SHORELINE INJURY ASSESSMENT
PART I: EXPOSURE CHARACTERIZATION
BOUCHARD 120 OIL SPILL,
BUZZARDS BAY, MASSACHUSETTS AND RHODE ISLAND

Prepared by:

Shoreline Assessment Team

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1.0 INTRODUCTION

1.1 Background

On the evening of April 27, the *T/B Bouchard No. 120* began leaking oil as it approached Buzzards Bay from the south in route to the Cape Cod Canal. An independent assessor estimated that 22,000-55,000 gallons of a heavy fuel oil were released from the barge into the Bay (Independent Marine Consulting, Ltd., 2003), although Costa (2004) re-interpreted these data and estimated that a conservative estimate was 97,000 gallons. The spill affected a variety of natural resources, including marshes, recreational beaches, wildlife, and fisheries. As part of the Natural Resource Damage Assessment, the Natural Resource Trustees (the state of Massachusetts, the state of Rhode Island, the U.S. Fish and Wildlife Service on behalf of the Department of the Interior, the National Oceanic and Atmospheric Administration, and the Wampanoag Tribe of Gay Head) and the responsible party (Bouchard Transportation Co.) were given the task of quantifying the impacts of the oil on the natural resources of Buzzards Bay. The Joint Assessment Team, comprised of representatives of the Natural Resource Trustees and the responsible party, coordinates and approves the activities of subgroups (i.e., Shoreline Assessment Team) that were formed to address impacts to different resource categories. This report documents the findings of the Shoreline Assessment Team (SAT) on the shoreline exposure to oil and cleanup and includes the data that were collected and analyzed to support those findings. Research Planning, Inc. (RPI) is providing technical assistance to the Trustees; ENTRIX, Inc. is the technical representative for Bouchard Transportation Co.

1.2 Objective of the Study

The overall goal of the Shoreline Assessment is to quantify the extent and duration of injury to shoreline natural resources (i.e., intertidal habitats and communities) and to identify appropriate options to restore those resources. The Shoreline Cleanup Assessment Team (SCAT) data and surveys conducted during the emergency and cleanup phases of the response were used to calculate that approximately 105 miles of shoreline were impacted with greater than trace amounts of oil from the *T/B Bouchard 120*. Shoreline cleanup activities included manual removal, sediment excavation and replacement, high-pressure washing (using both ambient and hot-water temperatures), and emergency planting of salt marsh vegetation. Both the oiling and cleanup activities have the potential to injure intertidal habitats and communities. The SAT used data from the SCAT teams, beached bird surveys, other sources, and observations gathered during a September 2003 site survey to assign a degree of oiling category to each shoreline segment affected by the spill. The site survey enabled the SAT to obtain direct information on the extent of residual oil and the general condition of the impacted habitats, as well as the impacts of different cleanup methods and activities (see the site survey report in Appendix A). This document describes the methodology, data collection, and findings on the spatial and

temporal extent of injury to the shoreline. The draft maps included in Appendices B and C display the degree of oiling for the impacted shoreline segments as well as the Environmental Sensitivity Index (ESI) shoreline types for both Massachusetts and Rhode Island (NOAA 1999, 2001).

2.0 METHODOLOGY

The SAT compiled all of the data available on the shoreline oiling and habitats, condensed the information and developed a framework for the injury assessment of shoreline habitats. ENTRIX developed a database of information from the SCAT forms and entered the oiling maps prepared by the cleanup teams into a Geographic Information System (GIS) database. RPI completed a preliminary analysis of the ESI data on shoreline habitat types. RPI and ENTRIX exchanged these data, met to review the information, and then drafted a map representing the highest oiling levels on all shorelines in the spill area. In August 2003, the SAT reviewed the maximum oiling and habitat maps. The SAT decided to focus on the maximum oiling on shorelines to represent the maximum potential injury to those shorelines. On 3-5 September 2003, the SAT visited selected areas of the impacted shoreline to validate the methods used to classify the shoreline into habitat types, investigate the residual oil and injury to the habitats, and evaluate the effectiveness and impacts of the various cleanup methods.

2.1 Mapping the Distribution of Oil

The mapping of oiling conditions on the shoreline was the first step in calculating the total injury. Two primary sources of information were available to create a map of the maximum degree of oiling conditions for the shoreline of Buzzards Bay and other affected waters: cleanup maps and SCAT forms. Additional information was obtained from data sheets prepared by the bird survey teams and Immediate Response Action Completion (IRAC) teams. The goal was to create a map that reflects the maximum amount of oil for every segment along the shoreline affected by the oil spill.

