FINAL RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT

for the April 7, 2000 Oil Spill at Chalk Point on the Patuxent River, Maryland

November 2002

National Oceanic and Atmospheric Administration
Maryland Department of Natural Resources
Maryland Department of the Environment
U.S. Fish and Wildlife Service

This final Restoration Plan was prepared by the natural resource Trustee agencies: the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, and the Maryland Departments of Natural Resources and Environment. These agencies have conducted a natural resource damage assessment (NRDA) for the April 7, 2000, pipeline rupture that spilled about 140,000 gallons of oil at Pepco's Chalk Point Generating Facility in Aquasco, Maryland. The goal of the NRDA was to restore the public's natural resources injured by the oil spill.

The Trustees have prepared this final Plan after review of the public comments on the preferred restoration alternatives proposed in the draft Plan (dated May 2002). Pepco and ST Services, the parties responsible for this spill will provide funding to implement the preferred restoration alternatives described in this Plan.

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EXECUTIVE SUMMARY

On April 7, 2000, a ruptured pipeline spilled about 140,000 gallons of oil at the Potomac Electric Power Company Chalk Point generating facility in Aquasco, Maryland. Under the federal Oil Pollution Act, four government agencies—the National Oceanic and Atmospheric Administration, U.S. Fish and Wildlife Service, Maryland Department of Natural Resources, and Maryland Department of Environment—are responsible for restoring natural resources injured by the spill. These agencies act as Trustees on the public's behalf to conduct a natural resource damage assessment to determine the nature and extent of injuries to resources and the restoration actions needed to reverse the losses resulting from this spill.

Final Plan to restore the resources

This final Restoration Plan describes the injuries and restoration actions selected by the Trustees to restore the losses. Restoration projects were selected following review of public comments on proposed restoration alternatives presented in the May 8, 2000 draft Restoration Plan. This final Plan was developed cooperatively among the Trustees, Pepco and ST Services (respectively, the owner and operator of the pipeline).

What was injured?

Studies conducted by the Trustees and other experts identified the following injuries to natural resources and recreational services from the spill:

- Wetlands – 76 acres lightly, moderately, or heavily oiled
- Beaches – 10 acres of shoreline lightly, moderately or heavily oiled
- Ruddy ducks – 553 estimated dead
- Other birds – 143 estimated dead
- Diamondback terrapins –122 estimated dead and a 10% reduction in hatchlings for year 2000
- Muskrats – 376 estimated dead
- Fish and shellfish – estimated total biomass loss of 2,464 kg (5,432 lbs)
- Benthic communities – estimated total biomass loss of 2,256 kg (4,974 lbs)
- Recreational services – an estimated 125,000 trips on the river affected by the spill

How were restoration alternatives evaluated and selected?

The Trustees considered numerous restoration alternatives to compensate the public for spill-related injuries. Each proposed project was evaluated using the following criteria:

- Cost to carry out the alternative,
- Extent to which the alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses,
- Likelihood of success,
- Extent to which the alternative will prevent future injury as a result of the incident and

avoid collateral injury as a result of implementing the alternative,

- Extent to which the alternative benefits more than one natural resource and/or service,
- Effect of alternative on public health and safety,
- Compliance with applicable federal and state laws and policies,
- Possibility for integration with existing management program,
- Affect on adjacent or nearby land uses,
- Site ownership,
- Logistical considerations,
- Consistency with local, regional, and national restoration goals and initiatives, and
- Longevity of the project.

After evaluating the proposals, the Trustees identified the following preferred restoration projects.

Create tidal marsh
Create about six acres of intertidal marsh wetland adjacent to Washington Creek, a tributary of the Patuxent River, located south of Chalk Point. This wetland would be similar to those impacted by the spill and provide habitat for juvenile fish, shellfish, birds, and mammals; improve water quality by filtering sediments and other pollutants from the water column; and provide storm surge and flood protection.

Enhance shoreline beach
Create roughly one acre of beach habitat to benefit diamondback terrapins and other organisms.

Acquire and restore ruddy duck nesting habitat
Restore ruddy duck nesting habitat and acquire perpetual protective easements in areas of the Prairie Pothole Region of the Midwest. Ruddy ducks breed in wetlands located in the Midwest and southern Canada and migrate to the Chesapeake Bay to spend the winter. Restoring and protecting their nesting habitats will enhance ruddy duck populations in the Bay.

Create an oyster reef sanctuary
Create roughly five acres of oyster reef sanctuary in the Patuxent River to address injuries to fish, shellfish, birds (excluding ruddy ducks), and benthic communities. Oyster reefs enhance benthic communities, increase aquatic food for fish and birds, and improve water quality by filtering out sediments and pollutants from the water column.

Improve recreational opportunities
The Trustees will implement the following projects to address the estimated 125,000 river trips that were affected by the spill:

- Create two canoe/kayak paddle-in campsites on the Patuxent River, one north of Golden Beach and one at Milltown Landing,
- Establish a disabled-accessible kayak/canoe launch at Greenwell State Park,
- Improve recreational opportunities at Maxwell Hall Natural Resource Management Area,
- Improve the Forest Landing boat ramp,
- Rebuild the King's Landing boardwalk and provide canoes for a river education program,
- Build a fishing pier at Cedar Haven Park, and
- Establish boat access at Nan’s Cove, located just north of Broomes Island.

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CHAPTER 1.0. INTRODUCTION

This final Restoration Plan and Environmental Assessment (Restoration Plan/ EA) was prepared by state and federal natural resource trustees responsible for restoring natural resources[1] and resource services[2] injured by the April 7, 2000 oil spill at the Potomac Electric Power Company (Pepco) Chalk Point generating facility. The purpose of restoration, as outlined in this final Restoration Plan/ EA, is to make the environment and the public whole for injuries resulting from the spill by implementing restoration actions that return injured natural resources and services to baseline (or prespill) conditions and compensate for interim losses.

The natural resource trustees for this oil spill include four federal and state agencies: the National Oceanic and Atmospheric Administration (NOAA), the primary federal Trustee for coastal and marine resources; the U.S. Fish and Wildlife Service (USFWS), the primary federal Trustee for migratory birds, some fish, many endangered species, and lands managed by the agency; and the Maryland Departments of the Environment (MDE) and Natural Resources (MDNR), which share responsibilities for natural resources and their supporting ecosystems belonging to, managed by, controlled by, or appertaining to the state of Maryland.

At the time of the spill, the pipeline was owned by Pepco and operated, at least in part, by Support Terminal (ST) Services. Under the federal Oil Pollution Act of 1990 (OPA), these Responsible Parties (RPs) are liable for the costs of conducting a natural resource damage assessment, as well as the costs of implementing the Trustees' preferred restoration actions identified in this final Restoration Plan/ EA.

The Trustees, in cooperation with the RPs, have assessed the injuries resulting from this incident, evaluated a range of restoration alternatives based on criteria established under OPA, and proposed for public review and comment preferred restoration alternatives in a draft Restoration Plan/ EA (dated May 8, 2002). After consideration of comments

[1] Natural resources are defined under OPA as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any State or local government or Indian tribe, or any foreign government.

[2] Services (or natural resources services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public.

received on the preferred alternatives, the Trustees selected final restoration projects that will make the environment and public whole for natural resource injuries and losses of services resulting from the incident. Both the preferred and non-preferred alternatives are described in Chapter 5 of this final Restoration Plan/ EA.

After analysis of the public comments on the draft Restoration Plan/ EA, the Trustees determined that the Restoration Plan could be adopted. The Trustee Adoption Resolution is provided in Appendix 7. A Finding of No Significant Impact determination by the federal Trustees is provided in Appendix 8.

1.1 Overview of the Incident

On April 7, 2000, at approximately 6 pm eastern daylight time, a leak was detected in a 12-inch underground pipeline that supplies oil to the Pepco Chalk Point generating facility in Aquasco, Maryland. Approximately 140,000 gallons of fuel oil spilled from the ruptured pipeline into Swanson Creek, a small tributary of the Patuxent River (Figure 1). The spilled oil was a mix of Number 6 fuel, the oil normally transported by the pipeline to generate electricity, and Number 2 fuel, much lighter oil that was being used to flush the pipeline as part of a cleaning process.

Pepco, the Environmental Protection Agency (EPA), and MDE began containment and clean-up following the April 7 spill. Initial response actions were focused in Swanson Creek, and included deployment of protective booms to limit the spread of oil and the use of vacuum trucks and tanks to collect the discharged oil. On the night of April 8, severe weather conditions caused oil to breach and/or crest over the booms that had been deployed (EPA Clean-up Order, May 1, 2000), spreading oil into the Patuxent River, approximately 17 linear miles downstream. About 40 miles of environmentally sensitive downstream creeks and shorelines along the Patuxent River were oiled.

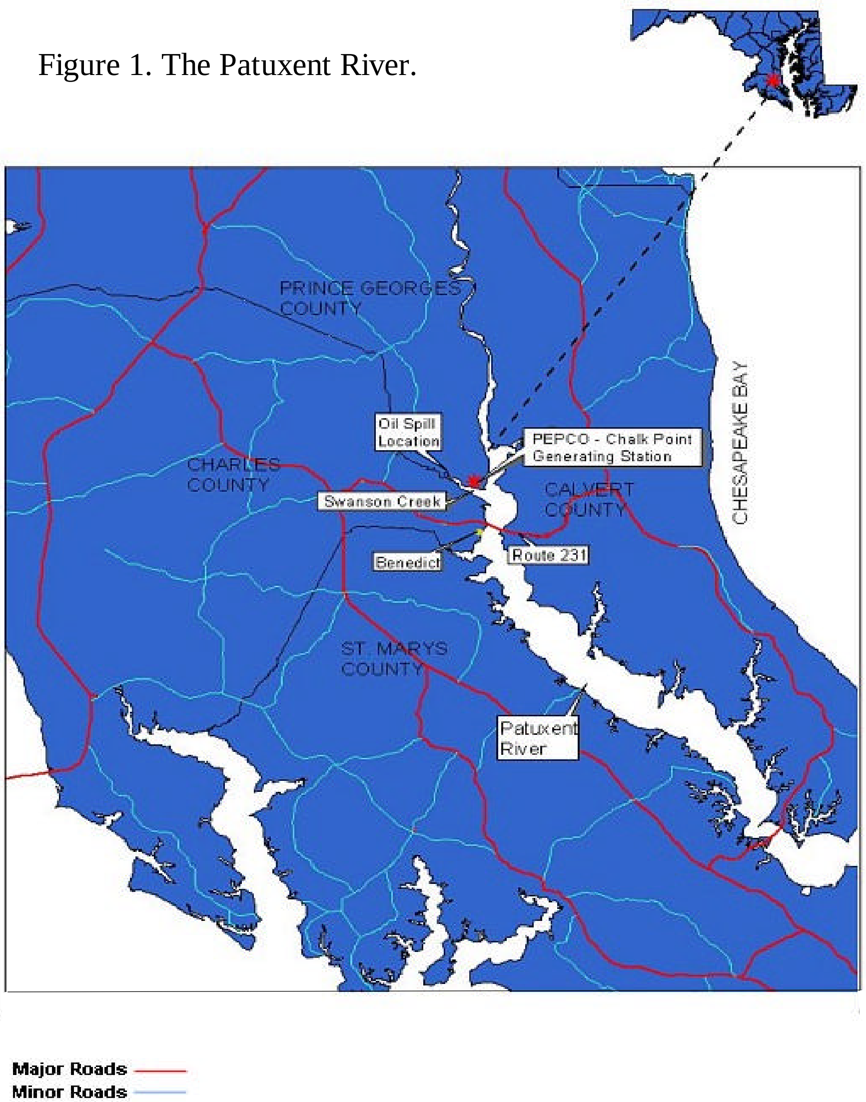
State and federal natural resource Trustee agencies also responded to the spill and observed potential indicators of injury from the effects of the release. Marshes were observed to have been exposed to black oil or sheen, birds were observed to have been oiled, and survey teams collected dead birds, fish, muskrats and other animals. As a result of health concerns associated with the possible consumption of contaminated shellfish by the public, MDE implemented an emergency health advisory for fishing and the temporary closure of harvesting for oysters and clams in the Patuxent River north of the Thomas Johnson Bridge. A Precautionary Beach Advisory urging residents not to use beaches and shorelines impacted by the spill was also issued by MDE.

Based on information and data collected immediately following the spill, the Trustees initiated a damage assessment pursuant to Section 1006 of OPA to determine the nature and extent of injuries to natural resources and services. Pepco and ST Services were active and cooperative participants in these efforts.

1.2 Summary of Natural Resource Injuries

The Trustees conducted more than 25 separate studies from April 7, 2000 through July 21, 2001 to assess the nature and extent of natural resource injuries and lost services resulting from this spill. Principal investigators included state and federal scientists, consultants with damage assessment experience, and local experts, including those from the University of Maryland's Chesapeake Biological Laboratory and the Academy of Natural Sciences Estuarine Research Center. The findings and injury estimates derived from these studies are presented in Chapter 4 of this final Restoration Plan/ EA. Based on this work, the Trustees believe that the spill caused injuries to natural resources in Swanson Creek and the Patuxent River, including wetlands and beach shorelines, fish and shellfish, benthic communities, birds, and diamondback terrapins. The spill also affected recreational use. Table 1.1 summarizes the Trustees' injury assessment findings.

Figure 1. The Patuxent River.



Throughout the injury assessment and restoration planning process, the Trustees used available information, expert scientific judgment, focused studies, and literature on the fate and effects of oil spills to arrive at the best estimate of the injuries caused by the spill. There is, however, some uncertainty inherent in the assessment of impacts from oil spills. While in certain instances collecting more information may increase the precision of the estimate of the impacts, the Trustees believe that the type and scale of restoration actions would not substantially change as a result of more research. The Trustees sought to balance the desire for more information with the reality that further research would delay the implementation of the restoration projects, at the expense of the local environment, the citizens of Maryland, and others who use and enjoy the area's natural resources. As part of the planned restoration efforts, the Trustees will conduct a significant monitoring effort, both to evaluate the effectiveness of the restoration projects, and to ensure that the natural resources affected by the spill are recovering.

1.3 Summary of Preferred Restoration Alternatives

The Trustees' mandate under OPA is to make the environment and the public whole for injuries to natural resources and natural resource services resulting from the discharge of oil. This requirement must be achieved through the restoration, rehabilitation, replacement or acquisition of equivalent natural resources and/or services (33 U.S.C. §2706(b)). Thus, for a project to be considered, there must be a connection between natural resource injuries and proposed restoration actions.

Restoration actions under OPA are termed primary or compensatory. Primary restoration is any action taken to accelerate the return of injured natural resources and services to their baseline condition. Trustees may elect to rely on natural recovery rather than primary restoration actions where feasible or cost-effective primary restoration actions are not available, or where the injured resources would recover relatively quickly without human intervention.

Compensatory restoration is any action taken to compensate for interim losses of natural resources and services pending recovery. The scale of the required compensatory restoration depends on the extent and severity of the initial resource injury and how quickly each resource and associated service returns to baseline. Primary restoration actions that speed resource recovery will reduce the requirement for compensatory restoration.

Based on observations made during the injury assessment studies and the best professional judgment of the scientific experts retained for those studies, the Trustees determined that active primary restoration would not significantly speed the recovery to baseline levels.[3] Therefore, the natural recovery alternative was chosen for primary restoration.

[3] As part of the clean up and response efforts, EPA replanted areas within the immediate vicinity of the pipeline break. These actions could be considered primary restoration.

The Trustees and their scientific advisors considered 60 different restoration ideas and alternatives with the potential to provide compensatory restoration. These were provided to the Trustees by members of the Governor's Citizen Advisory Committee, Patuxent River Commission, appropriate federal, state, and local officials, RPs, and the public. All of the restoration ideas and alternatives were evaluated based on selection criteria developed by the Trustees consistent with the legal guidelines provided under OPA (15 C.F.R. §990.54(a)). Chapter 5 of this final Restoration Plan/ EA presents OPA-based selection criteria developed by the Trustees for this spill, as well as a description and evaluation of the restoration projects selected by the Trustees. Based on the Trustees' evaluation, eleven projects were selected for implementation. These are presented for each category of injury in Table 1.1.

Table 1.1. Summary of injuries and restoration alternatives. Injury estimates are described in Chapter 4 of this final Plan; restoration alternatives are presented in Chapter 5.

<table>
<tr><th colspan="2">Injury Category</th><th>Injury Estimate</th><th>Primary Restoration</th><th>Preferred Compensatory Restoration Alternative(s)</th></tr>
<tr><td colspan="2" rowspan="3">Wetlands and Beach Shorelines</td><td>76 acres of brackish marsh habitat (40.5 acres lightly oiled, 12.0 acres moderately oiled, 23.4 acres heavily oiled)</td><td>Natural Recovery</td><td rowspan="2">Tidal Marsh Creation, Washington Creek (5.7 acres)</td></tr>
<tr><td>376 muskrats</td><td>Natural Recovery</td></tr>
<tr><td>10 acres oiled shoreline (0.5 acre heavy, 6.4 acres moderate, 3.2 acres light)</td><td>Natural Recovery</td><td rowspan="2">Shoreline Beach Enhancement, Washington Creek (1.7 acres)</td></tr>
<tr><td colspan="2">Diamondback Terrapins</td><td>122 estimated dead and 10 percent loss of hatchlings in the 2000 cohort
Total injury estimate is 5,245 lost discounted terrapin years</td><td>Natural Recovery</td></tr>
<tr><td rowspan="2">Birds</td><td>Ruddy Ducks</td><td>553 birds</td><td>Natural Recovery</td><td>Enhance and Protect Ruddy Duck Nesting Habitat</td></tr>
<tr><td>Other Birds</td><td>143 birds (comprising about 14 species)</td><td>Natural Recovery</td><td rowspan="3">Create and Seed an Oyster Reef Sanctuary (4.7 acres)</td></tr>
<tr><td colspan="2">Fish and Shellfish</td><td>2,464 kg lost biomass</td><td>Natural Recovery</td></tr>
<tr><td colspan="2">Benthic Communities</td><td>2,256 kg lost biomass</td><td>Natural Recovery</td></tr>
<tr><td colspan="2">Lost Recreational Use</td><td>12,704 lost trips
112,359 trips with diminished value.
Estimated dollar value loss $453,500</td><td>Natural Recovery</td><td>(1) Canoe/ Kayak Paddle-in Campsites
(2) ADA-Accessible Kayak/ Canoe Launch
(3) Maxwell Hall NRMA Recreational Improvements
(4) Forest Landing Boat Ramp
(5) King's Landing Boardwalk and River Education Project
(6) Cedar Haven Fishing Pier
(7) Boat Access at Nan's Cove</td></tr>
</table>

CHAPTER 2.0. PURPOSE AND NEED FOR RESTORATION

This final Restoration Plan was prepared by the natural resource trustees to evaluate a range of alternatives for restoring natural resource injuries and lost services resulting from the April 7, 2000 oil spill at Chalk Point. This final Plan also serves as an Environmental Assessment (EA) in compliance with the National Environmental Policy Act (NEPA) (42 U.S.C. §§4371 et seq.) and implementing regulations (40 C.F.R. 1501.3).

2.1 Authorities and Legal Requirements

The four federal and state agencies that prepared this final Restoration Plan/ EA -- NOAA, USFWS, MDE, and MDNR -- are designated pursuant to OPA (33 U.S.C. §2706(b)) and the National Oil and Hazardous Substances Pollution Contingency Plan (40 C.F.R. §§300.600 et seq.) as Trustees for natural resources injured by the Chalk Point oil spill. As a designated Trustee, each agency is authorized to act on behalf of the public to protect and restore natural resources that have been threatened by releases of oil.

2.1.1 Overview of the Oil Pollution Act

OPA provides the statutory authority for natural resource trustees to carry out the necessary studies and implement restoration projects, with reimbursement by the RPs, to assess and recover damages and to plan and implement actions to restore natural resources and resource services injured or lost as a result of a discharge of oil. The law defines injury as “an observable or measurable adverse change in a natural resource or impairment of a natural resource service”. Restoration, under OPA, means “restoring, rehabilitating, replacing or acquiring the equivalent of injured natural resources and services” and includes both primary restoration (returning injured natural resources and services to pre-spill (or baseline) conditions, and compensatory restoration (returning the interim losses of natural resources and services that occurred from the date of the incident until full recovery).

Pursuant to the natural resource damage assessment implementing regulations, a natural resource damage assessment consist of three phases: (1) Preassessment; (2) Restoration Planning; and (3) Restoration Implementation (15 C.F.R. Part 990). The Trustees may initiate a damage assessment provided that: an incident has occurred; the incident is not from a public vessel or an onshore facility subject to the Trans-Alaska Pipeline Authority Act; the incident is not permitted under federal, state or local law; and Trustee natural resources may have been injured as a result of the incident.

Based on information collected during the Preassessment, the Trustees make an initial determination as to whether natural resources or services have been injured or are likely to be injured by the release. Through coordination with response agencies (e.g., the EPA for the Chalk Point incident), the Trustees next determine whether the oil spill response actions would eliminate the injury or the threat of injury to natural resources. If injuries are expected to continue and feasible restoration alternatives exist to address such injuries, the Trustees may proceed with the restoration planning phase. Restoration planning also may be necessary if injuries are not expected to continue but are suspected to have resulted in interim losses requiring compensatory restoration.

