

**A SCREENING LEVEL CONTAMINANT  
SURVEY OF THE RACHEL CARSON  
NATIONAL WILDLIFE REFUGE**



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CONCORD, NEW HAMPSHIRE

**SEPTEMBER 1991**

**REPORT NO. FY91-NEFO-7-EC**

## **PREFACE**

Information presented in this report is final documentation of the 1990 environmental contaminants evaluation of sediments collected on the Rachel Carson National Wildlife Refuge, Maine, 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 inquiries should refer to Report Number FY91-NEFO-7-EC and be directed to the Service at the following address:

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Concord, New Hampshire 03301

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## **INTRODUCTION**

Rachel Carson National Wildlife Refuge lies within the Portsmouth, NH - Portland, ME urban corridor, and is situated within watersheds that reflect the developed nature of the corridor. This refuge receives point and non-point discharges from numerous municipalities and industries, including Maremont Corp., a historic polluter of Goosefare Brook. Two Superfund sites (Saco Tannery and Saco Landfill) are within watersheds potentially affecting the refuge, and Routes 1 and 95 are adjacent, major, potential sources of metals and petroleum hydrocarbons. Our objective was to determine if contaminants on Rachel Carson NWR are adversely affecting or potentially could affect wildlife resources. This objective was addressed by conducting a screening level contaminant survey of the major tributaries in each of the ten divisions that comprise the refuge.

## **METHODS**

Sediment samples were collected on July 18 and 19, 1990, from each of the major tributaries that flow into the 10 divisions that make up Rachel Carson NWR (Figure 1, Appendix 1). 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 clean glass containers and refrigerated until delivered to laboratories for analysis. Arsenic (hydride generation), mercury (cold vapor atomic absorption), metal ICP scan (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 analyses were performed by the Mississippi State Chemical Laboratory. Organophosphate/Carbamate scanning was performed by the Patuxent Analytical Control Facility. (See Appendix 4 for a more complete documentation of these procedures).

## **RESULTS**

The mean arsenic level for all sediment samples was 5.83 ppm (dry wt.) and ranged from 1.1 ppm at the Moody Division to 13.2 ppm at the Mousam River Division (Table 1). Mean arsenic levels were not significantly different between the five divisions that had two or more samples. The mean mercury level for all samples was 0.08 ppm (dry wt.) and ranged from 0.03 ppm at the Goosefare Brook, Lower Wells, and Upper Wells Divisions to 0.22 ppm at the Brave Boat Division (Table 2). Mean mercury levels were not significantly different between the five divisions that had two or more samples. ICP scans showed metal levels below known effect (Appendix 3).

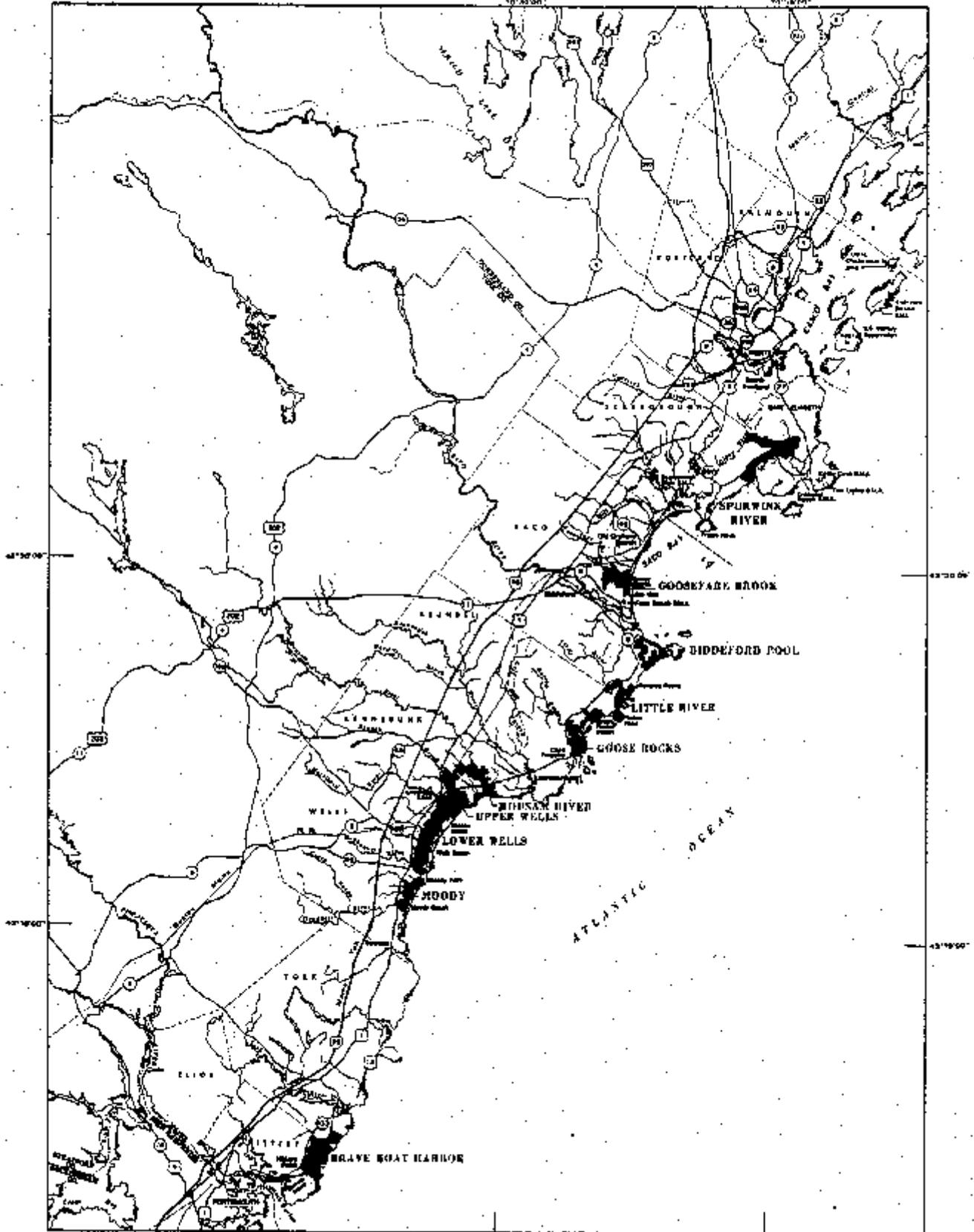
Figure 1. Map of Southern Maine showing the location of the ten divisions of the Rachel Carson National Wildlife Refuge

# RACHEL CARSON NATIONAL WILDLIFE REFUGE

## VICINITY MAP

UNITED STATES  
DEPARTMENT OF THE INTERIOR

UNITED STATES  
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF RECLAMATION  
FROM SURVEYS BY U.S.G.S. AND U.S.F.W.S.