The earliest information available was compiled on maps created daily by cleanup personnel to prioritize shoreline cleanup. The map produced each day represented the current oiling conditions for that day. On the map, the shoreline was divided into segments that often contained multiple oiling levels per segment. The cleanup maps were created using verbal information from cleanup crews and verbal reports from the SCAT teams, and the SAT presumed that the information accurately reflected the oiling conditions present.

The SCAT forms were the second primary source of information. Throughout the first six weeks of the spill, SCAT teams assessed the shoreline oiling conditions daily and recorded their observations on standard forms. The bird survey teams were not trained to evaluate oiling levels, but their observations were often helpful, particularly for establishing the presence of oil in areas not assessed by the SCAT teams. The purpose of the IRAC inspections was to assess whether immediate cleanup actions were complete. The data sheets produced by the IRAC teams were not used to provide information on maximum oiling levels, but to document remaining oiling conditions. They did provide information on two very small areas of oil within otherwise clean segments that were not previously identified as being oiled.

Shoreline oiling was classified by the SCAT and indicated on the cleanup maps as Very Light, Light, Moderate, or Heavy (VL, L, M, or H) based on the percent cover of the intertidal shoreline by oil and the width of the oiled band (Table 1). These categories were adopted by the SAT for the shoreline injury assessment. For completeness, the SAT has added a fifth category of "trace oiling" to reflect areas where minimal amounts of oil were reported. Oiling in these areas was typically limited to a few tarballs or pieces of oiled debris. With such minor oiling, the SAT did not include "trace oiling" as an injury category. Areas that were surveyed but had no oil were labeled as "clean". Areas with no oiling category indicate that the shoreline was not surveyed and that no data exits for that area.

TABLE 1. Shoreline oiling categories based on the oil band width and percent oil cover in the oil band.

COVERAGE	WIDTH OF OILED BAND			
	< 3 feet	3-6 feet	>6-9 feet	>9 feet
< 1% cover	Very Light	Very Light	Very Light	Light
1-10% cover	Light	Light	Moderate	Moderate
10-50% cover	Moderate	Moderate	Moderate	Heavy
51-90% cover	Moderate	Heavy	Heavy	Heavy
> 90% cover	Heavy	Heavy	Heavy	Heavy

Maximum oiling maps were generated from the daily cleanup maps created through mid-May. All of the daily cleanup maps were incorporated into a GIS database. Each daily map was put on a separate layer. A new map was created using only the cleanup maps that show the maximum oiling at any time for every location on the shoreline where oil was observed (Appendix B).

2.2 Review of the SCAT Data

When the SCAT forms and the cleanup maps were consistent, the maximum oiling map created from the daily cleanup maps would represent the maximum degree of oiling present on the shorelines at any time after the spill. When the two data sources differed, the SCAT forms were compared to the maximum oiling map to ensure that all of the oiling reports were reflected on the map.

When the SCAT form denoted an area of heavier oiling than shown on the map, the additional oiling was accounted for in one of two ways. In cases where enough information was provided, the maximum oiling map was changed to reflect the new information. Alternatively, for some records, there was enough information to determine that the SCAT form showed higher oiling than the maximum oiling map but not enough to change the map because inadequate positional information was given. For these cases, the area of heavier oiling was added to the area in the appropriate exposure category following analysis of the maximum oiling maps.

2.3 Determining Shoreline Habitat Types

The next step in determining shoreline injury was to map the shoreline habitat types. ESI line codes were extracted from the existing Rhode Island (2001) and Massachusetts (1999) ESI atlases and matched to the oiling shoreline used in this project using a nearest neighbor classification procedure within a GIS (Appendix C). The ESI codes assigned to the shoreline went through a QA/QC process by the SAT and were also ground-truthed during the September 2003 shoreline site survey. The technical process of the nearest neighbor classification involved creating a thiessen polygonal surface of the original ESI coded shoreline arcs. The oiling shoreline coverage created from the cleanup maps was then intersected with this surface. The resulting shoreline segments acquired the ESI attributes for the thiessen polygon that they intersected. A preliminary review of the habitat types in the oiled areas showed that the following ESI categories were present:

1A	Exposed rocky shorelines
1B	Exposed man-made structures
2A	Exposed wave-cut platforms in rock
3A	Fine to medium-grained sand beaches
3B	Scarps and steeps slopes in sand
4	Coarse-grained sand beaches
5	Mixed sand and gravel beaches
6A	Gravel beaches
6B	Riprap
7	Exposed tidal flats
8A	Sheltered rocky shorelines
8B	Sheltered man-made structures
9A	Sheltered tidal flats
9B	Vegetated low banks
10A	Salt and brackish-water marshes

The SAT initially considered all 15 of these shoreline types but decided to group together shoreline types that provide similar services (Figure 1). The shoreline types were first grouped into five categories: rocky shores, manmade structures, sand beaches, gravel beaches, and marshes. This grouping would have required the consideration of over 20 separate injury categories (4 oiling levels and 5 habitat types). During an initial assessment of approximately 86 miles of shoreline known to have been oiled, the following percentages in each of the 5 injury categories were calculated; rocky shores (3%), manmade structures (16%), sand beaches (28%), gravel beaches (42%), and marshes (12%).