The purpose of the Restoration Planning phase is to evaluate the potential injuries to natural resources and services, and to use that information to determine the need for, and scale of, associated restoration actions. Natural resources are defined as "land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States, any state or local government or Indian tribe, or any foreign government". Services (or natural resources services) means the functions performed by a natural resource for the benefit of another natural resource and/or the public. This phase provides the link between injury and restoration and has two basic components -- injury assessment and restoration selection. The goal of injury assessment is to determine the nature and extent of injuries to natural resources and services, thus providing a factual basis for evaluating the need for, type of, and scale of restoration actions. As the injury assessment is being completed, the Trustees develop a plan for restoring the injured natural resources and services. The Trustees must identify a reasonable range of restoration alternatives, evaluate and select the preferred alternative(s), develop a draft Restoration Plan/ EA presenting the alternative(s) to the public, solicit public comment on the draft Restoration Plan/ EA, and consider those comments before issuing a final Restoration Plan/ EA.

During the Restoration Implementation phase, the final Restoration Plan/ EA is presented to the RPs to implement or to fund the Trustees’ cost of implementing the Restoration Plan/ EA, thus providing an opportunity for settlement of damage claims without litigation. Should the RPs decline to settle a claim, OPA authorizes Trustees to bring a civil action against RPs for damages, or to seek reimbursement from the Oil Spill Liability Trust Fund equal to the value of the damages. Damages include the cost of conducting damage assessments (33 U.S.C. §2706(d)(1)(c)).

2.1.1.1 Coordination among the Trustees

Throughout the damage assessment and restoration planning process the four federal and state Trustee agencies worked together to meet their respective natural resource trustee responsibilities under OPA and other applicable federal law and state statutory and common law. A June 2000 Memorandum of Agreement (MOA) signed by all of the Trustees provided a framework for coordination by establishing a Trustee Council that has been responsible for all natural resource damage assessment activities, including restoration planning and implementation. The Trustee Council met on a regular basis. While the Trustees requested that NOAA's Damage Assessment and Restoration Program assume the role of the Federal Lead Administrative Trustee and the overall natural resource damage assessment coordinator, all decisions were made by a consensus of Trustee Council representatives.

2.1.1.2 Coordination with the Responsible Parties

The OPA regulations require the Trustees to invite the RPs to participate in the damage assessment process. Accordingly, the Trustees delivered a formal invitation to Pepco and ST Services on June 22, 2000. The RPs accepted the Trustees' invitation, and a Trustee-RP MOA was signed by the Trustees and RPs in September 2000.

The Trustee–RP MOA provided the framework for a cooperative damage assessment (15 C.F.R. §990.44(d)). Under this MOA, the Trustees and RPs formed a Natural Resource Damage Assessment Council that included the four Trustees and two RPs. The Council met regularly to review and discuss the progress of the injury assessment and restoration planning efforts. Under the Trustee–RP MOA, designated technical representatives of Pepco and ST Services participated in Technical Work Groups established by the Trustees to assist with the design of studies and interpretation of data. Information collected by all parties was shared, as were the results of those analyses that were undertaken independently by the Trustees and RPs. While the coordination between the Trustees and RPs reduced duplication of studies, increased the cost-effectiveness of the assessment process, and increased sharing of information and expertise, the final authority to make determinations regarding injury and restoration rested solely with the Trustees.

The Trustees also presented Pepco and ST Services with the draft Restoration Plan/ EA. This action is consistent with OPA regulations, and is intended to provide the opportunity for settlement of damage claims without litigation. RP comments on the draft Restoration Plan/ EA and Trustee responses are included in Appendix 5.

2.1.1.3 Coordination with the Public

Throughout the injury assessment and restoration planning process, the Trustees have provided the public with information on the status of injury assessment and restoration planning efforts (Appendix 1). The Trustees published a *Notice of Intent to Conduct Restoration Planning* in the Federal Register (Vol. 65, No. 28, pgs. 70698-70699, November 22, 2000), stating that based on preassessment findings, they were proceeding with restoration planning under OPA and opening an Administrative Record to facilitate public involvement in the restoration planning process. The Trustees also worked extensively with Pepco to disseminate information to the public; they conducted a number of outreach activities, including numerous public meetings with EPA and Pepco;

and they contributed to five newsletters (called the *Swanson Creek Bulletin*) that were mailed to about 30,000 residents.

The Trustees also worked closely with the Oil Spill Citizens Advisory Committee established by Governor Parris Glendening. Trustee representatives attended all of the Committee's scheduled meetings, responded to their suggestions, concerns and needs for information, and formally solicited their recommendations for (1) potential experts to peer review injury assessment studies and (2) restoration ideas that they considered appropriate. The Trustees also co-hosted a technical workshop with the Committee to present injury assessment methodologies to members of the local scientific community. In addition to the Governor's Committee, the Trustees also coordinated their efforts with the Patuxent River Commission, a state watershed commission charged with coordinating state, local and federal efforts to restore and protect the Patuxent River.

The Trustees also placed information about the spill on their internet sites and made the Administrative Record for the damage assessment available for public review at the Pepco offices in St. Mary's and Calvert counties, the Maryland Department of Natural Resources, and the NOAA web site (www.darp.noaa.gov/neregion/chalkpt.htm). Through all of the above-mentioned efforts, the public was able to obtain reports and fact sheets for injury assessment studies, provide restoration ideas and alternatives to the Trustees and identified agency contacts to obtain more information.

Public review of the draft Restoration Plan/ EA was also an integral component of the restoration planning process. The Trustees provided the public with the draft Restoration Plan/ EA on May 8, 2002. During the following 60-day public comment period, the Trustees attended a public meeting in Calvert County and provided briefings for both the Governor's Citizens Advisory Committee and the Patuxent River Commission. The Trustees' responses to the written comments received on the draft Restoration Plan/ EA are provided in Appendix 5.

2.1.1.4 Administrative Record

The Trustees compiled an Administrative Record, which contains documents considered and/ or prepared by the Trustees during the restoration planning process. The Administrative Record provided an opportunity for public participation in the restoration planning 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.

A copy of the Administrative Record index is provided in Appendix 2 of this final Restoration Plan/ EA. Administrative Record documents can be viewed at the following locations:

Lighthouse Point Center
30383 Three Notch Road
Charlotte Hall, MD
(301) 290-0946
1-800-685-1266
fax (301) 290-0943
Mon. - Fri. 9 am to 5 pm

Information Resource Center
MD Dept. of Natural Resources
580 Taylor Avenue, B-3
Annapolis, MD 21401
(410) 260-8830
fax (410) 260-8951
Mon. - Fri. 8 am to 4 pm

In addition, documents in the Administrative Record can also be viewed at the following website: www.darp.noaa.gov/neregion/chalkpt.htm.

2.1.2 NEPA Compliance

Restoration of natural resources under OPA must comply with NEPA (42 U.S.C. §§4371 et seq.) and its implementing regulations (40 C.F.R. §§1500 et seq.). In compliance with NEPA, the draft Restoration Plan also served as an Environmental Assessment (EA). As such, it included a summary of the current environmental setting, described the purpose and need for action, identified alternative actions and their potential environmental consequences and summarized opportunities for public participation in the decision process. This information was used to make a threshold determination as to whether preparation of an Environmental Impact Statement (EIS) is required prior to the selection of the final restoration action (i.e., whether the proposed action is a major federal action that may significantly affect the quality of the human environment).

As summarized in Appendix 5, no public comments were received that indicated that the preferred restoration actions will significantly affect the quality of the human environment. Based on the EA integrated into this plan, it was determined that the proposed restoration action does not meet the threshold requiring an EIS. Based on the evaluation of preferred alternatives in Chapter 5, a Finding of No Significant Impact (FONSI) determination was made by the federal Trustee agencies (Appendix 8).

CHAPTER 3.0. AFFECTED ENVIRONMENT

This chapter presents a brief description of the physical, biological, and cultural environment affected by the Chalk Point oil spill. The physical environment includes approximately 40 miles of surface water, sediments, and shoreline along the mainstem of the Patuxent River and associated tidal tributaries, marshes, and shoreline habitats including (but not limited to) the mainstem of the Patuxent River, Swanson Creek, Indian Creek, Trent Hall Creek, Washington Creek, Cremona Creek and Caney Creek. The biological environment includes a wide variety of birds, fish, mammals, shellfish, and other organisms. The federally recognized threatened bald eagle and Puritan tiger beetle reside in the Patuxent River region. The diamondback terrapin, Maryland's official state reptile, is also of special interest to state and federal wildlife managers and is found within the spill area.

3.1 Physical Environment

The 963-square-mile Patuxent watershed, located entirely in Maryland, drains into the western shore of the Chesapeake Bay and is the next major tidal arm of the Bay upstream from the Potomac River. There are 6,773 acres of coastal wetlands within the Patuxent River watershed, accounting for 2.6 percent of the total area of coastal wetlands in the State and consisting mainly of fresh and brackish marsh wetlands (McCormick and Somes, 1982). The portion of the Patuxent River watershed affected by the Chalk Point oil spill (the Lower Patuxent) stretches through Prince George's, Charles, St. Mary's, and Calvert counties. Coastal wetlands and associated estuaries are vital to commercial and sport fisheries and shellfisheries. At least 60 percent of the species important to these activities in Maryland are dependent on the estuarine environments during at least part of their lives (Metzgar, 1973). Wetlands are also transition zones from uplands to deepwater aquatic systems. Wetlands also provide valuable ecological functions, such as those of organic exporters or inorganic nutrient sinks (Mitsch and Gosselink, 1986).

The 113-mile Patuxent River, shown in Figure 1, is a major tributary to the Chesapeake Bay and meanders through seven counties in the state of Maryland. Major tributaries contributing to the Patuxent River include the Western Branch, Little and Middle Patuxent Rivers, in addition to two large water supply reservoirs that supply water to the Washington, D.C., metropolitan area. The Lower Patuxent River watershed consists of moderately saline water. Low salinity conditions exist in the Middle Patuxent, while the Upper Patuxent consists of both tidal and nontidal fresh water.

The Chalk Point spill released fuel oil into Swanson Creek (Figure 1), a tidal tributary of the Patuxent River approximately 23 miles from the mouth of the river at the Chesapeake Bay. The main stem of the Patuxent River, associated shoreline habitats, and other tributaries were impacted as far south as Broomes Island, approximately 15 miles from the site of the spill. The shoreline and riparian area is comprised of brackish marshes, which are the predominant estuarine wetland type in Maryland (Tiner and Burke, 1995).

Table 3.1 provides additional information about the types of wetlands found in the Patuxent River watershed. Within the freshwater marsh category, the most common types of wetlands are smartweed/rice cutgrass, composed almost entirely of one or several species of smartweeds or tearthumbs, and cattails, composed purely of the common cattail (McCormick and Somes, 1982). The freshwater marsh wetlands are generally farther north of the mouth of the Patuxent River or along tributaries that drain into the Patuxent. Within the brackish high marsh category, the most common types of wetland plants are cattails and salt marsh hay. The marshes, shrub swamps, swamp forests, and submerged vegetation of coastal wetlands are the principal sources of food for the animals that inhabit the waters of the Chesapeake Bay estuary, coastal bays, and the nearshore ocean (McCormick and Somes, 1982). These habitats provide many other benefits to society through fish and wildlife habitats, water quality maintenance (pollution filter, sediment removal, oxygen production, nutrient recycling), aquatic productivity, and socio-economic values such as flood control, wave damage protection, shoreline erosion, water supply, and groundwater recharge (Tiner and Burke, 1995)

Table 3.1. Wetlands in the Patuxent River watershed (from McCormick and Somes (1982)).

Category	Acres of Wetland	Percentage
Shrub Swamp	461	6.8
Wooded Swamp	20	0.3
Freshwater Marsh	2,605	38.5
Brackish High Marsh	2,866	42.3
Brackish Low Marsh	449	6.6
Saline High Marsh	0	0
Saline Low Marsh	0	0
Open Water	177	2.6
Mudflat/Sandbar/Beach	23	0.3
Submerged Aquatics	51	0.8
Untyped Wetlands	121	1.8
Total	**6,773**	**100**

The physical environment of the Patuxent River watershed is impacted by human development. Human activities that can affect wetlands include livestock grazing, timber harvesting, and drainage for agriculture and filling for industrial or residential development. In addition, there are many natural threats to the wetlands ecosystem such as subsidence (including the natural rise of sea level), droughts, hurricanes, tornados and biotic effects (Tiner and Burke, 1995).

3.2 Biological Environment

The waters of the Patuxent River and its tributaries serve as important spawning or nursery sites for many finfish and shellfish species such as spot, croaker, striped bass, menhaden, herring, and shad, as well as clams, oysters, and blue crabs. Freshwater spawning marine species, such as striped bass and American shad, and many marine spawners, including bluefish and menhaden, depend on wetlands for nursery, feeding, and cover areas. Metzgar (1973) recognized irregularly flooded salt marsh as a highly valued habitat for fishery resources based on usage by 21 species including prized commercial and sport fish such as bluefish, striped bass, and white perch. Major tributaries of the Chesapeake Bay, including the Patuxent River, account for approximately 90 percent of the striped bass spawned on the East Coast (Berggren and Lieberman, 1997).

Benthic invertebrates, including oysters, clams, and crabs, are among the most important components of estuarine ecosystems and may represent the largest standing stock of organic carbon in estuaries (Frithsen, 1989). Blue crab is the most abundant and valuable shellfish catch in Maryland, with a five-year average (1996 – 2000) harvest of 31.8 million pounds and an annual dockside value of $33.2 million (Chesapeake Bay Commission, 2001). Blue crabs commonly use marshes, wetlands and submerged aquatic vegetation in the Patuxent River as nursery grounds, and they seek refuge in these areas when molting.

Wetlands provide year-round habitats for a host of resident and migratory bird species and are particularly important breeding grounds, overwintering areas, and feeding grounds for migratory waterfowl and numerous other birds. The Chesapeake Bay and its associated wetlands have been the winter home of approximately one-third of all the waterfowl using the Atlantic Flyway (Tiner and Burke, 1995). The abundance of crustaceans, mollusks, and other invertebrates in the smooth cordgrass zone of the tidal marsh provides food for herons, egrets, boat-tailed grackles, laughing gulls, seaside sparrows, and other birds (McCormick and Somes, 1982). During the autumn and spring periods of migration, waterfowl, including black ducks and green-winged and blue-winged teal, are abundant on the brackish marshes along the bays in the upper Chesapeake region of Maryland (McCormick and Somes, 1982). Fresh water tidal marshes are common feeding grounds for red-winged blackbirds, bobolinks, rails, teals and other ducks (Stewart, 1949; Meanly, 1975). In addition to the large numbers of waterfowl that inhabit the Patuxent River watershed, ospreys and great blue herons commonly nest in the impacted region near Swanson Creek. Other wildlife that inhabit

Maryland's wetlands include mammals (e.g., muskrats), reptiles (e.g., turtles, lizards, and snakes) and amphibians (e.g., toads, frogs, and salamanders) (Tiner and Burke, 1995).

3.2.1 Species of Special Concern

The Patuxent River watershed ecosystem provides particularly valuable habitat for the bald eagle, a bird included on the federal list of threatened species. The section of Swanson Creek and Patuxent River impacted by the spill is used by several pairs of nesting bald eagles (McGowan, 2000). In total, six nests were identified within the spill zone, three of which were active during the spill. The nesting period of the bald eagle is generally from February 15 to August 1.

A second federally-recognized threatened species, the Puritan tiger beetle, is also present near the Patuxent River. Although this species is a member of the ecosystem affected by the Chalk Point oil spill, available information indicates that they are located outside of areas directly impacted by the spill.

Diamondback terrapins are also found along the Patuxent River. Although not currently on the state or federal list of threatened species, terrapins are of special concern to the state. Terrapins are long-lived animals (>40 years) with maturity at 4 to 7 years for males and 8 to 13 years for females. They mate in April and May depending on water temperatures. Their nesting season is roughly between early June and the end of July when eggs are laid above the high tide line on many of the narrow, isolated sandy beaches found along the fringes of Patuxent River salt marshes (Roosenburg, 1996). Roosenburg (1994) reported nesting densities ranging from 240 to 1125 nests per hectare in the Lower Patuxent River.

No plants listed under the Endangered Species Act were known to be impacted by the spill.

3.3 Cultural Environment

The Patuxent River has been a vital resource for the region for thousands of years. Native Americans lived in the area as early as 7,500 B.C. Early European settlements and plantations were established along the Patuxent River in the early 1600s (e.g., Jug Bay Wetlands Sanctuary). Several locations along the Patuxent were significant sites in the War of 1812.

In addition to valuable cultural resources, the Patuxent River watershed supports a considerable amount of recreational activity, including fishing, swimming, boating, and picnicking. Recreational anglers took 3,722,018 fishing trips and caught 17,175,687 fish within the state in 2000 (NMFS, 2000). National Marine Fisheries Service data indicate that $63 million of fish were landed commercially in Maryland in 1999 (NMFS, 1999). While available data are not sufficient to determine the contribution of economic activity in the impact area to these statewide totals, the contributions are significant and depend on a healthy ecosystem in the Patuxent River region.

CHAPTER 4.0. INJURY DETERMINATION

This chapter describes the Trustees' efforts to quantify the nature, extent and severity of injuries to natural resources and recreational uses resulting from the April 7, 2000 oil spill at Pepco's Chalk Point facility. It begins with an overview of the data collected immediately following the spill as part of the "preassessment", followed by a description of the Trustees' damage assessment strategy. The remainder of this chapter presents summaries of the injury assessment methods and results.

4.1 Overview of Preassessment Activities and Findings

The Trustees for the Chalk Point oil spill initiated preassessment activities on April 8, 2000, immediately following notification of the spill. Preassessment activities, as defined by OPA, focused on collecting ephemeral data essential to determine whether: (1) injuries have resulted, or are likely to result, from the incident; (2) response actions have adequately addressed, or are expected to address, the injuries resulting from the incident; and (3) feasible restoration actions exist to address the potential injuries. The following summarizes key preassessment activities and findings:

<u>Shoreline Oiling Surveys</u>: On-the-ground and aerial surveys from about four miles upstream of Swanson Creek to the Thomas Johnson Bridge at Solomons, MD were conducted to document the location, amount, and extent of oiling in Swanson Creek and along the Patuxent River and its tributaries. These surveys indicated that about 96 acres of beach shoreline, manmade shoreline and marsh habitat were exposed to oil (Entrix, 2002a).

<u>Oiled Wildlife Surveys</u>: Survey teams walked the shoreline from April 9 through April 16, 2000, recording the extent and degree of oiled wildlife, collecting dead wildlife, and capturing oiled birds (if possible) for rehabilitation. An aerial survey on April 12, 2000 provided information on bird populations in the area of the Patuxent River from Eagle Harbor to the mouth of the Patuxent River. A separate survey was also conducted to evaluate impacts of the oil spill on muskrats in Swanson Creek. A total of 831 dead animals was collected, including 67 birds, 90 mammals, 25 reptiles, 539 fish, and 84 invertebrates (McGowan, 2000).

Sediment Blotting: On April 29 and 30, 2000, a survey was conducted in the Patuxent River and its tributaries to determine if oil was settling on the river bottom. A weighted sorbent pad was pushed to the bottom sediments, retrieved, and visually inspected for the presence of oil. Sixty-four locations in Swanson Creek, Indian Creek, Trent Hall Creek, and the Golden Beach area were sampled at depths to 15 feet. Some oil was detected in the intertidal shoreline habitat (Entrix, 2002b).

Oil Properties and Fate: The spilled oil (a combination of Number 6 and Number 2 oils) was analyzed and determined to have the following physical properties: specific gravity of 0.94 g/cc at 60°F; API Gravity of 18.4 at 60°F; and kinematic viscosity of 287.53 centistokes at 60°F. To predict the amount of oil that evaporated into the air and/or dispersed into the water column, NOAA modeled the fate and effects of the spilled oil. Model results indicate that 31 percent of the spilled oil evaporated into the air and 8 percent dispersed into the water column within the first 5 days of the spill (Entrix, 2002b).

Shellfish, Crab, and Fish Tissue Surveys: The MDE implemented an emergency closure for harvesting oysters and clams in the Patuxent River north of the Thomas Johnson Bridge based on public health concerns associated with the consumption of potentially contaminated shellfish. Shellfish, crab, and fish tissue samples were subsequently collected from the Patuxent River and analyzed for concentrations of polycyclic aromatic hydrocarbons (PAHs). The shellfish survey, conducted in cooperation with a local waterman, included 25 locations from north of Broomes Island to Ramsey Creek, approximately 13 miles. The crab survey was conducted by commercial watermen at 10 locations between Broomes Island and Eagle Harbor. Pepco and MDE collected a variety of fish species by trawl following the spill. Analyses of the tissue data indicated that levels of petroleum substances in shellfish, crabs, and fish did not pose a human health risk (Entrix, 2002b).

Abiotic Surveys: On April 8, 2000, surface water and sediment samples were collected at six locations in Swanson Creek to characterize the extent and magnitude of PAHs in the spill area. On April 10, 2000, seven locations in Swanson Creek and six sites in the Patuxent River near the mouth of Swanson Creek were sampled. From April 12 to 14, 2000, surface water samples were collected at 26 stations and sediment samples were collected at 33 stations located from about 4 miles upstream of Chalk Point to Broomes Island. Total PAH concentrations in water samples ranged to 767.82 ug/l (Entrix, 2002b).

