

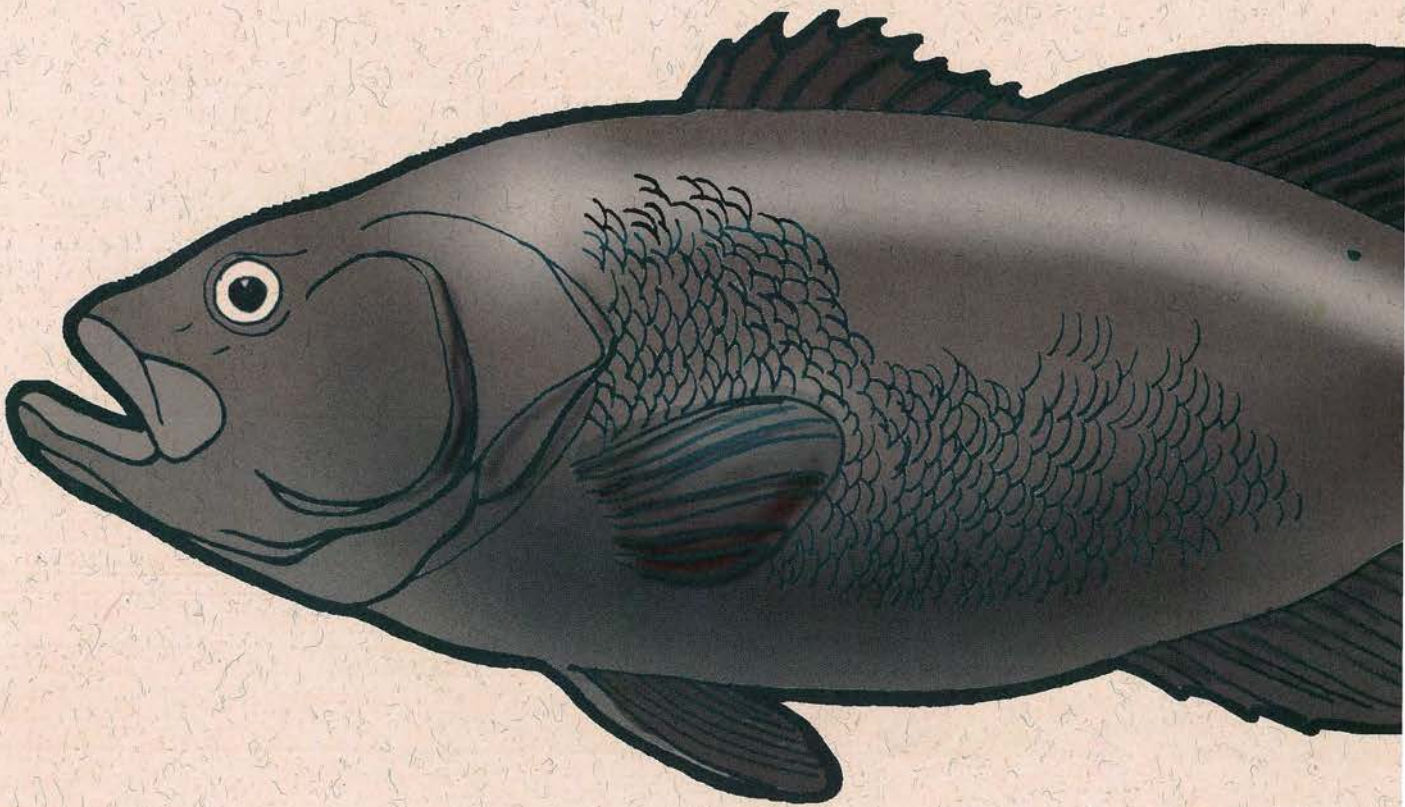
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# FRESHWATER FISH PRESERVATION

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Michigan Sea Grant Extension  
Michigan Sea Grant College Program

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## North Central Regional Publication 498

November 1994

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**W**hether you are one of the millions who catch fish in lakes and streams, or catch up with them at the market, freshwater fish provide a wealth of varied and delightful eating.

Fish and seafood are excellent sources of high quality protein and many essential vitamins and minerals, including thiamin (B1), riboflavin (B2), pantothenic acid, niacin, vitamin B-12, vitamin E, phosphorus, potassium, iron, iodine, fluoride, zinc, selenium and copper. A portion of the fat in some species of fish contains omega 3 fatty acids, which may help reduce the risk of some heart problems. Many species are also lower in fat and calories than other comparable sources of protein, making fish an ideal choice in today's health conscious lifestyles.

Fish is very versatile and can be preserved by a variety of methods. By following the procedures described in this bulletin, you can help ensure that the fish you preserve will be a tasty part of your meal in the weeks and months to come.

### Your Catch

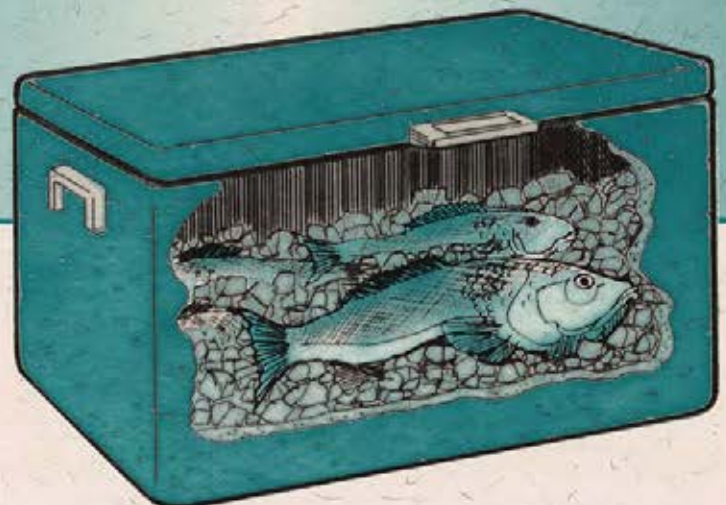
To make sure you eat your catch at its best, protect it from the beginning. Always keep fish in a fly-proof container. Refrigeration best protects quality, and a good ice chest is essential in the field. Try to stock or obtain enough crushed ice to protect your catch, and pack fish in the crushed ice immediately after removing them from the water. As soon as possible, gut the fish and remove the gills or fillet it. This allows for blood removal from and efficient chilling of the edible portion. Then pack ice around the drawn fish or fillets. Properly iced or refrigerated, fish can be held 2 to 3 days.

When stream fishing, a rigid creel that provides air circulation and protection from bumping, bruising, and crowding is preferable to a soft bag. Line your creel with clean, wet burlap, soft, moist sphagnum moss, ferns, grass or other greenery. Air circulation and evaporation keep fish cool.