Marshes and other vegetated areas provide services very distinct from the other habitat types and were left as a separate category. Sand beaches were also left as a separate category because they provide services different from the other habitats and because of differences in

FIGURE 1. PRELIMINARY ESTIMATE OF SHORELINE OILING BY % OF TOTAL SHORELINE LENGTH OILED

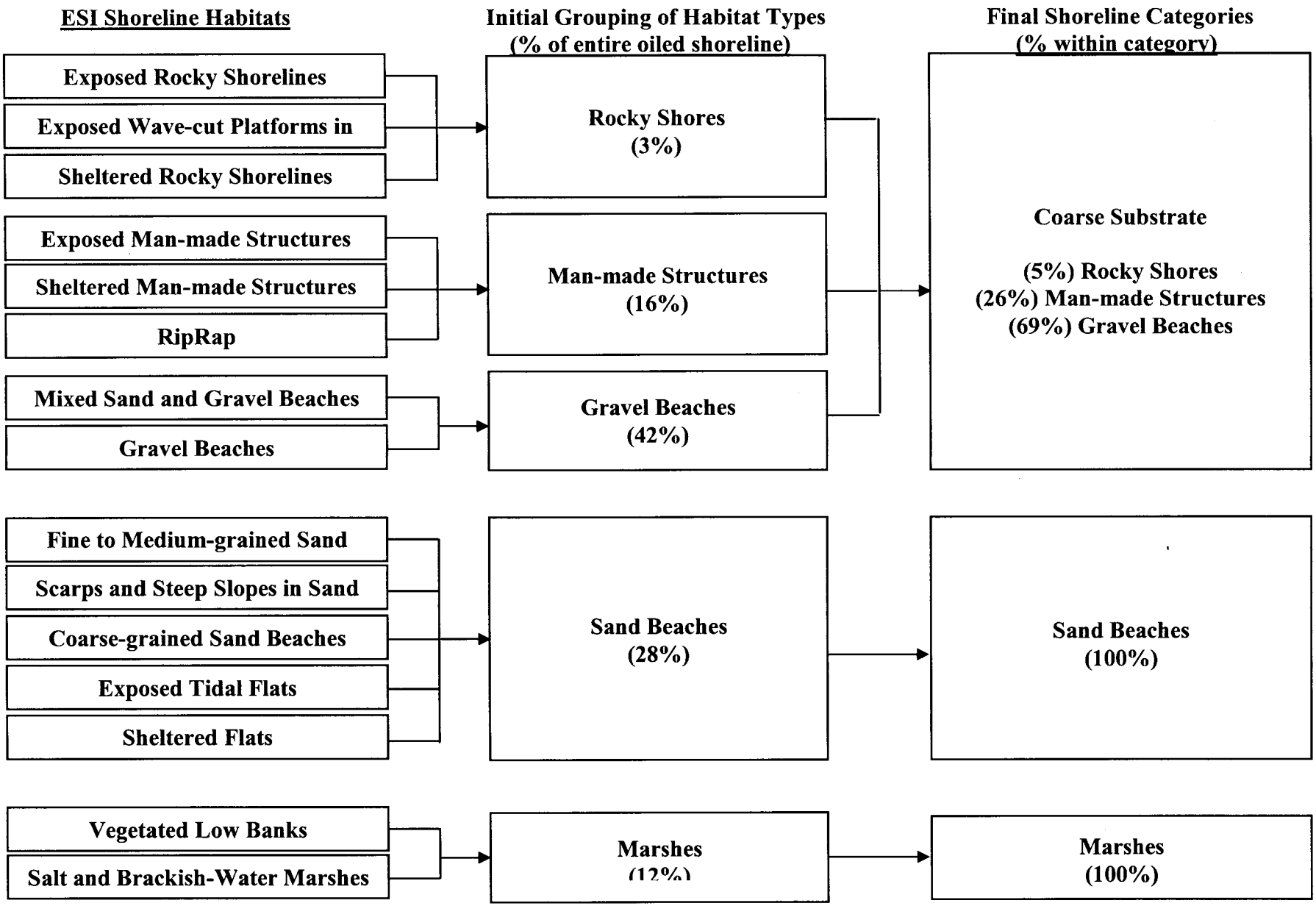
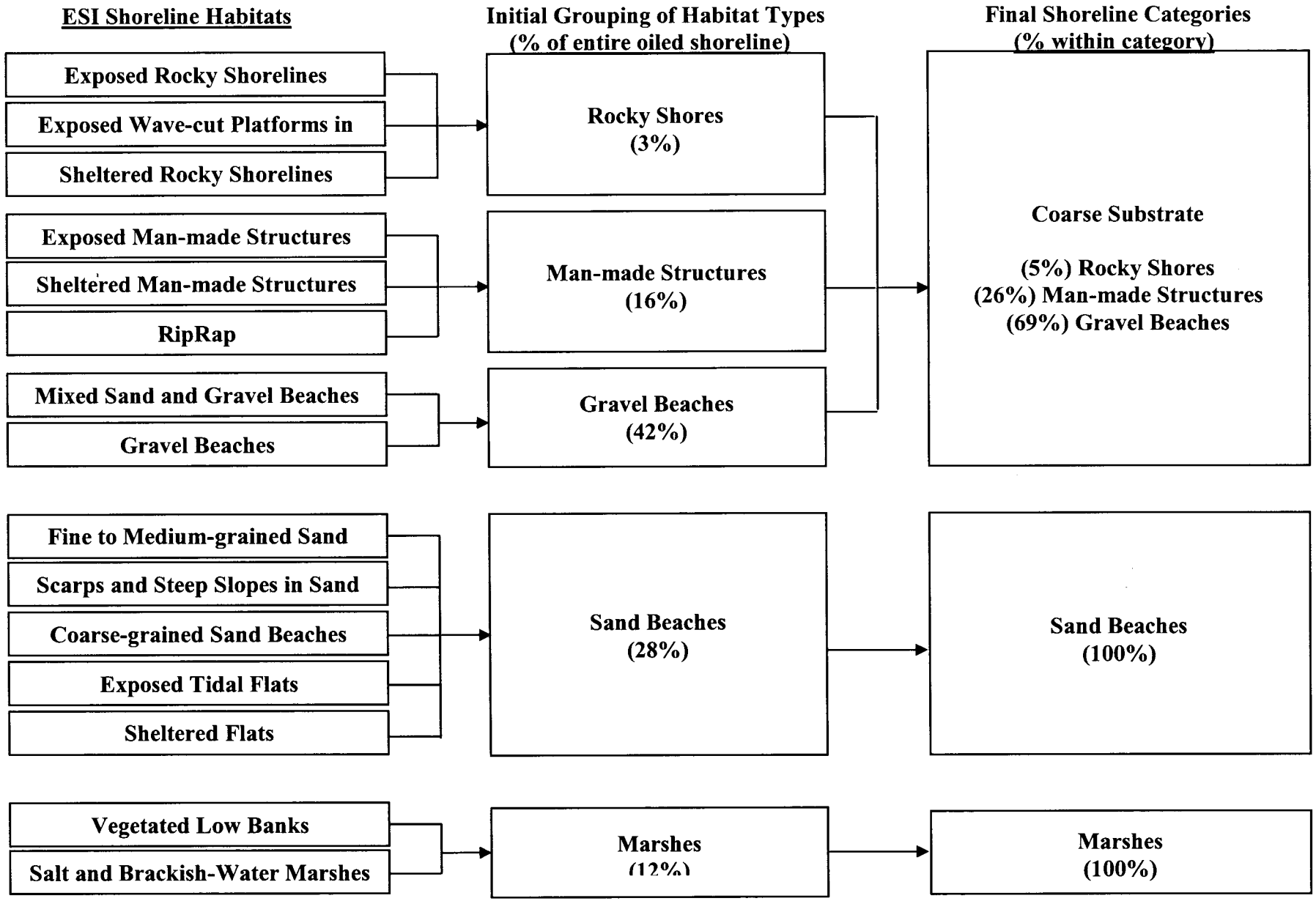


FIGURE 1. PRELIMINARY ESTIMATE OF SHORELINE OILING BY % OF TOTAL SHORELINE LENGTH OILED



cleanup strategies. The next phase of the report, the injury assessment, will provide greater detail on the ecological services of marshes and sand beaches.