Based on information collected during the preassessment efforts summarized above, the Trustees identified the following six categories of injury: (1) wetlands and beach shoreline, (2) fish and shellfish, (3) benthic communities, (4) birds, (5) diamondback terrapins and (6) recreational use. The Trustees determined that a number of potential restoration actions exist to compensate for the losses and proceeded with injury assessments.

4.2 Injury Assessment Strategy

The goal of injury assessment is to determine the nature, extent and severity of injuries to natural resources, thus providing the technical basis for evaluating and scaling restoration actions. The OPA defines injury as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service." Diminution in the quantity and/or quality of recreational use of natural resources also constitutes an injury as defined by OPA regulations.

For each of the six injury categories, the Trustees selected appropriate assessment procedures based on the: (1) range of procedures available under Section 990.27(b) of OPA regulations (15 C.F.R. §990.27(b); (2) time and cost necessary to implement the procedures; (3) potential nature, degree, and spatial and temporal extent of the injury; (4) potential restoration actions for the injury; (5) relevance and adequacy of information generated by the procedures to meet information requirements of planning appropriate restoration actions; and (6) input from local, state, and federal government officials, the RPs, and academic and other experts knowledgeable about the affected environment.

Each injury assessment focused on determining both the magnitude of the injury (i.e., number of animals killed or area of habitat lost) and the time to full recovery. This was accomplished for some resources, such as terrapins, by multiplying the number of lost animals by the recovery period to generate a number denominated in units such as terrapin-years. For wetland and beach shoreline habitats, injuries were quantified as service acre-years, where a service acre-year is the flow of benefits that one-acre provides over the period of one year. Injury assessments also considered “production foregone,” measured as either the growth in organism biomass or number of offspring that would have been produced in the absence of the spill. For recreational use, losses were calculated as the number of trips not taken to the spill zone and the diminished value of trips that were taken, expressed in dollars. Injury estimates in future years were discounted at three percent per year (NOAA, 1999), summed, and added to the injury in the year of the spill yielding an estimate of total injury. All of these methods produce an estimate of direct plus interim (from the time of injury until full recovery) loss of resources resulting from the oil.

Injury assessment studies were conducted by federal and state scientists, consultants with damage assessment experience, and local experts, including those from the Academy of Natural Sciences and the Chesapeake Biological Laboratory. A full description of the injury assessment methods and results is presented in resource specific injury reports prepared by the principal investigators. In each instance, the Trustees retained an outside expert to peer review key reports and, where appropriate, the Trustees modified each report to address peer review comments prior to approval. Final injury reports and peer review comments were then placed into the Administrative Record, where they are available for public review (see Section 2.1.1.4). Section 4.3 of this final Restoration Plan presents a summary of each injury assessment, including methods and findings.

4.3 Injury Assessment Methods and Results

The following sections describe the results of the Trustees' injury assessments for the Chalk Point oil spill. Descriptions of injuries are organized into the following six categories: wetlands and beach shoreline, fish and shellfish, benthic communities, birds, diamondback terrapins, and recreational use.

4.3.1 Wetlands and Beach Shoreline Injury Assessment

Field surveys and observations made during preassessment efforts indicate that about 76 acres of wetlands were oiled. Of this total, 40.5 acres were lightly oiled, 12.0 acres were moderately oiled, and 23.4 acres were heavily oiled (Entrix, 2002a) (Table 4.1).

The Trustees and RPs conducted a field study to determine the nature, extent and severity of marsh injuries. In July 2000, September 2000, and July 2001, data on degree of oiling, vegetative metrics (e.g., stem height, stem density, etc.), sediment chemistry, and abundance and composition of infauna were collected at 61 one square meter quadrats established in oiled and unoiled marshes. A comparison of field data from oiled and unoiled areas was then used as a relative indicator to estimate the degree of injury and time for full recovery.

To account for the different aspects of wetlands and the effects of oil on the different physical components, injury was estimated for wetland vegetation and wetland soils separately. Above-ground vegetation represents a broad range of ecological functions (or services) related to primary production, habitat structure, recreational and aesthetic value, food chain support, and fish and shellfish production. Assessment of soil function is also important to understanding potential effects of the oil on soil development, long-term plant response and biogeochemical cycling.

Table 4.1 shows the final estimated area and associated vegetative and soil injuries for wetlands based on habitat type and degree of oiling. A complete description of the injury assessment can be found in Michel et al. (2002). A brief description of the wetland injuries is presented below:

(1) Lightly oiled wetlands: Approximately 40.5 acres of marsh were lightly oiled, defined as areas with less than 10 percent oil distribution and 0.01 cm oil thickness. All lightly oiled wetlands were combined into one category, without distinction among vegetation types, because injuries were expected to be minimal. Marsh vegetation and marsh soils in this category were estimated to have suffered an initial 10 percent loss, with full recovery by October 2000 (six months following the spill and following the first growing season). The estimated interim loss of wetlands in this category is provided in Table 4.1.

(2) Moderately oiled wetlands: Moderately oiled marshes included areas outside of Swanson Creek with more than 10 percent oil distribution and 0.01 cm oil thickness. All moderately oiled wetland habitat types were combined into one injury category because few differences were noted between the different plant species, and they often formed

mixed stands. A total of 12.02 acres of marsh were exposed to moderate oiling. Field observations and data collected at these areas showed the following:

- At about 25 percent of the sites visited in July and September 2000, oil droplets were released from soils when disturbed. By July 2001, slight sheening was observed after soil disturbance at just two sites;

- One of the sites, located in an area that received intensive clean-up, showed significant vegetative mortality (i.e., reduced stem count and percent cover) in 2000 and 2001; and

- Total petroleum hydrocarbon (TPH) concentrations in soils from two sites in 2000 were 3,270 and 4,230 parts per million (ppm); concentrations of polynuclear aromatic hydrocarbons (PAH) in soils from these sites were 90 and 330 ppm, and the oil was characterized as weathered to significantly weathered.

Based on the field data, as highlighted above, the vegetation and soils in this wetland category were estimated to have suffered a 50 percent initial loss of function, with recovery in one year for vegetation and three years for soils. Table 4.1 provides the estimated interim loss of marsh in this category.

(3) <u>Heavily oiled wetlands</u>: This category included all areas within Swanson Creek with more than 10 percent oil distribution and 0.01 cm oil thickness. Heavily oiled wetlands were divided into shoreline and interior areas for each of the predominant vegetation types (*Typha sp., Spartina alterniflora,* and *S. cynosuroides)* because of significant differences in degree of oiling and expected natural rates of oil weathering for these settings.

(3a) Heavily oiled *Typha sp.*: A total of 0.16 acre of shoreline and 2.3 acres of interior *Typha sp.* wetlands were heavily oiled. Observations and data from these areas can be summarized as follows:

- Vegetative cover, stem density, and stem height data were highly variable, but generally comparable with controls in July 2000 and 2001;

- At all sites, oil droplets were released from the soils when disturbed underwater in 2000. By 2001, only sheens were released after disturbance;

- Soil chemistry data for 0 - 5 cm depths in 2000 showed widely different degrees of soil contamination, with one site having 40 times more TPH (37,000 ppm) than the other (840 ppm). Data from 2001 showed only slight decreases. PAH levels in surface soils in 2001 were 9 and 1,500 ppm and moderately weathered, indicating highly variable but very high and toxic levels; and

- Concentrations of TPH for interior sites in July 2000 were typically lower than those on the shoreline, and ranged from background to 7,600 ppm. Only one PAH analysis was available, from 2000, with a result of 540 ppm and exhibiting slight weathering.

Based on field data described above and observations at other spills, the Trustees estimated that heavily oiled *Typha sp.* vegetation in shoreline and interior areas suffered an initial 100 percent loss of function, with full recovery within 1 year. Interior soils were estimated to have suffered an initial 50 percent loss, with recovery to 80 percent in 5 years and 100 percent in 10 years. For shoreline soils, an initial 75 percent loss was estimated, with a return to 60 percent in three years, and 100 percent in ten years. Table 4.1 provides the estimated interim loss of marsh in this category.

(3b) Heavily oiled *S. alterniflora*: A total of 1.52 acres of shoreline and 3.80 acres of interior *S. alterniflora* wetlands were heavily oiled. Observations and data from these areas can be summarized as follows:

- Shortly after the spill, shoreline vegetation cover and stem densities were reduced compared to reference sites. Although values were still lower than reference sites in 2001, percent cover and stem density had increased by about a factor of two;

- Oil penetrated into the substrate, along stem cavities and roots. Oil droplets were released from the sediments when disturbed underwater in July 2000. By July 2001, only sheens were released upon disturbance;

- TPH levels in interior soils in 2000 were highly variable, ranging from background to over 15,000 ppm, with evidence of penetration at depths greater than 10 cm. By 2001, TPH levels had decreased (maximum 1,850 ppm), and all saturated hydrocarbons were characterized as significantly weathered. PAH levels in interior soils in 2000 ranged from 2 - 210 ppm; levels in 2001 were 1 - 54 ppm and characterized as moderately weathered; and

- Benthic community data collected in July 2000 from interior sites showed a reduction in both overall species numbers and numbers of oil-sensitive species (amphipods and isopods) compared to reference sites, but species numbers were similar to reference sites by September 2000.

The Trustees estimated from the field data summarized above that the heavily oiled *S. alterniflora* vegetation in both shoreline and interior habitats suffered an initial 100 percent loss of function, with a recovery to 50 percent in 1 year and 100 percent in five years. Soils were estimated to have suffered an initial 75 percent loss. Along the shoreline, recovery of soils is expected at 80 percent within three years and 100 percent within five years. As interior soils experienced higher initial oil levels and are subject to lower natural removal rates, recovery is estimated at 75 percent within five years and 100 percent within 10 years. Table 4.1 provides the estimated interim loss of marsh in this category.

(3c) Heavily oiled *S. cynosuroides*: A total of 1.66 acres of shoreline and 7.60 acres of interior *S. cynosuroides* marsh were heavily oiled. Oiling exposure and impacts in these areas can be summarized as follows:

- Impacts to interior vegetation varied widely. Some areas were completely devoid of vegetation while others had reduced stem densities or appeared normal. By 2001, two interior sites showed good recovery (similar to reference sites) while a third showed very little re-growth. Shoreline vegetation showed good recovery by 2001;

- Oil penetrated deep into root clumps, along stem cavities, roots, and burrows (20+ cm in some cores). In July 2000, black oil droplets were released from disturbed sediments at all quadrats. Soil cores at the interior sites had oil-filled pores in 2000 and 2001. Surface oil samples collected in both 2000 and 2001 contained over 40,000 ppm TPH. There was evidence of alkane weathering in the surface soils between 2000 and 2001, but little to no weathering of the PAHs; and

- Benthic communities showed partial recovery by September 2000, but poor recruitment of oil-sensitive species in July 2001.

The heavily oiled *S. cynosuroides* vegetation in both shoreline and interior habitats was estimated to have suffered an initial 100 percent loss of function, with a recovery to 50 percent in 1 year and 100 percent in 10 years. Shoreline and interior soil functions were estimated to have suffered losses of 75 percent initially, with shoreline habitats returning to 60 percent in three years and 100 percent in 10 years. Soil functions for interior habitats were estimated at 50 percent in five years and 100 percent in 20 years. Table 4.1 provides the estimated interim loss of these marshes.

(4) <u>"W1A" Wetlands</u>: Approximately 6.4 acres of wetlands in the immediate vicinity of the pipeline break (the area referred to as W1A) were the most heavily oiled and subject to the most aggressive clean-up activities (flooding, flushing, trenching, construction of boardwalks, nutrient augmentation, replanting, etc.). Oiling exposure and impacts in these areas can be summarized as follows:

- Initial oiling consisted of thick pools that formed and persisted on the marsh surface for several weeks until cleaned up. There was chronic re-oiling at least until July 2001, as residual oil was re-mobilized;

- Oil penetrated deeply into the root clumps, along stem cavities, roots, burrows, etc. In September 2000, one site contained 77,800 ppm TPH and 7,140 ppm PAH in the top 5 cm, with 6,300 ppm TPH and 420 ppm PAH at the interval 18-20 cm. At this same site in 2001, the surface oiling decreased by about half, but the subsurface oiling increased by about a factor of two, with no evidence of further weathering;

- Ditched areas, although backfilled with clean sand, contained 1,300 and 3,900 ppm TPH in 2000, indicating a substantial amount of re-oiling; and

- Vegetation in the replanted areas showed large reductions in cover and stem density.

Based on field observations, the W1A area was divided into "less-impacted areas" and "more-impacted areas." The "more-impacted" areas include those that were ditched to facilitate oil clean up and subsequently replanted, as well as areas of extensive physical disturbance during pipeline repair activities. The remainder of W1A, where the vegetation showed significant recovery, was considered "less-impacted." Vegetation in both areas was estimated to have suffered an initial 100 percent loss. At one year, vegetative recovery at less-impacted areas was 50 percent and at more impacted areas 20 percent. Both were estimated to recover fully in 10 years. For soil-related services at both "less-" and "more-impacted" areas, initial loss was estimated to be 100 percent, with full recovery in 20 years. Table 4.1 provides a summary of the estimated interim losses of marsh in this category.

(5) Restricted Access Areas: This category included 4.11 acres of unoiled wetlands that were nearly surrounded by oiled wetlands, thereby restricting access to wildlife during the time that oil persisted in adjacent areas. It was assumed that there was an initial 100 percent loss of vegetation in these areas, with full recovery within one year. There were no estimated reductions in soil function for this injury category. Table 4.1 provides a summary of the estimated interim losses of marsh in this category.

Table 4.1. Summary of wetland injury by habitat type and degree of oiling.

Degree of Oiling/ Habitat Type	**Total Area (Acres)**	**Vegetation Injury (Service Acre-Years)**	**Soil Injury (Service Acre-Years)**
Lightly oiled	40.50	1.01	1.01
Moderately oiled	12.02	3.01	8.87
Heavily oiled *Typha* sp. shoreline	0.16	0.08	0.46
Typha sp. interior	2.30	1.15	4.79
S. alterniflora shoreline	1.52	2.58	2.40
S. alterniflora interior	3.80	6.45	11.05
S. cynosuroides shoreline	1.66	4.62	4.81
S. cynosuroides interior	7.60	21.14	44.14
W1A: less impacted	3.21	8.94	18.99
W1A: more impacted	3.21	13.33	23.01
Total Oiled Area	**75.94**	**--**	**--**
Restricted Access (unoiled)	4.11	2.05	0.00
Total Injury Area	**80.05**	**64.35**	**119.53**

Summing the categories of wetland injuries provides a total injury estimate of approximately 64 service acre-years for vegetation-related services and 120 service acre-years for soils (Table 4.1)[4]. Assuming that the contributions of vegetation and soils to overall wetland functions are equal, the total injury is 91.94 wetland service acre-years.[5]

The loss of marsh habitat, as quantified in service acre-years, will be used to scale restoration actions that produce sufficient compensation for the losses. An assumption inherent in this injury assessment is that the quantification of wetland injury takes into account the entire flow of marsh services, including habitat for wildlife. To validate that the scale of marsh restoration will compensate for associated wildlife injuries, the Trustees assessed injuries to muskrats and the marsh acreage needed to compensate for these losses. Based on the 70 dead muskrats that were collected following the spill, a total of 376 muskrats were estimated to have been killed (Michel et al., 2002; Appendix D). The scaling calculations presented in chapter 5 indicate that the area of marsh needed to compensate for the wetlands injury will also compensate for the muskrat injuries.

(6) Beach Shorelines: Approximately 10.11 acres of beach shoreline were oiled by the Chalk Point spill. Of this total, about 0.5 acre was heavily oiled, 6.4 acres were moderately oiled, and 3.2 acres were lightly oiled.

Most beach shorelines recovered within a relatively short time after the spill. Approximately 70 percent of the oiled beach acreage met the Phase 1 clean-up criteria established by EPA[6] within several months of the spill. Ninety-six percent of the remaining oiled beach shoreline acreage met Phase 1 criteria within approximately one year (or less). Estimates of the initial loss were 25 percent for lightly oiled shorelines, 75 percent for moderately oiled shorelines, and 100 percent for heavily oiled shorelines. Full recovery in all areas was estimated at 6 - 30 months from the date of the spill. Estimated interim loss of shorelines is 4.7 service acre years. A complete description of the assessment of beach shoreline injuries is provided in Appendix E of Michel et al. (2002).

4.3.2 Fish and Shellfish Injury Assessment

The Chalk Point oil spill occurred during the spring spawning period of many fish that inhabit the Patuxent River. Preassessment data indicate that fish and shellfish resources were exposed to oil and died as a result of the Chalk Point oil spill. Water samples collected during the spill indicated that petroleum products were present in the water column in Swanson Creek at levels that may be toxic to aquatic organisms. In addition, laboratory tests conducted by the Academy of Natural Sciences indicated that water collected from Swanson Creek a few days after the spill occurred was acutely toxic to striped bass larvae (Breitburg and Riedel, 2001). Field surveys recovered more than 500 dead fish and 80 dead invertebrates, many of these with visible signs of oiling (McGowan, 2000).

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[4] An acre-year is the flow of benefits that one acre provides over the period of one year.
[5] (64.35 acre-years vegetation x 0.50) + (119.53 acre-years soils x 0.50) = 91.94 wetland acre-years.
[6] EPA Response Action Plan, July 2000

The full nature and extent of injuries to fish and shellfish were estimated through model analysis using SIMAP (Spill Impact Model Analysis Package) (French McCay and Jennings, 2002). This model system is based on the Natural Resource Damage Assessment Model for Coastal and Marine Environments (Version 2.4, April 1996), which is included in the Code of Federal Regulations (43 C.F.R. Part II) for performing natural resource damage assessments for spills under the Comprehensive Environmental Response, Compensation and Liability Act (42 U.S.C. §§9601 et seq.).

SIMAP includes two submodels. The physical fates submodel estimates the distribution of the spilled oil (as mass and concentrations) on the water surface, on shorelines, in the water column and in the sediments. The model is three-dimensional, using a latitude-longitude grid to map environmental data. Algorithms based on published research account for spreading, evaporation, transport, dispersion, emulsification, entrainment, dissolution, volatilization, partitioning, sedimentation and degradation (weathering) of the oil. Site- and incident-specific data used in the model include hourly wind speed and direction taken from Thomas Pt., MD (NOAA station TPLM2) and hydrographic data obtained from the NOAA National Geophysical Data Center. The results and outputs of the physical fates submodel, including the predicted oil trajectory and dissolved PAH concentrations, were validated by comparison with shoreline survey observations, aerial overflight maps made during the response and measured concentrations of TPH and PAH in samples taken during the week following the spill.

The second component of SIMAP is the biological fates submodel. This submodel assumes exposure to fish and shellfish through contact with dissolved aromatic compounds in water and sediments, as predicted by the physical fates model. It uses habitat-specific data, estimates of fish and shellfish biomass, and documented species-specific sensitivities to oil to estimate mortality of adults, as well as their eggs and larvae. Mortality is calculated for present and future years, using estimated abundance and mortality rates that will occur in the absence of the spill.

Fish and shellfish biomass (kg/ km^2) estimates used as input parameters for the biological effects model were based on surveys conducted by the MDE immediately following the spill and the historic literature, as well as the best professional judgment of fisheries experts within MDNR, MDE, NOAA, and the USFWS (Entrix, 2002c). Despite the inherent uncertainties associated with developing species-specific biomass estimates for use in the model, the Trustees believe that the estimates are reasonable, and that more precise estimates would require extensive monitoring in future years that would delay implementation of restoration, and substantially increase assessment costs.

Fish and shellfish losses estimated by SIMAP for all age classes are summarized in Table 4.2. Assuming the model input data and average species sensitivity to PAHs, the best estimate of total injury to fish and invertebrates is 2,464 kg. This total injury includes: (1) the biomass equivalent of the direct kill, equal to 1,485 kg and (2) future growth of the killed animals, had there not been a spill, totaling 979 kg (the production foregone) (French McCay and Jennings, 2002).

Table 4.2. Model estimates of fish and invertebrate losses totaled for all age classes, assuming average species LC50 = 75 ug/L.

Species	Kill (kg)	Production Forgone (kg)	Total Injury (kg)
Bay anchovy	0.01	0.0	0.01
Blueback herring	0.02	0.1	0.12
Atlantic menhaden	120	50	170
Atlantic silverside	1.39	0.21	1.6
Striped killifish	0.30	0.05	0.35
Mummichog	4.4	0.7	5.1
Spottail shiner	0.02	0.00	0.02
Inland silverside	0.01	0.00	0.01
Less common finfish	1.7	0.3	2.0
Striped bass	60	81	141
White perch	252	343	595
Atlantic croaker	329	317	645
American eel	17	20	38
Hogchoker	84	70	154
Brown bullhead	1.7	0.7	2.4
Blue crab	579	44	623
Horseshoe crabs	32	51	83
Oysters, dry weight	2.1	0.8	2.9
Total	**1,485**	**979**	**2,464**

4.3.3 Benthic Communities Injury Assessment

Preassessment activities provided evidence that the spilled oil contaminated intertidal and subtidal sediments, as well as created potentially toxic conditions in the water column. To evaluate the injury to benthic macroinvertebrates due to exposure to oil contaminated sediments or water, the Trustees undertook several studies to determine the extent and duration of injuries to benthic communities. The first was conducted by the Academy of Natural Sciences Estuarine Research Center to measure the abundance of infaunal invertebrates from intertidal and subtidal areas located in Hunting Creek (control site), Trent Hall Creek (moderately oiled site), and Swanson Creek (heavily oiled site) (Osman, 2001). The second benthic injury assessment study, conducted by Versar Inc., compared macrofauna and sediment characteristics in Swanson Creek to the mainstem of the Patuxent River and to Hunting Creek (control site) (Llanso and Volstad, 2001). The methods and analyses used by Llonzo and Volstad (2001) were consistent with the long-term benthic monitoring program in the Chesapeake Bay.

