating clams (Table 2, bold).

A. Metals eaten in KBCHA clams and mussels that were below health guidelines

Chromium, cobalt, copper, nickel, and zinc

Chromium, copper, and zinc are needed by the body to function correctly, and these metals are common in foods. Breads, nuts, and some shellfish may have these metals at concentrations up to 3,700 ppm (3-5). The mussels and clams collected in KBCHA had chromium, copper, and zinc concentrations between 0.39 and 13.50 ppm (Table 1). The amount of chromium, copper, and zinc in KBCHA clams and mussels are within the range of commonly eaten foods and are not a health concern.

The estimated chromium, copper, and zinc doses were lower than their respective health guidelines (Table 2). Contact with contaminants below the health guidelines (RfD, MRL) pose no risk of harmful health effects for almost all adults and children. No harmful health effects are likely from eating chromium, copper, and zinc in KBCHA clams and mussels.

Cereal and cocoa are two foods that may contain cobalt and nickel. The amount of these elements in foods may range from zero to 10 ppm (6, 7). KBCHA mussels and clams contained 0.27 to 1.71 ppm of cobalt and up to 1.26 ppm of nickel (Table 1). These mussels and clams contain less cobalt and nickel than from other foods, so there is no cause for concern. In addition, doses estimated for cobalt and nickel were less than their respective health guidelines (Table 2).

Cobalt and nickel are categorized as possibly carcinogenic to humans (IARC). If a person ate KBCHA clams or mussels everyday for a lifetime the nickel doses (Table 2) are far below those in a study that observed no increased cancer rates (7). The cobalt and nickel present in KBCHA mussels and clams are not expected to increase the risk of cancer, especially since the levels are within the range reported for other food items.

B. Metals eaten in KBCHA bivalves that were above health guidelines

Lead

A small amount of lead is common in foods. Fruit may have up to 0.06 ppm of lead while meat may have up to 0.5 ppm of lead (8). The maximum concentration of lead in KBCHA bivalves was 0.19 ppm observed in mussels collected from site 1 (Table 1). The lowest maximum concentration (0.04) was observed in littleneck clams collected from site 4. These lead amounts are below a level that a person may be exposed to when eating beef or poultry.

Children and adults may be exposed to low levels (Table 2) of lead from eating KBCHA mussels and clams. By eating KBCHA bivalves, the contact with lead for adult and child were above a State of California guideline (Table 2), but not above the World Health Organization's guideline (250 µg/day). By eating KBCHA mussels or clams there may be a slight increase in blood lead levels (see Appendix A). The estimated total blood lead levels for adults and children were below 3 µg/dL. Estimated blood lead levels would be below the current levels of concern established by the Centers for Disease Control and Prevention (10 micrograms per deciliter of blood, µg/dL) and also below a Finnish worker lead cancer study (>21 µg/dL). Health effects, including cancer, are unlikely from the amount of lead eaten in KBCHA clams and mussels.

Tin

Grain products (bread, pasta) and many meats have less than 0.003 ppm of tin, whereas preserved (in tin cans) fruits and vegetables may have tin levels of 0.5 to 128 ppm (9). The highest level of tin detected was 0.18 ppm (Table 1). However, 29 out of the 35 mussel and clam samples analyzed did not have any detectable amounts of tin. Since there was no tin in these samples then people will not be exposed, very often, to this metal. Only the maximum tin level for the samples at a site is reported in Table 1. KBCHA mussels and clams contain tin levels well below those observed in preserved fruits and vegetables.

Tin may be found in inorganic (chlorine, sulfur, or oxygen attached) or organic (carbon attached) forms. Inorganic tins do not usually cause harmful health effects. However organic tin may cause harmful health effects such as skin/eye/respiratory irritation, gastrointestinal effects, and neurological problems (9). To be protective of human health, it was assumed that the tin levels were 100% in the organic form named tributyltin. All of the high tributyltin doses were above (>0.3 µg/kg-day) the tributyltin RfD and MRL. However, the highest estimated doses were a thousand-fold below a less serious health effect (immune suppression), so no ill effects are likely from eating tin in KBCHA clams and mussels.

VI. Child Health Considerations

Children may take up, process, and eliminate contaminants differently than adults. Children generally eat a smaller portion of food than adults but contaminants within the food may be absorbed at a higher rate. For instance, lead absorption is 40 to 50% for children (up to 8 years old) and only 3 to 10% in adults (8). Additionally the systems that change and remove contaminants from children are not as well developed as adults. If children contact high levels of contaminants during critical growth stages, the developing body systems of children can sustain permanent damage. Children are dependent on adults and parents should help children learn to identify and avoid risk. Adults should encourage healthy behaviors and inform their children of potential dangers. Childhood contacts with contaminants were evaluated in this health consultation to aid parents in identifying risk.

