Introduction

For centuries the Great Lakes basin has supplied the Ojibwe people with abundant sources of food. Today, wild fish, game and plants continue to be important sources of nutrition for the Ojibwe. However, today tribal members must be alert to the potential of contamination in wild food sources, such as fish.

The Great Lakes Indian Fish & Wildlife Commission (GLIFWC) has prepared this supplement in an effort to support tribal members’ efforts to continue their traditional harvesting practices, promote traditional diets as a means of improving tribal members’ health conditions, and protect the health and safety of reservation communities. The following articles cover areas including:

- Making choices to reduce health risks from chemical contaminants found in fish;
- Health benefits of eating fish;
- GLIFWC’s fish sampling and testing programs for inland waters and Lake Superior;
- Cooperative implementation of new federal seafood safety regulations through cooperative training and partnership agreements between tribes and the U.S. Food and Drug Administration (FDA), and;
- Purchase locations for Lake Superior fish.

Making choices to reduce your risk

Fish provide a low-fat, high protein source of food that is known to provide health benefits. The challenge is to make decisions that enable you to obtain the health benefits of eating fish while minimizing the health risks to you and your family. To accomplish this, it is important to consider these important points:

- Contaminants in fish pose different risks for different ages of people. Special care needs to be taken by women intending to have children, pregnant women, breastfeeding mothers, and children under 15 years of age.
- Contaminant levels in fish vary by location. Choose lakes that are known to have fish with lower levels of contaminants.
- Contaminant levels vary by fish species. Choose fish that don’t eat other fish, because their contaminant levels are often higher.
- Contaminant levels in fish vary by size. Choose smaller fish.
- Cooking reduces PCBs and other pesticides in Lake Superior fish, but not mercury.
- Trimming Lake Superior fish significantly reduces PCBs and other pesticides, but not mercury.

Studies on contaminants in fish have been undertaken since the early 1970’s and continue to increase in their number and complexity. For instance, each of the states bordering Lake Superior publish and distribute “Fish Consumption Advisories.”

Tribes have also been active in conducting assessments to determine contaminant levels in fish harvested and eaten in reservation communities. Because of the numerous studies conducted, scientists are able to provide recommendations that can help you reduce your exposure to chemical contaminants in fish.

While chemical contaminants are found and regulated in many foods, easy access to information regarding the levels of chemical contaminants or recommendations to reduce your exposure from them is rarely publicized for consumers. Chemical contaminants also are present at various levels in foods such as milk, eggs, potatoes, meat fruits, and vegetables, although they have not received the attention given to fish. The information provided in this supplement allows readers to consider and apply advice to reduce your exposure from freshwater fish. The more you apply advice, the more likely you will be able to reduce your exposure.

Contaminants in fish pose different risks for different groups of people

Sensitive populations are considered to be women intending to have children, pregnant women, breastfeeding mothers, and children under 15 years of age. It is important for women planning to have children to reduce their risk from chemical contaminants in all foods including fish.

A fetus is very sensitive to methylmercury poisoning because its nervous system is developing. Also, some scientific studies have reported impacts on infant (See Risk related to size and species, page 2).

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A fetus is very sensitive to methylmercury poisoning because its nervous system is developing. Also, some scientific studies have reported impacts on infant (See Risk related to size and species, page 2).
Risk related to size and species

(Continued from page 1)

and child development from PCBs. If you are within this special population, you should carefully select the locations, types, and sizes of fish you plan to eat.

General populations are considered women not planning to become pregnant and men. Those individuals are considered to be at less risk and can safely consume fish with higher levels of chemical contaminants. While risks to sensitive populations are connected to abnormal infant and child development, risks to the general population are more commonly related to an increase chance for cancer. However, it is important to keep the perceived risk of cancer from eating fish in perspective.

As noted in the “Minnesota Fish Consumption Advisory,” May 2000: “At worst, using the EPA methods to calculate risk from a lifetime of eating contaminated fish, it is estimated that approximately one additional cancer case may develop in 10,000 people eating contaminated fish.”

Contaminant levels in fish vary by location

Choose lakes that are known to have fish with lower levels of contaminants

Contaminant levels in fish vary between lakes. If you or your family members are in the sensitive population, select fish from waters that have been shown to have lower contaminant levels. The graph below shows that PCB concentrations in lake trout have been decreasing throughout the Great Lakes and have historically been the lowest in Lake Superior (see Graph 1). If you are eating fish from inland waters, refer to GLIFWC’s Mercury Contamination of Walleye (Ogaa) maps to select harvest locations.

![Graph 1. Average total PCB concentrations in whole lake trout from the Great Lakes, 1972-1998 (DeVault et al. 1996, EPA unpublished date. Figure provided by Robert Day of the Michigan Department of Environmental Quality.]

Contaminant levels vary by fish species

As a general rule and absent any other information, choose fish that don’t eat other fish. Some contaminants can build up in ever increasing amounts as small insects are eaten by small fish, which in turn are eaten by larger fish.

For example, Table 1 shows that a Lake Superior lake trout, a predator known to eat other fish, has PCB levels 7 times greater than a similarly sized whitefish, a species that eats aquatic insects. Table 1 also shows the methylmercury level in lake trout was 2.5 times greater than that found in whitefish.

GLIFWC documented that Lake Superior whitefish and lake herring had low chemical contaminant levels, so by choosing these species, women of childbearing age and children can get health benefits from eating fish while reducing their risk from chemical contaminants.

Both lake trout & whitefish meet FDA restrictions

Whitefish are significantly lower in contaminants

<table>
<thead>
<tr>
<th>Lake Superior Fish</th>
<th>Size (inches)</th>
<th>PCBs ppm</th>
<th>Methylmercury ppm</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitefish</td>
<td>22-24</td>
<td>0.0323</td>
<td>0.065</td>
</tr>
<tr>
<td>Lake trout</td>
<td>25-26</td>
<td>0.229</td>
<td>0.163</td>
</tr>
</tbody>
</table>

Difference Lake trout v. Whitefish (trimmed off fillets) 7 times greater 2.5 times greater

(Table 1. Both of these fish species fall below FDA contaminant restrictions. This information has been presented to illustrate the point that predators often have higher contaminant levels than fish that do not eat other fish.)

Contaminant levels in fish vary by size

As a general rule and absent any other information, choose smaller fish. As fish grow, they take in more contaminants from their food and environment. You can reduce your exposure from environmental contaminants by obtaining smaller sizes of a particular fish. Table 2 shows that lake trout between 27-28 inches have 1.7 times the levels of PCBs than found in lake trout between 25-26 inches. Furthermore, the 27-28 inch lake trout had over two times the levels of methylmercury found in lake trout between 25-26 inches in size.

![Table 2]

If you eat walleye from inland waters, refer to GLIFWC’s Mercury Contamination of Walleye (Ogaa) maps to select the sizes of fish that are below .5 ppm for women and children. Select sizes of fish that are below 1 ppm for men, elders and women beyond child-bearing years.

Trimming Lake Superior fish significantly reduces PCBs and pesticides, but not mercury

While all Lake Superior lake trout, whitefish, and herring samples tested by GLIFWC were below U.S. FDA action limits for chemical contaminants, trimming the fat tissue from fillets and removing the skin from whitefish reduced PCB levels by 44%.

Trimming fillets and removing skin from lake trout and sicowet trout also significantly reduced the concentration for PCBs, chlordane, and other organic persistent contaminants (Table 3). The following diagram illustrates how subsistence fishers can trim their fillets to reduce PCBs and pesticides found in Lake Superior fish. (Figure 1). Trimming fillets and removing skin did not reduce mercury concentrations in Lake Superior fish due to mercury being bound to muscle tissue.

Cooking reduces PCBs and pesticides in Lake Superior fish, but not mercury

In 1993, Dr. Mary Zabik, Michigan State University, released the results of a study on contaminants in cooked Great Lakes fish. This study examined a variety of cooking methods including baking, charbroiling, charbroiling of scored fillets, deep fat frying, pan frying, salt boiling, smoking, and canning. The results of the study showed that PCBs could be reduced in lake trout by 51% through processing and cooking. The table below was prepared from information presented in Michigan Sea Grant Extension’s publication Eating Great Lakes Fish.

<table>
<thead>
<tr>
<th>Skin-on fillet</th>
<th>Three to seven pound lake trout</th>
<th>PCBs were reduced by trimming fat from the fillet and removing skin</th>
<th>PCBs were reduced by cooking</th>
<th>Total Reduction in PCBs</th>
<th>Percent of PCBs remaining in the edible portion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitefish</td>
<td>100%</td>
<td>-23%</td>
<td>-23%</td>
<td>51%</td>
<td>49%</td>
</tr>
<tr>
<td>Lake trout</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin-on</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Skin-off</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

“Scoring the fish resulted in an additional decrease in contaminants. Scoring—or making shallow cuts in the fish flesh—increases the surface area of the fish and decreases the fat in the flesh when cooked. An additional 3-5% of contaminants was lost in fish that were scored,” Zabik reported in her study.

