

**Thompson Island Salt Marsh Restoration
Feasibility Study**

Thompson Island, Boston, Massachusetts

June 2004

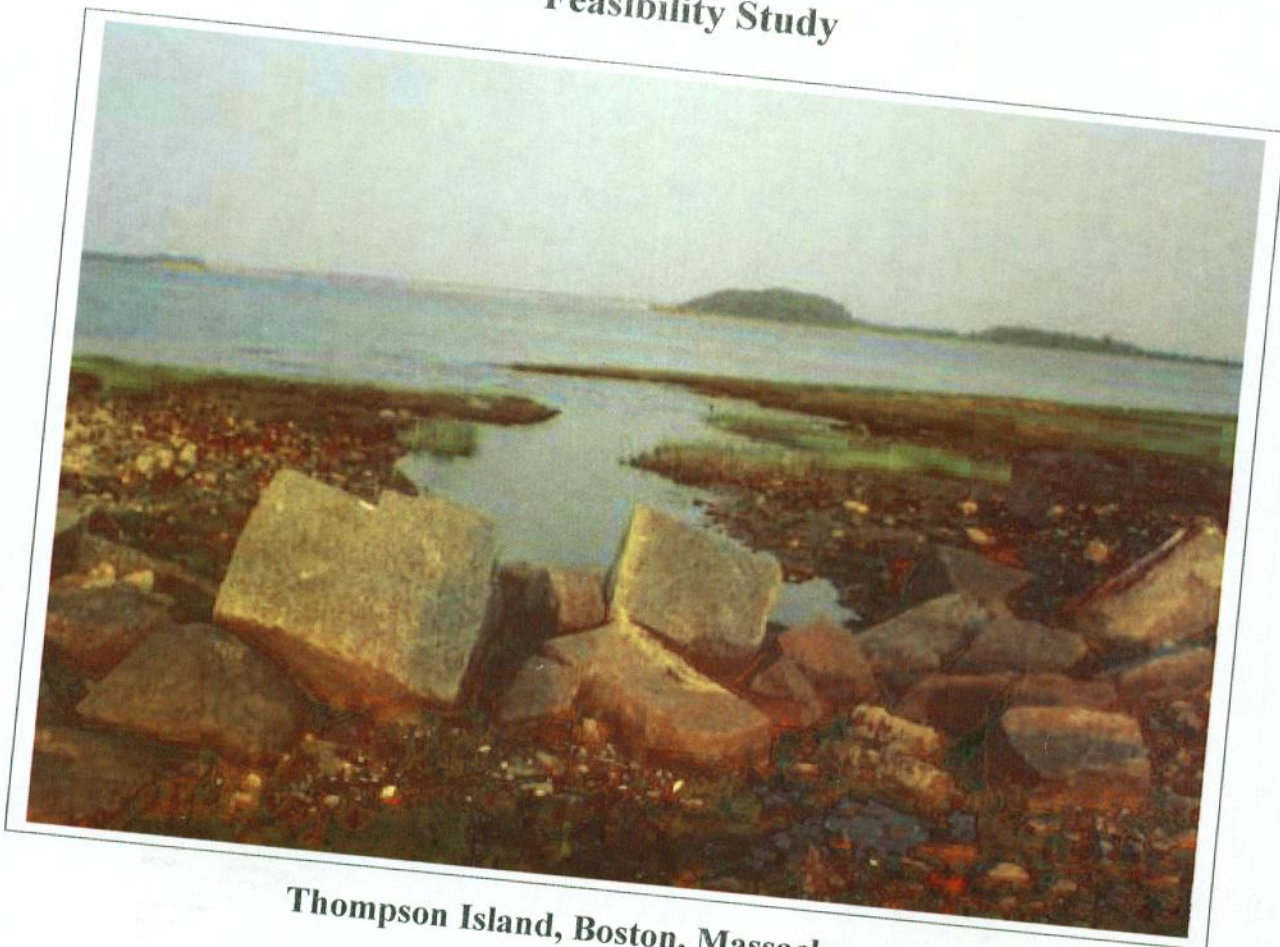
Prepared for:

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Wetlands Restoration Program
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1.0 INTRODUCTION

The Massachusetts Wetland Restoration Program (WRP) has undertaken this Study to evaluate the feasibility of restoring tidal flows and ecological function to a degraded salt marsh/pond located along the easterly shore of Thompson Island, Boston Harbor, Massachusetts (Figure 1). Thompson Island is 169.9 acres in size, and is located approximately 4.3 miles east of the south shore of Boston, Massachusetts. Thompson Island is currently owned and operated by *Outward Bound*, a not-for-profit organization that provides outdoor experiential learning programs to early adolescents from all economic and social groups.



Figure 1. Location of Thompson Island in Boston Harbor, Massachusetts.

1.1 Problems and Opportunities

Currently this degraded salt marsh/pond experiences limited tidal fluctuation. Island residents indicate that the existing man-made structure (berm) currently obstructing the mouth of the pond (Figure 2) is comprised of debris associated with a 1972 fire that destroyed a building on Island (Madeja 2004). This berm is approximately four (4) feet high and comprises various man-made materials including bricks, concrete, and rebar, mixed with natural materials such as sand, gravel, and cobble. Portions of this man-made berm have eroded during high-energy storm events (see Figure 2) resulting in the distribution of bricks, concrete, and other debris on both the landward and seaward sides of the existing berm.

A preliminary hydrologic assessment was conducted by WRP in September 2003 during an eight (8) day period from the spring new moon tide to the neap first quarter moon tide of the tidal cycle. These data indicated that there was very little tidal influence on the subject salt marsh/pond, and although water may drain from the pond, seawater only enters the pond during the highest spring full moon tides and presumably during storm tides. Lack of daily tidal flushing has resulted in a stagnant waterbody with severe algae blooms that form thick green mats over much of the surface of the pond during the growing season (Figure 3).

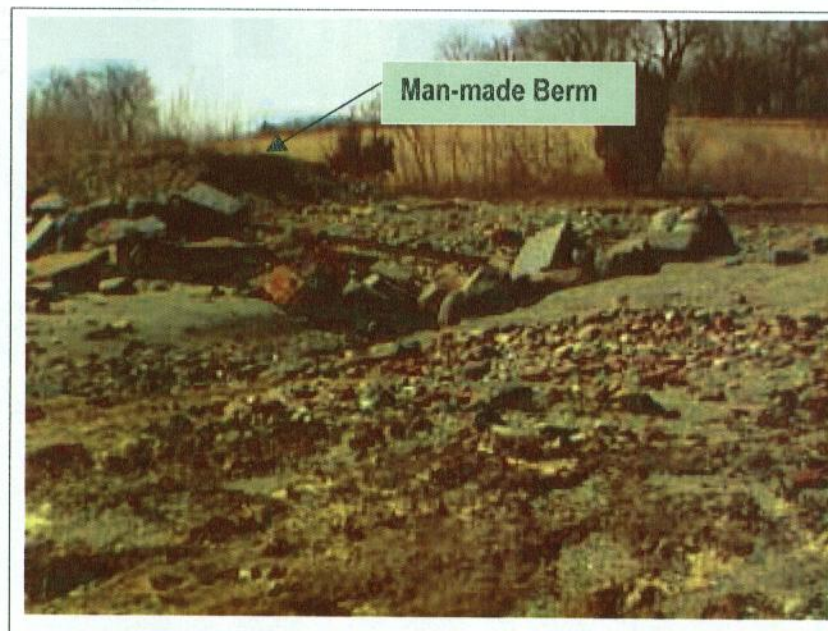


Figure 2. Man-made berm separating degraded salt marsh from ocean.



Figure 3. Algae bloom in degraded salt marsh, May 2004.

The invasive plant *Phragmites australis* (common reed) has taken advantage of accumulating biomass resulting from the large-scale algae blooms, and fresher water conditions, and has colonized the edges of the marsh (Figure 4). Review of recent aerial photography indicates that the aerial extent of *Phragmites australis* is increasing and spreading toward the center of the marsh. In addition, another pond located approximately 400 feet northwesterly of the subject degraded salt marsh/pond (see Figure 1) has already been entirely overtaken by *Phragmites australis*. Island representatives report that this has occurred over the past 10 years (O'Laughlin 2004). This aggressive and resilient species has the potential to encroach into the entire area of the degraded salt marsh/pond if corrective measures are not taken.

Baseline fish surveys conducted in June of 2004 (one week after spring full moon high tide) revealed that a large number of fish species utilize the salt marsh/pond (see Section 3.4 for more details). The setting and physical features of this salt marsh/pond indicate that it has potential to provide important habitat for a variety of marine fish, including use as feeding and nursery areas, and as protection from predators. Salt marsh, and particularly salt ponds like the Study area, are rare in Boston Harbor, and in the region, and provide important habitat. However, if the

advance of both algae and invasive species are not addressed, the functions and value of this resource may be entirely lost.