NEWTON CORNER, MASSACHUSETTS  
MARCH, 1966



MAP  
1:50,000  
MEAN  
EQUINOXIAL  
1958

Table 1. Levels of arsenic found in samples collected from Rachel Carson National Wildlife Refuge, 1990.

Ref. Number	Medium	Arsenic (PPM, DW)	Normalized Value <sup>a</sup>
BB-1	SEDIMENT	10.0	500.00
BB-2	SEDIMENT	6.0	139.53
BB-3	SEDIMENT	4.6	230.00
BP-1	SEDIMENT	5.2	288.89
GB-1	SEDIMENT	10.6	137.66
GB-2	SEDIMENT	6.1	152.50
GB-3	SEDIMENT	3.2	400.00
GR-1	SEDIMENT	6.2	187.88
LR-1	SEDIMENT	6.8	18.38
LW-1	SEDIMENT	4.6	143.75
LW-2	SEDIMENT	1.7	3400.00
M-1	SEDIMENT	1.1	2200.00
M-2	SEDIMENT	6.8	106.25
MR-1	SEDIMENT	13.2	6600.00
SR-1	SEDIMENT	3.5	500.00
UW-1	SEDIMENT	4.0	666.67
UW-2	SEDIMENT	5.6	193.10

<sup>a</sup> Expressed as micrograms arsenic/gram total organic carbon

**Division Means (As)**

Division	Dry Weight		Normalized Value	
	Mean	SE	Mean	SE
Brave Boat	6.88	1.62	289.84	108.28
Goosefare Brook	6.63	2.15	229.67	85.28
Lower Wells	3.15	1.45	1771.88	1628.13
Moody	3.95	2.85	1153.00	1047.00
Upper Wells	4.80	0.80	429.89	236.79
All Samples	5.83	0.76	933.03	413.77

Table 2. Levels of mercury found in samples collected from Rachel Carson National Wildlife Refuge, 1990.

Ref. Number	Medium	Mercury (PPM, DW)	Normalized Value <sup>a</sup>
BB-1	SEDIMENT	0.22	11.00
BB-2	SEDIMENT	0.09	2.00
BB-3	SEDIMENT	0.05	2.70
BP-1	SEDIMENT	0.08	4.50
GB-1	SEDIMENT	0.19	2.47
GB-2	SEDIMENT	0.11	2.75
GB-3	SEDIMENT	0.03	3.75
GR-1	SEDIMENT	0.09	2.61
LR-1	SEDIMENT	0.05	0.15
LW-1	SEDIMENT	0.03	0.94
LW-2	SEDIMENT	0.04	80.00
M-1	SEDIMENT	0.05	100.00
M-2	SEDIMENT	0.07	1.06
MR-1	SEDIMENT	0.20	100.00
SR-1	SEDIMENT	0.05	7.71
UW-1	SEDIMENT	0.04	6.67
UW-2	SEDIMENT	0.03	1.03

<sup>a</sup> Expressed as micrograms mercury/gram total organic carbon

**Division Means (Hg)**

Division	Dry Weight		Normalized Value	
	Mean	SE	Mean	SE
Brave Boat	0.12	0.050	5.23	2.89
Goosefare Brook	0.11	0.050	2.99	0.39
Lower Wells	0.04	0.005	40.47	39.53
Moody	0.06	0.010	50.53	49.47
Upper Wells	0.04	0.005	3.85	2.82
All Samples	0.08	0.015	19.37	8.64

The mean total aliphatic hydrocarbon level for all samples was 0.60 ppm (wet wt.) and ranged from 0.16 ppm at the Lower Wells and Upper Wells Divisions to 2.10 ppm at the Moody Division (Table 3). Mean total aliphatic hydrocarbon levels were not significantly different between the five divisions that had two or more samples. The mean total PAH level for all samples was 0.89 ppm (wet wt.) and ranged from 0.15 ppm at the Mousam River Division to 2.88 ppm at the Little River Division. Mean total PAH levels were not significantly different between the five divisions that had two or more samples (Table 3). Organochlorine, Polychlorinated Biphenyls (PCB's), and Organophosphate levels were all below detection limits (0.05 ppm for Organophosphates and 0.01 ppm for all others) at all sample site with the exception of Goosefare Brook #1 which had a DDE level of 0.01 ppm.

Table 3. Levels of aliphatic hydrocarbons and polynuclear aromatic hydrocarbons found in samples collected from Rachel Carson National Wildlife Refuge, 1990.

Ref. Number	Medium	Aliphatic Hydrocarbons <sup>a</sup> (PPM)		Polynuclear Aromatic Hydrocarbons <sup>b</sup> (PPM)	
		Dry Wt	Wet Wt	Dry Wt	Wet Wt
BB-1	SEDIMENT	1.788	0.64	5.754	2.06
BB-2	SEDIMENT	2.936	1.75	0.352	0.21
BB-3	SEDIMENT	1.148	0.48	0.598	0.25
BP-1	SEDIMENT	1.500	0.56	4.385	1.64
GB-1	SEDIMENT	1.188	0.81	3.504	2.39
GB-2	SEDIMENT	1.582	0.81	2.266	1.16
GB-3	SEDIMENT	0.710	0.24	3.521	1.19
GR-1	SEDIMENT	0.858	0.46	1.045	0.56
LR-1	SEDIMENT	0.767	0.48	4.601	2.88
LW-1	SEDIMENT	0.941	0.51	0.387	0.21
LW-2	SEDIMENT	0.584	0.16	1.861	0.51
M-1	SEDIMENT	1.038	0.27	0.346	0.09
M-2	SEDIMENT	2.877	2.10	0.233	0.17
MR-1	SEDIMENT	0.492	0.18	0.410	0.15
SR-1	SEDIMENT	0.602	0.20	0.994	0.33
UW-1	SEDIMENT	0.650	0.16	2.276	0.56
UW-2	SEDIMENT	0.944	0.44	1.931	0.90

<sup>a</sup> As total aliphatic hydrocarbons

<sup>b</sup> As total aromatic hydrocarbons

#### Division Means

Division	Aliphatic (wet wt.)		Aromatic (wet wt.)	
	Mean	SE	Mean	SE
Brave Boat	0.96	0.40	0.84	0.61
Goosefare Brook	0.62	0.19	1.58	0.41
Lower Wells	0.34	0.18	0.36	0.15
Moody	1.19	0.92	0.13	0.04
Upper Wells	0.30	0.14	0.73	0.17
All Samples	0.60	0.13	0.89	0.21

## DISCUSSION

The National Oceanic and Atmospheric Administration collects and analyzes coastal marine and estuarine sediment samples across the US as part of the National Status and Trends (NS&T) Program. In order to evaluate NS&T data, Long and Morgan, 1990, assembled a wide variety of information on contaminant levels in sediments. Chemical concentrations observed or predicted to result in detrimental biological effects were sorted, and the lower 10 percentile, called the Effects Range-Low (ER-L), and the median concentration, called the Effects Range-Median (ER-M) were identified.

