

Mercury and Selected Pesticide Levels in Fish and Wildlife of Utah:

I. Levels of Mercury, DDT, DDE, Dieldrin and PCB in Fish

by F. A. SMITH, R. P. SHARMA, R. I. LYNN,
and J. B. LOW

*Utah State University
Logan, Utah 84322*

Recent indications that Utah is an area relatively high in DDT and metabolites and also dieldrin residue levels (HEATH, 1969; WILDLIFE SERVICE NEWS, 1970) prompted initiation of a survey to ascertain levels of mercury, dieldrin, DDT, and DDE in consumable tissue of fish and wildlife of Utah. The study was designed to obtain information on levels of mercury and pesticides in fish and wildlife being consumed by sportsmen. Evaluation of safety to consume tissues of these animals was based on tolerance levels established by the Food and Drug Administration (FEDERAL REGISTER, 1954).

METHODS OF ANALYSES

This initial fish survey was restricted to areas where the potential of finding higher mercury and pesticide levels were presumed greatest. These areas included those on the Wasatch Front, Deer Creek Reservoir, Utah Lake, and Bear Lake.

Eleven different species of fish were randomly collected. The location of collection and species are listed in Tables 1 and 2. Muscle tissue was used exclusively for analysis. Filets were taken from the fish and the center section of muscle tissue used for digestion or extraction.

Mercury analysis was performed on a Coleman Mercury Analyzer model MAS-50, based on the flameless atomic absorption method of HATCH and OTT (1968). All samples were wet digested by the method of UTHE et al. (1970). In addition, random tissue samples were sent to three independent laboratories using different methods both to check our method and to eliminate single method bias.

Dieldrin, DDT, and DDE analyses were performed according to the method of STREET (1964), using gas-liquid chromatography.

Wildlife Management Institute, Utah Division of Wildlife Resources, Utah State University, and the U.S. Bureau of Sport Fisheries and Wildlife, cooperating.

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Present address of first author: Dow Chemical U.S.A., Chemical Biology Research, 1803 Building, Midland, MI 48640

Samples (10 g of muscle tissue or 0.5 g adipose tissue were ground in a mortar with 25 g anhydrous sodium sulfate. The ground mass was extracted five times with hexane (Skelly Solve B) and the combined extracts were reduced to 50 ml. The extract was eluted through a deactivated Florisil column (3% moisture) with 500 ml of 20% dichloromethane in hexane and concentrated to 25 ml. The concentrated elute was directly analyzed by electron capture gas chromatography using a MT-220 Tracor instrument equipped with ⁶³Ni detector (Column: 170cm x 2mm, i.d. packed with 3% QF-1 on Gaschrome Q, operated isothermally at 200°C; gas flow 80 ml/min). Additional column packings used for residue confirmation were 1.5% OV-17 + 1.95% QF-1 and 10% DC-200.

PCB's were not initially included as compounds to be analyzed in this study but were later included when it was observed that many of our samples did contain PCB's in quantities generally higher than dieldrin, DDT, or DDE. Retention times of the various PCB peaks corresponded well with those of aroclor standards and most closely with aroclor 1254. The retention times were compared on the three columns listed above. There was no attempt made to separate the PCB's into individual isomers but instead the entire group of isomeric peaks at the retention time range of the aroclor standards were used to quantitate by calculating ratios of areas under the groups of peaks of unknowns over those of standards. The details of the procedure have been described elsewhere (SMITH, 1973).

RESULTS AND DISCUSSION

Table 1 shows means and standard deviations of mercury levels in fish muscle tissue by area sampled and also by species. Fish from Utah Lake, Deer Creek Reservoir and Bear Lake are well within the 0.5 ppm guideline level and should present no health hazard upon consumption.

Seventy-seven percent of all fish sampled from Willard Bay Reservoir were above the 0.5 ppm guideline level for mercury (FEDERAL REGISTER, 1954). These fish, with a mean of 1.36 ppm and a range of 0.16 to 7.18 ppm mercury appear to be potentially hazardous to the individuals, especially pregnant women, who may consume them (NELSON, 1971).

