PREFACE

Information presented in this report is final documentation of the 1990 environmental contaminants evaluation of water, sediments, and fish in the Parker River National Wildlife Refuge, Massachusetts, under Catalog 6332, Region ID 90-5-103, Purchase Order 85800-0-6232. Study design, implementation, data analyses, and reporting were completed by Environmental Contaminants personnel in the New England Field Office (Fish and Wildlife Enhancement). Funding for the project was provided by Refuges and Wildlife.

Questions, comments, and suggestions related to this report are encouraged. Written enquiries should refer to Report Number RY91-NEFO-6-EC and be directed to the Service at the following address:

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INTRODUCTION

Parker River National Wildlife Refuge lies within the Boston, MA - Portsmouth, NH urban corridor, and is situated within watersheds that reflect the developed nature of the corridor. This refuge receives much of its tidal inundation from the Merrimack River estuary, which receives significant contaminant loading from the Merrimack River Watershed (Figure 1). Significant PCB, metal, and pesticide levels are documented in fish taken at Haverhill, MA, at the head of tidal influence on the Merrimack River (Carr 1984, Major and Carr 1991). Two superfund sites have been listed on the Merrimack in Haverhill, and several others are located on other rivers within the Merrimack River Watershed. In addition, a hazardous waste site was discovered on the mainland portion of the refuge (the proposed site of the new refuge headquarters). Our objective was to determine if contaminants from the Merrimack River Watershed and/or historic uses of the refuge had introduced contaminant levels to the island and estuarine portions Parker River NWR that are adversely affecting or potentially could affect wildlife resources. This objective was addressed by conducting a multimedia screening level contaminant survey.

METHODS

On August 1, 1990, water, sediment, and fish samples were taken from two of the three major freshwater pools on the refuge, and water and sediment samples were collected from the third (Figure 2). Additional water samples were taken at 3 salt pans and one freshwater well. Nine addled Piping Plover (*Charadrius melodus*) eggs were also collected (Appendix 1). Water samples were collected from the surface using cubitainers for metal analysis and chemically cleaned glass containers for organic analysis. 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 containers and refrigerated until delivered to laboratories for analysis. Fish (white perch, *Morone americana*) were collected using a gill net, and individual length and weight measurements were taken. The samples were wrapped in aluminum foil and frozen until delivered to laboratories for analysis. Arsenic (hydride generation), mercury (cold vapor atomic absorption), metal ICP scans (preconcentrated inductively coupled plasma), and total organic carbon analyses were performed by the Environmental Trace Substances Research Center in Columbia, Missouri. Organochlorine and Polychlorinated Biphenyls (PCB's), Aliphatic Hydrocarbon, and Polynuclear Aromatic Hydrocarbon (PAHs) analyses were performed by the Mississippi State Chemical Laboratory. Organophosphate/Carbamate scanning was performed by the U.S. Fish and Wildlife Service's Patuxent Analytical Control Facility.

(See Appendix 3 for a more complete documentation of these procedures).

RESULTS

Mean arsenic levels in the three major pools were 0.004 ppm for water, 14.1 ppm in sediments, and 0.16 ppm in fish (Table 1). Levels of arsenic in water from the salt pans were 0.008, 0.0011, and 0.0011 ppm at sample sites PR-8, PR-9, and PR-10 respectively. No arsenic was detected at the well (PR-11).

No mercury was detected in any of the water samples. The mean sediment mercury level was 0.27 ppm, and the mean fish mercury level was 1.88 ppm.

Lead levels were below the detection limit (0.005 ppm) in all of the water samples taken from the major pools and one of the salt pans (PR-8). The other two salt pans (PR-9 and PR-10), however, had lead levels of 0.052 and 0.40 ppm respectively, and the well (PR-11) had a lead level of 0.15 ppm (Appendix 2). Sediment lead levels ranged from 37 ppm at PR-3 to 82 ppm at PR-4.

No organic contaminants were detected in any of the water samples. Mean total aliphatic hydrocarbon levels were 0.76 ppm in sediments and 0.35 ppm in fish. The mean total PAH level was 0.22 ppm in sediments and 0.46 ppm in fish (Table 1). No aliphatic hydrocarbons or PAHs were detected in the eggs. Other organic contaminants found in tissue samples are summarized in Table 2.

Table 1. Contaminant concentrations among the three pools sampled on the Parker River National Wildlife Refuge, 1990.