The ER-L level for arsenic (33 ppm dry wt.) is well above arsenic levels at any of the stations sampled in this study (Table 1). The ER-L level for mercury (0.15 ppm dry wt) is above all sample sites except for Brave Boat #1 (0.22 ppm), Goosefare Brook #1 (0.19 ppm), and Mousam River (0.20 ppm). In Massachusetts Bay, benthos species richness was moderate at mercury levels of 0.2 ppm and high at levels of 0.06 ppm (Gilbert *et al.* 1976). A study conducted jointly by NH Division of Public Health Services and the US Fish and Wildlife Service in 1989 tested **soils** at 129 randomly selected sites (public schools) for selected metals. The mean arsenic level in that survey was 5.5 ppm and the mean mercury level was 0.08 ppm. These levels are nearly identical to **sediment** levels found in this study (5.83 ppm arsenic, 0.08 ppm mercury), suggesting that the New England Region has higher background level of mercury than those of the national NOAA study.

The ER-L level for total PAH's (4.0 ppm dry wt) was higher than any of the mean PAH values found in this study (0.29 - 3.10 ppm), although three individual sites had levels above 4.0 ppm (Table 3). High macrofaunal species richness in Massachusetts Bay was observed with PAH levels between 8.7 to 12.6 ppm (Gilbert *et al.* 1976). 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 ppm) (Johnson *et al.* 1985).

Aliphatic hydrocarbons are a component of motor oil and other petroleum products. Like PAHs, high aliphatic concentrations suggests 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 - 1.96 ppm) suggest that they are probably not harmful.

## **CONCLUSIONS**

No abnormally elevated contaminant concentrations were found in 17 sediment samples taken from the major tributaries of the 10 divisions of Rachel Carson NWR. Although it is possible that isolated locations may contain elevated contaminant levels, this survey indicates that there is no wide-spread, detrimental levels of common, persistent contaminants. Based on the data presented here, and the physiographic and social settings of the Refuge divisions, it is not likely that any of the divisions presently have significant, wide-spread contaminant concentrations.

## **LITERATURE CITED**

Gilbert, T., A. Clay, and C.A. Karp. 1976. Distribution of polluted material in Massachusetts Bay. Boston, MA: New England Aquarium. 173 pp.

Johnson, A.C., P.F. Larson, D.F. Gadbois, and A.W. Humason. 1985. The distribution of polycyclic aromatic hydrocarbons in the surficial sediments of Penobscot Bay (Maine, USA) in relation to possible sources and to other sites worldwide. *Mar. Environ. Res.* 5:1-16.

Long, E.R., and L.G. Morgan. 1990. The potential for biological effects of sediment-sorbed contaminants tested in the National Status and Trends Program. NOAA Tech. Memorandum NOS OMA 52. Seattle, WA. 175 pp.

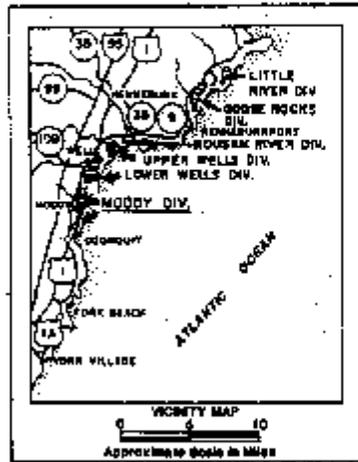
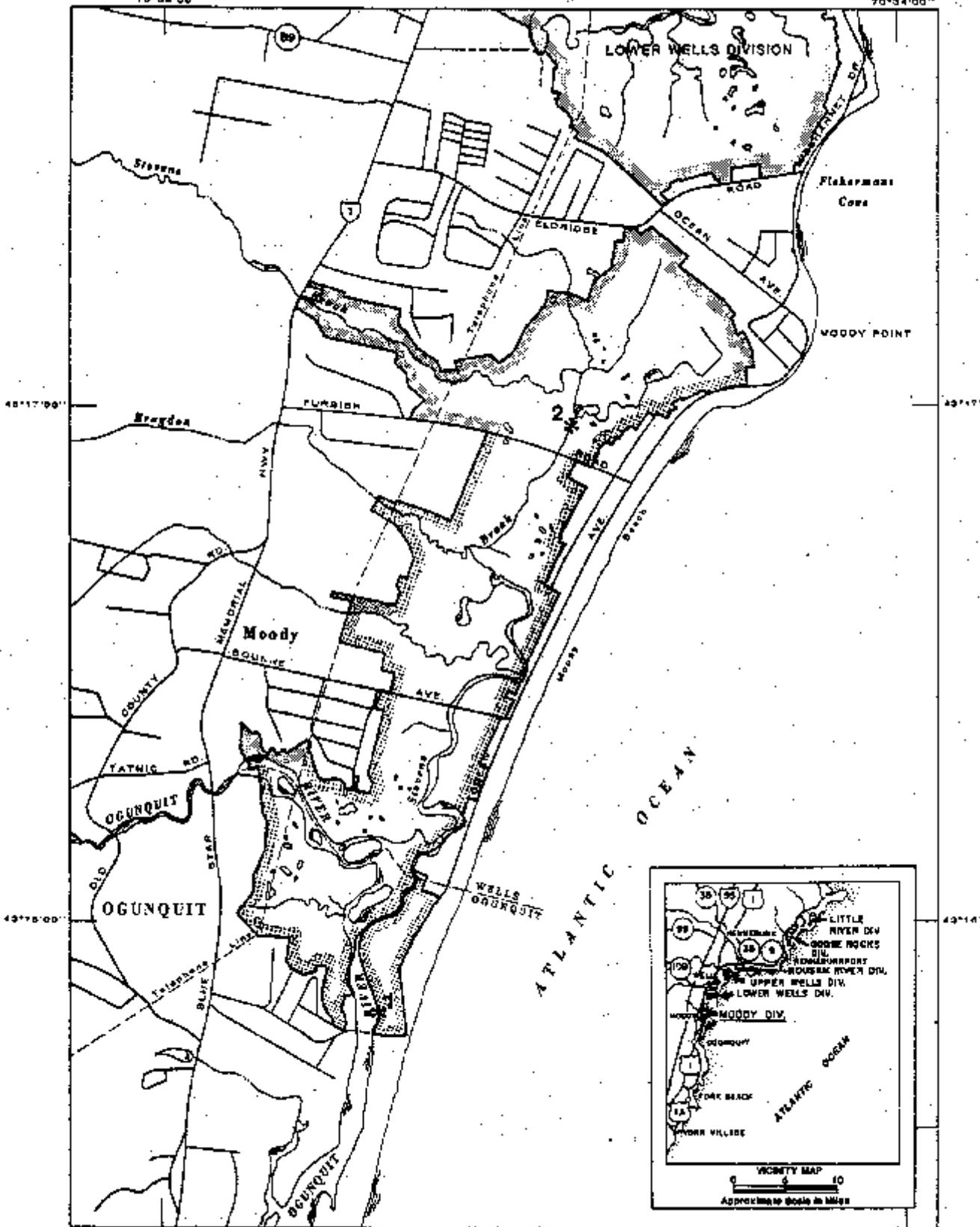
Appendix 1. Sample locations within the 10 divisions of Rachel Carson National Wildlife Refuge, 1990.