While Dr. Zabik’s study found “few significant differences in contaminant reduction between various cooking methods,” the “Michigan 2000 Fish Advisory” recommends that fish containing higher fat content be cooked so the fat drips away. This can be accomplished by baking, broiling, or grilling fillets on a rack to reduce chemical contaminants in the edible portion of the fish. The advisory also recommends against pan-frying fish in butter or animal fat. If fish is to be deep fried, the advisory recommends the use of vegetable oil, and after frying, drain and dispose of the oil. The basis for these recommendations is the belief that PCBs and pesticides are stored in the fat of fish. The higher the fat content of the fish and the greater the known PCBs and pesticide levels, the greater the risks to women of child-bearing years and children.

CLEANING GREAT LAKES FISH

1. Low levels of fat reduces water contact and tend to accumulate in fatty parts of the fish and should be removed.
2. Carefully fillet the fish with a sharp, long-bladed knife.
3. Skin the fillets, holding the tail section firmly. Run the blade between the skin and the meat along the table surface.
4. Trim fat along top corner of the fillet.
5. Trim fat along edges of fillet.
6. Beine, broil or barbecue fish on a rack to allow fat to drip off.

(Figure 1. Reprinted from Food Safety News, a publication of the Michigan State University Cooperative Extension Service.)
Health benefits of eating fish

The benefits of eating fish, a traditional source of nutrition for the Ojibwe, often becomes obscured by the contemporary focus on contamination. In November, 1995 Dr. Harriet V. Kuhnlein, McGill University, prepared a report for the Mille Lacs Band of Chippewa entitled Ojibwe Health and Traditional Food Use. Building upon many years of work with McGill University, the Canadian government, and native communities, Dr. Kuhnlein identified many important relationships between traditional foods, nutrition, and current health conditions in tribal communities. Excerpts of Dr. Kuhnlein’s findings are as follows:

What are the food-related health problems of the Ojibwe and Band members?

Food-related chronic disease for the Wisconsin and Minnesota Ojibwe...are documented to include obesity, diabetes and its complications, cardiovascular diseases including hypertension, gall-bladder disease and dental disease...

Can traditional Ojibwe food be used to improve the diet of Band members?

Modest adjustments to diets of adults that remove high fat food items, and replace the energy with traditional food species of deer, walleye, perch, trout, pumpkin and squash would make the average diet meet recommended dietary allowances (RDAs) levels for all nutrients assessed except calcium. The hypothetical average all-traditional diet appears nutritionally adequate in all respects, except calcium.

Can traditional Ojibwe food be used to improve the well-being of Band members?

In addition to improving diet and thereby contributing to health promotion, traditional Ojibwe food can be used to improve general well-being. Literature review and interview research results demonstrated that harvesting and use of traditional Ojibwe food are cultural activities that can impart connectedness to the environment and to Ojibwe society. These activities have emotional and, for some, spiritual values that promote cultural morale and mental health. Band members strongly agreed that the cultural values of harvesting and using traditional Ojibwe food were important to them in many ways and should be taught to their children.

In her research, Dr. Kuhnlein cited numerous studies documenting the health benefits of eating fish. “Traditional cultures using fish and sea mammal food are well-known to consume important quantities of n-3 fatty acids (the omega fats) that protect against cardiovascular disease, certain cancers, and have recently been implicated in diabetes prevention.”

—Dr. Harriet V. Kuhnlein, McGill University

Fish prepared over an open fire—a tasty, tantalizing and nutritious meal—is associated with some of the best time outdoors and is traditionally served at many Ojibwe feasts. (Photo by Amoose.)

• Increase the knowledge of the cultural and nutritional value of native foods in Canada;
• Promote an understanding of the current and potential contribution of native foods to good nutrition and health;
• Provide a better understanding of the effect of changing food habits on nutrition and health, and;
• Help individuals and communities choose native foods wisely, to substitute as needed with non-traditional foods, and to include a greater variety of foods in the diet.

Health Canada promotes native foods and nutritional education to improve health

The mission of Health Canada is to help the people of Canada maintain and improve their health. As part of this mission, Health Canada has prepared, published, and disseminated educational information regarding the health benefits of native foods including fish.

Using Native Foods and Nutrition—An Illustrated Reference Manual, Health Canada works with aboriginal peoples to:

![Nutrient Bar Graphs](https://example.com/nutrient_bar_graphs)

(Nutritional levels in fish)

The nutritional values for whitefish are presented in HealthCanada’s Nutrient Bar Graphs—An Illustrated Guide to the Nutrient Value of Some Foods used by Aboriginal People in Canada.

The Nutrient Bar Graphs enable readers to tell whether a serving of food is an important source of energy, and the graph reports on ten selected nutrients needed for good health: fat, carbohydrate, protein, calcium, iron, vitamin A, thiamin, riboflavin, niacin, and vitamin C.

The left-hand side of the bar graph (y-axis) gives the percentage of Recommended Nutrient Intake (RNI) for a female teenager, aged 10 to 15.

Health Canada chose a teenage girl because “her needs for essential nutrients are highest at this stage in her life. If a food makes a significant contribution to her nutrient requirements, it will also do so for other age groups.”

If a food contains more than 35% of the amount recommended for each nutrient, it is represented by a broken bar. The numbers within the bars denote per 100g serving.
**Fish continue to be culturally and nutritionally important**

(Continued from page 3) the bar show the percentage of Recommended Nutrient Intake (RNI) provided by various types of the fish. Across the bottom (x-axis) are listed energy (1 calorie = 4.183 kilojoules) and 10 essential nutrients. Table 4 shows the nutritional value of whitefish.

Numerous scientific studies have documented the health benefits of eating fish

Clearly, fish have been, and continue to be, a culturally and nutritionally important source of low fat, high protein food for the Ojibwe. Science continues to confirm the benefits of regularly eating fish (1-2 meal per week). Research has shown that fish is a good source of high-quality protein, essential fatty acids, and minerals such as iron and zinc, which are important in the diets of children. Pregnant mothers who regularly consumed fish were found to have longer gestational periods and heavier birth-weight babies, which has been associated with healthier children.**

Also, omega-3, long-chain polyunsaturated fatty acids found in several native species of Lake Superior fish are important in the development of the central nervous system (brain) and the retina (eye) of fetuses and young children.

**It is very important for women planning to have children to reduce their risks from chemical contaminants in all foods including fish. The fetus is very sensitive to mercury poisoning. Some scientific studies have reported impacts on infant and child development from PCBs. You can limit your exposure to chemical contaminants in fish prior to pregnancy, during pregnancy, and while breast-feeding by carefully selecting the locations, types, and sizes of fish to be eaten (See Advice to consider when eating fish, page 15.).

<table>
<thead>
<tr>
<th>Energy and nutrients</th>
<th>90 gram (3.17 oz) serving of broiled whitefish - percent RNI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calories</td>
<td>8% (176)</td>
</tr>
<tr>
<td>Fat</td>
<td>12% (10.2 grams)</td>
</tr>
<tr>
<td>Protein</td>
<td>50%</td>
</tr>
<tr>
<td>Calcium</td>
<td>3%</td>
</tr>
<tr>
<td>Iron</td>
<td>8%</td>
</tr>
<tr>
<td>Vitamin A</td>
<td>12%</td>
</tr>
<tr>
<td>Thiamin</td>
<td>13%</td>
</tr>
<tr>
<td>Riboflavin</td>
<td>5%</td>
</tr>
<tr>
<td>Niacin</td>
<td>41%</td>
</tr>
</tbody>
</table>

(Table 4)

Lake Superior fish have high amounts of omega 3 oils. One 8 ounce meal of siscowet trout per month, 2 meals of whitefish, 2 meals of lake trout, or 3 meals of lake herring each month would meet this requirement of 5.5 grams/month.

Consuming 1 to 2 meals of fish per week can reduce the risk of death by coronary heart disease

A project entitled “Comparative Dietary Risks: Balancing the Risks and Benefits of Fish Consumption,” funded by the U.S. Environmental Protection Agency (EPA) and conducted by Toxicology Excellence for Risk Assessment, reviewed 13 research projects that studied the relationship between fish consumption and reduced risk of death due to coronary heart disease (CHD).

Ten of the 13 studies found that consuming 1 to 2 meals of fish per week (fat or lean) reduced the risk of death due to coronary heart disease by 25 to 55% over those who ate little or no fish. These studies followed both men and women, both middle-aged and elders. The researchers concluded there was strong scientific evidence that consuming 1-2 meals of any fish a week reduces the risk of death due to coronary heart disease.