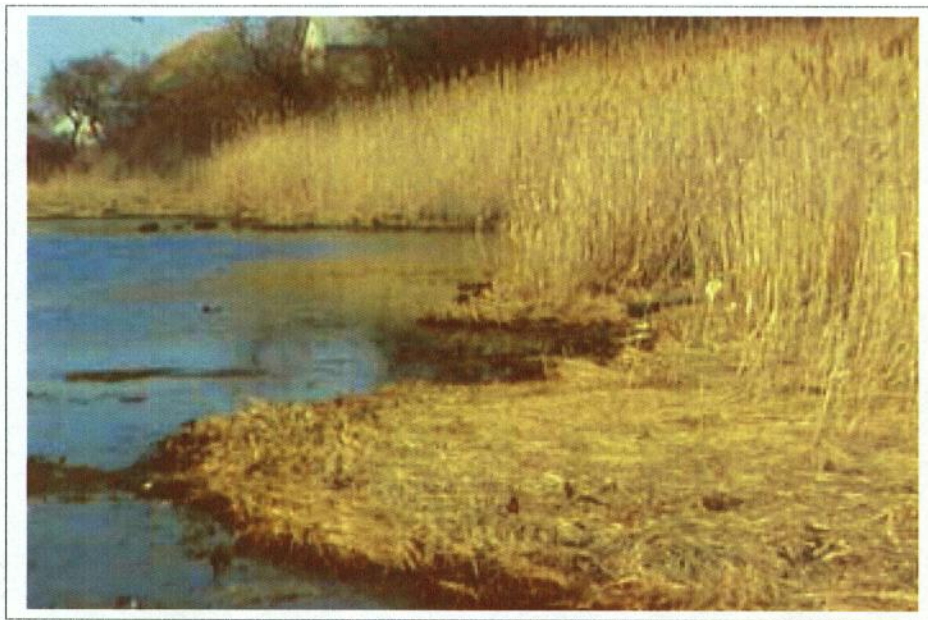


Figure 4. *Phragmites australis* community located along edge of degraded salt marsh.

1.2 Restoration Goals and Objectives

The primary objective for restoration of this salt marsh/pond is to restore ecological functions and values by reestablishing the hydrologic connection between the degraded salt marsh/pond and the ocean. The goal of reestablishing this hydrologic connection will be to control algal blooms, reverse the advance of invasive species, and improve the suitability of the salt marsh/pond as habitat for marine fish. The location of this salt marsh/pond on an island poses some logistical challenges for implementing alternatives that require the use of heavy equipment or engineered structures. Therefore, a secondary objective is developing alternatives that minimize the necessity for heavy equipment or for the use of engineered structures that would be difficult and expensive to transport to the island.

1.3 Reference Salt Marsh

The potential for improvements to this estuarine ecosystem are evidenced by the existing high

value salt marsh ecosystem located on the southwest side of Thompson Island, and approximately 800 feet southwesterly of the subject degraded salt marsh/pond. This "reference marsh" is flushed by the tides twice daily, has substantial areas vegetated with *Spartina alterniflora* (smooth cordgrass), has mudflat areas that are exposed at low tide, and currently shows no signs of algae blooms or encroachment by invasive species (Figure 5). No isolated salt ponds were observed in the reference marsh, and salt ponds are rare in Boston Harbor. There is no reference salt pond habitat for comparison.



Figure 5. Reference marsh located along southwesterly shore of Thompson Island.

2.0 BACKGROUND

2.1 Project Background

The Massachusetts Executive Office of Environmental Affairs (EOEA), Office of Coastal Zone Management (CZM), WRP issued a Request for Responses (RFR) to identify priority wetland restoration projects in the Commonwealth in December of 2003. The Thompson Island Salt Marsh Restoration Feasibility Study was one of 22 projects identified as priority wetland restoration projects based on the following criteria: clarity of goals and objectives; ecological importance and benefits; practicality and feasibility of the project; landowner support; funding received; cost-effectiveness; and, several other evaluation criteria (MACZM 2004). The priority wetland restoration project designation makes the project eligible (although not guaranteed) to receive private sector technical services supported by the Commonwealth, such as survey, mapping, permitting, and hydraulic modeling.

In March 2004, Thompson Island Outward Bound submitted a grant application to the Five Star Challenge Grants Program (FSCGP) to obtain financial assistance for the subject salt marsh restoration project. The FSCGP is administered by the Five Star Partnership, which includes the National Association of Counties, the National Fish and Wildlife Foundation, and the Wildlife Habitat Council, in cooperation with the U.S. Environmental Protection Agency (USEPA) and the National Oceanographic and Atmospheric Administration (NOAA) Fisheries. The FSCGP strives to develop knowledge and skills in young people through restoration projects that involve multiple and diverse partners, including local government agencies, elected officials, community groups, businesses, schools, youth organizations, and environmental organizations. Its objective is to engage five or more partners in each project to contribute funding, land, technical assistance, workforce support or other in-kind services that match the program's funding assistance. Consideration for funding is based upon the project's educational and training opportunities for students and at-risk youth, the ecological benefits to be derived, and the project's social and economic benefits to the community. The Thompson Island Salt Marsh Restoration Feasibility Study has formulated the following Five Star partnership for future funding assistance:

- Massachusetts Coastal Zone Management's Wetland Restoration Program (\$15,000 in contractual services and \$10,000 in in-kind services);
- Massachusetts Corporate Wetland Restoration Partnership (\$5,000 from the Gillette Company and Capaccio Engineering);
- Massachusetts Department of Conservation and Recreation-Boston Harbor Islands Partnership (\$5,000 in-kind services);
- National Park Service and Island Alliance on behalf of the Harbor Islands Partnership (\$5,000 financial support for Green Corps and staff time for consistency reviews); and,
- Thompson Island Outward Bound (\$7,800 labor and equipment).

This Feasibility Study was initiated in April 2004.

2.2 Thompson Island Background

According to a 2003 report on the historical vegetation of the Boston Harbor Islands National Recreation Area (Patterson and Richburg 2003), Thompson Island may have been one of the first Boston Harbor Islands to have European settlement. David Thompson opened a trading post on the island of his namesake early in the seventeenth century. Several different families from the 1630s to the early 19th century farmed Thompson Island. During this time, various planting, damming, and diking activities were conducted to promote growth and provide freshwater to irrigate the farmed crops (Patterson and Richburg 2003). The Boston Farm and Trade School (for orphaned boys) operated on the island, under various names, from 1833 until the 1930s. The School had a working farm, wood shop, and print shop (Benedetto 2004). In 1975, the school was renamed the Thompson Island Education Center, and in 1988 Outward Bound purchased the island and created the Thompson Island Outward Bound Education Center (Outward Bound 2004).

In November of 1996, Thompson Island, along with 33 other islands in Boston Harbor, became the Boston Harbor Islands national park. This national park is not owned by the National Park Service but is rather managed by the 13-member Boston Harbor Partnership consisting of the National Park Service, US Coast Guard, Massachusetts Department of Environmental Management, Metropolitan District Commission, Massachusetts Water Resources Authority, Massachusetts Port Authority, City of Boston, Boston Redevelopment Authority, Thompson

Island Outward Bound Educational Center, the Trustees of Reservations, Island Alliance, and Boston Harbor Islands Advisory Council.

Historical United States Geological Survey (USGS) maps, from 1903 and 1946, of Thompson Island indicate that the subject salt marsh/pond was previously connected to the ocean (Figures 6 and 7). Aerial photography indicates that the subject salt marsh/pond was farmed until as late at 1969 (Figure 8). In 1972, the berm was constructed along the eastern border of the salt marsh/pond, largely eliminating the tidal connection to the salt marsh/pond. Aerial photographs from 1977 and 1978 show that the subject salt marsh/pond was no longer farmed, and was predominantly open water (Figure 9).

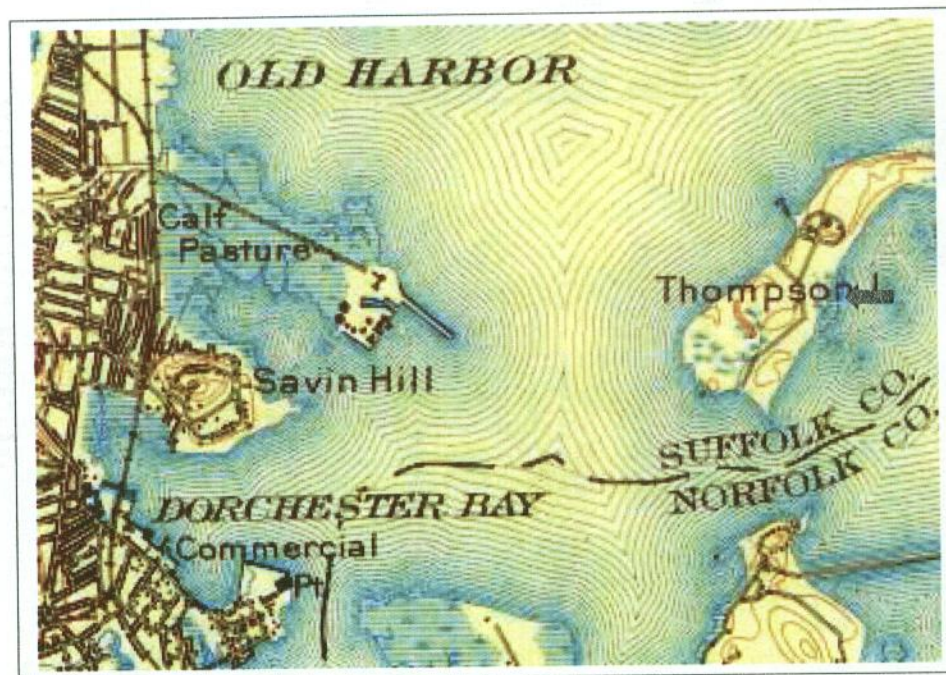


Figure 6. 1903 USGS topographic map excerpt showing the Study area with tidal connection.

