DAMAGE ASSESSMENT AND RESTORATION PLAN/ ENVIRONMENTAL ASSESSMENT FOR THE AUGUST 10, 1993 TAMPA BAY OIL SPILL

Volume 1 - Ecological Injuries

FINAL

JUNE 1997

PREPARED BY

**FLORIDA DEPARTMENT OF ENVIRONMENTAL PROTECTION,
NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION,
AND
US DEPARTMENT OF THE INTERIOR**

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FINAL DAMAGE ASSESSMENT and RESTORATION PLAN/ENVIRONMENTAL ASSESSMENT (DARP/EA) for the 1993 TAMPA BAY OIL SPILL

VOLUME I - ECOLOGICAL INJURIES AND LOSSES

1.0 INTRODUCTION

This document is part one (Volume I) of the Damage Assessment and Restoration Plan and Environmental Assessment (DARP/EA) developed by State and Federal natural resource Trustees to address the injury to, loss of, destruction of, and lost use of natural resources resulting from the August 10, 1993, oil spill incident in Tampa Bay, Florida. This DARP/EA has been prepared pursuant to Federal and State laws as discussed in Section 1.1 below.

Volume I of the DARP/EA focuses on direct injuries to natural resources and interim losses of ecological services which occurred as a result of the spill. Hereafter, use of the term "injury" or "injuries" in Volume I encompasses both types of harm. Definitions of injury applicable to specific natural resources are provided in Section 4.

The spill also resulted in lost human uses of natural resources which are of public importance. The Trustees are addressing these lost human uses separately within the assessment process. Assessment methods and restoration plans for lost human uses will be addressed in Volume II.

1.1 Authority

Volume I of the DARP/EA has been prepared jointly by the Florida Department of Environmental Protection (DEP), the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Department of the Interior (DOI) (collectively, "the Trustees"). Each of these agencies is a designated natural resource Trustee under Section 1006 of OPA, 33 U.S.C. 2706, or the Florida Pollutant Discharge and Control Act, Fla Stat. 376.011 through 376.21 (1992) (the State Act), for natural resources injured by the August 1993 oil spill incident in Tampa Bay, Florida. As a designated Trustee, each agency is authorized to act on behalf of the public under State and/or Federal law to assess and recover natural resource damages, and to plan and implement actions to restore natural resources and resource services injured as the result of a discharge of oil.

The State Act mandates the State of Florida, Department of Environmental Protection to assess pollutant spills in coastal waters of the State, including the compensation due for the injury or destruction of natural resources. Such injury or destruction includes the death or injury of living things, and damage to, or destruction of, habitat resulting from pollutant discharges. For discharges in excess of 30,000 gallons, the State Act offers a party responsible for a spill the alternative to pay compensation calculated pursuant to a compensation schedule in the statute, or to have the amount of compensation determined by a damage assessment performed by the Department. With respect to the Tampa Bay oil spill, the responsible parties (RPs) - Bouchard Transportation Co., Inc. and Maritrans Operating Partners - have opted to have the amount of compensation determined by an incident-specific damage assessment.

1.2 Public Participation

The Trustees prepared and issued a draft assessment and restoration plan, Volume I of the Draft DARP, December 1995, for public review and comment. Notices announcing the availability of the draft plan for public review appeared in the Federal Register (61 Fed. Reg. 1357; January 19, 1996), and in the St.

Petersburg Times (January 7, 1996). Copies of these notices and the list of persons and agencies to which the draft plan was distributed for comment are identified in Appendix E.

As a result of this opportunity for public review, the Trustees received two letters commenting on the plan. Comments and views contained in these letters were duly considered by the Trustees prior to finalizing Volume I of the DARP. A summary of these comments and the Trustees' responses thereto are summarized in Section 7.0, Summary and Responses to Public Comments on Volume I.

This final version of Volume I of the DARP/EA is being made available to the public pursuant to State or Federal laws and regulations which apply to or have been implemented to date to guide the natural resource damage assessment process, including Section 1006 of the OPA, the State Act, and 43 C.F.R. Part 11.

1.3 NEPA Compliance (Purpose of Document)

The purposes of this DARP/EA are to:

- Describe the Tampa Bay incident and the injuries caused by the spill,
- Summarize the procedures used to document injuries for the spill,
- Establish methods for assessing damages associated with each injury,
- Establish objectives for restoring these injuries,
- Identify alternative methods considered for achieving restoration objectives, and
- Identify the restoration alternatives that have been selected by the Trustees.

The DARP/EA represents a synthesis of the damage assessment process to date, including the comments and recommendations received by the Trustees from the public concerning the assessment.

In order to comply with Section 102(2)(C) of the National Environmental Policy Act (NEPA), this DARP/EA also addresses NEPA requirements for the restoration plans by summarizing the current environmental setting, describing the purpose and need for the restoration actions, identifying alternative restoration actions, assessing their applicability and environmental consequences, and summarizing public participation in the restoration planning and decision process.

The Federal Trustee agencies have reviewed this DARP/EA, Volume I, for consistency with NEPA requirements, and the impact of the planned restoration actions on the quality of the human environment. The results of this review are contained in Section 8.0 of this DARP/EA.

1.4 Administrative Record and Availability

The Trustees have each maintained records to document the available information considered by the Trustees as they have proceeded to plan and implement assessment activities and address restoration and compensation issues and decisions. These records facilitate public participation in the assessment process and will be available for use in future administrative or judicial review of Trustee actions to the extent provided by Federal or State law.

To date, the administrative record in the matter of the Tampa Bay spill includes data and information considered by the Trustees during the Preassessment Phase, the Preassessment Screen and Determination (Appendix A), the Trustees' MOU (Appendix B), the April 1994 "Natural Resource Damage Assessment Strategy, Tampa Bay, Florida" document (Appendix C), final study reports generated in the assessment process, the December 1995 draft of Volume I of the DARP, this Final Volume I of the DARP/EA, and other documents considered by the Trustees to document the actions of the Trustees and to be necessary or appropriate to understanding the natural resource injuries resulting from the spill. Further information and documents, such as Volume II of the DARP, public comments received on Volume II, and further restoration plan documents, will be included when available or completed.

Documents within the administrative record can be viewed at the following locations:

Federal Records -
U.S. Department of Commerce
National Oceanic and Atmospheric Administration
Damage Assessment Center - Southeast Region
9721 Executive Center Drive North
Koger Building, Suite 134
St. Petersburg, FL 33702
Telephone No.: (813) 570-5391

State Records -
Florida Department of Environmental Protection
Bureau of Emergency Response
8407 Laurel Fair Circle, Room 214
Tampa, FL 33610
Telephone No.: (813) 744-6462

The administrative record is comprised of documents at both locations.

2.0 OVERVIEW OF THE AUGUST 1993 TAMPA BAY OIL SPILL (Purpose and Need for Action)

2.1 Description of the Incident

At about 5:45 a.m. on Tuesday, August 10, 1993, the tank barge "OCEAN 255" and the tank barge "B-155" collided with the freighter "BALSA 37" just south of Mullet Key near the entrance of Tampa Bay, Florida (Figure 1). The 546-foot OCEAN 255 caught fire upon impact and burned for approximately 18 hours. During that period, approximately 32,000 gallons of Jet A fuel, diesel, and gasoline were discharged into lower Tampa Bay from the OCEAN 255. The 442 foot B-155 was also damaged by the collision and discharged approximately 330,000 gallons of #6 fuel oil in the same vicinity.

Some oil initially came ashore at Fort DeSoto Park (Mullet Key) and Egmont Key, oiling exposed beaches, seagrass beds and mangroves in the immediate area. However, winds and ebbing (outgoing) tidal currents in the first few days after the spill transported most of the discharged oil out of the bay into the Gulf of Mexico (Figure 2). The oil remained about 15-30 miles offshore with mild winds moving the oil northward, parallel to the Pinellas County shoreline, until a subsequent storm system with strong west winds quickly pushed the oil ashore along the Pinellas County barrier islands and tidal inlets (Figure 3). Most of the oil came ashore on Saturday and Sunday, August 14 and 15. Strong winds and incoming tides at John's Pass and Blind Pass resulted in rapid oiling of shoreline areas within Boca Ciega Bay near those passes.

Much of the oil became stranded on sand beaches on Pinellas County barrier islands where it could be removed effectively. However, oil also stranded in mangroves, salt marshes, seagrasses, mud flats, and oyster beds, where cleanup and removal actions were less effective. Oil also collected in finger canals and against seawalls. Additionally, some of the heavy and viscous #6 fuel oil sank, forming mats of oil in depressions along the bottom offshore of the beaches, in passes, and in Boca Ciega Bay. This oil was difficult to locate and has proved more difficult to remove.

Figure 1.

Map of Tampa Bay area with location of collision and spill, August 10, 1993

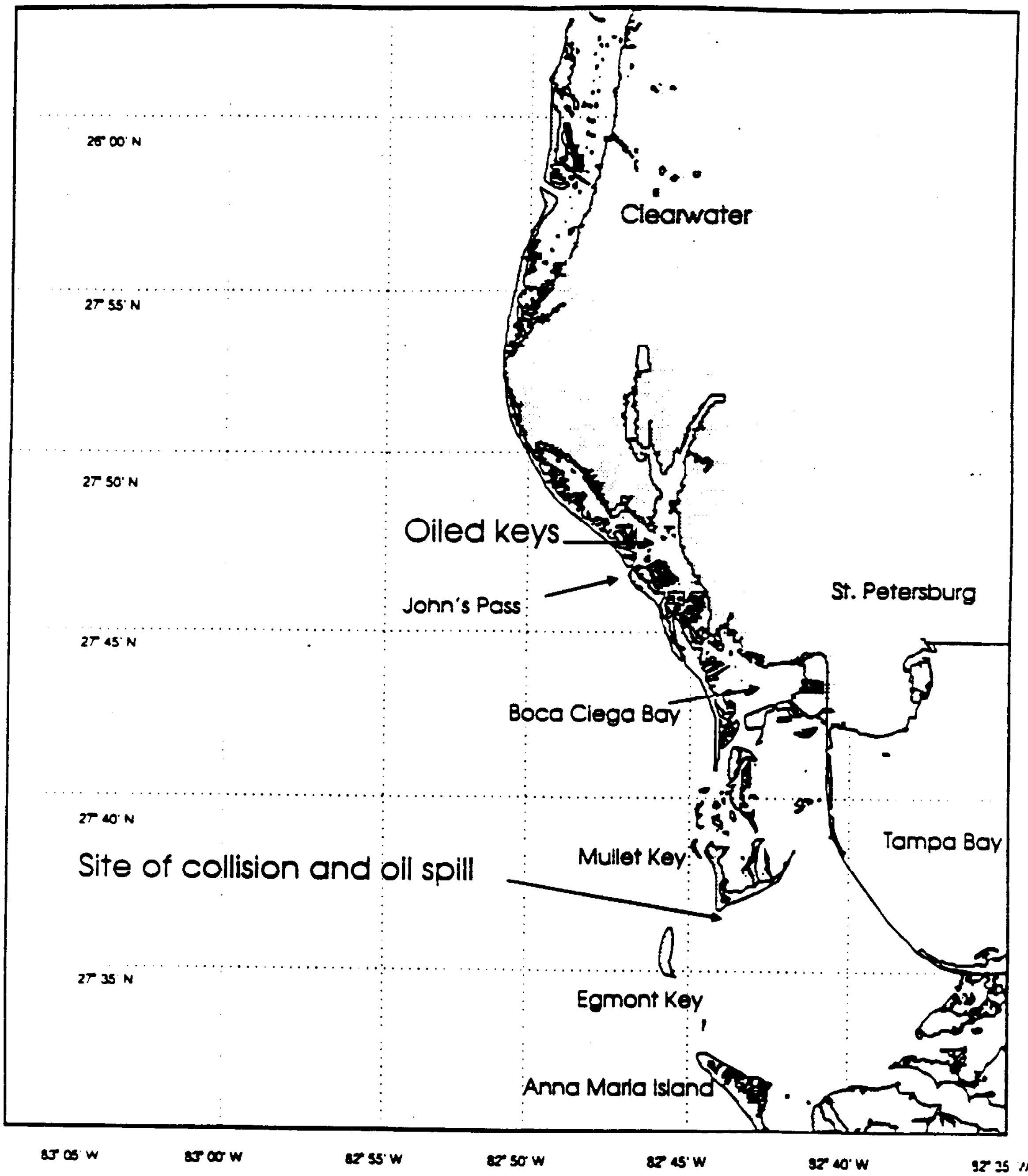


Figure 2.

Location of Oil Slick Offshore on August 11, 1993

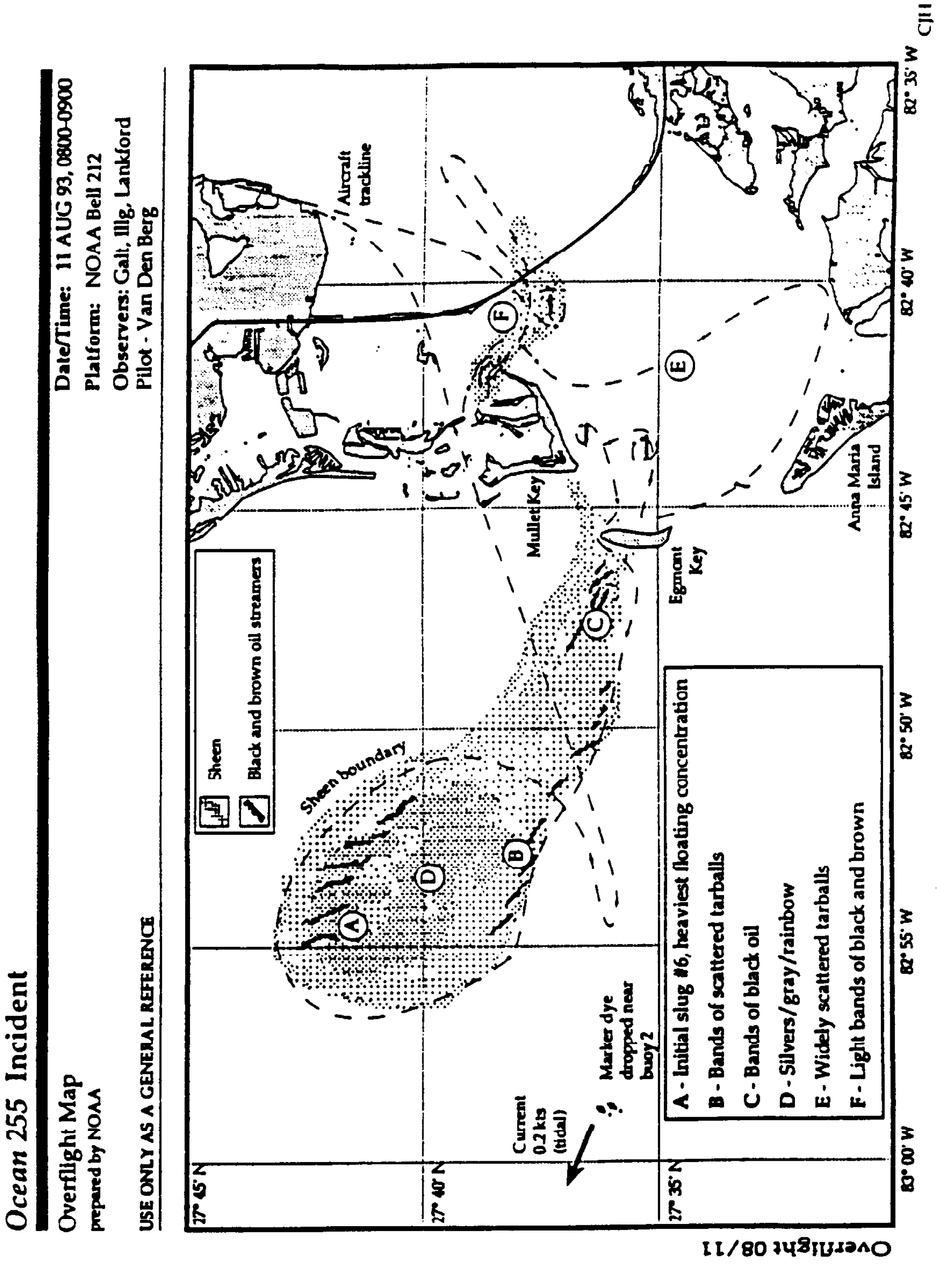


Figure 3.

