Appendix J

Habitat Injury Assessment Report

WORKING DRAFT

HABITAT INJURY ASSESSMENT REPORT
DREDGE STUYVESANT OIL SPILL
HUMBOLDT COUNTY, CALIFORNIA

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1.0
INTRODUCTION

This Habitat Injury Assessment Report serves to document the injury assessment process conducted cooperatively between the trustees and the representatives for the responsible party to the Dredge *M/V Stuyvesant* oil spill. This assessment process has been conducted by members of the Stuyvesant Technical Group. The trustees were represented by individuals from the U.S. Fish and Wildlife Service, California Department of Fish and Game, and California State Lands Commission. The responsible party was represented by individuals from ENTRIX, Inc.

This report will ultimately include four Chapters. Chapter 1.0 includes the Introduction and brief background of the spill, Chapter 2.0 the Shoreline Injury Assessment, Chapter 3.0 the Water Column Injury Assessment, and Chapter 4.0 the Shoreline and Water Column Credit Analysis. Chapters 1.0 and 2.0 are presented herein. Chapters 3.0 and 4.0 will be prepared seperately as the assessment work is completed.

1.1 SPILL SCENARIO

On September 6, 1999, the Dredge *M/V Stuyvesant* spilled approximately 2,000 gallons of Intermediate Fuel Oil 180 (IFO-180) into the Pacific Ocean off Humboldt Bay, near Eureka, California. The incident occurred when a dredge arm on the *M/V Stuyvesant* punctured one of its fuel tanks. The spill occurred on an outgoing tide and was not contained. Overflights identified oil slicks and tarballs in the ocean as far north as Patrick's Point, with the majority of the oil washing ashore between the North Spit and Trinidad Head (Figure 1-1). Shoreline Clean-up and Assessment Teams (SCAT) were mobilized on September 7, 1999 and conducted surveys daily through September 15. Beach sign-off surveys were conducted between September 14 and September 18, 1999, though selected sites were revisited November 30, 1999. From the time of the release, the oil was at sea for three days before it was observed on shore, as documented on the SCAT forms starting September 9, 1999.

