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Lead and Cadmium Concentrations in Mink from Northern Idaho

Abstract

The purposes of this study were to determine concentrations of cadmium and lead in mink (*Mustela vison*) in northern Idaho, to discuss potential effects, and to determine whether levels have declined. Mink (skinned carcasses) from the Coeur d'Alene River system (northern Idaho) were obtained from trappers during the 1981-82 (n = 17) and 1986-87 (n = 14) seasons. Livers of all eight mink from the uncontaminated North Fork contained low levels of lead; whereas, 9 of the 23 mink from lateral lakes adjoining the contaminated main stem, downstream from a mining-smelting complex, contained potentially hazardous lead levels (≥ 5 μg/g). Stomach contents of nine mink contained variable concentrations of lead (0.15 to 51 μg/g); samples from the main stem contained the highest values. No difference was detected in lead concentrations in livers of mink trapped from the lateral lakes in 1981-82 and 1986-87. Levels of cadmium were low in all samples, but lead levels were the highest ever recorded in mink. Our results suggest that metal pollution has probably led to localized declines in mink populations.

Introduction

Captive mink (*Mustela vison*) are sensitive to certain environmental contaminants such as polychlorinated biphenyls (Hornshaw *et al.* 1983) and methyl mercury (Aulerich *et al.* 1974); simultaneous exposure to both contaminants may result in synergistic effects (Wren *et al.* 1987). Mercury was suspected of causing declines in mink and river otter (*Lutra canadensis*) populations at a lake in Ontario, Canada (Fimreite and Reynolds 1973); however, only one verified mercury-induced mortality (an otter) was reported (Wren 1985). Mercury levels in mink were relatively low at the other collection sites in Ontario (Wren *et al.* 1986). Acid precipitation was suspected of causing a decrease in a mink population in Norway (Bevanger and Albu 1986). Although extensive residue data were recently reported, there is still uncertainty regarding effects of contaminants on populations of mink and other mustelids (Ogle *et al.* 1985, O'Connor and Nielsen 1980).

Our previous research in 1981-82 dealt with concentrations of metals in mink and other mammals from the northwestern United States; we reported elevated levels of lead in mink from the Coeur d'Alene River system (except the North Fork) that originated from an extensive mining-smelting complex on the South Fork (Blus *et al.* 1987). Most mining and smelting activities in the region ceased in 1981. During the 1986-87 trapping season, we obtained additional mink carcasses from trappers. The purposes of this paper are to determine concentrations of cadmium and lead in mink, to discuss potential effects, and to determine whether levels have declined since 1981-82.

Methods

Skinned carcasses of 31 mink were obtained from trappers working the Coeur d'Alene River system (Figure 1) in Kootenai County, Idaho; 23 mink were taken during the 1981-82 (n = 9) and 1986-87 (n = 14) seasons from Thompson Lake and other nearby lateral lakes adjoining the main stem about 40 km downstream from the main mining-smelting complex near Kellogg. Eight mink also were trapped from the North Fork in 1981-82. After storage in a freezer for several months, the carcasses were thawed, and the general condition of the specimens was noted. Samples of liver, kidney, and stomach contents were placed in nitric acid-rinsed jars and were then stored in a freezer.

The 1981-82 samples were shipped to the Patuxent Wildlife Research Center, Laurel, Maryland where they were analyzed for lead, cadmium, and several other elements; the residue concentrations (Blus *et al.* 1987) and analytical methodology previously were reported (Haseltine *et al.* 1981). For lead and cadmium analyses, tissues were homogenized in a Virtis blender. A 5g portion was placed in a Vycor crucible that was placed in a 110°C muffle furnace for 2 hr. The temperature was then increased to 550°C at a rate of 100°C/hr and samples were left to ash overnight. The cooled ash was dissolved in approximately 4 ml of nitric and hydrochloric acids over a hot plate, transferred to a 12-ml polypropylene tube, and diluted to 10 ml with distilled, deionized water. Concentrations were

