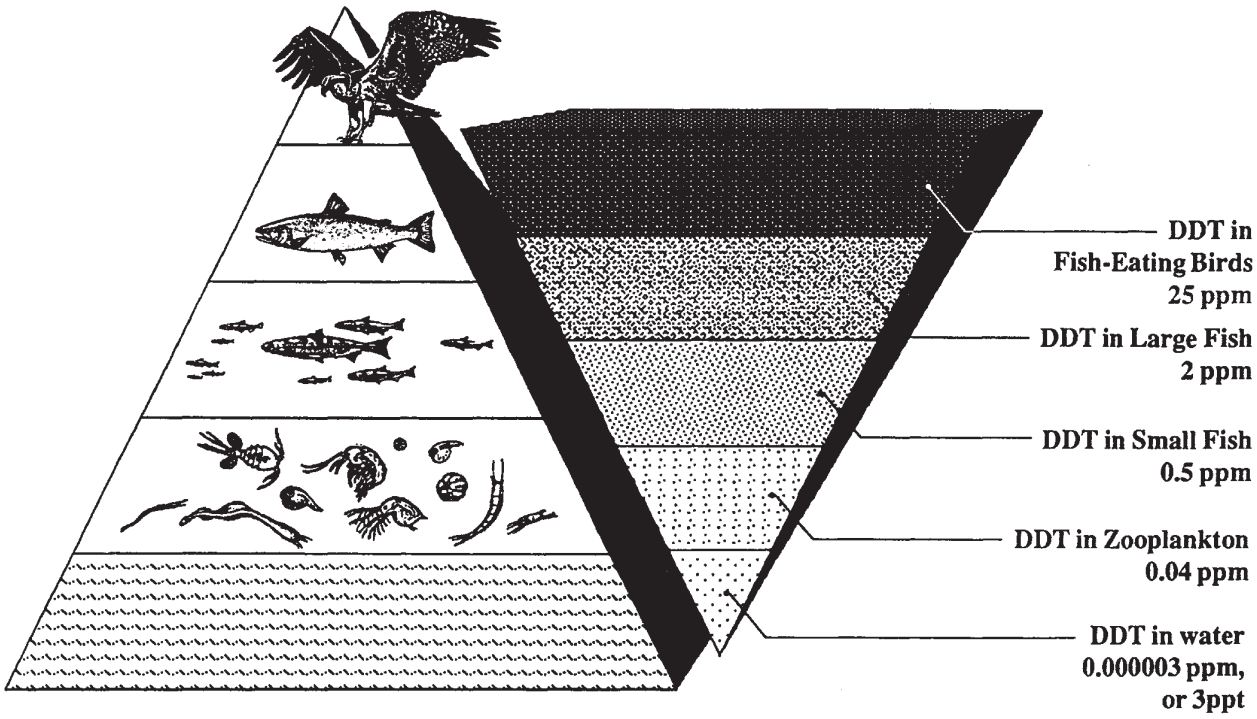
Which Fish Can We Eat?

Bioaccumulation of a toxin occurs when a toxin collects in the body of an organism. PCBs, a class of organic compounds, and DDT, a compound previously used as an insecticide, are toxins of concern in the Great Lakes, because they remain in the environment long after their use is prohibited. When some toxins (such as PCBs or DDT) are ingested, they do not pass through the body of the organism but collect and accumulate in its body. High concentrations of toxins can cause a variety of health problems, genetic disorders, and death in humans and animals. The class of toxin called PCBs (polychlorinated biphenyls) is soluble in fat, which means that it collects in fatty tissue. The family of PCBs includes 209 compounds, and PCB products contain both the chemicals and added components. As fish and other organisms live in bodies of water that contain PCBs, they eat other organisms, such as plankton, which contain the toxins. As the fish ingest PCB-laden food, the toxins collect in their fatty tissue so that the concentration of PCBs in their bodies is much higher than in the water around them. The longer they live in those waters, the more toxins they accumulate from the organisms they consume. If a bird eats several fish that are contaminated with PCBs then that bird "collects" the toxins from each of the fish it eats. In this manner, the PCBs are passed up the food chain at higher and higher levels of concentration.