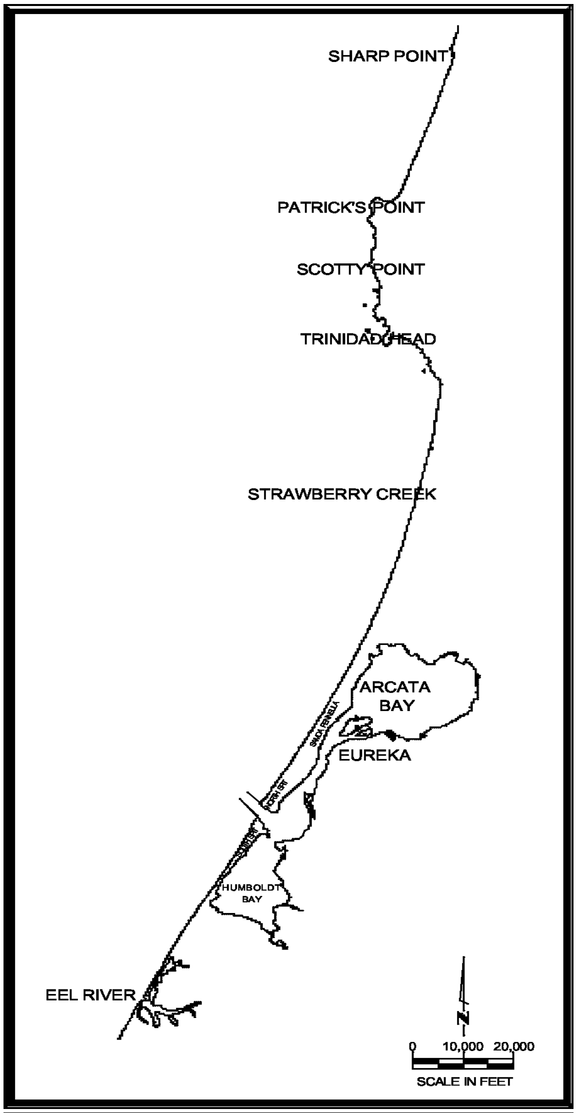

Figure 1-1. Stuyvesant Spill Area

2.0
SHORELINE INJURY ASSESSMENT

This chapter of the Habitat Injury Report focuses on the injury assessment for the shoreline habitats. The approach used for the shoreline injury assessment is discussed first. A description of the habitats (i.e., natural resources) and ecological services provided by those habitats, the degree of injury to these services, the considerations for the kinds of recoveries of these services, and finally, a summary of the service losses are also presented in this chapter. This report does not address active human use services of those habitats. Recreation use services are covered in a separate report prepared for this damage assessment.

2.1 APPROACH FOR ASSESSING SHORELINE INJURY

The Stuyvesant oil spill caused injury to the services provided by the shoreline habitats in the spill area. To evaluate the magnitude of these injuries and to determine the appropriate level of compensation for these lost services, the Stuyvesant Technical Group employed the Habitat Equivalency Analysis (HEA) model. Through the HEA process, the ecological services provided by each of the shoreline habitats and the subsequent injury sustained by the Spill were used to scale the size and determine the types of restorations projects needed for compensation.

HEA focuses on the ecological services provided by the affected habitats. The first step of HEA is to identify the services that the affected habitat would have provided had it not been injured. Second, the amount of service reduction caused by the oil spill is estimated over time. The input parameters needed for this model were the percent of services lost, acres of injured habitat, and duration of recovery for those service. The sum of service losses over time is called a HEA "debit." Next, the amount of service gain that will be produced by the restoration project(s) is determined, which gives a HEA "credit" per acre of restoration project. Finally, dividing the debit by the credit per acre of restoration project results in the acres of restoration project needed to compensate for the injuries. A detailed description of the HEA methodology can be found in Appendix A.

2.2 DIVISION OF HABITATS

Pursuant to the Cooperative Natural Resource Damage Assessment Agreement, Exhibit A, Task 5, and as an integral component to the HEA process, the Technical Group documented the types of shoreline habitats present in the spill area. For purposes of this assessment, the spill area was defined as the shoreline between Sharps Point to the north and Eel River to the south. Based on the U.S. Geologic Survey Environmental Sensitivity Index maps, 16 different shoreline habitats were identified. To streamline the HEA process, the technical group agreed that the shoreline habitats would be grouped into four categories of habitats, which provide similar types of services.

The shoreline habitats were grouped into two main categories: Beaches, and Rocky Habitat. The Beach category includes sand, gravel, and cobble beaches. The Rocky Habitat, however, was divided into three sub-categories based on substrates and types of services provided. The combination beach/rocky intertidal are habitats consisting of a beach backed with a rocky substrate so that on a lower tide a beach is exposed and at a higher tide only rocky substrate is exposed. These rocky intertidal areas provided service flows from both the beach and the rocky components of the habitat. The cliffs/offshore rocks/artificial habitat (e.g., riprap and jetties) were grouped together as the services of the vertical hard rock surfaces, regardless of origin or location, would provide similar services. The tidepools, though the substrate is similar to the hard rock surfaces of the cliffs, provides a unique habitat and service flow.

2.3 Services and Types of Injury for Each Habitat

This section addresses the first two steps of the HEA process. The first step is to identify the services that the affected habitat would have provided had it not been injured. The second step is to identify the types of injuries these services sustained as a result of the spill.

2.3.1 List of Services Provided

Generally, the services provided by the shoreline habitats include habitat for invertebrates, birds, and plants; nesting and roosting for birds; food services and shelter; and marine mammal haul out. Each habitat grouping provided the above types of services to a unique set of organisms in varying quantities and qualities.