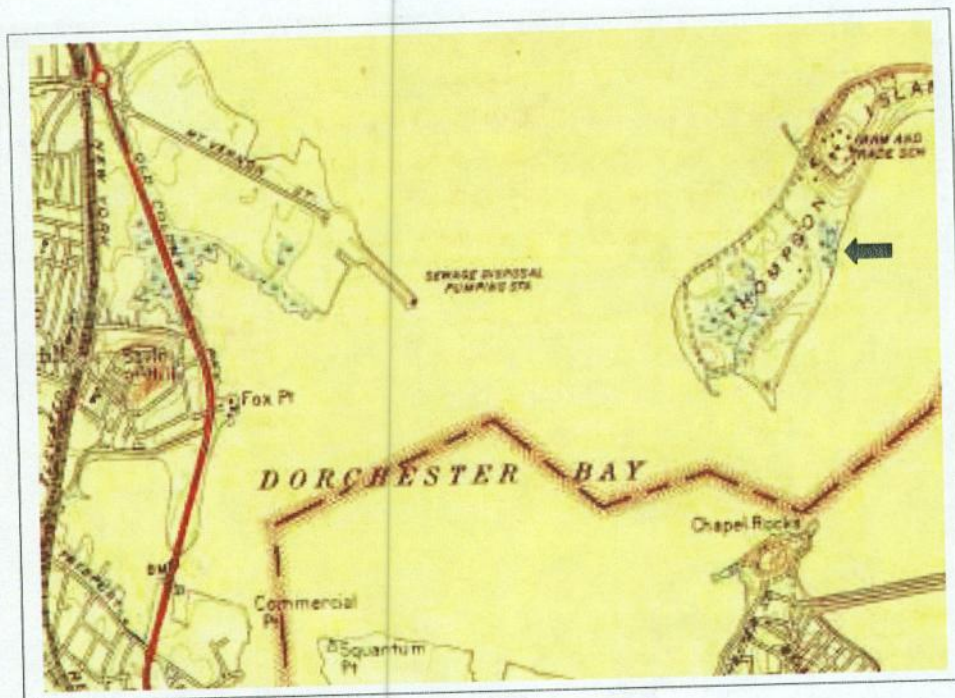


Figure 7. 1946 USGS topographic map excerpt showing the Study area with tidal connection.

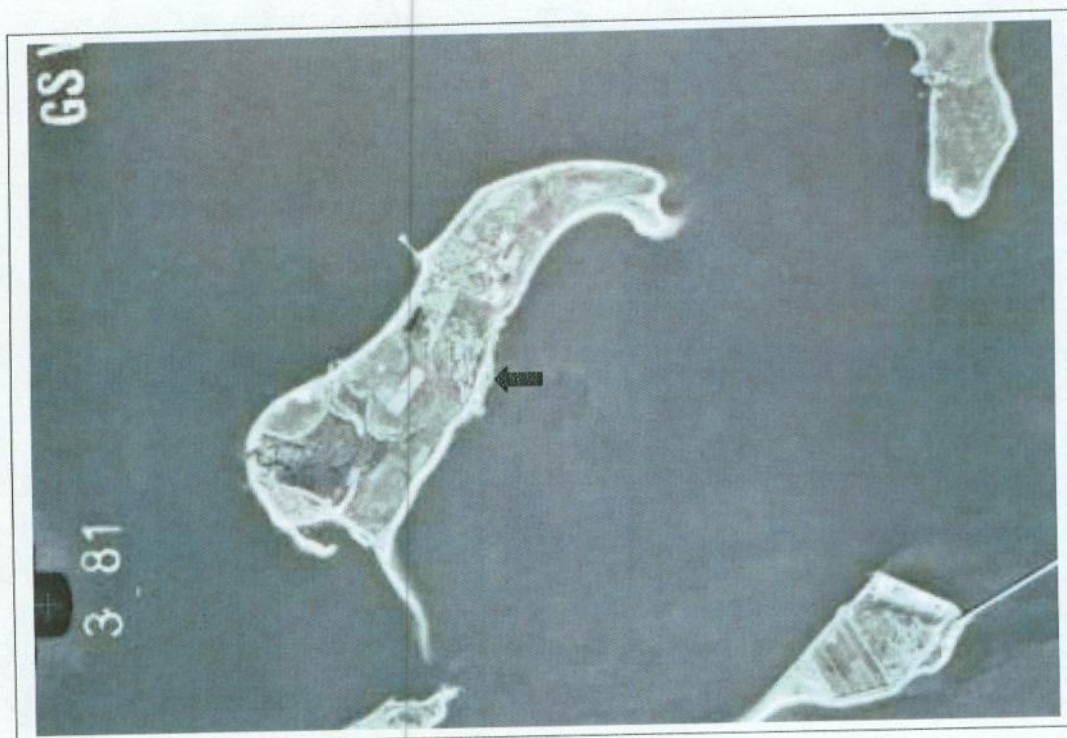


Figure 8. 1969 Aerial photograph showing the Study area with farming land use.

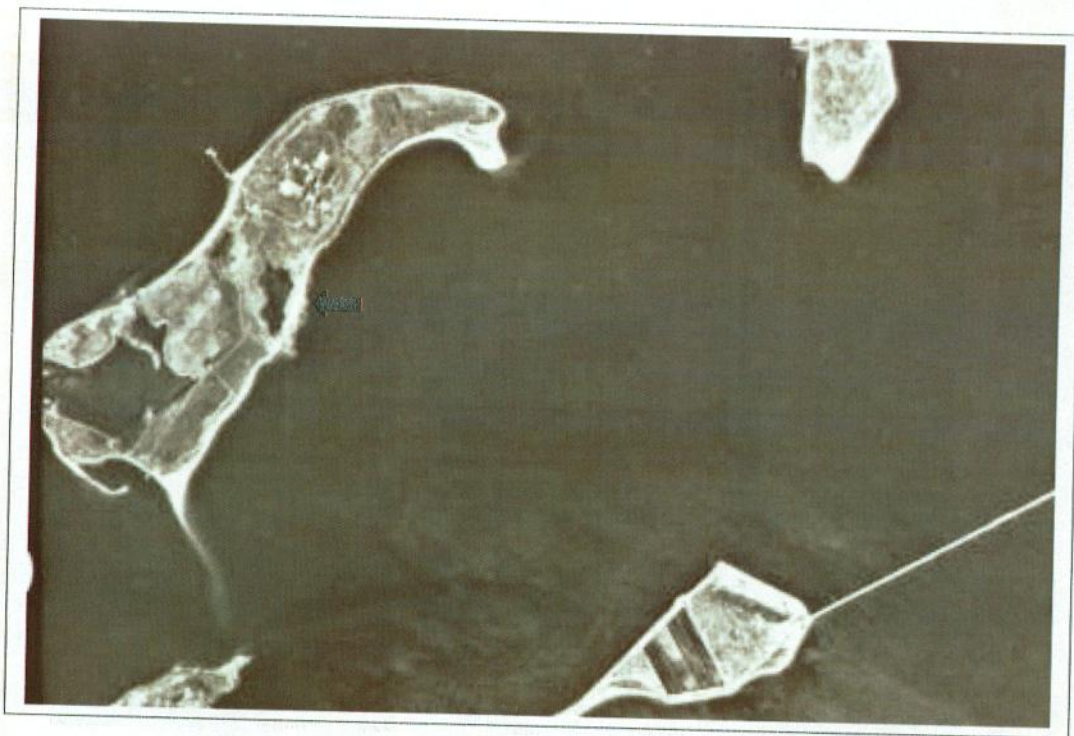


Figure 9. 1978 Aerial photograph showing the Study area as open water.

3.0 EXISTING CONDITIONS

Existing ecological conditions in the Study area were evaluated during May and June 2004. Existing conditions evaluated include water quality, vegetation, hydrology, fish and wildlife, and pond bathymetry/topography.