The SAT decided to group man-made structures, gravel beaches, and rocky shorelines together under the category of coarse substrates. Gravel beaches were by far the most common habitat type in this group. The majority of the man-made structures were comprised of riprap that was similar in grain size to boulders in the gravel beach category. In addition, many areas of riprap and groins had degraded to a state that was very similar to naturally occurring gravel beaches. The rocky shoreline type made up only 3% of the total length of oiled shoreline, with none classified as heavily oiled and less than 1,000 feet in the moderately oiled category. Rocky shorelines provide services that are similar to gravel beaches such as attachment points for sessile organisms.

Some shorelines consisted of a combination of more than one habitat type (i.e., tidal flat occurring seaward of a salt marsh). When two habitat types characterized a particular shoreline, it was assumed that the oil was distributed evenly between the shoreline types, unless there was evidence to the contrary. No tidal flats appeared to have been oiled and always appeared in conjunction with another habitat type. Where tidal flats and another shoreline type are present on the same section of shoreline, all of the exposure was assigned to the other shoreline type.

2.4 Estimating the Area of Exposure

The combination of habitat type and oiling level was used to determine the exposure categories. There were 12 exposure categories comprised of three habitat types at each of the four oiling levels to be assessed (Tables 2a and 2b). The area of exposure for each habitat type and oiling level was calculated using the average width of the oil band and the length of oiled shoreline. Many of the SCAT forms contained information on the width of the oil band, but this information was only available for a fraction of the oiled shorelines. Therefore, some assumptions and extrapolations were necessary. The SAT assumed that the oil band width information contained on the SCAT forms was representative of all affected Buzzards Bay shorelines. Only SCAT forms that contained both oil band width and shoreline length information were used to calculate average oil band widths for each oiling category. In some cases the length was not included on the SCAT form but could be calculated from GPS coordinates that were provided.

Average oil band width was calculated as a weighted average using the length of oiled shoreline as a weighting factor for each record in the following manner. The records were distinguished by oiling category. The area (length times width) was calculated for each record. The total area in each oiling class was divided by the sum of all the lengths in that oiling class. The result is the weighted-average width of shoreline oiling for that oiling class: very light (2.82 ft), light (10.91 ft), moderate (6.18 ft), and heavy (26.88 ft). However, the width of moderately oiled marsh (8.21 ft) was separated from other moderately oiled habitat types and modified based on additional measurements taken during the SAT's September 2003 site visit. These oil band widths were assumed to be appropriate for all shorelines within each oiling category.

To calculate the total shoreline acreages injured by exposure category, the total length of shoreline within each exposure category needed to be calculated. The length of oiled shoreline was obtained by overlaying the ESI maps onto the maximum oiling maps and generating lengths using a GIS application. The combination of data within the GIS allowed the SAT to determine the length of oiled shoreline by habitat type and maximum degree of oiling (i.e., by exposure category) (Tables 2a and 2b). The total length for an exposure category was then multiplied by the average oil band width for the applicable oiling category to calculate the total area of each exposure category. However, the total area calculated along the shoreline did not include the oiled "shorelines" of groins oriented perpendicular to the mainland.

There were 193 groins, based on recent aerial photographs, protruding from shorelines that were labeled as VL, L, M, or H oiling. The SAT agreed that the oiled area of the groins should be incorporated into the total acreage oiled. To calculate this, the length of all groins in VL, L, M, or H oiled areas were studied using aerial photos within a GIS. The average physical width (i.e., footprint width) of the groins was calculated from measuring the widths of a sub-sample of 40 groins and determined to be 14.4 ft. The oiled shoreline area of each groin was then calculated based on the oiling degree classified on the shoreline from which it protruded. For very light and moderately oiled groins, the average width of oiling was such that oil would not have extended across the entire groin and the area that was considered oiled was twice the average width of oiling (to account for oiling on both sides of the groin) times the length of the groin. For light and heavy oiling where the average width of oiling was more than half the physical width of the groin, then the oiled area was assumed to equal the physical area of the groin. The oiled area of the groins was totaled by oiling category and added to the total area impacted for coarse substrates. The total area oiled on the groins was estimated to be 4.20 acres.

TABLE 2a. Estimate of oiled shoreline length (feet) in each exposure category (not including groin lengths) and total miles in Massachusetts.

HABITAT	VERY LIGHT	LIGHT	MODERATE	HEAVY	TOTAL (miles)
Coarse Substrate	131,397	76,567	56,703	25,784	**55.01**
Sand Beaches	49,956	23,716	19,102	10,703	**19.60**
Marshes	40,345	11,435	9,615	5,210	**12.61**
Total (miles)	**41.99**	**21.16**	**16.18**	**7.90**	**87.22**

TABLE 2b. Estimate of oiled shoreline length (feet) in each exposure category (not including groin lengths) and total miles in Rhode Island.

