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No. 302 *"The Quality of Fishing Reflects the Quality of Living"* March, 1979

# RESEARCH ON PCB's IN AQUATIC ECOSYSTEMS

Polychlorinated biphenyls (PCBs) are complex mixtures of chlorine-substituted biphenyl compounds (highly heat-resistant) which have been used extensively since 1930 for a wide variety of industrial purposes, primarily in electrical capacitors and transformers in recent years. Mixtures of PCBs may contain over 200 distinct compounds containing various amounts of chlorine. Compounds containing the higher percentages of chlorine are generally the more stable and persistent or exhibit lower toxicity in the environment than compounds with lower chlorine content.

Due to their highly stable chemical nature and the apparent ease with which they may possibly be assimilated by fish and other organisms, PCBs have been popularly described as highly persistent and hazardous environmental contaminants. According to some estimates, approximately ten tons may be stored in freshwater fish, alone. Since the initiation by the U.S. Fish and Wildlife Service of a nationwide PCB monitoring program in 1969, 98 percent of all freshwater fish sampled have been found to contain PCBs in excess of 0.5 parts per million. The heaviest concentrations of PCBs in freshwater fishes have been found in the fatty tissues of fish such as lake trout, coho salmon, chinook salmon, chubs, etc., especially in the Great Lakes, in streams in the eastern U.S. (Hudson River in New York and Housatonic River in Connecticut) as well as in the Mississippi River Basin.

In August, 1977, the Sport Fishery Research Foundation recommended to the Environmental Quality Committee of the American Fishing Tackle Manufacturers Association that it grant funds through the Foundation to enable qualified staff at Tulane University to conduct research on Polychlorinated Biphenyls Translocation and Environmental Control. The initial grant ($25,000) was for a two-year study. Based on encouraging fundings at the end of the first year, the project was expanded in scope during the second year and extended in time to include a third year. As a result, funds committed to the project by AFTMA's EQ Committee now total $61,500 over the three-year period, ending mid-September, 1980.

This project was undertaken, (1) to determine the transport mechanisms of PCBs in a freshwater stream and reservoir, (2) to determine possible translocation mechanisms and seasonal fluctuation of bioaccumulation of PCBs in fish, and (3) to develop feasible methods of decontamination or control of PCBs under field conditions.

The field investigation is being conducted at nine field stations established at Logan Martin Reservoir (Alabama) and major tributaries, both above (control stations) and below the site of a recently inactivated chemical plant of the Monsanto Corporation which had released large quantities of PCBs into the receiving waters over a ten-year period.

Preliminary examination of the first year's field data suggests the following pertinent observations: (1) there is no observable bioaccumulation due to soluble PCBs (bioaccumulation appears to result from the intake of sedimented particles and organic detritus); (2) an observed drop in concentrations of PCBs over the ten-year period appears to have occurred at a substantially faster rate than the 50 to 100-year half-life that has been estimated by others based on limited laboratory studies; (3) PCBs do exert a major influence on both microecosystems and on macroecosystems, but aqueous translocation does not appear to be due to soluble PCBs; (4) the controlling "sinks" for the PCBs cycle appears to be the colloidal portions of the sediment and the bottom organisms (benthos); and (5) some of the benthos organisms appear to exhibit a detoxification mechanism for PCBs.

Fish samples collected from the area of river immediately below the chemical plant showed the highest average level (65.3 ppm) of PCBs residues. In general, residues of PCBs in fish samples obtained from the river gradually decreased with increasing distance downstream from the plant. Fish collected from the lowermost sampling stations located within Logan Martin Reservoir exhibited the least amount of PCBs. They averaged 4.7 ppm PCBs, somewhat less than the 5 ppm "action level" set by the Federal Food and Drug Administration.

Different species of fish expressed different trends of PCBs accumulation over their life cycles. For example, small "shiner" minnows (*Notropis* sp.) collected from Station 2, located immediately below the plant, accumulated PCBs throughout their lifetime. Older fish exhibited higher concentrations of PCBs than did the younger fish, indicating a direct correlation between PCBs concentration and age. However, sunfish and stone rollers (a large minnow species) showed higher concentrations in younger fish than in older ones. Also, different species of similar body weight from the same station appeared to accumulate PCBs at varying rates. Inherent differences in metabolic rates, fat content, extent of exposure to PCBs, or possibly other unknown factors, were assumed to be responsible for the differences in bioaccumulation rates observed among the various species and sizes of fish tested. However, additional fish sampling and refinement of statistical treatment techniques (now under way) will be necessary to accurately assess the precise relationships responsible for the observed differences in bioaccumulation rates of PCBs.

Analysis of PCBs in bottom organisms (benthos) and of the in-situ half-life of PCBs in sediments and in fish will be completed by mid 1979. Negotiations are under way with the

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Monsanto Corporation seeking permission to use their historical analytical data for PCBs collected earlier (1965-1970) below the plant outfall by their consulting investigator at the time. Comparison of such data with data acquired under the present investigation will be instrumental in confirming revised half-life estimates for PCBs developed in this investigation. Further laboratory studies are continuing with respect to biodegradation, sediment sorption, and bioaccumulation pathways.