Fish are most apt to be damaged in storage. The very weight of a full tub or pail of fish is bound to crush those at the bottom of the container. Use shallow flat containers such as those used by commercial fishermen, and add ice to keep the fish cold. Use the following table as a guide for the amount of ice required to chill and store fish.

### Pounds of Ice Required to Chill and Store Fish at an Ambient Temperature of 80°F

Fish (lbs.)	6 hr on ice	12 hr on ice	18 hr on ice	24 hr on ice
10	4.1	8.3	9.5	10.7
20	6.8	12.9	14.8	16.6
30	9.3	17.1	19.6	22
40	11.8	21.1	24.1	27
50	14.2	25	28.4	31.9
60	16.7	28.8	32.7	36.5



## BEFORE YOU BEGIN

### Safe Handling of Fish

Always wash hands thoroughly with soap and water before and after handling any food, including fish.

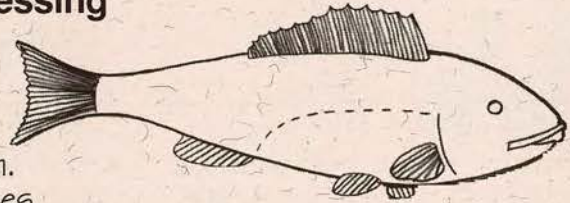
Microorganisms that cause food-borne illness can also linger in towels, sponges and cloths. Before reusing, wash dishcloths, sponges and towels used to wipe up juice from fish and seafood. Discard used sponges frequently.

Limit cross-contamination. Without proper precautions, microorganisms in raw fish can be transferred to other foods. After handling raw products and before continuing food preparation, use detergent to wash everything you have used, including coolers, cutting boards, knives, other utensils and counter tops, and wash your hands with soap and water. It is important to wash platters that held raw fish before reusing the dishes for cooked fish. Remember this tip when barbecuing!

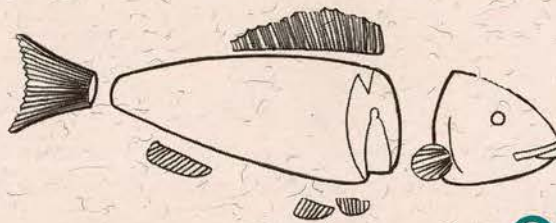
After washing, sanitize all equipment (knives, cutting boards and coolers) with a freshly mixed bleach and water solution. Use 2 tablespoons bleach (2% chlorine) to a gallon of water for your sanitizing solution; or 1 tablespoon of bleach (4% chlorine) per gallon; or 2 teaspoons of bleach (6% chlorine) per gallon. These are minimum proportions for sanitation; more bleach could be added.

### Cleaning and dressing your catch

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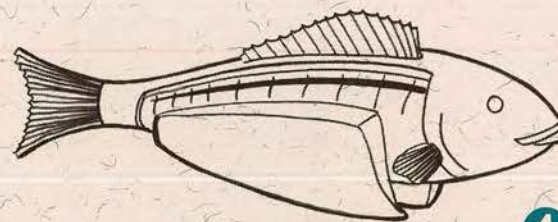
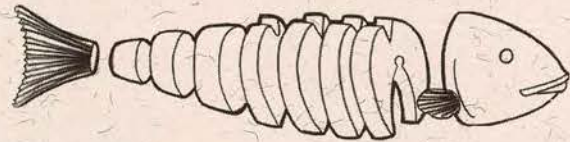


Round or whole fish. Dotted line indicates that the viscera have been removed



2 Dressed

3 Steaks



4 Fillet

Rinse and air dry or put in the sun. An alternative sanitizing process would be to place all equipment in 180 degree water for at least 30 seconds.

When purchasing a new cutting board or other fish preparation tools, consider those made of plastic or with plastic handles or hardwood such as hard maple.

### Cleaning and Dressing

Immediately upon getting your catch home or back to camp, clean and dress it. Keep it out of the sun. Remember to handle it carefully; fish flesh is delicate and bruises easily.

Fish, just as they come from the water, are referred to as whole (round) fish. The amount of clean-

ing depends on the kind of fish and intended use. **Whether you plan to preserve your catch, or cook and eat it immediately, check food preservation or cooking directions for the desired cut for each method selected.** If you plan to freeze the fish, prepare it as you will need it once it thaws.

If appropriate, fillet your fish. Filleting fish has a number of advantages:

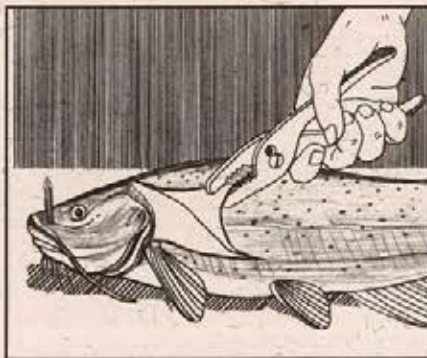
- it reduces fat in the edible portion;
- it reduces exposure to any fat soluble contaminants;
- it is simpler to clean since guts do not have to be removed;
- it saves only the edible portion instead of taking up space with inedible bones, organs, etc.;
- it is more convenient to wrap and store;
- it is simpler and faster to cook;
- it freezes faster and may increase storage time.

Dozens of gadgets for cleaning fish are available. Usually a sharp knife with a thin blade and some practice does the job. If you are going to fillet your fish, follow the steps on page 5. If your recipe calls for pan-dressed fish, use the following steps:

**SLIME**—Some species, such as northern pike, have a thick mucous coating. Placing the fish in vinegar solution (1 part vinegar and 3 parts water) will help remove it. Or, rub the fish with generous amounts of salt, then rinse with cold water.

**SCALES**—Fish vary in number of scales and difficulty of removal. Carp have scales which resemble a coat of armor and have to be "sawed" off or removed with the skin. Trout have fewer scales that need removing. Scaling can be avoided if the fish are filleted and skinned as described in a later section.

**SCALING**—Scaling fish is done in a number of ways. The most common way is to grasp the fish firmly by the head with one hand. With the other, hold the spoon or fish-scaling tool vertically and, starting at the tail and moving toward the head, scrape off the scales. Another and often safer way is to hold the fish by the tail and scrape off the scales as previously described. Because the tail is usually slippery, it may be difficult to grasp with a bare hand. An alternative is to hammer a nail through the tail and into the cleaning board. This holds the fish in place while scaling. There are also fish cleaning boards available that have a spring-powered clamp to hold the tail while scaling the fish. To help loosen the scales and make scaling easier,



Skinning

quickly dip the fish into boiling water. This also helps remove the slime layer.

