

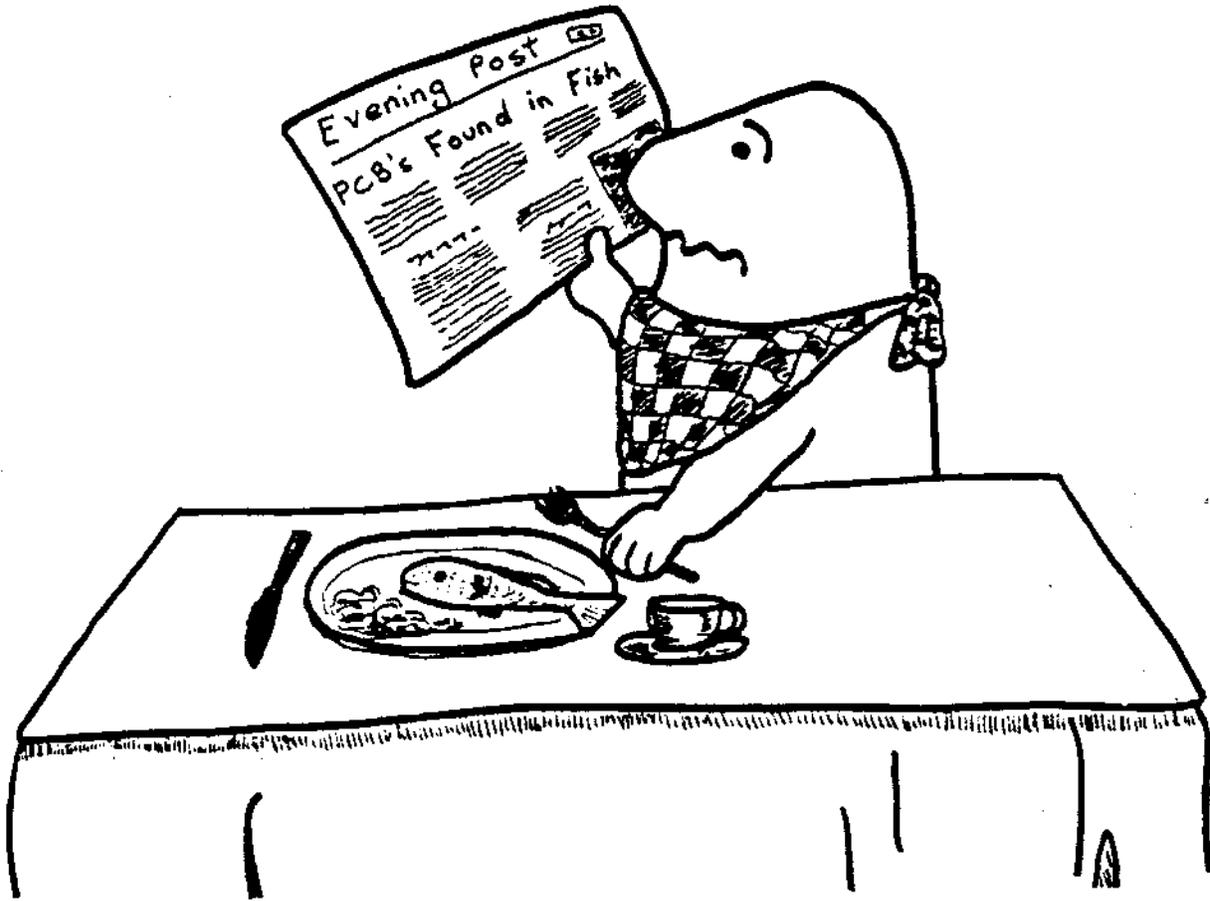


# PCBs in fish: A problem?

*Victor J. Mayer, Amy J. White-Predieri, Vanessa J. Steigerwald, & Stephanie Martin\**

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**OEAGLS**  
 OCEANIC  
 EDUCATION  
 ACTIVITIES FOR  
 GREAT  
 LAKES  
 SCHOOLS

TEACHER GUIDE



## OEAGLS EP-023T Teacher Guide

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## PCBs IN FISH: A PROBLEM? TEACHER GUIDE

by

Victor J. Mayer, Amy J. White-Predieri, Vanessa J. Steigerwald and Stephanie Martin  
Ohio Sea Grant Education

### OVERVIEW

In this investigation students determine the extent of dilution necessary for a substance to have a concentration of a few parts per million. They learn about the effects of PCBs contained in fish on the health of fish consumers, how PCBs get into water, and what variables affect their concentration in fish found in Lake Erie. In the second part of the investigation, students participate in a role playing simulation. They represent various experts from government and interest groups; they attempt to determine a policy regulating the use of contaminated fish from Lake Ontario.

### PREREQUISITE STUDENT BACKGROUND

Students should be able to construct bar graphs and to do basic multiplication and division. They should also be somewhat familiar with the concept of solution.

### OBJECTIVES

When the students have completed this investigation they will:

1. Know how PCBs and other dangerous materials enter the environment.
2. Understand the degree of danger in eating fish that contain PCBs.
3. Know what can be done to reduce the danger of eating harmful amounts of PCBs.
4. Understand the possible effects of different ways of controlling PCBs upon the fish and sports industries.
5. Realize the difficulties in taking action to lessen the threat of PCBs.

### MATERIALS

Demonstration: India ink, two eyedroppers, graduated cylinders: 10ml, 100 ml, and 1000 ml (or a liter vessel), two ten gallon aquaria or one 15 to 20 gallon aquarium. Map of Ohio (could be a state road map).

### SUGGESTED APPROACH

The first part of Activity A is written as a teacher demonstration. The first part (through Step II) could be conducted as a student lab if sufficient equipment were available. The section of Activity A dealing with PCB concentration in Lake Erie white bass could be completed as a homework assignment. If so, then this activity could be completed in one period.

NOTE: Information to teachers is enclosed in boxes in this guide.

# PCBs IN FISH: A PROBLEM?

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## INTRODUCTION

During the summer of 1978, New York State closed down many of the fishing areas on Lake Ontario. This was done to reduce the chance that people would catch fish containing PCBs and eat them. What are PCBs? How did they get into the water of Lake Ontario? Are they found in Lake Erie? How are they harmful to us? What can be done if they do enter our food chain?

## ACTIVITY A: WHAT ARE PCBs?

**KEYWORDS:** solution, dilution (dilute), concentration

The PCB story is a classic one on how we have knowingly created a threat to our health and that of animals that share our planet. This happened while providing something that improved our living standard. PCBs are produced from petroleum. They are very useful as insulating material. They will not burst into flames at high temperatures, and so are used in electrical transformers and capacitors. They have also been used in a variety of consumer products. These latter uses have been banned since 1971.

The tragic effect of this group of chemicals on human life was revealed in an event in Japan in 1968. Four people died from a mysterious disease. More than 1,000 others suffered symptoms such as stillbirths, miscarriages, skin disease, nervous disorders, hearing loss and discharge from the eyes. The one thing that all of these people had in common was that they had eaten rice oil prepared at the same plant. This plant had used PCBs as a coolant in pipes that circulated through the hot rice oil. The pipes had developed leaks, discharging the PCBs into the oil, which was then eaten by those that developed the disease. In some patients, the symptoms continued for three years after eating the rice oil.

PCBs and many other dangerous materials are found in very tiny, but often deadly, amounts in water and body tissue. The amount is expressed in parts of the material per million parts of the substance in which it is found. For example, the PCBs found in the rice oil in Japan were in a concentration of 2000 parts of the PCBs to one million parts of the oil.

## PROCEDURE

Concentrations of substances in solution are expressed as parts of the substance to the total parts of the solution. Therefore, if there were a solution of one part of ink and nine parts of water, the concentration would be expressed as one part in ten. Discuss this with your students as you begin the activity.

### Step 1

To begin this investigation, your teacher will place one drop of a colored material, probably ink, in a 10 ml graduated cylinder. Then your teacher will add nine drops (parts) of water. Answer the following questions on your answer sheet.

1. How many parts (drops) of ink are in the cylinder?

T1. 1

2. How many parts (drops) of water are in the cylinder?

T2. 9

3. How many total parts (drops) of solution are in the cylinder?

T3. 10

Since your teacher has 10 drops of solution that has one drop of ink in it, the concentration of solution is described as one part ink per 10 solution. This ratio can be written 1 part ink: 10 parts solution or 1 part ink/10 parts solution.

4. Look carefully at the graduated cylinder. What is the volume of the solution?

T4. 1/2 ml. (There are 20 drops to a milliliter.) At each step of the dilution, hold the vessel containing the solution in front of a white sheet of paper, and ask the class whether they can still see the ink.

Keep a record of all the data from Step I in the data chart on your answer sheet. Be sure to note on your answer sheet at what concentration you were no longer able to see the ink because it was diluted too much.

### Step II

In Step I we had a 1 part ink in 10 parts solution. Now we want to dilute the ink in solution by adding more water. The concentration of ink will be reduced because more water will be added.

In Step II we want to dilute the solution 10 times.

5. What volume of solution is ten times greater than the original volume of solution?

T5. 5 ml.

6. How many parts (drops) were in the original solution?

T6. 10

7. How many parts (drops) of water must be added to dilute this solution 10 times?

T7. 90

8. Now, what is the total number of parts (drops) in the solution?

T8. 100

Add the data from Step II to the data chart.

### Step III

Remember, PCBs are measured in ppm, or parts per million. Our original drop of ink is now diluted to 1 part per 1 hundred. Let's keep diluting this solution until the ink is diluted to 1 part per million.

9. What volume in milliliters would be ten times greater than the volume we have obtained in Step II?

T9. 50 ml

Our 10 ml graduated cylinder is too small to hold this volume so the teacher must transfer our solution into a larger 100 ml graduated cylinder. Then the teacher will add water to dilute the solution to the volume you have calculated in question 9. Instead of counting drops as in Step II, you can calculate the number of drops (parts) of total solution using the equation:

$$20 \text{ drops (parts)} = 1 \text{ milliliter}$$

10. How many total parts (drops) of solution are in our newly diluted solution?

T10. 1,000

Record the data from Step III dilution in the data chart.

### Step IV

11. If we dilute the new solution 10 more times, what volume (in milliliters) of solution would we have?

T11. 500 ml

12. What volume in liters would be equal to the number of milliliters in question 11?

T12. 0.5 liters

13. Using the equation  $20 \text{ drops (parts)} = 1 \text{ ml}$ , how many total drops (parts) of solution are contained in the volume obtained in question 11?

T13. 10,000

Your teacher will make the dilution to the volume you calculated in question 11. A liter vessel must be used to hold the solution since the 100 ml graduated cylinder is too small. Tabulate your results for Step IV in the data chart.

Step V

14. How many more tenfold dilutions are necessary to dilute the ink to one part per million? Explain how you arrived at this answer.

T14. Two additional dilutions. One dilution will take it to 100,000 drops and the second to 1,000,000 drops.

15. What volume (in liters) of solution is necessary to perform each of these dilutions?

T15. For the first dilution you will end up with 5,000 ml or 5 liters of solution and for the second, 50,000 ml or 50 liters of solution.

16. How many gallons of solution are needed to dilute the ink to a concentration of 1:1,000,000? HINT: 1 liter = 0.264 gallons.

T16. 13.2 gallons

As your teacher carries out the dilutions you have determined above, fill in the rest of the data chart.

17. At what concentration were you no longer able to see the ink?

T17. After a concentration of 1:1000 has been reached, students will find it difficult to see any indication of the presence of the ink.

PCBs are thought to enter bodies of water such as Lake Erie through the air as a result of burning plastic objects containing the chemical, from direct dumping of liquid waste from industries using PCBs in their industrial processes, and from water running through solid waste disposal sites where transformers or other PCB-containing materials have been dumped. Fish will take up the PCB from the water through their gills or through the food they eat. The PCBs are then concentrated in the tissue, especially the fatty tissue, of the fish's body. See Figure 1.

