Understanding Contaminants in Fish
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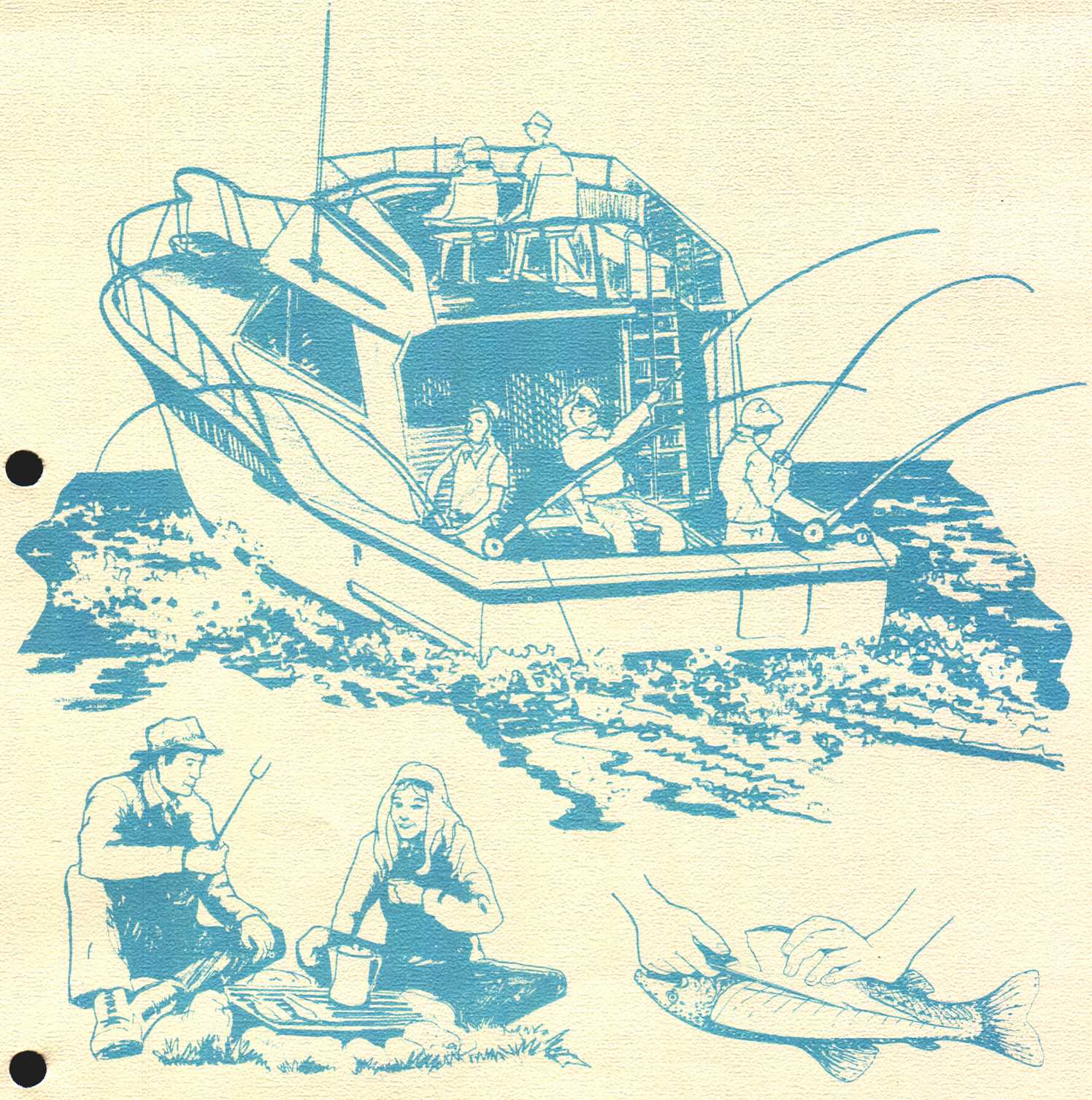

COOPERATIVE EXTENSION SERVICE • MICHIGAN STATE UNIVERSITY

Understanding Contaminants in Fish[1]