For the beaches, the intertidal sands in the beaches served have habitat for aquatic invertebrates. The lower beaches between the dunes and the high tide line were mainly used by birds for nesting and roosting. The wrack and debris found on the beaches provided food and shelter for terrestrial invertebrates and in turn food for birds. Marine mammals were observed using the gravel and cobble beaches for resting.

For the rocky habitats, during the lower tides, the rocky intertidal area provided similar services to the beaches. Otherwise the rocky habitats provided habitat for invertebrates, birds, and plants, particularly in the cracks and crevices in the rocks. The harbor snails, kelp, other invertebrates make up a substantial aspect of the biota in an intertidal rocky habitat outside the crevices and pools. The upper intertidal area and above the splash zones also provided some habitat for plants and invertebrates, but more likely provided nesting and roosting services. The tidepools and cracks in the rocks provided shelter to plants and invertebrates, and therefore food services to birds and mammals.

2.3.2 Types of Injuries Sustained

The injuries sustained by shoreline habitats were presented in terms of reduction in quantity and/or decrease in quality of services provided by each habitat. The provision of habitat for invertebrates, birds and plants was reduced by the organisms being smothered by the oil, the cleanup crews trampling habitat during the response effort, and the removal of oiled plants and sand. The nesting and roosting services were reduced by disturbance to the birds by cleanup crews and increased vehicular traffic, and avoidance of the oiled areas. The quantity of food services were diminished by a potential mortality of prey or plants items, by avoidance of the oiled area by either the foraging organism or prey item, and the fouling and removal of vegetation and debris. The oiling of edible food tissue reduced the quality of the food items.

2.4 Estimation of Injury

The magnitude of injury to the services provided by the shoreline habitats is based on the degree, extent, and duration of oiling. The degree of oiling was based on the density of oil stranded on the shore. The location and acreage of the observed oil and length of time the oil remains on the shore represent the extent and duration of oiling, respectively. The technical group developed the various methodologies for estimating the degree, extent, and duration of oiling and the overall shoreline acreage. These parameters were derived from a refinement and/or extrapolation from the available response data listed below.

The technical group reviewed data collected during the response as part of Tasks 1 and 2 in Exhibit A of the Cooperative Assessment. The source of data used to estimate degree, extent, and duration of oiling included, but was not limited to SCAT reports, wildlife reconnaissance reports, field notes and photographs, NOAA overflight maps, aerial photographs, additional field surveys, institutional knowledge from local scientists, tide data from NOAA, and other available data.

The beach habitat sustained three types of injury related to stranded oil, moving oil, and wrack-line oil. On a receding tide, the oil stranded on the beach with each wave, leaving the oil in place on the shore until the next incoming tide. This type of injury was represented by the stranded oil injury. The estimation of the stranded oil acreage was based on the band of stranded oil observed on the beach. However, as oil washed ashore with an incoming tide, the oil moved across the beaches with each wave. As each wave receded, the oil stranded momentarily. With the next wave, the oil re-suspended and moved to another location on the beach. The injury caused by this oiling scenario was represented by the moving oil injury. The moving oil acreage was calculated by subtracting the stranded oil acreage from the total intertidal or "wetted zone" acreage. As limited field data was available about the location, oiling, and removal of wrack material on the beaches, it was assumed that wrack material was present on all beaches and that its degree of injury was proportional to the corresponding degree of stranded oil.

For the rocky habitats, the injuries to the different types of habitats are included in the overall percent loss of services. Therefore, injured rocky habitat acres are for the entire rocky habitat intertidal area including splash zones.

Many beaches were surveyed by SCAT teams multiple times during the response leading to documentation of varying degrees of oiling. Based on the weight of evidence from the SCAT data, the technical group derived one consensus level of oiling. To be conservative, a process was developed for characterizing and quantifying the oiling that represented the heaviest density and acreage of observed stranded oil for each area with multiple SCAT
data. Typically, a beach segment observed to have a considerably larger

band of oiling at a higher density was selected. This degree of oiling was then applied to all injury types within that beach segment.

