Atka Traditional Foods Program Report on Steller Sea Lion • Qawaḵ • (*Eumetopias jubatus*)

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APIA’s Aleut Traditional Foods Program Mission Statement

*Protecting and encouraging the use of traditional foods and better understanding about environmental pressures on subsistence species and human health.*

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On the island of Atka, located in the central part of Alaska’s Aleutian chain, residents rely heavily on traditional foods including reindeer, sea mammals, birds, fish, and shellfish. Since military activities began on the island in the 1940’s, concern has grown among the Aleut population that contaminants, concentrating in the traditional foods, may be affecting public health.

The *Atka Traditional Foods Program Report on Steller Sea Lion* is a summary of the research project and results of testing Steller Sea Lion in Atka for nutrients and contaminants. This project developed a process that communities can use to evaluate diet at the local level. The process included community participation in strategic planning, a diet survey, human biomonitoring, sampling and analysis, and community education. The purpose of this report is to describe this process and present the preliminary nutrient and contaminant findings from eleven sea lion samples (from three different sea lions) donated by the community. The report also describes how analytical data can be used to assess the potential benefits and risks of consuming sea lion.

In response to local concern about contaminants in traditional foods in Atka, a dietary survey was completed in 1998-1999. Atka residents also took part in human biomonitoring to assess contaminant exposure in people. Of the five villages in the Aleutian and Pribilof region participating in biomonitoring in 1999, Atka residents had the highest blood concentrations of persistent organic pollutants. The Alaska Division of Public Health determined that the levels were not high enough to be of health or medical concern in any individual. Human biomonitoring is important to understanding the type and amount of contaminants people in Atka are actually exposed to. Continued human biomonitoring for contaminants in Atka is important for understanding contaminant trends and whether contaminants become a human health concern in the future. Testing local foods for contaminants helps identify potential pathways for contaminants entering the human body.

The *Atka Traditional Foods Program Report on Steller Sea Lion* describes some of the known benefits and potential risks of consuming sea lion.
Sea lion samples, including meat, meat with fat, fat, salted fat, heart, kidney and liver were analyzed for nutrients and contaminants. Results are qualified based on the limited numbers of samples collected and analyzed. Contaminants were detected in varying amounts in all samples analyzed. These preliminary results show that not only is sea lion an excellent source of many nutrients, it may also be a source of human exposure to various contaminants. These results concur with existing nutrient and contaminant data from other marine mammals referenced within this report. This study has made an important step in establishing that sea lion is one of the potential pathways for human exposure to contaminants.

Due to the limited number of sea lion samples, conclusions about the level of contaminants Atka residents are exposed to are not definitive. What can be concluded is that sea lion is a potential source of various contaminants detected in the human biomonitoring results. Further sampling of sea lion and other marine animals would provide more definitive data on contaminant levels, routes and exposure. Further human biomonitoring would help determine the actual risk of contaminants on human health. This model provides a process a community could use to pursue further research.

The social, cultural, economic, spiritual, nutritional and physical health attributes of harvesting and consuming sea lion are important factors to consider when weighing benefits and risks. Alaska State health officials recognize the many healthy aspects of sea lion consumption, and encourage continued sea lion consumption as part of a varied traditional diet. The lessons learned from this research project will be developed into curriculum and workshops to share statewide with other Tribes interested in addressing local concerns about dietary benefits and risks.

**PURPOSE**

The *Atka Traditional Foods Program Report on Steller Sea Lion* is a summary of the research project and results of testing Steller Sea Lion in Atka for nutrients and contaminants. The purpose of the report is to present the data collected through this research as well as to describe the process used to conduct the research. *The data presented in this report is based on a limited number of sea lion samples. Therefore, the reader should be mindful that it is not possible to make definitive recommendations or advice based on the limited sample size.* More importantly, the report describes the research process used to evaluate diet locally.
The Atka IRA Council partnered with the Aleutian Pribilof Islands Association (APIA) on a four-year research project entitled Dietary Benefits and Risks in Alaskan Villages. Funded by the National Institute of Environmental Health Studies (NIEHS), the project evaluated traditional food concerns in the Unangan villages of St. Paul Island and Atka, Alaska. Motivated by the question: “Is our traditional food safe to eat?” the Atka IRA, in partnership with APIA, developed a process to evaluate the benefits and risks of consuming sea lion in Atka. The ultimate goal of this project is to help people make healthy dietary choices.

Community participation was essential to the success of the project. The Atka Village Advisory Group (VAG) was formed to help lead the research. The VAG decided to look at the benefits and risks of consuming Steller Sea Lion. Sea lion is an important nutritional component of the Atka diet. Steller Sea Lions have haul-outs and rookeries near Atka Village and feed on Pacific Herring, sandlance, Atka Mackerel, pollock, salmon, cod, and rockfish in the Bering Sea. Although the migration route of the sea lions that live near Atka is uncertain, sea lions generally range throughout the Pacific Rim (from southern California to Northern Honshu in Japan, and to the Bering Strait). Because of its local importance, Atka residents wanted to learn more about the nutritional content of sea lion and to determine whether sea lion is a pathway for contaminants entering humans. Both of these goals were accomplished through this study.

There are many benefits to consuming traditional foods. The preliminary results from eleven samples show that sea lion is potentially a healthy and nutritious part of a varied diet in Atka. Results also show that sea lion is one pathway for human exposure to contaminants. Nutrient and contaminant data from testing the sea lion is presented in this report to give some context to potential benefits and risks of consuming sea lion. However, these preliminary results are based on a limited sample size and cannot be used to provide and definitive guidelines for consumption. Further sampling and analysis of sea lion, utilizing the process described in this report, would provide a better understanding of potential benefits and risks. This report begins to address some of the benefits and risks of consuming sea lion. It provides an excellent foundation and model for conducting further research of this nature on sea lion.
Concern about traditional foods in Atka is a result of a growing awareness of local, regional and global sources of contaminants. Formerly used defense sites in Atka have caused local concern. Six potential contaminant source areas were identified during a site investigation in Atka in 2001. Potential contaminants of concern at these sites include gasoline and diesel components, lead, Polychlorinated biphenyls (PCBs), and asbestos. Atka’s proximity to Amchitka Island, the site of three nuclear tests between 1965 and 1971, continues to raise concern locally and regionally. Residents are concerned about potential long-term radionuclide contamination of their local foods as a result of that testing. In addition, some contaminants in Atka arrive from other parts of the world through the air and water.

The presence of environmental contaminants has led people to question if there is a link between contaminants and cancer or other diseases. There is also concern that contaminants may be the cause of reported abnormalities of various traditionally harvested foods. For example, some residents in Atka have noted abnormalities in salmon caught in Korovin Lake where an old navy hospital was buried on the southern shore. Asbestos was buried at this site as well. Some salmon caught have been described: “the meat is mushy and soft, it changes color like yellow, and they stink, even right after you catch them out of there…” All of these concerns have made people in Atka ask, “Is our traditional food safe to eat?”

**Human Biomonitoring**

In the past, Atka residents have participated in contaminant biomonitoring. Biomonitoring is the measurement of toxic substances in the human body. Body fluids such as blood, urine and saliva are analyzed in a laboratory for contaminants. Sometimes samples of hair, nails, feces and other items are used as well. Human biomonitoring can tell us if we have been exposed to a contaminant, how much of that contaminant is in our body, and whether the amount of that contaminant in our body is enough to cause adverse health effects.

The findings from testing conducted in 1999 by the Alaska Division of Public Health (ADPH), showed the presence of several persistent organic contaminants in blood. Of the five villages in the Aleutian and Pribilof region, Atka residents had the highest blood concentrations of PCBs. However, the levels were not high enough to be of health or medical concern in any individual. As a result, the State of Alaska continues to recommend unrestricted consumption of traditional foods in the region.

As a result of the ADPH report, the Atka IRA enrolled in the Maternal and Infant Monitoring Program. This voluntary program, which is coordinated by the Alaska Native Tribal Health Consortium (ANTHC), tests pregnant women and newborns for contaminants and nutrients. This program tracks contaminant and dietary trends.

Atka residents also participated in a state-funded study to look at mercury in hair. The Maternal Hair Mercury Biomonitoring Program began in June 2002. As of December 2003, a total of 27 samples were received from Atka residents. Hair test results from Atka residents indicate that mercury exposures are below any level where adverse health effects are expected.

The southern shore of Korovin Lake is the disposal site of an old Navy Hospital and asbestos.
Where do these contaminants originate?
Ingestion of food and water is one way contaminants enter the body. Contaminants also enter the body through inhalation and absorption through the skin. Inhaling cigarette smoke or handling hazardous chemicals without gloves directly brings contaminants into our bodies.

This research project focused on potential dietary sources of contaminants. Although there are local sources of contaminants in Alaska, most of the contaminants detected in traditional foods arrive from other parts of the country and world through the air and water. Contaminant information is available for many store foods. However, there is limited contaminant data on traditional foods harvested in Atka. This study considered sea lion as one potential source of contaminants in the Atka diet. Testing local foods for contaminants helps us understand more about one pathway these contaminants may enter our bodies.

The nutritional benefits of a traditional diet are well documented. Store foods in Atka are limited mostly to dry, canned or frozen foods. The local foods available are expensive, not always nutritious, and some have outlived their shelf life. Store foods contain contaminants as well as additives such as artificial sweeteners, coloring, and hormones. The risks posed by exposure to contaminants from food apply both to traditional foods and foods from the store.
How do contaminants arrive in Alaska?
Although many people think of Alaska as relatively untouched by humans, contaminants are being found in the air, water, fish, plants, wildlife and people. Most of these contaminants arrive in Alaska from elsewhere, however, some are released locally.

The Arctic is a potential sink for contaminants which circulate around the globe and northward in air and ocean currents. Most of these contaminants come to the Arctic from the northern hemisphere. For example, contaminants such as pesticides that are used far to the south or equatorial latitudes make their way into Alaska’s waters. They settle out in Arctic waters, sea ice and land, where they remain for long periods and break down very slowly due to the colder climate.

Most contaminants come to Alaska through air and ocean currents from elsewhere, however, some are released locally.
**How do contaminants get into sea lion?**
Some contaminants come to Alaska in air and ocean currents. Once certain contaminants are in ocean water, they are taken up by microscopic plankton. Then, through a process called **biomagnification**, the contaminant levels increase at each level of the marine food chain.

Biomagnification is a process whereby an animal eats another animal, consuming the contaminants stored in that animal. Contaminant values increase with each step in the food chain because the animals higher up the food chain eat many of the animals below them and the contaminants inside them. Although some contaminants may enter sea lion through the water, the primary pathway for these contaminants is through the food the sea lions eat. The concentration of contaminants in water tends to be much lower than in the food chain.  

**FIGURE 2** Biomagnification of Contaminants  
Adapted from the Inuit Tapiriit Kanatami website www.itk.ca/environment/contaminants-wildlife-humans.php

(REFER TO FIGURE 2)  
Contaminants in the water are taken up by the plankton.  
Krill eat many plankton and the contaminants that come with them.  
Fish then eat many krill and the contaminants become more concentrated.  
The sea lion eat many smaller fish, and then we consume the sea lion.
Why are contaminant levels different in each individual animal?

There are several important biological factors that cause each individual sea lion to have a different contaminant concentration. These factors include the age, diet, and sex of the animal.

Age plays a role in contaminant levels because some contaminants are not metabolized by animals very easily. These chemicals build up in the animal's body as it ages. This process is called bioaccumulation (see figure 3). For chemicals that bioaccumulate, contaminant levels are usually higher in older animals than in younger animals. So the younger the animal, generally the lower the amount of some contaminants it will have. However, mammal offspring receive some contaminants from the mother while in the womb and then again through lactation. So, offspring are not contaminant free.

There is also a difference in the levels of contaminants in male and female sea lions. Female sea lions may have less of a contaminant burden because they pass some contaminants to their newborns when they give birth and during lactation.

Different contaminants also tend to concentrate in different parts of the sea lion. For example, metals tend to concentrate in organ tissues and meat. Organics such as pesticides, PCBs, Dioxins, and PBDEs concentrate in fatty tissues, such as blubber.

The contaminant results presented in this report are based on a limited number of sea lion samples. A much larger sample size would need to be collected and analyzed to address differences in age, sex, season harvested and location. All of these factors play a role in the concentration of contaminants found in sea lions.

How does cooking affect contaminants?

All of the sea lion samples collected in this study were analyzed raw. However, when we prepare foods, the contaminant concentrations can be affected. For example, baking sea lion would reduce the concentration of Polychlorinated biphenyls (PCBs) (See page 33) in the meat if the fat was baked off.

There have not been enough scientific studies on the effect of food preparation on contaminant levels in traditional foods. This would be a valuable topic for future work.
Are there contaminants in store foods?

YES! All foods have different amounts of contaminants inside them. Although this report mostly focuses on contaminants in sea lion, it would be incomplete without mentioning that common foods purchased from the store also have contaminants, albeit usually in very small levels. Studies in Northern Alaska have shown that some store-bought foods eaten as substitutes for traditional foods have higher levels of certain contaminants. In addition, foods from the store often have other chemicals added such as coloring, preservatives, hormones and artificial sweeteners.

The US Food and Drug Administration has tested selected foods for nutrients and contaminants as part of the Total Diet Study, sometimes referred to as the Market Basket Survey. The foods selected are believed to represent major components of the diet of the US population. In this study, about 280 store foods have been tested for radionuclides, pesticides, industrial chemicals, and toxic and nutritional elements. Samples have generally been collected from all over the country four times each year since 1982.

Although there is not complete contaminant data for all of the food we purchase from the store, the information from the Total Diet Study does demonstrate that many foods have low levels of contaminants. However, these contaminants are generally in small enough concentrations to not cause adverse health effects and are considered safe for consumption. Because the levels of contaminants are so low, it is more important to make healthy dietary choices based on nutritional information. Comparing nutrient labels on different foods and choosing the healthier option is a great way to help make positive dietary choices.

If you are interested in learning more about the Total Diet Study, go to the website: www.cfsan.fda.gov/~comm/tds-hist.html

Are there contaminants in the foods we buy from the store? YES!
Community Involvement

Essential to the success of this project was the involvement of Atka community members. A Village Advisory Group (VAG) helped guide and direct the research goals and objectives of this study. The Atka VAG was formed in 2001. Participants in this group included representative hunters, food preparers, a clinician, youth, elders, and the Environmental Protection Agency Environmental Coordinator in Atka. This group was facilitated by a local coordinator. The coordinator’s role was to facilitate VAG meetings and to transfer information between the VAG and a technical team.

The technical team consisted of Tribal representatives from Atka and St. Paul, coordinators from both communities, APIA staff, researchers from other Tribal institutions, the University of Alaska-Anchorage, the State of Alaska, and federal agencies. The exchange between these two advisory groups was important. The technical team was instrumental in providing technical information. The technical team provided technical guidance throughout the project by identifying research goals and objectives, reviewing and commenting on the community sampling plan, reviewing and interpreting data, and addressing specific research questions and concerns posed by the VAG.