### How PCBs Pass Through the Great Lakes Food Chain

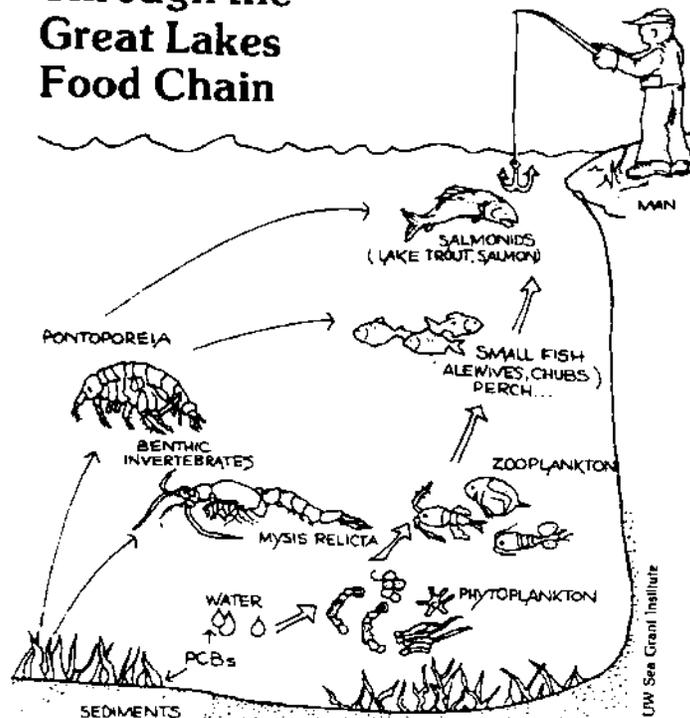


Figure 1. How PCBs get to people.

DATA CHART

	I	II	III	IV	V final step
PARTS	1:10	1:100	1:1000	1/10,000	1/1,000,000
VOLUME (ml)	1/2 ml	5 ml	50 ml	500ml	50,000 ml

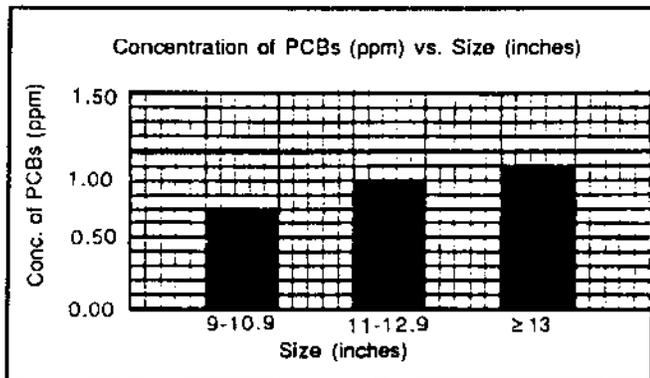
You might want to bring out some other comparisons of what one part per million means. For example: it is one minute in two years; one second in 11.6 days, one penny in \$10,000, and one ounce of chocolate in 8,000 gallons of ice cream.

Are PCBs found in fish from Lake Erie? 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 was obtained.

White Bass				Walleye			
Size	<u>Maumee Bay</u>	<u>Cedar Point</u>	<u>Sandusky Bay</u>	Size	<u>Middle Sister Island</u>	<u>Cedar Point</u>	<u>Lorain</u>
9-10.9"	1.34	0.66	0.74	14-17.9"	0.16	0.16	0.15
11-12.9"	1.27	0.93	0.91	18-21.9"	0.25	0.24	0.22
13" and over	1.64	0.96	1.06	22" and over	0.33	0.36	0.42

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

18. On your answer sheet, construct a bar graph of the data from Sandusky Bay for white bass.



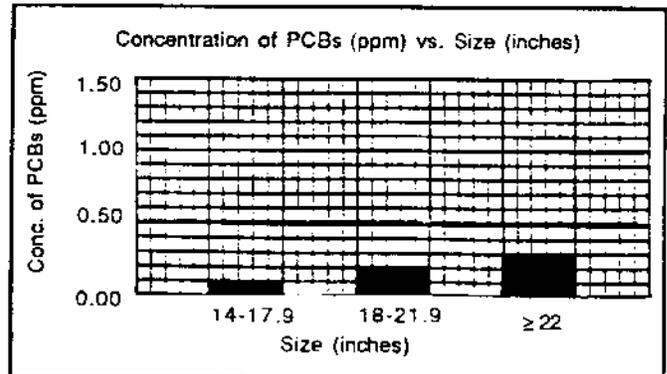
19. How is fish size related to PCB content?

T19. The concentration of PCBs increases as the size of the fish increases.

20. What could cause this relationship?

T20. This is probably true because the larger fish are older, and therefore have had more time to concentrate PCBs in their fatty tissues.

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



22. Do you see the same relationship?

T22. Yes, the concentration of PCBs increases as the fish increase in size.

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

T23. The relationship seems to hold at each site.

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

T24. 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.

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).

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

T25. 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.

26. 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?

T26. The concentrations did differ according to the sites at which the fish were obtained. This may be due to local sources of contamination such as industrial wastes or industrial dump sites on the adjacent land.

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.

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

T27. There may be a range of student answers on this question. However, the data suggests 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.

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## ACTIVITY B: HOW CAN THE PUBLIC HEALTH BE PROTECTED?

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**MATERIALS:** Set of role descriptions

### PROCEDURE

Assign roles at least a day or two before you plan to start the simulation. Duplicate enough of the role descriptions so that each member of a role group can have the one pertaining to his/her role. Have the students study the descriptions prior to the day that the simulation will be conducted. Also have them read the student guide for Activity B, especially the five policies that will be considered during the simulation. These policies should also be written on the chalk board where they can be referred to by the students during the simulation.

In 1978 it was determined that certain species of fish from Lake Ontario contained PCBs at a level that might be dangerous to the health of people eating them. The New York Department of Health considered several policies for reducing the health hazard. In this activity, you will play the role of a member of an interest group or an expert concerned with the PCB problem. You are attending a hearing that the Department of Health might have held to gain information so that it would select one of the policies to implement. Your teacher and two students will serve as the board conducting the hearings for the department. At the end of the hearings, the board will vote on a policy which will then be enforced throughout the state.

Your teacher will assign each member of the class to one of the following roles:

#### **Experts** (one student for each role):

Officer of the New York Department of Environmental Conservation

Scientist from the Federal Food and Drug Administration

#### **Interest Groups** (two or more students per group)

The Sports Fishers of New York

The New York Association of Commercial Fishers

The Marina Operators Association of New York

Association for the Protection of the Health of New York Citizens

Association of Local, Municipal and State Public Officials

The Department is considering the following policies:

- I. Close Lake Ontario to any fishing.
- II. Restrict the taking of fish to only those species that are not contaminated with PCBs in concentrations above 2 ppm.
- III. Restrict fish takes to only the smaller, and therefore less contaminated, of the affected species of fish.
- IV. Close only those areas of the lake in which fish are found to have concentrations of PCBs above 2 ppm.
- V. Develop and broadcast an advisory that tells the maximum amounts of fish that can be eaten without danger to health and describes ways to reduce the amount of PCBs from fish.
- VI. Take no action.

Following is the sequence of this activity:

1. The teacher will assign students their roles and hand out role descriptions.
2. Students will have time to study their roles and to do any additional background research that they may find necessary.
3. Those students assigned to an interest group will meet with their groups to discuss the positions that they plan to take, and to nominate a spokesperson. The experts will meet with the Department of Health hearing board to discuss the information that they plan to present at the hearing.

4. The hearing will be held and the following rules followed:
  - a. The experts will present prepared remarks to the board.
  - b. Each interest group will have no more than five minutes to present a prepared statement.
  - c. Only members of the board may ask questions, and they must be directed to the presenter immediately following the presentation.
  - d. When all presentations have been made, board members may ask additional questions of any of the presenters.
  - e. Board members meet to decide on one of the policies.

## REVIEW QUESTIONS

1. How do PCBs get into water? Into fish?

T1. PCBs get into water through the air as a result of burning plastic objects containing the chemical; from direct dumping of liquid waste from industries using PCBs in their industrial processes; and from water running through solid waste disposal sites where transformers or other PCB-containing materials have been dumped.

Fish take up PCBs from the water through their gills or through the food they eat. The PCBs are then concentrated in the tissue, especially the fatty tissue, of the fish's body.

2. How dangerous is it to eat fish from Lake Erie? Why?

T2. The data suggests 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. However, bottom feeders such as carp and catfish would be expected to contain higher PCB concentrations and should probably not be consumed.

3. List ways in which the threat of PCBs to human health can be reduced.

T3. The threat of PCBs to human health can be reduced by trimming off the fatty tissue when filleting fish and avoiding the consumption of fish that have PCBs in concentrations above 2 ppm, the recommended standard.

4. How would banning the taking of fish from Lake Erie affect the economy of towns along the lake?

T4. The economy of towns along the lake would be significantly affected if the taking of fish from Lake Erie was banned. Marina owners and operators, the charter boat business, and tackle and bait sellers would all be greatly affected.

5. Which of the policies discussed in Activity B would be most difficult to enforce? Why?

T5. Probably the most difficult policy to enforce would be the closing of Lake Ontario to any fishing because of all the opposition that would be met. For instance, many sports fishers do not eat what they catch. However, closing only those areas of the lake in which fish are found to have concentrations of PCBs above 2 ppm would also be very difficult to enforce. It would be difficult to keep track of the closed areas.

6. Which policy would you support? State your reasons.

T6. The answers to this question will vary. The reasons for students' choices are important to note. Hold a class discussion and compare the reasons in favor of each policy.

## APPENDIX

Following are the descriptions of each role. In addition some of the roles have supplementary background material.

### Experts:

1. Scientist from the Federal Food and Drug Administration - Excerpt from the *Federal Register*.
2. Officer of New York Department of Environmental Conservation - 'Fish Filleting Guide' and an article from *The New York Times* "State to Ban All Commercial Striped Bass Fishing."

### Interest Groups:

1. Association for the Protection of the Health of New York Citizens - Article from *The New York Times* "Bluefish Study Stirring Concern on Health."
2. Association of Local, Municipal and State Public Officials.
3. Marina Operators Association of New York.
4. Sports Fishers of New York - Article from *The Cleveland Plain Dealer* "State Warns Against Eating Lake Erie Carp, Catfish."
5. The New York Association of Commercial Fishers - Article from *The New York Times* "With Striped Bass Ban, A Way of Life is Fading."

## SCIENTIST FROM THE FEDERAL FOOD AND DRUG ADMINISTRATION (FDA)

Polychlorinated biphenyls (PCBs) are virtually indestructible pollutants produced by people and now found in food and water sources. For almost 50 years, this toxic chemical has been used in motor fuels, detergents, nylon, pesticides, plastics, paints and varnishes, adhesives, lubricants, printing inks, fluorescent light starters, waterproofing and fireproofing materials, and other products. Each year, millions of pounds of PCBs have been dumped into rivers and waterways through industrial waste disposal and accidental spills, leaked into the soil from trash in dumps and landfills, and carried into the air from burning of waste and vapor escaping from paints and varnishes. PCBs are chemically stable and not easily broken down. Complete destruction requires temperatures above 1,200 degrees Fahrenheit. Once PCBs are incorporated into fish, animals and other foodstuffs, they cannot be eliminated by processing.

About 1.4 billion pounds of PCBs were produced in the United States between 1929 and 1977. Although the United States production of PCBs has ceased, it is estimated that 450 million pounds of PCBs exist in the environment and 750 million pounds of PCBs are still in industrial and domestic use.

The effect of PCB contamination in humans was discovered in 1968 in Japan when some people ate rice oil containing PCBs that had leaked from a heat exchange unit at the oil processing plant. Many people developed severe symptoms of weakness, numbness of limbs, dark coloring of skin, swelling of eyelids, and disturbances in liver function. Babies born to mothers who had eaten the oil had skin discolorations. Recent laboratory studies have shown that monkeys fed PCBs developed reproductive problems, liver disease, acne, eye inflammations, weight loss, and loss of hair. Liver tumors or liver damage has also been produced in test animals such as chickens, rabbits, quail, mice, and rats which have eaten PCBs.