2.4.1 DEGREE OF OILING

The degree of oiling was categorized using the SCAT classifications. These classifications represent the percent of oiling present in bands of oil observed on the beaches. The SCAT forms indicated four categories of oiling observed during response, which are described below in Table 2-1. The highest degree of oiling observed during the response was the Broken category or 51 to 90% coverage.

SCAT Categories	Percent Coverage for Category
Broken	51% to 90%
Patchy	11% to 50%
Sporadic	1% to 10%
Trace	Less than 1%

Table 2-1. Degree of Oiling Categories

Most beaches were accessible to the SCAT teams during the response. The degree of oiling categorization of these beach segments was based on direct observations documented on the SCAT forms. For inaccessible beaches, the degree of oiling was extrapolated from the nearest surveyed beaches. The beaches were observed to have oiling in all four categories listed above. The rocky habitats, however, were largely inaccessible to SCAT teams, and oiling of the rocks was difficult see. Therefore, the degree of oiling for the rocky habitats was extrapolated from the surrounding beach categories. The rocky habitats north of Trinidad Head were assumed to have “sporadic” oiling, and the rocky habitats south of Trinidad Head were assumed to have “patchy” oiling.

2.4.2 EXTENT OF OILING

Once each segment of shoreline was assigned a degree of oiling described above, the next step was to estimated the acres or extent for each injury type: stranded oil, moving oil, and wrack for the beaches, and the rocky habitats.

The acreage of stranded oil was estimated based on the dimensions of the band of oil observed and noted on the SCAT forms. Each band of oil on the beach was observed to have a percent of oil coverage or degree of oiling as described in the above section. The acres within each oiling category were summed to obtain a total acreage of stranded oil within each category.

For this assessment it was assumed that wrack material was stranded on all the beaches at a constant width. The acreage for the wrack line was estimated for each segment defined above, by assuming that the wrack line width was five (5) feet wide and extended the full length of the defined segment.

The next step undertaken was to determine the acreage of moving oil. This was calculated by subtracting the stranded oil and wrack acreage within each beach segment from the intertidal zone (i.e., wetted zone) acreage for that segment. The width of the wetted zone was defined as the area of the beach from the lowest tide to the highest tide observed during the response period. The width varies for each segment depending on the slope of the beach. The wetted zone acres were determined by estimating the length and width of each segment using GIS, aerial photographs, additional field survey, institutional knowledge from local scientists, tide data from NOAA, and other available data. A summary of the acres for each injury type and oiling category is provided in Table 2-2.

Oiling Category	Stranded (acres)	Moving (acres)	Wrack (acres)	Total Wetted Zone (acres)
BROKEN	48	785	3	836
PATCHY	17	115	1	133
SPORADIC	29	268	2	299
TRACE	37	1739	11	1787

Table 2-2. Beach Habitat Acres

The rocky habitat contains microhabitats, such as crevices, tidepools, and rock faces. Although the crevices and pools can trap weathered oil, the rock surface areas and faces, between the crevices and pools, have little ability to gather floating residuals and thus would be less likely to suffer impacts to service flows from the weathered residuals. These areas of crevices and pools, where residual solids may collect, do not affect the service flows from the rock surfaces. For the HEA evaluation, the impacts to the different service flows are taken into account in the overall percent loss of services. Therefore, rocky habitat acres are for the entire rocky habitat intertidal area including splash zones. A summary of the acres for each combination of oiling category and habitat is provided in Table 2-3.