The Traditional Foods Project in Atka involved many community members, although members of the VAG had the most involvement. Work completed by the VAG included identifying relevant community outreach activities, reviewing dietary survey information, developing a sampling plan for sea lion, deciding on a traditional food to sample locally, and reviewing report drafts. A variety of outreach efforts helped raise community awareness, including an Aleut/English poster on nutrients in traditional foods, a sampling survey, a film series on diet, articles in Atka’s environmental newsletter, and several school and community presentations.

An informal survey was performed in 2002 to find out which traditional foods Atka residents
wanted to know more about. The results from the 21-person survey showed that people wanted to know the nutrient content in reindeer meat and liver, sea lion meat, harbor seal meat and octopus. People were interested in what contaminants were in chitons (bidarki and gumboots), halibut, reindeer meat, Pacific Cod, salmon, birds, and kidney, liver, and meat from sea lion and harbor seal.

The VAG chose to sample sea lion for this project. Sea lion samples were collected during one visit in March 2005. A community presentation and potluck of the project results was held in May 2006. Approximately 45 residents attended this event to hear the results of the sea lion testing done in Atka.

Alaska Native Diet Film Series

Three films were produced for this project as part of the Alaska Native Diet Series:

1) Introduction to Dietary Benefits and Risks in Alaskan Villages
2) The Importance of Traditional Foods
3) Monitoring for Contaminants in Rural Alaska.

Atka residents participated in making the first two films. The production process and viewing of these films in the community helped raise awareness of this project and dietary issues in Atka.15
Atka Dietary Survey

In 1998 and 1999, APIA conducted dietary surveys with 34 residents in Atka, approximately \( \frac{1}{3} \) of the population. The purpose of this survey was to measure food intake and nutrition in Atka and to engage public discussions about subsistence preference, dietary changes, health changes, and community priorities and concerns over diet. Further, the goals were to define the quantity of foods consumed, preparation methods of selected foods, the nutritional value of the total diet, and the nutritional contributions of traditional foods to the total diet.

The dietary survey was conducted with a total of three interviews during September 1998, January 1999 and April 1999. The survey consisted of a 24-hour recall and a semi-quantitative food frequency questionnaire. The food frequency questionnaire was performed once for each individual to assess the daily, weekly, monthly and yearly consumption of select traditional and store-bought food items for a one-year time period. For the 24-hour recall survey, participants reported in detail all of the food, beverages and nutritional supplements they consumed in the past 24 hours. The 24 hour recalls were evaluated to assess the nutritional quality of each individual’s total intake. A total of forty-five dietary intake records were collected. The Atka dancers were out of town during the data collection periods and therefore the survey did not include Atka residents ages 14-18.

The results of the survey are compiled in the report “What People Eat: Atka, Alaska, 1998-1999” prepared by IDM Consulting. The survey results were used to help the advisory group prioritize and select the traditional food for nutritional and contaminant analysis. Individual results were returned to those who took the survey. All individual survey results remain confidential. Please refer to the report for a comprehensive listing of methods.
**What were the results of the dietary survey?**

The dietary survey is a tool used to assess the general nutritional distribution of intake of an individual or population. This distribution can then be used to estimate the prevalence of inadequate intakes. Rather than stating that someone is deficient in a nutrient, it estimates that they may be at risk of developing a deficiency. The semiquantitative food frequency questionnaire gives a look at total intake of traditional foods over time, whereas the 24-hour recall, used to quantify actual consumption, is only one day in the life of the respondent. The dietary survey in Atka was also used to help define the types and quantities of traditional foods consumed in Atka. In combination with the contaminant results, the survey results were used to determine to what extent this consumption may contribute to contaminant exposures in residents.

In general, the nutritional quality of the diet was good in Atka. Traditional foods made a significant contribution to nutrient intake. Foods provided adequate amounts of protein, vitamin A, vitamin E, vitamin C, most of the B vitamins, phosphorus, selenium and iron. Foods eaten provided generous amounts of nutrients with the exception of fiber, folate, and calcium. However, total fat, saturated fat, monounsaturated fat, and cholesterol levels were higher than recommended. The results are consistent with dietary trends among other Native American populations and among the US population as a whole.

Traditional foods such as fish, terrestrial and marine mammals, and wild plants continue to be an essential part of the diet for many Atka residents. Based on the Food Frequency data, approximately 66% of the total meats consumed in Atka came from traditional protein sources. These meats, including reindeer, sea lion and fish, are high in protein, iron, selenium and vitamin B12 and low in saturated fats. Reindeer and seal are high in protein and relatively low in fat when compared to beef. Seafood is high in omega-3 fatty acids. According to the diet survey results, Atka residents have a varied diet, which is more likely to contribute sufficient amounts of essential nutrients. A varied diet will also reduce the exposure to contaminants that may concentrate in specific foods.

<table>
<thead>
<tr>
<th>Most frequently eaten local foods in Atka:</th>
<th>Most frequently eaten store-bought foods in Atka:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reindeer</td>
<td>Beef</td>
</tr>
<tr>
<td>Sea Lion</td>
<td>Chicken egg</td>
</tr>
<tr>
<td>Salmon</td>
<td>Chicken</td>
</tr>
<tr>
<td>Halibut</td>
<td>Spam</td>
</tr>
<tr>
<td>Seal</td>
<td>Hot dog</td>
</tr>
<tr>
<td>Bidarks</td>
<td>Hot pocket</td>
</tr>
<tr>
<td>Cod</td>
<td></td>
</tr>
<tr>
<td>Octopus</td>
<td></td>
</tr>
<tr>
<td>Birds</td>
<td></td>
</tr>
<tr>
<td>Wild rice</td>
<td></td>
</tr>
</tbody>
</table>

**Fat**

Results from the Atka dietary survey show that the average percent of energy from fat was 31% for men and 36% for women, with 10% and 12% of energy coming from saturated fat sources, respectively. The current American dietary fat recommendations from the American heart Association emphasize reducing total fat intake to less than 30% of dietary energy, and keeping saturated fat to less than 10% of total energy. Thirty percent (30%) or less of fat is generally thought to reduce the incidence of fat-related cardiovascular disease. The main sources of saturated fats reported in the Atka dietary survey were chocolate cake and candy, corned beef, reindeer and butter. Reported fat consumption in this survey is similar to other Alaska Native groups. Fat sources from traditional foods commonly eaten in Atka, and other communities throughout Alaska, are high in omega-3 and omega-6 fatty acids which may have preventative effects against hypertension and cardiovascular disease.

Therefore, the beneficial effect of these fatty acids must be considered when evaluating the adequacy of total fat intake compared to recommendations for the general US population. In addition, fat
has been described as “the currency for survival in the Arctic.” Survival in polar climates depends on sustained energy levels and fat provides this necessary energy for humans and other animals.\(^\text{21}\)

**Cholesterol**

Among men and young children, mean cholesterol intake reported in the Atka dietary survey results exceeded recommendations. Because heart disease is associated with eating too much fat, saturated fat and cholesterol, individuals who exceed recommended intake levels may increase their risk of heart disease and other chronic diseases.\(^\text{22}\) The National Cholesterol Education Program of the National Heart, Lung, and Blood Institute suggests that if you are healthy, you should average no more than 300 milligrams of cholesterol per day.\(^\text{23}\) People who have high blood cholesterol or a heart problem may have to eat less. Cholesterol is found only in foods that come from animals. Foods very high in cholesterol include egg yolks and organ meats (liver, kidney, and brains are especially high in cholesterol).

**Carbohydrates**

The Dietary Guidelines for Healthy Americans (2000)\(^\text{24}\) recommends limiting intake of foods high in calories or low in nutrition, including foods like soft drinks and candy that are high in sugars. Carbohydrate intake should come mainly from complex carbohydrates (vegetables and whole grains), rather than the simple carbohydrates found in sugars. Complex carbohydrates add more fiber, vitamins and minerals to the diet than foods high in refined sugars. Foods high in complex carbohydrates are usually lower in calories, saturated fat and cholesterol. Many national surveys have shown that sweetened beverage intake has increased substantially in the past few decades.\(^\text{25}\) The role of sweet drinks is being examined as to their contributing role in the increasing rates of diabetes mellitus (Type II) among Alaska Natives.

**Fiber**

Average intake of fiber, useful in chronic disease prevention, was below recommended levels for men and women. In Atka, the greatest sources of fiber in the diet came from consuming the vegetables in reindeer stew, other vegetables and bread. Fiber is highest in fresh fruits and vegetables, both subsistence and store-bought, and whole grains and cereals. Fiber refers to carbohydrates that cannot be digested. It is present in all plants that are eaten for food, including fruits, vegetables, grains, and legumes. Current recommendations suggest that adults consume 20-35 grams of dietary fiber per day, yet the average American eats only 14-15 grams of dietary fiber a day. Fiber appears to reduce the risk of heart disease, diabetes, intestinal disease, and constipation. Recent research indicates that increasing the intake of whole-grain cereal fiber may reduce the potential risks for both type II diabetes and cardiovascular disease.\(^\text{26}\)

**Folate**

Mean intake of folate, important in protecting against heart disease and birth defects,\(^\text{27}\) was less than recommended for women. For most people in the U.S., the main sources of folate in the diet are fortified grain products such as bread and especially highly-fortified, ready-to-eat cereal. Other sources of folate include some kinds of berries, rose hips, leafy greens, liver and other organs, beans and orange juice. Fruits and vegetables, especially deep yellow and green leafy vegetables, are good sources of folate and vitamin A.
Many subsistence plant foods have not been analyzed for folate content, so folate consumption may have been underestimated in this survey.28

Calcium
Mean intake of calcium, important for bone health, was less than recommended for men, women and young children. The low calcium intake of many participants in this study may be due in part to low consumption of dairy products such as milk and cheese. However, calcium consumption may have been underestimated because of incomplete information on the calcium content of traditional foods. For example, calcium is found in canned fish with bones, fish head soup, bones with soft ends, shellfish, some leafy green vegetables and seaweed.29

Minerals
Mean intake of magnesium was below recommendations among men and women. Magnesium is found in nuts, beans, whole grains and green vegetables. Magnesium helps maintain normal muscle and nerve function, supports a healthy immune system, and keeps bones strong.

Mean intake of zinc, found in meat, liver, eggs, and seafood (especially oysters), was below recommendations for women. The reported deficiency in zinc is puzzling as several of the top foods consumed in Atka from the store, land and sea contain high levels of zinc. Zinc is an essential mineral that supports a healthy immune system. It is needed for bone growth and wound healing, and helps maintain our sense of taste and smell. Zinc also supports normal growth and development during pregnancy, childhood, and adolescence. One serving of a quarter pound of sea lion provides almost 30% of the total zinc needed in a day. Other traditional foods, such as reindeer meat, seal meat and liver, clams, mussels, and fish head liver, eggs, and skin, are also rich with zinc.30

Mean intake of selenium was well above recommendations for both men and women. Seafood is an excellent source of dietary selenium.31 Selenium is a trace mineral that is essential for normal functioning of the immune system and thyroid gland. Selenium is a powerful antioxidant and many studies have suggested that people with greater intake of selenium are less likely to develop some forms of cancer such as those of the lung, prostate, stomach and breast. In addition, higher selenium intake has been associated with lower risks for heart disease and decreased pain from rheumatoid arthritis. Many studies suggest that selenium may help reduce the toxic effects of methylmercury (the organic form of mercury), however, this is controversial and the mechanisms are not fully understood.32 It is possible to get too much selenium in our bodies, however, selenium toxicity is rare in the United States. There have only been a few reported cases of selenium toxicity in the U.S. and these were associated with industrial accidents and not food consumption. Since most of us get enough selenium through our food, selenium supplements are not recommended for healthy children and adults.33 The major food sources of selenium are seafood, eggs, meat, and organ meats. Sea lion meat and halibut are rich in selenium.34

Canned fish with bones is a good source of calcium.

Halibut is a good source of protein, omega-3 fatty acids and selenium.
Steller Sea Lion Consumption in Atka

The results of the Atka Dietary Survey showed that sea lion was the second most frequently eaten traditional food in Atka. Reindeer was the most frequently consumed traditional food.

Based on the average and maximum daily intake of sea lion meat in ounces, people in Atka are consuming an average of 3-9 ounces of sea lion meat weekly or a maximum of 19 to 26 ounces weekly (See Table 1). These consumption amounts are used in calculating safe amounts of chemicals that can be consumed by individuals.16

*The month of May was not represented in the sample timeframe. October, November and December were not sampled separately from summer.

TABLE 1  Consumption of Sea Lion in Atka by Season (ounces or pounds)

<table>
<thead>
<tr>
<th>SEASON</th>
<th>Number of people surveyed</th>
<th>Average daily intake</th>
<th>Maximum daily intake</th>
<th>Calculated average weekly intake</th>
<th>Calculated maximum weekly intake</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Summer</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June-September</td>
<td>10</td>
<td>0.55 ounces</td>
<td>2.76 ounces</td>
<td>3.85 ounces</td>
<td>19.32 ounces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.03 pounds</td>
<td>0.17 pounds</td>
<td>0.24 pounds</td>
<td>1.21 pounds</td>
</tr>
<tr>
<td><strong>Summer/fall</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>June-December</td>
<td>10</td>
<td>1.23 ounces</td>
<td>3.07 ounces</td>
<td>8.6 ounces</td>
<td>21.47 ounces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.08 pounds</td>
<td>0.19 pounds</td>
<td>0.54 pounds</td>
<td>1.34 pounds</td>
</tr>
<tr>
<td><strong>Winter</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>January-April</td>
<td>25</td>
<td>0.54 ounces</td>
<td>3.68 ounces</td>
<td>3.8 ounces</td>
<td>25.77 ounces</td>
</tr>
<tr>
<td></td>
<td></td>
<td>0.03 pounds</td>
<td>0.23 pounds</td>
<td>0.24 pounds</td>
<td>1.61 pounds</td>
</tr>
</tbody>
</table>

Harvesting marine mammals in Atka
SAMPLING AND ANALYSIS

How was sampling and analysis done?
The Atka Village Advisory Group (VAG) decided to sample Steller Sea Lion. This decision was based on the groups’ consideration of the following:

- Atka dietary survey results
- Traditional foods known to have contaminants of concern
- Traditional importance and use of sea lion
- Limitations of sampling due to budget restrictions

Raw samples of sea lion were analyzed for nutrients and contaminants. The group considered analyzing prepared samples, but given the limited budget for testing, decided it was important to get baseline information on nutrients and contaminants in raw sea lion first. Many past studies analyzing traditional foods for nutrients and contaminants have analyzed the food raw.

Sample Permitting
Steller Sea Lion in the Bering Sea are listed as ‘endangered’ by the National Marine Fisheries Service. The purpose of this designation is to protect the remaining population. The ‘endangered’ designation does not affect subsistence take at this time.

APIA was authorized to collect, transport and analyze Steller Sea Lion samples from Atka through a permit from the Alaska Sea Otter and Steller Sea Lion Commission (TASSC). As an endangered species, Steller Sea Lion biological sampling requires a permit from the National Oceanographic and Atmospheric Agency’s National Marine Fisheries Service (NMFS). With assistance from TASSC and approval from the National Marine Fisheries Service, APIA was added to TASSC’s permit for biological sampling.

The sampling and analysis of Steller Sea Lion was guided by the required Quality Assurance Project Plan (QAPP), a detailed sampling and analysis plan developed in this study. The plan was primarily developed by APIA, with assistance and review by technical advisors as well as TASSC before being submitted to the regulating agency for approval.