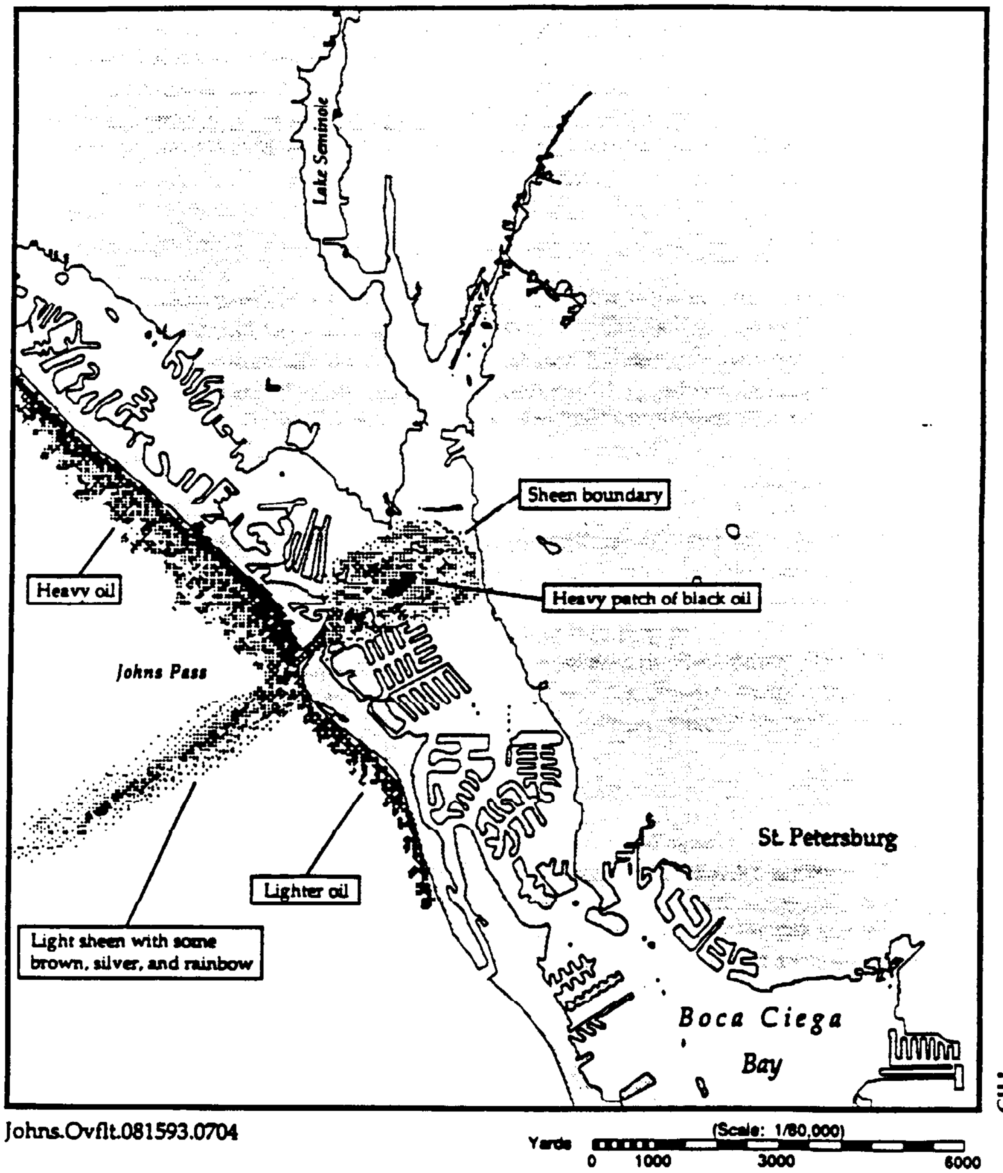
Location of oil spill on Pinellas County beaches on August 15, 1993

Ocean 255 Incident

Johns Pass
prepared by NOAA

USE ONLY AS A GENERAL REFERENCE

Date/Time: 15 AUG 93, 0704-0830
Platform: NOAA Bell 212
Observers: Galt, Lankford, Michel (NOAA); Harbert (USCG OSC)



Emergency response actions were undertaken by RP contractors cooperatively with federal, state and local agencies, under the leadership of the federal (USCG) and state (DEP) On-Scene-Coordinators (FOSC and SOSC, respectively). Response to the oil discharges included source control, containment, diversion, and cleanup of the oil on the water and shoreline. While response efforts were considerable and effective, such efforts could not prevent all natural resource exposure to oil and resulting injury. Oil was particularly difficult to recover from mangroves, oyster reefs, and salt marsh areas. Details of the incident and response actions are contained in both the Florida DEP "Tampa Bay Oil Spill After-Action Report" (DEP 1993) and the "FOSC After Action Report" for the incident (Harbert 1994).

2.2 The Receiving/Affected Environment: The Tampa Bay Estuary

The spill occurred in the Tampa Bay estuary, the largest estuary in Florida and a designated National Estuary. The Tampa Bay National Estuary Program (NEP), established in 1991, has conducted extensive technical investigations and public outreach to develop a community-based consensus about the status of Tampa Bay resources and restoration priorities to improve environmental quality. The findings of the Tampa Bay NEP are set forth in Charting a Course for Tampa Bay, Comprehensive Conservation and Management Plan (April 1997). The restoration proposals in this DARP/EA are consistent with the objectives and priorities of the Tampa Bay NEP.

2.2.1 Physical Environment

Located on the west central coast of Florida, Tampa Bay is the state's largest open water estuary. This roughly y-shaped estuary covers almost 400 squares miles, and can be subdivided into 7 geographic areas, including the 35 square miles of Boca Ciega Bay. The Tampa Bay watershed spans 2,300 square miles of 6 different counties. Activities in this watershed area directly affect the health of the Bay due to the large amount of rivers and tributaries that drain into the Bay. (See "Hydrology" below.)

Geology, Soils and Topography

The geology of Tampa Bay is composed of three layers. The bottom layer is igneous rock made up of diabases, basalts, and phyolites. The middle layer is composed primarily of shale, limestone and anhydrite. The upper layer is a carbonate platform common to the geographic areas of Florida and Georgia (Culbreth et al, 1985). There are five main soil types in the Tampa Bay region: Suwanee low clastic limestone; Tampa limestone; Hawthorne formation phosphoritic combination; Bone Valley formation with phosphatic boulders; and Caloosahatchee low clastic coquina limestone (Roush, 1985). Tampa Bay was formed by fluctuations in sea level rise during the Pleistocene glaciation (Doyle, 1985).

Climate and Weather

The Tampa Bay area is characterized by long, humid summers, and warm winters typical of a sub-tropical climate with a mean annual temperature of 22.7° C. This region receives approximately 49 inches of precipitation yearly distributed in a highly seasonal pattern. Most of the rainfall occurs June through September (accounting for 59% of annual rainfall) characterized by afternoon thunderstorms, and can be accompanied by tropical storms and hurricanes. Winters are relatively short with the possibility of occasional freezes (Wooten, 1985).

Hydrology

There are four principal drainage systems in Tampa Bay: the Manatee River, the Hillsborough River, Little Manatee River, and the Alafia River. Approximately 85% of the freshwater flow into the bay can be attributed to discharges from the rivers and their tributaries (Lewis and Estevez, 1988). The Boca Ciega Bay drainage system is composed primarily of freshwater flow from Lake Seminole and small urban tributaries. In addition, Tampa and Boca Ciega Bays are low wave action systems with average wave heights less than 50 cm.

2.2.2 Biological Environment

This estuary contains an exceptionally diverse biota of both tropical and temperate origin. The lower portion of Tampa Bay is an environmentally high-quality water body with extensive seagrass beds, mangrove-forested islands and fringing salt marshes (Boler 1992, Estevez 1989, Lewis and Estevez 1988, Treat et al 1985).

Vegetated Habitats

Seagrasses:

Seagrass habitat in the Tampa Bay region is characterized primarily by three species of seagrasses, turtle grass (*Thalassia testudinum*), manatee grass (*Syringodium filiforme*), and shoalgrass (*Halodule wrightii*) and all are found adjacent to the mangrove islands, such as Elnor[1] Key, in Boca Ciega Bay. This bottom habitat functions as an important nursery ground for many fish species. Seagrasses are also the primary source of food for turtles and manatees. In addition, they stabilize the sediments and reduce turbidity. Approximately 35% of the seagrass beds in Tampa Bay are moderately to heavily scarred from heavy commercial and recreational boating traffic.

Mangroves:

The mangroves of the Tampa Bay estuary are near the northern boundary for permanent mangrove forests on the west coast of Florida. The stands are primarily composed of three species: red mangrove (Rhizophora mangle), black mangrove (Avicennia germinans), and white mangrove (*Laguncularia racemosa*). They are located on protected shorelines and on island strands. Mangroves form an integral part of the ecological balance in coastal systems. They trap nutrients and particles in the water column. The fallen and decaying vegetation forms part of the nutrient rich detritus that feed small fish, shrimp, and invertebrates. Resident and migrating birds use the mangroves in Boca Ciega Bay for roosts and nesting sites. All three species of mangrove exist on the mangrove islands in Boca Ciega Bay with black and red mangrove predominantly occupying the shoreline zone adjacent to the fringing oyster population.

Salt Marshes:

The salt marshes of the Tampa bay region are dominated by the smooth cord grass (*Spartina alterniflora*). This intertidal marine grass habitat forms both narrow fringing marshes along the shorelines and more extensive marsh habitat in protected embayments within the estuary. Salt marsh and mangrove habitat are often found in close proximity and compete for the same shoreline areas. Salt marshes are known to be sensitive to oiling.

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[1] Previous documents may have used "Eleanor", an alternate spelling of this island; however, the preferred spelling is "Elnor".

Non-Vegetated Habitats

Soft-Bottom:

This bottom type is characterized by unvegetated soft mud or sand. Sediments may be resuspended by wave or tidal changes. This environment supports burrowing animals and one square meter can contain up to one million invertebrates (TBNEP, 1997). Approximately 83% of the Tampa Bay bottom is soft-bottom.

Hard-Bottom:

The hard-bottom habitat in Tampa Bay is scarce. Formed by rocky protrusions on the bay bottom, this habitat supports an array of plants and invertebrates.

Intertidal Mud Flats:

Intertidal mud flats, characterized by filter feeders, are exposed at low tides, and provide feeding grounds for seasonally migrating wading bird species. Terrestrial predators, such as raccoons, burrow through the exposed mud flats in search of prey items such as shellfish and crustaceans.

Fish and Wildlife Resources

The Tampa Bay estuary and nearby waters of the Gulf of Mexico host and support many recreationally and commercially important fisheries. The estuary provides critical feeding, reproductive, and nursery habitat for many of these species. Area waters also support specially protected wildlife such as marine mammals and sea turtles. Sea turtles use area sand beaches for nesting.

Tampa Bay has experienced a severe decline in commercial landings of finfish and shellfish. For example, catches of seatrout have declined 87% since 1960 with a drop from 800,000 pounds to 100,000 pounds. (TBNEP, 1996). Despite declines in commercial landings of black mullet and spotted seatrout, 4.7 million pounds of finfish and shellfish were harvested in 1992. A ban on gill netting came into effect in July 1995.

The commercial shellfish industry is virtually non-existent. Large portions of the bay are closed to harvesting due to bacterial contamination associated with septic tank leachate and agricultural runoff tainted with animal wastes. The unrestricted areas of the bay are not sufficient to maintain a profitable industry.

Many species of coastal and wading birds use the warm, shallow coastal waters for feeding and use shoreline habitats such as beaches, mangroves, and salt marshes for roosting and nesting. Mangrove-forested islands throughout the estuary serve as critical bird rookery and nesting habitat for brown pelicans and wading birds, such as herons and egrets. Several of these mangrove islands, including those around Mullet Key and those in Boca Ciega Bay near John's Pass, are wildlife preserves with access restricted to prevent disruption of bird colonies.

There are over 200 species of birds recorded in Tampa Bay and over 83 that utilize Tampa Bay habitats for transient, permanent, breeding, or wintering purposes. The brown pelican, *Pelecanus occidentalus*, nests in the canopy of mangrove trees and is dependent on nearby resources to feed the young. The current estimate of the breeding population of colonial pairs in Tampa Bay is approximately 40,000 (Paul, 1996).

Threatened and Endangered Species

The Tampa Bay region is home to several threatened and endangered species, such as the West Indian manatee, and other species of special concern. Tables 1 and 2 list the fragile species found in the Tampa Bay ecosystem.