**SKIN**—The skin is easily removed from fish such as bullheads, catfish, burbot, and some other fish. Hold the head firmly or nail it to a board. Slit the skin down the back and around the fins. Use pliers to pull off the skin. Pull from head to tail.



Gutting

**GUTTING**—Fish with gills and viscera removed are called *drawn* fish. Cut the entire length of the fish belly from vent to head and remove the viscera. Be sure to remove all dark material next to the backbone; this is the kidney. A

stiff-bristled brush will help remove remains that are difficult to get with a knife. Rinse the fish thoroughly with clean water.



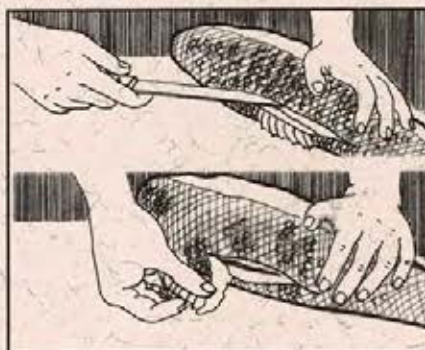
### Beheading

**HEAD**—Fish, especially large ones, are sometimes cooked with the head on. Then the gills must be removed. Insert the knife tip into the gill cover and pull out gills and gill rakers.

To remove the head, cut just above the collarbone behind the pectoral fins. If the backbone is large, cut down to it and then snap it over the edge of a table or cutting board. Cut any remaining flesh holding the head to the body. Remove the cheek meat from large fish and save it; some people consider this the best part!

**CLEANING THE HEAD**—The head can be useful for making

stock and soups. Remove the gills and gill rakers and wash thoroughly. It is not necessary to remove the eyes.



### Removing Fins

**FINS**—Remove the dorsal (large back) fin by cutting along both sides of the fin. Then give a quick pull toward the head (pliers are used with large fish) and pull out the fin with the root bones attached. Remove other fins in the same way. If you merely trim the fins off with a knife, the bones at the base will be left in the fish. Cut off the tail if you prefer.

**WASHING**—The fish is now pan-dressed and ready for cooking. Wash thoroughly in cold drinking-quality water. Store on ice or in the refrigerator.

### Cooking Cuts

Fish can be cut into several forms. Two of the most common are steaks and fillets.

**STEAKS.** Large fish are often steaked. To make steaks about 1 inch thick, cut crosswise, parallel to ribs.

**FILLETS.** If you plan to fillet, it isn't necessary to gut the fish as



### Steaking

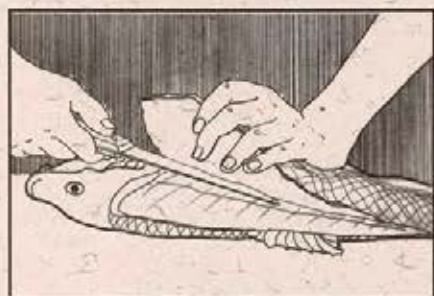
described previously. Just fillet as described here, remove fins and split into two pieces. To make butterfly fillets, you won't even split the fillets or cut through the belly.

Filleting requires a sharp, thin-bladed knife. Cut through the flesh along the back from tail to just behind the head. Then cut down to the backbone just above the collarbone. Turn the knife flat and cut the flesh along the backbone to the tail, allowing the knife to run over the rib bones. Lift off the entire side of the fish in one piece. Turn the fish over and repeat the operation on the other side.

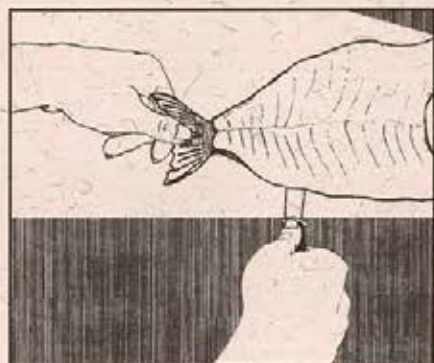
To skin a fillet, lay it on the cutting board skin-side down. Firmly hold the tail end with pliers (fingers will usually slip) and cut through the flesh to the skin. Flatten the knife on the skin and cut the flesh away, running the knife forward while holding the free end of the skin firmly with your pliers.

Bones and heads may be used in fish stock.

**BONES.** You can reduce problems with bony fish in a number of ways. Canning fish softens small



Filleting



Skinning

bones so they are edible, or you can grind them up in minced flesh. Fillet and skin or scale bony fish such as mullet (suckers) if desired. Put fillets through a meat grinder fitted with a fine blade. Use minced flesh in fish loaves, soups, casseroles and other dishes. Bones can be fried crisp.

Lay fillets on cutting board, skin-side down. Every  $\frac{1}{8}$  to  $\frac{1}{4}$  inch, cut crosswise through the fillet, but do not cut through the skin.

Remove the bones from cooked fillets. Cut along the area as shown by the solid lines in the drawing to remove the strips of bones.



Scoring

## DEALING WITH CONTAMINANTS

Many fish eaters are concerned about Great Lakes fish being contaminated with chemicals. Some trout and salmon, especially large ones, are found to have more of these substances than is considered safe by the U.S. Food and Drug Administration. Consult your state's annual fish consumption advisory. These advisories usually contain information on contaminants of concern and affected bodies of water, affected species and sizes of fish and on groups of people at risk.

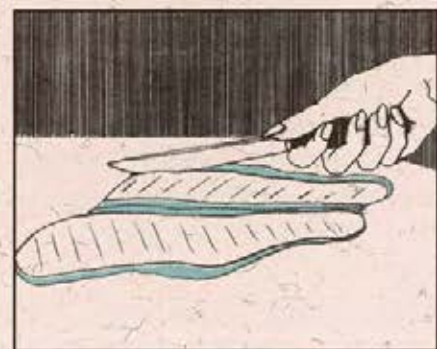
Follow the suggestions below to reduce your possible exposure to contaminants even further. Since many chemicals concentrate in the fatty portions of fish, the methods you use to clean and cook them can help you reduce your intake.

**CLEANING**—Fillet and skin the fish. Remove as much fat as possible. Fat deposits run along the lateral line, so remove them by cutting in a shallow V under the dark flesh. Trim the fillet along the back fin and belly flap before cooking.

**COOKING**—Bake, broil or charcoal broil the fish to remove more fat from the flesh. Use a rack which allows the oils to drain away. Do not use the drippings for anything.

There is no guarantee that these procedures will eliminate contaminants completely, but they will definitely reduce the total amount consumed.