The nature and extent of injuries to subtidal benthic resources was quantified by Peterson (2002), based on data and findings presented in Osman (2001) and Llanso and Volstad (2001). Specifically, the evidence for and against spill impacts to the soft-bottom macroinvertebrates was assembled and organized by geographic area and time frame. The results of statistical analyses, along with data on average densities, were then used to identify those species or higher taxonomic groups that demonstrated responses, positive or negative, to the spill and the geographic extent and temporal duration of the responses. The biomass contrasts for each of those affected species or taxa were then used to estimate the magnitude of the lost production per unit area (m^{-2}). The area of each impact was then calculated based on the shoreline oiling data, with the product of these latter two factors computed to estimate the total biomass change induced by the oil spill at that sampling date for each affected taxon.

The review and data analyses by Peterson (2002) found strong evidence that the spill caused injury to subtidal benthic communities in Swanson Creek. These findings included: (1) reduced biomass of bivalves (mostly *Macoma balthica* and *Rangia cuneata)* in upper Swanson Creek in June and September 2000, (2) reduced biomass of amphipods (*Leptocheirus plumulosus*) in upper and lower Swanson Creek in June 2000 and upper Swanson Creek in September 2000, and (3) increased biomass of polychaetes. The data did not indicate any compelling evidence of benthic injury in the mainstem Patuxent River (Peterson, 2002).

Table 4.3 summarizes the estimate of benthic injury, presented in units of Ash-Free Dry Weight (AFDW). The reduction of bivalve biomass in upper Swanson Creek was estimated to be 1.14 g m^{-2} in June 2000 and 2.73 g m^{-2} in September 2000. Because growth naturally slows dramatically as water cools in the fall and *M. balthica* is largely an annual species with strong year classes living little more than a year (Holland et al., 1987), the difference in biomass at the end of the warm season in September represents a reasonable estimate of total production lost from the oil spill during 2000. Thus, bivalve injury was calculated by multiplying the loss of 2.73 g m^{-2} by the area affected (about 708,000 m^2 for upper Swanson Creek) to yield the total bivalve biomass production lost in 2000 of 1,932.8 kg (Table 4.3).

The total biomass production lost by the amphipod *L. plumulosus* required two separate calculations, one for June when injury extended from upper Swanson Creek through lower Swanson Creek, and a second for September, when only upper Swanson Creek remained impacted. This species produces multiple broods per year and reproduction is continuous from May to November, with peaks of reproduction and population growth in spring and fall (Spencer and McGee, 2001). Hence, an estimation of injury that sums the biomass differences documented in June and September represented the best estimate of *Leptocheirus sp.* biomass production lost. In June, the lost amphipod production was 0.1067 g m^{-2} in upper Swanson Creek and 0.1024 g m^{-2} in lower Swanson Creek. Lower Swanson Creek has an area of about 1,320,000 m^2. Consequently, the total biomass production lost from the spring population peak is the sum of the products of loss per unit area and total area for each of the two segments of the creek, or 75.5 kg for upper Swanson Creek and 135.2 kg for lower Swanson Creek (Table 4.3). The September injury, presumably to the second population peak, only appeared in upper Swanson Creek and amounted to 42.6 kg of biomass production lost. Thus, the total *Leptocheirus* amphipod production lost from the oil spill in 2000 was 253.3 kg (Table 4.3).

The most likely injury to persist beyond September 2000, when field studies ended, would be to *Leptocheirus*, due to its sensitivity to contaminants and from the multi year duration of impacts to amphipods reported in other spills. Therefore, the loss of *Leptocheirus* was extended to June 2002. Assuming a similar loss of biomass for this period as occurred in 2000 (75.0 kg for June 2001, 42.6 kg for September 2001, and 75.5 kg for June 2002), an additional loss of 193.6 kg was estimated (Table 4.3).

The enhancement of polychaete production was considered as partial mitigation for the loss of bivalve and amphipod production. Like the injured bivalves *M. balthica* and *R. cuneata* and the injured amphipod *L. plumulosus*, polychaetes also serve a role as prey for higher trophic level consumers in the system. The biomass enhancement of polychaetes was greatest in June 2000. Totaled over the affected area of upper Swanson Creek, the oil spill resulted in 247.1 kg of increased polychaete production (Table 4.3).

Table 4.3. Estimation of subtidal benthos injury in units of biomass (ash free dry weight) production lost for Chalk Point oil spill of April 2000.

Injured or Affected Resource	**Date**	**Biomass Difference (Impact-Control)**	**Affected Area**	**Total Biomass Change over Affected Area**	**Biomass Production Lost [1] in 2000**
Bivalve mollusks (mostly *M. balthica* also *R. cuneata*)	Sept 2000	-2.73 g m^{-2} Upper Swanson	708,000 m^2	-1,932.8 kg	-1,932.8 kg
Polychaetes (mostly spionids, also capitellids)	June 2000	+0.349 g m^{-2}	708,000 m^2	+247.1 kg	+247.1 kg
Crustacean amphipod (*L. plumulosus)*	June 2000	-0.1067 g m^{-2} Upper Swanson	708,000 m^2	-75.5 kg	-253.3 kg
		-0.1024 g m^{-2} Lower Swanson	1,320,000 m^2	-135.2 kg	
	Sept 2000	-0.0602 g m^{-2} Upper Swanson	708,000 m^2	-42.6 kg	
	June 2001	-0.1067 g m^{-2} Upper Swanson	708,000 m^2	-75.5 kg	-193.6 kg
	Sept 2001	-0.0602 g m^{-2} Upper Swanson	708,000 m^2	-42.6 kg	
	June 2002	-0.1067 g m^{-2} Upper Swanson	708,000 m^2	-75.5 kg	

[1] negative number means a loss in production

While the increase in polychaete production totaled 247.1 kg, a full credit for the enhanced production is not warranted. Because of their greater longevity and greater capacity to filter water, the bivalves probably serve a more important biogeochemical function in protecting water quality than polychaetes, implying that the biomass credit for enhanced polychaete production should not be credited against polychaete production on a one-for-one basis. Similarly, substantially more of the amphipods that were lost could be expected to have been be preyed upon by higher trophic levels than the enhanced polychaetes because (1) amphipods and other small crustaceans are highly preferred fish foods and (2) the opportunistic polychaetes typically suffer from food limitation, die, and decompose in the sediments (Marsh and Tenore, 1990). Given the above, the Trustees assumed a credit equaling 50 percent of increased production of polychaetes for scaling. The net loss of production by benthic invertebrates from the Chalk Point oil spill thus involves summing the losses to each taxon by year and then applying partial credit for the enhancement of opportunistic polychaetes. In 2000, lost bivalve production was 1,932.8 kg, and lost *L. plumulosus* production was 253.3 kg (Table 4.3). The losses of *L. plumulosus* production are projected to be another 75.5 kg in June 2001, 42.6 kg in September 2001 and 75.5 kg in 2002, totaling an additional 193.6 kg. Thus the total injury to amphipods, not discounted by year of occurrence, was estimated to be 446.9 kg. Giving a 50 percent credit for enhancement of production by opportunistic polychaetes reduces overall injury by 123.6 kg. Consequently, the undiscounted sum of all injuries and credits to the benthos is 2,256.1 kg of AFDW. The complete benthic injury assessment is presented in Peterson (2002).

4.3.4 Bird Injury Assessment

The preassessment survey data indicate that a wide variety of birds were oiled by the Chalk Point oil spill and many died as a result of this exposure. Table 4.4 provides the list of the 61 oiled dead birds that were either collected dead by field survey teams and clean-up crews, or died during rehabilitation efforts.

Table 4.4. Observed number of dead birds by species.

Species	Number of Dead Birds Collected	Number of Birds Dying in Rehabilitation	Total Dead Birds (observed)
Ruddy Duck	35	4	39
Double-crested Cormorant	3	1	4
American Coot	1	1	2
Mallard	1	1	2
Great Blue Heron	2	0	2
Osprey	2	0	2
Virginia Rail	0	1	1
Herring Gull	1	0	1
Kingfisher	1	0	1
Loon	1	0	1
Ring-billed Gull	1	0	1
Savannah Sparrow	0	1	1
Unidentified Tern	2	0	2
Unidentified Warbler	0	1	1
Unidentified Bird	1	0	1
Total	**51**	**10**	**61**

The Trustees and RPs conducted four separate studies to determine the full nature and extent of injuries to birds resulting from the spill. The first study was conducted to estimate the number of birds that died and the lost future production of offspring as a result of the oil spill. The remaining three studies assessed the impact of the spill on the reproductive success of ospreys, great blue herons, and bald eagles.

Bird Mortality: The Trustees and RPs conducted a "risk-based" assessment to estimate the total mortality of birds. Data collected following the spill (total dead collected, population size, number rehabilitated, etc.) and life history information from the scientific literature were used to estimate the population at risk, the percent of the population oiled, and the total mortality. Tables 4.5, 4.6, 4.7 and 4.8 provide a summary of the injury assessment approach and findings.

Table 4.5 presents the results of the effort to estimate the number of dead birds that were not recovered by field survey. Estimates of population size were based on field surveys conducted by the USFWS. A total of 412 birds was estimated to have died, but were not recovered (Michel, 2001a).

Table 4.5. Calculations to estimate the number of dead birds that were not recovered.

Species	**Population Size**[1]	**Estimated and/ or Observed Number Oiled**[2]	**Number Collected (live and dead)**	**Estimated Number Not Collected**[3]	**Estimated Mortality Rate in the Field**	**Estimated Number Dying in the Field**
Ruddy Duck	851	426 (est. 50% of number in field)	59	367	0.85	312
Double-crested Cormorant	200	50 (est. 25% of number in field)	4	46	0.85	39
American Coot	40	40 (observed)	4	36	0.85	31
Mallard	29	53 (est. 50% of number in field + all 38 recovered)	38	15	0.5	8
Green-winged Teal	50	12 (est. 25% of number in field)	0	12	0.85	11
Greater Scaup	41	10 (est. 25% of number in field)	0	10	0.85	9
Osprey	15	6 (observed)	6	0	-	0
Great Blue Heron	7	7 (observed)	2	5	0.23	1
Canada Goose	13	12 (observed)	7	5	0.23	1
Virginia Rail	0	1 (observed)	1	0	-	0
Total			121	496		412

[1] Based on field surveys conducted by the USFWS following the spill.
[2] About half of the observed ruddy ducks in the spill zone were observed to be oiled. Other bird species were expected to have a lower probability of exposure to oil either because of their behavior or because they were observed in areas that were not heavily oiled. Consequently, the Trustees assumed that 25% of the observed scaup, teal and cormorants were oiled and used the actual observed number oiled for the remaining species.
[3] Number observed to be oiled minus number collected (live and dead).

Table 4.6 presents estimates of the number of birds that died following rehabilitation efforts, but were not recovered by field survey teams. Estimates of the mortality rate are based on studies by Anderson et al. (2000) on the survival, condition, and behavior of oiled and rehabilitated American coots, and Anderson et al. (1996) on the survival of oiled and rehabilitated brown pelicans. Of the 89 oiled birds that were rehabilitated and released alive, the Trustees estimated that 22 died shortly thereafter.

Table 4.6. Estimated number of birds dying after rehabilitation.

Species	Number Oiled Released Alive	Mortality Rate After Release	Estimated Number Dying After Release
Ruddy Duck	20	0.50	10
Canada Goose	7	0.23	2
American Coot	2	0.50	1
Mallard	36	0.25	9
Osprey	4	0.23	1 (was collected)
Other Birds	20		
Total	**89**		**22**

After reviewing the estimated number of lost birds, as well as the available data on fledging rates, survival rates, and population abundances, the Trustees and RPs concluded that ruddy ducks were the only bird species where the injury was large enough to affect future production. The Trustees and RPs therefore calculated the loss of future production for ruddy ducks based on the number observed oiled and/or dead, life history information available in the scientific literature (Johnsgard and Carbonell, 1996; Bellrose, 1978), and expert scientific judgment. Using the simplifying assumptions that none of the oiled ruddies nested after being oiled and that natural recovery occurred within one year, an estimated 384 fledged young were lost as a result of the spill. Adjusting for natural mortality between fledgling and adults (50 percent, based on Johnsgard and Carbonell, 1996), the Trustees estimate that the 384 fledged young would have yielded 192 adult ruddy ducks that were lost as a result of the spill.

Table 4.7 summarizes the bird mortality estimates, including birds observed dead, estimated number dying in the field, and estimated number dying after release from rehabilitation. A total of 687 adult birds were estimated to have died. A complete description of the methods and findings is presented in Michel (2001a).

Table 4.7. Summary of the estimates and total mortality of adult birds.

Species	Observed Dead	Estimated Number Dying After Release from Rehabilitation	Estimated Number Dying in the Field	Production Foregone	Total Dead
Ruddy Duck	39	10	312	192	553
Double-crested Cormorant	4	0	39		43
American Coot	2	1	31		34
Mallard	2	9	8		19
Green-winged Teal	0	0	11		11
Greater Scaup	0	0	9		9
Great Blue Heron	2	0	1		3
Osprey	2	0	0		2
Canada Goose	0	2	1		3
Virginia Rail	1	0	0		1
Other Birds	9	0			9
Total	**61**	**22**	**412**	**192**	**687**

Nesting Bird Studies: The Trustees and RPs conducted field surveys between April and August 2000 to determine the degree and extent to which the oil spill affected the reproductive success of ospreys, great blue herons, and bald eagles. For each of these three species, monitoring included the evaluation of hatching percentage, number of young, number of successful nests, and fledging success.

Osprey: Over one hundred osprey nests in the Patuxent River were monitored; forty-four were located within the middle section of the river thought to be impacted by the spill and twenty-eight were upstream of the spill. The mean of 1.50 young fledged per active nest in the middle section was similar to the twenty-five year average of 1.51 for the river. In addition, there were no significant differences in survival rates of nestlings from the middle and upper sections of the river in 2000 or in the number of young produced in 2000 and previous years. However, there was evidence of localized impacts to individual nests, with an estimated 17 osprey young lost due to the oil spill and associated clean-up activities. Assuming a survival rate of 55 percent from fledgling to adults (Henney and Wight, 1969; Spitzer, 1980), the 17 osprey young would have resulted in the loss of nine adults. A complete description of the methods and finding is available in Cardano et al. (2001).

Great blue herons: Twelve heron nests in Swanson Creek and seventeen in Black Swamp Creek, located roughly four miles upstream, were monitored from mid-May through mid-June 2000. Results indicate no detectable effects of the oil spill on the reproductive success of the Swanson Creek herons. There were no significant differences in the mean number of birds fledged or survival rates of nestlings between the sites. There was some uncertainty with the results due to the delay in initiating monitoring, which began almost a month after the spill occurred. Consequently, a follow-up nesting bird survey was conducted in spring 2001 at both colonies. Results indicate the number of breeding birds at both colonies was similar to, or greater than, the number in 2000. A complete description of the methods and findings is available in McGowan et al. (2001).

Bald eagles: Two active bald eagle nests were located within Swanson Creek and a third active nest was identified near Cremona Creek. Two of the three nests each initially contained two nestlings (one in Swanson Creek and the other in Cremona Creek). In mid-April, the Swanson Creek nest was destroyed by high winds, resulting in the death of both nestlings. The two nestlings successfully fledged from the Cremona Creek nest. Results of this study indicate that the spill did not affect bald eagles. A complete description of the methods and findings is available in Wearmouth and McGowan (2001).

Based on the results of the mortality and hatching success studies, the total number of birds estimated to have died as a result of the Chalk Point oil spill is calculated as follows: 687 adult birds + (0.55 x 17 osprey young) = 696 birds lost. Of this total, 553 were ruddy ducks.

4.3.5 Diamondback Terrapin Injury Assessment

Seven dead diamondback terrapins were collected during wildlife and shoreline surveys conducted immediately following the spill and four were subsequently reported dead by waterfront landowners in the spill zone. An additional 8 oiled, live terrapins were also captured in the spill zone. Seven of them were rehabilitated and returned to the wild, while the eighth died in captivity. Therefore, the number of known dead diamondback terrapins associated with the spill is 12.

The Trustees and RPs conducted two studies to determine the total mortality of terrapins resulting from the Chalk Point oil spill. The first was a nesting success study designed to assess the impact of the spill on the year 2000 hatchling cohort (Wood and Hales, 2001). The second study estimated the total terrapin injury, including total acute mortality and next generation production foregone (Michel et al., 2001b; Byrd et al., 2002b).

Nesting Success Study: The nesting success study compared the hatching success of terrapins at oiled and unoiled nesting beaches. At each of the nine selected nesting beaches, two 50 m^2 exclosures were constructed to enable detection of any terrapin hatchlings. Monitoring occurred over a nine-week period beginning on September 10, 2000. Selected exclosures were then excavated to identify the location of nests from which hatchlings had emerged prior to September 10, as well as to look for nests or hatchlings overwintering underground.

Results of the hatching success study suggest that the oil spill may have contributed to a reduction in nest size and may have increased the mortality of the year 2000 hatchling cohort. Based on statistical comparisons of hatching and hatchlings between variously oiled and unoiled sites, and comparison of egg and nest information from the excavation of terrapin nests at heavily oiled and unoiled enclosures, the following conclusions were reached:

(1) The density of nests on oiled and unoiled beaches did not differ;

(2) Hatching of terrapins in the fall did not differ between oiled and unoiled nesting beaches;

(3) Fall hatchlings recovered from oiled and unoiled sites were comparable in size and weight;

(4) Nest size at oiled and unoiled sites did not differ. However, observed nesting size at both oiled and unoiled beaches were significantly lower than those reported for the 1987-1991 period; and

(5) There was a significantly higher frequency of dead embryos and a lower frequency of presumed spring-emergers at oiled sites compared to unoiled sites. The cause of death of those embryos is not known and may not necessarily be attributed to the oil.

A complete description of the methods and findings from the terrapin nesting study is presented in Wood and Hales (2001).

Total Mortality Study: The Trustees and RPs used a "population-at-risk" approach to estimate total acute mortality to adult and juvenile terrapins. The population at risk from exposure to the oil was based on the mean population estimate of 2,293 adults and juveniles (86.2 terrapins/ km) from Roosenburg (1990). The total length of shoreline between Chalk Point and Spring Cove is estimated to be 54.5 km, including oiled and unoiled shoreline (only the oiled portion is used to estimate mortality, however). Thus, the total population of terrapins between Chalk Point and Spring Cove is estimated to be 4,698 (54.5 km x 86.2 terrapins/km).

The shoreline was then partitioned into three oil exposure zones. Total acute mortality was estimated based on best professional judgment concerning the mortality risks posed by the differential degrees of oiling and the length of oiled shoreline and population estimates, as follows:

- Chalk Point to Teague Point: This zone had the highest degree of oil exposure. The mortality rate for terrapins was estimated to be 10 percent in this zone because of the degree and persistence of oiling. The total shoreline length of this zone is 14.0 km and the oiled portion was 11.3 km long. Mortality is estimated (11.3 km x 86.2 animals/km x 10 percent mortality) to be 97 animals (range of 73 to 123).

- Teague Point to Long Point: This zone had relatively moderate amounts of oil exposure, with most of the oil confined to a narrow band along the outer fringes of marsh. The amount/ duration of oiling was much reduced, compared to the Chalk Point/ Teague Point area. The mortality rate for terrapins is estimated to be two percent in this zone. The total shoreline length for this zone is 13.9 km and the oiled portion was 8.2 km long. Mortality was estimated (8.2 km x 86.2 animals/km x 2 percent mortality) to be 14 animals (range of 11 to 18).

- Long Point to Spring Cove: This zone had relatively light amounts of oil stranded on the shoreline and little sheening. The mortality rate for terrapins was estimated to be 0.5 percent in this zone. The total shoreline length for this zone is 26.6 km and the oiled portion was 24.7 km. Mortality was estimated (24.7 km x 86.2 animals/km x 0.5 percent mortality) to be 11 animals (range of 8 to 14).

Total adult and juvenile acute mortality, using the population-at-risk approach, was estimated to be 122 individuals. This results in a loss of 616 discounted terrapin-years. An additional 3,793 discounted terrapin-years were lost due to production foregone in the next generation.

The Trustees and RPs also estimated a 10 percent reduction in the number of hatchlings produced in 2000 in the spill zone based on the findings of lower nest size (compared to the 1987 - 1991 period) and higher frequency of dead embryos at oiled sites (compared to unoiled sites) (Wood and Hales (2001)). The 10 percent increase in mortality of hatchlings in 2000 results in an additional 836 discounted terrapin years that were lost due to the spill. Thus, the total estimated injury is 5,245 lost discounted terrapin years[7]. A complete description of the methods and findings from the terrapin mortality study is presented in Michel et al. (2001b) and Byrd et al. (2002b).