Table 1. Federally Listed Threatened and Endangered Species in Pinellas County

Common Name	Scientific Name	Status
American alligator	*Alligator mississippiensis*	Threatened
Atlantic loggerhead turtle	*Caretta caretta caretta*	Threatened
Atlantic green turtle	*Chelonia mydas mydas*	Endangered
Leatherback turtle	*Dermochelys coriacea*	Endangered
Atlantic hawksbill turtle	*Eretmochelys imbricata imbricata*	Endangered
Kemps ridley sea turtle	*Lepidochelys kempii*	Endangered
West Indian manatee	*Trichechus manatus latirostris*	Endangered
Piping Plover	*Charadrius melodus*	Threatened
Bald Eagle	*Haliaeetus leucocephalus*	Endangered
Southeastern snowy plover	*Charadrius alexandrus var. tenuirostris*	Concern, Threatened in Florida
Wood Stork	*Mycteria americana*	Endangered
Roseate tern	*Sterna dongallii*	Threatened
Least tern	*Sterna antillurum*	Threatened

Table 2. Florida Listed Species of Special Concern in Pinellas County (April 29, 1996)

Common Name	Scientific Name
Little Blue Heron	*Egretta caerulea*
Reddish Heron	*Egretta rufescens*
Snowy Egret	*Egretta thula*
Tricolor Heron	*Egretta tricolor*
White Ibis	*Eudocimus albus*
Black Skimmer	*Rynchops niger*
Brown Pelican	*Pelecanus occidentalis*
Oyster Catcher	*Haematopus palliatus*
Roseate spoonbill	*Ajaia ajaja*

2.2.3 Cultural Environment

Historical or Archeological Resources

Historic maps show that Elnor, Rookery, and Little Bird Keys have been in the bay since the 1880's. There are no known historical or archaeological resources present on these sites. Furthermore, there are no records at the Florida Historic Preservation Office indicating that any archaeological work has been done on these islands.

Land Use and Recreation

The Tampa Bay planning district is home to a large and growing urban center, with an estimated population of 2.34 million in 1996 (Bureau of Business and Economic Research, 1996). The economic base in this region is quite diverse with agriculture, commercial fishing, and port activities as large contributors. The estuary itself is heavily used by the commercial fishing and shipping industry. The Tampa Bay region is also host to many tourists that contribute significantly to the economic base.

Tampa Bay and its surrounding waters and shores are used extensively by the public for a variety of recreational activities such as swimming, diving, beach going, boating, fishing, and windsurfing. Several areas within the bay system are designated for special management. These include Egmont Key and Fort DeSoto Park at the mouth of Tampa Bay. Egmont Key is both a National Wildlife Refuge and a State Park. Fort DeSoto Park, which is operated by Pinellas County, encompasses all of Mullet Key and some smaller keys, and is a wildlife preserve with extensive mangrove, salt marsh and seagrass areas within its boundaries. Fort DeSoto is also a very popular area for picnicking, swimming, camping, beach going, fishing and boating. It features the largest public boat ramp in Florida and is used by approximately 2.25 million visitors annually (Browning, 1995).

2.3 Summary of Preassessment Activities

Each of the Trustees received notice of the Tampa Bay incident on August 10, 1993 and, upon notification, coordinated to plan and implement a preliminary investigation of the spill and its potential to affect natural resources. These investigative activities focused on documenting the extent to which various natural resources were exposed to oil, the direct mortalities and other injuries to wildlife, and closed or impaired human uses of the natural resources. To avoid interfering with response activities and/or to provide efficiency, activities undertaken in this investigation were also coordinated with the FOSC, the SOSC, and the RPs. The Trustees' preliminary investigation continued for several months and included the following activities:

- Sampling of spilled oil and oiled areas[2],
- Documentation of the oil trajectory and pathways of resource exposure,
- Documentation of lost human uses of resources, including waterway, park and beach closures,
- Documentation by professional land surveyors of shoreline areas oiled,
- Aerial infrared photography of oiled shoreline vegetation,
- Early documentation of mangrove injury at the John's Pass islands,
- Water column sampling for hydrocarbons in areas affected by the spill,
- Plankton sampling for presence of larval fish and invertebrates in waters affected by the spill,
- Continuation of a State surf zone fish study at Pinellas County beaches,

[2] All sampling, shipping, and analyses were conducted under appropriate chain-of-custody procedures.

- Collection and review of records of bird and sea turtle rehabilitation facilities operating during the spill,

- Post-spill seagrass ecological community injury study,

- Residual oil study at Elnor Island area,

- Review of pre- and post-spill real color aerial photographs taken by the Florida Surface Water Improvement Program (SWIM) to document changes to seagrass beds,

- Field surveys to detect residual oil in sediments associated with seagrasses around Elnor Island, and

- Monitoring of heavily oiled oyster reefs to assess the need for emergency restoration.

Based on their preassessment investigation, the Trustees identified 13 categories of natural resource injuries resulting from the Tampa Bay oil spill which warranted further consideration in assessing natural resource damages. Each category was identified based upon consideration of the importance of the resource within the Tampa Bay estuary; the nature, degree and significance of its particular injury or loss; the associated need and potential for restoration; and the availability of information and methods to assess the injury and damages at reasonable cost.

Information and data obtained from the preassessment investigation were considered by the Trustees in accordance with criteria identified in 43 C.F.R. Part 11, Subpart B. That evaluation is documented in the "Preassessment Screen and Determination for August 10, 1993 Tampa Bay Florida Oil Spill," dated November 2, 1993 (Appendix A) which documents the decision of the Trustees to proceed with a formal assessment of natural resource damages for the Tampa Bay oil spill.

Further details and results of preassessment activities for specific natural resources are presented in Section 4.0.

2.4 Natural Resources and Resource Services Injured

The thirteen natural resource injury categories identified by the Trustees are listed below with a brief description of each. The first nine categories focus on ecological effects stemming from the spill. Volume I discusses each of the nine ecological injury categories separately in Section 4.0. The last four are human uses of natural resources that were disrupted by the spill (to be addressed in Volume II).

Ecological Injury categories addressed in Volume I:

1) <u>Mangroves</u> - Oil was carried into several mangrove-forested islands following the spill. Some mangroves at Mullet Key were oiled, but the most heavily exposed areas were three islands in Boca Ciega Bay near John's Pass, referred to as Elnor Island, Little Bird Key and an unnamed island hereinafter referred to as Rookery Key. Approximately 5.5 acres of mangroves at these three islands were moderately to heavily oiled.

2) <u>Seagrasses</u> - Approximately 255 acres of seagrasses were exposed to floating oil slicks during the course of the spill, including near Mullet and Egmont Keys and in Boca Ciega Bay near John's Pass. Heavy to moderate oiling of seagrass beds occurred in Boca Ciega Bay near John's Pass and southward. Approximately 2.5 acres of seagrasses in this area were initially destroyed as a result of smothering by submerged oil or from physical disruption caused by oil removal and cleanup activities.

3) Water Column - During the course of the spill, the oil slick traversed approximately 300 square miles of open Gulf waters and 27 square miles of bay waters. As it did, fractions of the discharged oils were dispersed into the water, and droplets of oil were entrained in the water column, especially in the surf zone. This contamination of the water column had the potential to affect exposed fishery stocks and planktonic organisms.

4) Birds - Three hundred and sixty-six (366) birds were recovered and processed by the bird rescue and rehabilitation facility at Ft. DeSoto Park. Bird injuries included direct mortality as a result of oiling, ingestion, or stress from capture and cleaning. In addition, experts indicate that a significant number of the affected birds would not have been captured or recovered. Indirect injuries - such as from disruption of nesting and foraging activities and habitat loss - are being addressed within the assessment for mangrove and salt marsh injuries.

5) Sea Turtles - The Federally endangered green sea turtle (*Chelonia mydas*) and the threatened loggerhead sea turtle (*Caretta caretta*), their nesting beaches, nests, and foraging areas were oiled or disrupted by cleanup operations. Special spill response efforts were directed toward protecting these sensitive resources. Injuries to these species included mortality, oiling, reduced hatching success, and disturbance.

6) Salt Marshes - At least 0.85 acres (36,809 square feet) of salt marsh vegetation were exposed to oil from the spill, primarily within Boca Ciega Bay from north of John's Pass to Gulfport. About 0.75 acres of these exposed marshes sustained some level of injury.

7) Shellfish Beds (Ecological Injuries) - Surveys documented that 0.22 acre (9,477 square feet) of oyster beds associated with intertidal areas of Elnor Island, Rookery, and Little Bird Keys were destroyed as a result of smothering by the spilled oil or physical disruption caused by removal and cleanup activities. In addition to these shellfish beds, approximately one vertical foot of 20 linear miles of seawalls in Boca Ciega Bay were oiled.

8) Bottom Sediments - At least 1.34 acre (58,540 square feet) of subtidal sediments were covered by submerged oil patties or mats. Submerged oil was found in the subtidal sandy sediments just off Pinellas County beaches as well as in seagrasses, mud flats and in deeper areas of Boca Ciega Bay. Observations of several species of crustaceans indicated that the oil caused injury to subtidal organisms.

9) Beach Physical Injury (Sand Removal) - At least 13 linear miles of sandy shoreline along Gulf beaches were oiled during the spill, from Redington Shores southward to Fort DeSoto Park and at Egmont Key. At least 39,827 cubic yards of sand were removed from public beaches incident to the cleanup, potentially diminishing the capacity of the beach to resist erosion or protect coastal areas from storms. Other ecological effects from the oiling of sandy shorelines, such as impacts to surf zone biota, shore birds, sea turtles, and the loss of public beach use, are being addressed as part of other injury categories in the assessment.

Lost-Use Injury categories to be addressed in Volume II:

10) Lost Use of Shoreline for Recreation - The initial oiling and associated cleanup of beaches from Redington Shores to Egmont Key (at least 13 linear miles) prompted closures along much of these beaches. Re-oiling by offshore deposits of submerged oil has occurred periodically after storms. A significant public loss of recreational beach use and associated shoreline activities occurred as a result of the spill and cleanup activities.

11) Lost Use of Surface Water for Recreation - Large areas of Tampa Bay, the Gulf of Mexico, and Boca Ciega Bay surface waters were directly affected by the discharged oil and resulted in a loss of access and recreational use of these waters by the public.

12) Shellfish Beds - Lost Use for Recreation - As a result of the discharge, the State of Florida closed shellfish beds in lower Tampa Bay and Boca Ciega Bay. In lower Tampa Bay, an estimated 14,424 acres of shellfish beds were closed for 45 days, and near Mullet Key an estimated 14,105 acres were closed as a result of continued high petroleum hydrocarbon levels in shellfish for a total of 112 days.

13) Surface Water - Lost Use for Navigation - Large areas of Tampa Bay, the Gulf of Mexico, and Boca Ciega Bay surface waters were directly affected by the discharged oil and resulted in a loss of use of these waters for commercial navigation.

2.5 Natural Resources with No Documented Injuries

Following the spill, there was concern over potential injuries to marine mammals, however, no marine mammal deaths or injuries have been associated with the spill. Additionally, some small areas of dune vegetation were reported to have been oiled or crushed by cleanup equipment, but inspection of these areas found little residual injury.

3.0 OVERVIEW OF VOLUME I

Sections 3.0 and 4.0 present the strategy and procedures that the Trustees will use to assess damages and restore the ecological injuries caused by the Tampa Bay oil spill. See Table 3 for a summary of these injury categories, the assessment methods, and preferred restoration alternatives.

3.1 Trustee Strategy

State and Federal liability frameworks for natural resource damages share a common objective -- to provide for expeditious restoration, replacement, or acquisition of equivalent resources to compensate the public when injuries to natural resources result from unlawful discharges of oil or other contaminants. Under these laws, the Trustees are responsible for determining the actions needed to restore injured resources to their baseline condition and to compensate for the loss of the injured resource pending full restoration. The costs of implementing those actions represent a primary measure of the natural resource damages liability of the RPs. Consistent with public policies and interests in achieving restoration, the Trustees' strategy in developing Volume I has been to define compensation for resource injuries caused by the Tampa Bay oil spill based on necessary or appropriate resource restoration actions wherever possible.

The Trustees' consideration of restoration issues and alternatives for resources injured as a result of the Tampa Bay oil spill has been ongoing since the incident. This early focus on restoration has allowed the Trustees to effectively integrate restoration objectives in selecting injury and damage assessment methods.

In addition to an early focus on restoration, the Trustees' strategy in developing this assessment and restoration plan has been to use simplified, cost-effective procedures and methods in the assessment wherever feasible to document resource injuries and develop a restoration strategy. Accordingly, depending on the injury category, Volume I uses, alone or in combination, relevant scientific literature, scientifically based models, and focused injury determination or quantification studies.

Table 3. Assessment Components for Ecological Injuries and Losses

Injury	Injury Assessment Method	Damage Assessment Method	Restoration Approach
1. Mangroves	Use ground surveys, aerial photography, and impact studies to determine extent, nature, and duration of injury.	Use Habitat Equivalency Analysis to determine appropriate scale of restoration; determine cost to implement the appropriate projects plus cost of any actions to promote recovery of injured area.	Promote natural recovery of injured areas by stabilizing fringing oyster reef (see #7 below) and protecting oil-exposed islands with fringe plantings of salt marsh grasses or mangrove propagules as needed; replace interim loss by creating or enhancing mangrove habitat in the Boca Ciega Bay system.
2. Seagrasses	Use aerial photography, exposure surveys, and community analysis to determine amount of area injured and estimate recovery rate.	Use Habitat Equivalency Analysis to determine appropriate scale of restoration; determine cost to implement the appropriate projects.	Natural recovery for injured areas; replace interim loss by improving Boca Ciega Bay water quality, with preference for projects that enhance seagrass communities.
3. Water Column	Use collected information to apply the NRDAM/CME, define water column injury using the model	Determine damages by applying the NRDAM/CME computer model output for water column injury only.	Natural recovery for water column injuries; use damages estimated by NRDAM/CME model to compensate for interim loss by funding water quality improvement projects and/or artificial reefs or seawall encrusting communities in the area.
4. Birds	Use records of injured birds from bird rehabilitation centers as representing 50% of birds actually injured; total injured birds = rehab # (366) times 2 or 732 birds.	Cost to replace the number of birds injured.	Rehabilitate or protect birds that otherwise would be lost by augmenting and/or removing fishing line, enhancing existing bird rehabilitation programs, maintaining existing bird rescue equipment, augmenting spill response equipment, and removing fishing line from bird habitats.
5. Sea Turtles	Use response records to estimate the number of sea turtles and eggs exposed to oil or disrupted by response activities.	Cost to improve or augment existing programs to replace or protect turtles in the area of the spill.	Promote recovery to baseline by expanding nest monitoring and protection programs and funding other high priority efforts identified in the Federal Turtle Recovery Plan.