As explained by Dr. Paul Addis, UW-Minnesota, in his paper, “Omega-3 Fatty Acid Content in Lake Superior Fish,“ and in several of the research papers previously referred to, fish species with greater amounts of omega-3 fatty acids diminished the risk of heart disease. One study found the more omega-3 fatty acids a person consumed (upper limit of study was 42 grams/month), the lower their risk of death due to coronary heart disease. Specifically, the study reported that an average intake of 5.5 grams of omega-3 fatty acids per month reduced on average the risk of coronary heart disease by 50 percent.

Lake Superior fish have high amounts of omega 3 oils. One 8 ounce meal of siscowet trout per month, 2 meals of whitefish, 2 meals of lake trout, or 3 meals of lake herring each month would meet this requirement of 5.5 grams/month (see Table 5).

<table>
<thead>
<tr>
<th>Lake Superior Fish Species</th>
<th>Total Beneficial Fatty Acids (100 grams or ~8 oz serving of muscle tissue)</th>
<th>No. 8 oz Meals/Month to Achieve 5.5 grams of Omega-3 FA related to 50% reduction in death due to CHD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Herring</td>
<td>2.2 grams</td>
<td>2.5</td>
</tr>
<tr>
<td>Smelt</td>
<td>1.0 grams</td>
<td>5.5</td>
</tr>
<tr>
<td>Lake Whitefish</td>
<td>3.2 grams</td>
<td>1.7</td>
</tr>
<tr>
<td>Burbot</td>
<td>0.4 grams</td>
<td>14</td>
</tr>
<tr>
<td>Lake Trout</td>
<td>3.0 grams</td>
<td>1.8</td>
</tr>
<tr>
<td>Siscowet Trout</td>
<td>6.0 grams</td>
<td>0.9</td>
</tr>
</tbody>
</table>

(Table 5)

It is important to realize that eating fish is a learned behavior. If parents do not serve fish to their children, children are unlikely to eat fish as they become older. This can have long term impacts on the health of families and reservation communities. A modern day challenge for parents is to learn how to reduce risks from chemical contaminants while encouraging children to continue the tradition of eating fish.

While all Lake Superior whitefish, lake trout, and herring samples tested by GLIFWC are below U.S. FDA action limits for chemical contaminants, trimming the fat tissue from fillets and removing the skin from whitefish reduced PCB levels by 44%. The diagram on page two shows how subsistence fishers can trim their fillets to reduce PCBs and pesticides found in Lake Superior fish. (Staff photo)
Overall Findings

- All lake trout, whitefish, and herring samples tested under this project were below U.S. FDA action limits that restrict commercial sales for chemical contaminants.
- Concentrations of chemical contaminants varied between Lake Superior fish species. Fish lower in the food chain, such as whitefish and lake herring, had significantly lower PCB, chlordane, and mercury concentrations than predators such as lake trout and siscowet trout.
- The concentration of chemical contaminants such as PCBs, chlordane, and mercury increased with age and length of the fish.
- Trimming fillets and removing skin significantly reduced the concentration for PCBs, chlordane, and other organic persistent contaminants.
- Trimming fillets and removing skin did not reduce mercury concentrations in Lake Superior fish due to mercury being bound to muscle tissue.

Realizing that the treaty fishery and its markets are impacted by publicity surrounding fish contaminant issues and FDA’s new Seafood safety regulations, GLIFWC contracted funding from the Administration for Native American’s (ANA) program to undertake a contaminant study of Lake Superior fish and develop a tribal regulatory structure in compliance with FDA’s Hazard Analysis Critical Control Point (HACCP) seafood safety regulations.

Tribes were particularly interested in determining how the removal of belly and back fat from Lake Superior fish could reduce chemical contaminant levels in the edible portion of fish sold by tribal fishermen.

Project design

In designing the project, GLIFWC realized the study needed to address the following:

- Adequate sample size and statistical power to determine if the test results were less than the FDA action levels and state contaminant guidelines;
- Analyzed fish tissue needed to be representative of the edible portion that is to be sold;
- Analytical results needed to be supported by good quality control and quality assurance procedures including documentation.

Furthermore, in order to limit the number of samples needed to be analyzed, the following were considered:

- Within a species, larger and older fish tend to have higher contaminant concentrations;
- Species of fish at the top of the food chain tend to have higher contaminant concentrations than species of fish lower in the food chain;
- A single species of fish from a given water body tends to be exposed to similar amounts of environmental contaminants.


Collecting Lake Superior fish samples

Sample size ranges were selected after analyzing data of the lengths of Lake Superior fish measured from the tribal commercial catch from 1986 to 1999. Within a species, up to 48 fish were collected per size range.

<table>
<thead>
<tr>
<th>Common Name</th>
<th>Range (in)</th>
<th>No. Composites</th>
<th>Total No. Fish/C</th>
<th>Fish</th>
</tr>
</thead>
<tbody>
<tr>
<td>siscowet</td>
<td>17.0-18.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>siscowet</td>
<td>19.5-20.5</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>siscowet</td>
<td>22.0-23.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>siscowet</td>
<td>24.5-25.5</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>siscowet</td>
<td>24.5-25.5</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>lake trout</td>
<td>25.0-26.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>lake trout</td>
<td>27.0-28.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>lake trout</td>
<td>27.0-28.0</td>
<td>3</td>
<td>8</td>
<td>24</td>
</tr>
<tr>
<td>whitefish</td>
<td>22.0-24.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
<tr>
<td>lake herring</td>
<td>15.0-17.0</td>
<td>4</td>
<td>12</td>
<td>48</td>
</tr>
</tbody>
</table>

(Table 6)

With the help of tribal fishermen, GLIFWC and tribal biologists collected four species of fish from the southern shore of Lake Superior (See map). Fishery biologists then measured fish for total length, recorded their round weight, determined their sex, and collected otoliths and scales for aging purposes. Each fish collected was then tagged, placed into a specialized storage bag, cooled, and placed into a freezer.

A chain-of-custody form was also started for each species of fish collected from a given location on a given date and updated as samples were transferred between freezers and laboratories. This enabled GLIFWC to trace back testing results to the specific fish collected and at a specific sampling location.

Lake Superior management units in U.S. waters and areas of collection for ANA-HAACP contaminant analysis during 1998 and 1999

Processing Lake Superior fish samples

All fish were aged using standardized techniques adopted by the Lake Superior Technical Committee of the Great Lakes Fishery Commission. Each set of 48 similarly-sized fish was then divided into four (4) groups of up to 12 similarly-aged fish.

Fish samples were then processed at the Lake Superior Research Institute (LSRI), UW-Superior, Superior Wisconsin. Larry Brooke, LSRI research chemist, and Joe Duffy, Red Cliff tribal fisherman, teamed their talents to process the fish samples. Two fillets were collected from each fish. One fillet was processed raw and divided into three separate tissues of skin, muscle and fatty tissue and the other fillet was saved for commercial smoking. During this process, data was also recorded on weights and water content of samples.

Laboratory staff then cut skin and fat tissue into small pieces, froze the tissue with liquid nitrogen, and ground the tissue into a coarse powder. Muscle tissue was also ground. Similar tissues (i.e. skin, muscle, or fatty tissue) were then combined from twelve fish of similar age to form a single composite sample.

An equal weight of each set of tissues (skin, muscle or fatty tissue) was combined (composed) into a single sample and placed into several special sample bottles and stored in a freezer. Chain-of-custody forms were then updated and samples were sent to EN CHEM, Inc. analytical laboratory in Madison, Wisconsin for chlorinated organic chemical analysis. Samples were also archived for future research.

All lake trout, whitefish, and herring samples tested under this project were below U.S. FDA action limits that restrict commercial sales for chemical contaminants.

Processing Lake Superior fish samples

All fish were aged using standardized techniques adopted by the Lake Superior Technical Committee of the Great Lakes Fishery Commission. Each set of 48 similarly-sized fish was then divided into four (4) groups of up to 12 similarly-aged fish.

Fish samples were then processed at the Lake Superior Research Institute (LSRI), UW-Superior, Superior Wisconsin. Larry Brooke, LSRI research chemist, and Joe Duffy, Red Cliff tribal fisherman, teamed their talents to process the fish samples. Two fillets were collected from each fish. One fillet was processed raw and divided into three separate tissues of skin, muscle and fatty tissue and the other fillet was saved for commercial smoking. During this process, data was also recorded on weights and water content of samples.

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(See Sampled Lake Superior fish, page 6)
Testing Lake Superior fish samples

Each composite sample was analyzed for total mercury, polychlorinated biphenyls as aroclor mixtures, and a suite of chlorinated pesticides. Mercury testing was completed at the Lake Superior Research Institute at the U.W. Superior and the University of Minnesota-Duluth. Chlorinated organic analyses were conducted by EN CHEM, Inc. of Madison, Wisconsin.