4.3.6 Lost Recreational Use Injury Assessment

The Trustees determined that the Chalk Point oil spill caused a reduction in the number of trips taken to the Patuxent River for swimming, boating, fishing and general shoreline use. The number of lost trips was estimated based on historical records available from Golden Beach, a residential community located in the spill impact zone. Golden Beach maintains records for its five private sites offering recreational opportunities similar to those available throughout the spill impact zone. Recreational use at the sites in 1999, adjusted for differences in weather, was used as an estimate for baseline recreational use in 2000 that would have occurred but for the spill. The difference between observed use at the Golden Beach sites following the spill in 2000 and the weather-adjusted 2000 baseline represents an estimate of lost trips at Golden Beach.

To extrapolate from Golden Beach to the entire spill impact zone, additional data was collected. First, an informal on-site survey was conducted along the shoreline of the Patuxent River to determine the extent of the spill impact zone. Based on responses to the surveys, it was determined that the spill affected recreational use from the town of Eagle Harbor, upstream and north of the spill, to Greenwell State Park in the south. Second, helicopter overflights were conducted to perform counts of recreational activity

[7] 616 lost discounted terrapin years from acute mortality + 3,793 lost discounted terrapin years from production foregone + 836 lost discounted terrapin years from year 2000 hatchlings = 5,245 total lost discounted terrapin years

throughout the spill impact zone. Five overflights were conducted, four on weekends and one during the week. By comparing recreational use at Golden Beach to the level of use observed during the overflights, estimates of lost trips at Golden Beach were extrapolated to the entire spill impact zone. Since the Golden Beach sites made up about 2.5 percent of the total recreational trips in the spill zone and since this proportion was relatively consistent across the five overflights, it was assumed that recreational use patterns in the entire spill zone mimic the patterns of visitors at Golden Beach. This assumption implies that changes in recreational use due both to differences in weather and to the effects of the oil spill are the same for Golden Beach and the rest of the spill zone. The total estimate of lost trips due to the spill was 12,704 from the time of the incident in April through the end of the summer recreation season in September. It was determined that no recreational-use losses occurred after September 2000.

Total lost trips were multiplied by a value per trip of $27, which was obtained from the relevant economics literature. The value of a trip to a particular recreational site represents the amount a visitor would be willing to pay for access to the site beyond any expenses actually incurred. Numerous studies have been undertaken over the past 30 years to determine the economic value of recreation. For example, Walsh et al. (1992), Freeman (1995), and McConnell and Strand (1994) report figures for recreational fishing ranging from $10 to over $100 per trip. The figure of $27 represents an average composite value derived from empirical studies that examined comparable recreational activities (e.g. fishing, boating, swimming and shoreline use) at comparable recreational sites in the United States.

In addition to recreational trips forgone by area residents, the Trustees determined that losses also occurred when trips taken under degraded conditions following the spill provided less value than they otherwise would have. Using the data from Golden Beach and the helicopter overflights, it was estimated that 112,359 trips were taken to the spill impact zone in the months from April to September 2000. The Trustees determined that the value of trips taken immediately after the spill was diminished by 20 percent. This loss was based on similar calculations presented in the *American Trader* oil spill damage assessment (Hanemann, 1997), which also used the 20 percent figure. Furthermore, responses to the Patuxent River on-site surveys indicated that some people perceived a significant, but moderate loss, in the value of trips taken. The loss per actual trip was estimated to decline gradually throughout the summer as the presence of the oil grew less severe through clean-up efforts and natural processes. The diminished value per trip began at $5.40 in April and declined to less than a dollar per trip by the end of September.

The two categories of loss were added together to calculate total losses. The estimate of 12,704 lost trips was multiplied by $27 to arrive at $343,010 for the total value of lost trips. There were an estimated 112,359 actual trips taken throughout the season. The number of actual trips on any given day was multiplied by the diminished value per trip as determined for that day. The total value of diminished trips was calculated to be $110,489. Estimated total losses to recreational use following the spill were $453,500. The complete analysis is presented in Byrd et al. (2001).

4.4 Summary of Injuries

A summary of the injury assessment results, as described in the preceding sections, is provided in Table 4.8.

Table 4.8. Summary of injury estimates for the Chalk Point oil spill.

Injury Category	Injury Estimate	
Wetlands and Beach Shorelines	76 acres of brackish marsh habitat (40.5 acres lightly oiled, 12.0 acres moderately oiled, 23.4 acres heavily oiled) 91.94 lost service acre years	
	10 acres oiled beach shoreline (0.5 acre heavy, 6.4 acres moderate, 3.2 acres light) 4.7 lost service acre years	
	376 muskrats	
Fish and Shellfish	2,464 kg lost biomass	
Benthic Communities	2,256 kg lost biomass	
Birds	696 dead birds	553 ruddy ducks
	696 dead birds	143 other birds (comprising 14 species)
Diamondback Terrapins	122 dead terrapins 10 percent loss of hatchlings in the 2000 cohort 5,245 lost terrapin years	
Lost Recreational Use	12,704 lost trips 112,359 diminished trips Estimated dollar value $453,500	

CHAPTER 5.0. RESTORATION ALTERNATIVES

The goal of restoration under OPA is to restore natural resources injured by oil spills to the condition that they would have been if the incident had not occurred. OPA requires that this goal be achieved by restoring natural resources and compensating for interim losses of those resources and their services that occur during the period of recovery.

Restoration actions are defined as primary or compensatory. Primary restoration expedites the return of injured resources to their baseline condition; compensatory restoration addresses interim losses of natural resources from the time of injury until recovery. Natural recovery, in which no human intervention is taken to restore the injured resources, is considered a primary restoration alternative, and is appropriate where feasible or cost-effective primary restoration actions are not available or where the injured resources would recover relatively quickly without human intervention. The scale of the compensatory restoration projects depends on the nature, extent, severity and duration of the resource injury. Primary restoration actions that speed resource recovery would reduce the scale of compensatory restoration.

5.1 Restoration Strategy

The Trustees' injury assessment studies indicate that the natural resources impacted by this spill either have recovered or, where injuries persist, would best recover to baseline conditions naturally over time. Therefore, the preferred restoration alternatives presented in the draft and this final Restoration Plan/ EA are for compensatory restoration. The only primary restoration considered by the Trustees was replanting the heavily oiled wetlands in the immediate vicinity of the pipeline break. EPA initiated this action as part of its clean up and response efforts, thereby eliminating the need for the Trustees to consider this action further.

The Trustees considered 60 different restoration ideas and alternatives potentially capable of providing compensatory restoration for injuries resulting from the Chalk Point oil spill (Appendix 3). These were provided to the Trustees by members of the Governor's Citizen Advisory Committee, Patuxent River Commission, appropriate federal, state, and local officials, RPs, and the public.

All of the restoration ideas and alternatives submitted to the Trustees were evaluated based on the criteria presented in Section 5.2. Preferred alternatives were then scaled to ensure that their size appropriately compensates for the injuries resulting from the spill. For injuries to ecological resources, the Trustees employed a resource-to-resource scaling methodology, where restoration actions provide natural resources and/or services of the same type and quantity as those lost. In contrast, projects to compensate for lost recreational use were scaled to a total dollar amount estimated as the value lost by the public who were unable to recreate because of the spill and/or experienced a reduction in trip quality.

The preferred restoration alternatives included in this chapter are based on preliminary designs rather than detailed engineering plans. The final selected projects may require additional refinements or adjustments to suit site conditions or other factors based on further Trustee analysis.

Cost estimates presented for each preferred project are the Trustees' best current estimates, and assume that project implementation will begin prior to January 2004. The Trustees' implementation costs are presented for each of the preferred ecological restoration projects. Oversight costs will be used by the Trustees to review data reports and reports assessing the progress and results of restoration projects, participate in Trustee meetings and conference calls and otherwise ensure that restoration objectives are met.

In contrast to the preferred ecological restoration projects, the Trustees anticipate that the preferred alternatives for restoring recreational losses will be implemented by state or local government officials. Costs incurred by state and local officials to implement recreational use restoration projects have been accounted for within each of the major cost components of these projects, and, therefore, are not presented separately.

Along with the cost elements associated with each preferred project, the Trustees added a contingency factor of 25 percent to account for the uncertainties inherent in these preliminary estimates. This 25 percent contingency is intended to cover the risk that (1) the costs of the projects will turn out to be higher than expected and/or (2) the projects will not result in the expected magnitude of benefits and need augmentation.

5.2 Evaluation Criteria

All of the restoration projects and ideas submitted to the Trustees (Appendix 3) were initially screened to narrow the list of potential projects and focus information-gathering efforts on the most likely alternatives. The two criteria initially applied to all proposed projects were: (1) will the project likely result in a quantifiable increase in one or more of the injured resources, and (2) does the project comply with existing law. These two criteria were used because they reflect important project attributes and could be applied in the absence of detailed project information. A third initial criterion was applied to proposals for restoring recreational losses. The Trustees excluded from further consideration project proposals exceeding $250,000 because the recreational injury, estimated as the dollar value loss, was $453,000, and the Trustees sought multiple projects to restore recreational losses that could be located throughout the spill area.

Of the 59 total project ideas considered by the Trustees, 38 did not meet the initial screening requirements and were eliminated from further consideration (Appendix 3). Twenty-one projects met the initial screening requirements and were brought forward for a closer evaluation.

The Trustees evaluated each of the 21 projects that met the initial screening requirements using the criteria from OPA and supplemental factors developed for this spill (NOAA, 2002). The OPA regulations (15 CFR § 990.54) identify the following six criteria to be used to evaluate alternatives:

1. Cost to carry out the alternative,
2. Extent to which each alternative is expected to meet the Trustees' goals and objectives in returning the injured natural resources and services to baseline and/or compensating for interim losses,
3. Likelihood of success of each alternative,
4. Extent to which each alternative will prevent future injury as a result of the incident and avoid collateral injury as a result of implementing the alternative,
5. Extent to which each alternative benefits more than one natural resource and/or service, and
6. Effect of each alternative on public health and safety.

In addition to the six OPA criteria, the Trustees adopted several other factors to assess the appropriateness of proposed restoration alternatives. These are listed below, and described in the document "Factors to evaluate proposed restoration alternatives under the Oil Pollution Act, Patuxent River oil spill" (NOAA, 2002).

1. Compliance with applicable federal and state laws and policies,
2. Possibility for integration with existing management programs that are consistent with Trustees' restoration goals under OPA,
3. Evaluation of the adjacent or nearby affecting land uses,
4. Site ownership,
5. Logistical considerations,
6. Consistency with local, regional, and national restoration goals and initiatives,
7. Longevity of the project.

The Trustees selected restoration projects using the above OPA criteria and Trustee factors. The Trustees then analyzed the effects of each project on the quality of the human environment, to comply with the requirements of NEPA. NEPA's implementing regulations direct federal agencies to evaluate the potential significance of proposed actions by considering both context and intensity. For the preferred actions identified in this final Restoration Plan/EA, the appropriate context for considering potential significance of the action is local, as opposed to national or worldwide.

With respect to evaluating the intensity of the impacts of the proposed action, the NEPA regulations (40 CFR § 1508.27) suggest consideration of ten factors:

1. Likely impacts of the proposed projects;
2. Likely effects of the projects on public health and safety;
3. Unique characteristics of the geographic area in which the projects are to be implemented;
4. Controversial aspects of the project or its likely effects on the human environment;
5. Degree to which possible effects of implementing the project are highly uncertain or involve unknown risks;
6. Precedential effect of the project on future actions that may significantly affect the human environment;
7. Possible significance of cumulative impacts from implementing this and other similar projects;
8. Effects of the project on National Historic Places, or likely impacts to significant cultural, scientific or historic resources;
9. Degree to which the project may adversely affect endangered or threatened species or their critical habitat; and
10. Likely violations of environmental protection laws.

5.3 Environmental Consequences (Indirect, Direct, Cumulative)

The Trustees examined a variety of proposed projects to restore resources and/or services lost as a result of the spill, as described above. Project-specific environmental consequences for each preferred project are provided in Section 5.5. This section addresses the potential overall cumulative, direct, and indirect impacts, and other factors to be considered in both OPA and NEPA regulations.

In summary, the Trustees believe that the projects selected in this restoration program will not cause significant adverse impacts to natural resources or the services they provide. Further, the Trustees do not believe the proposed projects will affect the quality of the human environment in ways deemed “significant.”

Cumulative Impacts: Since the Trustees designed the projects to achieve recovery of injured natural resources, the cumulative environmental consequences will be largely beneficial. Monitoring of projects funded under this final Restoration Plan/ EA will confirm that cumulative impacts will be beneficial rather than adverse. Any unanticipated cumulative adverse effects from a proposed project identified prior to implementation will result in reconsideration of the project by the Trustees.

Indirect Impacts: Environmental consequences may not always be limited to the project location. The preferred projects are expected to indirectly benefit a variety of species by improving habitats and recreational opportunities.

Direct Impacts: Overall, this final Restoration Plan/ EA will enhance the Patuxent River ecosystem. However, there may be some short-term impacts from the proposed projects such as:

- Noise and Air Pollution. Machinery and equipment used during construction and other restoration activities will generate noise. This noise may disturb wildlife and humans. It is not anticipated, however, that the proposed projects will cause significant noise impacts.

- Water and Sediment Quality. Although implementation of the preferred projects should result in no significant impact to water quality, there may be temporary increases in sedimentation and turbidity related to certain projects. Best management practices along with other avoidance and mitigation measures required by the regulatory agencies will be employed to minimize any water quality and sedimentation impacts.

- Visual/Aesthetic. There may be temporary visual impacts during implementation of some of the proposed projects. Once the Trustees complete those projects, the visual impacts will cease. Beneficial aesthetic impacts will then extend to the users of the projects.

- Public Access/Recreation. Public access may be temporarily affected during construction activities. Because implementation time for these projects will be relatively short, the impact will be short.

- Other (e.g., economic, historical, land use, transportation). No significant adverse effects are anticipated to sediment quality, soil, geologic conditions, energy consumption, wetlands or flood plains. The proposed restoration projects will have no adverse social or economic impacts on neighborhoods or communities. General land use patterns will not be affected by the preferred alternatives. The proposed projects will not adversely affect any known archaeological sites or sites of cultural significance.

Appendix 4 discusses potential impacts to the coastal zone and to endangered and threatened species.

5.4 Evaluation of No Action/ Natural Recovery Alternative

NEPA requires the Trustees to consider a “no action” alternative, and the OPA regulations require consideration of the natural recovery option. These alternative options are equivalent. Under this alternative, the Trustees would take no direct action to restore injured natural resources or compensate for lost services pending environmental recovery. Instead, the Trustees would rely on natural processes for recovery of the injured natural resources. While natural recovery would occur over varying time scales for the injured resources, the interim losses suffered would not be compensated under the no action alternative.

The principal advantages of this approach are the ease of implementation and low cost.

This approach relies on the capacity of ecosystems to "self-heal". OPA, however, clearly establishes Trustee responsibility to seek compensation for interim losses pending recovery of the natural resources. This responsibility cannot be addressed through a no action alternative. While the Trustees have determined that natural recovery is appropriate as primary restoration for injuries resulting from this incident, the no action alternative is rejected for compensatory restoration. Losses were, and continue to be, suffered during the period of recovery from this spill. Technically feasible, cost-effective alternatives exist to compensate for these losses.

5.5 Preferred Restoration Alternatives

The Trustees identified 11 preferred projects using the evaluation criteria presented in Section 5.2. As described below, four of the 11 restoration projects were scaled to restore ecological injuries; the remaining 7 were scaled to address recreational losses. Below is a description and analysis of each preferred restoration project.

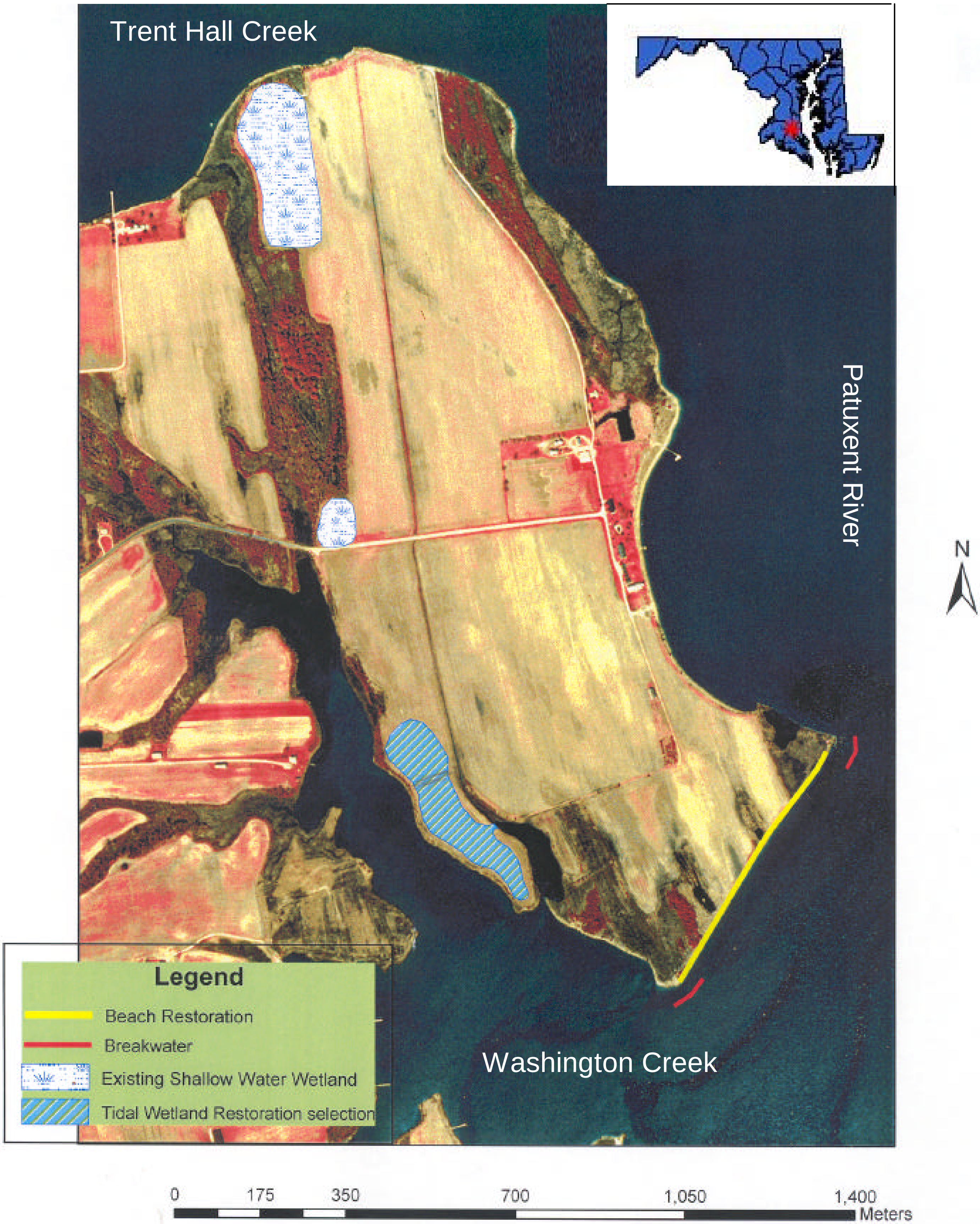
5.5.1 Restoration of Wetlands: Tidal Marsh Creation, Washington Creek, St. Mary's County, MD

The Trustees conducted an extensive search for opportunities to restore, create or enhance wetlands as compensation for the approximately 92 service acre-years of wetland loss (see Section 4.3.1) estimated to have resulted from the spill. The search for projects included soliciting potential sites from local resource agencies and interest groups including the Chesapeake Bay Foundation, Alliance for the Chesapeake Bay, EPA, Army Corps of Engineers, county Park and Recreation Departments (Calvert, St. Mary's, Charles, and Prince George's), a local chapter of the Audubon Society, Maryland State Highway Administration, Citizens Advisory Committee, Oyster Recovery Partnership, Chesapeake Biological Laboratory, and the Patuxent River Commission. Natural resource surveys and maps of the area were also searched, focusing on shoreline erosion, wetlands, oyster bars, and SAV occurrence and history. Aerial photographs of the area were review for restoration opportunities. Finally, real estate specialists prepared lists of shoreline properties for sale. Representatives of each Trustee agency and RPs then conducted reconnaissance surveys along the Patuxent River. During these trips, all potential sites identified through the above mentioned efforts were inspected and evaluated for their restoration potential. Appendix 3 provides the list of potential sites reviewed by the Trustee and RP representatives.

Project Description

The preferred compensatory restoration alternative for marsh injuries is the creation of 5 to 6 acres of brackish intertidal marsh on farmland adjacent to Washington Creek, a tributary on the western shore of the Patuxent River located in St. Mary's county just south of Chalk Point (Figure 2). The property is currently in private ownership and actively farmed.

Figure 2. Location of the preferred projects to restore marsh, shoreline, and diamondback terrapin injuries, Washington Creek.



This project will create a functioning intertidal marsh similar to the type of marsh injured by the spill. The site will be excavated to an intertidal elevation suitable for growth of wetland plants, channels will be constructed to carry water into and out of the marsh, and the excavated area will be planted with appropriate species (e.g., *S. alterniflora* and *S. cynosuroides*) installed on 1.5-foot centers and fertilized with time-release fertilizer at the time of planting. *Phragmites sp.*, a non-native invasive plant species, will be actively removed from the project site during the first five years.