The approved QAPP guided APIA during the sampling process. The sea lion samples were originally gathered for subsistence consumption. One community member donated nine samples from one sea lion identified as a small female caught outside of Atka Village. The remaining two samples of meat with fat were donated by two different individuals. There is no information available for these two sea lion samples regarding sex, age or location caught. Despite the lack of background information, timing and community distribution patterns allowed APIA to determine that these two samples were not from the sea lion that the other nine samples came from nor were these two samples from the same sea lion (see Figure 4). It should be noted that only three sea lions were sampled for this study, thus providing a very limited data set. Therefore results discussed in this report should not be generalized for all sea lion.

There are many variables that can affect the amount of contaminants or nutrients tested in each sea lion. (See page 12 Why are contaminant levels different in each individual animal?)

It is important to note that the limited number of sea lion samples donated reflected the lack of sea lion available in Atka at the time. People were reluctant to donate samples because of this scarcity.

The QAPP and TASSC permit were sent along with the sea lion samples from Atka to EnviroTest Laboratories in Edmonton, Canada for nutrient and contaminant analysis. Also included were customs declarations and chain of custody forms.
Sample preparation
The Village Coordinator prepared the samples according to local practices described below. Note that the use of table salt, used in the sample preparations, would increase the levels of certain minerals, such as potassium and calcium, detected in the samples analyzed.

Liver: The edges were cut off and the liver was soaked in tap water and refrigerated over night. It was then rinsed, bagged and frozen.

Salted Fat: The salted fat was aged for one night, cut and stored in a container filled with rock salt. It was then stored in a cool place.

Meat and Meat with Fat: The meat and meat with fat samples were aged for two nights, bagged and then frozen. They were not rinsed as this is usually done before cooking after it has thawed.

Fat/Kidney: The kidney and fat were aged for two nights, bagged and then frozen.
Nutrient and Contaminant Analysis

Table 2 shows the general contaminant and nutrient analysis completed on the sea lion samples. See Appendix A for a list of the specific contaminants and Appendix B for the specific nutrients tested. The methods used by Enviro-Test Laboratories are included in Appendices A and B.

Nutrient Analysis

Over 70 common nutrients were analyzed. The nutrients examined were chosen because they are essential for optimal human health and many are believed to provide protective effects against disease (i.e. amino acids, fatty acids, and certain trace elements including selenium). Nutrient analysis was conducted on seven sea lion samples. An additional four samples were analyzed for minerals. Liver, salted fat, meat, fat, kidney, and meat with fat were tested for nutrients. However, liver and kidney samples were depleted before some important analyses were completed.

Contaminant analysis

The contaminants selected for analysis in this project included contaminants identified from human and animal biomonitoring in the Aleut region. The Alaska Native Tribal Health Consortium’s Maternal and Infant Monitoring Program’s list of contaminants found in human blood was used as a guide for selecting contaminants. Additional contaminants of concern, such as Poly Brominated Diphenyl Ethers (PBDEs) commonly used flame retardants, were included.

Chemical Groups Tested (See Appendix A for list of specific chemicals):

- Metals/Inorganics
- Organochlorine Pesticides
- Polychlorinated Biphenyls (PCBs)
- Polybrominated Diphenyl Ethers (PBDEs)
- Polychlorinated Dioxins/Furans
- Radionuclides
- Polycyclic Aromatic Hydrocarbons (PAHs)

TABLE 2: Contaminants and Nutrients Analyzed in Each Sample

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Sample#</th>
<th>PCBs</th>
<th>PBDEs</th>
<th>D/Fs</th>
<th>PAHs</th>
<th>Metals</th>
<th>Arsenic &amp; Mercury</th>
<th>OC Pest</th>
<th>Rads</th>
<th>Nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>001</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Heart</td>
<td>002</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Salted Fat</td>
<td>003</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meat</td>
<td>006</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Fat</td>
<td>007</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meat</td>
<td>010</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat w. Fat</td>
<td>011</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat w. Fat</td>
<td>012</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kidney</td>
<td>013</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meat w. Fat</td>
<td>015</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
<tr>
<td>Meat w. Fat</td>
<td>016</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
<td>X</td>
</tr>
</tbody>
</table>

PCBs – Polychlorinated Biphenyl
PBDEs – Poly Brominated Diphenyl Ethers
D/Fs – Dioxins/Furans
PAHs – Poly Aromatic Hydrocarbons
OC Pest – Organochlorine Pesticides
Rads – Radionuclides
Contaminant Testing and Consumption Guidelines

Which units are used to measure contaminants?
The tables and figures presented in the contaminant analysis section report most of the data in the units of parts per million (ppm), parts per billion (ppb) and parts per trillion (ppt). These units are the most commonly used terms to describe very small amounts of contaminants in our environment. They are measures of concentration, the amount of one material in a larger amount of another material; for example, the weight of a toxic chemical in a certain weight of food. Sometimes, instead of using the “parts per” terminology, concentrations are reported in metric weight units, such as milligrams per kilogram (mg/kg).

The units used to measure contaminants in food are extremely small. For example, 7 to 8 drops of food coloring in a full bathtub of water would be the concentration of one part per million.

### TABLE 3 Units of Measurement

<table>
<thead>
<tr>
<th>Metric weight units</th>
<th>Parts per MILLION (small)</th>
<th>Parts per BILLION (smaller)</th>
<th>Parts per TRILLION (smallest)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1 kilogram (kg) = 1 million milligrams (mg)</td>
<td>1 kilogram (kg) = 1 billion micrograms (ug)</td>
<td>1 kilogram (kg) = 1 trillion nanograms (ng)</td>
</tr>
<tr>
<td>so: 1 mg/kg = 1 part per million</td>
<td>so: 1 ug/kg = 1 part per billion</td>
<td>so: 1ng/kg = 1 part per trillion</td>
<td></td>
</tr>
<tr>
<td>Examples</td>
<td>One part per million equals:</td>
<td>One part per billion equals:</td>
<td>One part per trillion equals:</td>
</tr>
<tr>
<td></td>
<td>• One inch in 16 miles</td>
<td>• One inch in 16,000 miles (That’s the same distance as 13 one-way trips from Atka to Anchorage!)</td>
<td>• One inch in 1.6 million miles • One second in 32,000 years • One cent in $10 billion</td>
</tr>
<tr>
<td></td>
<td>• One minute in two years</td>
<td>• One second in 32 years</td>
<td>• One second in 32,000 years</td>
</tr>
<tr>
<td></td>
<td>• One cent in $10,000</td>
<td>• One cent in $10 million</td>
<td>• One cent in $10 billion</td>
</tr>
</tbody>
</table>

| Tables using units | • Inorganics (Metals) | • Polychlorinated biphenyls | • Polychlorinated Dioxins/Furans |
|                   |                       | • Organic pesticides |                               |
|                   |                       | • Polybrominated diphenyl ethers |                               |
|
How do scientists decide how much of a contaminant is safe to eat?

Studying Health Endpoints: Scientists learn about the health effects of toxic chemicals in two main ways. Scientists called toxicologists expose laboratory animals to toxic chemicals in controlled experiments, and then observe the health effects from the exposure. If human populations have been exposed to a chemical in an accident, at work, or from the environment, scientists called epidemiologists examine those people to see if they have suffered any health effects from the exposure.

The U.S. Environmental Protection Agency provides two different health endpoints for risk-based screening of chemical concentrations detected in fish: chronic health endpoints and cancer endpoints. For persistent organic pollutants, the Alaska Division of Public Health places more importance on the chronic health endpoints because they feel that the cancer endpoints are overly conservative and likely to overestimate actual risk. Also, recent research suggests that fish consumption may protect against some forms of cancer. The chronic health guidelines consider possible reproductive and developmental effects for the developing fetus, when that is the most sensitive endpoint.

Calculating Safe Levels: The U.S. Environmental Protection Agency and other governmental agencies use the results of health research to determine safe levels of chemical exposure. Usually, they take the lowest exposure level of a chemical that has been shown to cause any harm, and they divide that by a “safety factor” to provide extra protection. These safety factors are often 100 to 1000-fold, which means the government’s “safe” chemical exposure levels are 100 to 1000 times lower than the chemical concentrations that have produced observable health effects in laboratory animals. For example, if 1000 teaspoons of a chemical was given to a monkey and caused the monkey to get sick, scientists might say that only one teaspoon of that chemical would be safe for humans to consume.

The safe exposure levels determined by governmental agencies are often expressed as “tolerable daily intakes”. When considering food consumption guidelines, scientists calculate food intake exposures that could occur every day during a person’s lifetime without causing ill effects. These chronic health guidelines consider, among other things, possible reproductive and developmental effects for the fetus, which is the most sensitive member of the human population to many chemical exposures. For example, the safe exposure level for methylmercury as defined by the World Health Organization is expressed as “No Observed Effect Level” (NOEL). The “NOEL” is the level below which no health effects would be expected.

Why are women of childbearing age more sensitive to contaminants?

Women of childbearing age (WCBA) are referred to throughout the contaminants section of this report. All of the guidelines used in this report are set for the most contaminant-sensitive population, the fetus. For many chemicals, including Polychlorinated biphenyls (PCBs) and mercury, the fetus is the most sensitive population. Therefore, guidelines are most restrictive for any woman who is capable of becoming pregnant and who is planning on having children. Although the greatest concern is for exposure of unborn children to contaminants, the child’s exposure depends on its mother’s lifetime stores of contaminants. Therefore, it is important for all WCBA to consider the benefits and risks of dietary choices.

It is very important to maintain a nutritious diet while pregnant and breastfeeding. A good way to make sure of this is by including traditional foods such as reindeer, sea lion, salmon, halibut, bidarki and other local foods in the diet. WCBA can limit their exposure to contaminants by eating foods lower on the food chain and limiting intake of organs and fat.
**INTRODUCTION**

The sea lion samples analyzed show the presence of several different contaminants. Marine mammals, such as sea lion, that feed higher on the food chain tend to concentrate more contaminants than animals lower on the food chain.

Appendix D shows a table with tolerable monthly consumption guidelines. This table provides an overview of the contaminant findings of this project. Calculations are provided for each individual sea lion sample and for each major chemical contaminant to show the maximum amount of that sample that could be safely consumed each month for an entire lifetime. These monthly intakes are derived from U.S. Environmental Protection Agency “Tolerable Daily Intake” (TDI) risk guidelines. There is a lot of uncertainty in the calculation of TDIs, therefore, a large safety factor is built in to account for the uncertainty.

The data in Appendix D should not be used as actual consumption guidelines. These data cannot be assumed to be representative of the entire sea lion population as a much larger sample size would need to be taken to accomplish this. The table is included in this report to show the calculations used to determine which chemicals may pose the greatest risk to human health. Using this TDI method, safe kidney consumption was most influenced by cadmium, safe fat consumption was most influenced by Polychlorinated biphenyls (PCBs), and safety limits for all other tissues were most influenced by mercury concentrations. The result for each chemical or chemical group is discussed in this section.

Below are some important points to consider when reviewing the contaminant results:

The sea lion samples tested were raw. Preparation of the sea lion meat could potentially have a large impact on the amount of contaminants in each sample. For example, if you boiled the sea lion meat and removed it from the water, most of the fat would remain in the water. This would remove many of the PCBs from the meat. Therefore, the results reported may actually overestimate the PCB exposure from eating cooked sea lion meat.

Because of the small sample size of sea lion, caution should be taken when interpreting the results. Samples can vary greatly in the amount of certain contaminants depending on the age and sex of the animal as well as the time of year and location it was harvested.

The consumption guidelines include large safety factors, so you could potentially eat more than the amount calculated without adverse health effects.

Consumption guidelines are set for the most sensitive population, women of childbearing age and the developing fetus. The next most sensitive population would be children. This means that other populations, such as male adults and older female adults could eat more than the amounts recommended by the guidelines.

No restrictions on traditional food consumption were recommended as a result of the persistent organic pollutant biomonitoring done in Atka by the Alaska Division of Public Health in 1999 or the mercury hair biomonitoring done in Atka.

4.5
<table>
<thead>
<tr>
<th>Chemical</th>
<th>What is it?</th>
<th>Where is it found?</th>
<th>How does it get to Alaska?</th>
<th>What are the health effects?</th>
<th>Where does it concentrate in animals?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mercury</td>
<td>Mercury is an element. Some microorganisms can turn mercury into methylmercury, a highly toxic form.</td>
<td>Mercury naturally occurs in rocks, soil and water. Activities such as making paper and burning fuel from coal increase the amount of mercury in the environment.</td>
<td>Mercury arrives mostly through air currents from Europe and Asia.</td>
<td>In high doses, mercury is toxic to living things, causing damage to the brain and nerves. In lower doses, it can affect learning in children.</td>
<td>Metals tend to accumulate in organs and bone. Mercury tends to build up in the liver. Mercury is usually higher in marine mammals and fish than in land animals.</td>
</tr>
<tr>
<td>Cadmium</td>
<td>Cadmium is an element. The greatest use of cadmium is for metal plating and coating operations. It is also used in nickel-cadmium and solar batteries and in pigments.</td>
<td>Cadmium is found naturally in bedrock and in fresh and sea water.</td>
<td>Cadmium is released into the air, water, and land through human activities.</td>
<td>Long term exposure to high levels of cadmium can cause permanent kidney damage.</td>
<td>Cadmium is known to accumulate in the liver and kidney of mammals.</td>
</tr>
<tr>
<td>Organochlorine Pesticides</td>
<td>Organochlorine pesticides are compounds that stay in the environment for a long time.</td>
<td>Pesticides are used to kill unwanted plants and animals such as insects, rodents, plants, and fungi.</td>
<td>Pesticides arrive mostly from the lower latitudes and are carried to the Arctic by wind and ocean currents.</td>
<td>The toxic effect of most pesticides is on the nervous system and the liver. Some pesticides interfere with animal reproduction.</td>
<td>Pesticides tend to accumulate in fatty tissues. Older animals and animals higher up in the food chain have more pesticides.</td>
</tr>
<tr>
<td>Polychlorinated Biphenyls (PCBs)</td>
<td>PCBs are chemically stable organic compounds that do not break down easily in the environment. PCBs are manmade and were introduced and manufactured beginning in 1929. They are no longer produced in North America.</td>
<td>PCBs were used worldwide as coolants and lubricants in transformers, capacitors, and other electrical equipment because of their resistance to heat.</td>
<td>Most of the PCBs in the North come from other parts of the world, carried by wind and ocean currents. Some may come from local sources, such as old power plants or military sites.</td>
<td>PCBs suppress the immune system, making people more likely to become ill or die from infections. They can also disturb behavior and reproduction in birds, fish and mammals, and cause certain types of cancers.</td>
<td>PCBs tend to accumulate in the fatty tissues of animals (i.e. fat of fish and blubber of marine mammals). Older animals and animals higher up in the food chain will have more PCBs.</td>
</tr>
<tr>
<td>Radionuclides</td>
<td>Radionuclides are naturally occurring radioactive elements. They can be released into the environment from testing of nuclear weapons, dumping of nuclear waste, and nuclear accidents.</td>
<td>Although there are natural geological sources of radionuclides in rocks and soils, almost all radioactive contamination results from human activity.</td>
<td>Radionuclides from various sources reach the Arctic by winds, ocean currents and north flowing rivers. Some radionuclides are transported from northern Europe, Asia and Russia.</td>
<td>Large doses of radionuclides can cause a range of health effects including reproductive problems and cancer.</td>
<td>Radionuclides tend to accumulate in bone and muscle.</td>
</tr>
</tbody>
</table>
Metals (Inorganics)

All metals are elements that naturally occur in the environment. Some of these elements (calcium, copper, magnesium, manganese, phosphorus, potassium, selenium, and zinc) are essential for the normal functioning of the body. The other elements (arsenic, lead, cadmium, and mercury) can have negative implications to human health. Lead was not detected in any sample analyzed. Arsenic, cadmium and mercury were detected and the results are discussed in this report.