Polychlorinated biphenyls (PCBs) findings

• None of the Lake Superior fish samples (lake herring, whitefish, lake trout, or siscowet trout) exceed the U.S. FDA’s PCB action limit for commercial sales for PCBs of 2000 ppb (2.0 ppm).

Trimming fillets lead to reduced PCB contaminant levels by 12% to 40% depending on the fish species. For example, PCB contaminant levels in whitefish were reduced 32% and in lake trout 23-25%. PCB contaminant levels in siscowet trout were reduced between 12-40% depending upon the length of the fish. (See Trimmed Skin-On figures in Table 7.)

Removing skin from fillets further reduced PCB concentrations in whitefish, lake trout, and siscowet trout between 17 and 20.5 inches. (See Trimmed Skin-Off figures in Table 7.)

Chlordane findings

• None of the Lake Superior fish samples of lake herring, whitefish, or lake trout exceeded the U.S. FDA’s chlordane action limit of 300 ppb (0.3 ppm) for commercial sale.

Siscowet samples in the 17-18 inch size group and the 19.5-20.5 inch size group did not exceed the U.S. FDA’s chlordane action limit of 300 ppb (0.3 ppm).

Siscowet from the 22-23 inch size group and 24.5-25.5 inch size group did exceed the U.S. FDA’s chlordane action limit of 300 ppb (0.3 ppm).

Trimming fillets led to reduced chlordane concentration levels by 13% to 38% depending on the fish species. For example, chlordane concentration levels in whitefish were reduced 33% and in lake trout 34%. Chlordane concentration levels in siscowet trout were reduced between 13-38% depending upon the length of the fish. (See Trimmed Skin-On figures in Table 8.)

Removing skin from fillets further reduced chlordane concentrations in whitefish, lake trout, and siscowet trout between 17 and 20.5 inches. (See Trimmed Skin-Off figures in Table 8.)

Using test results from 22 composite samples and linear regression, GLIFWC has determined that Lake Superior commercial fishermen could harvest and process siscowet trout up to 22 inches without exceeding FDA’s action limit for chlordane of 300 ppb (0.3 ppm), if the belly and back fat is removed from the fillet. (Note: see Total Chlordane Concentrations in Untrimmed and Trimmed Skin-on Siscowet Fillets from the South Shore of Lake Superior, Graph 5, page 7)
Mercury findings

- None of the Lake Superior fish samples (lake herring, whitefish, lake trout, or siscowet trout) exceed the U.S. FDA's methylmercury action limit for commercial sales of 1000 ppb (1.0 ppm).
- Only siscowet samples in the 22-23 inch size group and 24.5-25.5 inch size group exceeded 500 ppb (.5 ppm), a lower level used by Michigan for fish caught and sold in that state.

Lake Superior fish are tested for mercury

(Continued from page 6)

- Mercury findings

<table>
<thead>
<tr>
<th>Length Group</th>
<th>Processed* Age (Range)</th>
<th>Processing Revolution</th>
<th>Total Chlordane</th>
<th>Exceeds US FDA Action Limit</th>
</tr>
</thead>
<tbody>
<tr>
<td>inches</td>
<td>Filter years Percentage</td>
<td>Mean</td>
<td>Lower</td>
<td>Upper</td>
</tr>
<tr>
<td>Lake Herring (Total = 46 fish [4 composites x 12 fish])</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15-17.0</td>
<td>UT S-ON 9 (7 to 13)</td>
<td>22</td>
<td>21</td>
<td>23</td>
</tr>
<tr>
<td>Lake Whitefish (Total = 47 fish [4 composites x 11 to 12 fish])</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22-24.0</td>
<td>UT S-ON 9 (7 to 12)</td>
<td>22</td>
<td>25</td>
<td>28</td>
</tr>
<tr>
<td>22-24.0</td>
<td>T-S-ON 33%</td>
<td>18</td>
<td>15</td>
<td>21</td>
</tr>
<tr>
<td>22-24.0</td>
<td>T-S-OFF 47%</td>
<td>14</td>
<td>11</td>
<td>17</td>
</tr>
<tr>
<td>Lake Trout (Total = 128 fish [32 composites x 4 to 12 fish])</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-26.0</td>
<td>UT S-ON 9 (6 to 14)</td>
<td>93</td>
<td>97</td>
<td>115</td>
</tr>
<tr>
<td>25-26.0</td>
<td>T-S-ON 34%</td>
<td>81</td>
<td>96</td>
<td>79</td>
</tr>
<tr>
<td>25-26.0</td>
<td>T-S-OFF 38%</td>
<td>98</td>
<td>93</td>
<td>72</td>
</tr>
<tr>
<td>27-28.0</td>
<td>UT S-ON 10 (5 to 10)</td>
<td>154</td>
<td>139</td>
<td>210</td>
</tr>
<tr>
<td>27-28.0</td>
<td>T-S-ON 34%</td>
<td>108</td>
<td>75</td>
<td>141</td>
</tr>
<tr>
<td>27-28.0</td>
<td>T-S-OFF 42%</td>
<td>99</td>
<td>72</td>
<td>127</td>
</tr>
<tr>
<td>Siscowet Trout (Total = 208 fish [22 composites x 4 to 12 fish])</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>17-18.0</td>
<td>UT S-ON 15 (10 to 17)</td>
<td>152</td>
<td>143</td>
<td>153</td>
</tr>
<tr>
<td>17-18.0</td>
<td>T-S-ON 13%</td>
<td>116</td>
<td>95</td>
<td>137</td>
</tr>
<tr>
<td>17-18.0</td>
<td>T-S-OFF 13%</td>
<td>116</td>
<td>94</td>
<td>137</td>
</tr>
<tr>
<td>19-20.5</td>
<td>UT S-ON 15 (9 to 20)</td>
<td>230</td>
<td>167</td>
<td>299</td>
</tr>
<tr>
<td>19-20.5</td>
<td>T-S-ON 25%</td>
<td>174</td>
<td>131</td>
<td>216</td>
</tr>
<tr>
<td>19-20.5</td>
<td>T-S-OFF 24%</td>
<td>176</td>
<td>131</td>
<td>235</td>
</tr>
<tr>
<td>22-23.0</td>
<td>UT S-ON 16 (11 to 24)</td>
<td>502</td>
<td>207</td>
<td>797</td>
</tr>
<tr>
<td>22-23.0</td>
<td>T-S-ON 29%</td>
<td>310</td>
<td>180</td>
<td>440</td>
</tr>
<tr>
<td>22-23.0</td>
<td>T-S-OFF 36%</td>
<td>319</td>
<td>186</td>
<td>452</td>
</tr>
<tr>
<td>23-24.5</td>
<td>UT S-ON 18 (15 to 23)</td>
<td>487</td>
<td>392</td>
<td>721</td>
</tr>
<tr>
<td>23-24.5</td>
<td>T-S-ON 12%</td>
<td>488</td>
<td>309</td>
<td>668</td>
</tr>
<tr>
<td>23-24.5</td>
<td>T-S-OFF 19%</td>
<td>486</td>
<td>303</td>
<td>579</td>
</tr>
</tbody>
</table>

* UT S-ON = Untrimmed Skin-On, T S-ON = Trimmed Skin-On, T S-OFF = Trimmed Skin-Off

(Table 8)

Total Chlordane Concentrations in Untrimmed and Trimmed Skin-On Siscowet Fillets from the South Shore of Lake Superior.

<table>
<thead>
<tr>
<th>Length (inches)</th>
<th>Total Chlordane Concentration (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>16</td>
<td>100</td>
</tr>
<tr>
<td>17</td>
<td>200</td>
</tr>
<tr>
<td>18</td>
<td>300</td>
</tr>
<tr>
<td>19</td>
<td>400</td>
</tr>
<tr>
<td>20</td>
<td>500</td>
</tr>
<tr>
<td>21</td>
<td>600</td>
</tr>
<tr>
<td>22</td>
<td>700</td>
</tr>
<tr>
<td>23</td>
<td>800</td>
</tr>
<tr>
<td>24</td>
<td>900</td>
</tr>
<tr>
<td>25</td>
<td>1000</td>
</tr>
</tbody>
</table>

US FDA Action Limit = 300 ppb (closed line)
Linear Regression

(Graph 5: Trimming 22 inch siscowet fillets [closed circles] reduced the estimated average total chlordane concentrations from around 420 ppb to at or below 300 ppb, and thus allowed 22 inch siscowet to be at or below the U.S. FDA’s no-sale action limit (300 ppb).)