The material to be excavated from the project site is a sandy loam soil that will be used to restore an eroding shoreline and enhance nesting habitat for diamondback terrapins (see Section 5.5.6). The cost of using the sand for this additional project is considerably less than the cost of disposing of the material offsite.

Restoration Objectives

The primary objective of this restoration project is to provide wetland habitat sufficient to compensate for lost wetland services, including wildlife species such as muskrats. An important additional benefit is the ability to use the excavated sand to stabilize an eroding beach. This cost-effective option for disposal will prevent further erosion and increase the quality of nesting habitat for diamondback terrapins.

Scaling Approach

The Habitat Equivalency Analysis (HEA) method was used to determine the size of the marsh restoration to compensate for the losses resulting from the spill (NOAA, 1999). HEA is a resource-to-resource scaling method to determine compensation for lost services based on the quantification of incident-related natural resources injuries. HEA considers several project-specific factors in scaling restoration, including elapsed time from the onset of injury to restoration implementation, relative productivity of restored habitats (that is, the proportional equivalence of ecological services provided by the compensatory restoration project relative to the baseline productivity of the injured habitat), the time required for restored habitats to reach full function, and project lifespan.

To determine the appropriate estimates for the HEA input parameters identified above, the Trustees relied on resource agency staff experience with creating wetlands in this region, input from a wetlands restoration specialist (Ed Garbish, pers. comm., 2001)[8], data from other damage assessment cases, information in the scientific literature (including the recent National Research Council publication on Compensating for Wetland Losses Under the Clean Water Act (NRC, 2001)), and a synthesis of studies on created wetlands by Strange et al. (2001). Using this information, the Trustees assumed that the marsh would be completed in 2003, with a project life span of 50 years. Services provided (as a percent of a fully functioning marsh) were determined to be 50 percent in 5 years; 75 percent in 10 years; and 80 percent in 20 years and beyond[9]. Based on these

[8] Ed Garbisch. Environmental Concern, Inc., St. Michaels, MD.

[9] That is, the created wetland will never be 100 percent equivalent to an otherwise comparable natural wetland. Based on this assumption, a larger area of restoration is required.

inputs and assuming a three percent annual discount rate, each restored acre provides a credit of 16.23 service acre-years. Therefore, an area of 5.66 acres at the selected restoration site will compensate for the 92 service acre-years wetland injury determined in Section 4.3.1.

The Trustees assessed injuries to muskrats and the marsh acreage needed to compensate for these losses to validate that the scale of marsh restoration will compensate for associated wildlife injuries. A total of 376 muskrats were estimated to have been lost. Using HEA, the Trustees estimated that it will take 5.48 acres of new marsh to restore the muskrat losses (Michel et al., 2002; Appendix D). Because this area is less than that needed for restoration of injury to wetlands (i.e., 5.66 acres), this wetland restoration project is expected to fully compensate for injury to muskrats.

Probability of Success

Creating new wetlands is a feasible and proven technique with established methodologies and documented results. Local, state, and federal agencies have successfully implemented similar projects in this region of the Chesapeake Bay. Thus, the Trustees believe that this project has a high likelihood of success.

While final details of the project remain to be fully developed, the Trustees will carefully monitor plant handling and installation to ensure that appropriate guidelines are being followed. All plant material will be inspected to ensure that it is healthy and vigorous, and will be protected during mobilization from drying and physical damage. Container grown plants will be treated with a slow-release fertilizer at the time of planting. Replanting will occur if a significant number of plants die.

The project is located on privately owned land. The landowner is committed to the project and has ensured his full cooperation. This property already is encumbered by a conservation easement held by the Maryland Environmental Trust. The landowner has agreed to minor modifications of that easement to ensure it adequately protects this project in perpetuity.

Performance Measures and Monitoring

Project performance will be assessed by comparing quantitative monitoring results to pre-determined performance standards that define the minimum physical or structural conditions deemed to represent normal and acceptable growth and development (e.g., percent plant survival and cover at 60 days, one year, five years, etc.). The monitoring program for this project will use these standards to determine whether the project goals and objectives have been achieved, and whether corrective actions are required to meet the goals and objectives. Details concerning the performance measures and monitoring will be developed prior to implementation of the project.

In the event that performance standards are not achieved or monitoring suggests unsatisfactory progress toward meeting established performance standards, corrective actions will be implemented. Possible corrective actions include regrading the area to proper elevations and replanting appropriate vegetation. These corrective actions will be funded by the contingency component of the project costs (Table 5.1).

Approximate Project Costs

Project costs are summarized in Table 5.1. The major cost item is project construction ($361,200), which includes excavation of the site and plantings. Project implementation and oversight are estimated costs ($117,600) expected to be incurred by the Trustees during project implementation. Monitoring costs are estimated at $88,800. A 25 percent contingency ($151,000) has been added to cover the risk that (1) the costs of the project will turn out to be higher than expected and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, total project costs are estimated at $754,600.

Table 5.1. Summary of project costs: Tidal marsh creation, Washington Creek.

Cost Element	Cost
Engineering	$36,000
Construction	$361,200
Monitoring	$88,800
Project Implementation and Oversight	$117,600
Contingency (25%)	$151,000
Total	**$754,600**

Environmental and Socio-Economic Impacts

Marshes are widely recognized as providing numerous ecological functions, including habitat for juvenile fish and shellfish, exporting detritus (energy source for the aquatic food web) into the estuary, and increasing water quality by filtering sediments and other pollutants from the water column. Marshes also provide many additional benefits such as storm surge protection, habitat for birds and mammals, and enhanced recreational use of the area by increasing the numbers of important aquatic species.

Creating a marsh at the mouth of Washington Creek is not expected to have any significant adverse environmental or economic impacts. Any impacts to existing habitats from project construction are expected to be temporary.

Constructing this wetland will remove land from agricultural production. This property is currently leased to a local farmer by the landowner, and no problems are anticipated by withdrawing this land from production. This portion is a small fraction of the land remaining available for production.

Evaluation

This project meets the evaluation criteria discussed in Section 5.2. Creation of new wetland will compensate for interim losses of wetlands (in-kind restoration) and in the same geographic vicinity of the spill (in-place). This site was also selected because the excavated material can be used for a nearby beach replenishment project. This has a number of benefits including: (1) reduced impacts to the environment from the operation of heavy equipment, (2) significantly reduced costs associated with moving the excavated material, and (3) additional ecological benefits in the form of shoreline and terrapin nest habitat enhancement. In particular, the opportunity to combine the beach creation/terrapin nesting project with the marsh creation project makes this site cost-effective for both projects.

The Trustees do not anticipate any adverse impacts. Other than the inherent risk to workers, there is no significant risk to human health and safety.

5.5.2 Restoration of Fish and Shellfish: Create and Seed an Oyster Reef Sanctuary

The total loss of fish and shellfish biomass resulting from the Chalk Point spill was estimated to be 2,464 kg (Section 4.3.2) (French McCay and Jennings, 2002). As described below, the Trustees will create and seed an oyster reef sanctuary to restore the lost fish and shellfish biomass[10]. This cost-effective restoration option will be located within the Patuxent River and help satisfy federal, state, and local restoration goals for the Chesapeake Bay.

Project Description

The preferred compensatory restoration alternative for fish and shellfish losses (2,464 kg of biomass) is to create and seed about 1.7 acres of oyster reef sanctuary in the Patuxent River. MDNR will review potential sites in this region based on other oyster enhancement efforts that are scheduled or have already been done in the area; data on spat set, salinity, and disease; and on underwater surveys of potential sites to evaluate their condition. MDNR will then seek consensus among both local county oyster committees and environmental interests, and then recommend the specific location(s) for Trustee approval.

Once a sanctuary site is selected, it will be resurfaced with clean oyster shell (or alternate bar building material, if deemed suitable) and seeded at a density of 500 oysters per square meter (approximately 2 million oysters per acre). After five years, the bed(s) will be surveyed again and reseeded (at the same seeding density of 500 oysters per square

[10] The Trustees will also create and seed an oyster reef sanctuary as restoration of benthic injuries (see Section 5.5.3) and non ruddy duck bird injuries (see Section 5.5.5). While these are presented as separate projects to facilitate an understanding of how the proposed sanctuary compensates for specific injuries, it is likely that the three projects will be combined into one effort (totaling about 4.7 acres of new oyster reef sanctuary).

meter). Throughout the 10-year duration of the project, the oyster bed(s) will be monitored for survival, disease incidence, and extent of habitat created.

Restoration Objectives

Creating and seeding a new oyster reef will directly enhance benthic habitat, with increased biomass generated by the seeded oysters and biota associated with the reef. This enhanced production, once scaled to account for the ecological transfer efficiencies between different trophic levels (i.e., fish, shellfish, and benthos), will compensate for lost fish and shellfish biomass.

Scaling Approach

Restoring oyster reef habitat in the Patuxent River is expected to produce increased populations in four groups of organisms; oysters, mud crabs, grass shrimp and small crustaceans (amphipods, tanaids and isopods) (French McCay et al., 2002). Scaling calculations estimate the increased quantity of these invertebrates as prey biomass made available to the food web. The reef size is then adjusted to produce enough prey to restore lost fish and shellfish biomass, given assumptions about transfer efficiencies between different trophic levels of the food web.

Using data from local researchers and species life history information from the scientific literature (Kneib, 1987; Zimmerman et al., 1989; Llanso and Volstad, 2001; Peterson, 2001), reef-related increase in the production of oysters, mud crabs, grass shrimp and small crustaceans was estimated to be approximately 365.9 grams (ash free dry weight) per square meter of restored reef (French McCay et al., 2002). This estimate reflects the net increase in productivity associated with oyster reefs compared to shell bottom for the mesohaline conditions that exist in the vicinity of the spill based on the proposed seeding density and a lifespan of five years for each seeding. The five-year lifespan is a conservative estimate used to ensure minimum benefits are achieved. Actual oyster survival may produce benefits at or above calculated expectations.

The next step was to determine the area required to restore the 2,464 kg of lost fish and shellfish biomass resulting from the spill. For these calculations, injured and restored oyster biomass was assumed to be equivalent (from a biomass perspective). For fish, the ecological efficiency of prey to fish consumers was estimated to be about 20 percent (Slobodkin, 1960, 1962; Ryther, 1969; Odum, 1971; Steele, 1974; Petersen and Curtis, 1980; Cohen et al., 1982; Jones, 1984; Sissenwine et al., 1984; Borgman et al., 1984; Mills et al., 1984; Cohen and Grosslein, 1987). The implication of this assumption is that five kilograms of benthic production from the reef are required for every one kilogram of biomass injury to fish or invertebrate predators of these resources.

Based on the trophic level scaling calculations described above, 1.73 acres of oyster reef are required to compensate for the fish and shellfish biomass loss. More details of this scaling approach, including assumptions and ecological efficiency parameters, are presented in French McCay et al. (2002).

Probability of Success

Oyster populations in the Patuxent River, and the Chesapeake Bay in general, have decreased dramatically over the past several years. Reasons for the declines include mortality from disease, sedimentation, low dissolved oxygen, extended exposure to freshwater, predation, and harvest.

The proposed sanctuary will be located in the optimal zone for oyster restoration in the Patuxent, as determined by data on spat set, salinity, and disease. Oyster bed enhancement combined with seed planting has been done in the Chesapeake Bay area in general, and in this area in particular since 1980, and is generally practiced as the most effective method for supplementing oyster populations.

To compensate for the uncertainty of oyster survival, careful monitoring will assess mortality rates so that adjustments to the Implementation Plan can be made, if needed. Two seedings are planned for the same area five years apart to maintain the oyster population for a longer period than a single seeding, thus increasing the likelihood the oyster bed may persist after the restoration is complete. Quarterly monitoring during the first and second years following seeding will assess oyster survival, incidence of disease, and area of benthic habitat created. Sampling in subsequent years will be done in spring and fall until success criteria for the area of habitat created and its persistence have been met.

Performance Measures and Monitoring

Performance measures will be based on the generally accepted view that if the oyster reef is present, the benthic populations that were used to scale this restoration project will occupy it. Monitoring will be done by direct sampling for the expected ten-year duration of the project to determine oyster survival, incidence of disease, and area of benthic habitat created. Over time, the oyster population is expected to gradually decrease because of the environmental factors. Monitoring will allow adjustments to be made if the oyster population in this oyster bed decreases more rapidly than expected. This can be done by moving up the second seeding and using contingency funds for additional seeding, if mortality is greater than expected during the first few years of the restoration.

Approximate Project Costs

Table 5.2 provides a summary of the costs for creating and seeding approximately 1.7 acres of oyster reef sanctuary. An historical survey of the selected restoration site is required to ensure that historical resources, such as shipwrecks, will not be damaged by restoration activities. Site surveys will include bathymetry and video imaging of the oyster bed to determine the size and boundaries of the reef, as well as substrate types present. The material placed on the reef surface may be natural oyster shell or an alternative material if shell is not available. Costs for applying material to the reef include permitting, barge loading, transportation, and placement. Costs for storage of the reef material have also been included, so that the material can be purchased and reserved before application. Oyster spat costs for the first seeding are estimated as $150/million larvae with 9.38 million larvae required. Additional costs include staff time to produce the spat, and shell and bag material for setting the spat. The second seeding, five years later, is expected to require the same number of spat as the first seeding, and all related costs have been calculated to account for an expected increase of three percent per year. Monitoring will cost $35,200 for 20 sampling events over the 10-year monitoring period. Project implementation and oversight are estimated costs ($25,600) expected to be incurred by the Trustees during project implementation. The 25 percent contingency is included to cover: the risk that (1) the costs of the project will turn out to be higher than expected, and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, total costs are estimated at $261,000.

Table 5.2. Summary of project costs: Creating and seeding an oyster reef sanctuary (1.73 acres).

Cost Element	Cost
Historical Survey	$5,600
Site Survey	$8,000
Reef Resurfacing (6" layer)	$59,000
First Seeding	$34,900
Second seeding (costs increase 3% per yr)	$40,500
Project Implementation and Oversight	$25,600
Monitoring (ten years)	$35,200
Contingency (25%)	$52,200
Total	**$261,000**

Environmental and Socio-Economic Impacts

In addition to enhancing benthic and fish biomass, the created oyster reef could improve water quality. Oysters are known to reduce suspended particulate matter and consume phytoplankton that contribute to anoxia in bottom waters, thereby improving water clarity and light penetration critical for aquatic life.

Oysters are a harvestable resource and economically important in the area. While oyster harvesting will not be allowed in the sanctuary, these areas could provide broodstock populations. There are numerous commercial and recreational fisheries and supporting industries that could benefit from such enhanced production of naturally produced oysters and the reef structure.

Creating a new sanctuary will eliminate some of the currently available area for oyster harvesting. This decrease will be small, however, because the area withdrawn is small compared to the area remaining available. In addition, the oyster bar chosen for restoration is expected to improve in productivity after resurfacing with fresh shell.

Evaluation

This project is consistent with the Trustees' evaluation criteria, representing a cost-effective alternative for restoring lost fish and shellfish biomass within the immediate spill zone. Oyster enhancement is also consistent with state and federal policies seeking to restore Chesapeake Bay oyster populations. The Chesapeake 2000 Bay Agreement signed by both state and federal agencies establishes the goal of increasing native oysters in the Bay and its tributaries 10-fold by the year 2010. Additionally, both the 1993 and 2000 Maryland Oyster Roundtable Action Plans emphasize the need to restore Maryland's oyster resource. In particular, the Plan designates the Patuxent River as one of six Oyster Recovery Areas.

An important component of this project is that the created oyster reef will be designated as a sanctuary where harvesting is prohibited. According to many experts (Chesapeake Research Consortium (CRC), 1999), permanent sanctuaries have many significant ecological advantages. They will allow for the development and protection of larger oysters that have a higher fecundity. Thus, a small number of very large oysters can produce many more eggs than a large number of small oysters. In addition, large oysters have demonstrated greater ability to survive disease, a characteristic that is, at least in part, passed on to offspring when they reproduce. Reef sanctuaries are also critical for habitat and ecological value, allowing reef structure and function to fully develop (CRC, 1999).

The Trustees believe that the environmental benefits associated with creating and seeding an oyster reef sanctuary will be achieved with minimal negative impacts on the environment. Other than the inherent risk to workers, there is no significant risk to human health and safety.

The project will employ established methods and techniques currently in use by state and private organizations. Existing seed production capabilities are available to support this project.

5.5.3 Restoration of Benthic Communities: Create and Seed an Oyster Reef Sanctuary

The total benthic biomass loss resulting from the Chalk Point oil spill was 2,256.1 kg, comprised of 1,932.8 kg of bivalve mollusks (mostly *Macoma balthica*, also *Rangia cuneata*), 446.9 kg of amphipods (primarily *Leptocheirus plumulosus*), and offset by a spill-related increase of 123.6 kg in opportunistic polychaetes[11] (Section 4.3.3) (Peterson, 2002). The Trustees will create and seed an additional area of oyster reef sanctuary to restore these losses.

[11] As discussed in Section 4.3.3 and Peterson (2002) only 50 percent (123.6 kg) of the 247.2 kg total increase in polychaete production caused by the spill is "credited". This is because of the likelihood that a substantial fraction of this production of opportunists suffered food limitation, died, and decomposed. A well established pattern of succession in marine sediments is early explosion of opportunists, especially polychaetes, followed by starvation (Marsh and Tenore, 1990).

Project Description

The preferred compensatory restoration alternative for benthic losses is to create and seed approximately 1 acre of oyster reef sanctuary in the Patuxent River. The process and methods for establishing the sanctuary will be identical to those described under Section 5.5.2 (preferred alternative for restoring fish and shellfish injuries). In fact, it is likely that the two (in addition to the one described in Section 5.5.5) will be combined into one effort.

Restoration Objectives

The objective of this project is to restore lost benthic biomass through the enhancement of equivalent benthic biomass associated with the created oyster reef sanctuary.

Scaling Approach

The total benthic injury of 2,256.1 kg included losses of (1) bivalves in Year 2000 (1932.8 kg) and (2) amphipods in Year 2000 (253.3 kg), Year 2001 (118.1 kg), and Year 2002 (75.5 kg), with a credit of polychaetes in Year 2000 (123.6 kg) (Section 4.3.3: Peterson, 2002). The first step in the scaling analysis was to express the amphipod injury that occurred in Years 2001 and 2002 in Year 2000 units. Using a standard discount rate of three percent, the total discounted amphipod injury (expressed as Year 2000 equivalents) is 439.1 kg. Combining this number with the 1932.8 kg of bivalve injury and 123.6 kg credit for increased polychaete production results in a discounted net loss of 2,248.3 kg for benthic injuries that was used as the basis for the calculations performed in the restoration scaling analysis.

The scaling approach for this project is described under Section 5.5.2. In summary, the increased production associated with reef creation and seeding was estimated as 365.9 grams per square meter (French McCay et al. 2002). To determine the area required to restore 2,248.3 kg of lost benthic biomass, the simplifying assumption was made that restored biomass is equivalent to the injured biomass, and is therefore scaled on a one to one basis (i.e., one kilogram of benthic production is required for every kilogram of benthic biomass lost). These scaling calculations indicate that 1.11 acres of oyster reef (with seedings in year one and year five) are needed to compensate for the benthic losses. A complete description of the scaling analyses is provided in French McCay et al. (2002).

Probability of Success

Based on the information presented in Section 5.5.2, the Trustees believe that this project has a high likelihood of success.

Performance Measures and Monitoring

See Section 5.5.2.

Approximate Project Costs

Table 5.3 provides a summary of the costs of creating and seeding 1.11 acres of oyster reef sanctuary. Survey, resurfacing, seeding and monitoring costs are explained under Section 5.5.2. Project implementation and oversight are estimated costs ($16,600) expected to be incurred by the Trustees during project implementation. The 25 percent contingency is intended to cover the risk that: (1) the costs of the project will turn out to be higher than expected, and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, total costs are estimated at $169,200.

Table 5.3. Summary of project costs: Creating and seeding an oyster reef sanctuary (1.11 acres).

Cost Element	Cost
Site Survey	$5,200
Historical Survey	$3,600
Reef Resurfacing (6" layer)	$38,300
First Seeding	$22,600
Second seeding (costs increase 3% per yr)	$26,300
Project Implementation and Oversight	$16,600
Monitoring (ten years)	$22,800
Contingency (25%)	$33,800
Total	**$169,200**

Environmental and Socio-Economic Impacts

See Section 5.5.2.

Evaluation

This alternative is consistent with the Trustees' evaluation criteria. It is cost-effective, and restores the same type of injury (i.e., benthic biomass) and in the same geographical area of the spill. Creation and seeding of an oyster reef sanctuary is also consistent with state, federal, and local restoration goals established for the Chesapeake Bay.

5.5.4 Restoration of Ruddy Ducks: Enhance and Protect Ruddy Duck Nesting Habitat

The total number of birds estimated to have been lost as a result of the Chalk Point oil spill is 696, the majority of which (553) were ruddy ducks (see Section 4.3.4) (Michel, 2001a). While the Trustees considered several alternatives to restore these losses, restoration of ruddy duck nesting habitat was the only alternative identified that will provide direct restoration of this species.

Project Description

Ruddy ducks are a migratory species that breed in wetlands located in the Prairie Pothole Region (PPR) of the Midwest, including portions of Iowa, Minnesota, North Dakota, South Dakota, Montana and southern Canada. Their principle migration corridor to the Atlantic coast extends from North Dakota across Minnesota, and southeast Michigan to the Chesapeake Bay where they overwinter. By February (until mid April), ruddies begin their migration from the Bay back to their nesting grounds in the PPR (Bellrose, 1978).