VII. Other Potential Hazards

Although not related to the sandblasting event, Paralytic Shellfish Poisoning (PSP) continues to pose a serious threat to people who collect and eat shellfish from uncertified beaches in Alaska. ADHSS considers the health hazard from PSP to pose a much more serious health threat than any contact with trace chemical contaminants. PSP occurs when people eat bivalves that contain high levels of toxin produced by certain types of algae. While PSP is commonly associated with "red tides", water color is not a reliable indicator of a toxic algae bloom (11). Health effects of PSP can be severe. PSP symptoms include lip, tongue, finger and toe tingling, loss of control of arms and legs, and difficulty in breathing (10, 11). If a person consumes enough poison, muscles of the chest and abdomen become paralyzed and death can result in as little as two hours.

Certain bivalves retain the PSP toxin longer than others. Butter clams may have the PSP toxin for up to two years after a red tide event (10, 11). This health consultation did not collect data on the occurrence of the marine toxin responsible for PSP. However, a known public hazard exists if people collect and eat shellfish from beaches with a high amount of the algae responsible for producing the toxin that causes PSP.

ADHSS highly recommends that harvesting and eating of bivalves occur only from beaches that are **classified** (coliform-a type of bacteria, and PSP) **safe** by the ADEC, Environmental Health, Food Safety and Sanitation Program. Currently there are 29 **classified safe** areas with two located in Cook Inlet (KBCHA-East and Redoubt Creek South), five in Prince William Sound, and 22 in Southeast Alaska. The **classified safe** areas have many beaches and some beaches are unclassified. To determine if the beach that you plan on harvesting bivalves from is **classified safe** contact the ADEC Shellfish Coordinator at 907-269-7638. Before harvesting bivalves from **classified safe** beaches, people should also check for PSP warnings/closures for the where the beach is located. Alaska PSP warnings/closure can be found at the ADEC webpage at: http://www.dec.state.ak.us/eh/fss/seafood/psphome.htm. To protect yourself, adhere to the statewide advisory for PSP and do not harvest or consume clams from closed or unclassified areas. Lastly, the risk of PSP is higher in butter clams than in other Alaskan bivalve species. People may choose to harvest bivalves other than butter clams to reduce the potential of PSP illness.

VIII. Conclusions

The validity of the analyses and conclusions drawn for this health consultation are determined by the availability and reliability of the referenced information. The sampling protocol and sample chain of custody records were not adequately described for Alaska Department of Health and Social Services (ADHSS) to be able to evaluate the sample collection methodology.

Additionally, the laboratory has certified only the chromium results by using a tissue-specific Standard Reference Material to check for accuracy and precision of measurements.

- Eating the metals detected (chromium, cobalt, copper, lead, nickel, tin, and zinc) in KBCHA mussels and clams are not expected to harm people's health. This conclusion is based on raw foods and does not consider contaminant increases or decreases due to cooking. All contaminants are common in foods and were usually in the range of those reported for other commonly eaten foods.
- It is unknown if shellfish harvested between May 2006 and September 2007 had elevated levels of contaminants attributable to the paint sandblasted from the hull of a landing craft.
  - Shellfish will expel contaminants from their tissues when contaminants are no longer present in waters.
  - Contaminants would be swept into the head of KBCHA by deep water currents but glacier melt above and below Bear Cove would push contaminants out of the Bay. Whether the location of the sandblasting event is close enough to glacial runoff to affect the contaminant levels on the tidal flats is unknown.

IX. Recommendations

- Although contaminant levels in bivalves were below levels of health concern, people who wish to lower the amount of contact with contaminants may choose to restrict the number of mussel meals eaten per month from site 1. Site 1 mussels had higher maximum levels of lead and tin than did bivalves from the other sites. Site 1 also had relatively higher levels of chromium, copper, and zinc as compared to the other sites.
- As a part of a balanced diet, continue to eat mussels and clams but only from Alaska **classified safe** beaches.

X. Public Health Action Plan

Previous actions:

- The Alaska Department of Fish and Game (ADFG) did not issue a health warning or advisory for bivalve consumption to the public after the sandblasting event that occurred in KBCHA during May of 2006.