CONTAMINANT AND MEDIUM	POOL NAME NORTH	B.F.[a]	STAGE ISLAND	$\bar{x}$
METALS[b]				
Arsenic				
Water	0.005	0.004	0.003	0.004
Sediment(Dry)	17.7	11.1	13.5	14.1
Fish	ND	0.08	-	0.05*
Mercury				
Water	ND[c]	ND	ND	
Sediment(Dry)	0.28	0.09	0.43	0.27
Fish	0.56	0.60	-	0.58
ORGANIC HYDROCARBONS[d]				
Total Aliphatic				
Water	ND[e]	ND	ND	-
Sediment(Dry)	0.72	1.23	0.80	0.92
Sediment(Wet)	0.60	1.03	0.65	0.76
Fish	0.44	0.26	-	0.35
Total Polynuclear Aromatic				
Water	ND	ND	ND	-
Sediment(Dry)	0.20	0.08	0.52	0.26
Sediment(Wet)	0.17	0.07	0.42	0.22
Fish	0.91	ND	-	0.46*

[a]Bill Forward Pool.
[b]Water samples as µg/mℓ; sediments as mg/kg, dry wt; fish as mg/kg wet weight (whole fish).
[c]ND - None detected. Detection limit for metals was 0.0003 µg/mℓ in water and 0.2 mg/kg in whole fish.
[d]Sediments as mg/kg dry and wet wt.
[e]Detection limit for organics was 0.005 µg/mℓ in water and 0.01 mg/kg in whole fish.
*ND levels were assigned a value of 1/2 the reported detection limit in order to calculate mean values.

Table 2. Other organic contaminants (ppm wet wt.) found in tissue samples collected from the Parker River National Wildlife Refuge, 1990

	Reference Number and medium type		
	PR-1	PR-12	PR-13
CONTAMINANT	Eggs	Fish	Fish
Total Chlordanes	0.23	ND[a]	ND
Total PCB's	4.2	ND	ND
Total DDT's	0.71	0.02	0.09
Dieldrin	0.04	ND	ND

[a]None detected (detection limit was 0.05 ppm for PCB's and 0.01 ppm for all others).

DISCUSSION

Metals

Aquatic organisms should not be affected unacceptably if the 4-day average concentration of arsenic in water does not exceed 0.036 µg/mℓ in marine systems and 0.19 µg/mℓ in freshwater systems more than once every three years (EPA 1986). Arsenic levels in water from this study were considerably lower than these levels and should pose negligible risks to aquatic organisms. Long and Morgan's (1990) Effects Range-Low (ER-L) (the lower 10th percentile of numerous studies reporting **marine** sediment contaminant levels causing adverse biological effects) value for arsenic (33 ppm dry wt) was well above sediment arsenic levels in the three major pools of Parker River NWR, but **freshwater** sediments in Illinois having concentrations higher than 11.0 mg/kg dry weight were classified as "elevated" (Ingersoll and Nelson 1989). Levels of arsenic were comparable to those found in sediments from the Sudbury River near Wayland, MA (7.3 - 22.4 ppm dry wt.) (Eaton and Carr 1991). These sediment arsenic levels did not appear to cause adverse arsenic concentrations in water or fish, however. Arsenic levels in fish (0.05 ppm) from this study were lower than the national average from the 1984 National Contaminant Biomonitoring Program for freshwater fish (0.14), and comparable to levels found in smallmouth bass (Micropterus dolomieui) (0.04 ppm) collected from Lowell, MA (Schmitt and Brumbaugh 1990). There is some indication that concentrations of arsenic in freshwater sediments are naturally elevated in New England. Data from the Boston Third Harbor Tunnel Project show arsenic levels of 32.1 ppm in

native material (till) (Central Artery/Third Harbor Tunnel E.I.S., MA Department of Public Works).

The mean sediment mercury level from this study (0.27 ppm) was higher that the ER-L level of 0.15 ppm. The International Joint Commission considered <0.03 ppm as a background mercury sediment level in Great Lakes sediments (Ingersoll and Nelson 1989). The EPA classifies Great Lakes harbor sediment mercury levels below 1.0 ppm, dry wt, as nonpolluted (EPA 1977). The mean level of mercury in fish (0.58 ppm) was higher than the 1984 national average for freshwater fish (0.10 ppm) (Schmitt and Brumbaugh 1990) and higher than mean levels found in freshwater fish from the Merrimack River (0.20 ppm) (Major and Carr 1991). Mercury levels in fish flesh in excess of 1.1 ppm fresh weight, are considered to be presumptive evidence of an environmental mercury problem (Eisler, 1987a).