By Thomas E. Rippen
Department of Food Science and Human Nutrition

Both naturally occurring and synthetically produced chemicals are used regularly in commerce, industry and agriculture. Of the 5,000 to 10,000 new chemicals produced each year, approximately 1,000 are introduced into commerce. A chemical becomes a contaminant in fish when its presence is not normally expected or when it exceeds safe, desirable levels. It may alter the flavor of the food, disrupt the ecosystem or cause a health hazard to consumers.[2]

To protect the consumer from possible harmful effects, the Toxic Substances Control Act of 1976 dictates that certain classes of chemicals be screened for toxicity before they are allowed for use in industry. In addition, it allows for Federal regulation of the production and use of these chemicals. Michigan recently enacted the Hazardous Waste Management Act, which is expected to expand state control of waste production and disposal.

Once chemicals enter production, the U.S. Food and Drug Administration (FDA), which regulates commerce across state boundaries, establishes and enforces limits on the amounts of certain chemicals that may appear in foods. The Michigan Departments of Agriculture, Public Health and Natural Resources (DNR) also enforce these limits in foods produced or marketed in Michigan.

Types of Pollutants

Of those pollutants capable of rapid or long-term toxicity to animals, three classes of compounds most commonly build up in fish flesh and therefore may pose a risk to human health.

1) Halogenated hydrocarbons: A group of chlorine or bromine containing organic chemicals that may be quite toxic to fish, these tend to persist in the environment and accumulate in fatty tissues. PCB, DDT, dieldrin and PBB are examples. Although formally found in plastics, adhesives, paints and carbon paper, PCB is now restricted for use in enclosed electrical capacitors and transformers, where it is important as a poor conductor of electricty with a high boiling point and low flammability.

The pesticides DDT and dieldrin are now banned from sale and use, but due to their persistance, are still found in some Michigan fish. PBB (polybrominated biphenyl) a fire retardant, has been found in fish in a few southern Michigan streams.

2) Heavy Metals: Mercury, lead and cadmium are among those metals which may accumulate in fish tissues. Natural weathering of rock is often as important a source of these chemicals as are man-made materials such as pesticides, gasoline additives and metallurgy wastes. A metal's chemical form, the presence of other metals and various environmental factors can greatly affect its toxicity to fish.

3) Radionuclides: Radioactive atoms such as strontium-90, also occasionally accumulate in fish, although a reduction in atmospheric nuclear testing may minimize their significance in the future.

Health Effects of Fish Contaminants

When a chemical is determined to be a contaminant, action levels are established on the basis of human safety, enforceability and economic implications. There are difficulties in establishing these levels, however, because health effects are frequently very subtle, may be similar for more than one toxic substance and may not occur immediately. When direct evidence is lacking, animal studies are performed and implications drawn from the results. Establishing safe levels, below which little hazard or no hazard exists, is frequently a formidable task.

Current Health Standards

To date, mercury intoxication in Japan is the only evidence of an industrial chemical that has affected human health *due to eating fish*. PCB proved toxic to humans in 1968 when Japanese citizens consumed rice oil accidentally contaminated with