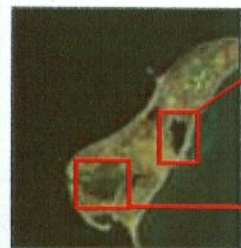
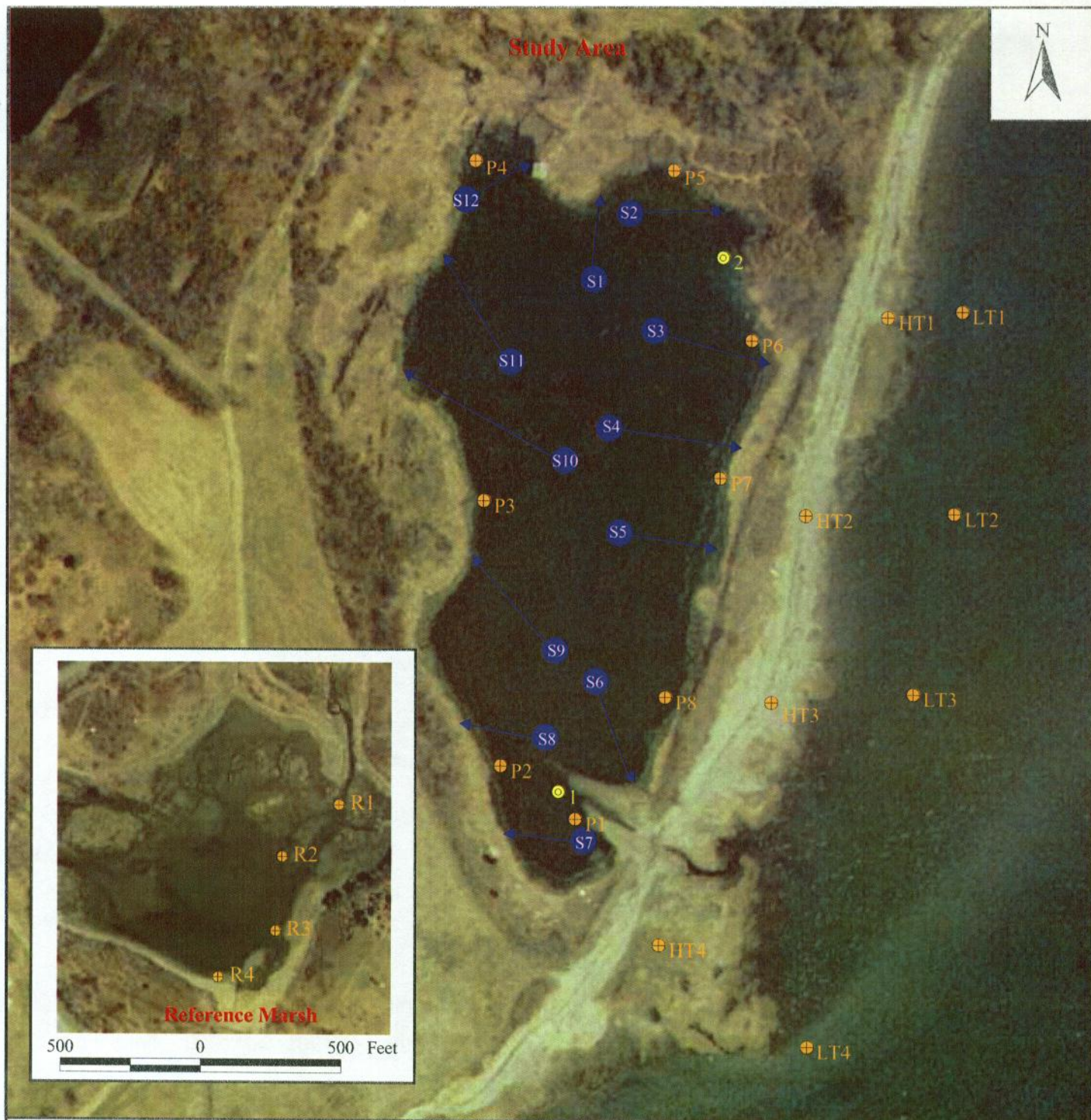
3.1 Water Quality

In situ water quality measurements (i.e., temperature, salinity, and dissolved oxygen) were recorded in the surface water of the existing degraded salt marsh/pond, in the ocean adjacent to the site during low and high tide, and in the reference marsh during an out-going low tide (Figure 10). Water quality measurements were recorded on May 14, 2004, at eight locations in the existing brackish pond, and on June 9–10, 2004, at four locations in the ocean adjacent to the site and four locations in the reference marsh. A YSI Model 85 hand-held oxygen, conductivity, salinity, and temperature system (YSI Incorporated 1996) was used for the water quality measurements. To ensure data quality, three replicate measurements of all parameters were taken at each sampling location, and mean values are presented for each location. Water quality data are presented in Table 1 and Figures 11–13, and are summarized briefly below.

3.1.1 Temperature

Mean temperatures in the pond ranged from 15.7°C to 25.2°C (Figure 11), with the lowest temperatures collected early in the day and nearest to the existing ocean inlet (P1 and P2), and the highest temperatures collected in the middle of the day (P6, P7, and P8). Low temperatures also were observed at sample location P5. This sample location was in a freshwater inlet that enters the pond near the northern end. The water entering at this point may be cooler than other samples collected in the pond because the sample water runs off from upslope areas that have substantial vegetative cover, providing shade and keeping the water temperatures lower.

Mean temperatures in the ocean adjacent to the site at high tide ranged from 17.0°C to 17.3°C, and at low tide from 18.0°C to 18.3°C. High tide samples were collected in the early morning in approximately 2-feet deep water, and low tide samples were collected at midday in



Study Area

Reference Marsh

Source: Mass GIS/EOEA and Massachusetts Highway Department, 1:5000 color ortho imagery, 2003; NEA 2004

LEGEND

-  Water Level Recorder Station
-  Water Quality Sampling Location
-  Fish Seine Transect

150 0 150 Feet

Figure 10. Baseline environmental sampling for Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

Prepared For: Massachusetts Coastal Zone Management Wetlands Restoration Program

Prepared By:



Date:
06/04

Table 1. Water quality measurements.

Location	Description	Date Collected	Dissolved Oxygen (mg/L)				Temperature (degrees C)				Salinity (ppt)					
			Replicate			Mean	Replicate			Mean	Replicate			Mean		
			1	2	3		1	2	3		1	2	3			
Pond	1	South of where berm is broken through	05/14/04	9.93	9.93	10.94	10.27		16.0	15.6	15.7	15.8	32.5	32.9	32.9	32.8
	2	Across pond to west from P1	05/14/04	17.05	16.71	16.80	16.85		16.4	17.5	17.5	17.1	13.7	31.4	12.6	19.2
	3	North of P2	05/14/04	12.60	11.60	12.62	12.27		19.1	19.2	19.2	19.2	31.4	32.9	33.0	32.4
	4	Near gazebo	05/14/04	2.95	1.75	1.11	1.94		22.9	24.3	24.5	23.9	13.1	12.7	12.4	12.7
	5	In small inlet, edge of Phrag, east of gazebo	05/14/04	1.84	2.24	2.05	2.04		18.2	17.7	17.6	17.8	1.5	1.8	1.5	1.6
	6	Along edge of Phrag/ Spartina	05/14/04	0.65	0.32	0.37	0.45		24.6	24.5	24.7	24.6	17.0	11.5	14.1	14.2
	7	South of P6, along berm	05/14/04	8.03	8.37	8.60	8.33		23.5	23.7	23.8	23.7	32.4	32.3	32.3	32.3
	8	South of P7, along berm	05/14/04	4.96	4.02	3.82	4.27		25.2	25.0	26.5	25.6	32.9	34.3	34.5	33.9
High Tide	1	North end	06/09/04	6.71	6.82	6.82	6.78		17.2	17.1	17.1	17.1	30.7	30.9	31.0	30.9
	2	Middle north	06/09/04	6.58	6.52	6.48	6.53		17.0	17.0	17.0	17.0	31.1	31.2	31.2	31.2
	3	Middle south	06/09/04	6.92	6.88	6.89	6.90		17.2	17.2	17.1	17.2	31.2	31.2	31.2	31.2
	4	South end	06/09/04	6.69	6.68	6.61	6.66		17.3	17.3	17.2	17.3	31.2	31.2	31.2	31.2
Low Tide	1	North end	06/09/04	8.06	8.04	8.09	8.06		18.3	18.2	18.5	18.3	31.5	31.4	31.3	31.4
	2	Middle north	06/09/04	7.40	7.38	7.39	7.39		18.2	18.2	18.1	18.2	31.4	31.4	31.4	31.4
	3	Middle south	06/09/04	7.85	7.85	7.82	7.84		18.0	18.0	18.0	18.0	31.3	31.4	31.2	31.3
	4	South end	06/09/04	7.45	7.33	7.26	7.35		18.2	18.3	18.3	18.3	31.3	31.3	31.3	31.3
Reference Marsh	1	Inlet near rope bridge	06/09/04	5.82	6.09	5.51	5.81		20.3	20.3	20.4	20.3	29.9	29.7	29.8	29.8
	2	Southwest of RM1	06/09/04	7.74	7.75	7.03	7.51		19.7	19.7	19.7	19.7	30.2	30.2	29.9	30.1
	3	South of RM1	06/09/04	6.68	6.60	6.56	6.61		18.8	18.8	18.8	18.8	30.3	30.3	30.3	30.3
	4	Southwest of RM3	06/09/04	6.90	6.76	6.70	6.79		19.0	19.0	19.0	19.0	30.3	30.3	30.3	30.3