Mercury, a heavy metal, is distributed throughout the muscle tissue of fish. It cannot be removed by cleaning or cooking.



Deboning

## FRESHWATER FISH PRESERVATION

Keeping freshwater fish flavorful and safe to eat requires proper preservation. Methods of preparing, preserving and cooking fish are diverse. Using incorrect methods or improperly using correct methods can cause the fish to spoil and can lead to food poisoning. This section outlines the basic principles and techniques for preserving fish for home use. A number of recipes are included to show the variety of products possible from these fish species and to serve as a guide for home processing and preparation. Successful preservation depends on careful attention to proper procedures and sanitation throughout the processes.

### Preservation and Quality

Preservation does not improve fish quality. The preserved product will be no better than fresh fish. But home-preserved products may be better than commercial products because the fish can be rushed straight from catch to cooking, freezing, canning or other process.

**FREEZING** is the most convenient and most highly recommended method for preserving fish. It keeps fish safe from spoilage during long storage, and it is easy and requires very little time.

**CANNING** is more time-consuming than freezing, but the product can be stored on the shelf for many months. Fish must be pressure

canned for safety. A temperature of 240°F or higher is needed and must be maintained for a specific time period to kill the spores of the bacteria *Clostridium botulinum* that causes the illness commonly known as botulism. This organism grows in improperly processed food and produces a deadly toxin. Using recommended pressure processing techniques avoids this problem and produces a high quality, safely canned product.

**SMOKING** is not preservation in the same sense as freezing and canning. In Native American fish camps, hundreds of pounds of fish were smoked for winter food, but that sort of process required around-the-clock smoking for weeks at a time and was accompanied by drying. As discussed in this bulletin, smoking is actually cooking. It adds flavor to the fish. Smoked fish must be stored in a refrigerator; it is not shelf safe.

**PICKLING** produces a very flavorful fish product that keeps for several weeks in the refrigerator. Pickled, cooked fish can be eaten without further preparation.

### FREEZING

Freezing is the easiest and most convenient way to preserve the quality and nutritive value of fish. All species of fish can be frozen. Successful freezing depends on low storage temperatures and airtight, vapor-proof packaging.

Freeze fish quickly. To quick freeze, set the freezer dial at -10°F or lower. Store fish at 0°F or below.

Large, thick pieces take longer to freeze, allowing quality to deteriorate during the freezing process. To speed up freezing, package fish in small or flat packages.

Moisture loss from frozen fish causes dehydration called "freezer burn." Off-flavors and poor quality result. To prevent dehydration and to lock in fresh fish flavor, package fish in airtight, vapor-proof packages. The following are appropriate: aluminum foil, plastic freezer boxes with airtight lids, thick plastic freezer bags, thin plastic freezer bags in paperboard boxes, freezer papers, and ice coatings at least 1/8 inch thick. Of these, the best protection is aluminum foil, cling freezer wraps or ice coatings. These are often used in a combination double package system such as freezer paper or brown paper wrapped over the foil, cling wrap or ice coatings.

### Freezing Fish in Protective Wraps

1. Use fresh fish, cleaned and dressed.
2. Cut fish into appropriate serving pieces. Fish can be frozen whole or as portions. The most economical way to freeze fish is in meal-size packages of steaks or fillets. To be able to separate one frozen fillet or steak from another, insert a double layer of wax paper or plastic wrap between fish portions when they are packaged for freezing.
3. Dip fish in the following solution to help preserve quality. Add 2 tablespoons of ascorbic acid



powder to each quart of water. This reduces fat rancidity. Place fish in the solution for one minute, drain on a paper towel, dip again. Products that prevent browning in fruits and vegetables and contain ascorbic acid and vitamin C also work well.

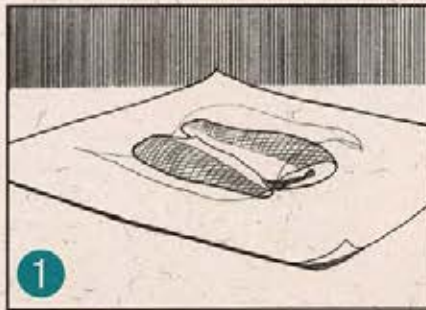
4. Wrap or place fish in airtight, vapor-proof packages. To wrap fish, pull the wrap tightly around the fish, squeezing out any air pockets. Seal (see illustration). In containers or bags, pack fish tightly, excluding as much air as possible. Never use large containers or freeze fish in cartons because it may take as long as three days before the center of the pack freezes. In the meantime, quality will deteriorate. This is because packages freeze from the outside toward the center, and the food expands when frozen. In addition, growth of spoilage organisms is not stopped until the flesh is thoroughly frozen.

### Individually Quick-Frozen Fish

Spread a single layer of fish or portions on a flat pan, such as a cookie sheet. Cover with a protective wrapping, and place in the freezer. When fish are thoroughly frozen, remove and package in heavy plastic freezer bags or freezer containers.

### Freezing Fish in Water

Water is the most effective airtight package. Three good ways to seal fish in water are glazing, ice blocks



without prior freezing and ice blocks with prior freezing.

**Glazing** - This method works especially well for whole fish, but other

portions can be frozen this way, too. Freeze the fish in a protective plastic bag. Have ready a pan of very cold, almost frozen water. Remove frozen fish from the plastic bag, dip in the very cold water and return to the freezer. Repeat dipping and freezing until the ice glaze is  $\frac{1}{8}$ - to  $\frac{1}{4}$ -inch thick. Fish can be stored without further wrapping, but the ice glaze will gradually evaporate. To improve keeping quality, wrap glazed fish in freezer wrap, then date and store.

**Ice Block 1** - Place a single layer of fish in shallow pan, such as a cake pan. Cover with water and freeze solid. Remove block from pan, wrap in freezer wrap, date the package and return to the freezer.

**Ice Block 2** - This method creates the least amount of pressure on tender fish flesh. Place a single layer of fish in a shallow container. Place the pan in the freezer overnight to freeze fish solidly. The next morning, cover the frozen fish with water, and freeze. Remove the frozen block from the pan.

### Storage

On a piece of freezer tape write the species of fish (such as trout, walleye, or bass), type of portions (fillet, steak, whole) amount (# of portions and/or weight) and date stored. This way, fish can be used within recommended amounts of time to ensure highest quality and you can take out only as many fish as you need for a single meal. Use a first in, first out policy when eating fish that has been frozen.