Some of the symptoms in humans associated with PCBs are cancer, neurological effects, and effects on reproduction and development. In wildlife, PCBs have been associated with premature deaths and effects on reproduction and the immune system. It is recommended that people not eat fish that have PCB concentrations of 2 parts per million or more.

Figure 1. Accumulation and amplification of organic contaminants in an aquatic system. Like PCBs, DDT is no longer produced in the U.S., but it persists in the environment. (Source: Green Bay/Fox River Mass Balance Study, Executive Summary, EPA-905/8-89-002, GLNPO Report 07-89, August 1989)



Materials

• Paper and pencil.

Earth Systems Understandings

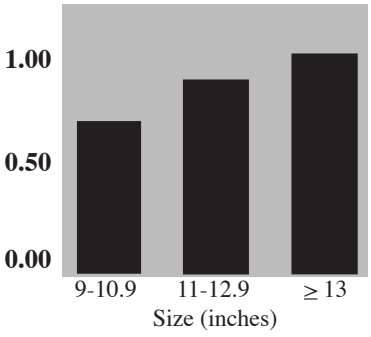
This activity focuses on ESU 2 (stewardship), 3 (science process and technology) and 4 (interactions).

Source

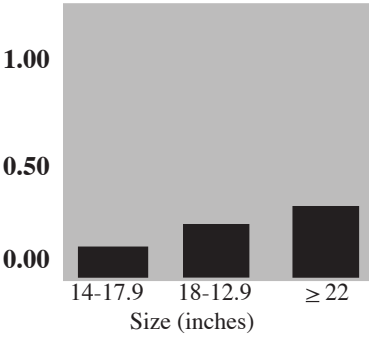
Modified from OEAGLS EP-23. *PCBs in fish: A problem?* Activity A, by Victor J. Mayer, Amy J. White-Predieri, Vanessa J. Steigerwald and Stephanie Martin.

Answers

1. Concentration of PCBs (ppm) in white bass vs. size (inches)



2. Concentration of PCBs (ppm) in walleye vs. size (inches)



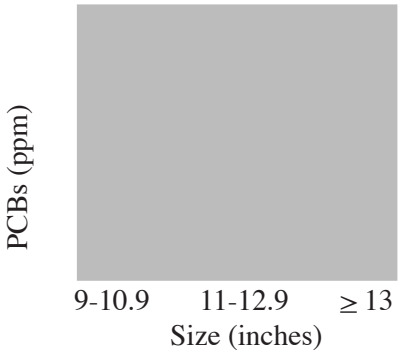
Objective

After completing this activity you should understand some reasons why toxic concentrations vary in fish.

Procedure

The Ohio Department of Natural Resources measured the PCB concentration in white bass and walleye in Spring 1987 and Fall 1987, respectively. Each was collected at three different places on Lake Erie. Table 1 has the data that were obtained.

1. Using Table 1 and the graph below, construct a bar graph of the data from Sandusky Bay for white bass (concentration of PCB vs. size of fish).



2. Construct another bar graph with the data from Middle Sister Island for walleye.

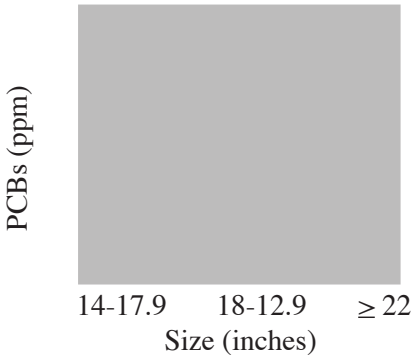


Table 1. Concentration of PCBs (ppm) in White Bass and Walleye taken from Lake Erie in Spring 1987 and Fall 1987, respectively.