Habitats	Oiling Category	Acres
tidepools - north	SPORADIC	25
rocky intertidal/combo north	SPORADIC	70
rocky intertidal/combo south	PATCHY	10
cliff north w/ offshore rocks	SPORADIC	30
cliff south w/ riprap & offshore rocks	PATCHY	27

Table 2-3. Rocky Habitat Acres

2.4.3 DURATION OF OILING

For the purposes of the HEA evaluation, the duration of oiling began on the first day the oil was observed on the shore and ended when the beach signoff forms were completed for the affected beaches. The oil came ashore on the third day after the release, September 9, 1999 and the beach forms were signed off on approximately September 16, 1999. Therefore, the duration of the oiling was considered to be 7 days.

2.5 DEVELOPMENT OF RECOVERY CURVES

For each habitat type and degree of oiling, a recovery curve was developed to calculate the total loss of services, or HEA debit. For the beach habitats, the moving oil injured the services differently than the stranded oil. Therefore, separate recovery curves were developed for both of these types of injury for the beach habitats. The type of injury to the wrack line is similar to the injuries of the stranded oil, therefore, wrack line acres and services losses are grouped with the stranded oil.

The factors influencing the curve inflections and duration are discussed below.

2.5.1 TYPES OF INJURIES AND RECOVERIES FOR EACH INFLECTION OF CURVE

The recovery curves vary depending on the services affected, the nature of the oiling, cleanup efforts, and other factors. For the Stuyvesant HEA, there were three general phases of recovery: initial injury, post-response recovery, and long term recovery (Figure 2-1). The duration of each phase of the recovery curve was influenced by the degree of oiling. The greater the degree of oiling, the longer the recovery time.