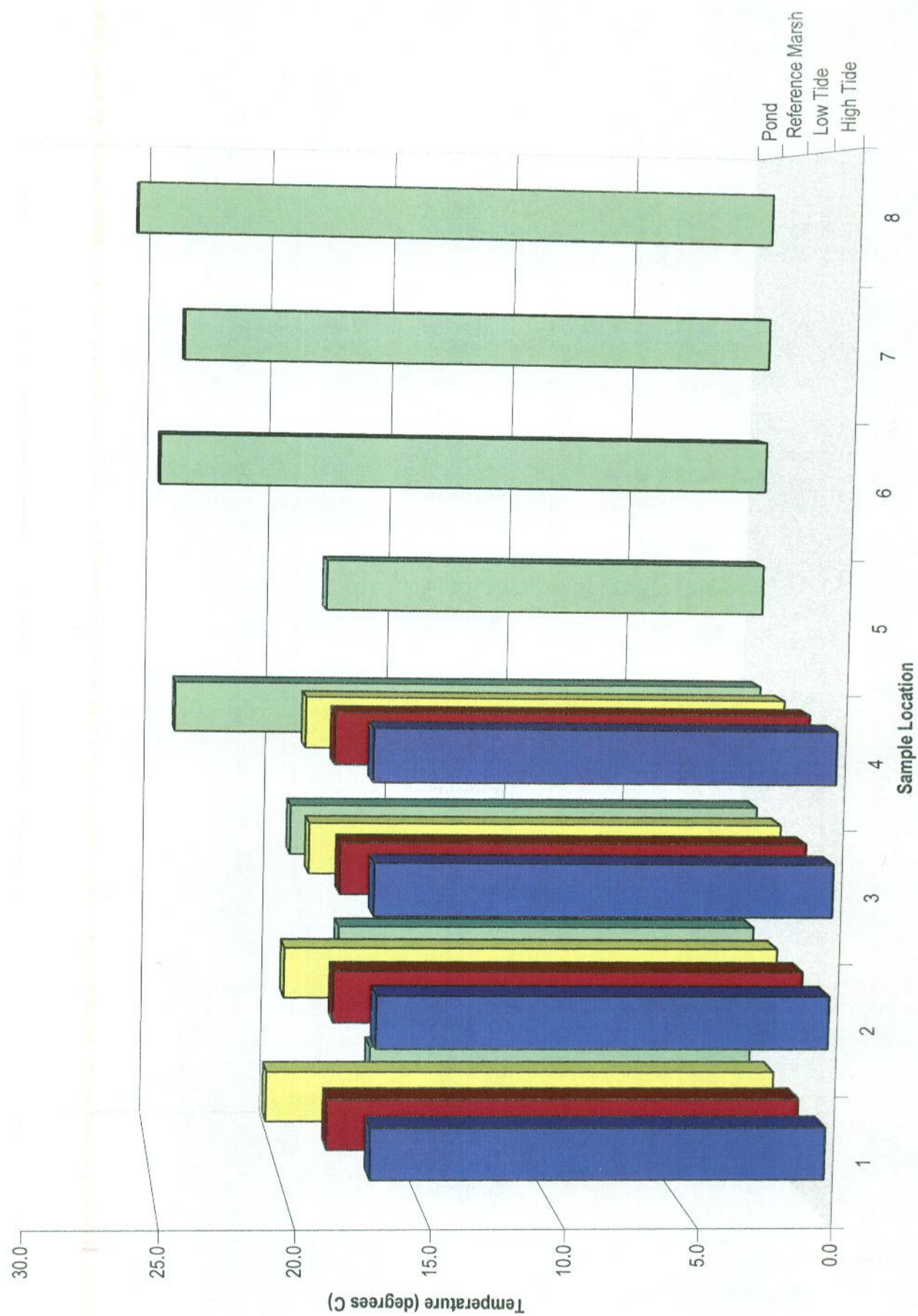


Figure 11. Mean temperature by sample location for Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

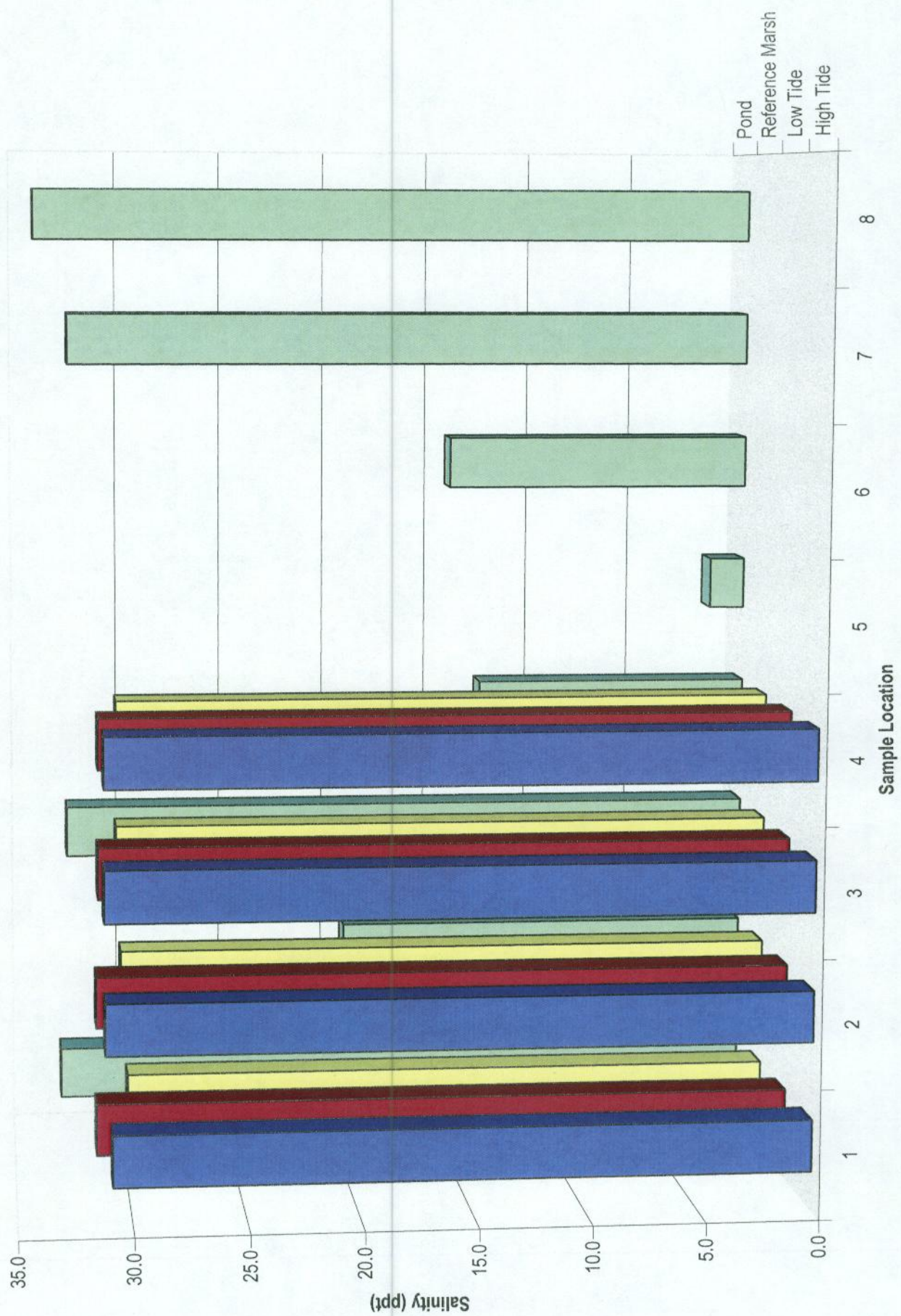


Figure 12. Mean salinity by sample location for Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