**RACHEL CARSON NATIONAL WILDLIFE REFUGE** **MOODY DIVISION**  
**YORK COUNTY, MAINE**

UNITED STATES  
 DEPARTMENT OF THE INTERIOR  
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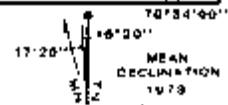
UNITED STATES  
 FISH AND WILDLIFE SERVICE  
 70°24'00"



70°24'00"  
 COMPILED IN THE DIVISION OF REALTY  
 FROM SURVEYS BY U.S.G.S. AND U.S.F.W.S.



NEWTON CORNER, MASSACHUSETTS  
 REVISED: MARCH 1989



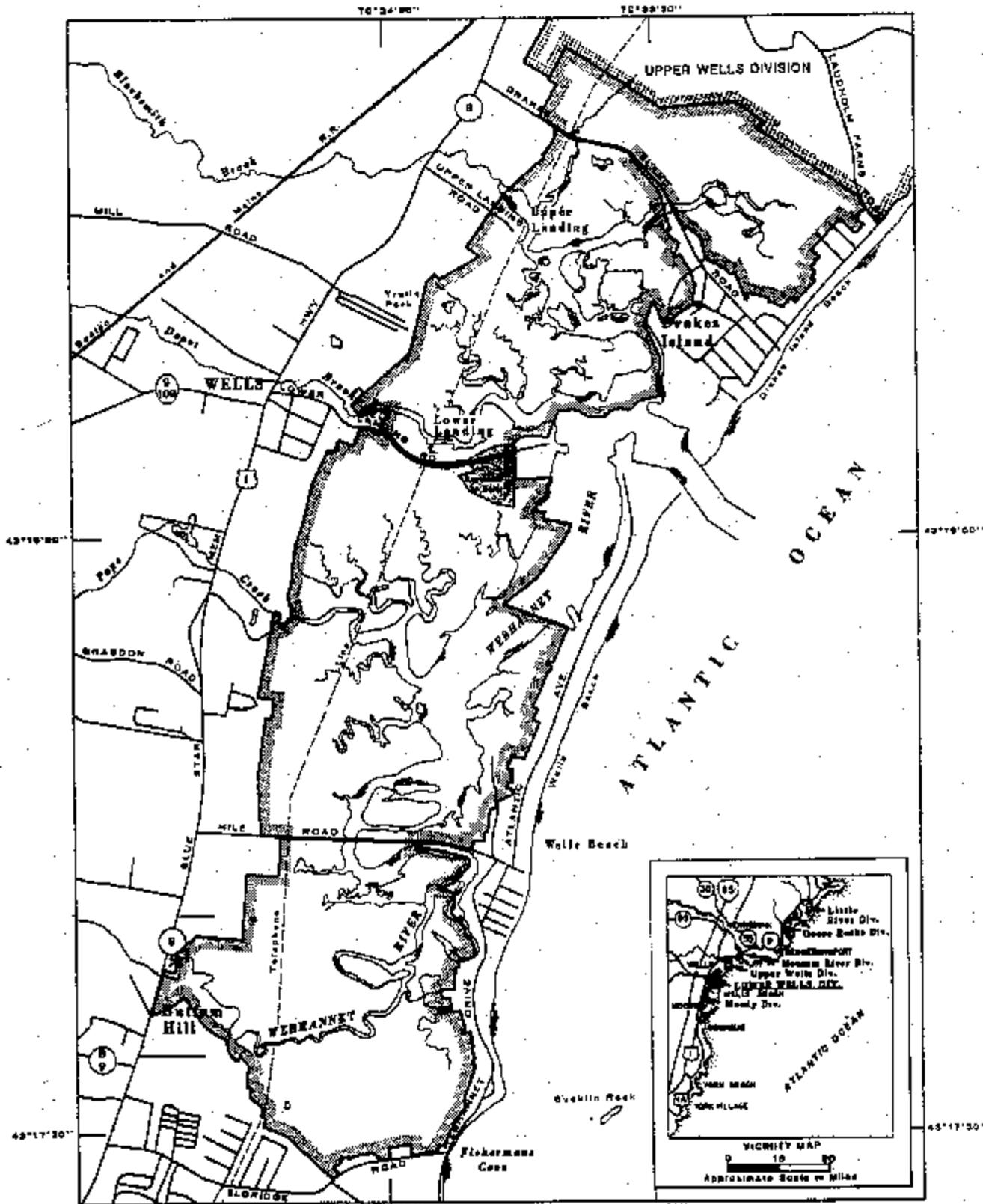
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DIVISION

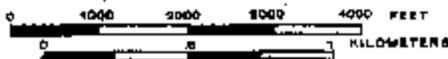
UNITED STATES  
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES  
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY  
FROM SURVEYS BY U.S.G.S. AND U.S.F.A.W.S.