Actions planned:

- This health consultation will be shared with ADFG. ADFG is planning to communicate the results to the local communities in KBCHA.
- After the report is distributed, within one month the ADHSS will conduct an informal needs assessment with the communities to ensure that the results of the report have been disseminated broadly, and to identify any potential health education needs or ongoing concerns.
- Based on the needs assessment findings, educational materials (e.g. fact sheets) and other information will be developed and distributed in a timely manner.
- No other public health actions are planned at this time.

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Certification

This Health Consultation (Contaminants in KBCHA Bivalves and Ship Sandblasting on Chugachik Island, Alaska) was prepared by the Alaska Department of Health and Social Services under a cooperative agreement with the federal Agency for Toxic Substances and Disease Registry (ATSDR). It was completed in accordance with approved methodology and procedures existing at the time the health consultation were initiated. Editorial review was completed by the Cooperative Agreement partner.

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The Division of Health Assessment and Consultation, ATSDR, has reviewed this public health consultation and concurs with the findings.

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Table 1. Maximum concentrations (ppm) of elements in KBCHA Bivalves (Littleneck and butter clams or mussels)

Element	Maximum Concentration (ppm)					
	Near Sandblasting Site				Control	
	Site 1	Site 2			Site 3	Site 4
	Mussels	Mussels	Littlenecks	Butters	Mussels	Littlenecks
Chromium (Cr)	1.63	**1.64**	1.03	1.60	0.58	**0.39**
Cobalt (Co)*	0.87	1.49	**1.71**	0.76	**0.27**	0.70
Copper (Cu)	3.23	2.79	1.56	**3.38**	1.12	**0.98**
Lead (Pb)*	**0.19**	0.16	0.06	0.09	0.09	**0.04**
Nickel (Ni)*	0.88	1.00	0.88	**1.26**	**0.38**	0.90
Tin (Sn)	**0.18**	<DL	**0.04**	0.05	<DL	<DL
Zinc (Zn)	13.50	**10.73**	11.04	12.23	11.06	**15.35**

<DL = Less than Detection Limit; DL for tin = 0.035 mg/kg; * Probable or possible human carcinogen from oral contact (EPA, IARC); **Bold indicates concentration used in calculating doses.**

Table 2. Dose (µg/kg-day) and Comparison Values (CVs) from eating KBCHA clams and mussels

Analyte	**Individual**	**Dose (µg/kg-day) Low**	**Dose (µg/kg-day) High**	**Comparison Value (CV)**	**Type of CV**
Chromium (Cr)	Adult	0.23	0.96	3 µg/kg-day	Reference Dose (RfD) for hexavalent chromium[3]
	Child (1-6 yrs)	0.15	0.63		
	Child (7-19 yrs)	0.30	1.26		
Cobalt* (Co)	Adult	0.88	5.56	10 µg/kg-day	Intermediate oral contact Minimal Risk Level (MRL)[6]
	Child (1-6 yrs)	0.57	3.65		
	Child (7-19 yrs)	1.15	7.29		
Copper (Cu)	Adult	3.18	10.96	20 µg/kg-day	Acute and intermediate oral contact MRL[4]
	Child (1-6 yrs)	2.09	7.19	1,000-8,000 µg/day	Dietary Reference Intake, Upper Limit (DRI-UL), 1-18 yrs old[12]
	Child (7-19 yrs)	4.17	14.39	10,000 µg/day	DRI-UL, 19-70 yrs old[12]
Lead* (Pb)	Adult	**0.08†**	**0.39†**	**0.5**-250 µg/day	**California Office of Environmental Health Hazard Assessment**[13]**, World Health Organization**[14], American National Standards Institute[15]
	Child (1-6 yrs)	0.05	**0.40†**		
				≥10 µg/dL blood	Centers for Disease Control and Prevention (CDC), level of concern, 1-6 yrs[16]
				≥25 µg/dL blood	CDC level of concern, 16+ yrs[16]
	Child (7-19 yrs)	**0.11†**	**0.51†**	21 µg/dL blood	Increased cancer risk for Finnish workers[8]
Nickel* (Ni)	Adult	1.23	4.09	20 µg/kg-day	RfD for nickel salts[7]
	Child (1-6 yrs)	0.81	2.68	200-600 µg/day	DRI-UL 1-13 yrs old[12]
				1,000 µg/day	DRI-UL, 14+ yrs old[12]
	Child (7-19 yrs)	1.62	5.36	600 µg/kg-day	No cancer in rats[7]
Tin (Sn)	**Adult**	0.14	**0.58**	**0.3 µg/kg-day**	**Intermediate oral contact MRL and RfD for tributyltin**[9]
	Child (1-6 yrs)	0.09	**0.38**	250 µg/kg-day	Lowest Observable Adverse Effect Level –rats, immune suppression[9]
	Child (7-19 yrs)	0.19	**0.77**		
Zinc (Zn)	Adult	34.79	49.78	300 µg/kg-day	Intermediate and chronic oral contact MRL[5]
	Child (1-6 yrs)	22.83	32.67	7,000-34,000 µg/day	DRI-UL, 1-18 yrs old[12]
	Child (7-19 yrs)	45.66	65.33	40,000 µg/day	DRI-UL, 19+ yrs old[12]