All samples were analyzed for metals except the two fat samples (with the exception that fat sample 003 was tested for methylmercury). Fat samples were not analyzed for metals because metals tend not to concentrate in fatty tissues. The concentrations of the 23 of 27 metals/inorganics detected in the sea lion samples are presented in Table 5.

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Heart 002</td>
<td>Salted Fat 003</td>
</tr>
<tr>
<td>ARSENIC (As)</td>
<td>0.28</td>
<td>0.24</td>
<td>NA</td>
</tr>
<tr>
<td>CADMIUM (Cd)</td>
<td>0.94</td>
<td>0.04</td>
<td>NA</td>
</tr>
<tr>
<td>MERCURY (Hg)</td>
<td>10.9</td>
<td>0.411</td>
<td>NA</td>
</tr>
<tr>
<td>METHYLMERCURY</td>
<td>1.09ª</td>
<td>0.73</td>
<td>0.019</td>
</tr>
<tr>
<td>ALUMINUM (Al)</td>
<td>&lt;2</td>
<td>&lt;2</td>
<td>NA</td>
</tr>
<tr>
<td>ANTIMONY (Sb)</td>
<td>&lt;0.04</td>
<td>&lt;0.04</td>
<td>NA</td>
</tr>
<tr>
<td>BARIUM (Ba)</td>
<td>0.15</td>
<td>0.11</td>
<td>NA</td>
</tr>
<tr>
<td>CALCIUM (Ca)</td>
<td>60</td>
<td>50</td>
<td>NA</td>
</tr>
<tr>
<td>CHROMIUM (Cr)</td>
<td>0.20</td>
<td>0.21</td>
<td>NA</td>
</tr>
<tr>
<td>COPPER (Cu)</td>
<td>18.9</td>
<td>3.06</td>
<td>NA</td>
</tr>
<tr>
<td>IRON (Fe)</td>
<td>90</td>
<td>67</td>
<td>NA</td>
</tr>
<tr>
<td>MAGNESIUM (Mg)</td>
<td>221</td>
<td>219</td>
<td>NA</td>
</tr>
<tr>
<td>MANGANESE (Mn)</td>
<td>6.64</td>
<td>0.37</td>
<td>NA</td>
</tr>
<tr>
<td>MOLYBDENUM (Mo)</td>
<td>0.45</td>
<td>&lt;0.04</td>
<td>NA</td>
</tr>
<tr>
<td>NICKEL (Ni)</td>
<td>0.03</td>
<td>0.03</td>
<td>NA</td>
</tr>
<tr>
<td>PHOSPHORUS (P)</td>
<td>3960</td>
<td>2630</td>
<td>NA</td>
</tr>
<tr>
<td>POTASSIUM (K)</td>
<td>2910</td>
<td>3190</td>
<td>NA</td>
</tr>
<tr>
<td>SELENIUM (Se)</td>
<td>6.93</td>
<td>1.22</td>
<td>NA</td>
</tr>
<tr>
<td>SILVER (Ag)</td>
<td>0.02</td>
<td>&lt;0.02</td>
<td>NA</td>
</tr>
<tr>
<td>SODIUM (Na)</td>
<td>883</td>
<td>1150</td>
<td>NA</td>
</tr>
<tr>
<td>STRONTIUM (Sr)</td>
<td>0.09</td>
<td>&lt;0.04</td>
<td>NA</td>
</tr>
<tr>
<td>TITANIUM (Ti)</td>
<td>0.07</td>
<td>0.14</td>
<td>NA</td>
</tr>
<tr>
<td>VANADIUM (V)</td>
<td>0.058</td>
<td>0.046</td>
<td>NA</td>
</tr>
<tr>
<td>ZINC (Zn)</td>
<td>41.4</td>
<td>22.4</td>
<td>NA</td>
</tr>
</tbody>
</table>

NA = not analyzed  
ªestimated concentration assuming methylmercury is 10% of total mercury  

43
**Arsenic**

All but one sea lion sample was analyzed for its total arsenic concentration, which was detected in each sample (Table 5). Arsenic may be present in either an organic or inorganic form. The organic form of arsenic is less toxic because it is not easily absorbed in the body when digesting food. Due to these differences in toxicity, it is important to know whether the arsenic is in an organic or inorganic form to accurately predict health risk.

Five samples were further analyzed to determine which type of arsenic was present in the tissues (Table 6). The most common form of arsenic in the sea lion samples is the relatively non-toxic organic form. Arsenobetaine, one organic species of arsenic, was detected in all the samples analyzed. The inorganic forms of arsenic are arsenite (As$^{3+}$), arsenate (As$^{5+}$), monomethylarsine (MMA), and dimethylarsine (DMA). Arsenite was detected in the liver sample and DMA was detected in the two meat with fat samples (Table 6). The inorganic arsenic levels detected in these three samples were not high enough to pose a health risk to human consumers of these sea lion (see Appendix D). However, this analysis is valid for only the specific sea lion samples analyzed in this study and should not be generalized for all sea lions.

---

**TABLE 6  Total Arsenic and Speciated Arsenic Detected in Steller Sea Lion** (ppm, wet weight)

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL ARSENIC (As)</strong></td>
<td>0.28</td>
<td>0.29</td>
<td>0.32</td>
</tr>
<tr>
<td><strong>INORGANIC ARSENIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARSENITE, AS$^{3+}$ (as As)</td>
<td>0.067</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>MONOMETHYLARSENINE (MMA) (as As)</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>DIMETHYLARSENINE (DMA) (as As)</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>ARSENATE, AS$^{5+}$ (as As)</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td><strong>ORGANIC ARSENIC</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>ARSENOBETaine (as As)</td>
<td>0.047</td>
<td>0.195</td>
<td>0.154</td>
</tr>
</tbody>
</table>
**Cadmium**

Cadmium was detected in three of the nine tissues analyzed (liver, heart and kidney) (Table 5). The highest concentration was detected in sea lion kidney. Cadmium is known to accumulate in the liver and kidney of mammals. Concentrations of cadmium are usually 3-4 times higher in the kidney than in the liver of marine mammals. The age and feeding habits have an influence on the levels of cadmium found in sea lion.

This data does not tell us how much sea lion kidney is safe to eat because it is based on only one animal. Kidneys from many more sea lions would need to be analyzed to better understand safe amounts for human consumption. The US Environmental Protection Agency (USEPA) provides the most conservative consumption guidelines for cadmium (see Appendix D). Based on the amount of cadmium in this one kidney sample, a person could safely consume 1.4 pounds of this specific kidney every month for the rest of his/her life, according to USEPA guidelines. However, the cadmium results are based on only one kidney and should not be generalized to all sea lion. The 1998-1999 Atka dietary survey results showed that the most sea lion kidney consumed by any individual surveyed was 0.54 pounds per month. Human biomonitoring studies conducted in Canadian and other Arctic populations indicate that smoking is the most important contributor of cadmium exposure.

---

*Smoking cigarettes and chewing tobacco exposes us to many different contaminants. Our bodies absorb cadmium easier through inhaling smoke than through eating food.*
Mercury
Mercury was detected in all tissues analyzed. Mercury concentrates in the liver and kidney and is also present in meat.\textsuperscript{2} Mercury concentrations are generally low in fat tissue. Mercury is present in different forms in marine mammal tissue as inorganic mercury and methylmercury. The liver and kidney contain primarily inorganic mercury and meat tissues contain primarily methylmercury.\textsuperscript{43} From a public health standpoint, methylmercury is the most important form of mercury because it is the toxic form.\textsuperscript{44}

Methylmercury was analyzed in three samples (Table 5). Unfortunately, there was not enough liver or kidney tissue for methylmercury analysis, but methylmercury is typically 10\% of the total mercury concentration in marine mammal liver and kidney.\textsuperscript{43} For the purposes of this report it is assumed that the kidney and liver samples contained 10\% methylmercury, and that methylmercury represented 100\% of the mercury detected in the other sea lion samples that were not specifically analyzed for methylmercury. However, for simplicity the term "mercury" is used throughout the text, tables, and figures of the report to represent the form of mercury most important to public health, methylmercury.

Mercury results and dietary intake rates of subsistence foods in Atka from the 1998-1999 dietary survey were examined to determine mercury exposure from subsistence foods in Atka. Mercury exposures in Atka were compared to risk levels established by the World Health Organization (WHO). WHO guidelines are commonly used worldwide, making comparisons to studies in other Arctic nations easier. WHO also considers the nutritional importance of the food being consumed.\textsuperscript{43} Risk guidelines have been established by other agencies such as the US Environmental Protection Agency, the Agency for Toxic Substances and Disease Registry, the Food and Drug Administration and Health Canada.

Figure 5 shows the amount of methylmercury in a variety of traditional foods consumed in Atka. Sea lion was the only traditional food in this figure specifically sampled in Atka. It is important to remember that this sea lion information is based on a very small sample size. The kidney, liver, heart and meat samples were all taken from one animal. The meat with fat results are the average from three different animals. Therefore, the analysis provided is based only on this small sample size. More samples would need to be analyzed in order to account for the large variability in size, age, sex and diet that exists between different sea lions.

As shown in Figure 5, the amount of mercury in sea lion consumed by Atka villagers is below the WHO “No Observed Effect Level” (NOEL) for women of childbearing age (WCBA). The NOEL is the level below which no health effects would be expected. Since the fetus is most sensi-
tive to the harmful effects of mercury, keeping exposures below the “No Observed Effect Level” for WCBA protects all people from the harmful effects of mercury. Mercury concentrations shown in Figure 5 were also below the upper limits (the equivalent of “NOEL”) established by other agencies with risk guidelines for mercury. For example, Health Canada has the most conservative upper limit of 1 ug/kg/day and the U.S Food and Drug Administration has the most liberal upper limit of 4.3 ug/kg/day.

**Mercury Biomonitoring**

The Alaska Division of Public Health has an ongoing maternal hair mercury biomonitoring program. The program offers free hair testing to any women of childbearing age in Alaska. In 2002, the Alaska Division of Public Health offered free hair testing to any women of childbearing age in the Aleutian and Pribilof Islands. Table 7 and Figure 6 show the results to date from five Aleutian and Pribilof communities. Results from human biomonitoring provide actual levels of mercury in our bodies. In general, the mercury in hair of populations that consume fish is 90% methylmercury. All hair total mercury concentrations were below the WHO NOEL for mercury of 14 ppm. Atka had the highest mean total mercury level compared to the other villages. This most likely reflects higher subsistence food use in Atka or higher consumption of sea mammals.

**FIGURE 6** Median Hair Total Mercury Level by Region for Women of Childbearing Age & Children (2005)*

**TABLE 7** Hair Total Mercury Concentrations For Children and Women of Childbearing Age in 5 Aleutian Pribilof Island Villages (ppm - 2002-2005)

<table>
<thead>
<tr>
<th>VILLAGE</th>
<th>NUMBER</th>
<th>MEAN</th>
<th>MEDIAN</th>
<th>LOW</th>
<th>HIGH</th>
</tr>
</thead>
<tbody>
<tr>
<td>Akutan</td>
<td>7</td>
<td>1.02</td>
<td>0.88</td>
<td>0.46</td>
<td>2.0</td>
</tr>
<tr>
<td>Atka</td>
<td>11</td>
<td>3.34</td>
<td>2.86</td>
<td>0.33</td>
<td>8.1*</td>
</tr>
<tr>
<td>Dutch Harbor</td>
<td>6</td>
<td>1.13</td>
<td>0.95</td>
<td>0.23</td>
<td>2.3</td>
</tr>
<tr>
<td>St. Paul</td>
<td>21</td>
<td>0.74</td>
<td>0.62</td>
<td>0.15</td>
<td>2.5</td>
</tr>
<tr>
<td>Unalaska</td>
<td>10</td>
<td>0.68</td>
<td>0.55</td>
<td>0.16</td>
<td>1.7</td>
</tr>
</tbody>
</table>

*average value for woman with two results
Polychlorinated Biphenyls (PCBs)

There are 209 types of PCBs, otherwise known as congeners. A total of 64 PCB congeners were measured in this study. (See Appendix A for a list of the PCB congeners analyzed.) PCBs were detected in all 11 sea lion samples analyzed. The preliminary results of the sum of 64 different forms of PCBs are presented in Table 8. PCBs concentrate in fat and, as expected, the levels of PCBs found in fatty tissues were much higher than the PCB levels in lean meat and organs. Sub-types of PCBs, called coplanar PCBs, were also analyzed individually. They will be discussed in the dioxin and furan section.

It is difficult to precisely predict the health risk of exposure to small amounts of PCBs through the diet. Obvious health effects from PCB exposure only occur at much higher levels than those experienced through the subsistence diet, such as occupational exposures or industrial accidents. The health effects associated with PCB exposure, such as depressed immune system, subtle learning deficits, changes in hormonal systems, and certain types of cancer, can all be caused by many other causal factors, so it is usually difficult to know whether PCBs played a specific role in any particular illness. Because of these difficulties, the risk guidelines developed by various governmental agencies for “safe” levels of PCB exposure vary greatly. For example, the consumption guidelines developed by the U.S. Environmental Protection Agency (USEPA) and Health Canada vary by 50-fold, with the USEPA’s recommendations being more cautious guidelines.

There is a huge variation between agencies when it comes to evaluating the amount of PCBs in food and how much is safe to eat. Consumption recommendations on PCBs fall into a “grey zone” of interpretation, where differences in agency recommendations cause confusion. Given the amounts of PCBs found in the Atka sea lion that was tested, USEPA guidelines say that people could safely eat around 13 pounds of sea lion meat with fat per year. However, Health Canada’s guidelines say you could eat almost 634 pounds of sea lion meat per year. (See Appendix C for calculations of these consumption limits.) Both of these calculations are set for the most sensitive population, women of childbearing age and the developing fetus. This means that other populations, such as male adults and older female adults could potentially eat more than the amounts recommended by the guidelines. Neither of the consumption guidelines includes consideration of the benefits of consuming traditional foods.