The preferred compensatory restoration alternative for ruddy ducks is the acquisition of perpetual protective easements on land necessary to support additional ruddy duck breeding. Selected sites will have wetlands where the adjacent upland areas have been converted to farmland, thereby making the associated wetland unsuitable for ruddy duck nesting. Once easements are acquired, farmland will be restored back to perennial grass cover, resulting in a net increase in ruddy duck nesting habitat. The increased nesting habitat will produce additional ruddy ducks. The portion of the additional ruddy ducks produced in this new habitat that will return to the Chesapeake Bay (70 percent) will then compensate for those lost as a result of the Chalk Point oil spill.

The USFWS has established programs in the PPR that protect and restore valuable nesting habitat for bird species like ruddy ducks. The USFWS will recommend potential sites to the Trustees for final approval, and then coordinate project implementation with the Trustees, including acquisition of easements, restoration, project oversight and monitoring.

Restoration Objectives

The objective of this alternative is to restore ruddy duck losses resulting from the spill. This objective will be accomplished by restoring nesting habitat and purchasing perpetual easements to protect the areas from farming or development. Acquiring protective easements and restoring enough land to increase the appropriate number of new nest sites can enhance future production of ruddy ducks sufficiently to compensate for the losses caused by the Chalk Point oil spill.

Scaling Approach

As described in Section 4.3.4, the Trustees estimated that 361 ruddy ducks were directly killed by the spill, with an additional production foregone loss of 384 fledglings. The fledgling loss was then adjusted to account for natural mortality between the time of fledging and recruitment to the fall population (50 percent survival rate; Johnsgard and Carbonell (1996)) and added to the adult injury to arrive at an estimated 553 ruddy ducks that need to be replaced as compensation for the losses resulting from the spill (Michel, 2001a).

The 553 ruddy duck loss was then adjusted to account for the differences in timing between injury and restoration. The Trustees assumed project benefits would begin to accrue in 2005. Consistent with standard practice in natural resource damage analyses, the restoration objective was increased three percent for every year that restoration is delayed. This results in a "time-adjusted" restoration goal of 641 ruddy ducks.

The area of habitat needed to compensate for the 641 lost ruddy ducks was then calculated. First, productivity at restored and protected breeding sites was estimated to be 1.5 birds per nest per year (Johnsgard and Carbonell, 1996). This productivity was converted into productivity per unit area of 0.038 birds per hectare (ha) per year using an estimated nesting density of ruddy ducks in the PPR of 40 ha per nest.[12]

Project lifespan was assumed to be 100 years, with future years' production discounted at three percent per year. Restoration credit will begin in 2005, to account for time to acquire easements and complete restoration activities. Taking the present value over 100 years gives the total habitat productivity per hectare over the life of the project, or 1.22 birds per ha. This productivity estimate was then reduced by 30 percent to account for the proportion of ruddy ducks produced by this project that will be expected to overwinter in areas outside the Chesapeake Bay area. These calculations result in a required project area of 750 ha.[13]

Probability of Success

The USFWS has established programs in the PPR that have a strong record of conserving critical breeding and/or migratory habitat for migratory birds. The Trustees will coordinate this project through these established programs to ensure success.

The Trustees will also seek to acquire easements and conduct habitat restoration in areas that will serve as high quality ruddy duck breeding habitat. Such habitat is likely to become available in the scale needed for this project, given past acquisition and restoration experience in the PPR.

Overall, the Trustees believe that the probability of success for this project is high.

Performance Measures and Monitoring

Successful implementation of the restoration project will be measured by two criteria: (1) occupation and use of restored habitat by ruddy ducks and (2) productivity of nesting pairs in the restored habitats. The USFWS Habitat and Population Evaluation Team Office in Bismarck, ND will monitor the restored sites to ensure that the project is meeting established biological objectives and that the landowner is complying with the

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[12] Density estimate based on 12 years of ruddy duck data from the PPR (Reynolds, FWS Field Office, Bismark, ND). Estimate represents the density of nests in the overall landscape (i.e., multiple wetlands and associated supporting grasslands) that will be most supportive of ruddy duck productivity. It incorporates factors related to ruddy duck nesting density, including the presence of semi-permanent and seasonal wetlands in the surrounding landscape, areas of surrounding grassland, temporal variability (driven largely by hydrologic conditions), and territoriality of nesting ruddy ducks.

[13] 750 ha = 641 ruddies / (1.22 ruddies per ha * 0.7 Chesapeake wintering ruddies).

terms of the easement, as required under National Wildlife Refuge System easement acquisition policy. Field surveys will be used to monitor breeding populations and productivity, while aerial surveillance will be used to monitor habitat conditions and easement compliance. Specific monitoring tasks may include twice yearly aerial surveillance monitoring for habitat disturbance; monitoring of habitat use by breeding pairs and productivity of nests; and analysis of remote sensing imagery to account for environmental variation and effects on ruddy duck populations.

Approximate Project Costs

Table 5.4 summarizes project costs. The cost to place the required farmland areas containing wetlands into perpetual conservation easement is estimated at $185,000. Realty costs to acquire the easements are estimated at $18,500. Costs for restoring grassland, which requires tilling and seeding, is estimated at $146,000 ($100 per acre)[14]. The ten-year monitoring costs total $40,200. Project implementation by the USFWS and Trustee oversight costs are expected to total $82,200. A 25 percent contingency is included to cover the risk that (1) the costs of the project will turn out to be higher than expected and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, estimated project costs total $589,900.

Table 5.4. Summary of project costs: Restoration of ruddy duck nesting habitat.

Cost Element	Cost
Easement Acquisition	$185,000
Realty Cost (fees, title searches, etc.)	$18,500
Restoration	$146,000
Monitoring	$40,200
Project Implementation and Oversight	$82,200
Contingency (25 percent)	$118,000
Total	**$589,900**

Environmental and Socio-Economic Impacts

This project is not expected to have any significant adverse environmental or economic impacts. While nesting habitat protection will restrict development on lands with easements, the program is voluntary and the landowners will be compensated at fair market value. The relatively small amount of agricultural land converted to grassland by this project is unlikely to have a measurable effect on the market for land in the region.

Evaluation

This project is consistent with the OPA criteria and Trustee selection factors established for this spill. In particular, it is the only proposed project that will directly restore the injured species.

[14] This is calculated by multiplying the number of acres of grassland (1462 acres, based on roughly a 4:1 ratio of grasslands: wetlands applied to the 1853 total acres or 750 total hectares) by the restoration cost per hectare of grasslands as follows: (1462 acres x $100/ acre = $146,000).

Federal and local biologists and information from the literature strongly suggest that the availability of breeding habitat constrains ruddy duck populations. The restoration and purchase of conservation easements for appropriate parcels will increase available ruddy duck breeding habitat and result in net gains to the population. The proportion of the enhanced population that returns to the Chesapeake Bay will directly compensate for the losses resulting form the Chalk Point oil spill.

This project effectively makes use of existing programs to restore and protect breeding habitat in the PPR previously used by ruddy ducks killed by the Chalk Point oil spill, and has a high likelihood of successfully restoring ruddy ducks in numbers equivalent to those lost due to the spill. The costs associated with this project are reasonable, and no adverse environmental or economic consequences are expected.

After considering all of the available restoration options, the Trustees determined that the only way to provide a direct benefit to the ruddy ducks with a high degree of success was to restore and preserve their nesting habitat. Therefore, it was decided that the ruddy ducks lost as a result of the spill would be replaced through the restoration of grassland in the PPR and the purchase of conservation easements on the restored nesting habitat.

5.5.5 Restoration of Birds (excluding Ruddy Ducks): Create and Seed an Oyster Reef Sanctuary

Project Description

In addition to the ruddy ducks, 143 other birds were lost as a result of the Chalk Point oil spill. These losses represent a relatively small number of over 14 different species, ranging from Virginia rail to double-crested cormorants (Section 4.3.4) (Michel, 2001a). The preferred compensatory restoration project for these losses is to create and seed about 1.9 acres of oyster reef sanctuary.

The process and procedures for establishing the sanctuary will be identical to those described under Section 5.5.2 (preferred restoration alternative for restoring fish and shellfish injuries) and Section 5.5.3 (preferred restoration alternative for restoring benthic injuries). In fact, it is likely that these three projects will be combined into one effort.

Restoration Objective

The objective of this project is to restore non ruddy duck bird injuries by creating and seeding an oyster reef sanctuary. The resulting increase of benthic biomass associated with the reef will serve as a food source that, once adjusted to account for trophic levels and ecological transfer efficiencies, will enhance bird biomass.

Scaling Approach

Losses of birds, other than ruddy ducks, were scaled on a biomass basis, to oyster reef production. By multiplying the number of lost birds by the estimated weight per bird (by species from Sibley (2000)), the total bird biomass was calculated to be 169 kg (French McCay et al., 2002). The increased production associated with reef creation and seeding (365.9 grams per square meter (see Section 5.5.2; French McCay et al., 2000) was then used to determine the area required to restore lost bird biomass. A "transfer ratio" of 2 percent was used for those bird species that feed directly on the enhanced benthic invertebrates (i.e., 50 kg of prey biomass needed for one kg of biomass injury). For bird species that feed on fish (where the fish feed on the enhanced benthic invertebrates), a transfer ratio of 0.4 percent was used (i.e., 250 kg of prey biomass needed for one kg of biomass injury) (McNeill and Lawton, 1970; Steele, 1974; Whittaker, 1975; Grodzinski and Wunder, 1975). Based on these assumptions and scaling calculations, 1.85 acres of oyster reef (with seedings in year one and year five) are needed to compensate for the losses of other birds (French McCay et al., 2002).

Probability of Success

Based on the information presented in Section 5.5.2, the Trustees believe that this project has a high likelihood of success.

Performance Measures and Monitoring

See Section 5.5.2.

Approximate Project Costs

Table 5.5 provides a summary of the estimated costs of creating and seeding 1.85 acres of oyster reef sanctuary. Survey, resurfacing, seeding and monitoring costs are explained under Section 5.5.2. Project implementation and oversight are estimated costs ($27,000) expected to be incurred by the Trustees during project implementation. A 25 percent contingency is included to cover the risk that (1) the costs of the project will turn out to be higher than expected, and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, estimated project costs total $275,000.

Table 5.5. Summary of project costs: Creating and seeding an oyster reef sanctuary (1.85 acres).

Cost Element	Cost
Site Survey	$8,400
Historical Survey	$5,800
Reef Resurfacing (6" layer)	$62,100
First Seeding	$36,800
Second Seeding (costs increase 3% per yr)	$42,600
Project Implementation and Oversight	$27,000
Monitoring (ten years)	$37,200
Contingency (25%)	$55,100
Total	**$275,000**

Environmental and Socio-Economic Impacts

See Section 5.5.2.

Evaluation

This project is consistent with the Trustees' evaluation criteria, providing cost-effective restoration of non ruddy duck bird losses within the spill zone. In addition, the oyster reefs provide direct and indirect benefits to waterfowl by providing food and improving water quality. The oyster reef itself provides habitat for other benthic invertebrates, which are an important food source to fish and birds. Increased oyster production in the Patuxent River will also improve the water quality by filtering out sediments and pollutants and improving the aquatic habitat, which in turn will increase reproduction and survival of fish and other aquatic food sources, potentially attracting and supporting an increased number of waterfowl. Creating and seeding an oyster reef sanctuary is also consistent with state, federal, and local restoration goals established for the upper Chesapeake Bay.

This project will restore lost bird biomass by producing an equivalent amount of bird biomass through increased feeding opportunities associated with the benthic production of oyster reefs. While the size of the reef has been scaled to ensure that the lost bird biomass equals the restored bird biomass, the restored bird biomass may not be the same species as those injured. However, direct restoration of each of the 14 species, given the relatively small number of each that was lost, will be impractical. Thus, combining these injuries and restoring them with a biomass-to-biomass approach is a cost-effective, practical restoration option.

5.5.6 Restoration of Diamondback Terrapins and Beach Shorelines: Shoreline Beach Enhancement, Washington Creek, St. Mary's County, MD

The total terrapin injury, as presented in Byrd et al. (2002b) and summarized in Section 4.3.5, is estimated to be 5,245 discounted terrapin years. This represents the sum of the direct terrapin years lost (122 adults and juveniles), production foregone, and loss from increased hatching mortality (10 percent of the year 2000 cohort). The Trustees selected a shoreline beach enhancement project at Washington Creek based on the likelihood of success and cost-effectiveness attributable to its close proximity and link to the preferred restoration alternative for wetlands.

Project Description

This project is linked to the preferred project to restore wetlands losses. It uses sand excavated to create the wetland at that site (see Section 5.5.1; Figure 2) to stabilize a nearby eroding beach, providing enhanced nesting opportunities for terrapins. This project also serves as the preferred restoration project for the relatively small injury to beach shorelines.

The projects (i.e., beach shoreline enhancement and wetlands creation) are located on farmland adjacent to Washington Creek, a tributary of the Patuxent located just south of Chalk Point. The property is currently in private ownership and actively farmed. At this site, there is currently a narrow width of sandy beach marginally suitable for terrapin nesting. As the beach has eroded over time, the bank has been undercut, resulting in a "wall" between the beach and an area of vegetation. As the erosion process continually has undercut the bank, the same width of sandy beach has "marched inward" over time. Rebuilding the shoreline to provide a gradual slope from water to "high beach" areas should make it easier for terrapins to find nest sites and should increase the area available for nesting.

Two breakwaters that will extend approximately two feet above mean high water will be constructed offshore to stabilize the shoreline. The excavated sand removed from the preferred marsh creation project will be used to rebuild the eroding beach behind the breakwaters. The area between the existing upland and the newly created beach will be planted to provide a windbreak that will keep the sand from migrating inland. Prior to project implementation, a detailed planting plan will be developed that meets state requirements and the objective of maximizing terrapin nesting habitat.

If determined to be necessary, a combination of nest relocation and/or hatchling "head starting" will be undertaken to help ensure that the enhanced high beach terrapin nesting habitat will produce an increase in terrapin hatchlings. These efforts will be aimed at imprinting hatchlings on the new beach with the expectation that the new females will return as adults to lay their eggs.

Restoration Objectives

This project will restore diamondback terrapins and beach shoreline injuries resulting from the Chalk Point oil spill by stabilizing an eroding shoreline, creating additional beach area, and enhancing the quality of existing terrapin nesting habitat.

Scaling Approach

This restoration project has the potential to (1) enhance the quality of existing terrapin nesting habitat, and (2) increase the amount of high beach nesting habitat. A complete description of the scaling methods for this alternative is provided in Byrd et al. (2002a). As a first step, the restoration potential associated with the enhanced habitat was estimated by assuming that the current nesting density is at the low end of the reported range, and, following project implementation, will be at the average nesting density. Using values reported by Roosenburg (1994), the increase in nesting density resulting from this project is calculated at 443 nests per ha[15]. Literature values for the number of

[15] 683 nests/ ha (average reported nesting density) – 240 nests/ ha (low end of reported nesting density) = 443 nest/ ha (as reported by Roosenburg (1994))

eggs per nest (13) and nest survivorship (20 percent) were then used to estimate the number of hatchlings produced per hectare per year ((442.5 x 13 x 0.2) = 1150.5)). Modeling presented in Byrd et al. (2002b) for the injury assessment, determined that each hatchling generates 2.095 discounted terrapin years. Thus, the discounted terrapin years produced per hectare per year is: (1150.5 x 2.095) = 2410.3. For scaling to terrapin injuries, the project was assumed to have a 25 year project lifespan, with 20 percent services provided at the end of 2003, increasing linearly to 100 percent at the end of 2007. Using these assumptions, the total discounted terrapin years produced per hectare is 34,233.4, requiring 0.15 hectares (0.37 acres) of enhanced beach to compensate for the terrapin losses. Preliminary project engineering indicates that about 0.38 ha (0.94 acres) of terrapin nesting habitat will be improved by this project. Thus, the increased terrapin productivity resulting from the enhancement of existing nesting areas was determined to be more than sufficient to offset the terrapin injury.

In addition to the high beach terrapin nesting area, approximately 0.31 ha (0.77 acres) of lower, intertidal beach will be created between the breakwaters and the existing shoreline. This area was scaled to the beach shoreline injury (4.7 beach service acre-years) quantified in Michel et al. (2002) (see Section 4.3.1). Applying the same assumptions that were used in the terrapin scaling (25 year lifespan of restored beach, 20 percent services provided at the end of 2003, increasing linearly to 100 percent at the end of 2007), one acre of restored beach will provide 13.8 service acre-years. Therefore, to compensate for the 4.7 service acre-year loss, 0.34 acres (0.13 ha) of beach is needed. The area of restored beach is therefore more than sufficient to compensate for the losses to beach shorelines.

Probability of Success

The Trustees believe that the beach augmentation portion of the project has a high probability of success, based on preliminary engineering surveys. The project is designed to create a stable beach by engineering offshore structures that will anchor beach transport, maintaining beach structure in a high-energy system. This portion of the project is patterned after a similar project at Jefferson Patterson State Park, located just downstream of this proposed project.

Conservative assumptions built into the modeling include: (1) the beach immediately returns to its current baseline condition after 25 years; (2) the improved habitat will provide an “average” nest density; and (3) there is no credit given for offspring using other nesting areas (the credit is limited only to the production on this specific parcel and the specific areas currently being used on this site by terrapins).

Performance Measures and Monitoring

Performance measures will be established to assess beach stabilization/ enhancement and terrapin nesting. These criteria will be monitored over the course of this project to ensure that enhanced nesting occurs at the densities expected. If nest densities fall below expectations, corrective actions will be taken with the contingency funds identified in Table 5.6.

Environmental and Socio-Economic Impacts

Beach augmentation will ensure that the shoreline is stable and create terrapin nesting habitat. It will also provide rare backbeach habitat for other organisms and plants. Construction of the offshore breakwaters will alter the bottom characteristics of the offshore bottom. Breakwaters most likely will be located on soft, silty, featureless bottom, and displace the existing flora and fauna that depend on that type of habitat and replace them with ones that rely upon a hard surface. The environmental benefits of constructing the breakwaters include perching sites for birds, attachment sites for aquatic macroinvertebrates (e.g., oysters), and a source of cover and food for fish and crabs.

Evaluation

This project is consistent with the Trustees' evaluation criteria. The opportunity to combine the beach creation/terrapin nesting project with the marsh creation project makes this site cost-effective for both projects and provides more acres of shoreline enhancement and terrapin nest habitat than will be possible at other locations. Disposal of the excavated sand along the eroding beach costs less than hauling and disposing the material offsite, and provides additional ecological benefits by reducing erosion and enhancing nesting habitat for diamondback terrapins. This project will also provide collateral benefits to water quality by stabilizing an eroding shoreline.

Finally, several experts[16] in terrapin ecology have suggested to the Trustees that loss of suitable terrapin nesting habitat resulting from shoreline development is a significant problem for this species.

Approximate Project Costs

A summary of project costs is provided in Table 5.6. The major items are construction of the offshore breakwaters necessary to stabilize the shoreline ($52,100) and planting to stabilize the beach ($20,000). Project implementation and oversight are estimated costs ($49,700) expected to be incurred by the Trustees during project implementation. Monitoring costs are estimated at $35,000. A 25 percent contingency is included to cover the risk that: (1) the costs of the project will turn out to be higher than expected, and/ or (2) the project will not result in the expected magnitude of benefits and need augmentation. As shown, estimated project costs total $207,300.

[16] Dr. Willem Roosenburg, Ohio University; Dr. Whit Gibbons, University of Georgia; and Dr. Roger Wood, The Wetlands Institute.