General Recovery Curve

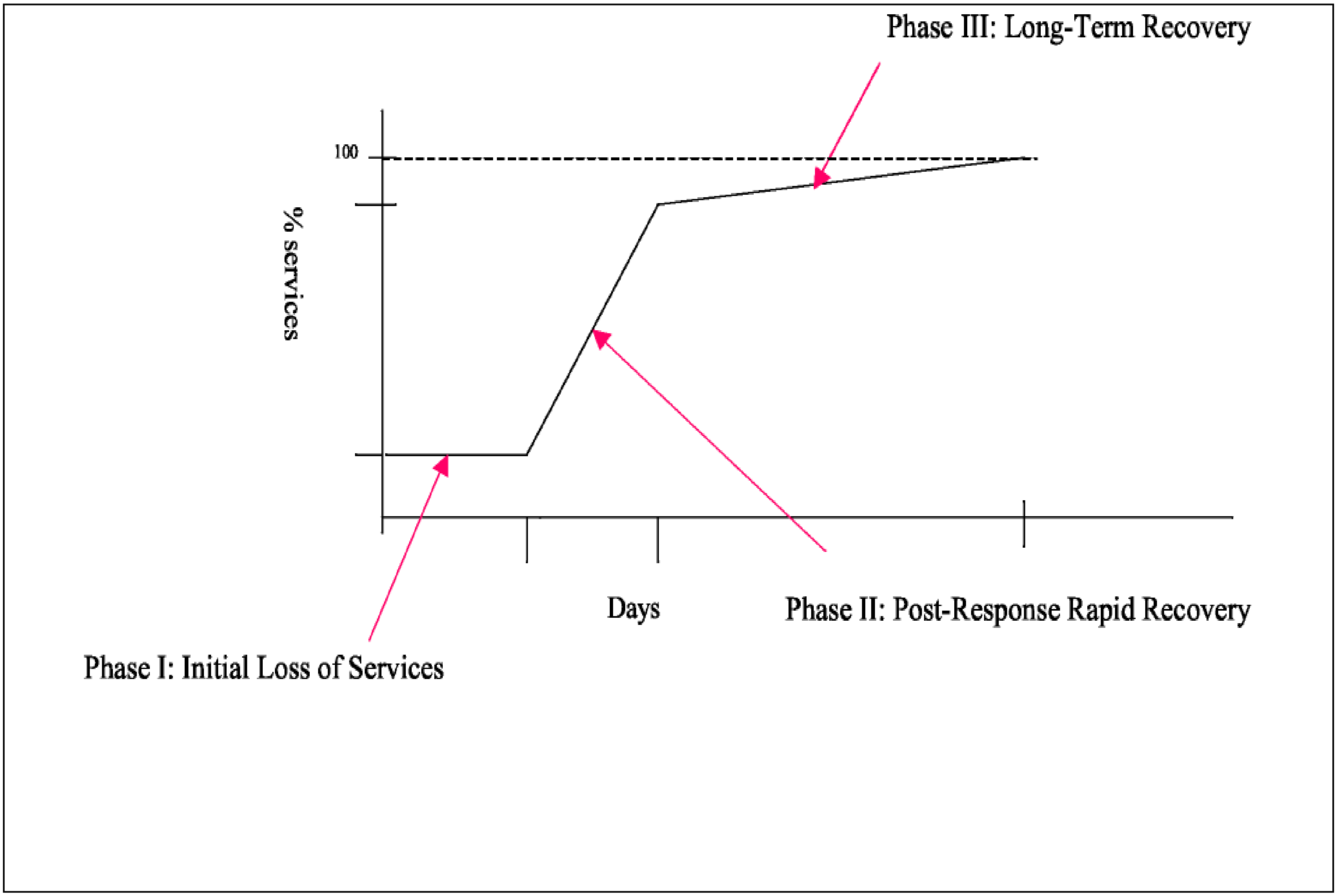

Figure 2-1. General Recovery Curve for Beach and Rocky Habitats

2.5.2 RATIONAL FOR DURATION OF EACH INFLECTION

The rational for percentage loss of services and the duration of those losses are presented in the following section, including the considerations influencing the inflections of the curves for each habitat.

2.5.2.1 Beaches

From the time of the release, the oil was at sea for three days before it was observed on shore, as documented on the SCAT forms starting September 9, 1999. Therefore, 100 percent of the services were available for three days after the release. The initial injury was based on the degree of oil observed stranded on shore. The highest density observed was assigned to that shoreline segment from when the oil came ashore until the end of the response period, which was 7 days in duration (or until 10 days post-spill). The postresponse recovery reflects the rapid recovery of services and was primarily due to the termination of disturbances caused by the cleanup effort and the reduced amount of oil on the beach. The limited amount of oil remaining on shore or coming ashore was weathered, and no longer tacky. The duration of the rapid recovery ranged from 15 to 30 days from time of spill depending on the type of injury and degree of oiling. The longterm recovery was based on the slower recovery of organisms from the presence of residual oil on shore and re-colonization of affected habitat. The more densely oiled areas recovered by 120 days after the release, while the less densely oiled areas recovered in 33 days after the release.

The percentage of service loss due to the initial phase of the recovery curve was dependent on the degree of stranded oiling. The degree of oiling was applied to all injury types within a beach segment. The greater the density of oil, the greater the services were injured. The initial loss due to the stranded and wrack injuries were a result of smothering and fouling of organisms beneath the stranded oil as well as the disturbance by the cleanup and response efforts. The initial loss due to the moving injury was caused by the oil mixing in each incoming wave. The moving oil presented toxicity to the organisms that inhabited the surf area of the beaches. For the HEA assessment, the “worse-case” degree of oiling was assigned to each segment of beach for the duration of the oiling (i.e., 7 days). Once the oil was presumed to no longer be coming ashore and removed from the shores to the extent practical, only residual oil remained on the shore, primarily in areas inaccessible to cleanup crews.