The U.S. Department of Agriculture and the FDA have been routinely inspecting fresh fruits and vegetables, dairy products, eggs, grains, fish, animal feeds and processed foods for high concentrations of PCBs. On May 22, 1984, the FDA lowered the maximum PCBs tolerance level from 5 ppm to 2 ppm in fish and shellfish. This new ruling became effective on August 20, 1984. Maximum tolerance levels of PCBs in foods have been established by the FDA to provide a margin of safety for the public:

- 2.0 ppm in the edible portions of fish and shellfish
- 1.5 ppm in milk and dairy products
- 3.0 ppm in poultry
- 0.3 ppm in eggs
- 0.2 ppm in finished animal feed
- 2.0 ppm in animal feed components of animal origin
- 0.2 ppm in infant and junior foods.

Other FDA regulations concern the use of PCBs in equipment and machinery employed in food and animal feed production and food packaging and storage materials. These are necessary since there have been cases of PCB contamination of various foodstuffs from herbicides, paper wrappers and cartons, and transfer fluid leakage.

PCBs pose a great threat to freshwater fish because it is extremely difficult to eliminate the PCBs already present in waterways. PCBs also tend to accumulate in the fatty tissue and flesh of fish and other animals that eat them. Freshwater fish most affected with PCBs include: coho, and chinook salmon, steelhead trout, striped and small-mouth bass, carp, eel, rockbass, catfish, alewife and lake trout. Fish from Lake Ontario and Lake Michigan have been found to contain a high level of PCB contamination. A two-year study, funded by FDA, revealed that people who eat Lake Michigan fish have more PCBs in their blood than people who do not; however, no adverse health effects could be identified in this study. Long range effects on human health have not yet been determined.

Additional information is included in the excerpt from the May 22, 1984, issue of the *Federal Register*.

**Food and Drug Administration**

**21 CFR Part 109**

(Docket No. 77N-0080)

**Polychlorinated Biphenyls (PCBs) in Fish and Shellfish; Reduction of Tolerances; Final Decision**

**AGENCY:** Food and Drug Administration.

**ACTION:** Final rule; final decision following a formal evidentiary public hearing.

**SUMMARY:** The Commissioner of Food and Drugs is issuing a Final Decision following a formal evidentiary hearing to consider objections to the agency's final rule concerning a tolerance for polychlorinated biphenyls ("PCBs") in fish and shellfish. The Commissioner concludes that the appropriate tolerance, after taking into account public health and human food loss considerations, is 2 parts per million ("ppm"), as provided for in the final rule.

**EFFECTIVE DATE:** August 20, 1984.

**I. Background**

This rulemaking proceeding involves the tolerance for unavoidable residues of PCBs in fish and shellfish, 21 CFR 109.30(a)(7). In 1977 the Food and Drug Administration ("FDA") proposed to lower the tolerance for PCBs in several classes of food. In relevant part, FDA proposed to lower the tolerance in fish and shellfish from 5 ppm to 2 ppm. 43 FR 17487 (April 1, 1977). In 1979 the agency promulgated a final rule based on the proposal, including lowering the tolerance in fish and shellfish to 2 ppm.

Section 408 of the Federal Food, Drug, and Cosmetic Act ("the act"), 21 U.S.C. 348, authorizes the establishment of tolerances for poisonous or deleterious substances added to food that cannot be avoided by good manufacturing practice. PCBs are such a substance. Although the agency's paramount concern is protection of the public health, under section 406 the agency must consider, in establishing a tolerance, the extent to which a contaminant is unavoidable. In essence, the agency is permitted to find where the proper balance lies between adequately protecting the public health and avoiding excessive losses of food to American consumers. 44 FR 38330-31. Pursuant to that mandate, the agency examined the amount of commercial fish that would be lost as human food as a result of lowering the tolerance.

My ultimate conclusion is that a tolerance of 2 ppm for PCBs in fish and shellfish adequately protect the public health, while not causing excessive loss of food to American consumers.

Administrative Law judge ("ALJ") Daniel J. Davidson issued his initial Decision on February 8, 1982.

**II. The Evidentiary Hearing Issues**

Judge Davidson made detailed findings about the human food loss resulting from lowering the tolerances from 5 ppm to 2 ppm:

Imports.....	0
Unviable fisheries.....	0
Related species.....	0
Domestic harvest in violation:	
Alewives.....	\$843,000
Buffalofish.....	128,000
Carp.....	223,000
Catfish.....	3,894,000
Trout.....	80,000
Whitefish and chubs.....	1,181,000
Bluefish.....	68,000
Lobster.....	4,081,000
Striped bass.....	2,964,000
Total.....	13,453,500
Times multiplier of six.....	80,721,000
Elasticity effect.....	8,000,000
Grand total.....	88,721,000

Judge Davidson's figures are in 1980 dollars.<sup>1</sup> The loss figures for the individual species are dockside values; except for alewives, they are not now in dispute. Judge Davidson determined the human food loss at 2 ppm by subtracting the loss at 5 ppm from the loss at 2 ppm so as to represent the net loss from reducing the tolerance. He concluded that retail value is the appropriate measure of human food loss and applied a "multiplier" of six to derive retail value from dockside value.

**III. Scientific Issues**

In view of the changing nature of scientific knowledge and the public health importance of a tolerance for PCBs in fish and shellfish, it is important that the agency's decision be based on all currently known relevant information. Therefore, I conclude that there is good cause for including in the rulemaking record all newly submitted reports and studies that are not presently part of the record.

In their briefs, NFI and GE generally take the position that FDA's concerns about the potential health risks associated with PCBs are overstated. I do not agree with that position. My responses to their specific arguments follow.

NFI argues that FDA's concerns are unfounded because PCBs are only a cancer promoter, not an initiator. NFI Brief at 5. Presently, there is no consensus in the scientific community regarding the mechanisms of initiation

and promotion. However, regardless of whether PCBs are promoters or initiators, I believe the data indicate that PCBs present a significant potential risk to our population. In the preamble to the final rule, FDA stated that "[a]lthough the data do not fully resolve such important questions as the carcinogenicity of PCB's they lead to the conclusion that neither 'no-effect' nor 'allowable daily intake' levels for PCB's can be established with any confidence and that, from a toxicological point of view, human exposure to PCB's should be reduced." 44 FR 38331, col. 2. I conclude that that statement continues to be valid today.

NFI and GE contend that PCB levels in fish pose no health problems. NFI Brief at 5; GE Brief at 9-10. I do not agree. NFI and GE cite a study that investigated potential adverse health effects from human consumption of Lake Michigan fish contaminated with PCB residues. The study was considered in the Risk Assessment and discussed in the preamble to the proposal, 42 FR 17492-93 (Reference 40). Although no adverse health effects or groups of symptoms that were clearly related to PCB exposure could be identified in the exposed group, the investigators reported a highly significant correlation between the quantity of Lake Michigan fish consumed and the concentration of PCBs in the blood of study participants. It is significant that abstinence from Lake Michigan fish consumption for a period of 90 days did not significantly change PCB blood levels. Moreover, the study's authors cautioned that the absence of any adverse health effects similar to those effects observed in workers exposed to PCBs does not exclude the possibility that long term effects will occur.

NFI states that occupational exposure to PCBs at levels very much higher than would be experienced by those ingesting contaminated fish "leads to some health problems but not cancer or chronic health problems." NFI Brief at 5-6. FDA has identified a potential risk of PCB-induced hepatocellular carcinoma and adenoma by use of data from rodent carcinogenesis bioassays. Report at 4. This risk is supported by data in non-human primates and man indicating that the liver is a target of PCBs. Report at 5-6. There are also reports that an increased incidence of cancer has been observed in workers exposed to PCBs (Brown and Jones [1981]).<sup>2</sup> Although the incidence is low and a cause-and-effect relationship has not been established.

<sup>1</sup>Unless stated otherwise, all dollar figures in my Final Decision are in 1980 dollars. Conversion from 1974 dollars to 1980 dollars is based on use of the factors in the Initial Decision at page 3, note 3.

<sup>2</sup>Citations are to references in Appendix I of this Report.

these data—coupled with the fact that cancer has a long latent period—support the conclusion that chronic exposure to PCBs through the diet poses a potential risk.

GE argues that, because extrapolation of animal data to human experience is difficult and often misleading, priority should be given to valid human data. GE Brief at 3. I agree. The agency would prefer to base its risk assessment completely on valid human data. 42 FR 17487-88. However, there are rarely enough adequate human data to assess actual human risk without using data from non-human studies. There is general consensus among scientists that properly conducted animal studies are useful in the assessment of human health risks. Here, the results of human and animal data show a significant similarity of PCB-related effects between animals and human beings. For example, a review of the available carcinogenesis data in 1978 compared the responses of man, monkey, and rat to PCBs and concluded that hepatic hypertrophy was one of the responses common to all species (IARC [1978]; see Table 9, p. 70). Liver has been found to be the predominant target organ in rodents and abnormal liver function has been observed in human beings exposed to PCBs in the workplace. Report at 5-6. Also, an abnormal incidence of liver cancer was reported in a population of PCB exposed workers (Brown and Jones [1981]).

I recognize that remaining unanswered questions about the human response to PCBs probably will be resolved only by valid human data. Nevertheless, submitted data not available at the time of the Risk Assessment underscore the agency's concerns about PCBs and support the hypothesis that the human liver is a target of PCBs and may be adversely affected by exposure to PCBs. Under section 406 of the act, FDA must make a qualitative judgment on the basis of available data—however incomplete—to insure the proper balance between adequate public health protection and excessive loss of food. Therefore, I conclude that the extrapolation of the animal data is both necessary and proper.

#### Conclusion

In promulgating the final rule, the agency concluded that a 2 ppm tolerance would strike a proper balance between protecting consumers from the risks associated with exposure to PCBs, and the loss of food due to the lowered tolerance. That balancing was based on an estimated annual food loss, in terms of landed value, of \$9.8 million (\$5.7

million in 1974 dollars). For the reasons discussed in the preamble and supporting economic analysis (G-2), that estimate was based on a number of assumptions and inherently subject to considerable uncertainty.

I have concluded above that the annual dockside human food loss is \$13.5 million, rather than the \$9.8 million estimate stated in the preamble to the final rule. I have further concluded that the Risk Assessment supporting the final rule continues to be valid in light of newly submitted scientific information. The only question that remains is whether a balancing of the unchanged public health considerations and the increased human food loss yields a tolerance greater than 2 ppm. I conclude that the answer is no. I conclude that, even with an estimated human food loss of \$13.5 million rather than \$9.8 million, 2 ppm is nevertheless the proper balance between public health protection and loss of food.

I believe that we should keep in mind the fact that total annual domestic landings of fish are almost \$1.6 billion.<sup>11</sup> Thus, the total human food loss is less than 1% of all domestic landings.

NMF argues that, based on a balancing of risks to human health and human food loss considerations, the tolerance should be 3.5 ppm. NMFS Brief at 4. Although the risk assessment supporting the final rule included calculations of risk only at 5 ppm, 2 ppm, and 1 ppm, NMFS submitted the results of risk calculations at various levels between 5 ppm and 2 ppm.<sup>12</sup> F-32 and F-33.

I do not agree with NMFS's reasoning. The risk calculations for tolerances between 5 ppm and 2 ppm do not show any sudden decrease in the number of expected cancers below the 3.5 ppm level. Rather, the expected cancer rate drops quickly between 2 ppm and 1 ppm. Those calculations show that the expected cancer rate is basically an arithmetic progression at levels between 5 ppm and 2 ppm and are consistent with my final decision that 2 ppm is the appropriate tolerance. Moreover, NMFS's argument is based on a comparison of Judge Davidson's total

human food loss findings at 2 ppm and 3.5 ppm. As I have already stated, Judge Davidson's human food loss figures for intermediate tolerances are seriously incomplete, such that no meaningful comparisons between 2 ppm and higher tolerances are possible.

NFI and GE argue that a balancing of economic costs and public health benefits leads to the result that the tolerance should be 5 ppm. NFI Brief at 14; GE Brief at 11. I have already discussed and rejected the arguments that the agency's public health concerns about PCBs are overstated, and that FDA has not considered the full economic impact of reducing the tolerance. Consequently, I reject the suggestion that the tolerance not be lowered.