Total Mercury Concentration in Skin-Off Fillets from Lake Superior Walleye Collected from around the Apostle Islands

<table>
<thead>
<tr>
<th>Species</th>
<th>Age (years)</th>
<th>Length (inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lake Herring</td>
<td>15-17</td>
<td></td>
</tr>
<tr>
<td>Lake Whitefish</td>
<td>22-24</td>
<td></td>
</tr>
<tr>
<td>Lake Trout</td>
<td>25-26</td>
<td></td>
</tr>
<tr>
<td>Siscowet Trout</td>
<td>27-28</td>
<td></td>
</tr>
</tbody>
</table>

US FDA Action Limit = 1000 ppb

(Graph 6: Total Mercury Concentrations in Three Types of Lake Superior Fish Fillets)

Total Mercury Concentration in Skin-Off Walleye Fillets

<table>
<thead>
<tr>
<th>Length (inches)</th>
<th>Total Mercury Concentration (ppb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>10</td>
<td>0.5</td>
</tr>
<tr>
<td>15</td>
<td>1.0</td>
</tr>
<tr>
<td>20</td>
<td>1.5</td>
</tr>
<tr>
<td>25</td>
<td>2.0</td>
</tr>
<tr>
<td>30</td>
<td>2.5</td>
</tr>
</tbody>
</table>

US FDA No-Sale Action Limit = 100 ppb

(Graph 7: Twenty-four walleye (16-28 inches) were collected from around Lake Superior’s Apostle Islands and only one of the largest walleye (28 inches) of the 24 collected exceeded the U.S. FDA’s 1.0 methylmercury action limit.)

The Thomas C. Mullens enters the Saxon Harbor Marina. The tug is owned by Bad River Commercial fisherman Joe Newago. (Photo by Charlie Otto Rasmussen.)

(See Testing reveals good news, page 11)
Tribes and FDA cooperatively implement seafood safety regulations

The Anishinaabe have a long commercial fishing history

According to the teachings of the Anishinaabe people, (also known as Chippewa or Ojibwe), it was the sacred Megis Shell that first guided the people to the rich regions of the Great Lakes. Lake Superior was known as Gitchi Gummi (big water) to the Anishinaabe. Here tribal fishermen harvested fish using large birchbark canoes and gill nets constructed from twisted and knotted strands of willow bark. As Europeans pushed into the Great Lakes region, the Anishinaabe people used fish to trade with French and English outposts.

GLIFWC member tribes signed treaties with the United States in 1836, 1837, 1842, and 1854 which reserved the right to harvest fish from Lake Superior for subsistence, cultural, and commercial purposes. These rights have been upheld in state and federal court decisions over the last 29 years.

Today, a number of GLIFWC member tribes license and regulate treaty fishing in Lake Superior, including Red Cliff, Bad River, Keweenaw Bay, and Bay Mills. This fishery provides an important source of income and jobs for reservation communities while supplying significant harvests of fresh water fish (See Table 10 below).

Lake Superior tribal harvest

<table>
<thead>
<tr>
<th>Species</th>
<th>1999</th>
<th>1998</th>
</tr>
</thead>
<tbody>
<tr>
<td>Whitefish</td>
<td>1,444,904</td>
<td>1,749,784</td>
</tr>
<tr>
<td>Lake Trout</td>
<td>312,723</td>
<td>304,790</td>
</tr>
<tr>
<td>Siscowet</td>
<td>87,043</td>
<td>117,501</td>
</tr>
<tr>
<td>Herring</td>
<td>71,169</td>
<td>87,971</td>
</tr>
</tbody>
</table>

(Table 10. Data from extractions report file.)

New federal seafood guidelines are established

On December 18, 1997 the Seafood Hazard Analysis Critical Control Point (HACCP) regulation became mandatory. Under this federal law all fish processors are required to:

- Complete a HACCP training program;
- Develop and adopt a HACCP plan to fit the specific needs of a processor;
- Reassess and modify the plan annually as the result of verification activities;
- Maintain and review adequate HACCP records.

The HACCP process examines biological threats, chemical threats, and physical threats on a product-by-product basis. For the Lake Superior region, federal HACCP regulations require commercial fishermen and fish processors to address potential threats, such as botulism in smoked fish products, and to control bacterial levels in fish and chemical contaminants found in the environment.

The regulation is enforced by the FDA through on-site inspections of fish processors. The Detroit District inspects fish processors in Michigan, and the Minneapolis District inspects fish processors in Wisconsin and Minnesota. Sometimes federal HACCP inspections are conducted by FDA employees and other times FDA contracts with state agencies, such as the Michigan Department of Agriculture, to conduct federal inspections.

The new federal regulations apply to both domestic producers and foreign importers and were established because of consumer demand. While the new federal HACCP regulation will not impact tribal fishermen who harvest, gut, and sell fish at dockside to processors within 24 hours, it will impact tribal fish processing operations, tribal fishermen processing and selling their harvest through their own fillet markets, or tribal fishermen smoking and selling fish.

ANA provides critical resources to develop regulatory structures and implement new federal seafood safety regulations

Realizing the impacts of the new federal HACCP seafood safety regulations on tribal fishermen, GLIFWC applied for and received a $232,000 grant from the Administration for Native Americans (ANA).

The grant enabled tribes and FDA to cooperatively implement new federal seafood safety regulations for the purpose of maintaining a viable Lake Superior fishery capable of continuing tribal fishing traditions. Under the ANA grant, GLIFWC and its member tribes:

- Tested contaminants in commercially sold Lake Superior fish;
- Determined how the HACCP process could be used to address PCB, mercury, and chlordane contaminant concerns in fish; and
- Built the foundation for a regulatory system that reaffirms tribal self-regulatory authority over tribal fishermen while meeting federal HACCP fish safety requirements.

(See Tribes and FDA enter partnership agreement, page 9)
Tribes and FDA enter partnership agreement on regulation of harvested and processed fish

(Continued from page 8)

Tribal fishermen complete HACCP training to improve the safety and quality of Lake Superior fish

With the support from ANA and FDA’s Partnership Grant, four basic HACCP training sessions were held at Keweenaw Bay (2 sessions), Bay Mills (1 session), and Red Cliff (1 session). In these three-day training sessions, 62 tribal fishermen and tribal staff were trained in seafood safety techniques, including basic HACCP principles, developing HACCP plans, and record-keeping requirements.

The training helped tribal fishermen and processors to understand why regulations regarding fish contaminants exist and how these regulations will protect both the human health and safety of their families and their markets for fish harvested under treaty rights. As the training progressed, revisions were made to the sessions resulting from suggestions on evaluation forms. For instance, more demonstration activities and customized training materials were added. Participants completing the training received an official certificate from the Association of Food and Drug Officials.

GLIFWC and the Michigan State University (MSU) Sea Grant developed computer templates and a supplemental training manual for tribal regulators, fishermen, and processors that specifically addressed chemical contaminant levels in Lake Superior fish.

The training packet incorporated FDA and EPA guidance levels for chemical contaminants (i.e. PCBs, etc.) into “real world” HACCP Hazard Analysis Worksheet models and HACCP Plan models likely to be encountered by tribal regulators and tribal fishermen/processors on reservations.

In addition to the Basic HACCP Training sessions, twelve tribal staff members completed a one day class and test for seafood safety regulators. This testing process certified tribal staff as FDA HACCP seafood safety inspectors.

FDA Partnership Agreements for the 1842 waters of Lake Superior

Bad River, Red Cliff, and Keweenaw Bay entered into formal partnership agreements with FDA concerning the protection of public health related to the regulation of fish harvested from and processed in the Michigan 1842 ceded territory. This agreement meets federal HACCP Seafood Safety requirements while reaffirming tribal sovereignty.

Under the agreement, tribal governments and the FDA will work cooperatively to promote the inspection of fish and fishery products based on HACCP principles, participate in training to improve the efficiency of inspection programs, explore the most effective ways to protect the public health, and participate in the HACCP national data base for the purpose of fostering confidence in tribally harvested and processed fish products.

In coming months, GLIFWC will be working with member tribes to develop a model tribal HACCP code establishing regulations and inspection procedures. This code will be based upon federal regulations and integrate laboratory testing results on chlordane, PCBs, and mercury. By establishing tribal seafood safety regulations, conducting HACCP inspections, and referring violations into tribal court, member tribes will maintain the self-regulatory authority over tribal fishermen and processors.

Within the Partnership Agreement, the FDA will refer all complaints to the appropriate tribal official when a complaint is made to the FDA concerning a matter that is in violation of tribal fishing regulations. This reaffirms tribal sovereign authority.

Acknowledgments

The Administration for Native Americans (ANA) program provided funding for contaminant testing of Lake Superior fish, training tribal fishermen to process fish safely, and the development of the FDA partnership agreement. The projects would not have been possible without the participation and assistance from the following individuals.