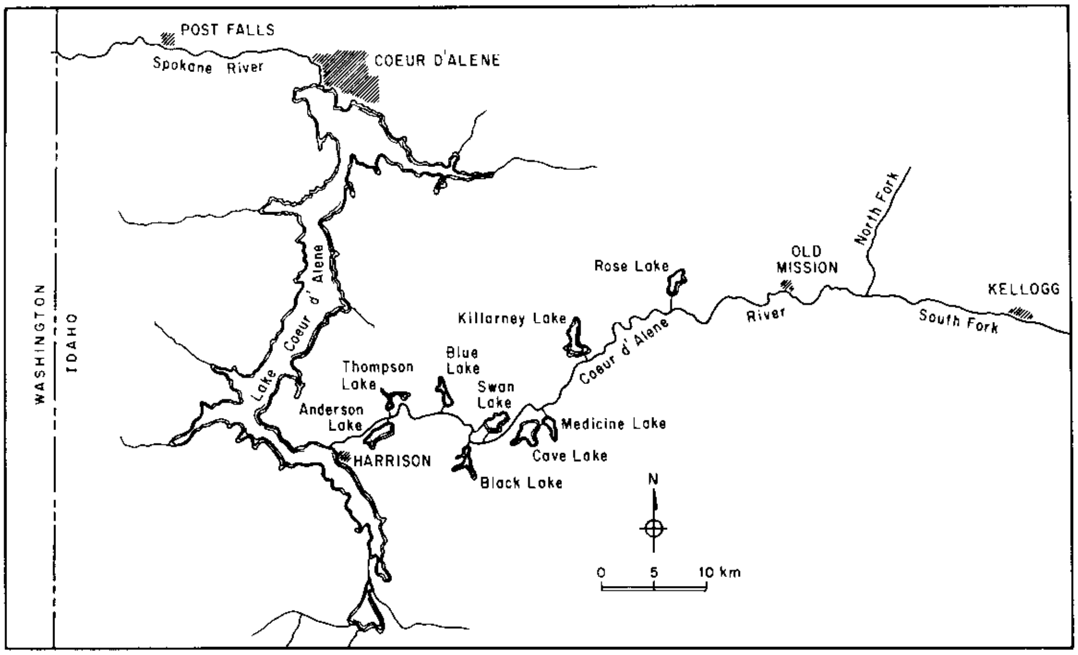

Figure 1. Map of Coeur d'Alene River system in northern Idaho where mink were trapped.

determined by comparison with aqueous standards on a Perkin-Elmer Model 1703 atomic absorption spectrophotometer. Except for the lead line of 217 mm, the standard conditions recommended by the manufacturer (Perkin-Elmer Corporation 1976) were used. Recoveries from spiked chicken livers ranged from 83 to 100 percent; concentrations were not corrected on the basis of these data. The lower limit for reportable residues was 0.10 μg/g for both cadmium and lead.

The 1986-87 samples were freeze-dried and analyzed at Environmental Trace Substances Research Center, Columbia, Missouri for lead in livers, cadmium in kidneys, and both metals in food samples. Metal levels in the 1986-87 samples were quantified by atomic absorption with a Perkin-Elmer Model 5100, Model HGA-600 graphite furnace, Model AS-60 autosampler, and a Model 7300 computer (Perkin-Elmer Corporation 1976). Dry weight concentrations were converted to wet weight based on the moisture content of each sample. All concentrations are based on wet weight unless indicated otherwise. The mean moisture content of liver and kidney samples was 72 percent compared to 75 percent for food samples. The lower limit of sensitivity (wet weight) was <0.03 μg/g for both metals. Recovery from spiked samples was 103 percent for cadmium and 102 percent for lead; concentrations were not corrected for recovery values.

Concentrations of lead or cadmium in the three collections were transformed ($\log_{10}$) and tested using one-way ANOVA; means for each metal were compared using Tukey's Q-test. When a metal was not detected, we used a value halfway between 0 and the lower limit of detection. We used linear regression analysis to examine the relationship between lead and cadmium concentrations for each of the three collections and for the entire sample. For all statistical testing, the level of significance was set at $P \leq 0.05$.

Results

Lead was detected in all samples analyzed for this element except three livers of mink from the North Fork in 1981-82 (Table 1). Mean lead concentrations in 23 livers of mink from lateral lakes adjoining the main stem of the Coeur d'Alene River were not significantly different between 1981-82 and 1986-87; however, both were significantly higher than the mean level found in eight samples from the North Fork in 1981-82. Livers

TABLE 1. Lead and cadmium concentrations in mink samples, Coeur d'Alene River system, Idaho.

Area[1]	Trapping season	n	µg/g, Wet weight Lead		Cadmium	
LIVER and KIDNEY[2]						
NF	1981-82	8	0.27(5)[3] 0.08-0.95 ND-3.2	A	0.40(8) 0.25-1.3 0.15-1.6	A
MS	1981-82	9	4.1(9) 1.8-9.7 0.39-22	B	0.57(8) 0.21-0.75 ND-2.4	A
MS	1986-87	14	3.2(14) 1.4-7.6 0.20-34	B	0.58(14) 0.41-0.81 0.27-2.9	A
STOMACH CONTENTS						
NF	1981-82	3	1.6(3)[4] 0.28-3.6		<0.10(1) ND-0.17	
MS	1981-82	1	3.8		0.38	
MS	1986-87	5	3.7(5) 0.15-51		0.24(5) 0.12-0.46	

[1]NF = North Fork, MS = Lateral lakes adjoining the main stem.

[2]Liver analyzed for lead and kidneys for cadmium; ND = None Detected

[3]Geometric mean for liver and kidney samples and number of positive samples (in parentheses) on the top line, 95% confidence limits on the middle line, and range on the bottom line. Means for each metal were compared using Tukey's Q-test; those in the same column sharing the same capital letter are not significantly different ($P > 0.05$).