According to the dietary survey done in Atka in 1998-1999, Atka residents consume, on average, between 9-30 pounds of sea lion meat per year. Atka residents consume slightly more sea lion meat than recommended by the most protective guidelines established by the USEPA and much less sea lion meat than the guidelines established

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**TABLE 8** Polychlorinated Biphenyls (PCBs) Detected in Steller Sea Lion (ppb, wet weight)

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver 001</td>
<td>20.5</td>
<td>11.0</td>
<td>38.0</td>
</tr>
<tr>
<td>Heart 002</td>
<td>11.0</td>
<td>1069.0</td>
<td>172.8</td>
</tr>
<tr>
<td>Salted Fat 003</td>
<td>7.8</td>
<td>1276.3</td>
<td></td>
</tr>
<tr>
<td>Meat 006</td>
<td></td>
<td>45.9</td>
<td></td>
</tr>
<tr>
<td>Fat 007</td>
<td></td>
<td>97.5</td>
<td></td>
</tr>
<tr>
<td>Meat 010</td>
<td></td>
<td>4.9</td>
<td></td>
</tr>
<tr>
<td>Meat w/Fat 011</td>
<td></td>
<td>8.3</td>
<td></td>
</tr>
<tr>
<td>Kidney 013</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat w/Fat 015</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Meat w/Fat 016</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ΣPCBs</strong></td>
<td>20.5</td>
<td>11.0</td>
<td>38.0</td>
</tr>
</tbody>
</table>
by Health Canada for these specific samples. However, these calculations are based on only three samples of sea lion and are not representative of all sea lion. It is interesting to note, however, that the PCB concentration for the sea lion fat sample from this study is consistent with other recent sea lion data for blubber. In addition, the sea lion PCB data is consistent with levels of PCBs found in beluga whale blubber. Beluga whale is used for comparison since they occupy a similar place on the food chain as sea lion.

Sea lion fat has a much greater PCB concentration than the meat. Using PCB data from this study on sea lion fat from one animal Health Canada guidelines would say that it would be safe to consume about 4 pounds of this specific sample of sea lion fat in one month, every month for the rest of our lives. However, the USEPA would not recommend that much sea lion fat from this specific sample be consumed at all. This information is based on only one sample and cannot be used to generalize about the levels of PCBs found in all sea lion fat. Consumption guidelines for this one sample are provided only to give some context as to the level of PCBs found in the one fat sample. Many more samples would need to be analyzed in order to provide accurate consumption advice. Because the consumption of sea lion fat and oil was not tabulated as a food item in the Atka’s dietary survey in 1998-1999, it is not possible to show how much sea lion fat people in Atka actually consume. More dietary information on fat consumption and analyzed samples of sea lion are needed in order to get a better understanding of total exposure from sea lion.

Variations in age, sex, and diet between individual sea lions may significantly influence the level of PCBs in any individual sea lion. These limited samples do not tell us if sea lion consumption is a concern for human health in Atka. However, they do demonstrate that sea lion is a potential pathway for PCBs entering humans. More samples would need to be collected and analyzed to adequately address questions regarding human health concerns.

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**PCBs were used worldwide as coolants and lubricants in transformers, capacitors and other electrical equipment because of their resistance to heat. They are no longer produced in North America.**
**PCB Biomonitoring**

Human biomonitoring of contaminants in blood is an important part of understanding if a person is exposed to chemicals in the environment. (See page 8) Results of biomonitoring provide the most accurate measurement of human exposure to chemicals.

In 1999, the Alaska Division of Public Health collected blood samples from residents of Atka, St. George, Akutan, Nikolski, and St. Paul for PCBs, pesticide, and dioxin analysis. The PCB results are presented in Figure 7. Results from human biomonitoring of PCBs in Atka show that residents are exposed to PCBs. Food is the most likely source of PCB exposure in Atka. Marine mammals such as sea lion tend to have higher amounts of PCBs than fish and land animals, such as reindeer. Since sea lion is a frequently consumed food by many residents in Atka, it is likely one of the most significant sources of PCB exposure. Harbor Seal may also be a source of PCB exposure. However, actual human exposure to PCBs is the most important factor in determining risk.

Figure 7 gives the median PCB results for women of childbearing age for the five villages. The median is the middle point at which half of the people had higher PCB levels and half had lower PCB levels. Atka had the highest median PCB levels among the five villages, which probably indicates that Atka villagers have a higher rate of marine mammal consumption. However, the Alaska Division of Public Health found nothing to cause them to change their recommendation of unrestricted consumption of traditional foods in Atka or elsewhere in the region. The PCB levels found in volunteer’s blood were similar to those in other arctic nations and in Alaska Natives in some other parts of the state. The report states “The levels we detected do not warrant recommending that any volunteer seek a medical exam or treatment, and do not warrant any restrictions on consumption of subsistence foods.”

The results of human biomonitoring for PCBs are reassuring for Atka residents. Although the sea lion tested for this study showed the presence of PCBs, the actual exposure detected through human biomonitoring in Atka was not considered by the Alaska Division of Public Health to be at levels of health concern. It is important to monitor contaminant exposure regularly through participating in human biomonitoring and sampling local food sources to understand trends and to provide assurances that traditional foods continue to be safe to eat.

**FIGURE 7 Median PCB Level By Village**

![Median PCB Level By Village](image)

*Males/Females

Women of Childbearing Age*

*WCBA is previously unpublished data*
**Polychlorinated Dioxins and Furans**

Polychlorinated dioxin and furans are a mixture of many chemicals with a similar chemical structure (known as congeners). Some PCB congeners have a similar chemical structure to dioxins and furans, and express their toxicity in a similar way. The relative toxicity of each congener can be compared to the most toxic dioxin congener (2,3,7,8-tetrachlorodibenzo-p-dioxin, or “TCDD”). The TCDD-like toxicity of each congener can be added to give the total TCDD equivalent (TEQ), which represents the sample’s total toxicity. The TEQs for these “coplanar” PCB congeners are presented in Table 9, along with the total dioxin, furan, and PCB TEQ for each sample. Dioxins and furans were detected in seven of eleven samples. The highest concentrations were found in the fat and kidney samples.

Interpretation of the human health risk posed by trace dioxin and furan exposures from the diet is just as difficult as the interpretation of PCB levels, for many of the same reasons. In general, the conclusions developed in this report regarding PCB exposures hold equally true for dioxin and furan exposures.

**TABLE 9**  
**Coplanar Polychlorinated Biphenyls (PCBs) and Polychlorinated Dioxins/Furans TCDD Equivalents (TEQ) Detected in Steller Sea Lion (ppt, wet weight)**

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Heart 002</td>
<td>Salted Fat 003</td>
</tr>
<tr>
<td>Dioxin/Furan TEQ*</td>
<td>1.0</td>
<td>&lt;0.10</td>
<td>8.9</td>
</tr>
<tr>
<td>PCB TEQ**</td>
<td>0.49</td>
<td>0.13</td>
<td>29.4</td>
</tr>
<tr>
<td>Total TEQ</td>
<td>1.5</td>
<td>0.1</td>
<td>38.3</td>
</tr>
</tbody>
</table>

*(ND=0); data shown are the sum TEQ of the congeners shown in Appendix A.
**PCB TEQ (reference # 51) is sum TEQ for coplanar PCB congeners 77, 81, 105, 114, 118, 123 (107/109), 126, 156, 157, 167, 169, 189
TCDD = 2,3,7,8-tetrachlorodibenzo-p-dioxin
Organochlorine (OC) Pesticides
Seven sea lion samples were analyzed for 27 organochlorine (OC) pesticides. Fifteen pesticides were detected in these samples. The concentrations of the pesticides detected are presented in Table 10. The sum of the hexachlorocyclohexanes (HCCHs), DDTs, and chlordanes are also provided.

Similar to PCBs, OC pesticides concentrate in fatty tissues. Although a few of the pesticides detected in the fat samples, such as the DDTs, the chlordanes, dieldrin and heptachlor epoxide were detected at levels of potential health relevance, the risk calculated for pesticides was not as high as it was for PCBs. (Refer to pages 33-35 for a discussion of PCBs.) Furthermore, human biomonitoring data from Atka showed that no adverse health effects would be expected at the levels of OC pesticide exposure occurring in Atka.  

### TABLE 10 Organochlorine Pesticides Detected in Steller Sea Lion (ppb, wet weight)

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Salted Fat 003</td>
<td>Meat 006</td>
</tr>
<tr>
<td>alpha-HCCH</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>beta-HCCH</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>gamma-HCCH (Lindane)</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>sum HCCH</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Heptachlor Epoxide</td>
<td>&lt;0.50</td>
<td>86</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>Dieldrin</td>
<td>3.8</td>
<td>150</td>
<td>4.1</td>
</tr>
<tr>
<td>4,4’-DDE</td>
<td>38</td>
<td>2000</td>
<td>42</td>
</tr>
<tr>
<td>4,4’-DDT</td>
<td>&lt;0.50</td>
<td>130</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>2,4’-DDE</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>2,4’-DDT</td>
<td>&lt;0.50</td>
<td>84</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>sum DDTs</td>
<td>38</td>
<td>2214</td>
<td>42</td>
</tr>
<tr>
<td>alpha-Chlordane</td>
<td>2</td>
<td>130</td>
<td>1.9</td>
</tr>
<tr>
<td>gamma-Chlordane</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>Trans-nonachlor</td>
<td>7.3</td>
<td>490</td>
<td>10</td>
</tr>
<tr>
<td>Oxychlordane</td>
<td>2.8</td>
<td>150</td>
<td>2.3</td>
</tr>
<tr>
<td>cis-Nonachlor</td>
<td>1.1</td>
<td>93</td>
<td>&lt;0.50</td>
</tr>
<tr>
<td>sum Chlordane</td>
<td>13.2</td>
<td>863</td>
<td>14.2</td>
</tr>
<tr>
<td>Mirex</td>
<td>&lt;0.50</td>
<td>12</td>
<td>&lt;0.50</td>
</tr>
</tbody>
</table>
Polybrominated diphenyl ethers (PBDEs)

PBDEs are another class of chemicals that are structurally similar to PCBs, dioxins and furans. PBDEs are extremely common flame retardants that are found in many products such as TV-sets, computers, building materials, foam cushioning, and textiles. PBDEs are found throughout the environment, but the ways that they get into our bodies are not fully known. PBDEs continue to be used in large quantities, and their concentrations are increasing rapidly in the environment. This is unlike PCBs, whose production was banned in the United States in 1977, or dioxins/furans, which are accidental byproducts rather than being intentionally produced. The concentration of PBDEs appears to be increasing in marine mammals. For example, they have increased 10-100 fold in the blubber of harbor seals collected in San Francisco Bay in the past ten years.

PBDEs were detected in all of the sea lion samples analyzed (Table 11). An interesting observation was made that should be further researched. In wildlife samples, it is currently common to see PBDE levels that are approximately 1000-fold lower than PCB levels in the same sample. That is, PBDE levels are often detected at the part-per-trillion level, while PCBs are detected at the part-per-billion level. However, in this study PBDEs were detected at the part-per-billion level, at levels similar to the PCB levels detected. In fact, in the liver and heart samples, the PBDE level was actually higher than the PCB level in the same sample. In general, this indicates that PBDEs are an established contaminant in Alaska’s marine environment that should be monitored.

Polycyclic aromatic hydrocarbons (PAHs)

Polycyclic aromatic hydrocarbons (PAHs) are a component of fossil fuels. They are not usually present in detectable amounts in the tissues of marine mammals unless they have been very recently exposed, because the PAHs are rapidly metabolized and excreted. In the marine environment, PAHs are usually present in higher amounts in shellfish than in fish or marine mammals, because shellfish are not as efficient at metabolizing these chemicals.

Five samples were analyzed for 40 different PAHs, including kidney, liver, and three meat with fat samples. As expected, most PAHs were below detection in the sea lion samples. Only six PAHs were detected in the samples analyzed. See Table 12 for a summary of PAHs detected.

---

**TABLE 11** Polychlorinated Biphenyls (PCBs) and Polybrominated Diphenyl Ethers (PBDEs) Detected in Steller Sea Lion (ppb, wet weight)

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Heart 002</td>
<td>Salted Fat 003</td>
</tr>
<tr>
<td>∑PBDE</td>
<td>25.8</td>
<td>39.3</td>
<td>42.7</td>
</tr>
<tr>
<td>∑PCB</td>
<td>20.5</td>
<td>11.0</td>
<td>1069.0</td>
</tr>
</tbody>
</table>
Radionuclides
The following radionuclides were not detected in any of the six samples analyzed: Cesium-137, Radium-226, Radium-228, Thorium-224. Only one radionuclide, Polonium–210, was detected in sea lion tissues. One sample of fat (sample # 007) was below detection limits for all radionuclides tested and is not shown in Table 13. These five radionuclides were analyzed because they cover a general spectrum of radionuclides that are man-made and natural.

Polonium-210 was detected in 5 samples, as shown in Table 13. All concentrations of polonium-210 were very low and were similar to background concentrations found throughout the global environment. Marine food products are generally much less contaminated by radionuclides than food products from the land.

The Consortium for Risk Evaluation with Stakeholder Participation (CRESP) has also looked at radionuclides in food in the Aleutian Island region. CRESP collected around 1500 marine plants, animals and birds near Amchitka in 2004. These samples were analyzed for radionuclides. Results from this research showed that the levels of radionuclides relevant to human health were well below human health risk levels.

### Table 12 Polycyclic Aromatic Hydrocarbons Detected in Sea Lion (ppm)

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Meat 006</td>
<td>Kidney 013</td>
</tr>
<tr>
<td>METHYL nAPHTHALENE-20</td>
<td>0.02</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
</tr>
<tr>
<td>NAPHTHALENE-20</td>
<td>0.02</td>
<td>&lt;0.02</td>
<td>0.02</td>
</tr>
<tr>
<td>NITROBENZENE d5-20</td>
<td>23</td>
<td>30</td>
<td>24</td>
</tr>
<tr>
<td>2-FLUOROBIPHENYL-20</td>
<td>58</td>
<td>63</td>
<td>53</td>
</tr>
<tr>
<td>p-TERPHENYL d14-20</td>
<td>108</td>
<td>98</td>
<td>102</td>
</tr>
<tr>
<td>BENZO(a)ANTHRACENE-20</td>
<td>&lt;0.02</td>
<td>&lt;0.02</td>
<td>0.02</td>
</tr>
</tbody>
</table>

### Table 13 Polonium-210 in Steller Sea Lion

<table>
<thead>
<tr>
<th>TISSUE &amp; SAMPLE NUMBER</th>
<th>Animal 1</th>
<th>Animal 2</th>
<th>Animal 3</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Liver 001</td>
<td>Meat w/Fat 006</td>
<td>Kidney 013</td>
</tr>
<tr>
<td>Polonium -210 (Bq/g)</td>
<td>0.026</td>
<td>0.003</td>
<td>0.017</td>
</tr>
</tbody>
</table>

*Bq/g is Becquerels per gram. Radiation is measured in Becquerels per second. BQ means one disintegration per second.
### NUTRIENT ANALYSIS RESULTS AND DISCUSSION

**Introduction**

The eleven sea lion samples analyzed were rich with nutrients important for our health. These preliminary results show that Steller Sea Lion is an especially good source of protein, iron, selenium, unsaturated fats and other vitamins and minerals. This is consistent with nutrient data collected on other marine mammals. Other traditional foods such as reindeer, salmon, halibut, bidarki and greens also provide important nutrients for good health.