NEWTON CORNER, MASSACHUSETTS JUNE, 1988  
REVISED: MARCH 1989

5R ME 770

# RACHEL CARSON NATIONAL WILDLIFE REFUGE

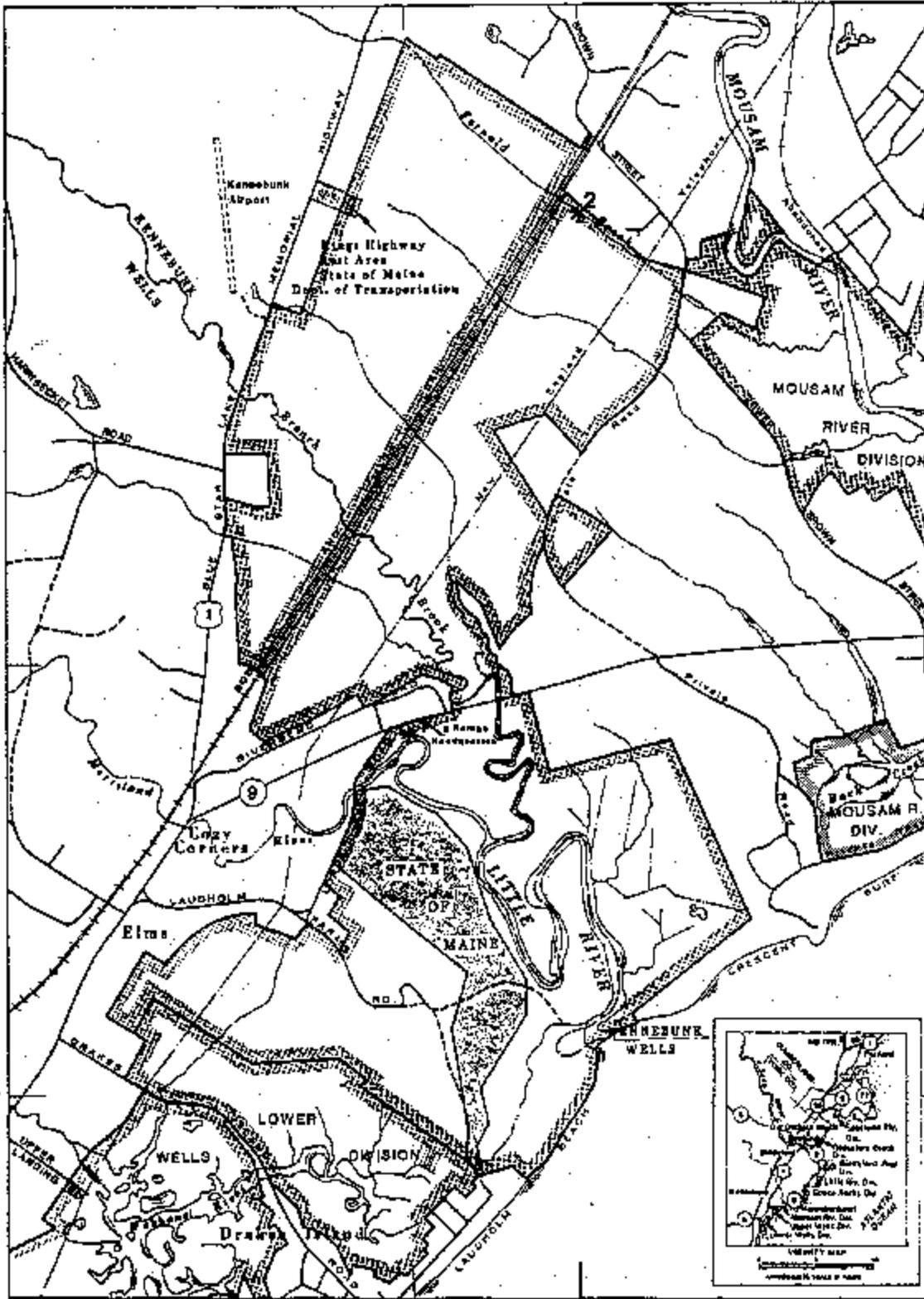
UPPER WELLS  
DIVISION

UNITED STATES  
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES  
FISH AND WILDLIFE SERVICE

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43°21'00"

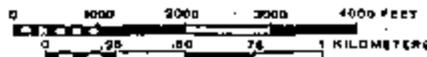
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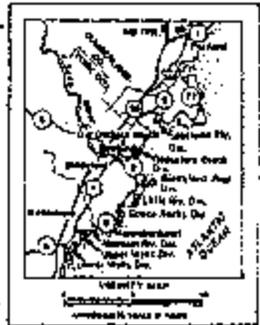
43°20'30"

70°32'00" 70°32'30"

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NEWTON CORNER MASSACHUSETTS  
REVISED: MARCH 1992

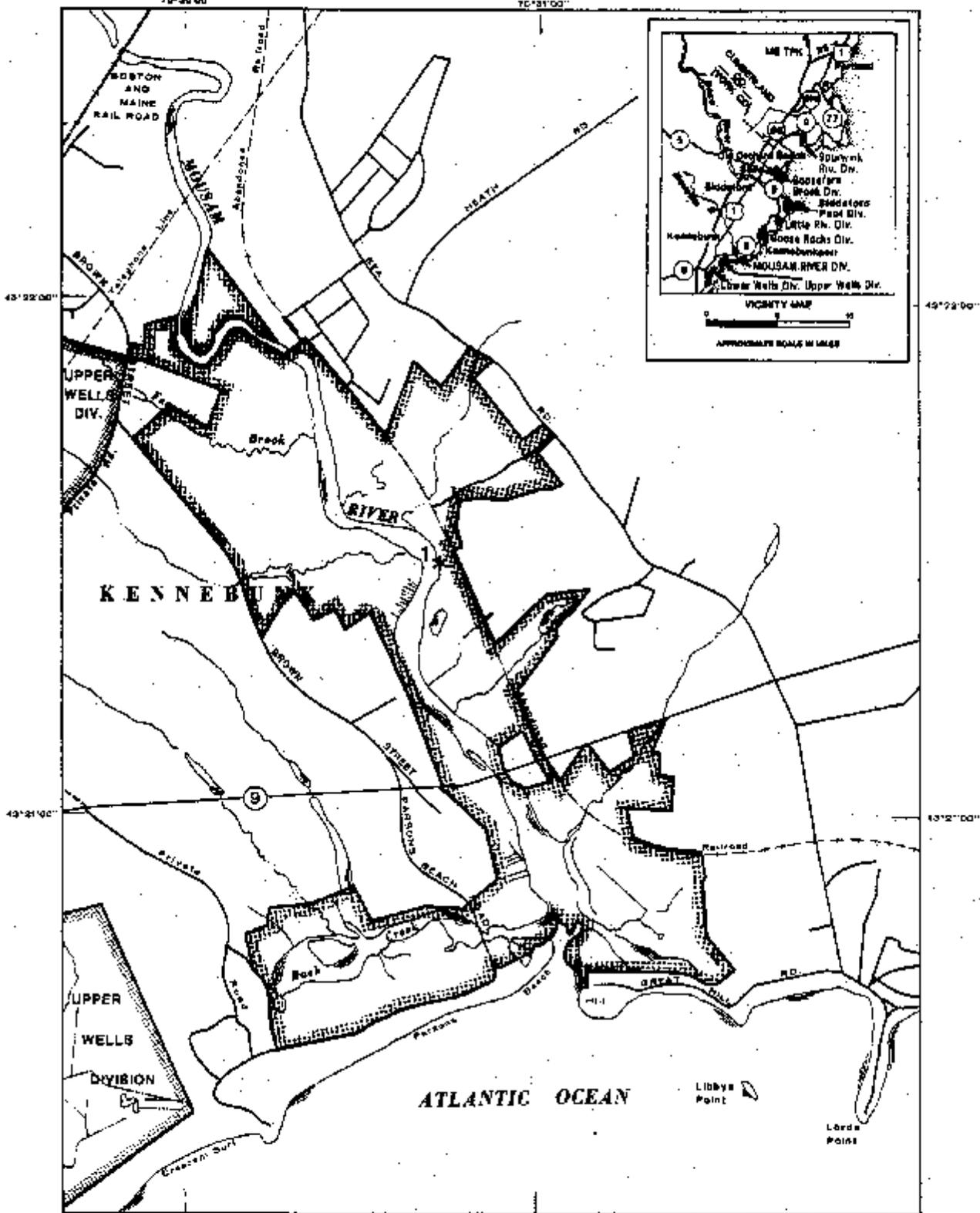


**RACHEL CARSON NATIONAL WILDLIFE REFUGE MOUSAM RIVER DIVISION**

UNITED STATES  
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES  
FISH AND WILDLIFE SERVICE



COMPILED IN THE DIVISION OF REALTY  
FROM SURVEYS BY U.S.G. AND U.S.F.W.S.