[4]Geometric mean for stomach contents and number of positive samples (in parentheses) on the first line and the range on the second line.

of mink from the lateral lakes varied in lead content; concentrations ranged from 0.20 to 34 µg/g. Lead concentrations in stomach contents also were variable and ranged from 0.15 to 51 µg/g in samples from the lateral lakes and 0.28 to 3.6 µg/g in those from the North Fork. There was a positive correlation between lead concentrations in liver and stomach contents, but the relationship was not significant. Ratios of lead in livers to stomach contents ranged from 0.1:1 to 2:1. Stomach contents of the nine mink that contained food consisted primarily of mammalian prey.

Cadmium was detected in all but three of the samples analyzed for this element (Table 1). Unlike lead, all cadmium levels were relatively low and ranged from none detected to 2.9 µg/g in kidney samples and from none detected to 0.46 µg/g in food samples. Cadmium content of kidney samples in the three collections were not significantly different from one another. Concentrations of lead and cadmium were not significantly intercorrelated either by time or place of collection or in the total sample.

Body condition, based on subjective determination of fat content, varied widely. Mink carcasses had medium to high fat content except one from the North Fork (low to medium) and one from the lateral lakes in 1981-82 (low), and four from the lateral lakes in 1986-87 (low—two and none apparent—two).

Discussion

Metal concentrations in mink from the main stem vs the North Fork resulted from the different levels of contamination. The North Fork is subject to little or no contamination with metals; whereas, the main stem is formed at the confluence of the North Fork and the heavily contaminated South Fork that flows through the major mining-smelting area near Kellogg.

Mean cadmium concentrations in kidneys of mink in this study were about double the 1.02 to 1.21 µg/g (dry weight) reported for mink trapped in Virginia from 1981-83 (Ogle *et al.* 1985) and were half to double the 0.22 to 0.87 µg/g detected in mink trapped at five sites in Ontario, Canada from 1983-85 (Wren *et al.* 1988). All of these cadmium concentrations were much lower than those associated with lethal or sublethal effects in experimental animals (Decker *et al.* 1958, Eisler 1985).

Lead concentrations of ≥10 µg/g have been associated with diagnostic lead toxicosis in experimental mammals (Osweiler *et al.* 1978); however, mammals with behavioral and physiological signs of lead intoxication have died with <5 µg/g (Zook *et al.* 1972, Clarke 1973). Captive mink have died after accidental exposure to lead (Clarke 1973), but there are no experimental data regarding the toxicity of lead to mink. Lead concentrations in livers of mink from the lateral lakes along the main stem of the Coeur d'Alene River included 5 (22%) with ≥10 µg/g and 9 (39%) with ≥5 µg/g. These animals were at risk from lead toxicosis. In the 1986-87 sample, livers of two emaciated females contained 0.22 and 5.5 µg/g of lead, while those of two males with low fat content contained 19 and 34 µg/g. In these examples, poor body condition was not necessarily related to high lead burden. Also, our sample represented mink that were killed by trapping rather than a random sample. Dead mink have not been observed along the Coeur d'Alene River; however, other more conspicuous animals such as tundra swans (*Cygnus columbianus*) have regularly died in the area from environmental lead (Chupp and Dalke 1964, Benson *et al.* 1976).

Few samples from wild mink have been analyzed for lead; mean concentrations in livers of mink from Ontario, Canada ranged from 0.12 to 0.48 $\mu g/g$ (Wren *et al.* 1988). In Virginia, Ogle *et al.* (1985) reported that only 6 percent of 125 mink livers contained detectable levels of lead with a maximum concentration of 12.7 $\mu g/g$ dry weight (approximately 4 $\mu g/g$ wet weight). Livers of mink from Washington State contained an average of 0.10 $\mu g/g$ lead with a maximum value of 0.44 $\mu g/g$ (Blus *et al.* 1987). Therefore, lead levels in mink are generally low except in localized areas such as parts of the Coeur d'Alene River system where we recorded the highest levels for this species. Avian and mammalian prey with ingested or embedded lead shot represent a hazard to some predators (Pattee and Hennes 1983), but there was no evidence of lead shot in the mink.

Lead levels in our liver and food samples of mink from the lateral lakes varied widely, indicating gradations of exposure that probably were related to different burdens of metals in these lakes that depended on the input of contaminated water from the main stem. Even during a period of unrestricted pollution of the South Fork with mining and smelting wastes, viable fish and invertebrate populations were found in a few lateral lakes but were low or absent in others and in the South Fork and main stem (Ellis 1940).

The persistence of high lead levels in the mink from the main stem are apparently related to the high concentrations in sediment and biota that are currently found throughout most of the Coeur d'Alene Lake and River system (Savage 1986). The effects of metals, particularly lead, on mink populations in northern Idaho remain unknown. Population trend data are unavailable; however, we suspect that mink are adversely affected along heavily contaminated segments of the river and some lateral lakes; mink are probably absent in the nearly denuded region around the main mining-smelting complex near Kellogg. In addition to direct toxic effects of lead and other metals, secondary effects associated with absence of food and cover are probably important.

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