Table 14 provides the results of the common nutrients analyzed in the eleven sea lion samples tested. The micronutrient values for liver, kidney, heart, fat and salted fat are the results from the analysis of one sample. The sea lion meat values are the average of two samples from one sea lion (006 and 010). The sea lion meat with fat samples were used for the nutrition facts label and graphs in this report. Four samples of meat with fat from three different sea lion (011, 012, 015 and 016) were analyzed for this study. Samples

---

**Table 14: Results of Common Nutrients in Atka Steller Sea Lion Organs, Meat and Fat (100 g samples)**

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Liver 001</th>
<th>Kidney 013</th>
<th>Heart 002</th>
<th>Meat 006/10</th>
<th>Meat with Fat 011/012/015/16</th>
<th>Salted Fat 003</th>
<th>Fat 007</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL FAT%</strong></td>
<td>NT</td>
<td>1.1</td>
<td>NT</td>
<td>&lt;0.1**</td>
<td>9.25†</td>
<td>76.3</td>
<td>41.1</td>
</tr>
<tr>
<td><strong>OMEGA-3</strong></td>
<td>0.4</td>
<td>&lt;0.3</td>
<td>NT</td>
<td>&lt;0.3**</td>
<td>&lt;0.3***</td>
<td>2.6</td>
<td>2.5</td>
</tr>
<tr>
<td>FATTY ACIDS</td>
<td><strong>g/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CHOLESTEROL</strong></td>
<td>0.4</td>
<td>0.4</td>
<td>NT</td>
<td>0.1**</td>
<td>62.7†</td>
<td>80.2</td>
<td>110.7</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SODIUM (Na)</strong></td>
<td>88</td>
<td>231</td>
<td>115</td>
<td>65</td>
<td>71.3</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CARBOHYDRATE</strong></td>
<td>0.0</td>
<td>2.1</td>
<td>NT</td>
<td>1.2 **</td>
<td>2.1†</td>
<td>14.9</td>
<td>NT</td>
</tr>
<tr>
<td><strong>g/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PROTEIN</strong></td>
<td>22.9</td>
<td>18.1</td>
<td>NT</td>
<td>25.3**</td>
<td>24.25†</td>
<td>0.9</td>
<td>9.1</td>
</tr>
<tr>
<td><strong>g/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VITAMIN A</strong></td>
<td>NT</td>
<td>&lt;60</td>
<td>NT</td>
<td>&lt;60**</td>
<td>88.7 *</td>
<td>99.6</td>
<td>&lt;60</td>
</tr>
<tr>
<td><strong>RE/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>VITAMIN C</strong></td>
<td>NT</td>
<td>&lt;3.0</td>
<td>NT</td>
<td>&lt;3.0**</td>
<td>&lt;3.0†</td>
<td>&lt;3.0</td>
<td>&lt;3.0</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>CALCIUM (Ca)</strong></td>
<td>6.0</td>
<td>9.0</td>
<td>5.0</td>
<td>6.5</td>
<td>6.2</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>IRON (Fe)</strong></td>
<td>9.0</td>
<td>7.0</td>
<td>6.7</td>
<td>10.8</td>
<td>10.5</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>ZINC (Zn)</strong></td>
<td>4.1</td>
<td>2.9</td>
<td>2.2</td>
<td>3.9</td>
<td>4.5</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>SELENIUM (Se)</strong></td>
<td>69</td>
<td>270</td>
<td>120</td>
<td>90</td>
<td>118</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mcg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>POTASSIUM (K)</strong></td>
<td>291</td>
<td>253</td>
<td>319</td>
<td>423</td>
<td>381</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>PHOSPHORUS (P)</strong></td>
<td>396</td>
<td>301</td>
<td>263</td>
<td>255</td>
<td>236</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>MAGNESIUM (Mg)</strong></td>
<td>22.1</td>
<td>16.0</td>
<td>21.9</td>
<td>23.1</td>
<td>21.6</td>
<td>NT</td>
<td>NT</td>
</tr>
<tr>
<td><strong>mg/serving</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The results of 016 only**

**The results of 006 only**

***The results of 015 only**

† The results of 015 and 016 only

NT - not tested

RE - Retinol Equivalents
011 and 012 were analyzed for minerals. Vitamin A data was available for sample 016 and omega-3 fatty acid data was available for sample 015. All other nutrients are an average of samples 015 and 016. These results are used in the following discussion to demonstrate the nutritional value of the sea lion tested. The interpretation of the sea lion results is based on a total of eleven samples, nine of which are from one animal. As is the case with contaminant results, the nutritional information for Steller Sea Lion will vary depending on the age, sex and diet of the sea lion. Therefore, this data should be considered preliminary and should not be generalized for all sea lion.

Table 15 shows nutritional information for each tissue of the sea lion that was tested. For example, the sample of sea lion liver tested is an excellent source of iron, protein, selenium, zinc and vitamin A, a good source of vitamin C and a fair source of total fat and potassium.

**Steller Sea Lion Nutrient Label: How does it compare to the ground beef nutrient label?**

Traditional and store-bought foods were selected for comparison of nutrients with Atka sea lion. The serving size used for comparison of the foods is 100 grams or about G pound (approximately the size of a deck of cards). The decision to select these specific foods was based on information

<table>
<thead>
<tr>
<th>TABLE 15 Nutrient Ratings of Steller Sea Lion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
</tr>
<tr>
<td><img src="image1" alt="Liver" /></td>
</tr>
</tbody>
</table>

**EXCELLENT SOURCE**
(supplies 25% or more of daily need)
- Iron
- Protein
- Selenium
- Zinc
- Vitamin A*
- Iron
- Protein
- Selenium
- Iron
- Protein
- Selenium
- Iron
- Protein
- Selenium
- Zinc
- Total Fat
- Omega-3 fatty acids*

**GOOD SOURCE**
(supplies 15-24% of daily need)
- Vitamin C
- Zinc
- Total Fat

**FAIR SOURCE**
(supplies 5-14% of daily need)
- Total Fat
- Potassium
- Total Fat
- Potassium
- Zinc
- Potassium
- Potassium
- Vitamin A

*Although complete nutrient data for Vitamin A and omega-3 fatty acids is not available for this project, liver is typically an excellent source of Vitamin A and marine mammal fats are typically excellent sources of omega-3 fatty acids. 56, 58
from the local store and results from the Atka Dietary Survey. Ground beef (with 20% fat) is sold at the Atka store and was reported to be the most frequently eaten store-bought food.\(^{16}\) The preliminary results from the three sea lion samples tested in this study show that sea lion is more nutritious than ground beef. See Figures 8 and 9 for a comparison of labels.

The nutrient label describes the nutritional quality of a food item. Nutrient labels are required on store-bought foods, but are not usually available for traditional foods. Our bodies need the right combination of nutrients to work properly, grow, and fight disease. The nutrient label in Figure 8 is specific to the raw Atka Steller Sea Lion meat with fat results in Table 14. This nutrient data should not be used to generalize for all sea lion, as it is based on a very small sample size. Nutrients can vary depending on the age and sex of the sea lion and the location and season that the sea lion was harvested. The sea lion nutrient data presented in the nutrient label should be considered preliminary. Many more samples would need to be analyzed to provide more accurate nutrient information.

One serving of sea lion meat has less than half of the total fat found in ground beef. Ground beef also has nearly five times the amount of saturated fat.

One serving of sea lion meat provides 49% of our daily need for protein whereas one serving of ground beef provides 34% of our daily need.

There is almost eight times as much selenium in one serving of sea lion with fat as there is in one serving of ground beef.

You would have to eat about five servings of ground beef to get the same amount of iron you get in one serving of sea lion.

Both Steller Sea Lion and ground beef are excellent sources of zinc.
TABLE 16  Guide to Reading the Sea Lion Nutrient Label

<table>
<thead>
<tr>
<th>NUTRIENT</th>
<th>DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>TOTAL FAT</strong></td>
<td>Sea lion is low in fat. Fats supply energy and essential fatty acids, and help absorb fat-soluble vitamins. We need some fat in the food we eat, but too much fat can increase the risk for coronary heart disease. It is recommended that total fat intake be 30 percent of calories, with most fats coming from foods containing polyunsaturated and monounsaturated fatty acids, such as fish, nuts, and vegetable oils. Less than 10 percent of calories should be from saturated fats. Fat stored in our bodies is used for insulation, connective tissues and as energy when needed. Sea lion provides good amounts of unsaturated fats, the “good” fats. They are “essential fatty acids” because they help in immune processes and vision, and help form cell structures. Humans cannot produce essential fatty acids, so they must be ingested from the food we eat. Sea lion, halibut, salmon, and other fish and marine mammals typically have high levels of omega-3 fatty acids.</td>
</tr>
<tr>
<td><strong>CARBOHYDRATES</strong></td>
<td>Sea lion is not a significant source of carbohydrates. Good sources of carbohydrates include potatoes, grains, pasta, beans, fruits, and vegetables. Carbohydrates are an important fuel source for the body. They fuel the brain and red blood cells. Simple carbohydrates such as candy and soda can be quickly turned into fat and stored for future energy use. Intake of too many simple carbohydrates in a diet can be hard on our system and have been shown to be a cause of obesity and late-onset diabetes.</td>
</tr>
<tr>
<td><strong>SUGARS</strong></td>
<td>Sea lion is sugar free. Sugars are naturally found in fruits and grains. Our bodies use sugars for energy. We also store sugar in the form of fat for future use. Many processed foods are high in sugar. With sugary foods, the rule is moderation. When we eat too much sugar, we 1- elevate our blood glucose level; 2- get full without the nutrients that come with vegetables and grains; and 3- gain weight. High sugar consumption is also a risk factor for developing diabetes and dental caries.</td>
</tr>
<tr>
<td><strong>CHOLESTEROL</strong></td>
<td>Sea lion is relatively low in cholesterol. Cholesterol helps to make cell walls, hormones, vitamin D and acids for digestion. Cholesterol comes from animals and is not found in fruits, vegetables or grains. Too much cholesterol is a leading risk factor for coronary heart disease.</td>
</tr>
<tr>
<td><strong>SODIUM</strong></td>
<td>Sea lion is low in sodium. Sodium is an essential mineral for our bodies, however too much sodium is unhealthy. Sodium helps our body maintain a balance of fluids. It also functions to send nerve impulses and absorb some nutrients. Some sodium occurs naturally in food, but most dietary sodium is added during cooking in the form of salt. Processed foods and foods eaten at restaurants are also high in sodium. It is recommended that one consumes less than 1 tsp of salt (2,300 mg sodium) per day. A diet high in sodium is often linked to high blood pressure.</td>
</tr>
<tr>
<td><strong>PROTEIN</strong></td>
<td>Sea lion is high in protein. Protein’s biggest job is to build, maintain, and replace the tissues in our bodies. Protein is important for growth and it provides energy. It also stabilizes blood sugar. One serving (3.5 ounces) of sea lion provides 49% of our daily need for protein without the added fat of most meat.</td>
</tr>
<tr>
<td><strong>SELENIUM</strong></td>
<td>Selenium is essential for normal functioning of the immune system and thyroid gland. Studies suggest that selenium may help counteract the toxic effects of methylmercury. The amount of selenium detected in one serving of the Atka sea lion samples analyzed was 118 mcg. One serving of sea lion exceeds the recommended daily intake for selenium. The government has set the daily tolerable upper intake level (UL) for selenium at 400 mcg. Selenium toxicity is rare in the U.S. and based on the amount of selenium found in the sea lion tested in this study, toxicity should not be a problem.</td>
</tr>
</tbody>
</table>
**Selenium in Steller Sea Lion**

*Selenium* is a naturally occurring mineral. It was found in great abundance in the sea lion samples analyzed and is also high in halibut and red salmon. The sea lion kidney had the highest amount of selenium. There is almost nine times as much selenium in one serving of sea lion meat with fat as there is in one serving of ground beef.

In addition to being important for general health, selenium may help reduce the potentially harmful effects of mercury. It is possible to get too much selenium in our bodies, however, selenium toxicity is rare in the United States. There have only been a few reported cases of selenium toxicity in the U.S. and these were associated with industrial accidents and not food consumption. Since most of us get enough selenium through our food, selenium supplements are not recommended for healthy children and adults.\(^{33}\)

The daily tolerable upper intake level for selenium has been established at 400 mcg. All foods shown in Figure 10 were below this upper level for one serving.

*St Paul halibut refers to Pacific Halibut (Hippoglossus stenolepis) tested in St. Paul in 2002 and reported in the 2006 St. Paul Report on Halibut.\(^{51}\)*

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**FIGURE 10 How much selenium is in a food serving?**\(^{62}\)
Protein in Steller Sea Lion

Protein serves as the major structural component of all cells in the body. It is important for proper growth and development. Figure 11 compares the amount of protein found in traditional and store-bought foods. A total of 50 grams of protein are recommended per day. Red salmon, St. Paul Halibut, sea lion, and reindeer, provide the best sources of protein in a serving in comparison to a hot dog, pinto beans, a chicken egg and ground beef. One serving of sea lion meat has about twice the amount of protein as a serving of chicken and five times as much protein as a serving of a hot dog.

FIGURE 11  How much protein is in a food serving? 62
Iron in Steller Sea Lion
Iron is an essential nutrient used in our body to carry oxygen to our cells. One serving of sea lion meat with fat provides 10.5 grams of iron whereas a serving of hot dog has 0.34 grams of iron. You would have to eat almost 32 hot dogs to get the same amount of iron you can get from one serving of sea lion meat with fat! See Figure 12. Salmon, reindeer, seal, and other traditional foods are good sources of iron. Dried fruits and beans also contain iron.

FIGURE 12  Comparing Iron in Sea Lion to Other Foods

1 serving of sea lion has 10.5g of iron.

One serving of reindeer has 6.2 grams of iron. You have to eat 1.7 servings of reindeer meat to get the same amount of iron in sea lion.

or

One hot dog has 0.34 grams of iron. You have to eat 31.8 servings of hot dog to get the same amount of iron in sea lion.

or

One serving of ground beef has 2.9 grams of iron. You have to eat 3.7 servings of ground beef to get the same amount of iron in sea lion.
Comparison of Total Fat and Total Saturated Fat

“Good fats” versus “bad fats”

Sea lion meat with fat provides a good source of healthy fats. Fat is an important part of a healthy diet. Foods with very little saturated fats and higher essential fatty acids (unsaturated fat) are best for our health. Total fat content includes saturated fats and unsaturated fats. Saturated fats, the “bad fats” raise cholesterol levels and contribute to heart disease and strokes. They tend to come from animal-based foods like butter, meat, eggs, and milk. The American Heart Association recommends consuming no more than 10% of total calories in a day from saturated fatty acids. Unsaturated fats, including essential fatty acids and omega-3 fatty acids, are the “good” fats. Humans cannot produce essential fatty acids, so they must be ingested from the food we eat. Essential fatty acids help in immune processes and vision, help form cell structures, and aid in the production of hormone-like compounds. Omega-3 fatty acids are good for the heart. They are needed for normal growth and development and may lead to decreases in cardiovascular disease, diabetes, hypertension, arthritis, autoimmune diseases, and may also improve mental health. Sea lion, halibut, and other marine mammals and fish typically have high levels of omega-3 fatty acids.