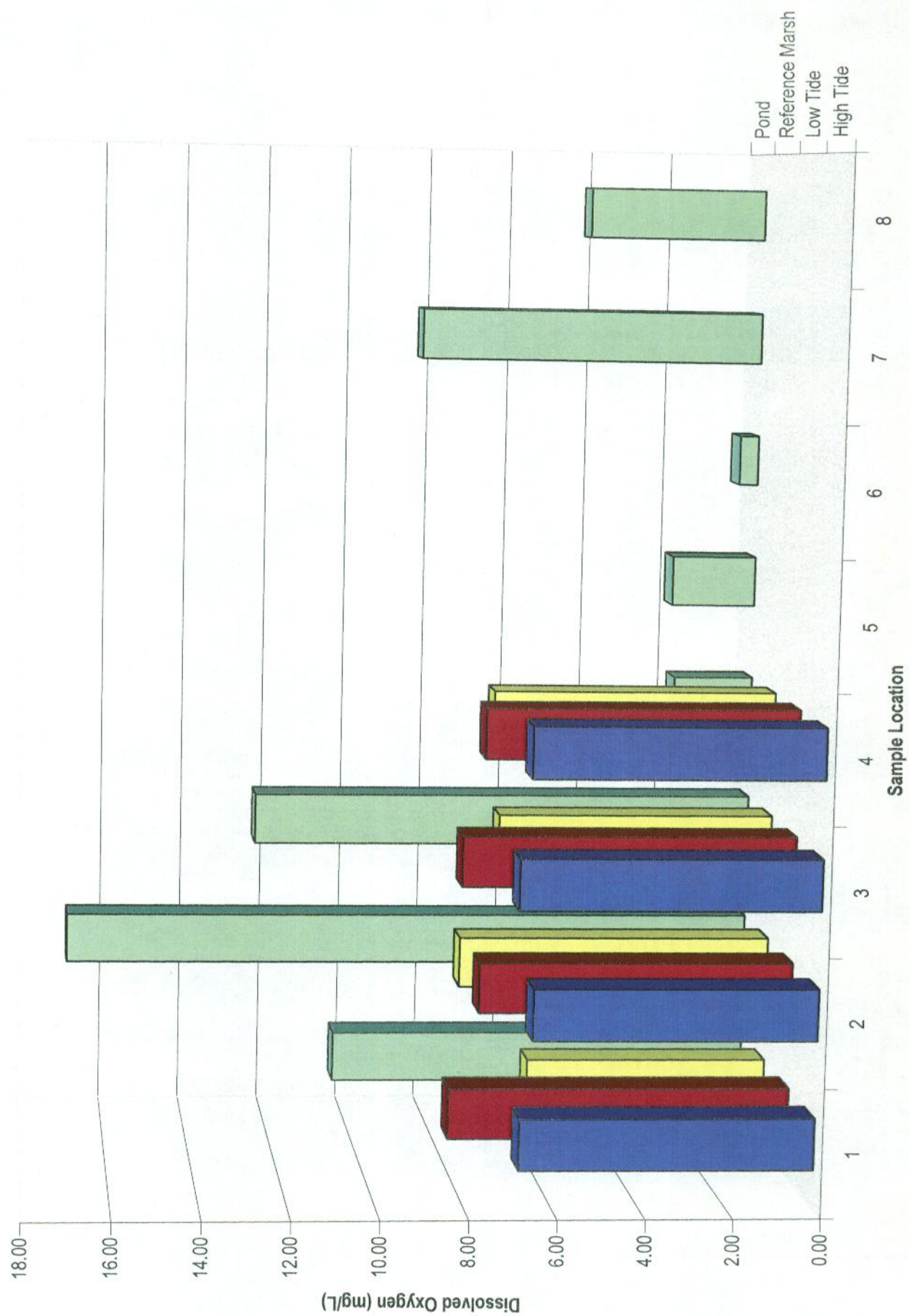


Figure 13. Mean dissolved oxygen level by sample location for Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

approximately 4-inch deep water, which likely contributed to the increase in temperature from high tide to low tide.

Mean temperatures in the reference marsh ranged from 18.8°C to 20.3°C. These samples were collected at midday, on an out-going tide, just prior to the collection of low tide samples in the ocean adjacent to the site. These temperatures may be higher than the ocean temperatures because the water conditions in the reference marsh are calmer and shallower than the ocean water.

Temperature measurements in the pond are consistent with expected levels for a shallow, brackish marsh, and are in line with temperatures measured in the ocean adjacent to the site and the reference marsh.

3.1.2 Salinity

Mean salinity in the pond ranged from 1.5 parts per thousand (ppt) to 34.3 ppt (Figure 12). The salinity at sample location P5 was the lowest. This sample was collected in a freshwater inlet that enters the pond at the northern end. Salinities from sample locations P4 and P6 also were low, possibly due to their proximity to sample location P5, the influence by freshwater overland runoff, and the distance from the ocean water inlet. The salinity at sample location P2 also was low, however the sampler observed that salinity varied greatly with depth at this location. Additional salinity measurements were taken at this location, and salinities ranging from 4.7 ppt to 31.9 ppt were measured, from top to bottom, in the approximately 4-inch water column. There may be freshwater runoff that is entering the pond in the vicinity of the sample location, creating a lens of freshwater on top of the more saline pond water; saline water has a higher density than freshwater (Wetzel 1983).

Salinity also was measured in the ocean adjacent to the salt marsh/pond, and in a reference marsh (Figure 12). Mean salinity in the ocean adjacent to the site ranged from 30.9 ppt to 31.2 ppt at high tide, and from 31.3 ppt to 31.4 ppt at low tide. Mean salinity in the reference marsh ranged from 29.8 ppt to 30.3 ppt. Reference marsh samples were collected on an outgoing, low tide.

Salinity measurements in the pond are consistent with expected levels for a shallow, brackish marsh, with some freshwater inputs, and compared to the ocean adjacent to the site and the reference marsh.

3.1.3 Dissolved Oxygen

Mean dissolved oxygen (DO) levels in the pond ranged from 0.37 milligrams per liter (mg/L) to 16.80 mg/L (Figure 13). Generally, the lowest DO measurements were observed in very shallow (i.e., less than 3 inches of water) areas where high densities of algal growth were observed (P4, P5, P6, and P8). The highest DO measurement was taken at sample location P2, however the sampler observed that DO varied greatly with depth at this location, despite the fact that this sample location was only approximately 4 inches deep.

Mean DO levels in the ocean adjacent to the site ranged from 6.52 mg/L to 6.89 mg/L at high tide, and from 7.33 mg/L to 8.06 mg/L at low tide. DO levels were lower during the low tide sampling than during the high tide sampling. This may have been a result of a decrease in oxygen levels attributable to nighttime respiration of micro and macrophytic vegetation. There are often marked diurnal changes in DO levels; photosynthesis by macrophytes generates large quantities of oxygen during the day, and large amounts of oxygen are consumed in respiration during the night (Wetzel 1983).

Mean DO levels in the reference marsh ranged from 5.82 mg/L to 7.74 mg/L.

The subject salt marsh/pond is relatively isolated, with substantial surface area coverage by aquatic macrophytes, including vascular hydrophytes and macroalgae. The amount of oxygen dissolved in water is affected by temperature, atmospheric pressure, and salinity, as well as by the amount of photosynthesis and respiration occurring in the water. The amount of DO in water is affected nonlinearly by temperature; as temperature increases, DO decreases. In addition, salinity reduces the solubility of oxygen in water; as salinity increases, DO decreases exponentially (Wetzel 1983). The DO level in normal seawater (35 ppt) is reduced by 20% compared to freshwater (Wetzel 1983). Therefore, based on the range of temperature and salinity readings in the pond, DO would be expected to range from 6.61 mg/L to 10.08 mg/L.

The distribution of oxygen in plant beds can be highly stratified depending on which portions of

the plants are actively photosynthesizing and which portions are predominantly respiring (Wetzel 1983). Therefore, based on the variable influence of aquatic macrophytes on DO and on the restrictions in the timing and number of water quality samples that were collected, the expected range for DO is much greater.

Massachusetts Department of Environmental Protection Surface Water Quality Standards for coastal and marine waters specify that dissolved oxygen levels shall not be less than 6.0 mg/L for Class SA waters, not be less than 5.0 mg/L for Class SB waters, and not be less than 5.0 mg/l at least 16 hours out of any 24-hour period, and not be less than 4.0 mg/L at any time for Class SC waters (MADEP 2004). Class SA waters are designated as excellent habitat for fish, wildlife, and other aquatic life. Class SB and SC waters are designated as habitat for fish, wildlife, and other aquatic life.

With these standards in mind, the DO measurements for the pond, a brackish marsh system, are expected to be variable. However they could be improved to provide continually high quality habitat for fish, wildlife, and other aquatic life.

It is important to note that a water quality analysis such as this, where a sample is taken only once, or in the case of the ocean adjacent to the site, twice, only depicts the water quality at one point in time (Wetzel 1983). These systems are complex, and DO levels in particular may vary significantly from hour to hour, day to day, and season to season. These data provide a snapshot in the overall picture of the water quality for that sample location. Therefore, these data should be used as a guideline indicating the range of water qualities that may be observed in each of the aquatic systems.

3.2 Vegetation

A cover type map was prepared to document existing vegetation communities in the Study area (Figure 14). Vegetation was mapped from the existing dirt road located west of the pond, approximately 200 feet north and south, to mean low water (ocean) to the east (approximately 13.15 acres). Distinct vegetation community types include upland herbaceous, upland shrub-scrub, upland forested, wetland herbaceous (e.g., *Spartina patens* and *Spartina alterniflora*), and



**Study
Location**

Source: Mass GIS/EOEA and Massachusetts
Highway Department, 1:5000 color ortho imagery,
2003; NEA 2004

LEGEND

EARTHEN COVER TYPES

- | | |
|--------------------|---------------------|
| BERM | WETLAND HERBACEOUS |
| DUCK BLIND | WETLAND SCRUB/SHRUB |
| INVASIVE SPECIES | |
| OPEN WATER | |
| UPLAND FOREST | DRAINAGE SWALE |
| UPLAND HERBACEOUS | |
| UPLAND SCRUB/SHRUB | |

100 0 100 200 Feet



**Figure 14. Cover Type Map
for Thompson Island
Salt Marsh Restoration
Feasibility Study,
Boston, Massachusetts.**

Prepared For: Massachusetts Coastal Zone
Management Agency
Wetland Restoration Program

Prepared
By:



Date:
06/04

wetland scrub-shrub. *Phragmites australis* communities were mapped separately in order to differentiate invasive species from native salt marsh communities. Green algae (e.g., *Enteromorpha* species and *Ulva* species) and submerged aquatic vegetation were present in the salt marsh/pond. During field activities in June 2004, green algae covered approximately 40% of the pond surface. Submerged aquatic vegetation, such as widgeon grass (*Ruppia maritima*), was present in the deeper sections of the pond. A species list by strata is presented in Table 2. In addition, disturbed areas such as the man-made berm separating the pond from the ocean and spoil material washed into the pond were mapped. Cover type boundaries were recorded using a Trimble TDC1 Global Positioning System (GPS) unit. Spatial data were georeferenced, and transferred to ARCView/ARC/INFO® GIS (Environmental Systems Research Institute, Inc. [ESRI] 1999, 2002) for figure preparation (Figure 14).

3.3 Hydrology

A preliminary assessment of hydrology was completed by collecting tidal signal (i.e., surface water depth) at two locations in the Study area (Figure 10). Tidal signal was measured using Global Water WL15 continuously recording pressure transducer/data loggers (Global 2001). Data loggers were placed in fluted PVC pipes so that the pressure-sensitive probe tip was located approximately 4 feet below the marsh surface; the probe tip depth below the sediment surface was recorded to the nearest 0.5 inch.