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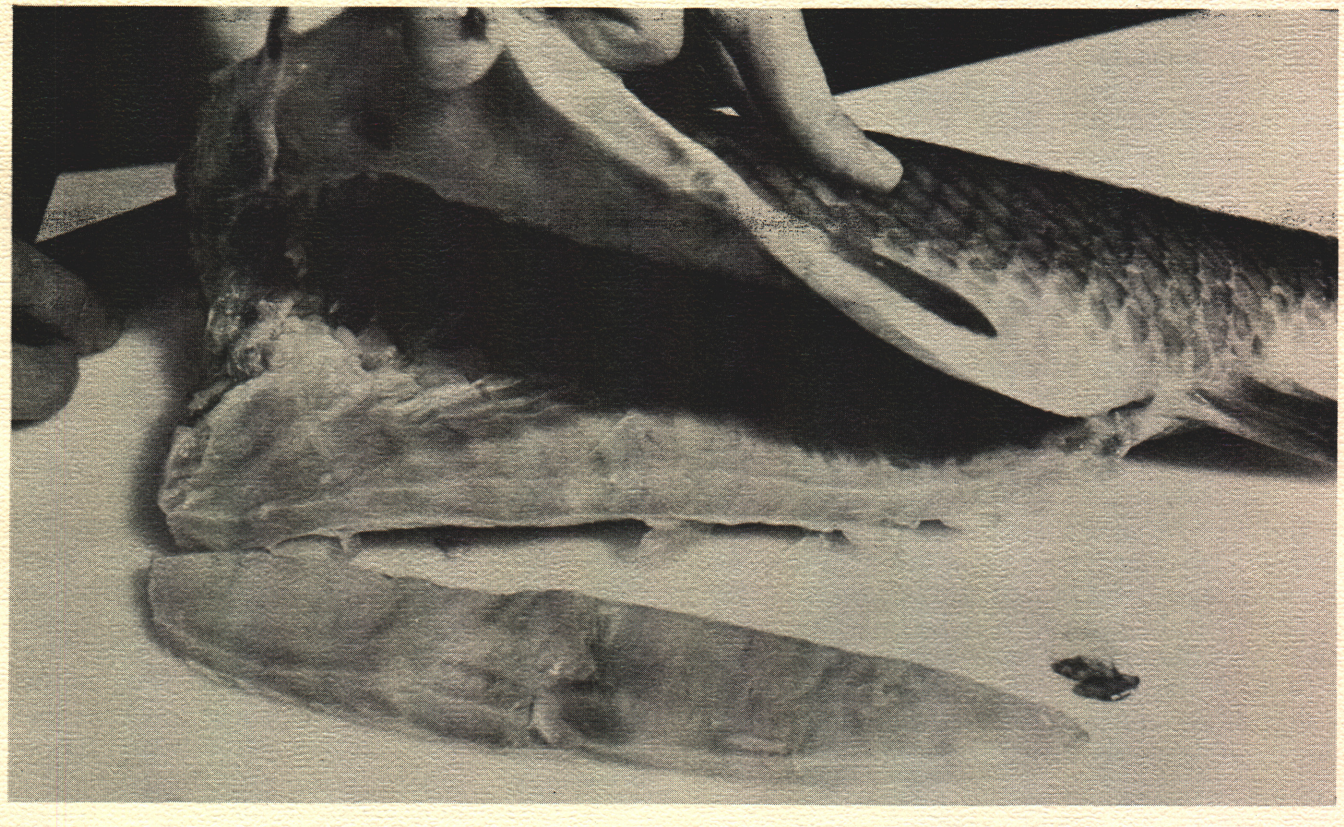
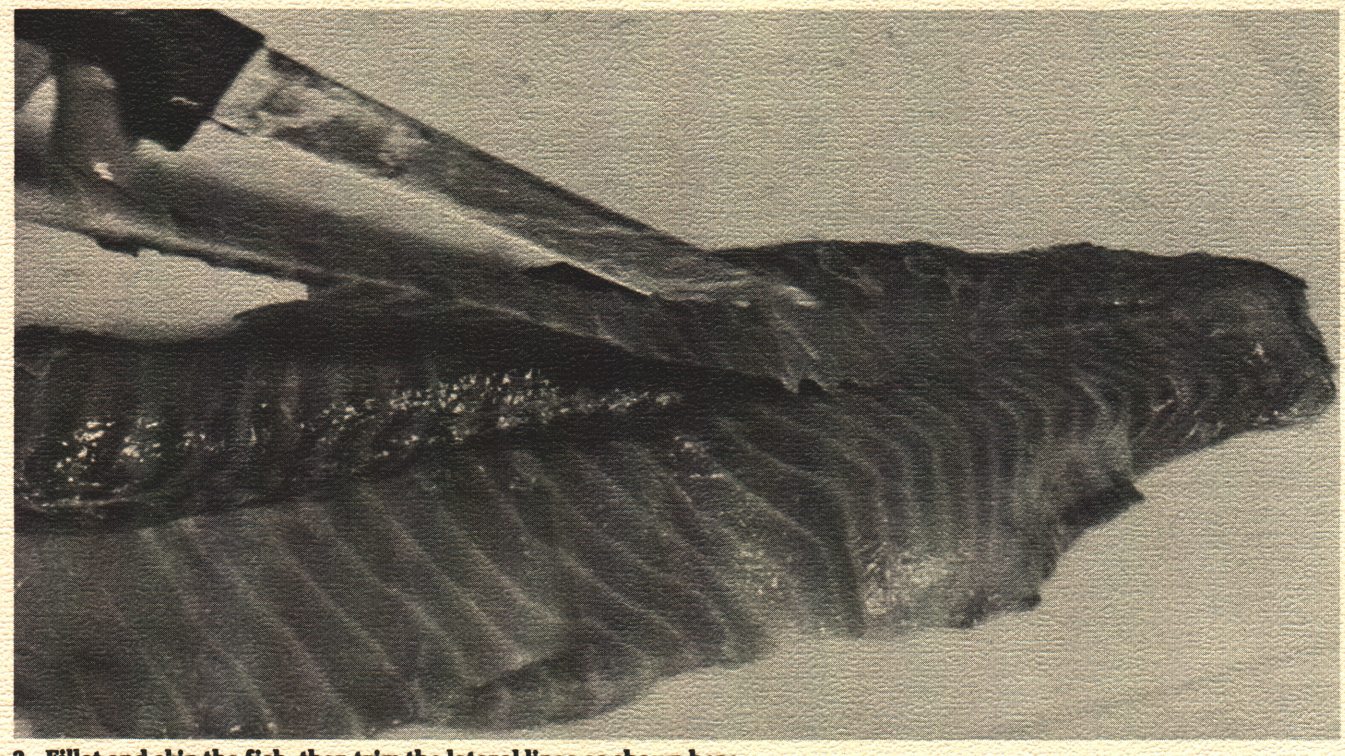
[1]Re-edited for Michigan from "Fish Contaminants: A Perspective," Fish Contaminants: Sources," and "Fish Contaminants: Human Health," by Michael W. Duttweiler, Sea Grant Extension Program, Cornell University Cooperative Extension Service.