Figure 13 shows a comparison between total fat and saturated fat in traditional and store-bought foods. The sea lion meat with fat samples analyzed in this study were very low in saturated fats, as are salmon, halibut and reindeer. Hot dogs and ground beef are high in these “bad” fats. In addition, sea lion, halibut, reindeer and salmon are lower in total fat than the store-bought foods. Sea lion, low in saturated fats, has a third less total fat than ground beef, which is also higher in saturated fats. One serving of sea lion meat has 2 teaspoons of total fat whereas halibut has 0.6 teaspoons of total fat and ground beef has 3.2 teaspoons of total fat.

It should be noted that the data presented here on the sea lion fat content in the meat with fat samples was based on a small number of samples. Factors such as age, sex, size, and location and time harvested can affect the levels of fat in any animal. Therefore, many more samples would need to be analyzed to account for this variation and provide more accurate data on fat content in sea lion meat.

**FIGURE 13** Comparison of Total Fat and Total Saturated Fat

<table>
<thead>
<tr>
<th>Food Serving (100g)</th>
<th>Total Saturated Fat</th>
<th>Total Fat</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sea lion kidney</td>
<td>0.3</td>
<td>1.3</td>
</tr>
<tr>
<td>St. Paul halibut</td>
<td>0.5</td>
<td>2.7</td>
</tr>
<tr>
<td>Reindeer Meat</td>
<td>1.7</td>
<td>4.4</td>
</tr>
<tr>
<td>Red Salmon (raw)</td>
<td>15.0</td>
<td>9.0</td>
</tr>
<tr>
<td>Sea lion meat w/fat (raw)</td>
<td>16.0</td>
<td>9.3</td>
</tr>
<tr>
<td>Chicken egg, boiled</td>
<td>3.3</td>
<td>10.6</td>
</tr>
<tr>
<td>Hot dog</td>
<td>5.0</td>
<td>13.0</td>
</tr>
<tr>
<td>Ground beef 20%fat (raw)</td>
<td>7.6</td>
<td>20.0</td>
</tr>
</tbody>
</table>
Health Benefits of Eating a Traditional Diet
The preliminary results of this study show that sea lion is a highly nutritious food. It is low in salt and saturated fat, and high in protein, unsaturated fats, and selenium. Sea lion plays an important role in a healthy diet in Atka. Like other traditional foods eaten in Atka, sea lion offers many nutritional benefits. The findings from a paper entitled “Nutritional Benefits of Subsistence Foods” written by Dr. Elizabeth Nobmann\(^58\) report that:

Subsistence foods make a substantial contribution to nutritional well being. Over half of the protein, iron, vitamin B-12 and omega-3 fatty acids in the diet of some Alaska Natives come from subsistence foods.

Subsistence foods have nutritional benefits that make them preferable to many purchased foods. They are rich in many nutrients, low in fat, and contain more heart-healthy fats and less harmful fats than many store-bought foods.

Alaska Natives eating subsistence foods have lower signs of diabetes and heart disease. The diet of Alaska Natives may explain their lower rates of certain kinds of cancer.

Eating and activity involved in gathering subsistence foods has positive benefits in avoiding obesity.

A shift from a traditional diet to a diet from the store may account for the increased prevalence of dietary related diseases in Alaska.\(^6, 58, 64, 65\) The diet of the Aleut people changed after WW2. People began to consume more foods from the store.\(^66\) Prior to the 1960s, diabetes was rare among Alaska Natives, whereas today it is a problem.

Weighing the Benefits and Risks
Every time we make important decisions, we weigh the benefits and risks of taking the action. For example, when deciding whether or not to take a job, we might write a list of pros and cons. After making the list, we examine the pros and cons and make our decision. We do the same thing with our diet, whether consciously or sub-consciously.

The choice of whether or not to consume sea lion or any other food is very personal and must be our own decision. Having good information on benefits and risks helps us make more informed decisions. The information on nutrients and contaminants in sea lion provided in this report can be used to better understand the benefits and risks of consuming sea lion. However, there are other benefits and risks that are not considered in this report because they are based on personal values and lifestyle.

Diabetes has become an epidemic in the United States. In Alaska, 3.4 percent of the population 18 and over is reported to have diabetes.\(^65\) The overall prevalence of diabetes among Alaska Natives is currently similar to that of whites, however, the prevalence of diabetes among Alaska Natives continues to increase at a higher rate than that of the United States as a whole.\(^65\) Diabetes is a disease that effects all ages. It occurs when the body is unable to metabolize all of the blood sugar from the carbohydrates in the foods that we eat. People with diabetes are not able to produce enough insulin and/or use insulin properly that their body does produce. Without proper insulin levels in the blood, high sugar levels become harmful to all tissues. This can lead to serious medical problems including kidney damage, amputations, and blindness. Diabetes is also closely linked to heart disease and obesity. High blood sugar can be lowered by diet and exercise, by a number of oral medications or by insulin injections. Some studies suggest that a diet high in omega-3 fatty acids help reduce the risk of diabetes and cardiovascular disease.\(^67\) According to “Healthy Alaskans 2010- Volume 1”, “Diabetes has increased among Alaska Natives over the past decade as a shift has occurred from a traditional lifestyle to a western lifestyle with accompanying increases in body weight, decreases in physical activity, and changes in diet.”\(^66\)
Benefits of Harvesting and Eating Steller Sea Lion in Atka
The following are some questions to think about to better understand potential benefits and risks of consuming sea lion. There is not a right or wrong answer to these personal questions.

Social
Is sea lion an important food at social gatherings?
Does catching, preparing, or consuming sea lion give me the opportunity to spend time with others?
Am I too tired, busy, or have other reasons not to eat and/or prepare sea lion?

Spiritual
Do I get any spiritual fulfillment catching, preparing or consuming sea lion?
How do I feel about eating sea lion?

“In spring time and summer, when we pick berries you’re out in the open, it’s peaceful, your mind is out and you feel like you’re being touched or something…you can hear every little thing around you and it feels good.”
—Millie Prokopeuff

Environment
How does my consumption of sea lion or a replacement store food affect the environment?
What have been some of the trends in population and how does that affect take and consumption of sea lion?

52.9% of the hunters interviewed on the Aleutian Islands reported a decline in the numbers of sea lions seen in 2000 compared to 1995. 31.4% of the hunters in the region reported that the sea lion population appeared to be stable during that time period and 15.7% reported an increase in sea lions.

Culture
Should young people know how to harvest and prepare sea lion? Do they?
Does catching, preparing or eating sea lion make me feel more connected to my culture?
Do I share sea lion with others or do others share sea lion with me?

“We only hunt for food here when it’s needed and they only hunt for the amount they need… whatever they get, they first try to give it to the Elders, and then the hunters get what they want and then the rest is passed on to whoever wants it…”
—Millie Prokopeuff
Physical Health

Does sea lion hunting, preparation, sharing, and cooking give me any exercise?

Do I get exercise from getting and making store foods?

Is it dangerous for me to get sea lion?

Do I choose healthy alternatives from the store if I don’t eat sea lion?

“A doctor asked me once…What did you do? What did you use? I asked him why. You used to have high blood pressure and now you have none. I told him I just live off the ground and sea… he said “that’s good, just keep it up.” So, that’s what I still do.”

—Louis J. Nevzeroff

“You have to be fit to go after reindeer, with all the mountainous terrain and hills, you have to be able to climb and move quickly if you need to.”

—Allen Zaochney

Economics: What are the costs of diet in Atka?

How much does a pound of sea lion cost, versus a pound of meat from the store?

If I had a boat, would sea lion cost me more or less than store meat?

How do I get sea lion? Are there other ways to get sea lion? How much would it cost?

What would I eat instead of sea lion and how much would that cost me?

“…one of the strong reasons why we need subsistence out here is because we can’t afford to buy all the groceries at the store.”

—Allen Zaochney

It is expensive to live in Atka. A subsistence-based diet greatly helps offset the costs of food. The University of Alaska- Fairbanks conducts a food cost survey four times each year in several different rural Alaskan communities. Atka submitted 4 surveys in 2004-2005. The purpose of the surveys is to find out the costs for selected food items in different areas of Alaska. 104 items are listed on the survey. The items are based on a month-long low cost nutritionally-balanced menu intended to feed a family of four with school age children. Some non-food items, such as gas and heating oil, appear on the survey as well. What do the results of the survey show for Atka in 2004? The information below is based on June, September and December 2004 survey results.

On average,

- The weekly food consumption rates for a family of 4 in Atka are around $290 or $1160 per month.
- About 50% of the 104 foods listed on the survey were unavailable at the store at the time of the survey.
- Atka exceeded food costs for Anchorage by about 187% during the three survey times in 2004.
- The cost for electricity in Atka in 2004 was 3.7 times higher than Anchorage.
Lessons Learned
There were important lessons learned throughout the research process. These lessons will guide further environmental health research and continued surveillance of the health of Unangan people in the Aleutian and Pribilof Islands.

Atka Diet Survey  Having current dietary data is important for understanding consumption rates of different foods in Atka. The diet survey, completed in 1999, did not include survey results from people ages 14-19. In addition, the survey did not include questions on marine mammal fat, salted fat and oil consumption. Data on fat consumption would further inform the possible human health risk from exposure to contaminants stored in fat tissue. Updated dietary information would help to better assess contaminant exposure and health concerns.

Small Sample Size  Due to budget constraints and limited donations of Atka Steller Sea Lion, only a small number of samples were analyzed for nutrients and contaminants. It is important to use caution in interpreting the results of this study since they are based on a very small sample size. Although the contaminant results are within the range seen in marine mammals across the Arctic, many variables could alter the results. More specific information on the samples collected in Atka (i.e. size, sex, location, and time of year harvested), as well as a wider variety of animals sampled, would have provided better information about variables in contaminant loads.

Sample Analysis  Analyzing raw samples was important for a baseline understanding of contaminant data of sea lion. However, analyzing samples prepared by the community, cooked the way sea lion is eaten, would provide a more accurate representation of the contaminants and nutrients in the sea lion eaten in Atka. This information would help give a more precise perspective on levels of contaminants actually consumed.

Omega-3 Analysis  Samples were not large enough to do complete nutrient analysis. Unfortunately, the omega-3 fatty acid results were inconclusive and should be reanalyzed in any further testing completed on Steller Sea Lion. Omega-3 fatty acids were only tested on one sample of meat with fat and the level was <0.3g/serving. Marine mammal fat is known to be rich in very long chain polyunsaturated fatty acids. The amount of omega-3 fatty acids found in the sample was less than expected and further testing on more than one sample is suggested before drawing conclusions on the omega-3 fatty acid content of sea lion meat.

PCB Guidelines  There is a broad discrepancy in how different agencies interpret the significance of human exposure to low levels of PCBs. Therefore, the consumption guidelines presented by different agencies for PCBs are conflicting. International and national health organizations do not agree nor do they completely understand the effects that these low levels of exposure may have on human health. This makes it difficult to provide PCB guidance information. More studies on PCBs need to be done to help strengthen the existing scientific data.

Women of Childbearing Age (wcba)  Consumption guidelines are set for the most sensitive population which for many contaminants is women of childbearing age and the developing fetus. Guidelines for children and adults vary, but it is not clear to what extent non-wcba adults should consider existing guidelines. Setting alternate advice for all populations may help people make better decisions.

Community Participation  Essential to the success of this project was community participation. The most important factors in mobilizing the community and assuring participation were an effective local coordinator and an active Village Advisory Group. It is important for a community-based research project to have an effective and dedicated community member helping to facilitate meetings and events and keep the community engaged and informed. The Village Advisory Group helped to guide research decisions in this
SUMMARY

project. Input from this group was important in making sure community needs were addressed. Community participation in Atka was jeopardized by the lack of a consistent local coordinator and community outreach. Small villages can have research challenges, as people are already very busy and it is difficult to find people to fill positions. Because the project lacked a local coordinator for about half of the project length, community outreach and awareness suffered. When the community was engaged, as it was through Village Advisory Group meetings, important project goals were successfully achieved.

Conclusion

The Atka IRA, in partnership with the Aleutian Pribilof Islands Association and research partners, developed a process to evaluate the benefits and risks of consuming sea lion in Atka. The process included community participation in strategic planning, a diet survey, human biomonitoring, sampling and analysis, and community education. The community-driven process was an extremely important part of the research. Community awareness of dietary benefits and risks was raised through community involvement in several films, participation in surveys, and presentations at the school and in the community at large. In addition, a Village Advisory Group helped direct the research process and interacted with a Technical Advisory Group through the Traditional Foods Program Coordinator in Atka.

The Village Advisory Group chose to test local sea lion for nutrients and contaminants. Three community members donated a total of eleven samples for analysis. The limited sample size provided baseline information on contaminants and nutrients in sea lion. More sea lion samples would need to be collected and analyzed to account for variations in size, sex, age, preparation methods, and location and season harvested. (The exact number of sea lion would need to be determined through statistical analysis.) This study recognized the difficulty in further sea lion sampling; sea lion is an endangered species with great local dietary importance. Still, sea lion is not readily available for residents. Any further sampling should be sensitive to the difficulties of collecting Steller Sea Lion. Further food sampling should include sea lion, if possible, as well as other marine animals eaten in Atka.

The preliminary results showed that Atka sea lion is highly nutritious. When compared with commonly eaten foods from the store, Atka sea lion is higher in protein, iron, and unsaturated fats (the “good fats”) and lower in saturated fats (the “bad fats”). Sea lion is an especially good source of protein, iron, selenium, unsaturated fats and other vitamins and minerals. This information cannot be generalized to all sea lion since the data is based on a very small sample size.

Marine mammals tend to concentrate more contaminants than fish and other sea animals. As expected, contaminants were detected in the sea lion samples. The preliminary results from the sea lion tested showed the presence of contaminants including inorganics (metals) and organics (pesticides, PCBs, etc.). The levels of different contaminants detected in the sea lion samples are described in this report. However, it is not possible to make any definitive dietary recommendations based on the limited samples analyzed. The data presented indicates that sea lion may be a route for human exposure to many of the contaminants previously detected in human biomonitoring. Further sampling and analysis is needed in
order to better understand if the levels of contaminants found in sea lion pose a health risk to consumers. This report provides some context for interpreting the data. However, as with the nutrient information, more samples would need to be collected and analyzed to account for variables such as size, sex, age, preparation methods, and location and season harvested, as these can play a large role in varying levels of contaminants. In addition, sampling of other animals would improve our understanding of other local dietary sources of contaminant exposure.

Human Biomonitoring is critical to understanding actual human exposure levels to the most sensitive population, women of childbearing age. Past biomonitoring in Atka and other Aleutian Pribilof Islands villages by Alaska Native Tribal Health Consortium and the Division of Public Health has shown that people are not being exposed to contaminants at levels of human health concern. The Alaska Division of Public Health found insufficient evidence to cause them to change their recommendation of unrestricted consumption of traditional foods in Atka or elsewhere in the region as a result of the persistent organic pollutant biomonitoring completed in 1999.⁴ Although the 1999 human biomonitoring in Atka showed no cause for a change in diet, continued biomonitoring for contaminants in Atka is important for understanding contaminant trends. Alaska state health officials recognize the many healthy aspects of eating traditional foods, including sea lion, and encourage continued consumption as part of a varied traditional diet.⁵ People wishing to limit their exposure to PCBs, PBDEs, dioxins/furans and OC pesticides can do so by choosing more lean tissues from sea lion (such as meat instead of fat), and by including animals lower on the food chain (such as salmon, halibut, or reindeer) in their traditionally-based diet.