6. Salt Marshes	Use ground surveys and aerial photography to determine the extent, severity, and duration of injury.	Cost of any on-site restoration actions plus cost of replacing one year of ecological services provided by .75 acres of salt marsh.	Natural recovery for most of the injured areas. If recovery is impeded, Trustees may consider limited planting of marsh grasses; replace interim loss of salt marshes by enhancing or creating salt marsh communities, preferably in conjunction with the mangrove project referenced in #1 above.
7. Shellfish Beds	Use data from spill response surveys and independent field evaluations to determine the area and duration of injury.	Cost of restoring fringing reef to baseline plus compensation for interim loss based on costs to create or enhance equivalent new reef areas.	Promote recovery to baseline by removing oiled substrate and replacing with stable oyster cultch materials; Replace interim loss of oyster bed services by creating new oyster reef communities, preferably in conjunction with the mangrove or water quality improvement project referenced in #1 above.
8. Bottom Sediments	Use response surveys to estimate exposed area, evaluate effects based on scientific literature.	Determine damages by using cost factors for sediment restoration in the NRDAM/CME computer model.	Natural recovery for injured areas; use compensation for interim loss to improve water quality in the vicinity of sediments injured in Boca Ciega/lower Tampa Bay system.
9. Beach Physical	Use response records to determine the amount of sand removed during cleanup.	Cost of implementing the appropriate amount of beach sand replacement.	Return beaches to baseline by replacing a volume of sand equal to that removed during the response; Loss of interim services could not be documented, so no replacement of interim loss is proposed.

The Trustees' emphasis in assessment and restoration planning has been on the areas most affected by the spill; however, the approach has taken into account that the injured resources are also part of a larger ecological system -- the Tampa Bay estuary. In identifying and evaluating restoration alternatives, the Trustees have included, where appropriate, actions offering multiple ecological or human use benefits to the larger Tampa Bay ecosystem in addition to those of benefit to a specific injured resource. As a result, Trustee strategies may reflect specific actions for specific injuries, may "bundle" actions for injuries within an appropriate watershed or water quality improvement project, or may reflect both types of approaches. Watershed-based actions are considered in terms of their ability to assist or benefit injured resources and their likely contribution to improving water quality or habitat availability in the affected system. This approach recognizes that watershed-based actions have the potential to reduce administrative oversight, procedural requirements, permitting needs, and construction logistics, all of which affect the costs of accomplishing restoration.

In forming the above strategy, the Trustees surveyed and considered the various sources of guidance currently available for use by Trustees, including OPA, the State Act, the natural resource damage assessment regulations promulgated by DOI at 43 C.F.R. Part 11, and the regulations then under development by NOAA pursuant to OPA for use in assessing natural resource damages for oil spills. The above strategy is consistent with the applicable statutes and all available guidelines. Additional details associated with the Trustees' approach to this assessment process are presented in the document entitled "Natural Resource Damage Assessment Strategy, Tampa Bay, Florida (April 1994) for the Bouchard BARGE 155, Maritrans barge OCEAN 255, and MV BALSA 37 collision and spill, 10 August 1993" previously released by the Trustees (Appendix C).

3.2 Framework for Identifying Preferred Restoration Actions

Section 4.0 of this Volume evaluates the potential for restoring natural resource injuries caused by the spill, identifies alternatives to restore or compensate for such injuries, and presents preferred alternatives identified by the Trustees to meet stated restoration objectives.

For each of the injuries, the likelihood of natural recovery and the prospects for continuing injury have been considered. Restoration alternatives were identified through initial screening by the Trustees to evaluate feasibility. Alternatives considered feasible for implementation are included in the DARP/EA for qualitative analysis according to the selection criteria listed below. The preferred alternatives identified provide the basis for defining the components and costs of actions required to restore or compensate for the ecological resource injuries caused by the Tampa Bay oil spill.

Selection Criteria - The following criteria were used in the Trustees' qualitative evaluation of restoration alternatives:

<u>Results of actual or planned response actions</u> - Considered the extent to which response activities restored an injury or loss.

<u>Relationship to assessed injury</u> - Considered the nature and extent to which a restoration action would address the natural resource injuries that occurred as the result of the spill, including those resulting from response actions. This includes the extent to which benefits of the action would be on-site, in-kind, or would be otherwise comparable in nature, scope, degree and location to injuries that occurred.

<u>Relationship to natural recovery</u> - Considered the extent to which implementation of a given restoration alternative would reduce the time it takes an injured resource to recover to baseline and the ability of the resource to recover with or without alternative actions.

Consistency with restoration objectives - Considered the extent to which a given approach to restoration achieves restoration objectives identified for the injured resource.

Consistency with community objectives - Considered the degree to which a given restoration alternative is consistent with objectives for protection or enhancement of natural resources in the impacted watershed which are the subject of community-wide consensus. Such objectives may be found in National Estuary Program - Comprehensive Conservation and Management Plans or other community-based planning documents for the impacted watershed.

Technical feasibility - Considered both the likelihood that a given restoration action will succeed in a reasonable period of time, and the availability of technical expertise, programs and contractors to implement the considered action. This factor includes, but is not limited to, consideration of prior experience with methods or techniques proposed for use, availability of equipment and materials, site availability and logistical difficulty.

Site requirements - Considered and compares the extent to which physical, biological or other scientific requirements of proposed restoration actions can be met by available sites.

Potential for additional natural resource injury - Considered the risk that a proposed action may aggravate or cause additional natural resource injuries.

Multiple benefits - Considered the extent to which a given restoration action will address more than one natural resource injury or loss.

Sustainability of a given restoration action - Considered the vulnerability of a given restoration action to natural or human-induced stresses following implementation, and the need for future maintenance actions to achieve restoration objectives.

Consistency with policies and compliance with law - Considered the extent to which the action is consistent with relevant Federal and State policies and complies with Federal and State laws.

Cost of restoration - Considered the relationship of costs associated with a given restoration alternative to the benefits of that alternative and the ability to achieve restoration objectives. Other factors being substantially equal, the Trustees give preference to the less costly restoration approach.

The Trustees have included the following cost factors in developing and evaluating restoration alternatives.

- Concept design and preparation of engineering specifications;

- Trustee administrative activity, including public review processes, contracting, direct and indirect labor costs, administrative overhead, and restoration oversight.;

- Site acquisition; e.g., costs associated with purchase, easements, environmental audits, title searches, property title transfer, etc.;

- Permitting and other procedural requirements, e.g., costs associated with Environmental Assessment/Environmental Impact Statement preparation, protected species consultations and permits, cultural resource surveys, contaminants screening, site preparation and "Section 404" dredge permits, biological material collecting or planting, special land use or zoning requirements, equipment transport, materials disposal, landfill use, etc.;

- Project construction, e.g., direct and indirect labor costs, costs associated with equipment acquisition and transportation, planting material acquisition, special logistical support, administrative overhead, etc.;
- Performance monitoring, e.g., costs associated with post-restoration monitoring to document project performance according to design objectives; and
- Contingency funds, e.g., costs associated with project maintenance, mid-course corrections, catastrophic events, performance failures, etc.

Costs of selected restoration actions will be developed utilizing data from similar projects in the Tampa Bay area, government estimates, cost estimates developed through surveys of contract service providers, and other available sources of information.

4.0 ASSESSMENT PROCEDURES AND RESTORATION PLAN FOR IDENTIFIED ECOLOGICAL INJURY CATEGORIES

Section 4.0 presents the assessment and restoration plan for each ecological injury category.

4.1 Mangroves

4.1.1 Overview of Preassessment Activities and Findings

Mangroves are critical coastal habitats that support many other important natural resources such as birds, finfish, and shellfish, and are known to be vulnerable and sensitive to oiling. Mangrove-forested islands around Mullet Key in lower Tampa Bay and in Boca Ciega Bay inside of John's Pass (Elnor Island, Rookery, and Bird Keys) were exposed to oil from this incident.

Survey of oiled areas - Field evaluations immediately following the spill by DEP oil spill coordinators, a supervisor from DEP's contract survey firm, and RP technical representatives (the "field group") collectively identified and marked (flagged) all mangrove areas that were "moderately to heavily oiled" for further delineation using professional land survey methods. "Moderately to heavily oiled" was defined by the field group as "areas of mangroves which exhibit more than two-inch bands of oil on the trunk, branches and prop roots of the trees." The field group also decided that mangroves exhibiting only a one-to-two inch wide band of oil on the trunks, branches and prop roots would not be included in the survey. Areas below this threshold, i.e. areas lightly oiled, were considered by the field group to be at low risk of significant injury. These lightly oiled areas were not surveyed to avoid additional physical injury to mangrove aerial roots and any disruption of bird nesting activities in the mangroves by the surveyors.

Genesis Group, Inc., a certified land surveyor and DEP's contract survey firm, implemented the survey to precisely delineate these areas. This survey documented the following moderately to heavily oiled areas:

Bonne Fortune Key (at Ft. DeSoto Park)	24,039 square feet
Elnor Island	93,393 square feet
Little Bird Key	29,677 square feet
Jungle Prada Area	2,769 square feet
Rookery Key*	90,986 square feet
Total	240,864 square feet
	= 5.53 acres

(*Note: Rookery Key was not surveyed to avoid disrupting the nesting birds. The field group, after consultation with the Florida Game and Freshwater Fish Commission biologists, agreed an estimated 80% moderate to heavy oiling of Rookery Key had occurred, which has a total area of 113,732 square feet)

Aerial infrared photography - Because oiling of the mangroves and other wetland plants was likely to result in stress and some mortality, the Trustees initiated color infrared aerial photography of affected areas as a means of documenting changes in oiled shoreline vegetation over time. Vegetative stress and mortality can be detected and documented using color infrared photography by recording changes in the color of the image of the affected plants in the infrared spectrum of radiation. The change in color is caused by reduction of the photosynthetic chlorophyll in the leaves of stressed plants. As this may take some time to occur, pre-change baseline photos are useful for comparison. Accordingly, immediately after the spill, on August 17, 18, and September 3, 1993, before any change in the infrared signature of the oiled areas was expected to appear, "baseline" color infrared aerial photography of all coastal vegetation in affected areas was conducted by I.F. Rooks, Inc. of Plant City, FL. The aerial color infrared photography has been continued into the assessment phase. The results are summarized in Section 4.1.4.

Ground studies of oiled mangrove islands - The oil carried into the mangrove islands was expected to cause some injury to all life stages of the exposed mangroves, to algae and invertebrates attached to the bases of the mangroves, and to motile animals using the mangrove trunks, aerial roots, and associated sediments. The Trustees retained Coastal Zone Analysis (CZA), a firm with extensive experience in assessing injuries to oiled mangroves, to assist the Trustees in developing and conducting injury studies for the mangrove islands. The first field observations were conducted on August 18 and 19, 1993 at oil-exposed mangroves in the Ft. DeSoto (Mullet and Bonne Fortune Keys) area, and on the islands inside of John's Pass (Elnor Island, Rookery, and Little Bird Keys). Elnor Island has two parts, referred to in this document as Elnor Front (western part) and Elnor Back (eastern part). Previous scientific studies of mangrove response to oiling and cleanup actions have shown that indicators of stress and mortality may take 2 to 4 years to become apparent. Thus, plans were initiated allowing for detailed field studies of the mangroves for up to 4 years, if necessary. The study plans were structured to include both oiled sites and unoiled sites near Tierra Verde Key just north of Mullet Key and at Veterans Memorial Park near John's Pass. The study includes the systematic collection of data to characterize and monitor:

- Changes to mangrove forest structure, including species composition and age classes, and their relative exposure to oiling,
- Oil penetration and persistence into the island interior and down into the associated sediments,
- Plant survivorship by species and age class,
- Effects of oil on red mangrove propagules (seeds that sprout while still on the tree, then fall),
- Observations of other causes of injury related to the spill, such as cleanup and booming operations, and
- Observations of wildlife use of the habitat and exposure to oil.

The earliest results from these studies, available in January 1994, indicated that a few of the heavily oiled red mangroves were already dead or dying (defoliated), with most mortality occurring in the younger age classes and the propagules in the most heavily oiled areas. More than 50% of the pneumataphores (aerial root structures that extend above the sediment surface and exchange gases for the plant) of the black mangroves in the heavily oiled areas were dead, as indicated by sloughing of the pneumataphore outer coat or "skin". Calculations indicated that more than 10,000 juvenile plants were already dead in the oiled areas, and more mortality was expected given the poor condition of many of the surviving plants.

4.1.2 Definition of Injury

The Trustees have evaluated a number of possible injuries to mangroves caused by exposure to the discharged oil, including mortality of mangrove plants, impairment of the mangroves' ability to reproduce, and population reduction in the associated plant and animal community. These injuries result in loss of ecological services such as photosynthetic production, island or shoreline physical stability, bird nesting or roosting capacity, and nursery functions for fisheries.

Based on field observations and the considerations described below, the Trustees define injury to mangroves as the total number of acres of mangroves exposed to oiling sufficient to cause injury or loss of ecological services as described above. The Trustees will determine the amount of acres oiled and losses in ecological services using methods described below.

4.1.3 Key Factors in Assessing Injury

The following factors are especially important in determining the nature and extent of the mangrove injury.

Area, duration and degree of exposure - The extent to which mangroves suffer adverse effects from oil is related to the degree and duration of oiling. Another factor that affects the degree of injury is the portion of the mangrove plant (trunk or stem, aerial roots, leaves) or sediments that are oiled or physically injured.

Species and age classes of oiled mangroves - Each species of mangrove (red, black, and white) has a different physiology that affects its susceptibility to injury from oiling. This is also true of the different age classes of the plants such as propagules, seedlings, older juveniles, understory and canopy adults.

Identification and duration of ecological services lost - This information is needed to plan the appropriate type of resource restoration and to scale it fairly.

4.1.4 Injury Assessment Method

After evaluating information available in January 1994, the Trustees determined that significant injury to the mangroves had occurred and that injuries would continue to become apparent in the near future. Because of the extent of the injury and the physical and ecological complexity of mangrove habitat, simplified methods of injury assessment were considered inadequate. Trustees continued or initiated studies described below to preserve ephemeral data for use during the assessment. The data generated by these studies includes information needed to develop a technically based assessment of the injuries sustained by the mangrove habitat. This information addresses the key factors discussed in Section 4.1.3. Thus, the Trustees will assess and quantify the injury to mangroves in terms of the ecological service reductions occurring in the oiled acres of mangroves, and will characterize those reductions in services based on quantitative and qualitative information provided by the studies described below.