## STORAGE TIMES AT 0°F

Maximum Quality

Kind of fish	Taste like fresh	Maximum Storage
<b>FAT—</b>		
salmon, lake trout, rainbow trout, chubs, whitefish, smelt, lake herring, carp, catfish	3 months	9 months
<b>LEAN—</b>		
northern pike, suckers, bluegills, bass, crappies and sunfish, walleyes and yellow perch	6 months	12 months
<b>SMOKED</b>		2 months

Store in freezer at 0°F or below. Fatty fish such as trout are best used within a few months to avoid rancid flavor problems. See the above chart for guidance on storage time for other species.

### Freezing Fish in Sauce

Fish can be frozen in boil-in-a-bag pouches or suitable containers with sauce included. (Good sauces include tomato sauce and mushroom sauce.) Place fish in a package with sauce, seal and date the package, and freeze. Boil-in-a-bag pouches need only be simmered in boiling water and served. This method leaves no fish cooking odors or messy pans to clean up. To serve fish frozen with sauce in other containers, partially thaw in the refrigerator before heating in a saucepan.

### TOMATO SAUCE

2 cups stewed tomatoes  
 ¼ teaspoon black pepper  
 1 small onion, chopped fine  
 2 tablespoons melted margarine or butter  
 1 teaspoon salt (optional)  
 2 tablespoons flour

Simmer tomatoes, onion, salt and pepper together for 10 minutes. Combine melted butter with flour. Gradually add the tomato mixture to flour and butter. Cook until thick, stirring constantly. Cool before adding to fish. Makes 2 cups.

### MUSHROOM SAUCE

½ cup diced onion  
 1 cup milk  
 2 tablespoon vegetable oil  
 1 teaspoons red pepper  
 1 tablespoon chopped green pepper

½ teaspoon salt (optional)  
 1 can undiluted cream of mushroom soup

Saute onion in oil until yellow. Add green pepper. Cook 3 minutes. Gradually stir in soup and milk. Add seasonings and heat, stirring constantly. Cool before adding to fish. Makes 2 cups.

### Storage

On a piece of freezer tape write the species of fish (such as trout, wall-eye, or bass), type of portions (fillet, steak, whole), amount (# of portions and/or weight), type of sauce, and date stored. This way, fish can be used within recommended amounts of time to ensure highest quality. Use a first in, first out policy when eating fish that has been frozen. This method allows you to take out only as many fish as you need for a single meal.

Store in freezer at 0°F or below. See table above for suggested storage times. Fatty fish such as trout are best used within a few months to avoid rancidity.

### Thawing Frozen Fish

Recipes that call for breading, stuffing or broiling work better if the fish is thawed first.

Thaw fish in its original wrappings in the refrigerator; allow 6 to 8 hours per pound. For faster thawing—1 to 2 hours/lb.—place fish in original wrappings under **cold** running water. Never allow fish to thaw at room temperature. Thaw fish only until it has just become pliable. It may still have some ice crystals in it.

**Microwave Thawing:** Fish not wrapped in foil can be thawed in the microwave before cooking. Microwave frozen fish for 15 to 30 seconds on medium-low (30%) power (or defrost), then let it stand 15 seconds, continue alternate microwaving and resting until fish is nearly thawed but still cold to the touch. Allow fish to stand 1 to 2 minutes before cooking. You can also follow your microwave manufacturer's directions, but do not let the fish thaw completely.

Free fish frozen in ice blocks by running cold water over the block. When the fish is free of ice, remove it and wipe dry. Cook at once.

If thawed fish is required, remove fish when freed of ice and let stand under clean, cold running water until just thawed. Drain, wipe dry and cook at once.

Thawing times vary with the size and shape of the package and with temperature. A rule of the thumb is: If frozen at 0°F or lower, each packaged or solid pound requires 6 to 8 hours to thaw in the refrigerator or 1 to 2 hours to thaw under cold running water.



## SMOKING

Wood smoke has little, if any, preservative action by itself. Smoking merely adds flavor and color and removes water from the flesh. Smoked fish are almost as perishable as fresh fish. Home processors would do well to heed the Michigan state law that applies to commercial smokers. Keep smoked fish at temperatures under 36°F and use within 14 days. If smoked fish is to be kept longer than 14 days, freeze or can it immediately after smoking, according to the directions at the end of this section. Canning or freezing old fish only further reduces the quality of an already deteriorating product.

The four basic steps in smoking fish are cleaning, curing, drying and smoking.

### Cleaning

Clean fish as soon as possible after taking them from the water. (Refer to previous directions for cleaning.) Scale fish and remove viscera, including the kidney, which is the dark streak along the backbone. The head may also be removed from larger fish, but the collarbone should be left to provide shape. Fish may be smoked drawn, steaked or filleted, skin on and off.

### Curing

Cure the fish in a brine of pickling or canning salt (iodized table salt is **not** recommended because it may produce off flavors). The goal of brining is to produce a

thoroughly and uniformly salted product. A basic brine consists of 1 cup salt to each gallon of cold water (30° salimeter). Sugar, spices, and saltpeter are often added to the brine.

### Here is one recommended sugar spice brine:

1-gallon cold water

1 cup salt

½cup sugar

1 teaspoon saltpeter (optional)<sup>1</sup>

Optional to taste:

Cloves

Bay Leaves

Pickling spices

Sage

<sup>1</sup>*Adding saltpeter directly is not recommended. Complete cures such as Morton's TenderQuick® already contain saltpeter (sodium or potassium nitrate). When using a complete cure in this formulation, omit 1 cup salt and 1 teaspoon saltpeter and add 1 cup TenderQuick.*

Use a mixture of spices at the rate of 1 tablespoon per gallon of water.

Another spice formula is 1 tablespoon of whole cloves and 1 teaspoon of bay leaves per gallon of water.

Saltpeter may or may not be added, according to personal preference, but it does provide a margin of safety against botulism.