HABITAT	VERY LIGHT	LIGHT	MODERATE	HEAVY	TOTAL (miles)
Coarse Substrate	23,130	19,373	2,228		**8.47**
Sand Beaches	24,756	20,603	1,791		**8.93**
Marshes	1,182	211			**0.26**
Total (miles)	**9.29**	**7.61**	**0.76**	**0.00**	**17.67**

The SAT also incorporated areas where sediment replacement was completed. The area of sediment replacement was obtained from the permits applied for by Operations Managers. Sediment replacement areas were calculated as follows: Long Island Point (0.67 acres), Brant Beach (0.113 acres), and Crescent Beach (0.076 acres). Sediment replacement was treated as an individual exposure, or injury category, and the area of replacement was added to the total acres of shoreline impacted (Table 3a). In turn, the areas shown as oiled from the SCAT data that were within the replacement areas were subtracted from the total acres of impacted shoreline to avoid double-counting.

3.0 RESULTS

3.1 Estimate of Impacted Shoreline

Tables 3a and 3b show the total area in each exposure category, calculated as described in Section 2.0 including oiling that could not be shown on the maps. Coarse substrates had the greatest amount of acres oiled, followed by sand beaches and marshes. Among the oiling categories, light oiling covered the largest amount of shoreline, and moderate oiling covered the least amount of shoreline. Sediment replacement contributed 0.86 acres of impacted shoreline. The total area of shoreline in Massachusetts impacted from the oil spill was 84.7 acres along 87.2 miles. In Rhode Island, 13.8 acres of shoreline were impacted along 17.7 miles.

TABLE 3a. Total estimated area (acres) of impacted shoreline in each exposure category in Massachusetts.

HABITAT TYPE	OILING LEVEL	ESTIMATED AREA (ACRES)	TOTAL BY HABITAT
Coarse Substrate	Very Light	8.54	56.02
	Light	20.72	
	Moderate	9.77	
	Heavy	16.13	
	Sediment Replacement	0.86	
Sand Beaches	Very Light	2.39	18.43
	Light	6.70	
	Moderate	2.71	
	Heavy	6.63	
Marshes	Very Light	2.61	10.27
	Light	2.86	
	Moderate	1.83	
	Heavy	2.98	
All Habitats	Total	**84.72**	

TABLE 3b. Total estimated area (acres) of impacted shoreline in each exposure category in Rhode Island.

HABITAT TYPE	OILING LEVEL	ESTIMATED AREA (ACRES)	TOTAL BY HABITAT
Coarse Substrate	Very Light	1.50	6.64
	Light	4.85	
	Moderate	0.29	
	Heavy	0.00	
Sand Beaches	Very Light	1.60	7.02
	Light	5.16	
	Moderate	0.25	
	Heavy	0.00	
Marshes	Very Light	0.08	0.13
	Light	0.05	
	Moderate	0.00	
	Heavy	0.00	
All Habitats	Total	**13.79**	

3.2 Additional Injury Categories

The SAT is further assessing the potential quantities and impacts of shoreline cleanup methods on the habitats in the next phase of the injury assessment. In particular, the effect of the high-pressure, hot-water flushing operations, sediment loss projects, and vehicular and foot tracking of vegetation and marsh peat substrate will be examined.

In addition, there are portions of the shoreline in Rhode Island that could have been oiled but where no record of the presence or absence of oil exists. As no information on oiling exists for those areas, potential oiling of those sites will be addressed by means other than those used in this report. Methods used to estimate potential injury in these undocumented areas will be provided in the shoreline injury assessment report.

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5.0 ACKNOWLEDGMENTS

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APPENDIX A

SEPTEMBER 2003 SHORELINE SITE SURVEY REPORT

SEPTEMBER 2003 SHORELINE SITE SURVEY REPORT

INTRODUCTION

The Shoreline Assessment Team (SAT) conducted site visits of shoreline areas affected by the *T/B Bouchard 120* oil spill from 3-5 September 2003. The overall objective of the site visits was to obtain first-hand information on the extent of residual oil and the general condition of the impacted habitats at the end of cleanup activities. Shoreline Cleanup Assessment Team (SCAT) data collected during the early period of the spill was used to characterize the extent of the maximum degree of oiling. However, there was the need to evaluate the effectiveness and impacts of cleanup actions, to provide information important in estimating the rate of recovery of shoreline habitats affected by the spill.