The increased funding granted for use during the second year of the project and the approved third-year extension of the project will facilitate expansion of project objectives along promising lines which have developed thus far in the currently-approved project.

Project augmentation provides for in-field investigations of PCBs decontamination to be conducted concurrently with expanded and more detailed laboratory procedures. The decontamination investigations will include, (1) experimental application under field conditions of promising sonication techniques (expected to effect a breakdown of highly chlorinated stable PCBs compounds to less chlorinated and more degradable forms), coupled with (2) experimental seeding of PCBs-laden sediments with especially acclimated bacteria capable of digesting the PCBs.

Attempts to culture such bacteria are currently under way using techniques successfully employed by Canadian investigators. Also, (3) the investigators will determine the possible efficiencies of various types of aquatic plants for removing PCBs from soil and sediment sinks. Subsequent harvest of these PCBs-laden plants would constitute yet another effective method of PCBs removal. This technique has excellent potential for effecting accelerated removal of PCBs throughout a wide range of ecosystems.

The project was conceived in collaboration with qualified representatives of the Sport Fishery Research Foundation, and is headed up at Tulane University by Dr. Robert Reimers, Assistant Professor, Department of Environmental Health Sciences. Assisting Dr. Reimers, as Advisory and Participating Investigators, are Dr. Gerald E. Gunning, Professor, Department of Biology (Ecological Group); Dr. Ann C. Anderson, Associate Professor, Department of Environmental Health Sciences (Microbial Degradation Group) and Dr. A. Aldeighani, Assistant Professor, Department of Environmental Health Sciences (Laboratory Group). Included in the research team as Student Investigators are Mrs. Mary Wilke Vitter, Ph.D. candidate; Mr. Henry S. Gardner, Jr., M.S. candidate; R. Brown, M.S. candidate; C. Paul Lo, Doctoral candidate, and other students.

## FURTHER SANDY HOOK DIVIDEND

New dividends from the federal marine game fish research program are in the form of addition compilations of BIOLOGICAL & FISHERIES DATA (on various species of finfishes), in the Technical Series Reports coming irregularly from the Sandy Hook Laboratory, Northeast Fisheries Center, National Marine Fisheries Service, viz:

No. 6 (March, 1978): BUTTERFISH, *Peprilus triacanthus*, by Steven A. Murawski, Donald G. Frank, and Sukwoo Chang.

No. 13 (June, 1978): NORTHERN SEAROBIN, *Prionotus carolinus*, by Susan C. Roberts.

No. 17 (August, 1978): AMERICAN EEL, *Anguilla rostrata*, by Michael P. Fahay.

The materials presented reflect reviews of the pertinent published scientific literature on the biology of and fisheries for the particular species addressed in each report, rather than original research by the authors thereof. Report format follows that of the FAO fisheries synopsis series. Results of ongoing research, not yet completed, and findings not as yet published in scientific journals, may not be reflected. Despite this particular possible shortcoming, doubtless inevitable in any effort of this sort, the series are immensely valuable.

Copies of the individual reports may be secured by writing to the Sandy Hook Laboratory, Northeast Fisheries Center, National Marine Fisheries Service, NOAA, U.S. Department of Commerce, Highlands, New Jersey. Request the Technical Series Report No. of your interest, and note the species of fish it reviews.

## AUSTRALIAN ANGLING

According to an item in the November-December, 1978, issue (Vol. 40, No. 8:10) of THE INTERNATIONAL MARINE ANGLER (International Game Fish Association, Fort Lauderdale, Florida), at least 30 percent of the population of New South Wales, Australia, fish for recreation. As reported by the IGFA, a May, 1977, survey of amateur fishermen, commissioned by the New South Wales State Fisheries, brought forward that finding. A report in the government publication, AUSTRALIAN FISHERIES, states: "The survey indicated that recreational fishing is a big industry, probably as important to the economy as the professional fishing industry."

The survey covered a stratified random sample of 2,092 people, aged 13 and over, in all States of Australia. It was primarily aimed at finding out how many people fished in New South Wales annually, how long, and their origins.

Data showed that 1,165,000 NSW residents (30%) fished in the State during the 12 months preceding the survey. About 88 percent of these, or one million people, fished in salt water at some time during the year.

Of the entire Australian population (excluding the Northern Territory), about 1,581,000 people (15%) fished in NSW during the same period. About 75 percent of these fished exclusively in salt water and about 12 percent fished exclusively in fresh water.

## OKLAHOMA BASS LENGTHS

According to a recent announcement by the Oklahoma Department of Wildlife Conservation, through its Wildlife News Service, black bass anglers will have 14-inch minimum length catch requirements at four additional reservoirs in Oklahoma under a regulation passed earlier (December 4) by the Oklahoma Wildlife Conservation Commission. New lakes with the restrictions are Waurika, Sooner, Tenkiller, and Arbuckle. This brings to six the number of lakes in the state having the 14-inch legal catch minimum since the limit is already in effect at Steed and Birch reservoirs.

Fisheries Division personnel at the Oklahoma Department of Wildlife Conservation indicated informational signs will be in place preceding the spring angling season.

The regulation was recommended to the Commission following a round of 26 public hearings conducted by fisheries



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