As older chemicals are being phased out of use because of their toxicity to people and the environment, newer chemicals are being introduced. For newer contaminants, such as PBDEs, it is important to advocate for a reduction in the use of all chemicals that could potentially cause adverse health effects. Governmental action should be encouraged to restrict continued global production and use of these chemicals. In addition to the potential risks of individual contaminants, the effects of mixing contaminants in the human body are still unknown. More effort needs to be made to understand the combined effects of these chemicals on human health.

In conclusion, there are clearly many benefits to consuming sea lion. More information is needed to confirm the levels of contaminants in Steller Sea Lion. This report helps identify some of the known and quantifiable benefits and potential risks of consuming sea lion. This information, together with our personal values, can help us make informed decisions on consuming sea lion.

**Recommendations**

**Eat a wide variety of traditional foods.**

**Women of childbearing age should participate in human biomonitoring.**

**If you would like to decrease your exposure to contaminants that may be present in traditional foods: eat more foods that are lower on the food chain and eat fewer organ tissue and/or fat.**

**Strive to replace a traditional food with another traditional food.**

**Undertake further studies on sea lion to better understand the benefits and risks of consuming it.**
ACTION: WHAT CAN YOU DO?

Participate in Human Biomonitoring Research
Measuring chemical contaminant levels in humans allows a deter-
mination of actual exposure levels of chemical contaminants in the
diet. There are currently several ways to get involved:

The Division of Public Health, Section of Epidemiology offers
statewide hair testing for mercury for all women of childbearing
age. The testing is confidential and free of charge. The results of
this program will be important in developing future public
health advice for fish consumption in Alaska. To participate in
the Statewide Hair Mercury Biomonitoring Program and for
more information on how to collect and submit hair samples,
call the Section of Epidemiology, Environmental Public Health
Program at 907-269-8000.

The Alaska Native Tribal Health Consortium’s Maternal and
Infant Monitoring Program offers pregnant women blood testing
for nutrients and contaminants. No additional needle prick is
necessary as blood is taken during the first prenatal visit when
blood is already being drawn. A sample of blood is also taken
from the umbilical cord when the baby is born. Contact Martina
Lauterbach, RN, for more information: 907-729-3680.

Reduce pollution
You can take simple steps to help prevent pollution in your com-
munity. Some ways to prevent pollution include: buying less pack-
aged food, walk for transportation, reduce your use of hazardous
materials, safely disposing of unused hazardous materials, not
spilling gasoline, and not burning plastic and other materials that
may produce toxic fumes. On a more global level, you can become
involved in helping to prevent the manufacture and use of toxic
chemicals internationally. Learn more about what persistent organic
pollutants are and what actions need to take place to eliminate these
chemicals. Check out this website for more information:
http://www.ienearth.org/pops_threat-p1.html

Get Involved! Participate in
Biomonitoring Research
**Eat Healthy**
Learn more about the traditional foods and store-bought foods you consume. Check out nutrient fact labels before purchasing food and compare labels. Also, be thoughtful about how you prepare your food. Adding extra salt, fat and sugar to food makes it less healthy. Support your immune system by eating well. Nutritious food helps your body function well, fight disease and reduce contaminants.

**Make Healthy Choices**
Smoking cigarettes introduces contaminants into the body. Children are even more susceptible to cigarette smoke than adults. Make sure to keep smoke free areas for children. Another healthy choice to make would be to use non-toxic household chemicals.

**Check out these websites:**

Centre for Indigenous Peoples’ Nutrition and Environment:
http://cine.mcgill.ca

Arctic Monitoring and Assessment Program:
http://www.amap.no/

Northern Contaminants Program:
http://www.aicn-inac.gc.ca/ncp/index_e.html

Arctic Health:
http://www.arctichealth.org/

American Indian Health:
http://americanindianhealth.nlm.nih.gov/

Alaska Native Science Commission:

Contaminants Found Me Curriculum Guides:
www.contaminants.ca/about/pdfVersions/CFMBook2.pdf

Health Canada Guidelines
http://www.hc-sc.gc.ca/fn-an/securit/chem-chim/
contaminants-guidelines-directives_e.html#guidelines

EPA PCB guideline explanation:
http://www.epa.gov/iris/subst/0389.htm
REFERENCES


5. Department of Health and Social Services, Division of Public Health, Section of Epidemiology, Correspondence, Hair Mercury Biomonitoring, Atka, Alaska, April 8, 2004.


24 Dietary Guidelines for Americans 2005, Department of Health and Human Services (HHS) and the Department of Agriculture (USDA).


36 The Extension Toxicology Network: http://extoxnet.orst.edu/tibs/partperm.html


41 Rey M, Turcotte F, Lapointe C, Dewailly E. High blood cadmium levels are not associated with consumption of traditional food among the Inuit of Nunavik. J Toxicol Environmental Health 1997; 51:5-14.


Mercury Graph

Halibut, salmon and cod: Alaska Department of Environmental Conservation (ADEC) Available 2005 results from ADEC’s fish monitoring project. The website is updated regularly to include recent fish monitoring results.
http://www.dec.state.ak.us/eh/vet/fish.htm


Department of Health and Social Services, Division of Public Health, Section of Epidemiology, Hair Mercury Biomonitoring, compiled by McLaughlin, Joseph, 2006.


Alaska Traditional Knowledge and Native Food Database. Available at: http://www.nativeknowledge.org/login.asp.


Dietary Guidelines for Americans 2005, Department of Health and Human Services (HHS) and the Department of Agriculture (USDA).


Nutrient calculations were performed using the Nutrition Data System for Research (NDS-R) software version 4.06, developed by the Nutrition Coordinating Center (NCC), University of Minnesota, Minneapolis, MN, Food and Nutrient Database 34, released May 2003.
Schakel SF, Sievert, YA, Buzzard IM. Sources of data for developing and maintaining a nutrient database. J Am Diet Assoc 1988; 88: 1268-1271.


66 Interview Mary Buordukofsky, St. Paul Island, AK., October, 2002.


68 Interview Millie Prokopeuff, Atka, Alaska. 2002

69 Wolfe RJ, Fall JA, Stanek RT. Alaska Department of Fish and Game Division of Subsistence. The Subsistence Harvest of Harbor Seals and Sea Lions by Alaska Natives in 2002 Technical Paper No. 277.

70 Interview Louis J. Nevzoroff, Atka, Alaska. 2002

71 Interview Allen Zaocnhey, Atka, Alaska. 2002

Appendix B: Nutrients Tested and Methods

The method reference is listed next to the nutrient in parentheses.

Proximates
Ash (AOAC 923.03)
Moisture (AOAC 925.09)
Protein (HPLC)
Carbohydrates (total) (AOAC)
Fats (total) (AOAC 950.54)
Dietary Fiber (AOAC 992.16)
Calories (AOAC)

Fats
Cholesterol (AOAC 994.10)
Saturated (AOAC 996.06)
Monounsaturated (AOAC 996.06)
Polyunsaturated (AOAC 996.06)
Stearic Acid (AOAC 996.06)
Trans Fatty Acid (AOAC 996.06)
Omega-3 Fatty Acids (GCFID)

Amino Acids
Alanine (Phenomenex EZ:faast GC-FID)
Arginine (Phenomenex EZ:faast GC-FID)
Aspartic acid (Phenomenex EZ:faast GC-FID)
Cystine (Phenomenex EZ:faast GC-FID)
Glutamic acid (Phenomenex EZ:faast GC-FID)
Glycine (Phenomenex EZ:faast GC-FID)
Histidine (Phenomenex EZ:faast GC-FID)
Isoleucine (Phenomenex EZ:faast GC-FID)
Leucine (Phenomenex EZ:faast GC-FID)
Lysine (Phenomenex EZ:faast GC-FID)
Methionine (Phenomenex EZ:faast GC-FID)
Phenylalanine (Phenomenex EZ:faast GC-FID)
Proline (Phenomenex EZ:faast GC-FID)
Serine (Phenomenex EZ:faast GC-FID)
Threonine (Phenomenex EZ:faast GC-FID)
Tryptophan (HPLC)
Tyrosine (HPLC)
Valine (Phenomenex EZ:faast GC-FID)

Minerals
Calcium (Ca) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Chromium (Cr) (EPA 200.3/200.8 ICPMS)
Copper (Cu) (EPA 200.3/200.8-ICPMS)
Iron (Fe) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Magnesium (Mg) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Manganese (Mn) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Molybdenum (Mo) (EPA 200.3/200.8-ICPMS)
Phosphorus (P) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Potassium (K) (EPA 6020 and EPA 200.3/200.7-ICPOES)
Selenium (Se) (APHA 3114 C-Auto Continuous)
Sodium (Na) (EPA 6020)
Zinc (Zn) (EPA 6020 and EPA 200.3/200.8-ICPMS)

Vitamins
Vitamin A (AOAC 992.04)
Vitamin C (AOAC 967.22)
Vitamin D3 (HPLC)
Vitamin E (HPLC)
### U.S. EPA Calculation of Tissue Consumption Limits for PCBs

<table>
<thead>
<tr>
<th></th>
<th>PCB conc (mg/kg)</th>
<th>Daily Limit (g)</th>
<th>Monthly Limit (g)</th>
<th>Monthly limit (oz)</th>
<th>Monthly limit (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL meat w/ fat*</td>
<td>0.087</td>
<td>16.09195402</td>
<td>482.7586207</td>
<td>16.9</td>
<td>1.1</td>
</tr>
<tr>
<td>SL fat</td>
<td>1.28</td>
<td>1.09375</td>
<td>32.8125</td>
<td>1.1</td>
<td>.07</td>
</tr>
<tr>
<td>SL salted fat</td>
<td>1.1</td>
<td>1.272727273</td>
<td>38.18181818</td>
<td>1.3</td>
<td>0.083522727</td>
</tr>
</tbody>
</table>

Reference Dose (RfD) is .00002 mg/kg/d
Daily CRlim (kg/d) = (.00002 mg/kg/d)(70 kg)/tissue concentration (mg/kg)
*(SL meat w/fat is average of 3 animals; others are one sample)

### Health Canada Calculation of Tissue Consumption Limits for PCBs

<table>
<thead>
<tr>
<th></th>
<th>PCB conc (mg/kg)</th>
<th>Daily Limit (g)</th>
<th>Monthly Limit (g)</th>
<th>Monthly limit (oz)</th>
<th>Monthly limit (lbs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SL meat w/ fat*</td>
<td>0.087</td>
<td>805</td>
<td>24137.93103</td>
<td>844.8</td>
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<tr>
<td>SL fat</td>
<td>1.28</td>
<td>55</td>
<td>1640.625</td>
<td>57.4</td>
<td>3.6</td>
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<tr>
<td>SL salted fat</td>
<td>1.1</td>
<td>64</td>
<td>1909.090909</td>
<td>66.8</td>
<td>4.2</td>
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</tbody>
</table>

Per Kuhnlein 1995 #3803:
Tolerable daily intake 1 ug/kg and was under review as of 1995
Daily CRlim (kg/day) = (0.001mg/kg/d) (70kg)/tissue concentration (mg/kg)
*(SL meat w/fat is average of 3 animals; others are one sample)
## Appendix D: Tolerable Monthly Consumption Guidelines for Steller Sea Lion Samples (pounds/month)

<table>
<thead>
<tr>
<th>Tissue</th>
<th>Sample Number</th>
<th>Sum PCBs</th>
<th>Sum DDT</th>
<th>Sum Chlor-dane</th>
<th>Sum HCH</th>
<th>Dieldrin</th>
<th>Hepatoclor Epoxide</th>
<th>Mirex</th>
<th>Mercury</th>
<th>Cadmium</th>
<th>Inorganic Arsenic</th>
<th>Dioxin TEQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Liver</td>
<td>S001</td>
<td>4.51</td>
<td>60.79</td>
<td>21.00</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>0.42</td>
<td>4.91</td>
<td>20.69</td>
<td>30.80</td>
<td></td>
</tr>
<tr>
<td>Heart</td>
<td>S002</td>
<td>8.40</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.81</td>
<td>115.50</td>
<td>NA</td>
<td>462.00</td>
<td></td>
</tr>
<tr>
<td>Salted Fat</td>
<td>S003</td>
<td>0.09</td>
<td>1.04</td>
<td>0.32</td>
<td>ND</td>
<td>1.54</td>
<td>0.70</td>
<td>77.00</td>
<td>24.32</td>
<td>NA</td>
<td>NA</td>
<td>1.21</td>
</tr>
<tr>
<td>Meat</td>
<td>S006</td>
<td>11.85</td>
<td>55.00</td>
<td>19.52</td>
<td>ND</td>
<td>56.34</td>
<td>ND</td>
<td>ND</td>
<td>0.67</td>
<td>ND</td>
<td>ND</td>
<td>462.00</td>
</tr>
<tr>
<td>Fat</td>
<td>S007</td>
<td>0.07</td>
<td>0.80</td>
<td>0.27</td>
<td>47.79</td>
<td>1.22</td>
<td>0.55</td>
<td>48.63</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
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<tr>
<td>Meat</td>
<td>S010</td>
<td>2.01</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.72</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>15.40</td>
</tr>
<tr>
<td>Meat w.Fat</td>
<td>S011</td>
<td>0.95</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.76</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>33.00</td>
</tr>
<tr>
<td>Meat w.Fat</td>
<td>S012</td>
<td>18.86</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>NA</td>
<td>0.68</td>
<td>ND</td>
<td>ND</td>
<td>ND</td>
<td>77.00</td>
</tr>
<tr>
<td>Kidney</td>
<td>S013</td>
<td>11.13</td>
<td>144.38</td>
<td>54.35</td>
<td>ND</td>
<td>64.17</td>
<td>ND</td>
<td>3.70</td>
<td>1.41</td>
<td>ND</td>
<td>9.06</td>
<td></td>
</tr>
<tr>
<td>Meat w.Fat</td>
<td>S015</td>
<td>2.43</td>
<td>42.78</td>
<td>12.43</td>
<td>ND</td>
<td>49.15</td>
<td>ND</td>
<td>ND</td>
<td>1.21</td>
<td>ND</td>
<td>55.44</td>
<td>57.75</td>
</tr>
<tr>
<td>Meat w.Fat</td>
<td>S016</td>
<td>0.53</td>
<td>7.45</td>
<td>1.84</td>
<td>389.33</td>
<td>7.97</td>
<td>5.46</td>
<td>ND</td>
<td>1.54</td>
<td>ND</td>
<td>40.76</td>
<td>9.06</td>
</tr>
</tbody>
</table>

| USEPA RfD ug/kg-bw/day** | 0.02 | 0.5 | 0.06 | 0.3 | 0.05 | 0.013 | 0.2 | 0.1 | 1 | 0.3 | 10* |

ND = not detected
NA = not analyzed

*Health Canada Tolerable Daily Intake (pg/kg-bw/day or picograms per kilogram body weight per day)

**micrograms per kilogram body weight per day

This data should not be used as actual consumption guidelines. This data cannot be assumed to be representative of all the sea lion population, as a much larger sample size would need to be taken to accomplish this. This table is provided to illustrate the calculations that were performed to determine which chemicals may pose the greatest human health risk to consumers from sea lion consumption.