Detailed Physical Survey - The Genesis Group land survey of the oiled mangrove habitat on Elnor Island was repeated in the fall of 1994. Both CZA and Genesis Group participated in the repeat survey in order to correlate the data generated by these two contractors. This coordination allowed information on the degree of oiling to be related directly to the evidence and observations of injury to the mangrove community, and ensured no overlap or gaps in the determination of injured areas.

Ground Injury Study of Oiled Mangrove Islands - The study of the mangrove-forested islands initiated by CZA in the weeks following the oil spill was continued. Major field data collection by CZA has been conducted in October 1993, January 1994, April-June 1994, November-December 1994, March-April 1995, and October-November 1995. Some CZA field work related to detecting or documenting sub-lethal injuries to mangroves was conducted at monthly intervals between fall 1994 and April 1996. The CZA studies included areas with all degrees of oiling (from sheen to heavy). The CZA studies were used in conjunction with the Genesis surveys to ensure that all exposed areas were assessed for injury. Preliminary results of the CZA studies were presented in the following reports:

- "The 10 August 1993 Tampa Bay Oil Spill: Injury Assessment for the Mangrove Keys inside John's Pass, Final Report: Findings through June 1994, prepared September 14, 1994"
- "The 10 August 1993 Tampa Bay Oil Spill: Injury Assessment for the Mangrove Keys inside John's Pass: Update of Findings through December 2, 1994, prepared February 23, 1995"

- "The 10 August 1993 Tampa Bay Oil Spill: Injury Assessment for the Mangrove Keys inside John's Pass: Update of Findings through April 19, 1995, prepared May 30, 1995"

- "The 10 August 1993 Tampa Bay Oil Spill: Injury Assessment for the Mangrove Keys inside John's Pass: Final Report, Findings Through January 1996, prepared June 21, 1996"

The final CZA report prepared June 21, 1996 included all CZA mangrove injury findings. Below is a summary of these findings.

- A total of 14.4 acres of mangrove forest at the islands within John's Pass were oiled, including 9.2 acres with light oiling, 4.3 acres with moderate oiling, and 0.9 acres with heavy oiling.

- Oil stranding on sediment was heaviest on Elnor Front's west and northwest faces and on Elnor Back's northwest face. Oil and oil patty stranded throughout the outer fringe, penetrating to interior raised berms or upland areas.

- Overwash islands and areas (i.e., water at high tide passes completely through), such as Little Bird Key, had little oil stranding on sediment. In these areas, oil was deposited on mangrove surfaces, often in discrete bands.

- At lightly oiled sites, most or all visible oil disappeared from the sediments within six months, and from mangrove plant structures within 15 months after the spill. Heavily oiled sites had appreciable amounts of oil on and in sediments and on mangroves more than two years post-spill.

- The presence of residual surface and buried (to 20 centimeters deep) oil within the mangrove sediments was investigated in November 1994 and March 1995 at random quadrats (sample plots) in heavily oiled areas on Elnor Front, west and north-west faces (EF-W and EF-NW). In November 1994, oil was visible on 19% of surface sediments and buried oil was detected in an additional 29% of the areas sampled. Less oil was detected on the surface between March and September 1995 (<1 to 3%), but buried oil was detected at an additional 14-30% of the area sampled. Reductions in the amount of visible oil with time may reflect burial by shifting sediments. Observations following storms or seasonal shifts in tidal amplitude have shown that some of the buried oil may become reexposed.

- Sublethal injury and mangrove mortality were associated with heavy oiling of sediments and/or plant surfaces such as apical meristems or aerial roots.

- Mortality of all three species of mangroves occurred at the most heavily oiled site (EF-NW, 9% of all stems), with the greatest mortality to red mangroves (23% of marked trees). Marked deterioration in tree condition has been observed in some surviving trees and may indicate that additional mortality may occur in the future.

- Approximately 9% of adult stems died on the most heavily oiled section of Elnor Front Key (northwest face) and there were losses of major branches in additional trees. The same area dropped significantly in canopy height and had a significantly lower canopy standing crop of leaves.

- There was significant partial mortality of red mangrove prop roots and black mangrove pneumatophores on heavily oiled sections of both Elnor Front and Elnor Back Keys. Additionally, there was a significant drop in leaf size and in production of red mangrove leaves, wood and propagules at these heavily oiled sites. On Elnor Front Key, part of the excess mortality of black mangrove pneumatophores may have been due to collateral injury from manual removal of oil patty.

- Juvenile mangrove mortality was approximately 23,500 individuals at the three most heavily oiled keys, two years post spill.

- The presence of oil patty in sediments significantly decreased the survival of planted red mangrove propagules.

- Successful recruitment of mangrove seedlings was low at both oiled and unoiled sites through the fall of 1995. Mortality of seedlings in oiled areas was higher than for unoiled sites.

- The abundance of algae and invertebrates growing attached to mangrove surfaces, and of molluscs and crabs living in mangroves was reduced at moderately to heavily oiled sites in 1993. Observations suggested most, but not all, had returned by November 1995.

- Between August 1993 and February 1996, fifty-nine species of birds were positively identified in oiled mangroves or on sand/mud flats around the shores of oiled mangroves. Fourteen of these species are listed as endangered, threatened, species of special concern or as candidates for listing by either the State of Florida Game and Freshwater Fish Commission or the United States Fish and Wildlife Service.

The above observations indicate that injury and loss of ecological services have occurred in the oiled mangroves. The results of the CZA mangrove injury study and the physical survey by the Genesis Group will be the primary information used to quantify the injury to mangroves.

Aerial Infrared Color Photography - Aerial infrared color photography was continued for mangroves and salt marshes only in areas expected to show vegetative changes sufficient to be detected by infrared photography. These areas included the John's Pass and Veterans Park areas of Boca Ciega Bay. The aerial infrared photographs did not detect injuries in these areas beyond or in addition to what ground studies revealed. As a result, they were discontinued after November 1994.

Evaluation of Residual Oil - In addition to the investigation of buried oil discussed above, the injury potential of residual oil in several habitats on and around Elnor Island, including sediments within the mangroves, was evaluated for the Trustees in the cooperative study by the University of South Florida and Mote Marine Laboratory (USF/Mote). Field sampling by USF/Mote was conducted June 20 and 21, 1994 and a final report submitted to the Trustees on February 24, 1995 (Van Vleet et. al, 1995). The study found residual oil persisted in the mangrove sediments. USF/Mote reports that the oil was generally found in discrete globules and that natural decomposition of the oil varied greatly. Some oil had lost the most toxic and volatile fractions such as the naphthalenes and polyaromatic hydrocarbons (PAHs), but the oil in the core sample (M2D) from mangrove sediments on the west side of Elnor Front showed little change since stranding in August 1993, retaining the toxic naphthalenes and PAHs.

4.1.5 Damage Assessment Method

The Trustees will assess damages for mangrove injuries caused by the Tampa Bay oil spill based on the costs of any on-site actions necessary to facilitate recovery of the injured mangroves, plus the costs to create mangrove services equivalent to those lost pending resource recovery. The Trustees will use Habitat Equivalency Analysis (HEA) in making the latter determination.

HEA is a restoration-based approach to determining damages, as it provides a quantitative tool to define compensation for the injured mangroves in terms of created, in-kind resource acreage. Mangrove habitat is one of several specially protected coastal wetland types within the Tampa Bay estuary system. Technology is available and has been successfully applied to effectively and economically create mangrove habitat.

HEA allows the application of information derived from the injury studies to estimate the quantity of mangrove habitat necessary to functionally replace the ecological services lost as a result of the injuries to mangroves caused by the spill. HEA is appropriate for use where service losses are primarily ecological and the creation of habitat like that injured is technically feasible.

To apply HEA, specific input parameters must be determined from data and information being used to define the injuries suffered by the mangroves. The HEA formula converts the injury to the acres of oiled mangroves into the level of ecological services required to replace the services lost. The replacement level of services is expressed as the number of acres of mangroves that need to be created to replace those services. HEA takes into account the time it takes both impacted and created habitat areas to reach full productivity. The field studies were designed to provide necessary information and input parameters to the HEA.

The input parameters for applying the HEA are listed below. The Trustees will determine the final inputs using a combination of field measurements, literature review, and technical expertise and judgment.

Measure of Mangrove Oil Exposure - This input is specified in terms of area and degree of oiling.

Percent of Ecological Services Lost Due to Oiling or Response Efforts - This input is selected based on field measures of mortality and sub-lethal injury, previous experience with mangrove injury from oiling, literature review, and technical expertise and judgment. Ecological services may be subdivided to reflect separate injuries to various components of the habitat such as different mangrove age classes (adult canopy trees, understory trees, seedlings, and propagules), attached algae and invertebrates, motile invertebrates and fishes, and sediment-dwelling biota.

Number of Years to Full Recovery - This parameter addresses the number of years needed by the oiled mangroves to return to their pre-discharge level of ecological services. Various components of the habitat can take different times to recover.

Functional Form (Shape) of the Recovery Curve - This input expresses the pattern and pace of recovery of the injured habitat. The simplest form of this parameter uses a linear recovery function for all services. This generally gives sufficient accuracy for HEA, however, alternate recovery curves could be used, if necessary or appropriate.

For the Restoration Project, Time to Full Ecological Service Flow - This input addresses the number of years after creation of habitat for it to reach full ecological service flows. The identification of this period is dependent on certain aspects of the candidate restoration action(s).

For the Restoration Project, Form of the Maturity Curve - This input represents the pattern and pace of development and growth to maturity for the created habitat.

Relative Level of Services Produced by Created vs. Natural Mangrove Habitat - This parameter allows adjustment for the fact that created habitat may not provide the same level of ecological services as the pre-discharge natural habitat, even after reaching full maturity.

Additional discussion of HEA can be found in "Habitat Equivalency Analysis: An Overview" (NOAA 1995).

4.1.6 Restoration Plan

As noted above, mangroves in Boca Ciega Bay have suffered injuries as a result of exposure to oil from this spill. The objectives of restoration planning for mangroves are to:

(1) determine what actions, if any, are necessary or appropriate to enable or facilitate the recovery of mangroves at the site of injury; and

(2) determine what actions, if any, are appropriate to replace or acquire the equivalent of the ecological services lost due to exposure of mangroves to oil from the Tampa Bay spill, and to restore these services or compensate the Boca Ciega Bay ecosystem for this loss.

A. Restoration Actions for Resource Recovery

This section considers the actions that may be required or appropriate to directly restore or facilitate the recovery of the injured mangroves. Mangroves that were directly exposed to oil are being monitored to determine if conditions develop or occur, such as the loss of mature trees, immature understory trees, seedlings, or shoreline stability, which would warrant direct intervention to facilitate recovery or prevent additional losses of mangrove resources. If needed, sediment analyses and trial planting studies could be used to provide information on residual sediment contamination, toxicity, and receptivity for restoration.

Alternatives Considered:

The following alternatives were considered for direct mangrove restoration:

1 - No action - This alternative would involve no direct intervention to restore the resource. While ongoing management programs, cleanup activities, and natural processes may assist or provide for the natural recovery of this resource, no additional actions are proposed under this alternative.

2 - Additional actions to remove residual oil - Some oil remains in sediments in and around the impacted mangroves. Where field assessment information indicates that residual oil is inhibiting or retarding the natural recovery of the mangrove community, consideration of additional removal actions may be appropriate.

3 - On-site maintenance actions - Maintenance actions may be appropriate where natural recovery processes on-site are physically limited, inhibited or threatened by debris movement, erosion, exotic species encroachment or other conditions. Implementation of this alternative will include monitoring to determine the need for additional site stabilization actions. When indicated by monitoring results, actions to maintain and protect the site, such as removal of debris, removal of competitive species or replacement/creation of appropriate substrate to control erosion (such as through spartina or mangrove plantings), may be needed to eliminate risks of further injuries to the mangrove community or to facilitate the recruitment and recovery process.

4 - On-site planting of mangrove propagules or nursery-grown understory plants - Direct plantings may be appropriate to ensure that mangrove replacement occurs or to expedite the recovery period.

5 - Successional mangrove replacement or recovery through salt marsh planting - The establishment of *Spartina alternaflora* marsh through planting has been shown to effectively facilitate the establishment or recovery of mangroves in areas with opportunities for natural recruitment of mangroves. Under this approach, mangrove recovery or replacement follows the establishment of the salt marsh. Actions to control invasive or competitive exotic species may be included in this approach until this successional process for restoration yields a mangrove-dominant community.

6 - Successional mangrove replacement or recovery through seaward oyster reef creation or enhancement - Like the previous alternative, this approach to restoring or replacing mangroves capitalizes on the enhanced opportunity for mangrove restoration which may occur incident to the creation or enhancement of fringing oyster reefs.

Evaluation of Alternatives:

During the assessment the Trustees became concerned about potential further injury to the oiled mangrove islands due to erosion of fringing oyster reefs. Exposure to residual asphalt and leaching oil caused oyster mortality and subsequent oyster recruitment failure. As a result, oyster reefs fringing the mangrove areas became unstable and risk of erosion of nearby mangroves increased. Thus, a replacement of the fringing oyster reef in some areas was completed. Further information on this action is provided in Section 4.7 (Shellfish Beds/Ecological Injuries). This action was considered critical where breakup of consolidated cultch was exposing mangroves to increased erosional forces and potential mechanical injury from shell debris. Implementation of this action removed asphalted cultch and replaced it with clean, consolidated cultch material to provide a substrate to encourage natural spat settlement and oyster community re-establishment, and also a natural revetment reducing erosional forces for the mangrove islands. Because on-site maintenance actions were required to adequately protect the mangrove island community from additional injuries, the "no action" alternative is not appropriate.

The removal of residual oil from within the mangrove prop roots and pneumatophores would eliminate a source of continuing stress to these resources. However, the potential for additional mechanical injury to the trees from this action risks further injury to the mangroves. The potential for doing more harm is considered to outweigh the advantages from this action. Where mortality of individual trees has occurred at discrete locations, the removal of the dead tree(s) and any oil in the associated substrate has been completed to facilitate natural recruitment and recovery. These actions will continue, provided they can be conducted without adversely impacting adjacent mangroves.