In rejecting the balancing results urged by NMFS, NFI, and GE, I believe it is important to keep in mind that a decision to set the tolerance at 2 ppm, rather than at some other higher or lower level, is inherently, judgmental in character. As stated in the preamble to the final rule, section 406 of the act does not provide a formula for weighing public health concerns against loss of food. 44 FR 38336, col. 1. In the final analysis, as Commissioner of the agency charged by Congress with protecting the public health in this area, I must make an informed judgment in light of the statutory criteria. My judgment is that 2 ppm is the appropriate tolerance.

The foregoing decision in its entirety constitutes my findings of fact and conclusions of law.

Dated: May 14, 1984.

Mark Novitch,  
Acting Commissioner of Food and Drugs.

(FR Doc. 84-13858 Filed 5-17-84; 10:30 am)

<sup>11</sup> According to the economic analysis for the final rule, domestic landings in 1974 were \$632 million. G-2 at 2. Expressed in 1980 dollars, that figure becomes \$1.56 billion.

<sup>12</sup> Judge Davidson granted the motions of the Bureau and EDF to strike these submissions because they were beyond the scope of the hearing. Order, dated October 16, 1981. Judge Davidson's decision on the motions was correct. For the reasons already stated, however, page 20 *supra*, the submissions are part of the overall rulemaking record and can be considered by the Commissioner in making a final agency decision.

## OFFICE OF THE NEW YORK DEPARTMENT OF ENVIRONMENTAL CONSERVATION

The Department is responsible for the enforcement of all laws and regulations relating to fishing on Lake Ontario. Its budget for these activities comes from fees for the licenses it issues to commercial and sports fishers. These revenues are also used for stocking fish in many of the waters of New York State. Although the Department is part of the executive branch of the state government, it is sensitive to the concerns of state legislators, since they are responsible for approving any increase in the Department budget.

The Federal Food and Drug Administration (FDA) has issued maximum standards for PCB content in milk, poultry, eggs, animal feed and fish. (The PCB level tolerated by the FDA in fish is 2.0 ppm.) Tests in 1979 have shown that all species of fish in Lake Ontario contain some PCBs; however, only salmon, trout, white bass, striped bass and channel catfish contain concentrations of PCBs above the 2.0 ppm level. Generally the older and larger the fish, the higher the PCB contamination. Many of the young of the fish species mentioned above have less than the 2.0 ppm level. Also, the Department has found that the amount of contamination varies according to the area of the lake in which the fish were caught; only in certain bays do the fish exceed the 2.0 ppm level. The Department intends to test Lake Ontario fish monthly for PCB levels.

It is important that fishers are advised of the PCB contamination in fish. The Department intends to print a warning on the fishing license of the sport fishers. It cautions them to eat no more than one meal per week of contaminated species. Besides advising fishers of the PCB danger, the general public should be protected from eating contaminated fish caught by commercial fishers. Pregnant women and younger children are especially susceptible to the side effects of high PCB concentrations. The Fish Filleting Guide is one effort of the Department to inform the public of ways to reduce PCB content of fish.

The New York State Department passed a regulation which became effective before the fishing season opened on May 8, 1986, which placed a statewide ban on all commercial striped bass fishing. As a result, fishers must turn to other fish species. This legislation has caused impacts on consumption and affected the livelihood of commercial fishers, charter boat operators, and other businesses such as restaurants that rely on this industry as well.

In addition, any regulation enacted by the health department which calls for strict regulations on species or size of fish caught commercially in Lake Ontario will be difficult to enforce. Depending on the amount of additional enforcement needed, the Department may not be able to fund it for at least two years. The Department operates on a fixed budget which is developed and appropriated two years ahead of time.

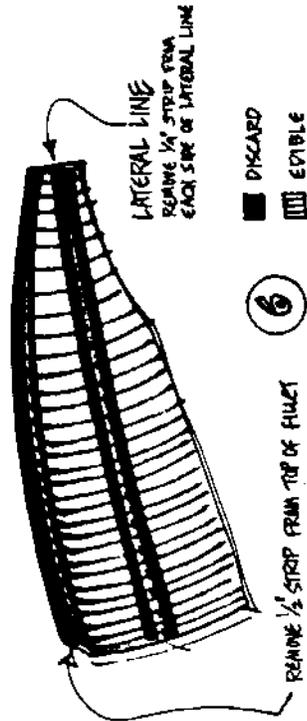
A copy of the Fish Filleting Guide accompanies this role description. Additionally, information is in the article entitled "State to Ban All Commercial Striped Bass Fishing" from the *The New York Times*.

5. Remove the fillet and repeat steps 2 through 5 for the other side.



### REMOVE THE FILLETS

5



6. Trim the two fillets as follows.
- remove 1/2" strip from the top of the fillet and discard.
  - remove 1/4" strip (1/4" from each side of the lateral line) along the entire length of the fillet and discard.
7. The four fillets are now ready to be served.

## REDUCING TOXICS

# FISH FILLETING GUIDE

Fishing is a sport enjoyed by millions of men, women and children in New York State.

The full use and enjoyment of New York's outstanding freshwater fishery resources have been marred by contaminants found in some fish species taken from certain waters.

According to the New York State Health Department, although the total biologic impact on humans of frequent eating of chemically contaminated fish is unknown, certain of these chemicals, mirex included, produce cancer and other pathologic conditions in laboratory animals and the chemicals are transmitted to the animals' offspring through mammalian milk.

### HEALTH ADVISORY

The State Health Department has advised the public that eating Lake Ontario fish may pose a hazard to health and has urged that pregnant women and nursing mothers as well as infants and young children eat **no** fish from Lake Ontario.

The Health Department's general advisory that persons limit themselves to no more than one meal per week of fish from any water in the State is still in effect.

As a general rule, the larger and older the fish, the higher the concentration of contaminant in its flesh. Thus, smaller fish are generally safer to eat than larger fish.

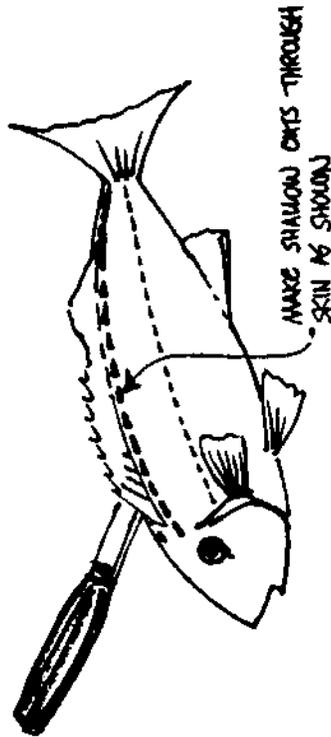
Research conducted by the Department of Environmental Conservation shows that careful trimming of fish can reduce levels of chemical contaminants by 45 to 60 percent.

We recommend that the trimming and filleting guidelines contained in this folder be followed.



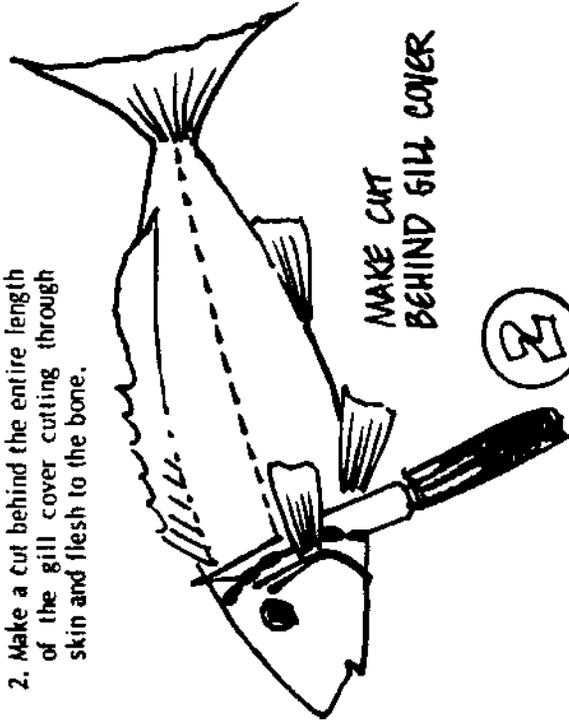
The following trimming procedure will reduce organochlorine contaminants in freshwater fish:

1. Make a shallow cut through the skin (on either side of the dorsal fin) from base of the head to the tail.



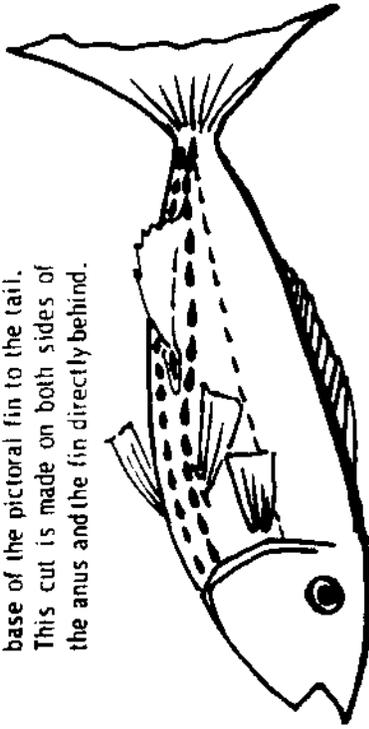
1

2. Make a cut behind the entire length of the gill cover cutting through skin and flesh to the bone.



2

3. Make a cut along the belly from the base of the pectoral fin to the tail. This cut is made on both sides of the anus and the fin directly behind.

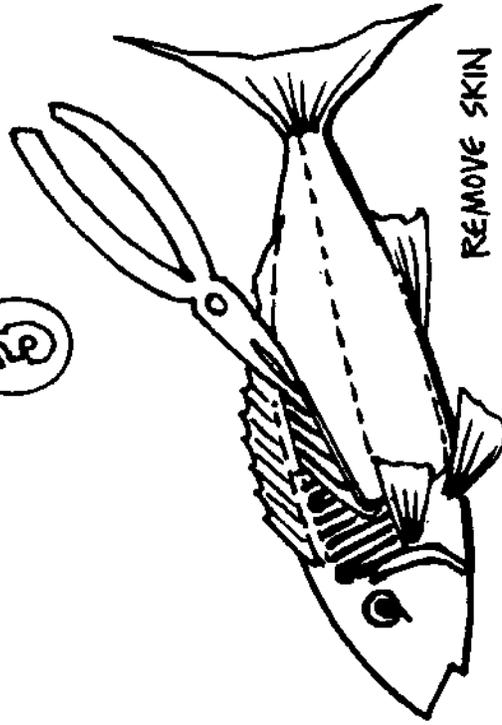


3

REMOVE SKIN FROM FISH

4

4. Grasp the skin at the base of the head (preferably with pliers) and pull towards the tail removing both the skin and belly meat. If belly meat does not come off with skin, trim it off. Discard this trimmed material along with the skin.



# State to Ban All Commercial Striped Bass Fishing

By HAROLD FABER

Special to The New York Times

ALBANY, April 21 — New York State will ban all commercial fishing for striped bass in its waters because of unsafe levels of PCB's in the fish. As a result, striped bass will be virtually unavailable in restaurants or stores in the metropolitan area.

Since last summer, commercial fishing for striped bass has been banned in all state waters except those off eastern Long Island.

But on the basis of a new study, the State Department of Environmental Conservation said the levels of PCB's — polychlorinated biphenyls — in the fish in all waters exceeded the safe

limits set by the Federal Food and Drug Administration.

"This leaves little alternative but to close the commercial striped bass fishery," Clarence Bassett, assistant commissioner of the department, said today. "We have no choice but to act."

The ban does not deal with recreational fishing for striped bass. But to conform with Federal efforts to prevent overfishing, the state plans either to impose a statewide moratorium on recreational bass fishing or to raise the size limits on fish that can be kept. At present, fish 24 inches or longer can be kept.

The decision to extend the ban on commercial fishing in effect reverses a decision made last year by the Cuomo administration.

At that time, commercial striped bass fishing, which had been banned in

the Hudson River since 1976, was halted off western Long Island and in New York Harbor.

But eastern Long Island, with its major fishing industry, was exempted by the administration, which explained that even though PCB's had been found in fish from the region, more samples were needed.

The Governor, who was traveling out of state today, could not be reached for comment.