[2]Most "grassy" or "muddy" flavors in certain fish are attributable to harmless, biologically produced compounds, not to contaminants having health significance.

1. After the fish is gutted and the head removed, remove the backstrip from the fish.



2. After removing the backstrip, the belly flap should be separated from the fish.



3. Fillet and skin the fish, then trim the lateral lines as shown here.

b. removing or puncturing the skin to let the fat drain off during cooking.

c. cooking by broiling, poaching, deep-fat frying or baking such that cooked out fat is removed and discarded.

Studies indicate that proper trimming can reduce PCB by 25 percent in chinook salmon and 65 percent in smallmouth bass.[6]

Legal Action

There are two levels at which legal action may be taken to control the marketing of contaminated fish:

1. Food entering *inter-state* commerce, (under FDA), and
2. Food entering *intra-state* commerce (under the Departments of Public Health and Agriculture).

The FDA reviews available health and toxicity data of a compound, then sets a tolerance level for the amounts allowed in food sold in commerce. For some chemicals, this limit may be called an action level when there is not enough information available to determine an acceptable concentration. Fish catches are sampled periodically to insure that these standards are not exceeded.

Fish commercially caught and sold or consumed within Michigan come under the jurisdiction of the Michigan Departments of Health, Natural Resources and Agriculture. Contaminant tolerance levels established by the Department of Public Health are in agreement with those of the FDA. The Michigan Department of Agriculture is responsible for testing market fish for contaminants. Regulations which restrict or prohibit the taking of certain fish are imposed by the DNR.

The contaminant policy governing the Michigan sport fishing industry is established by the state Department of Public Health and enforced by the DNR. Regulations may include closing bodies of water to fishing, prohibiting the taking of certain species of fish, or most commonly, recommending consumable amounts of some fish species from certain waters. Regulations are likely to have an economic impact on the sport fishing industry and their enforceability may be difficult.