D, dose = (C*IR*AF*EF*CF)/(BW); C, Concentration (lowest maximum and highest maximum) from Table 1; IR; IR, Intake Rate adults = 227,000 mg/d, children = 34,050 mg/d (1-6 yrs) or 204,300 mg/d (7-19 yrs); AF, Absorption Factor =1 except for Cr (0.18), Pb (0.63) ; EF, Contact (exposure) Factor = 1; CF, Conversion Factor = 0.001 kgµg/mg^2; BW, Body Weight adults = 70 kg, child (1-6 yrs old) =16 kg, child (7-19 yrs old) = 48 kg; Superscript numbers are reference numbers; * Probable or possible human carcinogens from eating (EPA, IARC, NTP); † see Appendix A for calculations from dose**; Bold indicates a contaminant that exceeds a health CV.**

APPENDIX A

Calculating a Dose (micrograms per kilogram per day, µg/kg-day):
The Concentration (in mg/kg = ppm) of the analyte (chemical) is multiplied by Intake Rate (milligrams eaten), bioavailability factor (amount absorbed), Exposure Factor (amount of contact), and a Conversion Factor (in this case 0.001 kg·µg/mg^2). This number is then divided by an estimated Body Weight. The equation looks like this:

$$\text{D, Dose} = \frac{\text{(Concentration)(milligrams eaten) (amount absorbed)(Exposure Factor)(Conversion Factor)}}{\text{Body Weight in kg}}$$

A range of doses are possible because different values can be used in the equation. For example, the concentration of the contaminant is not always the same in each sample nor is the amount of food eaten. The amount that a person eats or weighs will also be different. A child between the ages of 1 and 6 years may have an estimated weight of 16 kg while an adult may be estimated to weigh 70 kg. The different values used in the equation will result in several doses by concentration and age.

Calculating a Rate (micrograms per day, µg/day):
Doses can be changed to daily rates by multiplying the Dose by Body Weight. This process will effectively remove the weight value in the result. For example, the chromium concentration observed in children between the ages of 7-19 years old is 1.26 µg/kg-day and the assumed weight of these children is 48 kg. 1.26 µg/kg-day multiplied by 48 kg = 60.5 µg/day.

R, Rate = (dose in µg/kg-day)(body weight in kg) = µg/day

Calculating a Blood Lead Level from Environmental Data:
The concentration of lead for the different media is multiplied by media-specific slope factor (m) and the relative time spent (T). Using the equation:

$$\text{PbB, blood lead level} = (m_s{*}T{*}Pb_{s)}) + (m_d{*}T{*}Pb_d) + (m_w{*}T{*}Pb_w) + (m_{ao}{*}T{*}Pb_{ao}) + (m_{ai}{*}T{*}Pb_{ai}) + (m_f{*}T{*}Pb_f)$$

m = respective slope factor for specific media	T = relative time spent
Pb_s = soil lead concentration	Pb_d = dust lead concentration
Pb_w = water lead concentration	Pb_{ao} = outside air lead concentration
Pb_{ai} = inside air lead concentration	Pb_f = food lead concentration

By eating KBCHA bivalves a person might obtain 0.006 (adult) or 0.05 µg/dL (child) of blood lead (Table A1, bold). Using ATSDR default values (8) for missing media (air, water, soil, dust) and the site-specific food lead concentration results the estimated blood lead levels for adults and children were below 3 µg/dL from all environmental sources. These levels are below the levels of concern for children (≥10 µg/dL) and adults (≥25 µg/dL) established by the CDC.