With the new regulation, which will take effect before the fishing season opens May 8, the two major striped bass fisheries in the Northeast — New York, which once provided about half the striped bass for the region, and

Continued on Page B3, Column 3

## All Commercial Fishing For Bass to Be Banned

Continued From Page A1

Chesapeake Bay — will be closed. This will virtually halt the supply of striped bass to market. Chesapeake Bay was closed last fall because of overfishing.

Small amounts of the fish come from other states, but authorities are considering banning out-of-state fish to avoid confusion over their origin.

In addition to its impact on consumption, the new prohibition will affect the livelihood of 240 commercial fishermen who had permits to catch striped bass off Long Island in 1985. They caught 466,145 pounds of fish off eastern Long Island last year with a dockside value of \$608,788, according to state figures.

Richard Miller, executive secretary of the Long Island Fishermen's Association, said of the decision: "We don't think it's valid. We don't think there's been enough study. But we don't have the experts on our side."

He said the decision would affect all fishermen because bass fishermen would now turn to other types of fish.

"That means fewer fish for more fishermen," he said. "You see, most guys don't want to leave this way of life. So they try to hang on as long as they can."

The Department of Environmental Conservation defines the marine waters of western Long Island as those east of an imaginary line from Mastic in the south to Wading River in the north.

In its new report, the department said it had studied 644 striped bass collected during the 1985 fishing season, most of them provided by fishermen. Almost all the fish were contaminated with more than two parts per million of PCB's, the safe limit set by the Food and Drug Administration.

"The PCB findings were not so much different from those we found last year," said Lawrence Skinner, a fish ecologist for the department. "There is no increase in the PCB's. But last year we had only seven samples from eastern Long Island, and this year we have a much larger sample, something we can really rely upon for data."

Striped bass are especially vulnerable to PCB contamination because they spawn in the Hudson and stay there longer than other fish, such as shad. In addition, they contain more fat, where the PCB's concentrate, than other species. The ban does not affect other species of bass, such as the sea bass.

PCB's, which are believed to cause cancer, were dumped in the river as waste products over a period of years from two upstate General Electric plants. The chemicals, which have special insulating qualities, were used in the manufacture of heavy electrical equipment.

Since then, the state has been preparing a plan to clean up the river by dredging some of the PCB-laden sediment from the bottom and burying it on land. But the plan has been halted by the resistance of towns situated for the

PCB burial.

Over the last year, the State Department of Health has warned the public not to eat striped bass from the Hudson River, New York Harbor or the waters of western Long Island, and to eat no more than one meal a month of bass from eastern Long Island marine waters.

Despite the new prohibition, the department has not changed its cautionary notice, according to William Faget, a spokesman. He added, "We are in the process of reviewing our advisories and I would suspect they would be changed to reflect the new report."

The regulations on recreational fishing, which are sure to raise objections from sport fishermen, must be issued to conform to a Federal plan to protect the striped bass population in Chesapeake Bay and other northeastern waters, the department said.

"If a moratorium on recreational fishing were enacted, it would add have the benefit of conserving the dwindling Chesapeake Bay stocks and adding an increased measure of protection for unknowing consumers who might eat illegally marketed PCB-contaminated striped bass," the department said.

Public hearings on the proposed new recreational limits will be held Tuesday at the Suffolk County Community College on Long Island and on Wednesday at the Bear Mountain Inn in Rockland County. No changes can be made for at least 60 days, unless an emergency is declared, according to Mr. Bassett.

The new measures to protect the public from PCB's in the Hudson River and adjacent waters come 10 years after the chemicals were discovered in the river.

The New York Times,  
Tuesday, April 22, 1986.

## ASSOCIATION FOR THE PROTECTION OF THE HEALTH OF NEW YORK CITIZENS

The Association for the Protection of the Health of New York Citizens is an activist organization. Its members monitor industry for pollution sources. The organization acts as a watchdog over governmental actions that might affect regulation of possible pollution sources and health hazards. It has a small professional staff of two lawyers and one environmental scientist.

The Association has engaged in a variety of activities. It will frequently bring lawsuits against polluting industries. It can turn out large numbers of members at hearings which the organization feels could influence policies having an impact upon health and the environment. It sponsors letter writing campaigns to elected officials when they are considering issues of importance to the Association. The staff will write newspaper articles and articles for magazines on issues of importance. They can call on members who are effective speakers to present the Association's point of view on health and environmental issues at conferences, public meetings and on radio and television broadcasts.

The representatives of the Association present at this hearing want the obtaining and distribution of fish tightly controlled. They feel that this is the best policy for insuring that New York citizens are not affected by PCB contaminated fish. They feel that any effect of tight regulations on the economy of the state would be less than the cost of health care and loss of wage earning potential to those citizens whose health would be affected by the eating of contaminated fish.

Additional information is provided in the article from *The New York Times* entitled "Bluefish Study Stirring Concern on Health."



Donald Hulse with bluefish he caught while surf-casting, above, at Montauk Point.

# Bluefish Study Stirring Concern On Health

By THOMAS CLAVIN

**T**HE good news for East End fishermen and charter boat owners is that bluefish, traditionally the most plentiful and catchable of fish, have appeared in area waters earlier and in greater numbers than in the last several years. The bad news is a Federal report to be released within the next two to three weeks that is expected to cite high levels of PCB's in bluefish, above Federal standards, which could pose a health concern for regular consumers of the fish.

Every year bluefish migrate north from Florida and usually appear in Long Island waters in late spring. They are so prevalent that some fishermen complain they interfere with the gathering of other fish.

Though bluefish are harvested commercially, most are brought in by recreational anglers, approximately 150 million pounds a year. Of this, nearly two-thirds are brought in off the coasts of New Jersey and Long Island.

Especially on the East End, bluefish have been a favorite of charter-boat customers and part-time fishermen. Nutrition experts have hailed the fish's low fat content and the oils that may help lower cholesterol levels in humans.

But recently there has been concern that, like the striped bass and other preferred catches, bluefish have been affected by PCB contaminants dumped in the waters by manufacturing industries.

In 1984 Congress allotted nearly \$1 million to the National Marine Fisheries Service to undertake a study of the PCB level in bluefish in Northeastern waters. The first part of the study, released last year, showed that almost half the bluefish studied that weighed more than four pounds contained PCB's above acceptable Federal standards. On the East End, nearly 60 percent of the bluefish caught are over four pounds.

The second part of the study, which is expected to be made public in early July and which includes analysis of previous data and recommendations of action, is being reviewed by the Federal Environmental Protection Agency and the Food and Drug Administration. Fifty copies have also been sent to members of Congress.

New Jersey has issued a health advisory on bluefish, warning that

*Continued on Page 21*

# Worry on Bluefish Study

Continued From Page 1

It should be eaten not more than once a week, and not at all by pregnant or lactating women.

"One of their conclusions is that there's no concern for the bluefish caught commercially because it's a small percentage and consuming it spread over a 12-month period," said Dr. Stuart Wilk, a National Marine Fisheries Service biologist based in Sandy Hook, N.J., who has been taking part in the study since its inception. "The real concern is recreational anglers and their families who catch large volumes of weight on a single trip, sometimes 75 to 100 pounds of fish. These people fish from once a month to every day, and they eat what they catch on a regular basis and give the rest to friends."

Dr. Wilk said that bluefish less than 20 inches in length and under four pounds had relatively low PCB levels, but that larger fish had PCB levels well above the two parts per million found acceptable by both the Federal Government and New York State. The study sampled bluefish found in waters from North Carolina to Massachusetts.

"The weight of a bluefish can go as high as 30 pounds," Dr. Wilk said. "There are an increasing number of fish caught that are above 20 pounds. That is a good sign as far as the strength of the fish, but of course it increases the risk of catching a fish containing a higher level of PCB's."

Dr. Wilk said he could not predict if the study's conclusions would inspire Federal and state agencies to issue a ban on bluefish, but he added that portions of the report were controversial and might cause some debate before any action is taken. He said the study is the most extensive he has ever been involved in, but until its conclusions are released he cannot discuss specifics.

"I've been on the hot seat over a year on this because it's potentially a very volatile issue," Dr. Wilk said. "If we scoop the Congress, there will be hell to pay. It will travel down to the least common denominator, and that's going to be me. I've got a third of a career left in this business, and I don't want to spend it up in Alaska."

On the East End, bluefish are a favorite catch of recreational anglers, who enjoy the abundance and easy catches and the long season, which can extend into November. Visitors to the area haul in bluefish during group charter runs, and local residents have taken advantage for decades of the northern migration, either from boats or by surf-casting.

"I'm retired, so it's easy for me to go three to four times a week for blues," said Lewis Seitz, a Montauk resident. "Last week I caught 70 in one trip. Most of what I get I give away to friends, then I'll eat bluefish about once a week."

Mr. Seitz said that this spring bluefish arrived in East End waters in large numbers in early May, about a month earlier than usual. "Right now there are mostly three- to five-pounders coming through," he said. "It won't be long before the 15- to 20-pound whoppers are available off Montauk. Most of the fishermen I know take in as many as they can."

The Federal report troubles charter boat owners, who are still smarting from last year's state ban on striped bass, which was also found to contain unacceptably high levels of PCB's. For many of their customers, the availability of bluefish has been a welcome alternative and has helped to maintain the viability of the East End's charter boat industry.

"You can always count on bluefish in the spring, summer and fall," said Capt. Gene Kelly, president of the Montauk Boatman's Association. "In fact, right now there are too many of them. They've been getting in the way of shark fishing, and soon they'll interfere with the hauling in of tuna."

Captain Kelly said he believes that the report could have a strong effect on the recreational industry, but he is concerned that the study will produce more questions than answers.

"The bluefish is so highly migratory and widespread, you could find one group picked up the PCB's in one place and another didn't, so can you really tell which is which?" Captain Kelly said. "If there is an overall ban on bluefish, not only will it hurt us, but without hauling in bluefish that will eliminate population control, and because there's so many of them, that



The New York Times/Ramseywar Dax

Albert Barecchio, captain of the King Wayne fishing boat, filleting bluefish for his charter clients.

will have an effect on almost every other kind of fishing that goes on out here."

The New York State Department of Environmental Protection is awaiting the Federal study's final conclusions to determine if renewed testing of bluefish should be conducted, according to Dr. Ron Sloan at the department's headquarters in Albany.

Dr. Sloan said that fish connected to the Hudson River and its branches are more likely to contain PCB's because of the many years of chemical dumping into that waterway. However, it was believed that fish found further offshore would not be significantly affected by PCB contamination.

"We're concerned that the PCB's are out there," Dr. Sloan said. "We'll review what the Fisheries Service came up with and go from there." ■

The New York Times,  
Sunday, June 28, 1987.