The most recent health advisory from the Michigan Department of Public Health was issued September 1978, based on data from the Michigan Departments of Natural Resources and Agriculture. A copy can be obtained from your local health department, or refer to the advisory printed in the Michigan fishing regulations brochure that accompanies the purchase of a sport fishing license.

For more information contact your county Cooperative Extension Service office.

[6]Quarterly Report on Toxic Substances Impacting Fish and Wildlife, June 1979.

high levels of PCB. Symptoms included spontaneous abortion, hair loss, changes in skin color and smaller infant birth weights. There is little evidence, however, of the long-term effects of humans consuming small amounts of this chemical.

Studies of monkeys fed steady diets containing as little as 2.5 parts per million PCB[3] resulted in noticeable adverse health effects within two months.[4] This is cause for concern because there is no completely safe concentration of PCB which is known and a contaminant may be more toxic to one species of animal than to another. It is important to note that the probability of a human regularly ingesting such quantities of PCB as those fed to the monkeys is small and the chemical forms used in the studies may be different than those found in fish tissue.

The currently imposed tolerance level of PCB set by the FDA is five parts per million (ppm). It is possible that this will be lowered to two ppm in response to animal studies such as those listed above. The five ppm tolerance level and related consumption advisories are based in part on a level that is one-tenth of that which produced detectable toxicity in Japanese citizens following the rice oil tragedy.

There is no scientific concensus on the danger to humans of the *occasional* consumption of PCB contaminated fish. But, based on animal experiments, the sportsfisherman is considered a higher risk than the consumer who purchases fish. While commercially sold fish are monitored for PCB and other major contaminants, sportsfishermen who may eat substantial quantities of problem fish do not have the benefit of such sampling.

Sources of Fish Contaminants

Fish become contaminated when contaminants enter bodies of water via:

1. Direct discharge: Contaminants spilled or discharged into rivers and lakes.
2. Runoff: Surface and ground waters carry contaminants from landfills, weathered soils and rocks, and other sources to rivers and lakes.
3. Air: Contaminants in the air may enter water by being washed out by rain or through natural fallout.

The very existence of many source points at which contaminants may enter the environment makes their control extremely difficult.

Usually, levels of contaminants in bodies of water or in soil are low, but once they enter the river and lake systems they tend to accumulate in plant and animal tissues. Tiny organisms assimilate chemicals present in sediment or water, and are eaten by small fish and other aquatic animals. These are eaten in turn by larger and larger fish where chemicals persist in elevated concentrations.

Fish may also absorb poorly soluble compounds directly from the water. PCB, DDT and dieldrin are accumulated in fatty tissues, while mercury and cadmium are retained in muscle tissue. Fatty species, such as trout or salmon, tend to accumulate PCB, DDT and dieldrin more readily than fish with a lower percentage of fat. Older, larger fish of any given species have greater opportunity for accumulating contaminants than smaller, younger ones. The waters of origin and the source of food are other important factors to consider.

Humans also tend to accumulate chemicals such as PCB, DDT and heavy metals. Small amounts of these chemicals are not known to pose a health hazard, but a large dose received in a short period of time or small amounts accumulated over long periods may cause health problems.

Personal Precautions

For those who do catch and eat freshwater fish, the following suggestions will be helpful in minimizing the amount of contaminants consumed:

1. Check the health advisory for species and waters known to be contaminated. Fish from most inland lakes and streams have no recognized contamination problems. But fish taken from certain stretches of a few southern Michigan streams should not be consumed.
2. For a given species of fish, avoid larger, older fish which may have had more time to accumulate contaminants.
3. Eat no more than one fish meal (one-half pound) per week of those fish listed in the health advisory. Small children and pregnant and nursing women should eat none of the listed fish.
4. Remove excess fat from freshly caught fish by:[5]
   a. trimming the back strip, lateral lines and belly flaps from the fish.

[3] 2.5 parts PCB per 1 million parts food.

[4] Barsotti et. al.

[5] These procedures are generally not effective for removing heavy metals such as mercury.

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