The specific objectives of the site visits surveys were to:

1) Make visual, systematic observations on the condition (residual oil, physical disturbance, general condition of biota and plants) of shoreline segments representative of the different exposure categories developed from the SCAT data;
2) In particular, observe the condition of the shoreline habitat in areas where intensive shoreline treatments were conducted;
3) Verify the accuracy of the shoreline type assigned to segments based on Environmental Sensitivity Index (ESI) data;
4) Confirm the assumption that, for a shoreline segment with two shoreline habitats present, the oil band should be split evenly between the two;
5) Determine whether it is appropriate to combine some of the exposure categories (currently 4 oiling exposure and 5 habitat types, thus 20 combinations);
6) Collect sediment samples of weathered oil for temporal comparison with sediment samples collected in early May (only if this does not replicate other sediment sampling efforts); and
7) Monitor Ram Island planting/restoration.

This report presents the methodology used during the site visits, a summary of the field observations, and the consensus reached on selected issues.

METHODOLOGY

Based on the draft Shoreline Oiling Database produced on 15 August for SAT review, shoreline segments representative of the different exposure categories were selected for site visits. SAT members also recommended sites to survey, based on their knowledge of the oiling conditions and cleanup efforts. Unoiled segments were also surveyed. Participants in the site visits are listed in Table 1. A field survey form (Fig. 1) was completed for each shoreline segment surveyed. Table 2 lists the segments that were visited and the shoreline features that prompted selection of the segment.

1. GENERAL INFORMATION	Date (dd/mm/yy)	Time (24h standard/daylight)	Tide Height
Segment ID:			L/M/H
Segment Name:		hrs to	H/M/L
		hrs	
Survey By: Foot / Boat / Helicopter / Overlook / _____		Sun / Clouds / Fog / Rain / Snow / Windy	

2. SURVEY TEAM	Name Phone Number	Organization

3. SEGMENT	Total Length _____m/yd	Length Surveyed _____m/yd	Differential GPS Yes/No
Start GPS:	LAT _____deg. _____ min	LONG _____deg. _____ min	
End GPS:	LAT _____deg. _____ min	LONG _____deg. _____ min	

4. SHORELINE TYPE

5. OIL Observations	Use SCAT Terminology; Include Physical Damage Observations

6. BIOTA Observations			
Habitat /Tidal Zone	Species	Abundance	Condition

7. OTHER Observations
Sketch: Yes / No Photos: _____ (Roll#____Frames_____) Sediment Sample #_____

FIGURE 1. Form used to record observations during the segment site visits.

TABLE 1. Participants in the September 2003 shoreline site visits.

Name	Organization
David Janik	Massachusetts Coastal Zone Management
Michael Mulhare and Scott Squires	Rhode Island Department of Environmental Management
James Turek and Lisa Cavallaro	National Oceanic and Atmospheric Administration
Veronica Varela	U.S. Fish and Wildlife Service
Gary Harmon	Entrix (Bouchard Contractor)
Jacqueline Michel	Research Planning, Inc. (NOAA Contractor)

TABLE 2. Shoreline segments visited during the September 2003 survey, the shoreline feature that was addressed during the survey, and the recommended changes.

Segment	Issue/Recommended Change
W2A-8 Wilbur's Point	ESI classification as riprap/change to gravel beach
W2A-17 Earl's Marina	Unoiled marsh
W2A-10 Long Island (marsh)	Heavily oiled salt marsh; marsh revegetation; width of oiled zone in marsh/change to double shoreline with salt marsh and gravel beach
W2A-10 Long Island (gravel)	Sediment replacement
W2A-10 Long Island (sand beach)	Heavily oiled sand beach
W2A-11 West Island	Heavily oiled gravel beach and riprap; hotsy treatment during cleanup
W2A-12 West Island Town Beach	Lightly oiled sand beach
W2A-13 Girls Creek	Moderately oiled salt marsh
W2C-4 Barney's Joy	Heavily oiled gravel platform
W2C-3 Barney's Joy	Heavily oiled sand beach
W3E-5 Little Compton Town Beach	Very lightly oiled gravel beach in RI
W1G Ram Island	Heavily oiled gravel beach; marsh re-vegetation/change to double shoreline with salt marsh and gravel beach
W1F-2 Brant Island (adjacent to)	Heavily oiled salt marsh/change double shoreline to single habitat of salt marsh
W1F-4 Brant Island Cove	Heavily and moderately oiled salt marshes
W1F-8	Very lightly oiled gravel beach; double shoreline
W1F-5	Moderate to heavily oiled marsh
W1F-6	Heavily oiled salt marsh

RESULTS

Two samples of oiled debris were collected from the marsh surface in segments W1F-2 and W1F-8 and sent to B&B labs in College Station, Texas for characterization and weathering analysis. The following issues were decided by consensus during the field site surveys.