An ongoing regime of maintenance to facilitate recovery does not appear to be necessary as neither debris nor exotic species appear to be a significant factor limiting mangrove community dynamics on these islands. Some incidental removal of accumulated debris from the site could be included as a preventative or aesthetic measure during any on-site work. However, care would need to be exercised to ensure human actions and equipment involved with removal activities did not adversely impact the surrounding mangroves and seagrasses. The selected maintenance action should have less environmental impact on mangrove recovery than no action.

Direct planting on-site remains a technically feasible alternative for replacing the loss of individual mangroves. However, current levels of mortality on the islands seem to be insufficient to warrant a full-scale planting project. Limited planting of available red mangrove propagules can be accomplished in areas with red mangrove mortality. Ongoing monitoring of the mangroves will allow assessment of the success of natural recruitment and the need for supplemental plantings. Although care would need to be exercised to ensure human actions and equipment involved with mangrove planting activities did not adversely effect the surrounding mangroves and seagrasses, environmental impact is anticipated to be minimal.

The alternative of planting salt marsh to facilitate successional marsh/mangrove development is becoming the preferred technique for establishing mangrove communities among restoration experts. This alternative may be considered to facilitate mangrove recruitment and to stabilize the island perimeter and "blow-out" areas, provided natural elevations permit the establishment of salt-marsh plants.

All of the on-site restoration alternatives considered above might cause minor, short-term adverse environmental consequences. During implementation there would be short-term risk of resuspension of oil, physical impacts such as increased erosion and damage to vegetation, and loss of mangrove or other nearby habitat and services for birds and aquatic life. While these short-term adverse impacts may occur, they would be minimized by careful planning and implementation of restoration activities and there would be an overall net benefit to the physical and biological environment after the construction phase is completed.

Section 2.2 above provides a general discussion of the Tampa Bay physical, biological and cultural environment. Sections 4.1.1 and 4.1.2 provide a specific discussion of mangrove island impacts. Historical maps show that Elnor, Rookery and Little Bird Keys have been in the bay since the 1880's. There are no known historical or archaeological resources present on these sites. There also are no records at the Florida Historic Preservation Office indicating that any archaeological work has been done on these islands. There are therefore, no impacts anticipated to the cultural environment as part of any of these alternatives.

Selected Alternative(s):

The Trustees identified the need to take emergency action to stabilize the mangrove islands to facilitate their natural recovery (Elements of Alternative 2, 3 and 6). These actions addressed the breakup and continuing loss of the fringing oyster community, conditions that exposed the mangrove islands to increased erosional forces and residual leaching oil.

The Trustees will continue to monitor the conditions affecting natural recovery of the injured mangroves, and will take additional on-site actions as necessary. Trustees will consider planting salt-marsh grasses or mangrove propagules, as appropriate, at selected locations along the edges of the three mangrove islands, to the extent permitted by natural elevations, to further stabilize substrate and facilitate natural mangrove recruitment (consistent with Alternatives 4 and 5, as needed). The limited access required to hand plant mangrove propagules and marsh grass along the fringing areas of the mangrove islands is not expected to impact this environment.

B. Compensatory Restoration Alternatives

As a result of exposure to oil, ecological services provided by mangroves have been lost. These service losses will be experienced until the injured mangroves recover to pre-spill conditions. The following alternatives to replace or acquire the equivalent of these lost services have been considered. The appropriate size or scale of a project(s) under any of these alternatives would be defined using the HEA method discussed previously.

Alternatives Considered:

1 - Enhancing or expanding an existing mangrove community - This alternative would focus on mangrove areas which have been stressed by human activities such as cutting or changes in elevation and water flow, which have allowed invasion of exotic competitors or resulted in depressed productivity. This

alternative would expand the size of, or improve conditions in, an existing mangrove community. This could be accomplished by actions such as adjusting land elevations, controlling exotic or invasive species, or converting shoreline or upland areas for this purpose. Depending on the location of existing mangrove communities, this alternative could include costs to acquire land or require authorized changes to publicly held shorelines or upland areas.

2 - Creating a mangrove community on a spoil island - This alternative would involve ecological enhancement through the creation of a new mangrove community on an existing, publicly owned dredge spoil island in Boca Ciega or lower Tampa Bay. Creating a mangrove community on an island site would maximize the similarity between the services being replaced or acquired and the island-based services lost.

3 - Incorporating appropriate acreage or features for mangrove creation into a coastal wetland habitat restoration project within the impacted watershed - This alternative, as part of an approved habitat restoration project, would contribute to converting degraded/developed sites back to productive native mangrove habitat. The enhancement of other habitat restoration projects being conducted in the area (e.g., SWIM program or similar projects), or the implementation of a complementary new habitat creation or restoration project, may provide an appropriate opportunity to create additional mangroves. This may occur through direct plantings or through design features such as salt-marsh planting, which facilitate the natural successional recruitment and establishment of mangroves at project sites. Such an approach may also incorporate compensatory elements from other natural resource injury categories.

4 - General water quality improvement project - This alternative addresses community infrastructure which influences human impacts on water quality, which in turn impacts the ecological community in the entire Tampa/Boca Ciega Bay system. This would apply the monetary equivalent (i.e., the costs to create or enhance appropriate mangrove acreage) to fund or contribute to a water quality improvement project in the Boca Ciega or lower Tampa Bay watersheds. Such projects improve the overall health of the bay ecosystems and promote natural improvements in the size and ecological quality of mangrove communities in the watershed. Projects appropriate for consideration under this alternative would include modifications to the system of stormwater and sewage outfalls into the bays, construction of surface runoff catchments, and culvert enlargements. These types of projects would facilitate water exchange, reduce siltation and nutrient loading from stormwater runoff, reduce contaminant runoff, and generally improve the water quality within the bay systems, which would directly contribute to the overall health of resident mangrove communities.

5 - No action or compensation for the interim losses to mangroves - This alternative focuses primarily on the impacted mangrove islands and their associated services. This alternative would be appropriate where no measurable or significant interim losses occurred as a result of the oil spill, or where actions to assess compensation for mangrove injuries are not cost-effective or technically feasible.

Evaluation of Alternatives:

The enhancement of an existing mainland mangrove community would provide the biological basis for augmenting ecological services similar to those impacted by the spill. This could be accomplished by removal of exotic species (e.g., Brazilian Pepper) or adjusting slope and elevations of shoreline adjacent to existing mangrove stands to facilitate their expansion. This alternative is technically feasible and consistent with ongoing activities in the Boca Ciega watershed. The cost and practicality of this approach would need to be evaluated on a site-by-site basis relative to ownership and land use. The impacts to surrounding ecological communities would be expected to be minimal for exotic species removal, when done by hand. If more aggressive methods are employed to enhance existing mangrove communities, including use of heavy equipment to modify slope and elevations of adjacent shorelines, specific actions would be required to ensure that the ecological impacts would be localized to the areas being enhanced. An interim decrease in water quality adjacent to the construction site could be expected where there is a need to use heavy equipment or other means to remove exotics and/or to change shoreline slope elevations. These impacts will need to be minimized and contained through the use of booms and other controls during construction and subsequent revegetation. While human use of the acres being returned to mangrove stands will be constrained, there are no negative impacts anticipated to the cultural environment as a result of this action.

The alternative of creating a spoil island mangrove community, while meeting restoration objectives, would likely involve higher logistics costs for project implementation than would a comparable land-side site (e.g., higher transportation costs for moving people and equipment to and from the project site). A mangrove creation project could be included as a beneficial use for a new spoil island created incidental to scheduled or permitted navigation channel dredging. The design requirements for the mangrove project and associated environmental impacts of this approach would need to be addressed during the dredge and fill (sec. 404) permitting process. The siting of a mangrove project on an existing spoil island would have to consider potential displacement of current uses, such as recreational boating, future spoil placement, and bird nesting. Additional ecological considerations associated with the use of existing spoil island would be the potential for interim water quality decreases adjacent to the site during construction activities, potential for damage to existing seagrass beds, and potentially increased boat traffic through sensitive areas for construction. These potential impacts will need to be constrained through the use of booms, designated access routes, and other controls during construction and the subsequent revegetation period. While human use of the areas being planted with mangroves will be constrained, there are no negative impacts anticipated to the cultural environment, since these are man-made sites with no historical cultural uses.

Incorporating a mangrove community into a habitat restoration project is similar to the types of actions proposed in the prior alternatives, but would involve modifications (re-engineering) to ongoing or new projects in the bay to enhance the mangrove component. This alternative would facilitate restoration where compensation is received as a cash payment that could be used to supplement existing state or local restoration program actions (e.g., SWIM or similar programs). This alternative, as part of a larger habitat restoration project, could potentially impact local water quality and expand the impacts on adjoining areas during the construction phase. The use of booms , designated access routes, and other controls during construction and the subsequent period required for revegetation, could be used to control the impact zone. Specific ecological impact controls would be addressed as part of the requirements for the complete project. There are no negative impacts anticipated to the cultural environment as a result of actions associated with this alternative, since most project sites are in previously disturbed areas.

An out-of-kind water quality project would indirectly contribute to the replacement of lost mangrove ecological services. Improving water quality in Boca Ciega or lower Tampa Bays would increase biological productivity from existing mangrove communities. It would also contribute to enhanced productivity of other coastal habitats, including facilitating the continued recovery of seagrasses. The direct link between these types of projects and mangrove services would be difficult to measure unless the project had a narrowly targeted impact area that included mangroves. The on-site consequences of water quality projects associated with this alternative would be addressed through the state permitting process. Most of these projects would be located in coastal and upland areas which would include standard construction control requirements such as run-off controls to prevent short-term impacts from siltation and water quality degradation. These types of projects improve the overall health of the bay ecosystem and indirectly promote natural improvements in the health and productivity of the mangrove communities. There are no anticipated negative cultural impacts associated with this alternative.

The "no action" alternative is not acceptable since a significant quantifiable injury to mangroves did occur, and compensation for interim mangrove service losses can be determined at a reasonable cost.

With the exception of no-action, any of the other alternatives will contribute to the overall recovery of many of the natural resources injured by the oil spill. The alternatives that include an in-kind component to enhance or create mangroves represent more timely and direct means for replacing the ecological services lost than implementing general water quality improvement measures. Unavoidable adverse effects for all alternatives would be minimal and short-term.

Selected Alternative(s):

The Trustees' selected alternative is to create or enhance mangroves in a mainland area adjacent to, or as a complement to, ongoing or proposed restoration actions within Boca Ciega Bay. Such a project would be designed to provide a successional salt marsh-to-mangrove community, a developmental sequence that follows natural processes. This is a proven technique for mangrove restoration and is the most cost-effective compared to other options. This selected action would directly address the service losses of the injured mangrove community and secondarily contribute to overall improvement of water quality in Boca Ciega Bay. The project would require site preparation such as substrate elevation adjustments, hydroperiod and water exchange improvements, exotic or invasive species removal and control, planting of salt-marsh vegetation, and subsequent natural recruitment and/or supplemental direct planting of mangroves. This type of project is consistent with both natural resource and community restoration objectives, as reflected in the ongoing programs within the Tampa Bay/Boca Ciega Bay system to restore degraded habitats and water quality (e.g., the Florida program SWIM). This project will have multiple benefits in that it will provide salt-marsh services during the early successional stages and will contribute indirectly to improved seagrass recovery through improved water quality. The created mangroves will provide habitat and foraging services to birds as replacement for any such services lost due to the oil spill, and will enhance the bird populations in the bay system by providing additional nesting areas. Short term losses of ecological services would be experienced at the project site during construction. Impacts on surrounding areas would be minimized by the use of booms, and other control mechanisms. There are no cultural impacts associated with this alternative, since most project sites are in previously disturbed areas.

4.2 Seagrasses

4.2.1 Overview of Preassessment Activities and Findings

Seagrass beds in Tampa Bay are composed primarily of 5 species of marine non-emergent plants: (1) turtle grass (*Thalassia testudinum*), (2) shoalgrass (*Diplanthera wrightii*), (3) manatee grass (*Syringodium filiforme*), (4) widgeon grass (*Ruppia maritima*), and (5) *Halophila engelmanni*. These plants and others found in seagrass beds provide a variety of ecological services, including habitat and food for juveniles and adults of many species.

Records from the spill response, including oil trajectory maps generated by NOAA and FMRI (see Section 4.3, Water Column for details) indicate that oil floated over seagrasses around Mullet and Egmont Keys, then moved out of Tampa Bay into the Gulf of Mexico. A subsequent storm system pushed oil ashore along Pinellas County barrier islands and tidal inlets on August 14 and 15 as shown in Figure 3.

As this weathered oil contacted and picked up sediments on the shore and intertidal areas of the bay, it formed oil mats that were heavier than seawater. Some oil became stranded in seagrass beds surrounding the mangrove islands just inside John's Pass, particularly around Elnor Island. Cleanup crews were only partially successful in removing this submerged oil.

The floating oil and submerged oil represented different mechanisms for exposure and seagrass injury. These different circumstances for exposure and injury are identified and discussed separately in this section.

Submerged or Heavy Oil Exposure: Seagrass areas inside John's Pass were tagged by the field group for delineation in the Genesis Group survey (described generally in Section 4.1, Mangroves) based on any one of the following injury conditions:

- Presence of observable oil, generally present as a layer of 1/2" to 4" thick;
- Presence of oil "mousse" patties (an oil-water emulsion resembling chocolate mousse), including those covered with silt;
- Areas of manual cleaning or vacuuming prior to the survey; and
- Areas of mechanical denuding by boats, barges or other cleanup equipment and activities.

The Genesis Group survey of these areas documented a total of 110,519 square feet (2.54 acres) of seagrasses that were moderately to heavily oiled or otherwise lost as a result of this spill.

Trustee technical representatives recognized that a method would be needed to assess the seagrass bed loss over time to determine its period of loss and rate of recovery. Trustee technical representatives decided to use analysis of real color aerial photography and mapping for this purpose. The SWIM program of the Southwest Florida Water Management District (SWFWMD) routinely conducts aerial seagrass mapping using real color, high-resolution photography. These surveys were conducted prior to the spill in late summer 1988, 1990, 1992, and after the spill in 1994. These surveys include the areas of seagrass affected by this oil spill. These aerials, in combination with the Genesis Group survey results, were used by the DEP-FMRI aerial photo-interpretation staff to map the baseline and post-spill seagrass beds in the area of Elnor Island. The color infrared aerial photography which was initiated to document shoreline vegetation changes (discussed in Section 4.1, Mangroves) was also used for seagrass analysis, but factors such as sunlight angles, water depth and water clarity affect its utility for seagrass mapping.