White Bass			
Size	**Maumee Bay**	**Cedar Point**	**Sandusky Bay**
9-10.9"	1.34	0.66	0.74
11-12.9"	1.27	0.93	0.91
13" and over	1.64	0.96	1.06

Walleye			
Size	**Middle Sister Island**	**Cedar Point**	**Lorain**
14-17.9"	0.16	0.16	0.15
18-21.9"	0.25	0.24	0.22
22" and over	0.33	0.36	0.42

3. Answer the following questions:

   A. How is fish size related to PCB content for the white bass at Sandusky Bay?

   B. Is the relationship between size and PCB content the same for the walleye at Middle Sister Island?

   C. What could cause this relationship?

   D. Now examine the data from the other sites. Does the relationship seem to hold for fish taken at each site?

   E. Compare the data collected for the concentration of PCBs in white bass and walleye. Which species contains higher concentrations of PCBs?

When comparing data, be careful to note the size categories. The walleye samples were larger than the white bass. Remember, PCB concentration should increase with size because PCBs bioaccumulate (i.e., concentrate in fatty tissues as fish become larger and older).

   F. Why might the concentration of PCBs be lower in walleye compared to white bass?

   G. Locate each of the sites on a map of Ohio. Is the concentration of PCB in the fish related to the site at which they are obtained? Which site seems to have fish with the highest concentration?

   H. Update the information on PCBs in Great Lakes fish by examining data from the Internet site http://CS715.cciw.ca/glimr/data/sogl-final-report. Investigate the figures, specifically Figure 10 (Source: Government of Canada). What seems to be the trend over the years for the amount of PCBs? Find the concentration of PCBs in fish from your lake and other Great Lakes as well.

"Levels of persistent toxic contaminants have been reduced substantially since 1970."

(Source: Government of Canada, 1996).

Answers

A. The larger the fish, the higher the concentration of PCB.

B. Yes, the concentration of PCB increases as the fish increase in size.

C. This is probably true because the larger fish are older, and therefore have had more time to concentrate PCBs in their fatty tissues.

D. The relationship seems to hold at each site; however, the white bass at Maumee Bay deviate somewhat.

E. The white bass have higher concentrations of PCBs than the walleye, even though the white bass size categories sampled were smaller than those for walleye.

F. The walleye may have lower PCB concentrations because they tend to inhabit the open, cooler waters of the lake more than white bass. Thus, local sources of contamination such as industrial wastes or industrial dump sites on the adjacent land would be more dilute by the time they reached the farther, cooler open waters where walleye feed. Additionally, bottom feeders of the lake such as carp and catfish would be expected to contain higher PCB concentrations than both walleye and white bass. Both carp and catfish tend to remain close to shore and therefore uptake higher concentrations of local sources of contamination from industrial wastes and industrial dump sites on the adjacent land.

G. The concentrations did differ according to the sites at which the fish were obtained. This may be related to local sources of contamination such as industrial wastes or industrial dump sites on the adjacent land.

H. "Levels of organochlorine contaminants in the tissues of top predator and forage fish declined significantly from the late 1970s to mid 1980s but have shown a slower rate of decline more recently. (L)evels . . . in some areas continue to be high enough to restrict consumption by humans" (Government of Canada, 1996).

Public Health Advisories for Great Lakes Fish (1996)		
	Restrict Consumption*	**Do not eat**
Lake Michigan	Lake trout over 23"(north of Frankfort) [A] Lake trout 20-23" (south of Frankfort) [A] Walleye over 22" [B]	Brown trout over 23" Carp and Channel catfish Lake trout over 23" (south of Frankfort) Whitefish over 23" (south of Frankfort)
Lake Superior	Lake trout 20"-30" [A]	Lake trout over 30" Ciscowet over 18"
Lake Huron	Brown trout over 21" [A] Lake trout up to 22" [A]	Lake trout over 22"
Lake Erie[1]	Walleye Freshwater drum (See State of Ohio Advisory)	Carp and Channel catfish
Detroit River *Lk. St. Clair*	Freshwater drum over 14" [B] Walleye over 20" White bass over 13" Smallmouth bass over 18" White perch over 10" Rock bass over 8" Largemouth bass Bluegill over 8" Freshwater drum over 14" Carpsucker over 18" Brown bullhead over 14" Northern pike over 26" [B] Carp over 22" [A]	Carp Channel catfish over 22" Muskellunge and Sturgeon
Lake Ontario **	White perch Coho salmon up to 18" Rainbow trout up to 18"	American eel Channel catfish Lake trout Chinook salmon Coho salmon over 21" Rainbow trout over 25" Brown trout over 18"

* Restricted consumption: No more than one meal per week, or

[A] Nursing mothers, pregnant women, those who anticipate bearing children, and children under age 15 should not eat these fish.