APPENDIX A (Cont'd)

Table A1. Contribution to blood lead (PbB)

Adult					Child 1-18 yrs				
Media	**Concentration, Pb (mg/kg)**	**Relative Time Spent (T)**	**Slope Factor (m)**	**PbB (µg/dL)**	**Media**	**Concentration, Pb (mg/kg)**	**Relative Time Spent (T)**	**Slope Factor (m)**	**PbB (µg/dL)**
Outdoor Air	0.2	1	1.92	0.38	Outdoor Air	0.2	1	1.92	0.38
Indoor Air	0.06	1	1.92	0.12	Indoor Air	0.06	1	1.92	0.12
Food	**0.19**	**1**	**0.034**	**0.01**	**Food**	**0.19**	**1**	**0.24**	**0.05**
Water	4	1	0.06	0.24	Water	4	1	0.26	1.04
Soil	70	1	0.003	0.21	Soil	70	1	0.0068	0.48
Dust	70	1	0.0096	0.67	Dust	70	1	0.00718	0.50
Total Predicted PbB (µg/dL)				1.63	Total Predicted PbB (µg/dL)				2.56

PbB = (m*T*Pb); Total predicted PbB = sum of all PbB

Glossary

Acute Contact	Contact with a substance that occurs once or for only a short time (up to 14 days).
Alaska Department of Environmental Conservation (ADEC)	Alaska state government agency tasked with conserving, improving, and protecting Alaska's natural resources and the environment.
Alaska Department of Fish and Game (ADFG)	Alaska state government agency with the mission to protect, maintain, and improve the fish, game, and aquatic plant resources of the state, and manage their use and development in the best interest of the economy and the well-being of the people of the state, consistent with the sustained yield principle.
Alaska Department of Health and Social Services (ADHSS)	Alaska state government agency with the mission to promote and protect the health and well-being of all Alaskans.
Agency for Toxic Substances and Disease Registry (ATSDR)	The principal federal public health agency involved with hazardous waste issues, responsible for preventing or reducing the harmful effects of contact to hazardous substances on human health and quality of life. ATSDR is part of the U.S. Department of Health and Human Services.
Bivalve	Having a shell consisting of two hinged sides, usually refers to shellfish in the mollusk family. E.g. oysters, clams, etc
Carcinogen	Any substance that causes cancer.
Chronic Contact	Contact with a substance that occurs over a long time (more than 1 year).
Coliform	A type of bacteria that is commonly used to in tests to indicate whether food or water is free of bacterial materials that may cause illness.
Comparison Value (CV)	Concentration of a substance in air, water, food, or soil that is unlikely to cause harmful (adverse) health effects in exposed people. These may also be doses (an amount per unit time) that are unlikely to cause harmful health effects.
Composite	Combining samples into one sample.
Contact	Contact with a substance by swallowing, breathing, or touching the skin or eyes. Contact with a substance may be acute (14 days or less), intermediate (15-364 days) or chronic (365 days or more).
Contaminant	A substance that is either present in an environment where it does not belong or is present at levels that might cause harmful health effects.
Dietary Reference Intake (DRI) Upper Limit (UL)	The highest daily intake of a nutrient that is likely to pose no risks of harmful health effects for almost all individuals as established by the Institute of Medicine.

Dose (for chemicals that are not radioactive)	The amount of a substance to which a person has contact with over some time period. Dose is a measurement of contact but it is not necessarily the amount that is absorbed.
Environmental Protection Agency (EPA)	United States Environmental Protection Agency. The mission of the Environmental Protection Agency is to protect human health and the environment.
Exposure (Contact) Duration (ED)	The amount of time, in years, that a person contacts a contaminant.
Ingestion (Eating) Rate (IR)	The amount of an environmental medium that could be eaten typically on a daily basis.
Intermediate Contact	Contact with a substance that occurs for more than 14 days and less than a year.
Lowest Observed Adverse Effect Level (LOAEL)	The lowest tested dose of a substance that has been reported to cause harmful health effects in people or animals.
Minimal Risk Level (MRL)	An ATSDR estimate of daily human contact to a hazardous substance at or below which that substance is unlikely to pose a measurable risk of harmful, non-cancerous effects. MRLs are calculated for a route of contact (inhalation or oral) over a specified time period (acute, intermediate, or chronic).
No Apparent Public Health Hazard	A category used in ATSDR's public health assessments for sites where human contact to contaminated media might be occurring, might have occurred in the past, or might occur in the future, but where the contact is not expected to cause any harmful health effects.
No Observed Adverse Effect Level (NOAEL)	The highest dose of a substance that has been reported to have no harmful health effects on people or animals for the organ system studied.
Reference Dose (RfD)	An amount of chemical that can be eaten daily over the course of a lifetime and not cause serious harmful health effects. RfDs are calculated and published by EPA.