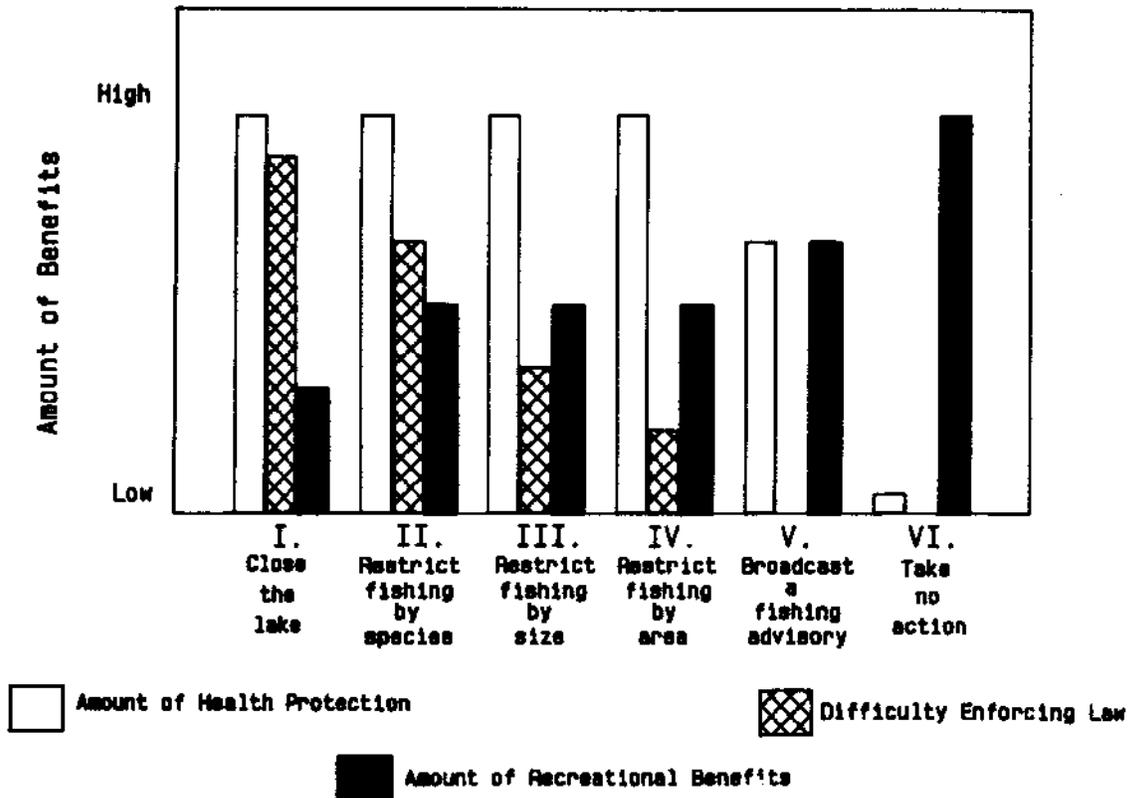
## ASSOCIATION OF LOCAL, MUNICIPAL AND STATE PUBLIC OFFICIALS

Membership of this organization includes local and state elected officials. Mayors, county commissioners and state legislators make up the most powerful groups within the organization. The Association has a responsibility first to its membership: to lobby for bills and regulations that the membership agrees best serve their voters and themselves. Because the people they represent have different interests and needs, they are frequently in conflict, making it difficult for the Association to develop single, coherent positions on issues. For instance, health interest groups such as the American Cancer Society want benefits for the consumer that provide high health protection. Business groups dealing in recreation, such as hotel owners, restaurant operators and marina operators do not want policies that would cut into their business, such as restrictions on fishing. The public officials know how important income from recreation is to New York and they do not want any policies that would give New York a bad name and thereby discourage people from spending their vacations there.

Because they are responsible for law enforcement, public officials realize that any regulations resulting from policies must be enforceable to be effective. Yet they do not want to burden enforcement agencies with programs that will require a great deal of money and additional staff.

With these points in mind, examine the graph below. It shows the relative amount of health protection, ease of law enforcement and recreational benefits to society of each of the policies under consideration.

### Comparison of Policies



## MARINA OPERATORS ASSOCIATION OF NEW YORK

Marina owners and operators earn their living from recreation activities near Lake Ontario. A big source of income is from the charter boat business. Many anglers cannot afford to own a boat, and do not have the experience necessary to safely operate a boat on the lakes, but they can still enjoy the relaxation and challenge of fishing by chartering a boat for a day. Marinas often rent space to charter boat operators. A marina is important to those who own their own boats too. If the owner has no room to store a boat, or does not want to tow the boat to the lake every time it is used, the owner will rent a space for the boat at a marina. If fishing is restricted in Lake Ontario, boat owners will take their boats to other lakes where there are no restrictions. There would be many empty marinas on Lake Ontario if this happened, and some would be forced to close. Another major source of income comes from selling tackle and bait to fishers.

Lake Ontario marinas employ many workers and are important to the economy of lake towns. Restricted fishing would hurt marina business and force many to close. Instead, the Department of Health should use marinas as a valuable information source. They are the perfect location for distributing pamphlets and brochures on PCBs. Used this way, they could supply every angler with information on unsafe fish species, proper cooking techniques, and instructions for cleaning fish to reduce PCB content. In this way, the angler could decide, on the basis of impartial information, whether to fish and how to handle the fish once it is caught.

Marina operators are very concerned about the anglers' health--after all, they keep the marinas in business! But restricting fishing would not benefit anyone. Instead, they believe the angler should be allowed to make the decisions that bear on his/her recreation and health.

## SPORTS FISHERS OF NEW YORK

(Based on Ohio Data)

Sports fishers are a very large group of people with influence in the state legislature. There are over one million throughout the state, many of whom spend much of their fishing time on Lake Ontario. Overall, anglers spend over \$60 million per year on fishing licenses, charter boats, fishing tackle, bait, hotel accommodations and meals while at Lake Ontario. This money supports many lake-town businesses. The license money helps to stock fish in the lake and supports enforcement of fishing laws on the lake and throughout the state. It is easy to see why sports fishers are a powerful group whose recreational dollars are important to New York State.

Many anglers are business people who like the relaxation and enjoyment that fishing provides. Because of their busy schedules, they do not have a lot of free time to devote to fishing and they are glad that there are no major restrictions on their fishing. Recreational freedom is important to them. Sports fishers also believe that restrictions on Lake Ontario fishing would violate their freedom of choice for eating fish. Most fishers say they are aware of the danger of PCBs, but they know how to minimize these dangers. Many pamphlets are available that explain which species are affected, which sizes of fish are affected, and how to clean and cook fish to reduce the PCB content. Most anglers feel that this information is sufficient to control PCB problems.

Also, some people do not even eat the fish that they catch! Restrictions would be very unfair to those who fish just for the fun of it.

Additional information is in the article from *The Cleveland Plain Dealer* entitled "State Warns Against Eating Lake Erie Carp, Catfish."

# State warns against eating Lake Erie carp, catfish

By PETER GELLER

STAFF WRITER

The Ohio Department of Health has issued a warning against eating Lake Erie carp and catfish caught by sport fishermen.

Acting jointly with the Michigan and Pennsylvania health departments, the Ohio department found many of those fish contained higher than acceptable levels of polychlorinated biphenyls (PCBs), a toxic substance now banned from manufacture.

New York, the other state bordering Lake Erie, announced a modified warning recommending restricted consumption of the fish caught in the eastern end of the lake.

The joint advisory, issued Monday, does not pertain to commercially caught fish available in markets. Those are regulated separately by the federal Food and Drug Administration.

Deborah Gray, the environmental official who authorized the warning for Ohio, said a high proportion of the carp and catfish sampled by the Lake Erie states slightly exceeded federal standards for PCB contamination. The PCB level tolerated by the FDA is 2 parts per million, and most of the fish samples had between two and three parts per million, she said.

Walleye, perch, smallmouth bass and other species did not fall under the PCB warning for Lake Erie, Gray said. Carp and catfish, which are bottom feeders, would be expected to accumulate more PCBs from lake sediments,

she said.

Advisories for the other lakes have covered such species as large lake trout, coho salmon, chinook salmon and brown trout. Carp and catfish have been included in the warnings for most of the Great Lakes, said Gray.

The joint advisory on Lake Erie stems from an agreement to control toxic substances, signed last May by the governors of the eight lake states. The agreement included exchanging and unifying pollution information and, wherever possible, developing joint standards and policies for protecting health and the lake environment.

Until now, health advisories on fish consumption have been issued by the states individually, under differing standards and monitoring programs. Ohio was the only state in the basin that failed to issue advisories for the open lake.

*The Cleveland Plain Dealer,*  
Wednesday, January 28, 1987.

### **THE NEW YORK ASSOCIATION OF COMMERCIAL FISHERS**

(This role is based on information from the fishing industry on the Ohio portion of Lake Erie. Lake Ontario does not have an important commercial fishery.)

Many of the fisheries on Lake Ontario have been owned by one family for many generations. The owners have fished all their lives and are dependent upon the fish for their livelihood. Most have either a grade school or high school education. The fisheries employ many additional people to catch and process the fish for eating. A restriction on commercial fishing would have a severe economic effect upon the owners and their employees. In fact, the fishery on the lake may have to close down completely causing a great deal of unemployment.

Fisheries are significant contributors to the State's economy. All of the fisheries on the Great Lakes contribute \$95 million each year to the United States and Canadian economies. New York would lose millions of dollars if restrictions were placed on commercial fishing.

Businesses such as restaurants and grocery stores depend on Lake Ontario fishers to supply them with fresh and processed fish. They spend their dollars in New York, instead of buying expensive out-of-state fish. This benefits New York by keeping money in the State, and consumers by providing less expensive fish.

When consumers buy Lake Ontario fish, they are getting a great deal. Lake fish are just as tasty as ocean fish, they cost less than ocean fish, and a fish dinner is a healthy and nutritious meal. The National Marine Fisheries Service in Washington, D.C., reports that a serving of fish has less calories and more protein than an equal size serving of beef or pork. Consumers really benefit when they eat fish. Even though PCBs can accumulate in fish, there are effective ways to prepare fish so that they are safe to eat. Pamphlets are available from the New York Department of Fish and Wildlife that illustrate methods of trimming fat and procedures for cooking that can reduce PCB content 25-64 percent.

Additional information is included in the article from *The New York Times* entitled "With Striped Bass Ban, A Way of Life is Fading." This article describes both the economic and social consequences on banning striped bass fishing.



Daniel King, a commercial fisherman, with bags of catch in Amagansett, L.I.

## With Striped Bass Ban, A Way of Life Is Fading

By THOMAS J. KNUDSON  
Special to The New York Times

EAST HAMPTON, L.I., May 8 — Traditionally, the opening day of striped bass season has brought a flurry of activity to this area as commercial and recreational fishermen assault the ocean in pursuit of the elusive and valuable fish.

But today — on what was scheduled to be the opening day of New York's 1986 striped bass season — the ocean and beaches on eastern Long Island were strangely empty.

"I'd be out catching bass if I could," said Daniel King, a 36-year-old commercial fisherman. "That's what I want to do. That's what I know how to do."

The lack of activity is the result of a statewide ban on striped bass fishing, ordered by the State Commissioner of Environmental Conservation, Henry G. Williams, because of the contamination of striped bass with unsafe levels of PCB's — an industrial compound believed to cause cancer. This year's statewide ban extends, for the first time, previous bans in other parts of New York to the East End of Long

Island — the heart of the state's striped bass industry.

All along the ocean beach from Southampton to Montauk, the traditional sounds of opening day — the whine of outboard motors and the swish of nets through the water — gave way to the eternal sounds of the ocean, the steady slapping of waves and the random cries of seagulls. Quietly, a way of life for generations of fishermen, known as baymen and Bonackers, was fading.

The effect of the ban is expected to have widespread economic and social consequences here, according to local fishing officials. In Montauk, a popular fishing port on the eastern tip of Long Island, some charter boat operators may go out of business, and motels, restaurants and other businesses that rely on fishermen could be hurt as well.

In East Hampton and other eastern Long Island towns, the ban is expected to devastate commercial fishermen,

Continued From Page B1

already beleaguered by the loss of last fall's valuable bay scallop harvest from an algae bloom. Many baymen have already gone out of business and others are in poor financial shape, fishing officials said.

"The striped bass is the difference between profit and loss for most commercial fishermen on the East End who concentrate on fin fishing," said Arnold Leo, secretary of the East Hampton Baymen's Association. "So the effect of the ban will be disastrous."

"The striped bass can make the difference between a guy staying in business or going out of business," said Gene Kelly, a charter boat captain in Montauk and the secretary of the Montauk Boatman's Association.

Mr. Leo estimated the ban on commercial striped bass fishing could cost fishermen, boat and tackle dealers, fuel stations and other fishing-related businesses on eastern Long Island from \$3 million to \$8 million each year. In Montauk, the ban could cost marinas, restaurants, charter boats and other businesses up to \$2.5 million a year, one official said.

Last year, 466,145 pounds of striped bass were landed commercially in New York, worth \$858,769 at the dock. Officials say the striped bass have become contaminated with PCB's — polychlorinated biphenyls — because they spawn in the Hudson River, where PCB's were dumped by two General Electric plants for several years.

Governor Cuomo has directed the State Office of Economic Development to set up a program to help displaced fishermen with job training, counseling and placement services as well as low-interest loans to pursue other occupations. But many people here believe the baymen will be unlikely to accept the help.

"It's welfare to them — they're too proud to do that," said Judith Hope, the Town Supervisor in East Hampton.

"The fishermen are very important to us," she said. "They are a very unique breed of characters who have managed to make a living in perhaps one of the most difficult enterprises remaining. They are part of the whole history and social fabric of this 300-year-old community."