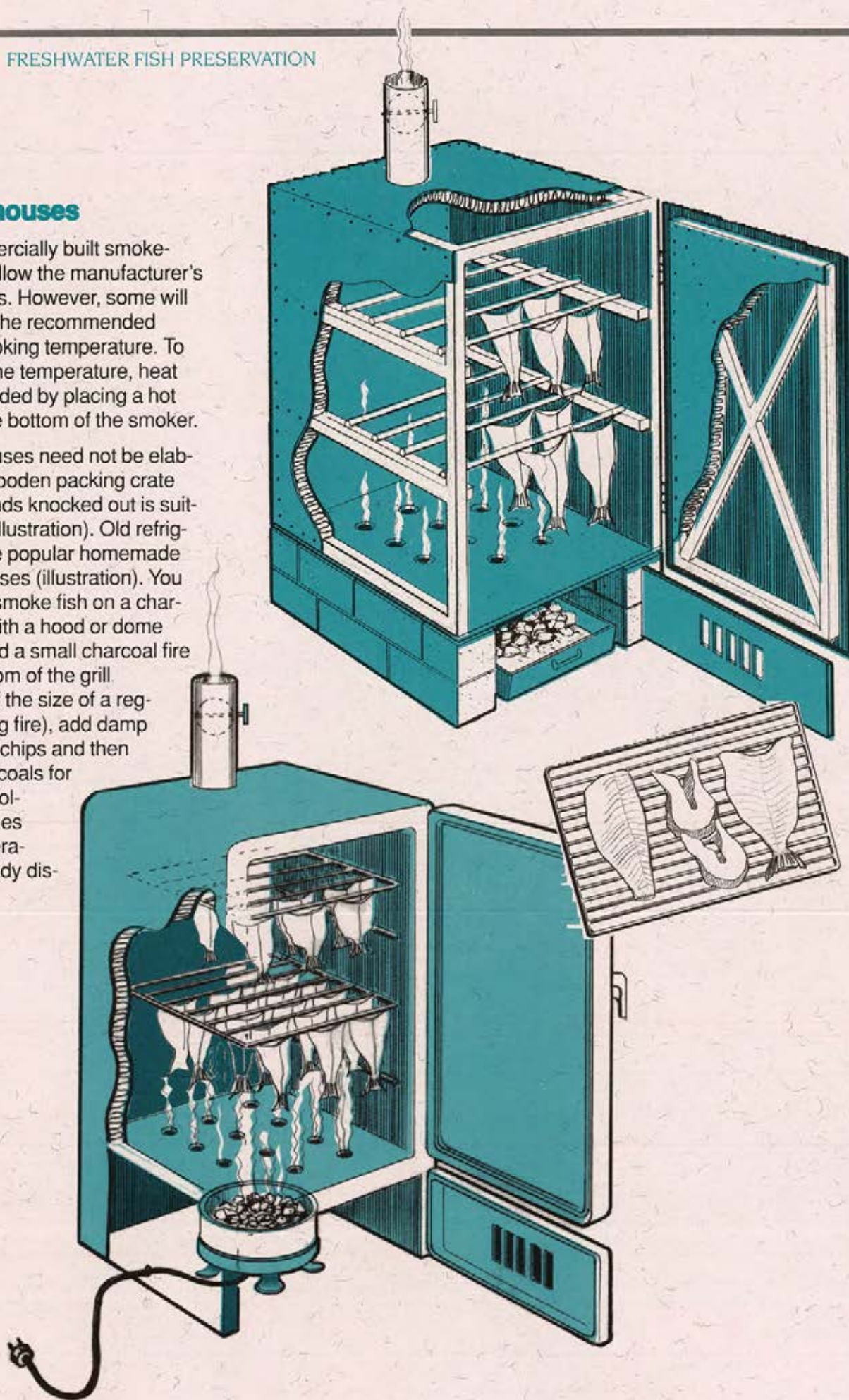
Place fish in a large, food-grade plastic, ceramic or stainless container so that they lie flat. Cover with brine. Use one gallon for each 5 pounds of fish. Use a plate or cover to weigh the fish down

*Continued on page 11*

## Smokehouses

For commercially built smokehouses, follow the manufacturer's instructions. However, some will not reach the recommended smoke cooking temperature. To increase the temperature, heat may be added by placing a hot plate in the bottom of the smoker.

Smokehouses need not be elaborate. A wooden packing crate with the ends knocked out is suitable (see illustration). Old refrigerators are popular homemade smokehouses (illustration). You can even smoke fish on a charcoal grill with a hood or dome cover. Build a small charcoal fire in the bottom of the grill (about half the size of a regular broiling fire), add damp hardwood chips and then additional coals for cooking. Follow the times and temperatures already discussed.



## TABLE OF BRINING TIMES

(for a brine of 30° salimeter, 2 parts brine to 1 part fish)

Size	Condition		
	Fresh	Refrigerated	Thawed
	<i>Hours</i>	<i>Hours</i>	<i>Hours</i>
½-inch thick to 1-inch thick, fillets or split fish	12 to 14	10	6 to 8
Large whole fish, 10 lbs or larger	48 to 72	36 to 60	24 to 48

ator for 24 hours absorbs salt faster—about 10 hours is required. Thawed fish absorb salt still faster—in about 6 to 8 hours. These times are for the concentration and ratio of brine outlined above.

**Size** - Brining times are affected by the thickness of the fish pieces. Fresh pieces ½- to 1-inch thick require 6 to 14 hours of brining. Large, whole, fresh fish, like salmon, require 48 to 72 hours of brining. For such large fish, do not exceed a concentration of 30° salimeter.

### Drying

When fish are cured, remove from brine, rinse thoroughly and dry. Fish may be dried in the smoke-house or other place protected from dust. Place on racks (the best method) wiped with vegetable oil, and allow the surface to dry. A shiny, skin-like pellicle will form on the fish surface. The pellicle seals the surface and prevents loss of natural juices during smoking.

Fish require approximately ½ hour of drying at 70° to 80°F before smoking. Air circulation and humidity affect the time. A fan speeds up the process.

enough to submerge them without packing them together. Allow fish to cure in a cold place (34° to 38°F) for the appropriate time (see table).

No one brining time is right for all fish under all conditions. Brining times vary because of brine concentration and amount, and fish condition and size affect how quickly and how much salt is absorbed. Fish that have been previously frozen and thawed absorb salt more uniformly and quickly than fresh fish.

**Concentration** - The stronger or more concentrated the brine, the shorter the brining time required. However, short brining times will not salt fish as uniformly as long times. A brine concentration of 30° to 40° salimeter (a measure of the concentration of salt in a solution) is recommended. This is about 1 or 1½ cups salt for each gallon of cold water.

**Amount of brine** - The amount of brine to the amount of fish affects how uniformly and thoroughly the fish will be salted. A good ratio is 2 parts brine to 1 part fish. One gallon of brine weighs about 9 pounds. This means you would need 20 pounds or a little over 2 gallons of brine for each 10 pounds of fish.

**Fresh, refrigerated or thawed** - The muscle fibers of freshly caught fish are still intact. This slows the rate of salt absorption. Freshly caught fish requires about 12 to 14 hours of brining, depending on the thickness of the portion (see table). Fish held in the refriger-



## Smoking

A number of simple, serviceable smokehouses can be built at home (see page 10), but smoking procedures are about the same for all. Follow the manufacturer's instructions for commercially built smokers.