[B] The above-mentioned group should not eat more than one meal a month of these fish.

**Lake Ontario data from 1992

[1]Data obtained from Michigan Department of Community Health, Public Health Advisory; and State of Ohio Advisory, Meal Advice for Eating Lake Erie Sport Fish, printed in *Twine Line*, Ohio Sea Grant Program.

For the most up-to-date information, contact the Michigan Department of Community Health, Department of Environmental Epidemiology. Updated February, 1996. Phone: (517) 335-8350.

State of Ohio Advisory Meal Advice for Eating Lake Erie Sport Fish	
Fish	**Number of Meals Suggested**
Yellow perch	No Restrictions
Walleye Freshwater drum	One Meal a Week (52 meals/year)
Carp under 20" White perch Steelhead trout Coho salmon Chinook salmon over 19" Smallmouth bass White bass	One Meal a Month (12 meals/year)
Carp over 20" Carp from Maumee Bay (all sizes) Channel catfish Lake trout	One Meal Every Two Months (6 meals/year)
Channel catfish from Maumee Bay	Do **Not** Eat

Source: *Twine Line*. February 1996. Ohio Sea Grant Program.

Answer

I. There may be a range of student answers on this question. However, the data suggest that there should not be any problems in consuming white bass and walleye that have been taken from Lake Erie, since the recommended standard of 2 ppm was not exceeded at any of the sampling locations.

Answer

Larger fish are often older than small fish and have had more time to accumulate toxins.

See the role play that follows this activity for additional review questions.

Teacher's Note

Even if you do not do the role play in the following activity, find ways to introduce the important information in the roles and resources.

Extension Notes

In the minds of some anglers and charter boat owners, the *National Wildlife* article and other publications had an economic effect on fishing in the Great Lakes. The number of charter trips dropped, for example by as much as 50% in Wisconsin (Butterbrodt 1996). Some boat owners sold their boats, and some bait and tackle store owners also experienced an impact (Butterbrodt 1996). One observation is that the charter fleet declined from 1,200 boats to 340 on Lake Michigan in Wisconsin (Appleby 1996).

Many people believe that warning articles and fish consumption advisories do have an economic impact on fishing in the Great Lakes. For example, FDA maintained a 5ppm action level through the '70s to early '80s but then lowered it to 2 ppm. States follow different consumption advisories even though they may share the same Great Lake (Thomas, November 14, 1996). Students can investigate similar issues.

PCBs are found in Lake Erie fish – but are they dangerous? The Food and Drug Administration, using information from the occurrence of PCB poisoning in Japan and from studies of laboratory animals, has established a standard of 2 ppm of PCBs as the maximum allowable concentration in fish used for human consumption. The white bass and walleye are an important food and sports fish.

I. What would you recommend to a fellow sports fisher about eating white bass and walleye caught on a fishing trip to Lake Erie?

Review Question

Why is it often more dangerous to eat larger fish from the Great Lakes?

Extension

Brainstorm what impact a "fishing scare" caused by possible contamination in fish in the Great Lakes would have on the sport fishing industry, commercial fishing and the states economy. What other impacts would there be?

Consider the 1996 "crazy cow" scare in Great Britain. The possibility that the disease known as "crazy cow" could spread to humans who eat contaminated beef caused many people to stop buying and eating beef (even though the connection between eating beef and catching the disease has not been proven). The economic repercussions of this scare on the beef industry climbed into the billions of dollars.