0 800 1600 2400 3200 FEET

0 4 8 KILOMETERS

17° 31' 11.62"

MEAN  
DECLINATION  
1970

NEWTON CORNER, MASSACHUSETTS AUGUST, 1966  
REVISED: MARCH 1969

5R ME 770

# RACHEL CARSON NATIONAL WILDLIFE REFUGE

GOVERNMENT  
DIVISION

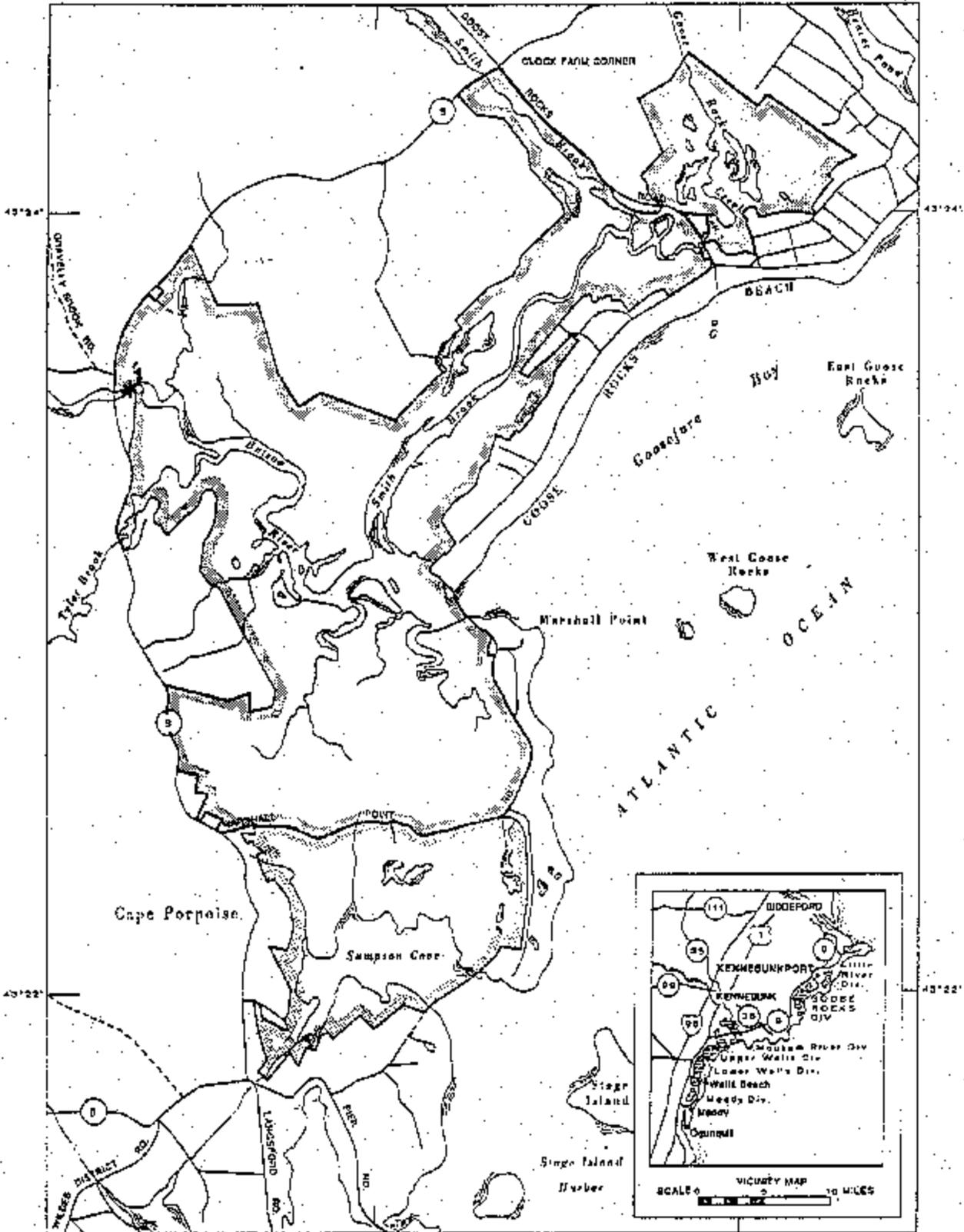
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DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

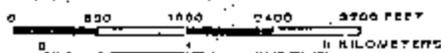
UNITED STATES  
FISH AND WILDLIFE SERVICE

70°28'

70°22'



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FROM SURVEYS BY U.S.G.S. AND U.S.F.W.S.