The data loggers were deployed May 14, 2004, at the beginning of the neap third quarter moon tide, and remained in place during the spring new moon, neap first quarter moon, and spring full moon tides (Figures 15 and 16). The data loggers were removed on June 9, 2004, on the first day of the neap third quarter moon tide. The highest tides were expected to occur during the spring full moon tide, in the first week of June.

The water level data reveal that during the May–June lunar tidal cycle, water only entered the Study area during the highest of the spring full moon tides. The water surface elevation in the pond rose by approximately 2 feet at the maximum high tide, to 8.32 feet at Station 1 and 8.29 feet at Station 2. For the duration of the spring full moon tide, the water level in the pond was at

Table 2. Vegetation by strata.

Common Name	Scientific Name	Indicator Status ¹
Herbs		
Black grass	<i>Juncus gerardii</i>	FACW+
Smooth cordgrass	<i>Spartina alterniflora</i>	OBL
Saltmeadow cordgrass	<i>Spartina patens</i>	FACW+
Northern sea lavender	<i>Limonium nashii</i>	OBL
Purple loosestrife	<i>Lythrum salicaria</i>	FACW+
Common reed grass	<i>Phragmites australis</i>	FACW
Spotted touch-me-not	<i>Impatiens capensis</i>	FACW
Common ragweed	<i>Ambrosia artemisiifolia</i>	FACU
Marsh orach	<i>Atriplex patula</i>	FACW
Sea milkwort	<i>Glaux maritima</i>	OBL
Shrubs		
Sweet gale	<i>Myrica gale</i>	OBL
Marsh elder	<i>Iva frutescens</i>	FACW+
Rugosa rose	<i>Rosa rugosa</i>	FACU-
Staghorn sumac	<i>Rhus typhina</i>	UP
Multifloral rose	<i>Rosa multiflora</i>	FACU
Poison ivy	<i>Toxicodendron radicans</i>	FAC
Indigobush	<i>Amorpha fruticosa</i>	FACW
Trees		
Red maple	<i>Acer rubrum</i>	FAC
Staghorn sumac	<i>Rhus typhina</i>	UP
Cedar	<i>Thuja occidentalis</i>	FACW
English oak	<i>Quercus robur</i>	UP
American elm	<i>Ulmus americana</i>	FACW-
Apple	<i>Malus sylvestris</i>	UP
Vine		
Saltmarsh morning glory	<i>Ipomoea sagittata</i>	N/A
Aquatic		
Widgeon grass	<i>Ruppia maritima</i>	N/A
Sea lettuce	<i>Ulva lactuca</i>	N/A
Green algae	<i>Enteromorpha</i> species <i>Ulva</i> species	N/A

¹ Indicator status based on U.S. Fish and Wildlife Service's National List of Plant Species that Occur in Wetlands, Region 1-Northeast.

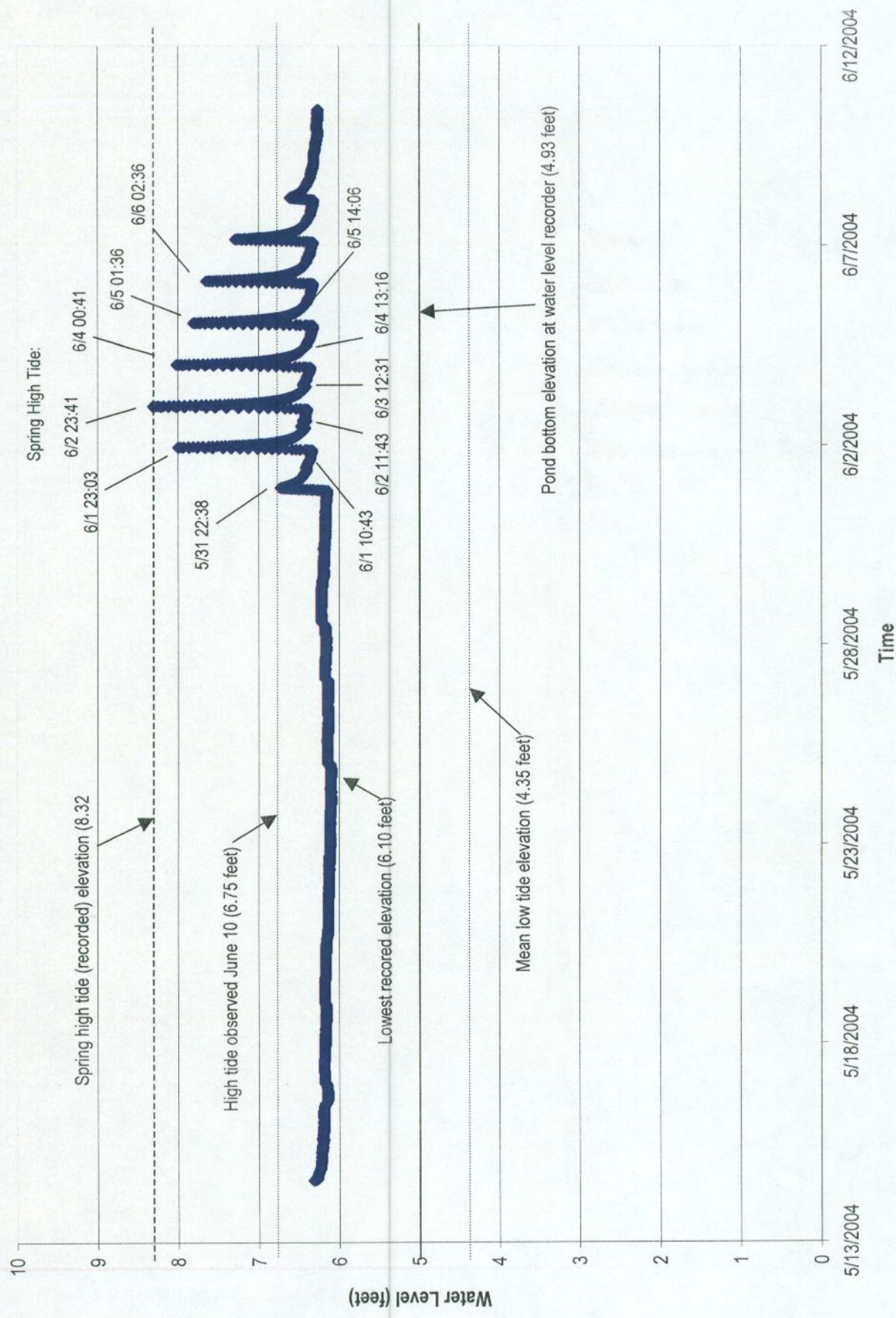


Figure 15. Water level at Station 1, Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