Lake Superior fish sample collection and aging:

• Tribally licensed commercial fishermen Joe Duffy, Joe Newago, Alan Newago, Gilmore Peterson, Neil Malmgren, & Cecil Peterson
• Mike Donofrio, Keweenaw Bay Biological Services Director
• Mike Gallinat, Red Cliff Fisheries Biologist
• Ed Leeso, Bad River Lake Superior Technician
• Bill Mattes, GLIFWC Great Lakes Section Leader
• Mike Pucinskas, GLIFWC Great Lakes Technician
• Dan North and Kristen Anderson, Northland College Interns
• Chuck Smart, GLIFWC limited term employee

Laboratory processing and testing:

• Joe Duffy, Red Cliff Commercial Fisherman
• Larry Brooke and Christine Polkinghorne, Lake Superior Research Institute at the University of Wisconsin—Superior
• Tom Markée, En Chem Inc.
• Tod Noltemeyer, En Chem Inc.

Project and data managers:

• Cory Groetsch, GLIFWC Environment Biologist
• Neil Kmieciak, GLIFWC Biological Services Director
• Rick Madsen, GLIFWC Data Analyst
• Jennifer Knaeger, GLIFWC Data Base Manager
• Jim Thannum, GLIFWC Natural Resource Development Specialist

Technical advisors and instructors:

• Sally Eberhard, FDA Detroit District Office
• Michael Erdman, MSU Extension Service
• Timothy Treadway, Michigan Department of Agriculture
• Ron Kinnunen, MSU Sea Grant
• Ken Gephardt, Bay Mills Fisheries Biologist
• Ralph Wilcox, Wilcox Fishery
Buy, cook, and eat fish safely

To ensure that the fish you buy and eat is as safe as possible, follow these recommended guidelines:

- Think twice before you eat raw fish. You can never be absolutely sure the fish doesn’t harbor parasites or high levels of bacteria.
- Cook fish thoroughly until it is opaque and flakes easily with a fork. Overcooking makes it dry. The best way to learn the technique is to practice.
- When buying whole fish, look for bright, clear, bulging eyes. Cloudy, sunken, discolored or slime-covered eyes often signal fish that is beginning to spoil. The skin of freshly caught fish is covered with a translucent mucus that looks a bit like varnish. The color is vivid and bright. Avoid fish whose skin has begun to discolor, shows depresions, tears or blisters, or is covered with sticky, yellowish brown mucus.
- When buying steaks or filets, look for moist flesh that still has a translucent sheen. Watch out for flesh that is dried out or gaping—the muscle fibers are beginning to pull apart. That’s a sign of over-the-hill fish.
- Note how the fish is displayed and look for clues that the temperature may be too high. Fish that are piled high, displayed in open cases or sitting under hot lights are perfect places for bacteria to grow. If fish fillets are displayed inside separate pans surrounded by ice, that’s usually a sign the retailer is paying some attention to quality. Whole fish should be displayed under ice.
- Keep an eye out for displays featuring cooked and raw fish or seafood next to each other. There’s a potential health hazard from cross-contamination—the transfer of bacteria from raw to cooked products. Buying anything from this kind of display can be risky.
- Use your nose. Fresh fish smell like the sea but have no strong odor. Fresh-water fish in good condition sometimes smell like cucumbers. Strong odors usually indicate spoilage.
- Once you buy fish, refrigerate it quickly. At home, store it in the coldest part of your refrigerator, keep it in the original wrapper and use it fast—within a day.
- If you’re concerned about quality, look for evidence that fish has been frozen and then thawed. Look for chunks of ice floating in the fish liquid—a clue that the fish had been frozen. There’s nothing wrong with frozen fish that’s been thawed, but if you unknowingly refreeze it, its texture and flavor will suffer. It’s probably better to buy frozen fish instead.

Controlling bacteria improves fish safety and taste

If you are fishing for either sport, subsistence, or commercial purposes, it is important to understand that bacteria impacts the quality and safety of fish. Fortunately, steps can be taken to control the growth of bacteria.

- Bacteria is naturally found in the slime, digestive tracts, gills, and exposed blood. It grows quickly, multiplying exponentially, after the fish is removed from the water. Bacterial growth is further increased if coolers, fish boxes, or other storage items are not properly cleaned. Once established, bacteria soon changes the texture, color, odor, and, most importantly, flavor of fish.

Don’t bruise your fish

Few people realize that fish flesh is easily damaged. If fish are bruised, enzymes are released. These enzymes soften the flesh and make nutrients available to bacteria. Food scientists have found that flesh taken from bruised fish contain 10 times more bacteria than flesh from unbruised fish. By separating fish bruised in nets, fishermen can avoid having a few highly contaminated fish, accelerating spoilage of those fish that have not been bruised.

Propperly ice your fish as soon as possible

It is important to properly ice fish. This is done by making a 1 to 2 inch bed of crushed ice, layering ice with fish, and topping the fish box or cooler off with 2 to 3 inches of additional ice. Icing fish provides the benefits of:

- Rapidly cooling the fish
- Slowing bacteria growth and enzyme activity;
- Flushing away bacteria as the ice melts;
- Prevents drying;
- Improving texture by delaying rigor mortis in hot weather; and
- Improving texture by resisting freezing in cold weather.

Food scientists have conducted studies on bacterial growth that support the recommendation that fish be iced regardless of weather conditions. Their studies have also determined that the flushing action of melting ice extended the shelf life of fish in coolers by controlling bacterial growth.

Controlling bacteria at your fish cleaning location

It is important to clean all surfaces that come into contact with fish, including coolers/fish boxes, slickers/rain gear, knives, and cutting boards or tables. After cleaning fish, it is important to remember to first clean with a detergent. Then separately sanitize your fish shed by using one pint of unscented bleach to 12 gallons of water. You can improve the safety and taste of your fish if you follow these recommendations:

- Rinse surfaces to remove blood, scales, and other fish wastes.
- Brush with a warm noncaustic detergent solution.
- Rinse with clean water.
- Brush on chlorine sanitizer (unscented bleach).
- Allow to dry on plastic and wood. If you use a stainless steel table for cleaning fish, rinse with clean water.

It is important to remember that all of your cleaning efforts will mean little if you fail to properly wash your hands before handling fish products. Antibacterial soap and hand sanitizers can be used at any location and assist in maintaining high quality and safe food products.

Storage times at 0° F

<table>
<thead>
<tr>
<th>Kind of fish</th>
<th>Tastes like fresh</th>
<th>Maximum storage</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>FAT</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>salmon</td>
<td>3 months</td>
<td>9 months</td>
</tr>
<tr>
<td>lake trout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>rainbow trout</td>
<td></td>
<td></td>
</tr>
<tr>
<td>chubs</td>
<td></td>
<td></td>
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<tr>
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Freezing freshwater fish

The quality of frozen fish is affected by several factors—prefreezing quality, handling during preparation, and protection by packaging during freezing and storage.

Below are recommendations summarized from Michigan State University Cooperative Extension Service’s Commercial Freezing of Freshwater Fish, Extension Bulletin E-1323. If you are fishing for either sport, subsistence, or commercial purposes, following these recommendations will improve the safety and quality of your frozen fish.

- Only freeze the finest quality fish. Fish quality deteriorates rapidly, the longer you wait to freeze freshwater fish the poorer the quality. In a short time the connective tissue in the muscle becomes soft and causes gaping. This allows the flesh to dry out and lose juices.
- Freezing effects quality—poor quality results from freezing fish slowly. Slowly freezing causes less protein and ice crystals to form. This destroys the fish’s texture and taste. To prevent this problem, freeze fillets individually or in thin boxes—small objects freeze faster.
- Freezer burn is caused by dehydration. Prevent freezer burn by tightly packaging fish so moisture is not lost during frozen storage.
- Fish need to be properly packaged to prevent freezer burn, fat oxidation, or cross-contamination. PVC and polyester are commonly used to freeze fish. Vacuum packing is becoming more popular as prices have come down in recent years. While wax paper and cartons have been traditionally used by the fishery industry, they allow the passage of air and moisture.
- Each lot of fish should be labeled with the lot number and date to insure that frozen fish is turned over on a first-in, first-out basis. Those fishing for subsistence purposes should also refer to GLIFWC’s contaminant information to determine the chemical contaminant levels in fish to be frozen and label selected bags as, “reserved for children and women of child bearing age,” to minimize exposure to individuals in sensitive populations.

For more information on fish farming, fishing, and processing, see the Michigan Sea Grant Program’s Commercial Freezing of Freshwater Fish, Extension Bulletin E-1323.
Tips for keeping smoked fish safe

Smoked Lake Superior fish has been enjoyed by the Anishinabe and their visitors for hundreds of years. This regional delicacy remains available today at numerous locations along Lake Superior’s south shore (See Tribal retail & wholesale outlets, page 12).