How might a Great Lakes fish scare be similar or different from the crazy cow scare? Consult the Michigan (http://www.dnr. state.mi.us/) and Wisconsin (gopher://gopher.dnr.state.wi.us:70/1) Departments of Natural Resources and the Great Lakes Sport Fishing Council (http://www.execpc.com/~glsfc/) for information on how charter fishing was impacted by the *National Wildlife* article "Are Great Lakes Fish Safe to Eat?" August/Sept. 1989, Vol. 27, No. 5, p. 16(4). See also the *Federal Register* June 29, 1979, Vol 44, no. 127, p.38330-38340 regarding the FDA reducing tolerances of PCBs in fish from 5 to 2 ppm.

References

Cooper, Kathy and Kai Millyard. 1986. *The Great Lakes Primer; Pollution Probe*, Pollution Probe Foundation, Toronto, 1986. 58pp.

Downhower, Jerry F. *The Biogeography of the Island Region of Western Lake Erie*. The Ohio State University Press, 1988. 280 pp.

Environment Canada and U.S.E.P.A., 1995. *State of the Great Lakes*. Request copies from:

Environment Canada or
867 Lakeshore Road
Burlington, Ontario
Canada
L7R 4A6

Environmental Protection Agency
Great Lakes National Program Office
77 West Jackson Blvd.
Chicago, IL 60604
U.S.A.

Fortner, Rosanne W. and Victor J. Mayer, editors. *The Great Lake Erie*. The Ohio State University Research Foundation, 1993. Ch. 15.

Great Lakes Sport Fishing Council (http://www.execpc.com/~glsfc/) email: glfsc@execpc.com

Hazardous Substances and Public Health, A quarterly newsletter by ATSDR – http://atsdr1.atsdr.cdc.gov:8080/HEC/hsphhome.html.

Hileman, Bette. "The Great Lakes Cleanup Effort," *Chemical and Engineering News*, Feb. 8, 1988, pp 22-39.

Luoma, Jon R. 1996. "Biography of a Lake," *Audubon*.Vol. 98, No. 5 (September-October): 66 (13).

PCBs, ATSDR Public Health Statement, June 1989. Agency for Toxic Substances and Disease Registry. http://atsdr1.atsdr.cdc.gov:8080/ToxProfiles/phs8821.html

The Great Lakes. An environmental atlas and resource book. 1995. Jointly produced by the Government of Canada and U.S. EPA, 3rd edition. Copies available from E.P.A. Great Lakes National Program Office, 77 West Jackson Blvd., Chicago, IL 60604

Top 20 Hazardous Substances, ATSDR/EPA Priority List for 1995 – http://atsdr1.atsdr. cdc.gov:8080/cxcx3.html – includes ranking of substances (i.e., PCBs are sixth).

ToxFAQ's Menu of Chemical/Hazardous Substances, Agency for Toxic Substances and Disease Registry (ATSDR) – http://atsdr1.atsdr.cdc.gov:8080/toxfaq.html. To find a fact sheet, click on the letter of the chemical name; some entries also show molecular models.

National Sea Grant Resources

Consult the National Sea Grant Depository database for publication information (http://nsgd.gso.uri.edu/search.htm)

See Also

Priority Contaminants of the Great Lakes – http://CS715.cciw.ca/glimr/data/sogl-final-report/table4.html
(Source: Government of Canada, 1995).

ATSDR Science Corner – http://atsdr1.atsdr.cdc.gov:8080/cx.html

U.S. E.P.A. *The EPA Great Waters Program: An Introduction to the Issues and the Ecosystems*. Office of Air Quality Planning and Standards, Durham, North Carolina 27711. EPA-453/B-94/030, April 1994.

Additional Resources

Appleby, Maxine. Fish Advisories. [Online] Available email: mapplebyy@execpc.com

Butterbrodt, Jim. Great Lakes Study Committee. Personal Interview. December 2, 1996.

Thomas, Dan. Contaminants in fish tissues and fish advisories. [Online] glsfc@maui.netwave.net

The results of an EPA study (1995) on fish consumption advisories are available on PC-based disks that can generate statistics and maps for a specific fish species, state, or pollutant. Refer to document number EPA-823-C-95-001 and contact:

The Environmental Protection Agency,
National Center for Environmental Publications and Information
11029 Kenwood Rd.
Cincinnati, OH 45242
Phone: (513) 489-8190
E-mail: waterpubs@EPAmail.EPA.gov