Upon finding high levels of mercury in the fish of Willard Bay Reservoir, the inputs into the reservoir (the Ogden and Weber Rivers) were sampled above and below Ogden, Utah to determine whether there were an industrial contribution of mercury to these rivers. No measurable quantities of mercury were found in the waters from the inputs. Sediment samples of the rivers were taken and one sample of the Weber River's sediment taken at the mouth of Weber Canyon above Ogden was found to contain 0.01 ppm mercury. Water from Willard Bay Reservoir was found to contain 0.00001 to 0.0001 ppm mercury. Saline water in the channels and mud flats on the south and west sides of the dikes of Willard Bay Reservoir were found to range from 0.002 to 0.015 ppm mercury. Salt crusts on the mud flats in August ranged from 0.002 to 0.03 ppm mercury.

TABLE 1

Mercury levels for fish by area and by species, Utah 1970-71. All results reported as ppm total mercury in wet muscle tissue.

Area	# of Samples	Mean \pm S.D.	Range
Willard Bay Reservoir	46	1.385 \pm 1.550	0.120-7.300
Utah Lake	20	0.152 \pm 0.102	0.030-0.470
Deer Creek Reservoir	21	0.150 \pm 0.116	0.020-0.430
Bear Lake	6	0.165 \pm 0.085	0.100-0.330
Ogden Bay WMA ^a	11	0.321 \pm 0.191	0.060-0.670
Farmington Bay WMA ^a	9	0.130 \pm 0.066	0.040-0.230
<u>Species (All areas except Willard Bay Reservoir)</u>			
Carp (<u>Cyprinus carpio</u> , Linnaeus)	30	0.221 \pm 0.159	0.040-0.820
Black Bullhead (<u>Ictalurus melas</u> , Rafinesque)	10	0.113 \pm 0.054	0.030-0.240
Yellow Perch (<u>Perca flaescens</u> , Mitchill)	5	0.286 \pm 0.120	0.130-0.430
Bonneville cisco (<u>Prosopium gemmiferum</u> , Snyder)	2	0.225 \pm 0.148	0.120-0.330
Bonneville white fish (<u>Prosopium spilonotus</u> , Snyder)	4	0.130 \pm 0.027	0.100-0.160
Brown trout (<u>Salmo trutta</u> , Linnaeus)	10	0.146 \pm 0.103	0.130-0.430
Rainbow trout (<u>Salmo gairdneri</u> , Richardson)	25	0.141 \pm 0.108	0.020-0.390
Whitefish (<u>Prosopium williamsoni</u> , Girard)	6	0.065 \pm 0.027	0.020-0.100
<u>Species (Willard Bay Reservoir)</u>			
Walleyed pike (<u>Stizostedion vitreum</u> , Mitchill)	25	1.424 \pm 1.167	0.160-3.890
Carp (<u>Cypinus carpio</u> , Linnaeus)	6	0.802 \pm 0.293	0.520-1.210
Large mouth black bass (<u>Micropterus salmoides</u> , Lacepede)	12	1.935 \pm 2.558	0.270-7.300
Green sunfish (<u>Lepomis cyanellus</u> , Rafinesque)	1	0.120	-- - --
Brown trout (<u>Salmo trutta</u> , Linnaeus)	1	1.330	-- - --

^aWaterfowl Management Area

Willard Bay Reservoir is rather shallow averaging 20 feet with little stratification taking place. It has a pH in the range of 8.1 to 8.3 at 25°C. Optimum conditions for methylation of mercury, i.e., aerobic, alkaline conditions, are therefore present.