Place brined fish in the smokehouse. Clear all combustible material from around and under the smoking area. Form a small bed of coals on the hot plate for a small fire. Take care to keep it from flaring up. Once the coals have burned enough to be covered with ash, cover them with dry hardwood chips. Use only hardwoods such as hickory, fruitwood or maple, because other materials such as pine, moss and leaves may leave unpleasant tastes on the fish. Chips may be dampened to prevent them from flaming. Add chips as needed to keep the smoke dense throughout the process. Regulate the draft by the vents or by raising or lowering the lid or side of the chamber.

Cold-smoke 1-2 hours at 90-100°F. Then, gradually add hot coals to the smoker to raise the temperature of the smokehouse to 225°F. Maintain this temperature until the internal temperature of the fish reaches 180°F, which should take 3 to 4 more hours. Hold the fish at the 180°F flesh temperature for 30 minutes. Insert a thermometer into the thickest part of the fish to be sure all the flesh reaches this temperature. Whole fish also need to be smoked and cooked thor-

oughly. The total time required may be as much as 12 hours for whole fish.

When smoking is completed, remove the fish and allow them to cool. Keep fish protected from dust and insects; then wrap in waxed paper or plastic wrap, date and refrigerate. Use smoked fish within 14 days.

## Canning Smoked Fish

1. Allow up to  $\frac{2}{3}$  pound of smoked fish per pint. Cut smoked fish into lengths suitable for pint jars. The fish may be lightly smoked or smoked to a ready-to-eat stage. The smoked flavor tends to intensify with canning.
2. Pack fish into jars, leaving 1 inch head space. If frozen, the fish should be thawed to at least 35° F before processing. It may be packed either loosely or tightly.
3. Adjust lids and put jars into the canner.
4. Vent the canner by allowing a steady stream of steam to escape for 10 minutes. This prevents cold spots that result in underprocessing.
5. Cover the canner petcock with the pressure regulator or close the petcock. Process for 110 minutes (1 hour and 50 minutes) at 10 pounds pressure (weighted gauge canner) or 11 pounds pressure (dial-gauge canner) for elevations between sea level and 1,000 feet. See tables on p. 15 for pressures recommended above 1,000 feet.
6. Remove canner from heat at the end of processing. Then remove

jars from canner when pressure returns to zero.

## Pickling

Pickling makes use of vinegar, salt and optional spices to preserve fish. Pickling preserves fish for shorter periods than freezing or canning. Although vinegar slows the growth of spoilage bacteria, gives flavor and softens bones, it is only a temporary preservative, because enzymes continue to act, softening and eventually spoiling the product.

The acetic acid content of the vinegar is important. Use ordinary vinegar containing 5 percent acetic acid. Do not use apple cider vinegar, wine vinegar or homemade vinegars. The final pickling solution should contain at least 2½ percent acetic acid, no less than one part vinegar for each part water. If the taste of vinegar in the pickling solution is too strong, offset it with more sugar. Do not dilute it with water.

Pickled fish must be refrigerated. When properly preserved, they should keep for 4 to 6 weeks at 40°F.

## Ingredients

To pickle fish, you need:

**Fish** - Only good quality fresh fish.

**Soft water** -Hard water has too much iron, magnesium and/or calcium. Boil hard water for 5 minutes, allow the minerals to settle and remove the top scum. Then, pour off the water to use. Strain heavy sedimentation through several layers of cloth, or dilute hard

water with soft water. To dilute, mix one part hard water with two parts soft water.

**Vinegar** - Vinegar should be clear without foreign flavors or odors and have a guaranteed 5% acetic acid content. Distilled white vinegar is recommended. Cider and other fruit vinegars containing 5% acetic acid may be used, but the fruit compounds may give the fish off-flavors.

**Salt** - Use finely ground canning and pickling salt. Table salt contains iodine, calcium and magnesium compounds which may give the fish a bitter flavor. Flaked salt varies in density and should not be used. Do not use reduced sodium salts because they do not contain enough sodium to ensure the safety of the product.

**Sugar** - Regular table sugar is suitable.

**Spices** - Use only fresh, whole spices to minimize messiness on brined fish flesh.

### Basic Brining Procedure

1. Clean fish thoroughly.
2. Soak fish in the refrigerator in a weak brine made of 1 cup salt to each gallon of cold water for 1 hour. Drain.
3. Make saturated brine of 4 cups salt to each gallon of cold water. Soak whole fish in saturated brine in the refrigerator for 12 hours. Soak small fish such as smelt for 4 hours.
4. Rinse fish in fresh water.
5. Cut fish into serving size portions

### BASIC PICKLING RECIPE

Prepare fish as in Basic Brining Procedure.

- 10 pounds fish (brined and cut)
- 1 clove garlic, crushed (optional)
- 5 cups water
- 1 ounce white pepper (optional)
- 2 quarts vinegar (5% acidity)
- Crushed red pepper (optional)
- ½ pound sliced onions (to taste)
- 2 ounces mixed pickling spices

#### To Pack in Jars With Fish:

- Bay leaves
- Lemon slices
- Onion slices

1. In a large kettle, bring to boil water, vinegar, onions and sugar.
2. Add fish and simmer for 10 minutes or until fish is easily pierced with a fork.
3. Remove fish from liquid and spread in single layer in a shallow pan. Refrigerate until cold.
4. Pack cold fish loosely in clean glass jars.
5. Add onion slices, lemon and bay leaves if desired.
6. Strain the vinegar solution, bring to a boil, and pour into jars to cover the fish.
7. Seal immediately and date.
8. Store in the refrigerator. Use within 4 to 6 weeks.

*This recipe makes 6 to 8 quarts of pickled fish. It is suitable for all kinds of freshwater fish, especially carp, herring, smelt and mullet (sucker).*

## CANNING FISH

Although freezing is the easiest way to preserve fish, canning does offer some advantages. Canned fish may be stored on a shelf at room temperature for long periods of time, produces a moist, flaky product and eliminates the bone problem. For this reason, mullet (suckers) and other bony fish are often canned. The bones soften and become edible with the meat.

Use only pint jars (or smaller) for canning fish; do not use quart jars. Jars must be thoroughly clean. It is not necessary to sterilize them, however. Just wash them in hot soapy water and rinse well.

Choose jars with two-piece canning lids. Wipe the jar rim clean. Put the lid on, with the ring of the sealing compound next to the top of the glass. Screw the band down firmly, so that it is hand tight. Some lids with sealing compound require boiling or holding in boiling water for a few minutes before use. Follow the manufacturer's directions.