Floating Oil Exposure: DEP-FMRI, using oil trajectory and seagrass habitat mapping in a Geographic Information System (GIS), determined that over the course of the incident approximately 255 acres of seagrasses were exposed to floating oil in Tampa Bay near Mullet and Egmont Keys and in Boca Ciega Bay near John's Pass. Exposure of seagrasses in these areas was likely by direct but transient contact with the oil itself or through exposure to dissolved oil fractions of some toxicity to grasses or their associated ecological community.

4.2.2 Definition of Injury

The Trustees have evaluated a number of possible injuries to seagrasses, including mortality and reproductive impairment of seagrass plants, and mortality or population reduction of associated algal and animal communities. These injuries result in loss of ecological services such as photosynthetic production, seagrass bed physical stability and integrity, bird, manatee, or sea turtle foraging habitat, and nursery functions for fisheries.

Based on field observations and the considerations described below, the Trustees define injury to seagrasses as the total number of acres of seagrasses exposed to oiling sufficient to cause injury or loss of ecological services as described above. The Trustees will determine the amount of acres oiled and loss of ecological services using methods described below.

4.2.3 Key Factors in Assessing Injury

Area of exposure - The spacial extent of seagrass exposure to oil or oil removal activities.

Duration of loss - The time required for the seagrass beds to return to baseline conditions.

Presence of residual oil within seagrass beds - The extent and degree of oil remaining in the environment and continuing to expose seagrass beds.

The effects of oil on seagrasses - This factor considers the various effects of oil on seagrasses and the link between the effect and exposure to the spilled oil. Mortality of seagrasses caused by direct exposure to oil or to oil removal operations is relatively straightforward to document, while the effects of transient or residual exposure are not as well understood.

4.2.4 Injury Assessment Method

Submerged or Heavy Oil Exposure: The preassessment work cited in Section 4.2.1 above resulted in an estimate of 2.54 acres of seagrass beds moderately or heavily oiled by the spill. In order to evaluate the potential for continued exposure to residual oil, the Trustees conducted three activities.

First, in January 1994, Trustee technical representatives, in cooperation with RP technical personnel, conducted an experimental survey designed to detect the presence of oil on the surface of the seagrass sediments or blades in the vicinity of the mangrove islands within John's Pass. An oil-absorbent sleeve fastened around a 1.5-meter (m) length of 3/8 inch chain was dragged by one end through the seagrass beds. The survey was conducted along parallel transects 40 meters wide. Sleeves were checked for the presence of oil at 100 meter intervals. The method was not suitable for detecting oil buried in the sediments or to quantify the amount of oil present. Trace amounts of oil were detected during the survey but no areas of gross contamination were detected at that time. A brief comparison of this method with simple manual wiping of oiled seagrass blades with an oil-absorbent pad indicated that the sleeve survey was much less sensitive. Additionally, field personnel participating in the survey observed significant oil spotting of new field boot covers while walking in the surveyed areas.

Second, in June 1994, the USF/Mote study (Van Vleet, et al., 1995) to assess the presence of residual sediment oil in the Elnor Island area (previously discussed in Section 4.1, Mangroves) included sample areas for seagrasses, with 5 sample sites on the east side and 5 sample sites on the west side of Elnor Island. Two of the sites on the west side showed elevated hydrocarbon levels in the sediment (S2A = 872 micrograms per gram at 0 to 5 centimeters depth and 357 micrograms per gram at 5 to 10 centimeters depth, S2B = 1332 micrograms per gram at 0 to 5 centimeters depth). The USF/Mote team also observed oil sheen and oil spotting on clothing produced from walking within the seagrasses around Elnor Island during these field studies.

Third, in October 1994, NOAA technical and CZA personnel conducted a limited survey to detect buried oil in the sediments of seagrass beds on the west of Elnor Island. This survey used 30 cm thin wooden probes pushed into the sediment at random points along a 150 m transect. Fourteen percent (14%) of these probes showed the presence of subsurface oil in the seagrass sediments, with the majority of these from sample sites closer to the island. These results are consistent with a patchy distribution of oil (as discrete patties or globules) observed in these seagrass areas during field assessment work by all investigators.

All three of these activities detected the presence of some residual oil in seagrass beds. The aerial photography and seagrass mapping by DEP-FMRI revealed observable changes to these seagrasses following the spill, but indicated that the 2.54 acres of documented vegetation loss recovered in the year following the spill. Such rapid recovery is consistent with the recent trend of seagrass recoveries in Boca Ciega Bay, which is attributed to improvements in the quality and clarity of bay waters.

Based on the existing information, the Trustees will assess the injury to seagrasses inside John's Pass as the total loss of ecological services provided by the 2.54 acres of seagrasses for one (1) year. While the continuing presence of residual oil in the seagrass beds suggests that some sublethal injury may continue, studies to detect and document such continuing injury would be difficult and expensive to design and conduct.

Floating Oil Exposure: For the 255 acres of seagrass with transient oil exposure, a preliminary evaluation was conducted for the Trustees by Dr. Susan S. Bell, University of South Florida (Bell, 1994) and Dr. Margaret O. Hall, FMRI. Bell and Hall compared available data on the ecological community structure (animal and plant) from pre-spill studies to similar information collected after the spill. Post-spill field sampling was conducted in December 1993 and January 1994 at 3 "oiled" sites (where oil sheen had been observed during the incident), and 3 control sites (where oil sheen was absent during the incident). All sites were located in lower Boca Ciega and Tampa Bays, mostly around Mullet and Egmont Keys. Bell and Hall's data suggest some differences between the control and oiled areas, with oiled areas showing lower abundances of most species of animals. However, due to high variation in the data, none of these differences are statistically significant.

Based on available information, the Trustees could not detect significant injury to the seagrass community in these larger areas. Accordingly, further action to assess seagrass injuries from floating oil exposure will not be part of this assessment.

4.2.5 Damage Assessment Method

Documented injuries to seagrass resources occurred in a relatively small area and were of short duration, factors that weigh in favor of using a simplified method for determining damages. As a result, the Trustees will assess damages for the one-year loss of ecological services associated with the 2.54 injured acres. These damages will be calculated as the cost to create sufficient seagrass habitat to replace the seagrass services lost due to the spill, using the HEA method (discussed earlier in Section 4.1, Mangroves). The required input parameters for this habitat type are similar to those previously discussed and can be determined with sufficient accuracy based on existing information. Compensation will be calculated as the projected costs to create this amount of seagrass habitat, including land acquisition, material, labor, and monitoring and other expenses associated with project planning, implementation, oversight and monitoring.

4.2.6 Restoration Plan

As explained above, seagrasses injured as a result of the Tampa Bay oil spill experienced a relatively rapid, natural recovery within the year following the spill. Due to the small area and limited duration of the injuries, no permanent injury has been detected. As a result, restoration planning for injured seagrasses focuses on actions that are appropriate to compensate for the loss of seagrass ecological services which occurred until the injured seagrasses recovered to pre-spill conditions.

The objective of restoration planning for the injured seagrasses is:

> (1) To determine what actions, if any, are appropriate to replace or acquire the equivalent of the ecological services lost due to the exposure of seagrasses to oil from the Tampa Bay spill, as compensation to the Boca Ciega Bay ecosystem.

A. Restoration Actions for Resource Recovery

This section addresses actions which would directly restore or facilitate recovery of the oil-impacted seagrass beds. As noted above, the Trustees have observed natural recovery of the seagrasses in the impact area, including areas of seagrass lost due to scouring by response barges in front of Elnor Island.

Alternatives Considered:

1 - No action - This alternative would involve no direct intervention to restore the resource. While ongoing management programs, cleanup activities, and natural processes may assist or provide for the natural recovery of this resource, no additional actions are proposed under this alternative.

2 - Removal of residual oil from impact site - Action to remove additional oil from an impact is appropriately considered where the continued presence of oil would inhibit or retard the natural recovery process.

3 - On-site enhancement actions - On-site conditions, such as a lack of natural recruitment and recolonization of seagrasses, or substrate erosion, may be sufficient to warrant direct intervention. These actions may be necessary to ensure or enhance the recovery of injured seagrasses or to prevent additional ecological service losses. Actions to stabilize substrate and assist in recruitment or recolonization could include the placement of wave dampening structures or oyster shell.

4 - Direct replacement of seagrasses by on-site planting - Such actions may be appropriate under circumstances indicating natural recolonization is inadequate to provide for timely recovery of

impacted seagrasses and that direct planting of seagrasses is necessary to ensure seagrass recovery.

5 - Substrate replacement at site of barge scour depressions - If depressions in the sediments adjacent to Elnor Island were of sufficient persistence and depth to inhibit or retard the recovery of seagrass vegetation, substrate replacement could be used to eliminate these depressions and restore elevations appropriate to seagrass recolonization. Revegetation associated with such an effort could be accomplished through natural recruitment, planting of precursor species of seagrasses to stabilize substrate and facilitate recolonization, or direct planting of the lost seagrass species.

Evaluation of Alternatives:

Current evidence indicates that the injured seagrass areas inside John's Pass have recovered naturally. Under these circumstances, direct restoration actions are not needed. Section 2.2 above provides a general discussion of the Tampa Bay physical, biological and cultural environment. Sections 4.2.1 and 4.2.2 provide a specific discussion of seagrass impacts. There are no known historical or archaeological resources present on these sites, so there are no adverse environmental or cultural impacts expected to develop from the natural recovery alternative.

Selected Alternative(s):

The Trustees have selected the "no action" alternative since current evidence and expert opinion indicates that natural recovery occurred within one year of the incident and additional on-site intervention will be unnecessary.

B. Compensatory Restoration Alternatives

Pending its natural recovery, injured seagrasses suffered a reduction in their ability to provide their full and normal range of ecological services. This section describes restoration actions considered by the Trustees to compensate for such losses. The scale of such actions is determined through the HEA, which will be used in the assessment of injured seagrasses.

Alternatives Considered:

1 - Seagrass community creation - This alternative contemplates a project to create or improve conditions necessary for the establishment and growth of a seagrass community within an affected watershed or receiving basin. This alternative would focus on bay bottom sites where seagrass has historically occurred or where there is potential to support seagrass with some site enhancements. Such a project may include actions to adjust substrate (water) depth to provide sunlight intensity needed by seagrasses, to control storm water inflow, or to reduce siltation.

2 - Wetland habitat creation - This alternative would involve ecological enhancement of mangrove or salt marsh to compensate for loss of seagrass ecological services in the bay system and would contribute to converting degraded/developed sites to fully productive habitat. This alternative would substitute the creation of another type of wetland habitat (e.g., mangrove, salt marsh) to compensate for the interim loss of seagrass ecological services. An appropriate factor would be used to adjust the scale of the out-of-kind project to replace services at a comparable level to those lost.

3 - General water quality improvement project - This alternative addresses community infrastructure which influences human impacts on water quality, which in turn impacts the ecological community in the entire Tampa/Boca Ciega Bay system. Under this alternative, funds representing the costs to

replace lost services would be applied to fund or contribute to a project(s) to improve water quality in the Boca Ciega or lower Tampa Bay watersheds.

4 - No action or compensation for the interim losses to seagrasses - This alternative focuses primarily on the impacted seagrass beds and their associated services. This alternative would be appropriate where there were no measurable or significant interim losses incurred as a result of the oil spill or where the cost to assess compensation for the lost services is not determined to be cost-effective.

Evaluation of Alternatives:

A review of historical aerial photographs of the seagrass beds in front of Elnor Island indicate that these beds have been naturally expanding as the overall water quality in Boca Ciega Bay has improved. Improving water quality is considered responsible for the general pattern of seagrass growth and expansion being observed in the bay system and is considered an important factor in the successful natural recovery of seagrasses and other resources injured due to the Tampa Bay oil spill. Each of the above project alternatives would be beneficial to overall water quality in the bay system. Creation of seagrass habitat would replace the services lost due to the spill with similar services. However, in some situations creation or enhancement of wetlands might be preferable to seagrass bed creation, if seagrass creation has a lower probability of success due to site or area- specific factors. Also, it may prove useful to establish wetlands to stabilize an area and improve water quality so that seagrasses may naturally recolonize an area.

Creation of a seagrass community could involve adjusting water depth by adding fill material or dredging to redistribute sediments. These actions would create areas where sunlight intensity will reach levels needed to support seagrasses. Creation of a seagrass community also could involve construction of community infrastructure to reduce nutrient enriched or siltation carrying water inflows which limit seagrass growth. The predicted impacts of either approach to the physical and biological environment would be interim impacts during the construction phase, in the form of decreased water quality, disturbance of sediments and benthos, and potential impacts to the surrounding seagrasses, to the extent water turbidity and sediments are not controlled. There are no impacts anticipated on the cultural environment, since these are submerged sites.

Wetland habitat creation would not directly address seagrass habitat but would focus restoration actions on areas of degraded or developed mangrove or salt marsh to improve productivity. The predicted impacts to the physical and biological environment would be interim impacts during the construction phase, in the form of decreased water quality, disturbance of sediments and benthos, and potential impacts to surrounding seagrasses, to the extent water turbidity and sediments are not controlled. There are no impacts anticipated on the cultural environment, since many of these are previously disturbed sites.

The "no action" alternative is not acceptable since a quantifiable injury did occur. Further, a cost-effective method is available to assess compensation for these interim losses. No negative impacts would be expected under the general water quality improvement alternative or the no action alternative. There are no impacts anticipated on the cultural environment as a result of either of these alternatives.

Selected Alternative(s):

Water quality improvements will have broad, long-term benefits to the Boca Ciega and lower Tampa Bay systems, including specific benefits to seagrass communities. Therefore, the Trustees strongly favor projects that will directly or indirectly improve water quality in the Bay. The Trustees will implement one or more projects based on the first, second or third identified alternatives to compensate for the loss of ecological services associated with injured seagrasses. In identifying and selecting specific projects from among these alternatives, the Trustees will give preference to proposals that most directly replace seagrass losses with similar services.

Compensatory restoration actions for the benefit of seagrasses may be combined, where appropriate, with restoration actions which the Trustees identify and implement to compensate for other resource injuries. Such an approach will minimize costs associated with project design, implementation, oversight and monitoring.

4.3 Water Column

4.3.1 Overview of Preassessment Activities and Findings

During the initial response to the incident, numerous overflights were conducted by response agencies, the RPs, and the Trustee agencies, to determine the location and extent of floating oil. From August 10-20, 1993, data collected during these flights were entered into a Geographic Information System (GIS) database, which was used to prepare oil trajectory maps in support of U.S. Coast Guard response operations. Analysis of the data shows that the discharged oil affected approximately 300 square miles of open Gulf waters and 27 square miles of bay waters.