During the second phase, the service losses rapidly recovered to some percentage below the baseline of services. This rapid recovery is due mainly to these factors: the weathering and hardening of the oil remaining on shore and/or the limited amounts of oil still coming ashore, and the end of the cleanup/response effort. The weathered oil no longer had a sticky consistency; therefore, incidental contact with the oil would not cause fouling of an organism. The cleanup crews, SCAT teams, and other reconnaissance teams were no longer present on the beaches. Vehicular and pedestrian traffic activity levels had substantially increased during the response effort, but injury from this disturbance quickly returned to baseline level once this increased activity ceased.

The third phase, the long-term recovery, involved the depuration of oil and toxins from the organisms affected by the moving oil. During the cleanup efforts of the stranded oil, sand, vegetation, and debris were removed from the beaches. The duration of the long-term recovery was dependent on the re-establishment of the vegetation and debris on the beaches and the re-colonization of this wrack material. A summary of the percent service losses and duration of each phase of recovery are shown in Table 2-4.

Broken Stranded w/ Wrack		**Broken Moving**	
Time (days)	% Services	Time (days)	% Services
0	100	0	100
3	100	3	100
3	0	3	10
10	0	10	10
33	50	24	80
120	100	90	100
Patchy Stranded w/ Wrack		**Patchy Moving**	
Time (days)	% Services	Time (days)	% Services
0	100	0	100
3	100	3	100
3	50	3	50
10	50	10	50
33	80	24	90
120	100	60	100
Sporadic Stranded w/ Wrack		**Sporadic Moving**	
Time (days)	% Services	Time (days)	% Services
0	100	0	100
3	100	3	100
3	85	3	90
10	85	10	90
33	95	17	95
120	100	33	100
Trace Stranded w/ Wrack		**Trace Moving**	
Time (days)	% Services	Time (days)	% Services
0	100	0	100
3	100	3	100
3	95	3	95
10	95	10	95
33	100	15	100

Day 0 = time of release -10
Day 3 = first observation of oil on shore

Table 2-4. Beach Habitat Percent Service Losses and Duration

2.5.2.2 Rocky Habitats

Based on the service flows injured and the mechanisms for oiling, the tidepools and rocky intertidal habitats had similar recovery curves. Though the offshore rocks, riprap and cliffs recovery curves differed from the tidepools/rocky intertidal, they were similar to each other. These curves are described below.

2.5.2.2.1 Tidepools and Rocky Intertidal

From the time of the release, the oil was at sea for three days before it was observed on shore, as documented on the SCAT forms starting September 9, 1999. Therefore, 100 percent of the services were available for three days after the release. The initial period of service loss extends to 30 days, since crews were unable access or effectively clean these areas. However, by 30 days, the oil became weathered and volatile components dissipated, and any residuals either stranded themselves in crevices or on shorelines. Examples of the types of injuries that might be associated with these weathered residuals include ingestion of the oil by mobile organisms such as snails and starfish, and/or oil stranding on stationary organisms such as sea urchins and mussels. This middle phase of recovery was estimated to take 60 to 120 days after spill for the rocky intertidal depending on the degree of oiling. The middle phase of recovery was estimated to take 90 days for the tidepools because of the pooling characteristics of this habitat. The remainder of the recovery (long term recovery) occurred over the next 210 days (270 days from time of spill).

2.5.2.2.2 Offshore Rocks, Riprap, and Cliffs

From the time of the release, the oil was at sea for three days before it was observed on shore, as documented on the SCAT forms starting September 9, 1999. Therefore, 100 percent of the services were available for three days after the release. Because of the high wave action associated with, and non-porous surfaces of the offshore rocks, riprap and cliffs, the overall percent service losses and duration of injuries are considerably less than with the other habitats, given the degree of oiling. The initial injury caused by the oil splashing against the rock surfaces extended for a period of 10 days. The flushing effects of the high wave action in these areas resulted in a rapid post spill recovery of 24 days, with the long-term injuries recovering in a total of 60 days after spill. A summary of the percent service losses and duration of each phase of recovery are shown in Table 25.