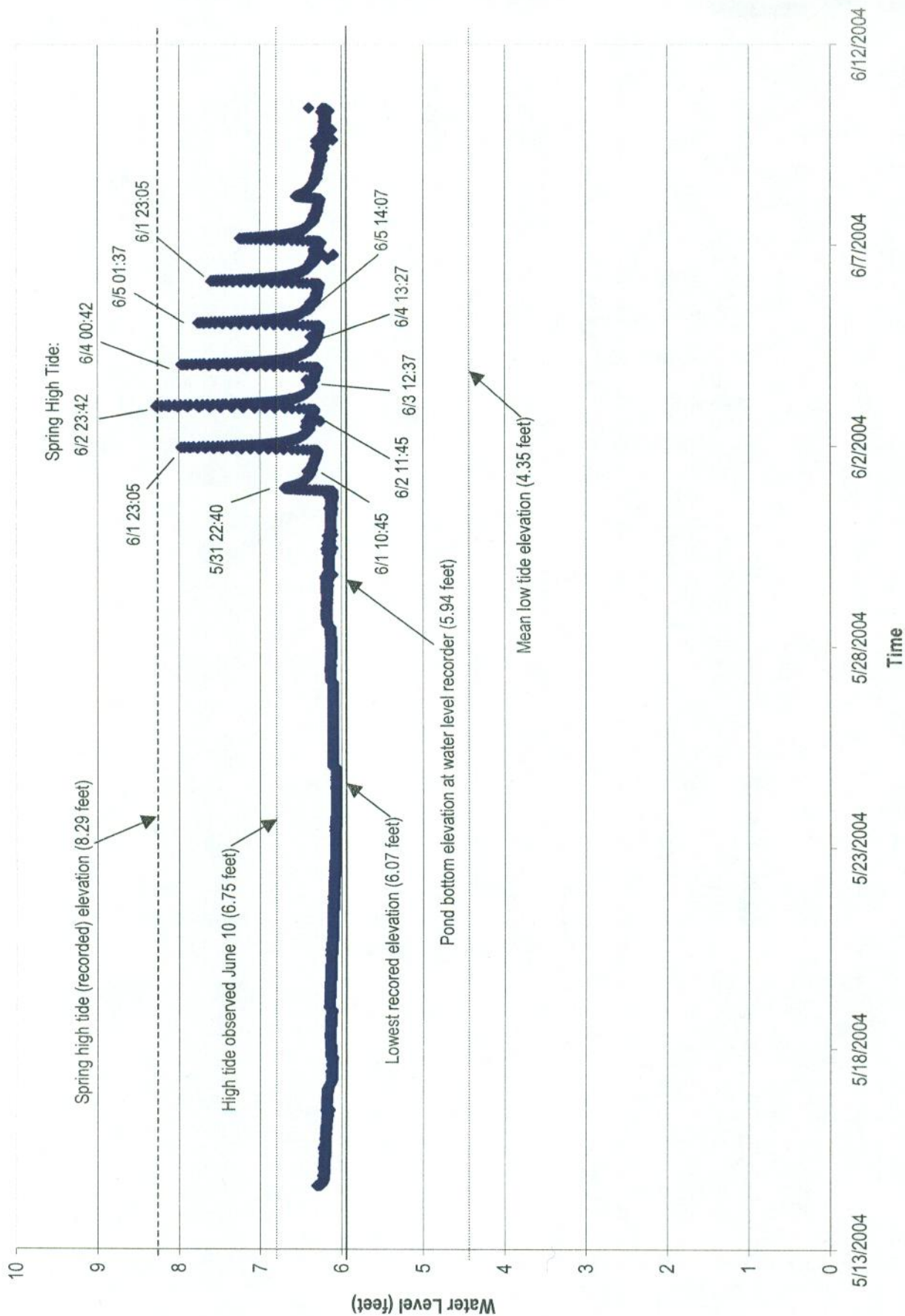


Figure 16. Water level at Station 2, Thompson Island Salt Marsh Restoration Feasibility Study, Boston, Massachusetts.

least 0.20 feet higher than during the remainder of the tidal cycle. The minimum elevation in the pond was 6.10 feet at Station 1 and 6.07 feet at Station 2.

It appears that inundation occurs only once per day, during either the spring full or spring new moon tide, when the tide height in Boston is estimated to be 11 feet or higher according to Maine Harbors tide data for Boston Harbor (2004). A review of NOAA, National Ocean Service (NOS) historic tide data for Boston Harbor for the past three years indicate that the tide height in Boston rises above 10.9 feet during approximately 15% of the high tides per year (NOS 2004). Therefore, it is estimated that inundation occurs in the subject salt marsh/pond only 15% of the year.

3.4 Fish and Wildlife

Fish surveys were conducted on June 9–10, 2004, to document the presence/absence of fish species in the existing degraded salt marsh/pond. Nekton species also were recorded during fish surveys. A seine net (1/4 inch mesh) was used for fish sampling in the existing brackish pond. The seine net was deployed along 12 transects in the pond (Figure 10).

A total of 13 different fish and nekton species were caught during fish seining. Results are presented in Table 3. The three most abundant species caught were three-spine sticklebacks (*Gasterosteus aculeatus*), scud (*Gammarus* species), and mummichog (*Fundulus heteroclitus*). Approximately 965 three-spine sticklebacks were caught, or 42.1% of the total catch. Approximately 865 scuds and 424 mummichogs were caught, or 37.7% and 18.5% of the total catch, respectively. The remaining 10 species each comprised less than 1% of the total catch.

Fish sampling was conducted in the pond early in the summer and approximately 1 week after the spring full moon tide. Water quality conditions in the salt marsh/pond may deteriorate during the course of the lunar tidal cycle, resulting in increased temperatures, concentrated salinities, and decreased DO levels, potentially stressing the fish and nekton utilizing this system. The highest spring tides enter the salt marsh/pond system, mix with the existing pond water, and likely restore water quality conditions that are more similar to ocean conditions. The three-spine stickleback, scud, and mummichog are all very hearty species and can tolerate a wide range of

Table 3. Fish species and abundance.

Seine Number	Common Name	Mummichog	Three-spine Stickleback	Scud	American Eel	Common Shore Shrimp	Green Crab	Water Boatman	Crane Fly Larvae	Moon Jelly	Alosa species	Fingernail Clam	Dog Whelk	Blood Worm
	<i>Scientific Name</i>	<i>Fundulus heteroclitus</i>	<i>Gasterosteus aculeatus</i>	<i>Gammarus</i> species	<i>Anguilla rostrata</i>	<i>Palaemonetes</i> species	<i>Carcinus maenas</i>	Order Hemiptera	Order Diptera	<i>Aurelia aurita</i>		Family Sphaeriidae	<i>Nassarius</i> species	<i>Glycera</i> species
1	# caught	50	100	70	1	1	1							
	average size (mm)	20	15	--	75	22	--							
	smallest (mm)	17	8	--	--	--	--							
	largest (mm)	80	60	--	--	--	--							
2	# caught	75	50	60				1						
	average size (mm)	15-20	15	--				--						
	smallest (mm)	10	--	--				--						
	largest (mm)	63	--	--				--						
3	# caught	100		70					1					
	average size (mm)	20		--					--					
	smallest (mm)	10		--					--					
	largest (mm)	50		--					--					
4	# caught	40	200	25						1				
	average size (mm)	15-20	15-20	--						--				
	smallest (mm)	10	10	--						--				
	largest (mm)	50	35	--						--				
5	# caught	12	50							1	1			
	average size (mm)	35	25							--	15			
	smallest (mm)	15-20	15-20							--	--			
	largest (mm)	45-50	40							--	--			
6	# caught	45	10	25								1		
	average size (mm)	15-20	15-20	--								--		
	smallest (mm)	10	--	--								--		
	largest (mm)	60	--	--								--		

Table 3. Fish species and abundance (continued).

Common Name	Mummichog	Three-spine Stickleback	Scud	American Eel	Common Shore Shrimp	Green Crab	Water Boatman	Crane Fly Larvae	Moon Jelly	Fingernail Clam	Dog Whelk	Blood Worm
Scientific Name	<i>Fundulus heteroclitus</i>	<i>Gasterosteus aculeatus</i>	<i>Gammarus</i> species	<i>Anguilla rostrata</i>	<i>Palaemonetes</i> species	<i>Carcinus maenas</i>	Order Hemiptera	Order Diptera	<i>Aurelia aurita</i>	Family Sphaeriidae	<i>Nassarius</i> species	<i>Glycera</i> species
# caught	20	85	25		1							
7 average size (mm)	20	15	--		25							
smallest (mm)	10	10	--		--							
largest (mm)	55	35-40	--		--							
# caught	15	73	30	2	1						2	
8 average size (mm)	15-20	15	--	--	20						--	
smallest (mm)	10	10	--	47	--						--	
largest (mm)	45	20	--	160	--						--	
# caught	10	12	35		4					1	2	
9 average size (mm)	25	15	--		14					--	--	
smallest (mm)	10	10	--		10					--	--	
largest (mm)	60	50	--		18					--	--	
# caught	12	35	25		1						1	
10 average size (mm)	15	20	--		20						--	
smallest (mm)	10	10	--		--						--	
largest (mm)	30	35	--		--						--	
# caught	25	300	300	2	7	1						
11 average size (mm)	40-45	15-20	--	137	15	--						
smallest (mm)	15	10	--	75	10	--						
largest (mm)	67	35	--	200	30	--						
# caught	20	50	200	3								1
12 average size (mm)	20	15-20	--	80								6
smallest (mm)	5	5	--	70								--
largest (mm)	35	15-20	--	100								--
Total Catch	424	965	865	8	15	2	1	1	2	2	5	1

water quality conditions. However, as the summer progresses and water temperatures increase, evaporative losses would result in increased salinities, and as a result of temperature and salinity changes, the amount of DO available in water would likely decrease, potentially resulting in unacceptably low DO conditions for fish. Additionally, this salt marsh/pond is shallow enough that the entirety of the pond can support growth of macrophytes, including rooted and floating vascular plants and algae. When these macrophytes senesce and die at the end of the growing season in late summer when temperatures are still high (i.e., September), the decomposition of organic matter can result in severe depletion of oxygen. In shallow waterbodies such as this, the concern is that macrophyte decomposition can deplete the oxygen content to the extent that conditions become anoxic, resulting in massive die-offs of the animals in the pond (Wetzel 1983).

During fish sampling activities, incidental observations of birds and mammals also were noted. Birds observed in the vicinity of the site include black-crowned night-heron (*Nycticorax nycticorax*), greater black-backed gull (*Larus marinus*), red winged blackbird (*Agelaius phoeniceus*), least tern (*Sterna antillarum*), American oystercatcher (*Haematopus palliatus*), glossy ibis (*Plegadis falcinellus*), song sparrow (*Melospiza melodia*), house sparrow (*Passer domesticus*), tree swallow (*Tachycineta bicolor*), barn swallow (*Hirundo rustica*), American robin (*Turdus migratorius*), belted kingfisher (*Ceryle alcyon*), double crested cormorant (*Phalacrocorax auritus*), snowy egret (*Egretta thula*), mallard duck (*Anas platyrhynchos*), and mourning dove (*Zenaida macroura*). Hatched egg shells for the American oystercatcher and a glossy ibis were observed in the Study area. The least tern is listed in Massachusetts as a species of special concern (MANHESP 2004).

No direct or indirect observations of mammals were noted during field activities.

3.5 Pond Bathymetry/Topography

Baseline topographic surveys were conducted in June 2004 and topographic maps were prepared using a 1-foot vertical contour interval. Existing local control points on the island were identified by Thompson Island representatives and were used to establish horizontal and vertical datums. Spot grades were taken of the bottom of the pond using an approximate 30-foot grid to