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ABSTRACT

The concentration of lead in fish muscle tissue from lakes where boating is heavy and where it is prohibited was measured. The lead levels ranged from less than 0.05 to 1.35 ppm but did not differ significantly between those in the controlled and noncontrolled boating lakes. Lead levels apparently pose no public health hazard. ***Trans. Kans. Acad. Sci., Vol. 79 (3-4), 1976.***

In recent years, studies have revealed that lead concentrations are increasing in our environment. This increase can be attributed to the combustion of leaded gasoline (Page and Panje, 1970). Investigators have demonstrated significant correlations between motor vehicle traffic density and the amount of lead associated with soils (Page and Panje, 1970; Satterlee et al., 1975) and plants (Schuck and Locke, 1970; Lagerwerff and Specht, 1970). It was hypothesized that heavy motor boating traffic might contribute significantly to lead concentrations in the aquatic environment.

Lead in the aquatic environment from exhaust wastes is most likely to occur in relatively insoluble forms as in soil (Daines et al., 1970). Sedimental lead may be assimulated by plants and certain invertebrates. If biomagnification does occur, fish tissues would be expected to contain lead. Lead is known to be toxic, cumulative and deposited in bone tissue (Bowen, 1966).

Immediate concern was over excessive amounts of lead occuring in edible portions of fish. English et al. (1963a and 1963b) and Surber (1971) examined the tainting of the taste of fish due to outboard motor exhaust wastes. Lead in fish tissue was not determined at that time, but palatability was deleteriously affected. Several lakes in the eastern part of Nebraska are subject to heavy recreational use by both fishermen and water skiers. A study to determine lead levels in tissues of selected species of fish was therefore initiated. The purpose was to determine if fish from lakes receiving heavy motor boating pressure might constitute a health hazard.

Fish samples were taken from three lakes which received considerable boating pressure (Connestoga and Pawnee near Lincoln and Victory Lake at Fremont State Recreational Area). Two control lakes were chosen from the same areas: Yankee Hill near Lincoln and Lake #2 at Fremont. Victory Lake and Fremont Lake #2 are sandpit type lakes;

Table I. Mean total length and weight of fishes collected for lead analysis.

COLLECTION SITE	SPECIES	N	MEAN TOTAL LENGTH (mm)	MEAN WEIGHT (gm)
Victory Lake	Largemouth Bass	10	247.1	234.2
	Bluegill	10	157.3	79.3
	Black Crappie	10	171.6	53.0
Fremont Lake #2	Largemouth Bass	9	244.3	300.1
Pawnee Lake	Black Crappie	10	212.1	144.8
	Bluegill	10	159.9	77.3
Connestoga Lake	Black Crappie	9	184.4	64.7
	Bluegill	10	152.7	62.2
Yankee Hill Lake	Black Crappie	10	206.0	130.9
	Bluegill	10	162.2	84.0

Connestoga, Pawnee and Yankee Hill lakes are surface water impoundments. Species collected and analyzed included largemouth bass *(Micropterus salmoides)*, bluegill *(Lepomis macrochirus)* and black crappie *(Pomoxis nigromaculatus)* (Table 1).

All samples were homogenized boneless fillets which were stored at -20° C in glass containers until analysis. Lead was analyzed via Pekin-

Table II. Average concentrations of lead in fish muscle by individual species.

AREA	SPECIES		N	MEAN (ppm)	STANDARD DEVIATION
Victory Lake	Bluegill	(a)	10	0.18	0.150
	Crappie	(a)	10	0.32	0.443
	Largemouth bass	(a)	10	0.31	0.093
Fremont Lake #2	Largemouth bass	(b)	9	0.41	0.239
Conestoga Lake	Bluegill	(a)	10	0.28	0.158
	Crappie	(a)	9	0.77	0.259
Pawnee Lake	Bluegill	(a)	10	0.33	0.186
	Crappie	(a)	10	0.28	0.335
Yankee Lake	Blugill	(b)	10	0.45	0.366
	Crappie	(b)	10	0.22	0.182

(a) Lakes with power boating
(b) Lakes without power boating

Elmer methodology using an organic extraction technique devised by Yeager et al. (1971) Results are reported in parts per million on a wet weight basis (Table II).