NEWTON CORNER, MASSACHUSETTS  
REVISED: MARCH 1989

JR ME 770

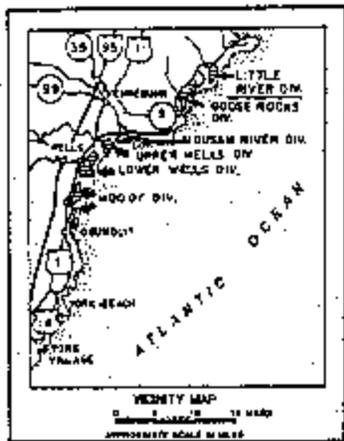
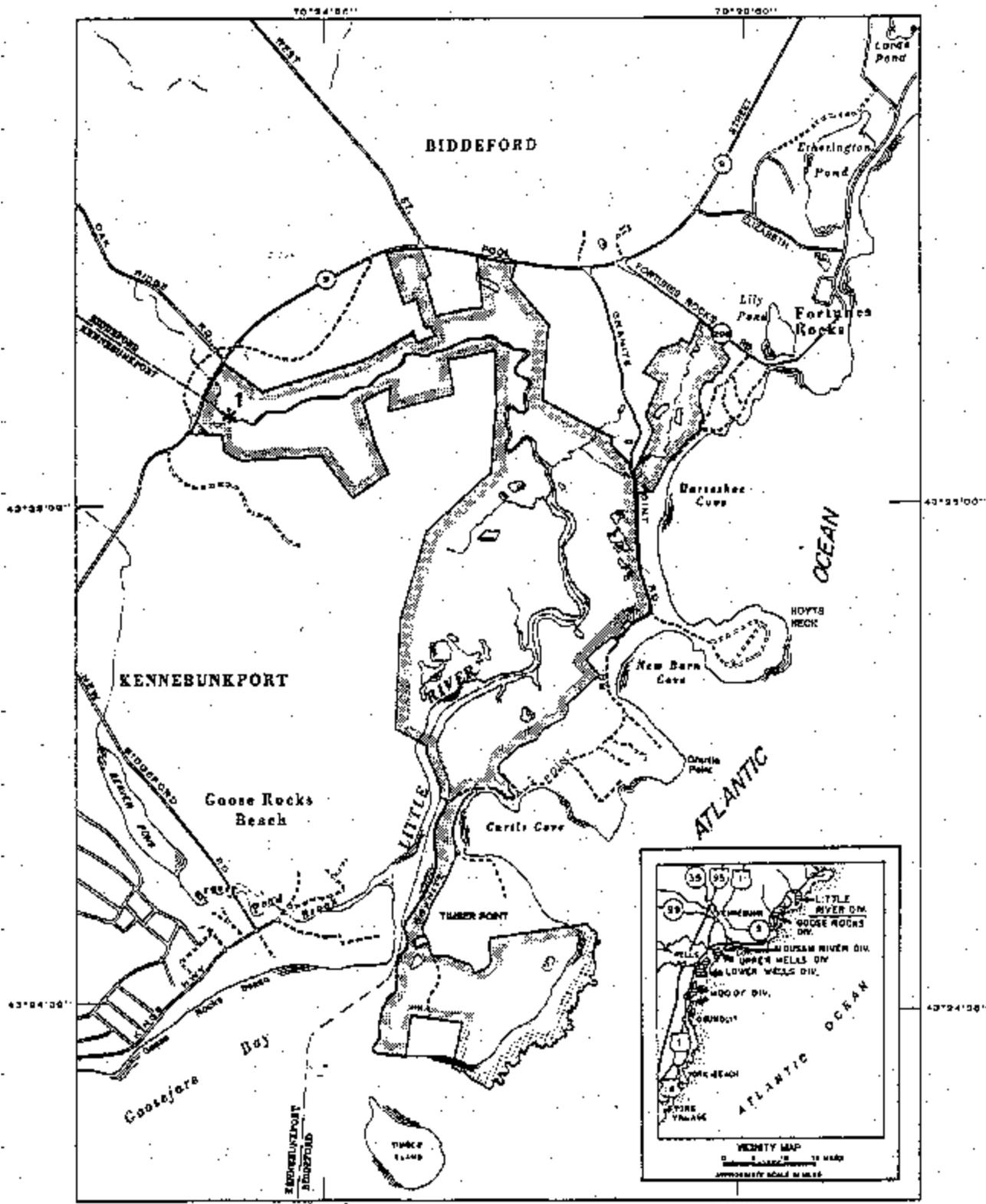
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LITTLE RIVER  
DIVISION

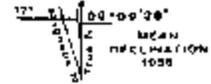
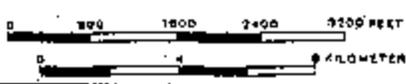
UNITED STATES  
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE

UNITED STATES  
FISH AND WILDLIFE SERVICE



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NEWTON CORNER, MASSACHUSETTS

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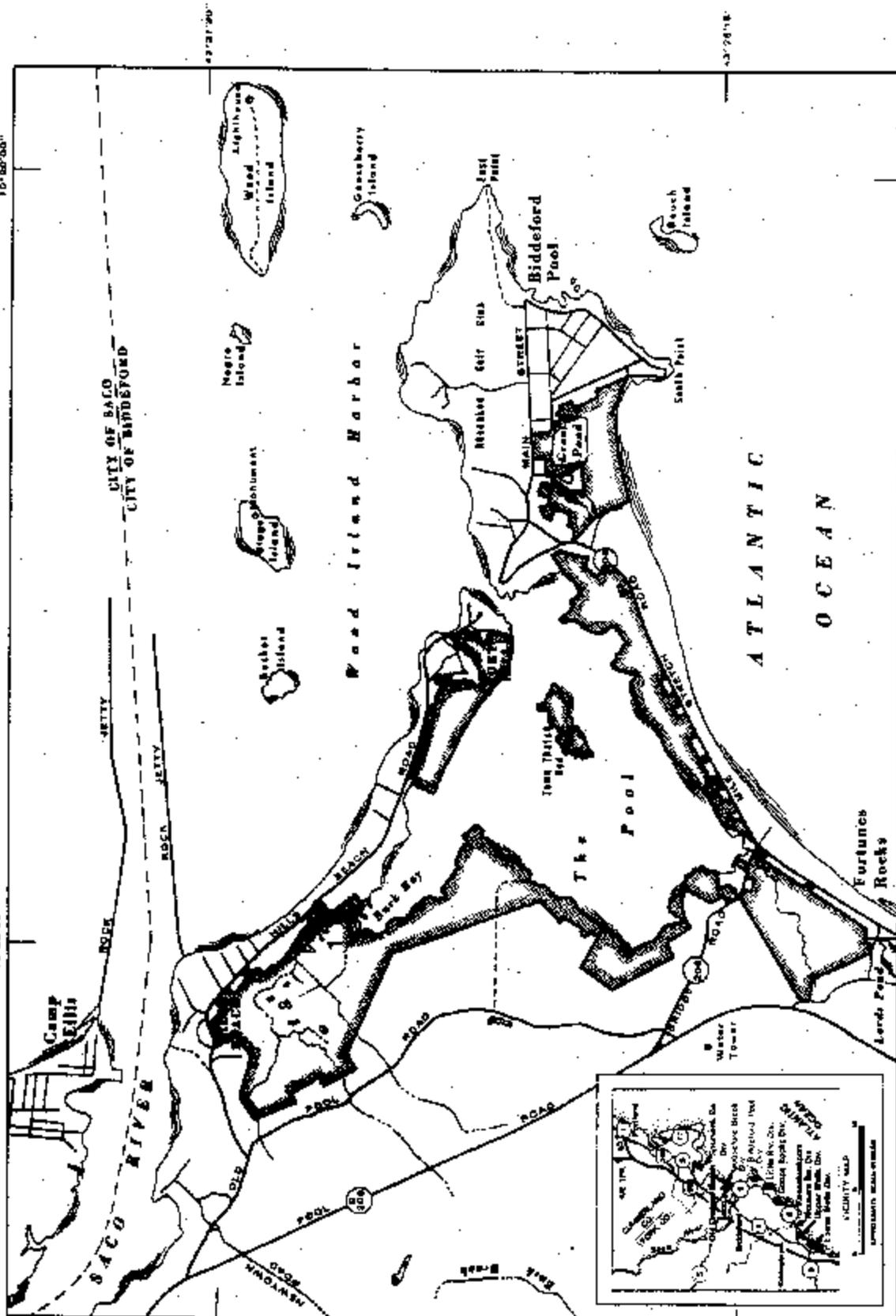
# RACHEL CARSON NATIONAL WILDLIFE REFUGE

YORK COUNTY, MAINE

BIDDEFORD POND  
DIVISION

UNITED STATES  
FISH AND WILDLIFE SERVICE  
10-807000

UNITED STATES  
DEPARTMENT OF THE INTERIOR



70°22'30"

70°22'30"



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FROM SURVEYS BY T. S. S. AND N. B. PAW 5