Tidepool Habitat North of Trinidad Point – Sporadic

Time (days)	% Services
0	100
3	100
3	50
30	50
90	90
270	100

Rocky Intertidal North of Trinidad – Sporadic

Time (days)	% Services
0	100
3	100
3	75
30	75
60	90
270	100

Rocky Intertidal South of Trinidad - Patchy

Time (days)	% Services
0	100
3	100
3	50
30	50
120	90
270	100

Offshore Rocks and Cliff North of Trinidad - Sporadic

Time (days)	% Services
0	100
3	100
3	75
10	75
24	90
60	100

Offshore Rocks, Riprap and Cliff South of Trinidad – Patchy

Time (days)	% Services
0	100
3	100
3	50
10	50
24	80
60	100

Table 2-5. Rocky Habitat Percent Service Losses and Duration

2.6 Calculation of Debit

The degree, extent, and duration of oiling parameters presented above were used in the HEA model. This model is discussed in Appendix A. The HEA model allows for the various injury types to be summed within each habitat. For the beaches, the debit for each of the four degrees of oiling for the stranded/wrack and moving injury types were calculated and then summed. The total debit for the beach habitats is 58.6 discounted services per acres per years (DSAYs). The HEA debit for the rocky habitat sums the injuries from the tidepools, and the two degrees of oiling to both the rocky intertidal and the offshore rock/riprap/cliff habitat. The total debit for the rocky habitats is 10.4 DSAYS. A summary of the debits for each individual category/habitat pair is presented in Tables 2-6 and 2-7.

	DEBIT		
Oiling Category	Stranded (DSAYs)	Moving (DSAYs)	Total (DSAYs)
BROKEN	6.5	44.0	50.4
PATCHY	0.9	3.0	3.9
SPORADIC	0.5	1.2	1.6
TRACE	0.1	2.5	2.6
TOTAL	8.0	50.6	58.6

Table 2-6. Beach Habitat Debit Summary

Habitats	Oiling Category	DSAYs
tidepools - north	SPORADIC	2.9
rocky intertidal/combo north	SPORADIC	4.4
rocky intertidal/combo south	PATCHY	1.7
cliff north w/ offshore rocks	SPORADIC	0.5
cliff south w/ riprap & offshore rocks	PATCHY	0.9
TOTAL		10.4

Table 2-7. Rocky Habitat Debit Summary

2.7 SUMMARY

This chapter of the Habitat Injury Report described the injury assessment for the shoreline habitats for the Dredge *Stuyvesant* oil spill, which occurred on September 6, 1999. The approach used for the shoreline injury assessment included a description of the habitats (i.e., natural resources) and services provided by those habitats, the degree of injury to these services, the considerations for the kinds of recoveries of these services, and finally, a summary of the service losses.

The Stuyvesant Technical Group worked cooperatively to develop this approach and to estimate the input parameters used in the calculations of total service losses. The HEA model was agreed upon as an appropriate approach for the shoreline injury assessment. HEA focuses on the ecological services provided by the affected habitats. The first step of HEA is to identify the services that the affected habitat would have provided had it not been injured. Second, the amount of service reduction caused by the oil spill is estimated over time. The sum of service losses over time is called a HEA "debit." Next, the amount of service gain that will be produced by the restoration project(s) is determined, which gives a HEA "credit" per acre of restoration project. Finally, dividing the debit by the credit per acre of restoration project results in the acres of restoration project needed to compensate for the injuries.

The HEA debits are expressed in debit service acre years (DSAYs). The shoreline habitat injury debit was calculated to be 58.6 and 10.4 DSAYs for the beach and rocky habitats, respectively. The HEA debits will be used to scale the restoration projects needed to compensate for the injuries. The HEA credit analysis will be completed in a cooperative process, and summarized in subsequent chapters in this report as it is completed.

3.0
WATER COLUMN INJURY ASSESSMENT

Pending

4.0
SHORELINE/WATER COLUMN CREDIT ANALYSIS

Pending