The highest mean concentrations of lead (0.51 ppm) were found in fish from Connestoga Lake (heavy motor boating); and the lowest mean concentrations (0.27 ppm) from Victory Lake (heavy motor boating). The highest mean concentration of lead in an individual species was found in crappie (0.77 ppm) from Connestoga Lake. The lowest mean was for Victory Lake bluegill (0.18 ppm). Statistical analysis of lead concentrations in crappie from surface water impoundments indicated that these concentrations were significantly higher in fish from the two lakes where motor boating was heavy, (Table III). A similar test for lead concentrations in bluegill found the reverse to be true. The mean lead concentration was significantly higher in fish from the non-motor boating lake, (Table IV). In the sandpit type lakes the mean concentration of lead in largemouth bass was also higher (0.41 to 0.31 ppm) in the non-boating lake than in the lake where motor boating was permitted. A one-way

TABLE III. Comparison of mean lead concentrations in black crappie from surface water impoundments.

T TEST

AREA	N	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.
Yankee Hill Lake*	10	0.22	0.182	0.058	4.51	0.27
Connestoga & Pawnee Lake	19	0.51	0.388	0.089		

*No power boating

Table IV. Comparison of mean lead concentrations in bluegill from surface water impoundments.

T TEST

AREA	N	MEAN	STANDARD DEVIATION	STANDARD ERROR	F VALUE	2-TAIL PROB.
Yankee Hill Lake*	10	0.45	0.366	0.116		
					4.61	0.006
Connestoga Lake & Pawnee Lake	20	0.30	0.170	0.038		

*No power boating

analysis of variance of all fish species combined indicated that there was no significant difference (95% level) in lead concentrations in fishes from these lakes (Table V). A Duncan's multiple range test on the combined fish species showed overlap in lead concentrations for the controlled and non-controlled motor boating lakes (Table VI).

Table V. One-way analysis of variance of lead concentations in fish muscle from several Nebraska lakes.

SOURCE	D.F.	SUM OF SQUARES	MEAN SQUARES	F RATIO	F PROB.
Between groups	4	0.7587	0.1897	2.300	0.064
Within groups	93	7.6711	0.0825		

Table VI. Duncan's multiple range test (95% confidence level) of lead concentrations in fish muscle.

AREA	N	MEAN (ppm)	DUNCAN MULTIPLE RANGE TEST	STANDARD ERROR	Range MINIMUM (ppm)	Range MAXIMUM (ppm)
Victory Lake	30	0.27		0.0499	0.05	1.35
Pawnee Lake	20	0.30		0.0593	0.08	1.22
Yankee Hill Lake	20	0.33		0.0685	0.05	1.22
Fremont Lake #2	9	0.41		0.0795	0.20	1.00
Connestoga Lake	19	0.51		0.0752	0.07	1.08

Analysis of whole fish or skeletal tissue might have shown a more significant difference in the lead concentrations for undetected bones can lead to incorrect and elevated values for some filleted samples.

The Food and Drug Administration has established a tolerance level for lead in evaporated milk of 0.3 ppm to protect infants that may acquire more than half their average daily diet through dairy products (Federal Register, 1974). A tolerance has not been set for other foods. The Canadian Food and Drug Directorate has set a tolerance of 10.0 ppm for lead. All samples were well below a 10 ppm tolerance level. In order to give some perspective to our values, Kleinert et al. (1974) found lead concentrations ranging from 0.0 to 4.31 ppm in twenty-six species of fish from Wisconsin. Morris et al. (1972) found values ranging from less than 0.01 to .45 ppm in Iowa catfish. Dalton et al. (1969) found 0.88, 6.93 and 3.30

ppm of lead in pork, beef and turkey tissue respectively. Our values ranging from less than 0.05 to 1.35 appear to indicate no public health hazard.

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