### Turning to Other Work

Mr. King said he did not want any state aid. "I wish they'd take the money and use it to clean up the river," he said. "I wish they'd tell me I could fish tomorrow."

The father of three children, Mr. King, 36 years old, said he and other commercial fishermen have already begun to feel the economic impact of the ban. "What it means is I'm going to have to be looking for something else to feed my family and pay my bills," he said.

Already he has turned to landscaping, chopping wood and to harvesting conchs, a mollusk popular in Italian dishes. Other fishermen have turned to other species, but none are as profitable as the striped bass, which can bring up to \$3.50 a pound during the summer, Mr. King said.

Mr. Leo said that "the social fabric of this very old community is starting to break up — Some of these families have been fishing for many generations, and suddenly the younger generation is confronted with the fact that they cannot do what their fathers have done."

The timing of this year's striped bass ban was particularly unfortunate, said Mr. Leo, because it came after last fall's disastrous harvest of bay scallops — another key species for many baymen.

"There is just no question that on the East End the striped bass is the key finfish and the bay scallop is the key shellfish," said Mr. Leo. "And to lose both of them at the same time has got to be seen as a major catastrophe for commercial fishermen."

Continued on Page B2

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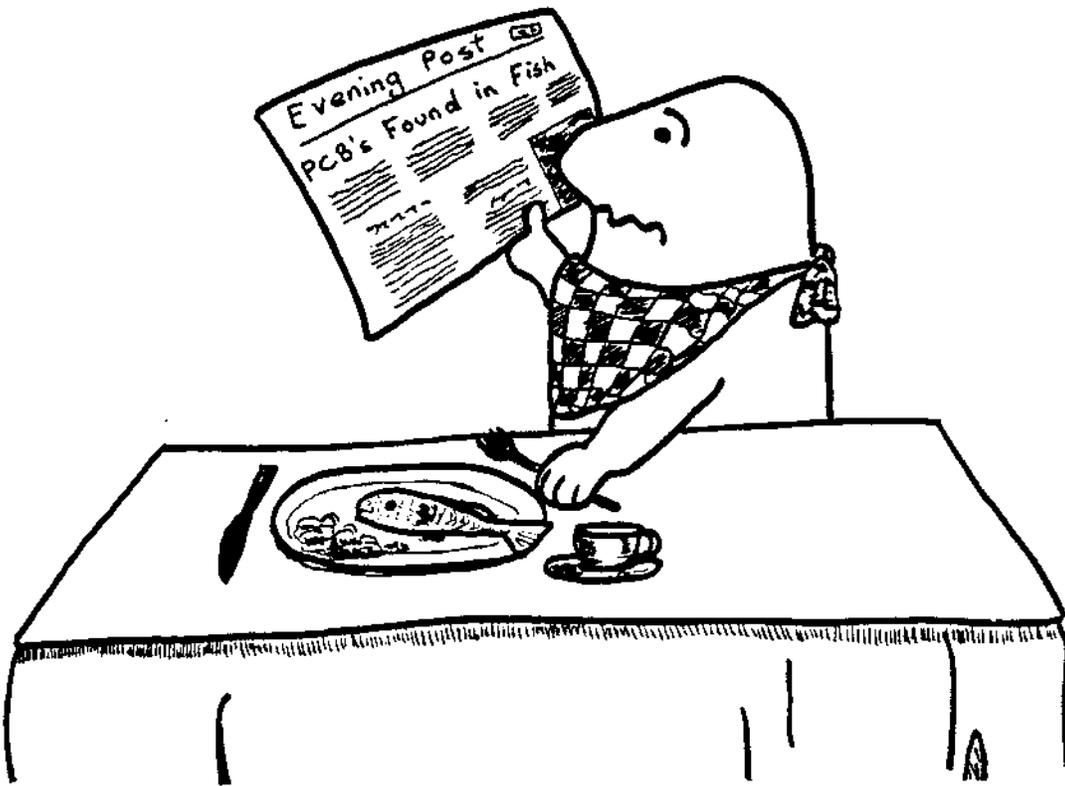
*Dr. Jeffrey M. Reutter*, Ohio Sea Grant Director



# PCBs IN FISH: A PROBLEM?

by

Victor J. Mayer, Amy J. White-Predieri, and Vanessa J. Steigerwald,  
The Ohio State University,  
and  
Stephanie Martin, Center of Science and Industry, Columbus, Ohio



**OEAGLS-Oceanic  
Education  
Activities  
for  
Great  
Lakes  
Schools**

## **OEAGLS Investigation #19**

Completed March 1981  
Revised January 1983 and July 1988

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# PCBs IN FISH: A PROBLEM?

by

Victor J. Mayer, Amy J. White-Predieri, Vanessa J. Steigerwald and Stephanie Martin  
Ohio Sea Grant Education

## INTRODUCTION

During the summer of 1978, New York State closed down many of the fishing areas on Lake Ontario. This was done to reduce the chance that people would catch fish containing PCBs and eat them. What are PCBs? How did they get into the water of Lake Ontario? Are they found in Lake Erie? How are they harmful to us? What can be done if they do enter our food chain?

**OBJECTIVES:** When you have completed this investigation, you will:

1. Know how PCBs and other dangerous materials enter the environment.
2. Understand the degree of danger in eating fish that contain PCBs.
3. Know what can be done to reduce the danger of eating harmful amounts of PCBs.
4. Understand the possible effects of different ways of controlling PCBs upon the fish and sports industries.
5. Realize the difficulties in taking action to lessen the threat of PCBs.

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## ACTIVITY A: WHAT ARE PCBs?

---

The PCB story is a classic one on how we have knowingly created a threat to our health and that of animals that share our planet. This happened while providing something that improved our living standard. PCBs are produced from petroleum. They are very useful as insulating material. They will not burst into flames at high temperatures, and so is used in electrical transformers and capacitors. They have also been used in a variety of consumer products. These latter uses have been banned since 1971.

The tragic effect of this group of chemicals on human life was revealed in an event in Japan in 1968. Four people died from a mysterious disease. More than 1,000 others suffered symptoms such as stillbirths, miscarriages, skin disease, nervous disorders, hearing loss and

discharge from the eyes. The one thing that all of these people had in common was that they had eaten rice oil prepared at the same plant. This plant had used PCB as a coolant in pipes that circulated through the hot rice oil. The pipes had developed leaks, discharging the PCB into the oil, which was then eaten by those that developed the disease. In some patients, the symptoms continued for three years after eating the rice oil.

PCBs and many other dangerous materials are found in very tiny, but often deadly, amounts in water and body tissue. The amount is expressed in parts of the material per million parts of the substance in which it is found. For example, the PCBs found in the rice oil in Japan were in a concentration of 2000 parts of the PCBs to one million parts of the oil.

## PROCEDURE

### Step I

To begin this investigation, your teacher will place one drop of a colored material, probably ink, in a 10 ml graduated cylinder. Then your teacher will add nine drops (parts) of water. Answer the following questions on your answer sheet.

1. How many parts (drops) of ink are in the cylinder?
2. How many parts (drops) of water are in the cylinder?
3. How many total parts (drops) of solution are in the cylinder?

Since your teacher has 10 drops of solution that has one drop of ink in it, the concentration of solution is described as one part ink per 10 solution. This ratio can be written 1 part ink: 10 parts solution or 1 part ink/10 parts solution.

4. Look carefully at the graduated cylinder. What is the volume of the solution?

Keep a record of all the data from Step I in the data chart on your answer sheet. Be sure to note on your answer sheet at what concentration you were no longer able to see the ink because it was diluted too much.

### Step II

In Step I we had a 1 part ink in 10 parts solution. Now we want to dilute the ink in solution by adding more water. The concentration of ink will be reduced because more water will be added.

In Step II we want to dilute the solution 10 times.

5. What volume of solution is ten times greater than the original volume of solution?

6. How many parts (drops) were in the original solution?

7. How many parts (drops) of water must be added to dilute this solution 10 times?

8. Now, what is the total number of parts (drops) in the solution?

Add the data from Step II to the data chart.

### Step III

Remember, PCBs are measured in ppm, or parts per million. Our original drop of ink is now diluted to 1 part per 1 hundred. Let's keep diluting this solution until the ink is diluted to 1 part per million.

9. What volume in milliliters would be ten times greater than the volume we have obtained in Step II?

Our 10 ml graduated cylinder is too small to hold this volume so the teacher must transfer our solution into a larger 100 ml graduated cylinder. Then the teacher will add water to dilute the solution to the volume you have calculated in question 9. Instead of counting drops as in Step II, you can calculate the number of drops (parts) of total solution using the equation:

$$20 \text{ drops (parts)} = 1 \text{ milliliter}$$

10. How many total parts (drops) of solution are in our newly diluted solution?

Record the data from Step III dilution in the data chart.

#### Step IV

11. If we dilute the new solution 10 more times, what volume (in milliliters) of solution would we have?
12. What volume in liters would be equal to the number of milliliters in question 11?
13. Using the equation 20 drops (parts) = 1 ml, how many total drops (parts) of solution are contained in the volume obtained in question 11?

Your teacher will make the dilution to the volume you calculated in question 11. A liter vessel must be used to hold the solution since the 100 ml graduated cylinder is too small. Tabulate your results for Step IV in the data chart.

#### Step V

14. How many more tenfold dilutions are necessary to dilute the ink to one part per million? Explain how you arrived at this answer.
15. What volume (in liters) of solution is necessary to perform each of these dilutions?

16. How many gallons of solution are needed to dilute the ink to a concentration of 1:1,000,000? HINT: 1 liter = 0.264 gallons.

As your teacher carries out the dilutions you have determined above, fill in the rest of the data chart.

17. At what concentration were you no longer able to see the ink?

PCBs are thought to enter bodies of water such as Lake Erie through the air as a result of burning plastic objects containing the chemical; from direct dumping of liquid waste from industries using PCBs in their industrial processes; and from water running through solid waste disposal sites where transformers or other PCB-containing materials have been dumped. Fish will take up the PCBs from the water through their gills or through the food they eat. The PCBs are then concentrated in the tissue, especially the fatty tissue, of the fish's body. See Figure 1.

### How PCBs Pass Through the Great Lakes Food Chain

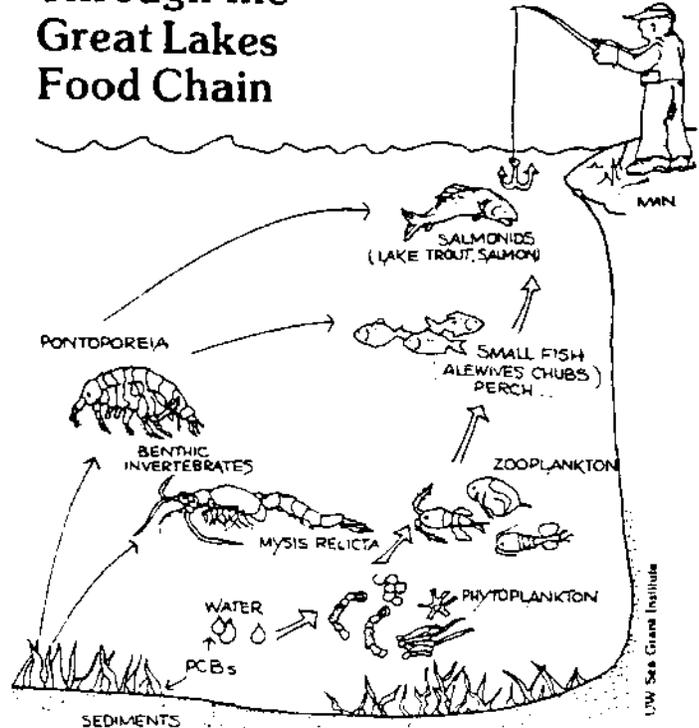


Figure 1. How PCBs get to people.

Are PCBs found in fish from Lake Erie? 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 was obtained.