It is felt that a major contribution of mercury to Willard Bay Reservoir may be made from insoluble mercury salts or sulfides in the muds deposited from the time of Lake Bonneville which receded to form the highly saline Great Salt Lake. The reservoir was built on the mud flats near the east shore of the Great Salt Lake. Indications that the Weber River contributes mercury to Willard Bay are two fold: (1) the Geological Survey (LAND POLLUTION REPORTER, 1971) indicates the greatest concentration of mercury found in a soil sample was from Summit County, Utah, which is the area of the headwaters of the Weber River. (2) Mercury levels in the tissues of carp (average age 4.9 years) obtained from Ogden Bay Waterfowl Management Area, fed by the Weber River, ranged from 0.060 to 0.670 ppm. Tissues of carp (average age 4.4 years) taken from Farmington Bay Waterfowl Management Area, located only 18 miles south and fed by the Jordan River, were found to contain 0.040 to 0.230 ppm mercury. The mean mercury levels of carp from Ogden Bay was 0.355 ppm compared to the mean of 0.130 for carp from Farmington Bay.

An analysis of variance of the mercury levels found in fish of Willard Bay Reservoir showed a species effect, i.e., the species of fish sampled had a direct relationship to the mercury content in muscle tissue. Predators such as black bass and walleyed pike had the greatest accumulations of mercury (Table 1).

Levels of pesticides and PCB in fish muscle tissue are given in Table 2. Dieldrin was found in 56 percent of the samples analyzed. Levels of dieldrin in muscle tissue ranged from none to 0.038 ppm. None of the samples inspected showed levels near the 0.30 ppm maximum permissible concentration. It is notable that though dieldrin was generally found in a high proportion of monitored samples, no measurable amount of dieldrin was found in any of the 17 samples from Willard Bay Reservoir, which contain relatively high concentrations of mercury.

DDT was detected in 85 percent and DDE in 95 percent of the samples of fish muscle tissue analyzed. Levels of DDT ranged from 0.011 to 0.175 ppm. All of the samples (DDT + DDE) were well below the maximum permissible concentration of 5.0 ppm as established by the Food and Drug Administration for edible portions of fish.

PCB's were found in 93 percent of the samples analyzed. Levels in muscle tissue ranged from 0.05 to 0.97 ppm. These levels of PCB are considerably higher than those found for dieldrin, DDT or DDE.

SUMMARY

Levels of mercury and selected pesticides were determined in the muscle tissue of fish obtained from different regions in the state of Utah. The levels of mercury present were generally lower

TABLE 2

Mean levels of selected pesticides in fish of Utah. All mean values reported as ppm in wet muscle tissue. Mean \pm S.D.

Area	# of Samples	Dieldrin	DDT	DDE	PCB
Willard Bay Reservoir	17	N.D. ^a	0.024 \pm 0.023	0.073 \pm 0.042	0.216 \pm 0.212
Utah Lake	19	0.010 \pm 0.007	0.012 \pm 0.008	0.015 \pm 0.016	0.103 \pm 0.054
Deer Creek Reservoir	2	0.031 \pm 0.010	0.016 \pm 0.001	0.012 \pm 0.001	0.125 \pm 0.035
<u>Species^b</u>					
Carp (Utah Lake)	10	0.012 \pm 0.009	0.011 \pm 0.010	0.022 \pm 0.019	0.115 \pm 0.067
Black Bullhead (Utah Lake)	9	0.007 \pm 0.002	0.012 \pm 0.005	0.007 \pm 0.004	0.089 \pm 0.033
Rainbow trout (Deer Creek Reservoir)	2	0.031 \pm 0.010	0.016 \pm 0.001	0.012 \pm 0.001	0.125 \pm 0.035
Carp (Willard Bay Res.)	6	N.D.	0.009 \pm 0.010	0.070 \pm 0.024	0.137 \pm 0.050
Large mouth black bass (Willard Bay Reservoir)	6	N.D.	0.029 \pm 0.033	0.042 \pm 0.014	0.312 \pm 0.333
Walleyed Pike (Willard Bay Reservoir)	5	N.D.	0.037 \pm 0.011	0.112 \pm 0.052	0.196 \pm 0.120

^aN.D. represents non-detected.

^bScientific names of species are given in Table 1.

than the guideline limit (0.5 ppm) in most fish except those obtained from one localized area (Willard Bay Reservoir). Predators had the greatest accumulation of mercury. Only small amounts of pesticides were found in fish. A majority of the tissues contained appreciable levels of PCB's. No definite relationship between the levels of mercury and pesticides or PCB's was noted.

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