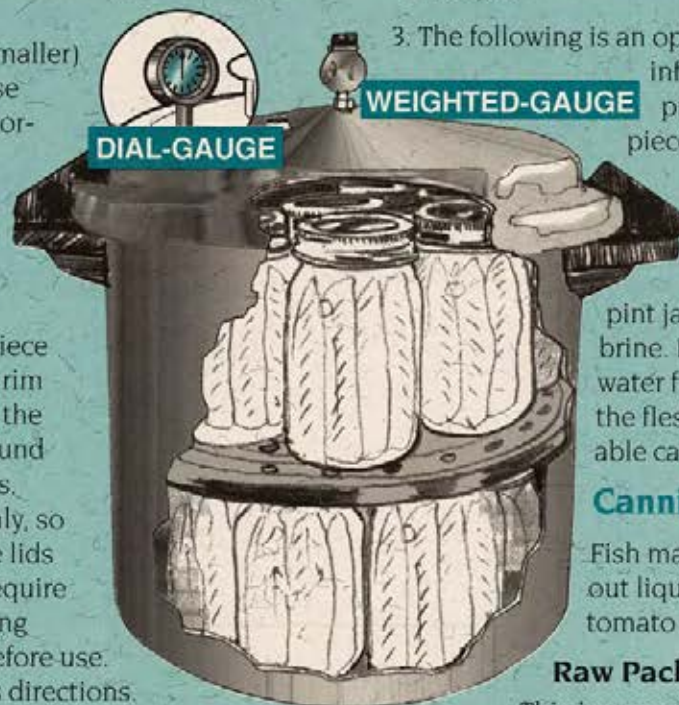
The only safe way to process fish is in a pressure canner. To prevent any risk of botulism food poisoning, the pressure canner must be in perfect order, including accuracy of the pressure gauge. Canning directions must be followed exactly, including up-to-date researched process times and pressures for the size of the jar, style of pack and kind of food being canned. The jar lid must be firmly sealed and concave once cooled. Nothing must leak from the jar, and no liquid should spurt out when the jar is opened. No unnatural or off odors should be detectable.

Fish that has been frozen may be safely canned. Thaw the fish in the refrigerator. As soon as it has thawed, prepare and process it according to the directions that follow. Processing the fish promptly after thawing is essential for a safe product.

### Preparation

It takes 25 to 35 pounds of whole fresh fish to fill about a dozen pint jars with boneless fish.

1. Clean and wash fish thoroughly. Remove the entrails, heads, fins and tails. The skin and dark flesh along the lateral line is usually removed.
2. Cut into desired size ( $3\frac{1}{2}$ " ) pieces—usually the size of the jar.
3. The following is an optional step and does not influence the preservation process. If desired, soak pieces in brine made of 1 cup of salt per gallon of cold water. Pieces  $\frac{1}{2}$  inch thick require 10 to 15 minutes, while pieces the size of a pint jar require an hour in the brine. Brining removes blood and water from the fish flesh and firms the flesh to produce a more desirable canned product.



### Canning Methods

Fish may be packed into jars without liquid, or it may be packed in tomato sauce or tomato juice.

#### Raw Pack

This is a good method for canning salmon or trout.

1. Drain the washed or brined fish. Fill pint jars, leaving 1 inch headspace. If canning fish with skin on, place skin side next to the glass. Add 1 teaspoon of salt per pint, if desired. Do not add liquids.
2. Wipe jar rims. Adjust lids.
3. Process half pints or pints in a pressure canner at the pressure indicated for your altitude in the charts on page 11.

#### Fish in Tomato Juice

1. Drain the brined fish (mullet or suckers). Pack solidly into clean, hot half-pint or pint jars, but do not jam or crush the flesh. Leave 1 inch head space.
2. To each pint jar, add a mixture of 4 ounces boiling



tomato juice, 1½ teaspoons of vinegar and 1½ teaspoons of prepared mustard. Cover with the fish, leaving 1 inch head space.

3. Wipe jar rims. Adjust lids.
4. Process half pints or pints in a pressure canner using the schedule for raw pack.

**Using a Pressure Canner**

Follow the manufacturer's directions for the canner you are using. Here are a few pointers for using any pressure canner.

1. Put 2 or 3 inches of boiling water in the bottom of the canner.
2. Set jars on a rack in the canner using a jar lifter. If two layers of jars are put in a canner, use a rack between them. Stagger the second layer.
3. Fasten the canner cover securely so that no steam can escape except through the vent (pressure regulator or weighted gauge opening).
4. Heat at the highest setting until steam pours steadily from the vent. Let it escape for 10 minutes to drive all air from the canner. Then put on the weighted gauge or close the petcock.
5. Let pressure rise to the recommended pressure. As soon as this pressure is reached, start counting the processing time. Keep pressure constant by regulating the heat under the canner.
6. When the processing time is up, turn off the heat and remove the canner from the heat source if possible. Let the canner stand until pressure drops to

zero by itself. Do not force cool the canner. Force cooling may result in improperly processed food and could warp the canner or open the petcock. Unfasten the canner cover, tilting it away from your face.

7. Place the hot jars on a board, towel or rack to cool. Keep them out of drafts.

**After Canning**

When jars are cool (12 to 24 hours after processing), check the seals. If the lid is depressed or concave and will not move when pressed, it is sealed.

Label sealed jars with species and date. Store in a cool, dry, dark place. For best eating quality, try to use canned fish within a year.

If unsealed jars are found 24 or more hours after processing, dispose of the product. Do not taste or smell the product or feed it to pets. Discard the jar and its contents in the trash or bury it in soil. If within 24 hours after processing you find a jar that did not seal, either refrigerate the fish and use it within 5 days, freeze it, or refrigerate it immediately and recan again within 5 days using the same time-temperature schedule. Remove the lid and check the jar-sealing surface for nicks. If necessary, replace the jar and add a new lid and reprocess. At times when the lid is removed from canned fish, glass-like crystals are present on the canned fish. If there is no evidence of glass breakage, the crystals (termed "Struvite") are magnesium ammonium phosphate, a natural product formed during canning. They are safe to eat and usually are dissolved by heating.

**Recommended process time for fish in a dial-gauge pressure canner\***

Style of Pack	Jar Size	Process Time	Canner Pressure (PSI) at Altitudes of			
			0–2,000 ft	2,001–4,000 ft	4,001–6,000 ft	6,001–8,000 ft
Raw	Pints	100 minutes	11 lb	12 lb	13 lb	14 lb
		<i>110 minutes for smoked fish</i>				

**Recommended process time for fish in a weighted-gauge pressure canner\***

Style of Pack	Jar Size	Process Time	Canner Pressure (PSI) at Altitudes of	
			0–1,000 ft	Above 1,000 ft
Raw	Pints	100 minutes	10 lb	15 lb
		<i>110 minutes for smoked fish</i>		

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