**Botulism toxins can be deadly**
Clostridium botulinum, commonly referred to as botulism, is found in soil, water, vegetables, meats, dairy products, and fish. The botulism toxin develops from spores of the botulism bacteria. These spores grow and produce a toxin when non-acid food (e.g., meat, fish, poultry, and vegetables) is held in an air-tight container such as a plastic bag or cans.

Botulism is both deadly and hard to detect since it produces little noticeable evidence of spoilage. Because botulism produces heat-resistant spores and requires the absence of oxygen for growth, it has been commonly associated with improperly canned food (usually home canned).

**Botulism toxins are easily controlled**
While the botulism toxin can be deadly, it is easily controlled. Using Hazard Analysis Critical Control Point (HACCP) techniques, Lake Superior fish smokers ensure proper salt content in their brining solutions. Fish smokers also ensure adequate cooking times (i.e. a minimum of 30 minutes) and temperatures (i.e. a minimum of 145°F) to destroy the bacteria that produces the botulism toxins.

**Refrigerate smoked fish**
Lake Superior fish smokers also use HACCP techniques to ensure that smoked products are stored at proper temperatures (38°F or below) and are properly labeled. Consumers reading the labels provided on smoked fish products will find these products must be:

- kept refrigerated at or below 38°F, and
- eaten by a specified expiration date.

Ensuring that your smoked fish is in a refrigerated condition will keep you and your family safe and returning for more of Lake Superior’s famous smoked fish.

**Freezing freshwater fish**
(Continued from page 10)

- Keep your freezer cold. A storage temperature of -20°F or colder is strongly recommended by food scientists. When stored at 0°F, fish have only half the storage life possible at -20°F.
- Thawing fish in still air is not recommended—the surface of the fish will warm, become soft and begin to spoil before the center thaws. Thawing fish under refrigeration (35 to 40°F) or submerging securely packaged fish in cold running water is recommended. It is important to remember that thawed fish deteriorate rapidly due to the release of enzymes and nutrients for bacteria growth.
- Avoid thawing and refreezing fish. The flesh becomes mushy and dry when cooked.

**Testing reveals good news on Lake Superior fish contaminant levels**

(Continued from page 7)

<table>
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<tr>
<th>Chemical</th>
<th>FDA Action Level (ppb)</th>
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<th>Lake Whitefish (22-24 in) n = 4</th>
<th>Mean (Range)</th>
<th>Lake Trout (26-26 in) n = 4</th>
<th>Mean (Range)</th>
<th>Lake Trout (27-29 in) n = 8</th>
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<th>Siscowet Trout (22-23 in) n = 8</th>
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GLIFWFC’s Lake Superior study was conducted in the western and central portions of Lake Superior. ITFAP’s study was conducted in the eastern portion of Lake Superior. (See story below.)

**Contaminant results good in Whitefish Bay**

Sault Ste. Marie, Mich.—There’s good news for people who like to eat fish. Lake Superior fish are well below government guidelines for safe consumption. Lake Superior whitefish and lake trout collected from commercial catches in the Whitefish Bay area (MI-8) recently tested well below state and federal guidelines.

Contaminant levels of the Lake Superior fish were analyzed as part of a joint project of the Michigan Department of Natural Resources (MDNR) and Michigan Department of Environmental Quality (MDEQ) to determine contaminant levels in commercially caught fish. Results from an independent laboratory analysis are compared to contaminant levels determined to be safe by various government agencies. ITFAP also shares the results with these agencies, including the Michigan Department of Public Health.

Lake Superior fish were tested for a wide range of contaminants, including mercury, organochlorines, PCBs, dioxins and pesticides such as DDT. All fish were considerably below the guidelines for commercial fish issued by the U.S. Food and Drug Administration (FDA) and below the Michigan Department of Public Health’s guidelines for consumption of sport fish by the general public. Lake Superior fish were remarkably low in mercury, especially when compared to levels of mercury found in fish from most inland lakes. Mercury, mostly from sources such as coal burning electrical plants, accumulates in rain and snow and then concentrates in Lake Superior and in the smaller inland lakes.

Levels of pesticides such as DDT, which was banned in the United States in the 1970s, are also remarkably low in Lake Superior fish. Contaminant levels in fish from all of the Great Lakes have declined dramatically since the 1970s, when regulations were put in place to reduce pollution.

These results are encouraging for those who enjoy eating Great Lakes fish, especially since studies show that most Americans eat a diet high in saturated animal fats.

Most Americans could dramatically reduce their risk of heart attack and stroke by switching to a more lean protein source, such as properly prepared fish (fillet and cook with no additional fat).

Other studies also show that a different type of fat, Omega-3 fatty acids, significantly reduces the risk of heart disease and may actually reduce the risk of cancer. Great Lakes fish (like whitefish, lake trout, or chub) are especially high in Omega-3 fatty acids. For more information, contact Mike Ripley, ITFAP Environmental Coordinator, at 906-632-0072.
Tribal retail & wholesale outlets

**Eastern Lake Superior region**

Clear Water Cooperative  
Jamie Massy  
P.O. Box 114  
Moran, MI 49760  
(906) 643-9147

Bob’s Fish  
Lakeshore Drive  
Brimley, MI 49715  
(906) 248-5764

Lothrop Fish Market  
Route 1, Lakeshore Drive  
Brimley, MI 49715  
(906) 248-3640

Wilcox Fishery  
Lakeshore Drive  
Brimley, MI 49715  
(906) 437-5407

Brown’s Fish Market  
Hwy. 123  
Paradise, MI 49768  
(906) 492-3313

**Central Lake Superior region**

Smack’s Smoked Fish  
Richard Semasky  
Pequaming Road  
L’Anse, MI 49946  
(906) 524-6073

Joe Dowd  
P.O. Box 462  
L’Anse, MI 49946  
(906) 524-5167

Newago Fisheries  
Route 1, Box 508  
Chassell, MI 49916  
(906) 532-FISH (3474)

Peterson’s Fish Market  
Route 1, Box 219  
Hancock, MI 49930  
(906) 482-2343

**Western Lake Superior region**

Jack’s Fish  
P.O. Box 72  
Odanah, WI 54861  
(715) 682-2052 or  
(715) 682-5631

Peterson’s Fisheries  
P.O. Box 766  
Bayfield, WI 54814  
(715) 779-5023

Gurnoe & Sons Fishery  
Rte. 1, Box 89  
Bayfield, WI 54814  
(715) 779-3613

Auntie Grampa’s Specialties Inc.  
Skip and Debbie Hipsher  
HCR 62, Box 44D  
Iron River, WI 54847  
(715) 372-5221

Peterson’s Fish Market, Hancock, Michigan, is a family business owned and operated by the Peterson family. From the left, (back row) Gilmore and Pat Peterson; (front row) Tami Peterson and Ray Defoe. (Photo by Jim Thannum.)

Commercial tugs at Red Cliff continue tribal fishing traditions that have been carried on for centuries in the Apostle Islands. By improving seafood safety and quality, tribal fishermen ensure a viable Lake Superior fishery is maintained for their suppliers and customers. (Photo by Jim Thannum.)

Brad Dakota, Keweenaw Bay tribal member and commercial fisherman, is the owner of Keweenaw Bay Fisheries. The shop features fresh Lake Superior fish, including lake trout and whitefish. (Photo by Jim Thannum.)

Lothrop Fish Market operated by Eddie Lothrop, sells fresh whitefish and lake trout at Brimley, Michigan. (Photo by Charlie Otto Rasmusen.)
**Smoked Trout Salad**

6-8 servings

**Smoked Trout Salad**
- 2 cups fresh spinach, broken
- 2 cups red lettuce, broken
- 2 cups romaine lettuce, broken
- 18 ounces smoked trout, flaked
- 1 cup slivered almonds

**Vinagrette Dressing**
- 1/2 cup lemon juice
- 1/4 cup orange juice concentrate
- 1 tablespoon white wine vinegar
- 1 tablespoon dijon-style mustard
- 3/4 cup mayonnaise

Salt and white pepper to taste

1. Toss the greens together and place on chilled plates.
2. Place flaked trout on greens.
3. Sprinkle with almonds.
4. Drizzle with dressing.

