INTRODUCTION

Parker River National Wildlife Refuge is located in the far north-eastern corner of Massachusetts, within the Boston, Massachusetts - Portsmouth, New Hampshire urban corridor (Fig. 1). Three major rivers feed into the bays around the refuge: the Merrimack River, The Parker River, and the Ipswich River. Due the urban environments through which these rivers flow, there is a potential for contaminants to be carried by the rivers. Since the Parker River NWR lies at the mouth of the three rivers, there is concern that contaminants would be deposited at the refuge. To address this concern, a multimedia screening level contaminant survey was conducted on the refuge in 1990. Lead levels in water of two of three salt pans sampled were found to exceed the Environmental Protection Agency's (EPA) acute marine water quality criterion. A water sample taken from a well was also found to exceed the maximum level for lead established by the Safe Drinking Water Act. One possibility for the elevated lead levels in the water of the salt pans is that lead shot was deposited during past hunting activities. Water in the well could be contaminated with lead due to ground water contamination on the refuge or due to leaching of the pipes. The purpose of this study was to determine if the sediments in the salt pans are contaminated with lead, and to determine if lead levels remained high in water samples from the well after the well had been flushed for four minutes (the well was not flushed in 1990).

METHODS

Three sediment samples were collected from each of three salt pans on Parker River NWR on July 27, 1992 (Fig. 2). Sediment samples were collected from the top six inches of depositional area using a stainless steel spatula that was solvent-cleaned prior to each sample collection. Samples were placed directly into chemically cleaned glass jars and refrigerated until delivered to laboratories for analysis. A water sample was also collected from the drinking water well after it had been flushed for four minutes. The water sample was collected in a cubitainer.

Samples were analyzed by the Geochemical and Environmental Research Group at Texas A&M University. A full metal scan and total organic carbon analyses were conducted on all samples. Arsenic was detected using hydride generation. Mercury was detected using cold vapor atomic adsorption. The other metals were detected using preconcentrated inductively coupled plasma, or ICP scan.

RESULTS

The results of the analyses for the metals of concern in sediments are provided in table 1 (results for all metals are provided in the appendices). Since there were some high variances between the three samples collected from each pool, the high and low concentrations for each metal are reported in table 1 rather than the mean of the three values. The table also lists an ER-L and ER-M value. These values were established by Long and Morgan (1990) from a compilation of effect levels in the literature. The ER-L represents a concentration at the low end of the range in which biological effects had been observed, and the ER-M is a concentration approximately midway in the range of values associated with biological effects.

All of the sediment samples from the pools had arsenic and cadmium concentrations well below the ER-L's for these metals. One sample from pool PR-8 had a chromium concentration equivalent to the ER-L for chromium. One sample from pool PR-9 had a zinc concentration that exceeded the ER-L. Lead and mercury concentrations exceeded the ER-L's in all three pools, however, all of the samples were well below the ER-M's for these metals.

Metal concentrations found in the well water and maximum levels acceptable under the Safe Drinking Water Act are listed in table 2. With the exception of mercury, the concentrations of all of the metals, including lead, were well below regulatory levels. Mercury, however, was found at a level ten times the regulatory level for this metal in drinking water.

Table 1. Range of metal concentrations (ppm dry weight) in sediments of three salt pans at Parker River NWR as compared to effect levels ER-L and ER-M (Long and Morgan 1990)[a].

	SALT PONDS				
METAL	PR-8	PR-9	PR-10	ER-L	ER-M
Arsenic	0.89- 5.90	2.51- 4.15	2.94- 5.23	33.00	85.00
Cadmium	0.31- 1.02	0.58- 0.84	0.37- 0.77	5.00	9.00
Chromium	4.52- 80.89	20.33- 28.73	36.47- 65.84	80.00	145.00
Lead	5.33- 39.26	53.03- 67.52	34.80- 65.00	35.00	110.00
Mercury	0.10- 0.22	0.17- 0.18	0.13- 0.23	0.15	1.30
Zinc	<0.50-104.84	91.10-139.94	49.29-102.71	120.00	270.00

[a]ER-L represents a concentration at the low end of the range in which effects had been observed in biota in the literature.
ER-M represents a concentration midway in the range of reported values associated with biological effects.

Table 2. Metal concentrations (ppm) found in well water at Parker River NWR in 1991, as compared to thresholds established under the Safe Drinking Water Act (SDWA).

METAL	PR-11	SDWA
Arsenic	<0.0050	0.050
Cadmium	<0.0005	0.010
Chromium	<0.0030	0.050
Mercury	0.0204	0.002
Lead	<0.0100	0.050
Zinc	0.0100	-

- No threshold established.

DISCUSSION

The metal concentrations in the salt pan sediments indicate a chronic low level risk to fish and wildlife from mercury and lead. The mercury levels in the sediments of the salt pans slightly exceeded the ER-L in all three pans. Mercury was detected in the sediments of two freshwater pools at the refuge in 1990 (Major and Carr 1991) at similar levels to those found in the salt pans in 1991. Fish collected from the freshwater pools had an average concentration of 0.58 ppm of mercury in their tissues, which is higher than the 1984 national average for freshwater fish (0.10 ppm) (Schmitt and Brumbaugh 1990), but lower than the FDA action level of 1.0 ppm for fish fillets. However, fish from the freshwater pools may not be good indicators for the salt pans because of the differing chemistry of fresh and salt water. Although the concentration of mercury in the sediments of the salt pans are not at an exorbitantly high level, due to the high toxicity of mercury and its high bioaccumulation and biomagnification potentials, its presence in the environment can never be ignored.

Lead levels in the water of the salt pans was found to exceed the EPA's acute marine water quality criterion in the 1990 study. Lead concentrations in the sediments collected in 1991 were found to exceed the ER-L in all the salt pans. However, there was a wide variance between samples, suggesting that the concentrations of lead in the salt pans are spotty. Lead is a highly toxic substance that exhibits some persistence in body tissues. Diet is the primary means of ingestion for birds and mammals (Eisler 1988). A single oral dose of lead shot (4 shot or 440 mg) caused mortality in 71% of ringed turtle-doves (*Streptopelia risoria*) tested (Kendall *et al.* 1982). A single oral dose of one number 4 shot (1.4 g) caused some deaths in mallards (Longcore *et al.* 1974). This suggests that birds feeding in the salt pans are not likely to be acutely affected by the lead. However, "hot spots" on the refuge may contribute to chronic affects of lead, such as reduced weight, survival, increased rates of birth defects and cancer.

The water sample taken from the well on the refuge was found to contain significantly elevated levels of mercury. This well is used to service a public bathroom on the refuge, therefore, the elevated mercury in the water requires that signs be posted in the bathrooms indicating that the water is not suitable for drinking. However, the detection of high levels of mercury in ground water raises questions regarding the source of the mercury and the extent to which ground water is contaminated with mercury throughout the island.

CONCLUSIONS

Lead and mercury concentrations found in the salt pans suggest that these sites pose a low level chronic risk to fish and wildlife. The presence of mercury in the environment above background levels is always a concern because of its ability to bioaccumulate and biomagnify. However, collection of biological samples would be necessary to determine the bioavailability of the mercury. The wide variance in sample concentrations for lead indicates that there are "hot spots" of lead in the salt pans which could pose a risk to biota. Again, collection of biological samples would be necessary to determine the level of risk, however, we would not expect it to be severe.

The concentration of mercury found in the well is of significant concern, and warrants additional study to determine the source of the mercury and the extent of contamination. Since there are many residences on the island, it would be prudent for any drinking water wells to be tested for mercury contamination.

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