1) The calculated average width of oiling for the heavy category (26.9 feet) is appropriate.
2) The calculated average width of oiling for the moderate category (6.2 feet) is too low for marshes. Measurement of the oiled band at four locations in segment W2A-3 (Girls Creek) averaged 20.5 feet. The width of oiling in salt marshes should be further evaluated by reviewing all reported widths of the oiled band in salt marshes as recorded on the SCAT forms.
3) All other oiling widths appear to be appropriate (e.g., light = 10.9 feet; very light = 2.8 feet).
4) Add salt marsh to the gravel beach classification on Ram Island, making it a double shoreline.
5) In general, the proposed allocation of the oiling width for segments with double shorelines (50% to each shoreline type) is appropriate.
6) The shoreline types for injury quantification will be combined as follows:
    a. Coarse substrates: rocky shores, gravel beaches, mixed sand and gravel beaches, riprap and seawalls
    b. Sand beaches
    c. Salt marshes

Other issues that need further data gathering are:

1) It was observed that gravel beaches included numerous riprap groins that effectively increased the length of the shoreline. It may not be appropriate to increase the shoreline length for the heavy oiling category, since the oil width of 26 feet would greatly exceed the natural width of the groins. However, on gravel beach and riprap segments with moderate oiling, it may be appropriate to increase the shoreline length of oiling.
2) Two additional sources of information will be reviewed for their potential usefulness in supplementing the SCAT data:
    a. In Rhode Island, staff from RIDEM will provide maps showing the results of shoreline surveys along with copies of field notes as documentation
    b. Forms completed by bird survey teams will be reviewed to add data on oiled and unoiled areas. These reports will be used only to confirm the absence of oil on segments without SCAT data, or add oiling to areas where oil was not noted previously.

General observations on the condition of intertidal habitats include:

1) Oil residues were observed on one sand beach (W2A-10, only by smell), though only a minimal effort was made to look for buried oil layers as the amount of sand being deposited on the beaches would have been very high at the time of the site visit.
2) In heavily oiled marshes, there were scattered areas of bare ground where patches of oil had apparently stranded and been removed during cleanup. Some of these bare areas had been planted with sprigs of *Spartina alterniflora* in July. The survival of the planted sprigs varied by location but was generally good. Appendix 2 includes the measurements made for two of the planted areas on Ram Island.
3) Heavily and moderately oiled salt marshes contained the highest amount of residual oil, occurring as spots of stain and coat on shells and small tarballs that had penetrated slightly into the marsh soil surface. The salt marsh on Long Island had the highest amount of residual oil.
4) Residual oil on gravel beaches and riprap occurred mostly as widely scattered spots of stain and coat. There was some oil staining of shells. Little of the oil was tacky to the touch. At Barney's Joy, algae covered the oil coat.
5) Wrack accumulations appeared normal, with abundant numbers of amphipods in most places. The exception was in the area of sediment replacement on Long Island, where the extensive wrack (1 to 2.5 feet deep) contained few amphipods and significantly more gnat-like flying invertebrates than amphipods. No oiled wrack was observed.
6) In most oiled areas, intertidal fauna were abundant. The exception was in the area of sediment replacement, where the gravel was very clean, lacking an epiphytic cover and thus grazing organisms that were normally abundant elsewhere.
7) Black oil droplets and sheen was observed coming in with the tide on 5 September 2003 at W1F-5 (Antassawamock, Mattapoisett Neck). The source of the oil was not determined.

COPIES OF THE FIELD SURVEY FORMS COMPLETED DURING THE SEPTEMBER 2003 SITE VISITS

FIELD MEASUREMENT AT TWO TRANSECTS THROUGH MARSH PLANTING SITES ON RAM ISLAND

Transect RI#1: 50 ft long x 6.5 ft wide transect running approximately west from stake marked RI#1

Water-ward (south) side of transect - 130 live stems, 16 dead stems

Upland (north) side of transect - 67 live stems, 22 dead stems

It should be noted that the counts included live natural (not planted) vegetation.

To track an area of eroding vegetated mat that might intrude into the counting area, the distance from the apex of the erosional area to the transect stake was measured. The apex was approximately 1.66 meters from the SW point of the "white rock," and the rock was a little more than 5 meters from the stake.

Transect RI#2: 50 ft long x 6.5 ft wide transect running west from stake marked RI#2

Upland side of the transect - 74 live stems, 13 dead stems

Water-ward side of transect - 76 live stems, 9 dead stems

APPENDIX B

MAXIMUM OILING MAPS

APPENDIX C

SHORELINE CLASSIFICATION MAPS