Water lead levels in two of the salt pans (PR 9 and 10) exceeded the EPA's acute marine water quality criterion of 0.0085 ppm (EPA 1986), and the well water sample exceeded the maximum lead contaminant criterion of 0.05 ppm under the Safe Drinking Water Act of 1987. The well sample also had elevated levels of copper. Sediment sampling in the salt pans was not done during this study. Sediment lead levels from the three major pools exceed criteria (EPA 1977, Ingersoll and Nelson 1989) for levels indicative of "contamination". When compared to estuarine sediments from nearby Great Bay, NH, the range of lead values from this study (37-82 ppm) were higher than those from Great Bay (13-43 ppm) (Isaza et. al 1989). One possible explanation for the elevated lead levels in water (salt pans) and sediments (pools) is that lead shot was deposited in these areas during past hunting activity. Stage Pool, which had the highest sediment lead level (82 ppm) has a history of lead shot deposition due to hunting. The elevated levels of lead and copper in the well could be due to the condition of the pipes. The well was not flushed before sampling.

Organics

The marine sediment ER-L level for total PAH's (4.0 ppm dry wt) was much higher than any of the mean freshwater sediment PAH values found in this study (0.07 - 0.17 ppm). The levels in this study are lower than those found in Penobscot Bay, Maine (0.28 - 8.79 ppm), Casco Bay, Maine (0.22 - 14.43 ppm), and selected Adirondack, NY lake sediments (4.07 - 12.81) (Johnson et al. 1985). PAH levels in fish (0.46 ppm) were higher than mean levels found in freshwater fish from the Merrimack River (0.12 ppm) (Major and Carr 1991). No standards are known to have been set for PAH's by any regulatory agency for the protection of sensitive species of aquatic organisms (Eisler, 1987b). PAH levels in fish are usually low because this group rapidly metabolizes PAHs (Lawrence and Weber, 1984).

Aliphatic hydrocarbons are a component of motor oil and other petroleum products. Like PAHs, high aliphatic

concentrations suggest that oil or petroleum pollution may be present. Aliphatics tend to be less toxic than PAH's (Brian Cain, U.S. Fish and Wildlife Service, personal communication). The low levels of mean total aliphatic hydrocarbons found in this study (0.76 ppm in sediments and 0.35 ppm in fish) suggest that they are probably not harmful. Levels of contaminants found in the Piping Plover eggs (Table 2) also do not appear to be at harmful levels.

CONCLUSIONS

With the exception of lead, no abnormally elevated contaminant concentrations were found in either water, sediment, or tissue samples from Parker River NWR. Background sediment arsenic and mercury levels appear higher than those found in some other areas, but these sediment levels do not appear to result in adverse concentrations in either water or whole fish.

We recommend that the well be resampled after flushing to more accurately determine metal levels. In the interim, the well should be posted against drinking because the one lead concentration measured was higher than the maximum level as proposed in the Safe Drinking Water Act. We also recommend sediment sampling in the salt pans to determine if lead levels are elevated to the same degree as those from the pools. These additional data might give us a better idea as to the reason for the elevated lead levels on parts of the refuge.

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Appendix 1. Data from samples used in metal and organic contaminant analysis.

METALS

REFERENCE NUMBER	MEDIUM	PERCENT MOISTURE	TOTAL WT (gm)	TOTAL ORGANIC CARBON (%)
PR-5	WATER	100.0	-	-
PR-6	WATER	100.0	-	-
PR-7	WATER	100.0	-	-
PR-8	WATER	100.0	-	-
PR-9	WATER	100.0	-	-
PR-10	WATER	100.0	-	-
PR-11	WATER	100.0	-	-
PR-2	SEDIMENT	85.2	244.5	0.073
PR-3	SEDIMENT	84.2	210.8	0.081
PR-4	SEDIMENT	81.0	442.2	0.084
PR-12	WHOLE FISH	79.1	204.8	-
PR-13	WHOLE FISH	73.3	170.5	-

ORGANICS

REFERENCE NUMBER	MEDIUM	PERCENT MOISTURE	TOTAL WT (gm)	PERCENT LIPID
PR-5	WATER	100	356	-
PR-6	WATER	100	394	-
PR-7	WATER	100	368	-
PR-8	WATER	100	355	-
PR-9	WATER	100	364	-
PR-10	WATER	100	345	-
PR-11	WATER	100	405	-
PR-2	SEDIMENT	83.8	149	-
PR-3	SEDIMENT	83.6	208	-
PR-4	SEDIMENT	80.8	376	-
PR-12	WHOLE FISH	79.5	1600	0.624
PR-13	WHOLE FISH	73.0	883	2.64
PR-1	AVIAN EGG	71.0	62.3	15.0

Note: North Pool included samples PR-5, PR-2, and PR-12; Bill Forward Pool included samples PR-6, PR-3, and PR-13; Stage Pool included samples PR-7 and PR-4. Salt pan water samples were samples PR-8 - PR-10, and the well sample was PR-11.