**Salad**
- 1-1 1/2 pounds smoked lake trout fillets
- 1 1/2 cups grated cheddar cheese
- 1 tsp. fresh dill, chopped

**Rice**
- 1 cup wild rice
- 2 cups water
- 1/4 cup chicken stock

**Sauce**
- 2 tablespoons horseradish
- 1 cup mayonnaise
- 1/2 tsp. anchovy paste
- paprika to color

**Garnish**
- large leaves of kale, chard, or similar ornamental lettuce
- freshly sliced lemon wedges, de-seeded
- tomato slices

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Recipes reprinted with permission from Favorite recipes from the Old Rittenhouse Inn, Bayfield, Wisconsin.
GLIFWC has been testing walleye fillets for mercury content since the early 1990's with a focus on those lakes frequently harvested by member tribes during spring spearing. The past several years of testing has been funded by the Agency for Toxic Substances and Disease Registry (ATSDR) in cooperation with Dr. John Dellinger, senior research scientist at the UW-Milwaukee NIEHS Marine and Freshwater Biomedical Center. Mercury analyses were conducted by the Lake Superior Research Institute at UW-Superior.

In 1999, GLIFWC collected walleye (329 fillets, 39 egg, 7 testes samples) from 23 Wisconsin, two Minnesota, and five Michigan lakes. Sampling included adult walleye from five of twelve long-term study lakes monitored at least biennially.

The Wisconsin Department of Health recommends limiting consumption of fish with 0.5 ppm mercury, and no consumption of fish with 1 ppm or more. All walleye from 19 of the 30 lakes tested were below 1.0 ppm, and in six of these lakes all fish were below 0.5 ppm.

As provided in a Memorandum of Understanding between GLIFWC and the Wisconsin Department of Natural Resources (WDNR), results from mercury testing are exchanged between the two agencies. GLIFWC then compiles all the data from the WDNR with their own data for the ceded territories. GLIFWC’s data comprises approximately 25 percent of the mercury data on walleye within the ceded territories.

Using this database, GLIFWC produces, and regularly updates, Geographic Information System (GIS) maps that provide a comparison of lakes based on mercury concentrations in walleye. General information regarding methylmercury and the consumption of fish is provided on the back of the map (see page 15).

One project was to investigate whether mercury was evenly distributed throughout the muscle tissue of walleye and muskellunge. If so, then a small section of tissue could be collected for testing rather than the entire fish. Since many of the walleye used for testing are from tribal spearers, using only a small sample would allow fishermen to keep most of the fish.

Six walleye and four muskellunge fillets were cut into 4 and 8 fillet segments, respectively, and each segment as well as the whole fillet was analyzed for mercury. No significant differences (p-value > 0.05) were detected between fillet segments or whole fillets. Thus, initial results indicate that it may be a reliable method to just use a small sample of these fish for testing.

Since 1996, GLIFWC has tested 31 perch and 32 walleye from Mille Lacs Lake for mercury content in skin-off fillets. In addition, the Minnesota Department of Natural Resources has tested 10 walleye and 10 northern pike. The data show that these species in Mille Lacs Lake are low in mercury content and safe to eat (see Graph 9.).

A tribal fish consumption study started in 1997, will continue for five years. Each year twelve volunteer families from Wisconsin and Minnesota tribes are asked to record the number of meals and the amount of fish consumed per family member per meal over the course of a year. This study is also funded by ATSDR and will end after the 2001/2002 fishing year.

Through the above research, GLIFWC hopes to provide tribal governments and tribal members with the information needed to make decisions about how to avoid the health risks of eating contaminated fish while enjoying the health and cultural benefits of eating fish.

Steve White, GLIFWC environmental aide, filleted walleye and collected dorsal spines for aging while Kory Groetsch, GLIFWC environmental biologist, recorded the length data and packed the samples for shipment to the Lake Superior Research Institute where mercury testing was conducted. (Photo by Charlie Otto Rasmussen.)
Advice to consider when eating fish

Remember that for many native people gigoonh (fish) are part of a traditional diet and, as such, provide health benefits. However, it is difficult to provide advice as to when the health risks outweigh the health benefits of eating fish.

So if you rely on fish as part of your normal diet, try to achieve a balance. Continue to eat gigoonh but take steps to avoid highly contaminated ones and space meals out.

Look for lakes where the larger ogaa (walleye) have low mercury levels and eat only the smaller ogaa from these lakes; put these smaller ogaa in freezer bags labeled as reserved for children and women of child bearing age.

The other ogaa with mercury levels between 0.5 and 1.0 ppm can be saved for men and elders, but intake of these gigoonh should also be limited. Gigoonh with levels above 1.0 ppm shouldn’t be eaten by anyone.

Mercury: Where it comes from

Mercury is a natural element that is found in air, water, rocks, and soil. Mercury evaporates from these sources and returns to Aki (the earth) attached to small airborne particles or is washed out of the air by rain or snow. Since about 1850 the amount of mercury cycling through Aki has been increasing about 1.7 percent per year due to human activity.

For example, burning coal, wood, and waste (both household and industrial) releases mercury into the atmosphere. An estimated 75% of newly deposited mercury entering Minnesota’s land and lakes comes from human activities; the other 25% is natural.

Efforts are being made to reduce the amount of mercury entering the environment. For example, the White Pine smelter in northern Michigan was the largest source of mercury pollution in the Lake Superior basin and was shut down in 1995. Also, it is no longer legal to use mercury as a fungicide in latex paints.

Mercury: How it gets into gigoonh

When mercury enters lakes and streams, bacteria or chemical reactions transform it into methylmercury. This form of mercury is absorbed by gigoonh as water passes over their gills. All gigoonh probably contain some methylmercury and absorb it throughout their life.

Methylmercury is easily absorbed by animals which eat fish. It builds up in ever increasing amounts as small insects are eaten by small fish, which then are eaten by large fish, which are eaten by Anishinaabe.

For example, water containing two (2) parts per trillion of mercury can build up to 450 parts per billion methylmercury in ginoozhe (northern pike), a 225,000-fold increase. So larger, older, and predatory fish like ogaa (walleye) and ginoozhe will have higher levels of methylmercury than smaller, younger fish such as agwadaashi (sunfish). Mercury is tightly bound in fish tissue and can’t be removed by any special cooking or cleaning method.

Health risks of eating contaminated fish

Methylmercury is neurotoxic; it affects the brain and spinal cord. Methylmercury can build up in the body gradually and it may take months or years of regularly eating fish to accumulate levels which are a health concern. Small amounts can be safely eliminated.

However, when the amount taken into the body exceeds the amount that can be eliminated, methylmercury builds up. In adults the first signs of poisoning are tremor of the hands and a burning or tingling sensation in the fingers or toes. At higher levels, walking is affected, followed by blurred vision. Severely-affected people have speech and hearing problems. In rare cases of severe exposure, a person can become paralyzed and die.

The fetus is most sensitive to mercury poisoning because its nervous system is developing. However, young children, pregnant and nursing women, and women of childbearing age also need to take extra care.

In the early 1970's, more than 400 people in Iraq died from eating bread made from wheat treated with methylmercury which was intended for planting. Researchers found that children exposed while in the womb experienced delayed development in walking and talking, even though the mother was not affected.

Concerns expressed by tribal spearers

A 1993 survey of tribal spearers indicated that mercury levels in fish were of concern. Out of 69 people responding to the survey:

- Mercury was a concern to 90% of the respondents.
- Some spearers were modifying their behavior.Over half (64%) avoided spearung lakes where walleye were believed to be unsafe to eat because of high mercury levels. About half (49%) avoided taking a walleye or chose only the “safer to eat” small walleye.
- Assumptions upon which state health advisories are based may not be appropriate for tribal spearers. For example, the Wisconsin Fish Consumption Advisory assumes that the average meal size is eight (8) ounces and that people consume fish uniformly throughout the year. In contrast, tribal spearers reported consuming larger meal sizes and more meals during spring than in other seasons.

Using mercury maps to make informed decisions

Map for use by women planning to have children and children under 15 years of age

The map on the top half of the opposite side is based on 0.50 ppm (parts per million) of methylmercury, which is the level used by the Wisconsin Division of Health to give the following advice:

- If mercury levels are below 0.50 ppm, then pregnant women are advised to eat only one meal of fish per month. Children, men, and women who are not pregnant or breastfeeding may eat unlimited amounts of these fish.
- If mercury levels are above 0.50 ppm, then pregnant or breast-feeding women, women who plan to have children, and children under 15 years of age should not eat any of these fish.

Map for use by women not planning to have children and by men

The map on the bottom half of the opposite side is based on 1.0 ppm (parts per million) of methylmercury. According to the Wisconsin Division of Health, no one should eat fish with mercury concentrations of 1.0 ppm or more.

Supplement credits:
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Editing: Susan Erickson, Masinaigan Editor, and Neil Kmiecik, Biological Services Division
Photography: Charlie Otto Rasmussen, Masinaigan writer/photographer
Layout: Lynn Plucinski, Masinaigan Assistant Editor
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Mercury contamination of ogaa in lakes harvested by Bad River