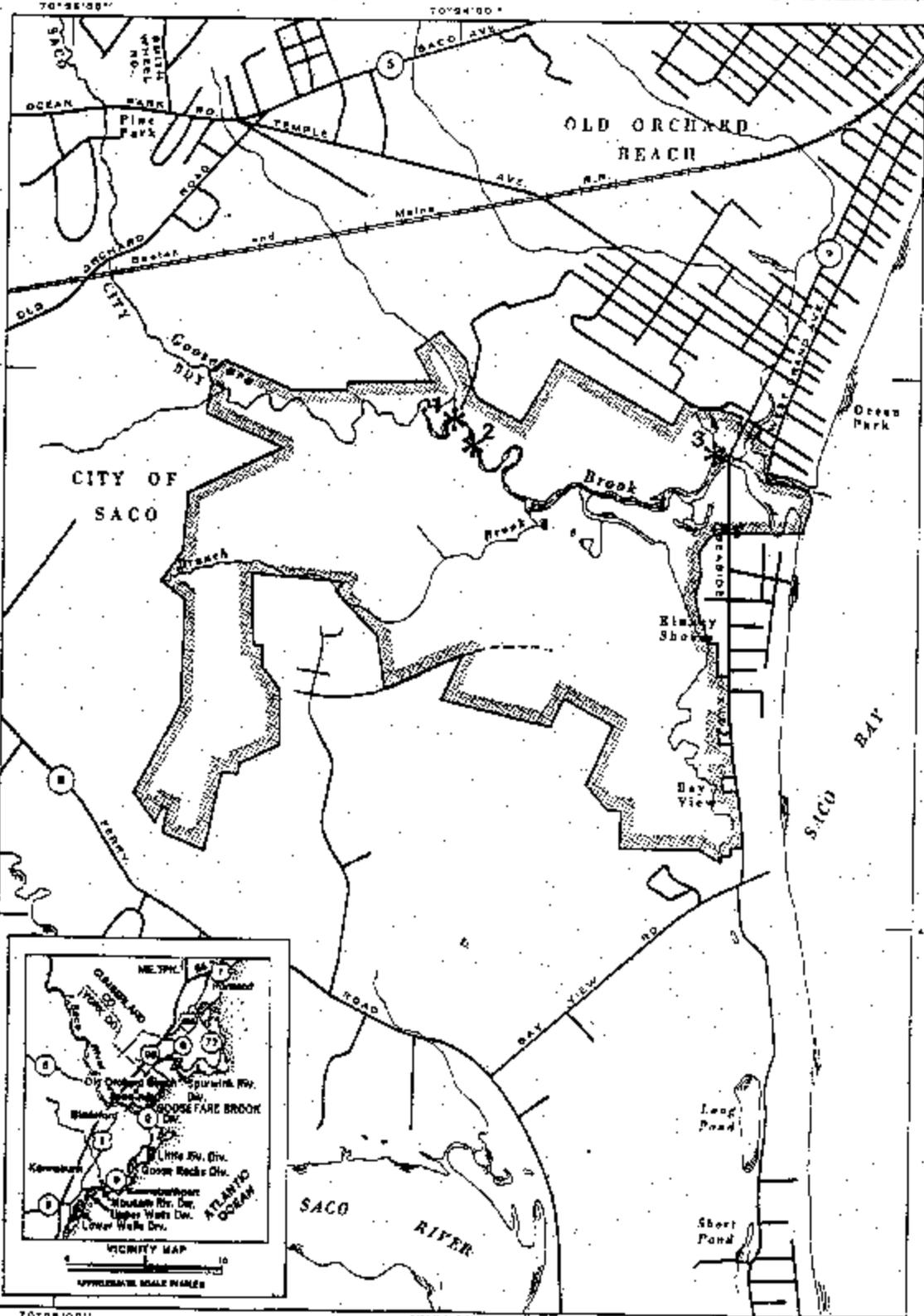
NEWTON CORNER MASSACHUSETTS SEPTEMBER 1948  
REVISED: MARCH 1968

# RACHEL CARSON NATIONAL WILDLIFE REFUGE

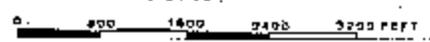
GOOSEFARE  
BROOK  
DIVISION  
UNITED STATES  
FISH AND WILDLIFE SERVICE

UNITED STATES  
DEPARTMENT OF THE INTERIOR

YORK COUNTY, MAINE



COMPILED IN THE OFFICE OF REALTY  
FROM SURVEYS BY U.S.G.S. AND U.S.A.W.S.



ON  
Scale 1:10,000



Appendix 2. Percent moisture, total weight, total organic carbon, and percent lipid found in samples from Rachel Carson National Wildlife Refuge, 1990.

Appendix 2. Data from samples used in metal and organic contaminant analyses

**METALS**

Ref. Number	Medium	Percent Moisture	Total Wt (gm)	Total Organic Carbon (%)
BB-1	SEDIMENT	39.8	246.1	0.020
BB-2	SEDIMENT	59.4	201.7	0.043
BB-3	SEDIMENT	44.5	308.6	0.020
BP-1	SEDIMENT	41.8	565.0	0.018
GB-1	SEDIMENT	69.2	432.8	0.077
GB-2	SEDIMENT	51.4	365.8	0.040
GB-3	SEDIMENT	30.6	305.7	0.008
GR-1	SEDIMENT	56.7	441.1	0.033
LR-1	SEDIMENT	47.8	257.1	0.370
LW-1	SEDIMENT	51.6	469.1	0.032
LW-2	SEDIMENT	25.7	495.7	0.001
M-1	SEDIMENT	28.2	406.4	0.001
M-2	SEDIMENT	79.6	400.5	0.064
MR-1	SEDIMENT	33.8	247.2	0.002
SR-1	SEDIMENT	34.6	279.2	0.007
UW-1	SEDIMENT	27.4	417.2	0.006
UW-2	SEDIMENT	37.9	302.5	0.029

**ORGANICS**

Ref. Number	Medium	Percent Moisture	Total Wt (gm)	Percent Lipid
BB-1	SEDIMENT	35.8	326	-
BB-2	SEDIMENT	59.6	275	-
BB-3	SEDIMENT	41.8	319	-
BP-1	SEDIMENT	37.4	337	-
GB-1	SEDIMENT	68.2	239	-
GB-2	SEDIMENT	51.2	291	-
GB-3	SEDIMENT	33.8	201	-
GR-1	SEDIMENT	53.6	237	-
LR-1	SEDIMENT	62.6	257	-
LW-1	SEDIMENT	54.2	415	-
LW-2	SEDIMENT	27.4	534	-
M-1	SEDIMENT	26.0	344	-
M-2	SEDIMENT	73.0	342	-
MR-1	SEDIMENT	36.6	303	-
SR-1	SEDIMENT	33.2	502	-
UW-1	SEDIMENT	24.6	413	-
UW-2	SEDIMENT	46.6	309	-

Appendix 3. Inductively Coupled Plasma (ICP) scan results.

Appendix 4. Residues of organic constituents in samples from Rachel Carson National Wildlife Refuge.

Appendix 5. Quality control reports.