During the passage of the oil slick over the water surface, it was anticipated that fractions of discharged oils would disperse into the water column. Further, droplets of oil were expected to become entrained in the water column as a result of wind and wave action, especially in the surf zone. To document this anticipated water-column exposure and to evaluate the extent of vertical exposure in the water column, water samples were collected and analyzed for hydrocarbons by a Mote Marine Laboratory (Mote) and University of South Florida, Dept. of Marine Science (USF-MS) team (Sherblom, Pierce, & Kelly, 1993). Sampling was conducted on August 12 and 17, 1993 at 30 locations in lower Tampa Bay, in southern Boca Ciega Bay including all quadrats around Mullet Key and near Egmont Key, and in nearshore areas of the Gulf of Mexico from Egmont Key northward to St. Pete Beach. Most water samples were taken at 0.3 m below the surface, but at 3 locations they were also taken at 2 m depth.

Analysis of the 23 samples from 20 sites sampled on August 12 showed 3 were below detectable limits of hydrocarbons (less than 0.5 micrograms/liter), 6 had predominantly biogenic (naturally occurring, non-petroleum) hydrocarbons less than 5 micrograms/liter, and 16 had primarily petroleum hydrocarbons exhibiting dissolved and/or dispersed hydrocarbons up to 46 micrograms/liter, representing suspended particles of weathered, discharged oil from the spill. The 2 m deep samples at stations 13 and 17 between Egmont and Mullet Keys showed higher amounts of petroleum hydrocarbons at that depth than did the 0.3 m deep samples at the same sites, indicating that at some locations, the oil was well dispersed vertically in the water column. Water samples collected on August 17 showed a similar wide range (less than 0.5 to 39 micrograms/liter) of petroleum hydrocarbons in both Bunces Pass on the north side of Mullet Key and in Boca Ciega Bay inside of John's Pass. Clams (*Mercenaria mercenaria*) were collected from Bunces Pass on September 29, 1993 to assess shellfish contamination from oil in the water column as opposed to direct oiling. Elevated petroleum hydrocarbons were observed in several of the clams, indicating uptake of oil-containing particulates (Sherblom and Pierce, 1993). These results document that contamination of the water column occurred immediately following the spill.

To provide information on the presence of water-column biota, including planktonic life stages of important fishery stocks, ichthyoplankton (larval fish) sampling was conducted after the spill. This sampling was in areas of lower Tampa Bay and nearshore areas at the mouth of Tampa Bay that were exposed to the oil slick, and in nearby areas considered to have had no oil exposure at control sites. Sampling was conducted by the DEP-FMRI to document the presence and life stages of species in the water column during August, for comparison with existing baseline data and model databases.

DEP-FMRI has an ongoing study of beach surf zone fishes and their relationship to the sand beach infauna (animals that live in the sand of the shoreline) that they eat (such as sand fleas, *Emerita spp.* and coquinas (*Donax spp.*). This study was initiated prior to the spill, and includes beach areas that were oiled by this spill and areas that were not oiled. After the spill occurred, additional sites were sampled at Treasure Island (oiled) and at Indian Shores Beach (unoiled) to better compare the two areas. Samples were taken August 30 through September 16, 1993 and included seine net samples for larger fish and small mesh nets for juvenile and larval fish, plus sediment cores taken in the intertidal beach.

Results of the study indicated that the oiled sites had reduced numbers of two significant fish species, Gulf kingfish (*Menticirrhus littoralis*) and permit (*Trachinotus falcatus*), as compared to the unoiled sites. At the unoiled sites the variety and abundance of fishes was similar to previous years.

4.3.2 Definition of Injury

The Trustees have considered a number of possible injuries to water column resources caused by exposure to the discharged oil, including mortality of larval, juvenile, and adult fish and invertebrates in the water column, and food-web disruptions resulting in decreased prey items available to other species.

Based on field observations and the considerations described below, the Trustees define injury to the water column as the projected loss in fishery stocks caused by exposure to the discharged oil. Fishery stock losses will be estimated using the methods described in Section 4.3.4.

4.3.3 Key Factors in Assessing Injury

Unlike shoreline habitats and readily observable wildlife, effects on water-column biota are not easily observed or measured. Even direct observation of mortality of larger fishes and invertebrates can only occur when carcasses float to the surface or wash ashore in observable areas. The smaller planktonic components of the water column decompose rapidly upon death. "Fish kill" reports alone underestimate injury to water-column resources. As a result, assessment of water-column injuries and losses relies heavily on indirect methods such as calculations or models that use measurable physical and chemical parameters known to determine the effect of an oil spill on these resources. The following parameters are important.

The amount and toxicity of oil discharged - Needed to quantify the degree of exposure and potential for injury to water-column biota.

The discharge characteristics and mass balance - The physical and chemical characteristics of the oils are needed to predict or determine their fate and toxicity to aquatic resources. Circumstances associated with the discharge - such as the time, location, rate and depth, vessel speed and direction - affect where the oil goes. Mass balance is a calculation of the fate of the discharge. It requires an accurate determination of the volume of oil discharged, the oil type(s), the trajectory of the spill, and the amount of oil removed from the environment during cleanup, as well as when, where, how much and what fraction of oil evaporated, dissolved, became entrained, or sank in the water column.

The attributes of the receiving water body - This information is needed to predict or determine the trajectory and fate of the discharged oil. Important water-body attributes include water temperature, salinity, depths, suspended solids concentrations, water current velocities (both tidal and wind-driven), wind and weather conditions, sea state, and shoreline locations.

Water column resources at risk - This information is needed to predict or determine the resources of the water column that are at risk from oil exposure and their susceptibility to injury. Small animals in the water column (plankton) include invertebrates that are food for larger animals, and larval and juvenile life stages of important fisheries stocks such as blue and stone crabs, edible shrimps, and the large number of commercially and recreationally important finfish.

Relationship of the assessment method for water-column resources to other assessment categories - The assessment method for water-column injury must be selected with due regard to its relationship to the rest of the assessment plan, both to avoid gaps in addressing resource injuries and to avoid double counting of injuries or compensation.

4.3.4 Injury Assessment Method

Field studies to quantitatively assess changes in fishery stocks are technically very difficult and expensive to conduct for oil spills. Experience from previous oil spills has shown that factors such as the natural variability of fish stocks, inadequate baseline data, costs associated with field studies and the short notice for planning, limit the ability of biologists to document the amount of injury to water-column biota using field methods.

As a result of this prior experience, computer models and other simplified methods have been developed to assist in assessing water-column injury due to oil spills and determining compensation for these injuries. In the early days after the spill, Trustee technical personnel used a draft Natural Resource Damage Assessment Model/Coastal and Marine Environments (NRDAM/CME) computer model to determine the level of effort necessary to capture the relevant ephemeral data to assess water-column injuries. Much of the information required to use this model is routinely gathered immediately following a spill by both response organizations and Trustee technical personnel, as was the case in the Tampa Bay spill. The model indicated that water-column resource losses would not likely be severe enough to warrant a large-scale field investigation to support the assessment of water-column injuries. As a result, the Trustees looked to available simplified methods as the most appropriate for consideration in assessment planning. These include compensation tables, formulas, and computer models.

Compensation tables and formulas determine damages directly as a function of the volume and type of oil spilled, the location of the spill, the characteristics of the water body, and other readily determinable factors. However, available compensation tables and formulas are limited in their ability to be adapted to a specific spill, are generally not designed for spills greater than 50,000 gallons, and do not distinguish damages by specific resource category. Because of these limitations, the Trustees considered these methods inappropriate for use in the assessment for this spill.

Computer models, especially more recent models developed specifically to assess natural resource damages resulting from spills, are also relatively simple to implement using readily available data as input parameters. Some of the required data is predetermined by geographic area and incorporated in the model database. Other input data is routinely gathered immediately after the spill. Within the range of assessment procedures available, use of the NRDAM/CME model for water column injury is the most cost-effective method that is relevant and accurate, given the nature, degree, and extent of the injury. Information obtained by the Trustees during the pre-assessment has confirmed that the model will accurately predict the observed physical fate of the discharged oil. The presence of expected water column biological resources has been confirmed for the areas exposed to oil. This model determines injury and damages to specific resource categories, including water-column resources. If necessary, additional information could be added to the model database to increase its precision for this particular spill.

The Trustees will use a part of the NRDAM/CME model, Version 2.4, to assess injury and damages for the water-column resources. Specifically, the Trustees will apply only the damages output for water-column injuries of the NRDAM/CME as the basis for determining damages for this resource category.

The NRDAM/CME model is complex, but operates in three sub-models which calculate: 1) the physical fate of the oil, 2) the biological injury it causes, and 3) the value of that injury. For water-column resources, usable output includes short- and long-term fisheries losses due to population effects. The Trustees will compare the results of each sub-model with the known spill information. Trustee technical representatives will determine the most appropriate model input parameters to accurately reflect the Tampa Bay discharge events. The Trustees will compare the model's injury and damage determination for water-column resources with the other proposed assessment actions to ensure that no double counting of injuries or damages occur.

4.3.5 Damage Assessment Method

The NRDAM/CME model determines injury to water column resources and calculates the dollar value associated with the injury. Dollar values are based on the consumptive recreational and commercial use values of the fisheries losses. The Trustees will use this dollar output as the damages determined for water-column injuries. In restoration planning, this dollar output will determine the scale of restoration actions.

4.3.6 Restoration Plan

Restoration planning for injuries to the water column have the following objectives:

(1) to determine what actions, if any, are necessary or appropriate to facilitate the recruitment or recovery of the resident water-column species; and

(2) to determine what actions, if any, would appropriately replace or represent an acquisition by the Tampa Bay ecosystem of ecological services equivalent to those lost as a result of the exposure of water-column resources to oil from the Tampa Bay spill.

A. Restoration Actions for Resource Recovery

This section considers actions that may be appropriate to restore or facilitate the recovery of the injured water column.

Alternatives Considered:

1 - No action - This alternative would involve no direct intervention to restore the resource. While ongoing management programs, cleanup activities, and natural processes may assist or provide for the natural recovery of this resource, no additional actions are proposed under this alternative. Natural recovery occurs when natural biological, physical, and chemical processes in the coastal ecosystem sufficiently degrade, dilute, and neutralize oil in the water column to a degree to permit ecological services to recover without human intervention.

2 - Population enhancement - This alternative could include actions such as fertilization, artificial spawning or hatchery rearing, and release of selected species in the impact area. Intervention of this type may be appropriate where injuries to the water column are not transitory in nature or important resident species will not naturally recruit back into the impact area within a reasonable period of time even though oil concentrations have dropped below levels that are toxic or trigger avoidance behaviors.

Evaluation of Alternatives:

As explained above, studies to accurately evaluate injuries to water column biota and the duration of those injuries are difficult and expensive to undertake. The Trustees have determined that such studies would not be cost-effective. Resident water-column communities are likely to have recruited back into oil-exposed areas of Tampa Bay once oil concentrations fell below levels that were toxic or resulted in avoidance behavior in resident species. The Tampa Bay oil spill did not coincide with any major, periodic, or seasonal spawning event associated with resident water-column species. Under these circumstances, injuries to the water column from the Tampa Bay spill were likely to have been of relatively short duration.

Section 2.2 above provides a general discussion of the Tampa Bay physical, biological and cultural environment. Sections 4.3.1 and 4.3.2 provide a specific discussion of water column impacts. There are no known historical or archaeological resources present on these sites.

Selected Alternative(s):

The Trustees have selected the "no action" alternative as an appropriate strategy for resource recovery. There are no adverse environmental impacts expected to develop from the no action alternative.

B. Compensatory Restoration Alternatives

Ecological services provided by the marine water column in and adjacent to Tampa Bay were lost as a result of exposure to oil from the Tampa Bay spill. This section describes restoration actions considered by the Trustees to compensate for such losses. The scale of such actions will be determined by the NRDAM/CME model output for water column injuries.

Alternatives Considered:

1 - Installation of artificial reefs - This alternative would focus on providing substrate for encrusting communities and structural complexity required to increased survival of larval and juvenile stages of fishes and invertebrates which occupy the water column during some phase of their life history. This alternative would involve projects to create or enhance seawall encrusting communities or other artificial reefs within lower Tampa and Boca Ciega Bays as a means of enhancing the protection and survival of larval and juvenile fishes and invertebrates. Increasing available protection and survival facilitates and increases the opportunities for natural recruitment to coastal marine resource populations.

2 - General water quality improvement project - This alternative addresses community infrastructure which influences human impacts on water quality, which in turn impact the ecological community in the entire Tampa/Boca Ciega Bay system. Under this alternative, damages would be used to fund or contribute to a project(s) to improve water quality in the Boca Ciega or lower Tampa Bay watersheds. Possible water quality improvement projects were described in Section 4.1.6 (Mangroves).

3 - No action or compensation for the interim losses to the water column - This alternative focuses primarily on the impacted water column and associated services. This alternative would be appropriate where there were no measurable or significant interim losses incurred as a result of the oil spill, or where action to assess compensation for this resource injury is not determined to be cost-effective.

Evaluation of Alternatives:

Either of the first two alternatives would be beneficial to the overall productivity of Tampa Bay and the coastal marine ecosystem, and each would benefit the water-column community and services that were lost due to exposure to oil from the Tampa Bay spill. Compensation for services lost to the water column can be achieved by improving the water quality throughout Tampa Bay. The listed alternatives would achieve this by reducing pressures upon larval and juvenile marine species, limiting siltation, or reducing sewage and contaminant loading of the bay. The artificial reef alternative would cause some injury to benthic organisms in a limited area under the reef structure footprint, while enhancing the survival of larval and juvenile live stages for other resources. The consequences of this action at the restoration site would be addressed through the appropriate state and federal permitting processes. The water quality project alternative would contribute to the general health and survival of the marine resources using the coastal waters of Tampa Bay. The onsite consequences of water quality projects associated with this alternative would be addressed through the state permitting process. Most of the project would be located in coastal and upland areas which would include standard construction control requirements such as run-off controls to prevent short term impacts from down-stream siltation and water quality degradation. There are no anticipated negative cultural impacts associated with either of these alternatives.

The "no action" alternative is not acceptable since a quantifiable injury did occur. A cost-effective method is available to assess compensation based thereon. This alternative assumes natural recovery of the water column and the associated services.

Selected Alternative(s):

The Trustees will implement one or more projects based on alternatives 1 or 2 to compensate for the interim loss of biota and ecological services caused by the water-column injury.