White Bass				Walleye			
Size	Maumee Bay	Cedar Point	Sandusky Bay	Size	Middle Sister Island	Cedar Point	Lorain
9-10.9"	1.34	0.66	0.74	14-17.9"	0.16	0.16	0.15
11-12.9"	1.27	0.93	0.91	18-21.9"	0.25	0.24	0.22
13" and over	1.64	0.96	1.06	22" and over	0.33	0.36	0.42

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

18. On your answer sheet, construct a bar graph of the data from Sandusky Bay for white bass.
  19. How is fish size related to PCB content?
  20. What could cause this relationship?
  21. Construct another bar graph with the data from Middle Sister Island for walleye.
  22. Do you see the same relationship?
  23. Now examine the data from the other sites. Does the relationship seem to hold for fish taken at each of the sites?
  24. Compare the data collected for the concentration of PCBs in white bass and walleye. Which species contains higher concentrations of PCBs?
  25. Why might the concentration of PCBs be lower in walleye compared to white bass?
  26. 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?
  27. Which site seems to have fish with the highest concentration?
- 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 important food and sports fish.
28. What would you recommend to a fellow sports fisher about eating white bass and walleye caught on a fishing trip to Lake Erie?

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).

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## ACTIVITY B: HOW CAN THE PUBLIC HEALTH BE PROTECTED?

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**MATERIALS:** Set of role descriptions

### PROCEDURE

In 1978 it was determined that certain species of fish from Lake Ontario contained PCBs at a level that might be dangerous to the health of people eating them. The New York Department of Health considered several policies for reducing the health hazard. In this activity, you will play the role of a member of an interest group or an expert concerned with the PCB problem. You are attending a hearing that the Department of Health might have held to gain information so that it would select one of the policies to implement. Your teacher and two students will serve as the board conducting the hearings for the department. At the end of the hearings, the board will vote on a policy which will then be enforced throughout the state.

Your teacher will assign each member of the class to one of the following roles:

**Experts** (one student for each role):

Officer of the New York Department of Environmental Conservation

Scientist from the Federal Food and Drug Administration

**Interest Groups** (two or more students per group)

The Sports Fishers of New York

The New York Association of Commercial Fishers

The Marina Operators Association of New York

Association for the Protection of the Health of New York Citizens

Association of Local, Municipal and State Public Officials

The Department is considering the following policies:

- I. Close Lake Ontario to any fishing.
- II. Restrict the taking of fish to only those species that are not contaminated with PCBs in concentrations above 2 ppm.
- III. Restrict fish takes to only the smaller, and therefore less contaminated, of the affected species of fish.
- IV. Close only those areas of the lake in which fish are found to have concentrations of PCBs above 2 ppm.
- V. Develop and broadcast an advisory that tells the maximum amounts of fish that can be eaten without danger to health and describes ways to reduce the amount of PCBs from fish.
- VI. Take no action.

Following is the sequence of this activity:

1. The teacher will assign students their roles and hand out role descriptions.
2. Students will have time to study their roles and to do any additional background research that they may find necessary.
3. Those students assigned to an interest group will meet with their groups to discuss the positions that they plan to take, and to nominate a spokesperson. The experts will meet with the Department of Health hearing board to discuss the information that they plan to present at the hearing.
4. The hearing will be held and the following rules followed:
  - a. The experts will present prepared remarks to the board.

- b. Each interest group will have no more than five minutes to present a prepared statement.
- c. Only members of the board may ask questions, and they must be directed to the presenter immediately following the presentation.
- d. When all presentations have been made, board members may ask additional questions of any of the presenters.
- e. Board members meet to decide on one of the policies.

### REVIEW QUESTIONS

- 1. How do PCBs get into water? Into fish?
- 2. How dangerous is it to eat fish from Lake Erie? Why?
- 3. List ways in which the threat of PCBs to human health can be reduced.
- 4. How would banning the taking of fish from Lake Erie affect the economy of towns along the lake?
- 5. Which of the policies discussed in Activity B would be most difficult to enforce? Why?
- 6. Which policy would you support? State your reasons.

Name \_\_\_\_\_

**PCBs IN FISH: A PROBLEM?  
ANSWER SHEET**

**Activity A: What are PCBs?**

Step I

1. How many parts (drops) of ink are in the cylinder? \_\_\_\_\_
2. How many parts (drops) of water are in the cylinder? \_\_\_\_\_
3. How many total parts (drops) of solution are in the cylinder? \_\_\_\_\_
4. What is the volume of the solution? \_\_\_\_\_

DATA CHART

	I	II	III	IV	V final step
PARTS					
VOLUME (ml)					

Step II

5. What volume of solution is ten times greater than the original volume of solution? \_\_\_\_\_
6. How many parts (drops) were in the original solution? \_\_\_\_\_
7. How many parts (drops) of water must be added to dilute this solution 10 times?  
\_\_\_\_\_
8. Now, what is the total number of parts (drops) in the solution? \_\_\_\_\_

Step III

9. What volume in milliliters would be ten times greater than the volume we have obtained in Step II? \_\_\_\_\_

10. How many total parts (drops) of solution are in our newly diluted solution?

\_\_\_\_\_

Step IV

11. If we dilute the new solution 10 more times, what volume (in milliliters) of solution would we have? \_\_\_\_\_

12. What volume in liters would be equal to the number of milliliters in question 11?

\_\_\_\_\_

13. Using the equation 20 drops (parts) = 1 ml, how many total drops (parts) of solution are contained in the volume obtained in question 11? \_\_\_\_\_

Step V

14. How many more tenfold dilutions are necessary to dilute the ink to one part per million?

\_\_\_\_\_ Explain how you arrived at this answer. \_\_\_\_\_

\_\_\_\_\_

15. What volume (in liters) of solution is necessary to perform each of these dilutions?

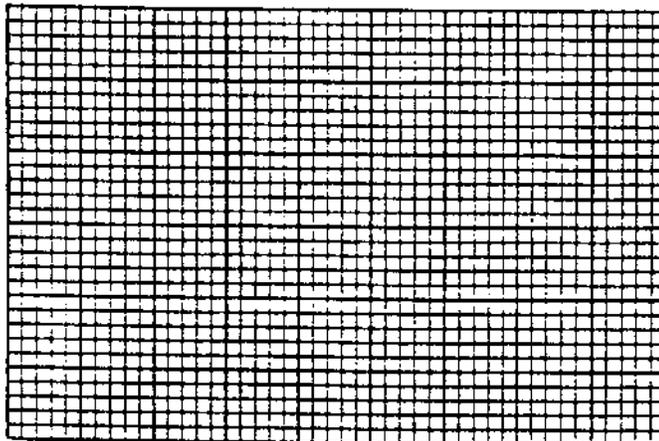
\_\_\_\_\_

16. How many gallons of solution are needed to dilute the ink to a concentration of

1:1,000,000? \_\_\_\_\_

17. At what concentration were you no longer able to see the ink? \_\_\_\_\_

18. Construct a bar graph of the data from Sandusky Bay for white bass. Plot fish length vs. ppm.



19. How is fish size related to PCB content? \_\_\_\_\_

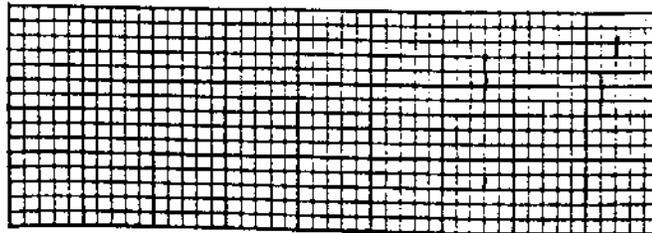
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20. What could cause this relationship? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

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



22. Do you see the same relationship? \_\_\_\_\_

23. Does the relationship seem to hold for fish taken at each of the sites? \_\_\_\_\_

24. Which species contains higher concentrations of PCBs? \_\_\_\_\_

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

\_\_\_\_\_

\_\_\_\_\_

26. Is the concentration of PCB in the fish related to the site at which they are obtained?

\_\_\_\_\_

27. Which site seems to have fish with the highest concentration? \_\_\_\_\_

\_\_\_\_\_

28. What would you recommend to a fellow sportsfisher about eating white bass and walleye

caught on a fishing trip to Lake Erie? \_\_\_\_\_

\_\_\_\_\_

**Review Questions**

1. How do PCBs get into water? \_\_\_\_\_

Into fish? \_\_\_\_\_

2. How dangerous is it to eat fish from Lake Erie? Why? \_\_\_\_\_

\_\_\_\_\_

3. List ways in which the threat of PCBs to human health can be reduced. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

4. How would banning the taking of fish from Lake Erie affect the economy of towns along the lake? \_\_\_\_\_

\_\_\_\_\_

5. Which of the policies discussed in Activity B would be most difficult to enforce? Why? \_\_\_\_\_

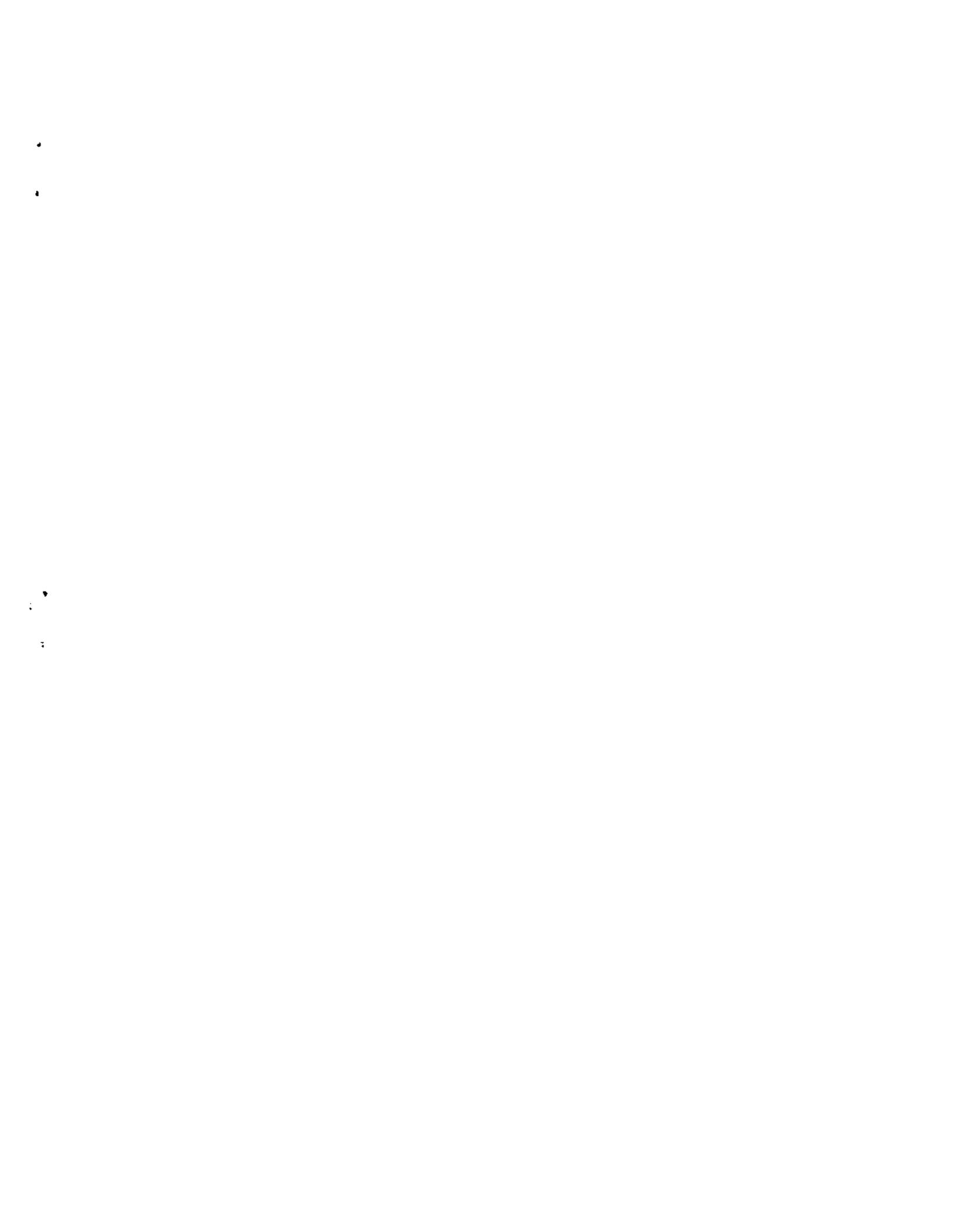
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6. Which policy would you support? State your reasons. \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



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