Table 5.6. Summary of project costs: Shoreline beach enhancement, Washington Creek.	
Cost Element	**Cost**
Engineering	$9,000
Construction of Offshore Breakwaters	$52,100
Plants	$20,000
Project Implementation and Oversight	$49,700
Monitoring	$35,000
Contingency (25%)	$41,500
Total	**$207,300**

5.5.7 Restoration of Lost Recreational Uses

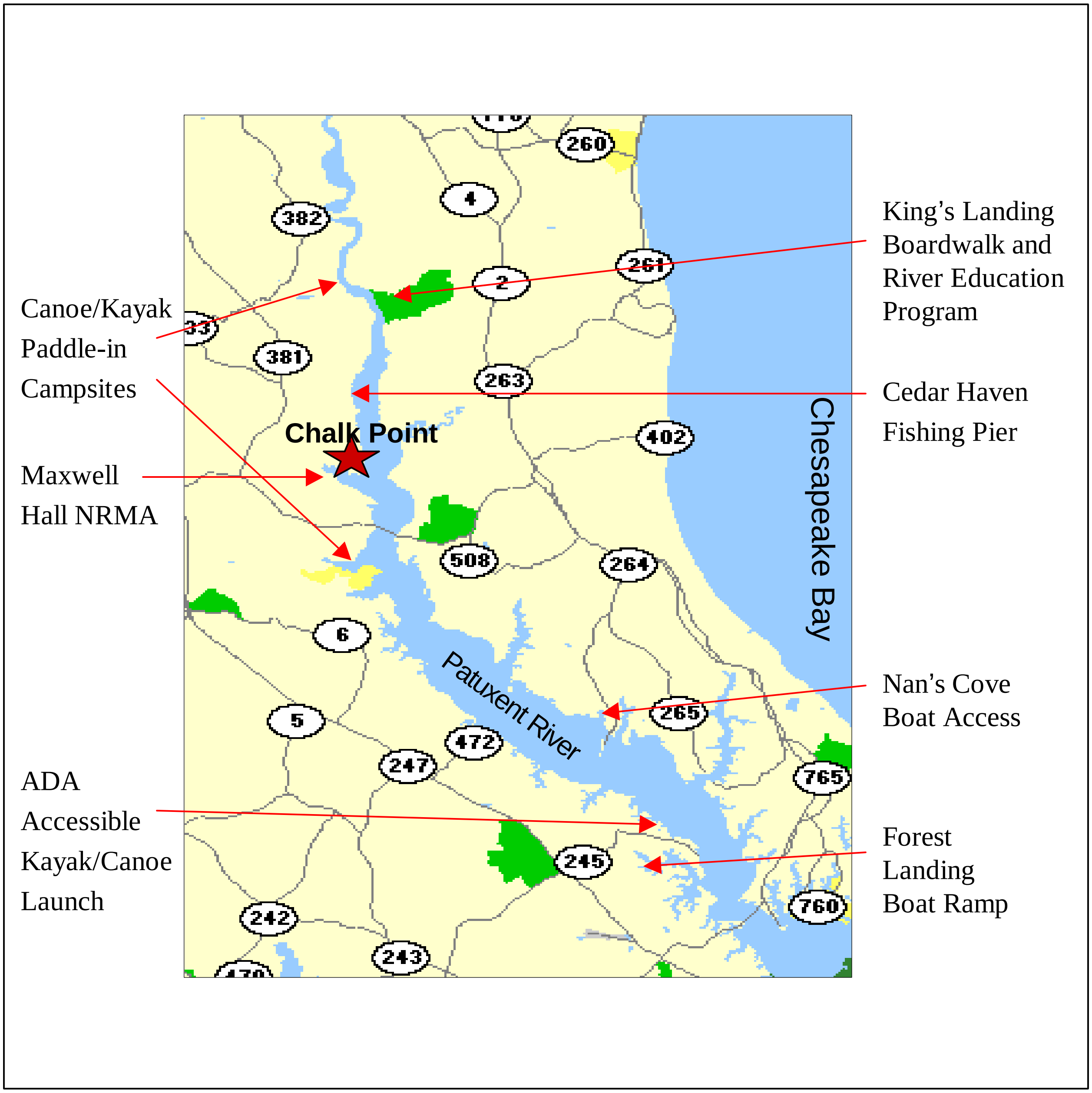
Trustee analysis indicates that the Chalk Point oil spill had a direct adverse impact on recreational use of the Patuxent River. Recreational losses occurred from the outset of the spill in April 2000, through September 2000, when recreational activity appeared to return to normal. An estimated 125,000 trips to the river were affected, amounting to $453,500 in lost value (see Section 4.3.6) (Byrd et al., 2001).

The Trustees solicited restoration ideas and alternatives from government officials, including park and planning officials from each of the affected counties, state officials, Citizens Advisory Committee, Patuxent River Commission, and the public. These preliminary restoration proposals are included in Appendix 3.

Using the selection criteria described in Section 5.2, the Trustees selected seven projects to restore recreational losses resulting from this spill. The Trustees then scaled these projects using a "value-to-cost" approach. Relying on this approach, the Trustees have selected projects such that the total value of recreational losses ($453,500) is equal to the total cost of implementing the projects. The Trustees did not use a "service-to-service" scaling approach whereby restoration actions are chosen to precisely offset lost recreational services. This is due to uncertainty regarding the increase in recreational trips the preferred restoration projects could be expected to provide. The Trustees also elected not to undertake a monetary valuation of restoration actions, which would have permitted a "value-to-value" scaling approach, whereby the value of restoration equals the value of lost recreational services. The Trustees believe that the high cost of implementing the value-to-value approach is not warranted in this case. This is due to uncertainty regarding the increase in recreational trips the preferred restoration projects could be expected to provide. The Trustees also elected not to pursue a "value-to-value" scaling approach, whereby the value of restoration equals the value of lost recreational services, because of the high cost of undertaking a monetary valuation of restoration actions. Based on OPA regulations, the "value-to-cost" scaling approach may be used where Trustees have determined that the first two approaches are not appropriate.

The seven preferred projects selected by the Trustees to restore lost recreational uses are described below. Figure 3 shows the approximate geographic location of each preferred recreational use restoration project.

Figure 3. Location of preferred projects to restore recreational losses.



5.5.7.1 Canoe/Kayak Paddle-In Campsites

Project Description

The Trustees have identified two sites where overnight canoe/kayak campsites will be established. Both sites are on state-owned land and will be managed by the Forest and Park Service of the MDNR. One site is on the west shore of the Patuxent River just north of Golden Beach, and the other is at Milltown Landing, also on the west shore of the Patuxent about five miles north of Eagle Harbor (Figure 3). Each site will include a picnic table, a fire ring for campfires, a sanitation facility and a space suitable for tents.

The sites will be identifiable by a marker and directions to the sites will be available upon registering for an overnight stay with the state Forest and Park Service.

Restoration Objective

The objective of the project is to provide additional boating opportunities in the vicinity of the spill to compensate for boating losses incurred during the period of the spill. Extended overnight trips on established canoe/kayak trails are a popular recreational activity throughout the Chesapeake Bay. Existing paddle-in sites on the Patuxent River are a considerable distance apart, and the new sites will enable extended trips in areas that are currently difficult to access.

Probability of Success

Paddle trails have been established throughout Chesapeake Bay and the state Forest and Park Service successfully maintains other paddle-in sites on the Potomac River and elsewhere. The state already owns the sites under consideration, which are accessible for maintenance using existing roads. Available sites on the Patuxent River are limited, and based on the requests park officials have received, demand for more sites appears to be substantial.

Performance Measures and Monitoring

The performance measure for this project is construction of the necessary facilities at the paddle-in sites by the Maryland Department of Natural Resources. Contingent upon an agreement by state officials to maintain the sites, no further monitoring of the project is anticipated.

Approximate Project Costs

Approximate project costs for the two campsites are provided in Table 5.7. The total cost is expected to be about $16,750. A 25 percent contingency has been included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.7. Summary of project costs: Two paddle-in campsites.	
Cost Element	**Cost**
Picnic Table, Fire Ring and Other Materials	$3,670
On-Site Installation (Labor)	$2,840
Access Road Improvements	$6,000
Permitting	$890
Contingency (25%)	$3,350
Total	**$16,750**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The Trustees believe this project represents a low-cost way to enhance water-based recreation without adverse impacts. Recreational boating use throughout the spill impact zone will be enhanced, since overnight paddle-in campsites are used for extended canoe and kayak trips up and down the shore. Paddle-in campsites are part of a larger plan to expand paddle trails in the Patuxent River and throughout Chesapeake Bay. State tourism officials indicate that considerable demand exists for additional overnight sites.

5.5.7.2 ADA-Accessible Kayak/Canoe Launch

Project Description

Located at Greenwell State Park in St. Mary's County (Figure 3), this project will consist of a launch for canoes, kayaks and other small boats. While this project is intended to improve access for all patrons, it will be specially designed and equipped to assist physically disabled patrons under the guidelines of the Americans with Disabilities Act (ADA). The launch will include a floating pier equipped with overhead grips for support, and it will be accessible by a short access road from a nearby parking lot. The facility will be constructed and managed by MDNR officials at the park.

Restoration Objective

The objective of the project will be to provide additional boating opportunities to compensate for activities that were displaced or diminished during the period of the spill. Canoeing and kayaking are popular activities throughout the spill impact zone. ADA accessible recreation is a focus of Greenwell State Park, which is included in the area affected by the spill. Users of this facility will be among those whose boating activities were impacted by the spill.

Probability of Success

Greenwell State Park attracts considerable shoreline recreational use. Although there is currently no designated boat-access site, patrons use the park informally for launching and landing canoes and kayaks. The creation of a facility for canoe and kayak access, with emphasis on access for the disabled, will enhance boating use and complement the other recreational amenities available at the park.

Performance Measures and Monitoring

The performance measure for this project is construction of the canoe and kayak launch as agreed upon by the Trustees and state MDNR officials. Contingent upon an agreement by MDNR officials to maintain the facility, no further monitoring of the project is anticipated.

Approximate Project Costs

Approximate project costs are provided in Table 5.8. The ADA accessible launch combined with improvements to the access road will cost about $95,485. A 25 percent contingency is included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.8. Summary of project costs: ADA-accessible kayak/ canoe launch.

Cost Element	Cost
Engineering and Design	$5,000
Dock and Walkway	$17,300
Kayak Launch Purchase/Installation	$31,218
Road Improvements/Parking	$22,870
Contingency (25%)	$19,097
Total	**$95,485**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The Trustees believe this project represents a low-impact way to restore recreational use of the Patuxent River. The project takes advantage of facilities already in place, since the site is accessible by an existing road and connected to a day-use area with parking, shelter and other facilities. The site is in the immediate vicinity of the spill impact zone, and canoeing and kayaking are popular boating activities throughout the length of the Patuxent River. ADA accessible amenities are an important feature of Greenwell State Park and this project will be compatible with the park's other recreational programs.

5.5.7.3 Maxwell Hall NRMA Recreational Improvements

Project Description

This project consists of opening to the public for recreational use a 670-acre parcel of land adjacent to the Patuxent River. The land is a Natural Resource Management Area (NRMA) jointly owned by the MDNR and Charles County, and is managed by the Charles County Division of Parks. The site is located at the mouth of Swanson Creek just south of the Chalk Point facility in an area heavily impacted by the spill (Figure 3). The recreational improvements will include foot trails, benches, a boardwalk across a tidal marsh area, and interpretive signs. The area will be accessible from Teagues Pt. Road and a 15-car parking area will be created near the entrance. The improvements will be constructed and managed by the Charles County Division of Parks.

Restoration Objective

Trustees believe the project will provide recreational opportunities of the kind lost during the spill, including fishing and shoreline activities such as picnicking, wildlife viewing, and hiking.

Probability of Success

Given the lack of public access to the Patuxent River in Charles County and the scenic nature of the Maxwell Hall property, the Trustees believe it is likely that this project will provide highly desirable and appropriate opportunities for increased shoreline use.

Performance Measures and Monitoring

The performance measure for this project is construction of the necessary facilities and recreational amenities by Charles County Park and Recreation authorities. Contingent upon an agreement by county officials to maintain the site, no further monitoring of the project is anticipated.

Approximate Project Costs

Estimated costs total $97,986 (Table 5.9). Major components include cost of constructing a boardwalk ($45,000) and trail construction ($13,500). A 25 percent contingency is included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.9. Summary of project costs: Maxwell Hall NRMA recreational improvements.

Cost Element	Cost
Trail Construction	$13,500
Boardwalk	$45,000
Parking, Benches, Interpretive Signs	$19,889
Contingency (25%)	$19,597
Total	**$97,986**

Environmental and Socio-Economic Impacts

No significant environmental, social or economic impacts are expected. Ecological impacts will be minimized. For example, the parking lot will be constructed using a pervious surface to minimize the visual and ecological impacts. The planned boardwalk will be constructed high enough above the surface of the water to minimize the impact of shading on aquatic vegetation. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The site's proximity to the spill zone in an area of limited shoreline access makes this a desirable restoration project. Ground zero of the spill is visible from this site and interpretive signs will be used to educate visitors about local natural resources and the spill.

The project will encourage low-impact recreational activities of the kind lost during the spill. The improved maintenance and oversight of existing trails and shoreline areas may reduce the potential for ecological or personal harm resulting from unauthorized use. Ecological impacts of the recreational improvements to the site will be minimized.

5.5.7.4 Forest Landing Boat Ramp

Project Description

The existing boat ramp at the end of Forest Landing Road in Hollywood, MD, will be lengthened to ensure the safe launching of longer boats. This site provides access to the Patuxent River via Cuckold Creek in an area just outside the southern border of the spill zone (Figure 3). The boat ramp is currently too short for many boat trailers, with the ledge at the end of the ramp creating a hazard when trailers are lowered too far into the water. The pier beside the boat ramp is in need of replacement, and will be rebuilt in conjunction with extension of the boat ramp. Additional features, such as a floating pier alongside the fixed pier, will improve ADA accessibility. The facility improvements will be constructed and managed by the St. Mary's County Department of Parks and Recreation.

Restoration Objective

The extension of the boat ramp at Forest Landing will expand boat access to the Patuxent River by enabling longer boats to use the ramp and providing safer conditions for all boaters. Reconstruction of the pier will extend the life of the facility, thereby permitting additional recreational use in future years. The Trustees believe that the project will help facilitate recreational boating opportunities of the type lost during the spill.

Probability of Success

The Trustees believe there is a high probability that this project will provide increased opportunities for Patuxent River boating by enhancing the utility and safety of the boat ramp facility.

Performance Measures and Monitoring

The performance measure for this project is completion of the boat ramp extension and reconstruction of the pier. Contingent upon an agreement by county officials to maintain the site, no further monitoring of the project is anticipated.

Approximate Project Costs

A breakout of the approximate cost is provided in Table 5.10. The total estimated cost of the project is $106,281. A 25 percent contingency has been included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.10. Summary of project costs: Forest Landing boat ramp extension.

Cost Element	Cost
Permitting, Design and Engineering	$9,000
Demolition and Removal of Existing Ramp and Pier	$37,000
Construction of New Ramp	$12,000
Construction of New Pier and Dock	$27,025
Contingency (25%)	$21,256
Total	**$106,281**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The Trustees believe the project will improve boating access on the Patuxent River by enhancing the utility and safety of the existing site. Although located outside the spill zone, the Forest Landing boat ramp is open to all and serves residents throughout St. Mary's County. There is limited boating access along the west shore of the Patuxent River in much of the spill zone, so the Forest Landing location is important for those wishing to access the spill zone from the south.

5.5.7.5 King's Landing Boardwalk and River Education Project

Project Description

Located at King's Landing Park in Calvert County, MD, this project involves replacing a deteriorated boardwalk and establishing a river education project. King's Landing Park is located on the eastern shore of the Patuxent River, just north of the spill impact zone (Figure 3). The boardwalk is about 160 feet long by six feet wide, and extends from a footpath in a wooded area, across a marsh, to the open water of Cocktown Creek. A 10-by-20 foot platform at the end of the boardwalk will also be replaced, and canoe access will be enhanced using steps that lead into the water. In addition, restoration funds will be used to purchase several canoes and canoe accessories that will be used for guided tours by school groups and the general public as part of a river education program. Park authorities will be responsible for the construction of the boardwalk and future maintenance of the boardwalk and canoes.

Restoration Objective

The boardwalk needs to be replaced. By creating a safer facility and by extending the life of the facility, shoreline and water access will be enhanced. The canoes and river education program will enhance use of the site and will restore lost boating activity.

Probability of Success

The Trustees do not believe there are any obstacles to the success of this project.

Performance Measures and Monitoring

The performance measure for this project is completion of the boardwalk. Contingent upon an agreement by county officials to maintain the site, no further monitoring of the project is anticipated.

Approximate Project Costs

Table 5.11 provides estimated project costs totaling $44,340. A 25 percent contingency has been included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.11. Summary of project costs: King's Landing boardwalk and education program.

Cost Element	Cost
Boardwalk Materials and Labor	$28,500
River Education Program	$6,972
Contingency (25%)	$8,868
Total	**$44,340**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The Trustees believe the Cocktown Creek boardwalk and river education program will be an important amenity at King's Landing Park. The boardwalk is currently used for canoe and kayak access to Cocktown Creek and to the Patuxent River, especially when high winds or waves make access difficult on the main channel of the River. The boardwalk and canoes will also be used for educational study of the marsh, for guided river tours, wildlife viewing and other activities. Though the facility is north of the spill impact zone, it is open and accessible to residents throughout Calvert County and the Patuxent River area. It can be expected to attract visitors from the local area where recreational activities were adversely affected by the spill.

5.5.7.6 Cedar Haven Fishing Pier

Project Description

A pier will be constructed at an existing public recreation site in Cedar Haven, MD. It is located in Prince George's County, on the western shore of the Patuxent just north of the spill impact zone (Figure 3). The site currently includes vehicle access and parking, with picnic tables and shore access for fishing and crabbing. The Maryland National Capital Park and Planning Commission (MNCPPC) will construct and manage the pier. All parks operated by the MNCPPC are open to the public for a one-time five-dollar annual fee.

Restoration Objective

The pier will improve fishing access by expanding the area available for shoreline fishing and crabbing. Users of the fishing pier will be drawn from among area residents whose use of the river was adversely affected by the spill.

Probability of Success

The newly expanded Cedar Haven recreation site has ample parking to accommodate additional fishing access. The site currently receives considerable use by anglers, and historically has been a popular crabbing site. The Trustees believe that the probability of success of the project is high.

Performance Measures and Monitoring

The performance measure for this project is completion of the fishing pier according to specifications agreed upon by the Trustees and county officials. Contingent upon an agreement by county officials to maintain the site, no further monitoring of the project is anticipated.

Approximate Project Costs

A breakout of the approximate cost is provided in Table 5.12. The total estimated cost of the project is $65,481. A 25 percent contingency has been included to account for uncertainties associated with the project that result in higher than expected project costs.

Table 5.12. Summary of project costs: Cedar Haven fishing pier.

Cost Element	Cost
Permits, Design and Engineering Fees	$12,250
Materials and Labor	$40,135
Contingency (25%)	$13,096
Total	**$65,481**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

A pier at this location will provide fishing access to many area residents. The site is popular with anglers and crabbers despite the shallow depth, and the area available to anglers will be expanded considerably by the addition of the pier. ADA access will also be improved. Cedar Haven is close to the site of the spill and there are currently few if any piers on the west shore of the Patuxent River with significant size and parking. A similar pier on the east shore of the River at King's Landing receives considerable use. The addition of a fishing pier at Cedar Haven will increase use without causing significant ecological impacts.

5.5.7.7 Nan's Cove Boat Access

Project Description

This project involves creating a boat launch platform next to an existing pier at Nan's Cove. Located just north of Broomes Island on the eastern shore of the Patuxent River (Figure 3), the Nan's Cove site currently includes an 8-by-30-foot fixed pier and parking for eight to ten vehicles. The pier is relatively high off the water and does not provide reasonable access for canoes and kayaks. The planned project involves construction of a wooden ramp leading from the side of the existing dock to a fixed platform located slightly above mean high tide. No changes would be made to the parking lot or shore area of the site.

Restoration Objective

The facility would restore losses to water recreation by providing canoe and kayak access to the cove, the Patuxent River and several nearby creeks. Additional benefits of the project include improved access for powerboats and sailboats, additional space for shore anglers, and enhancement of ADA access at the site.

Probability of Success

The Trustees have heard considerable evidence that recreational opportunities on the Patuxent River would be enhanced by additional canoe and kayak facilities. Anglers and boaters would likely benefit from the project as well. The Nan's Cove site has ample parking to accommodate moderate additional use. The Trustees believe that the probability of success of the project is high.

Performance Measures and Monitoring

The performance measure for the project is completion of the ramp and platform according to specifications agreed upon by the Trustees and county officials. Contingent upon an agreement by county officials to maintain the site, no further monitoring of the project is anticipated.

Approximate Project Costs

A breakout of the approximate cost is provided Table 5.13. The total estimated cost of the project is $27,175. A 25-percent contingency has been included to account for

uncertainties associated with the project that may result in higher than expected project costs.

Table 5.13. Summary of project costs: Nan's Cove boat access.

Cost Element	Total Cost
Engineering/Permits	$3,500
Materials/Construction	$18,240
Contingency (25%)	$5,435
Total	**$27,175**

Environmental and Socio-Economic Impacts

No significant project specific adverse environmental, social or economic impacts are expected. Potential indirect and cumulative impacts are discussed in Section 5.3.

Evaluation

The Nan's Cove project will enhance shoreline recreational use and provide benefits to many residents affected by the spill. The primary goal of the project is the addition of boat access at the site. There is considerable boat use on the Patuxent River, and there is significant demand for additional facilities. Anglers currently fish from the pier, and they are also expected to benefit from the additional space for shore fishing provided by the construction of the new platform. Some sail boaters and power boaters may be able to board and launch more easily at the site, since the new platform will be closer to the water than the existing pier. The pier and new platform would be accessible by ramps, so the project will also enhance ADA access for both boaters and anglers.

5.6 Summary of Preferred Restoration Alternatives

Table 5.14 summarizes the preferred restoration alternatives and restoration costs for the Chalk Point oil spill. As indicated below, costs to implement these projects total $2,710,498.

Table 5.14. Summary of preferred restoration alternatives for the Chalk Point oil spill.

Injury Category	Preferred Restoration Project	Cost
Wetlands	Tidal Marsh Creation (5.7 acres), Washington Creek	$754,600
Diamondback Terrapins and Beach Shorelines	Shoreline Beach Enhancement (1.7 acres), Washington Creek	$207,300
Ruddy Ducks	Enhance and Protect Ruddy Duck Nesting Habitat	$589,900
Birds (excluding ruddy ducks)	Create and Seed an Oyster Reef Sanctuary (4.7 acres)	$705,200
Benthic Communities		
Fish and Shellfish		
Lost Recreational Use	Canoe/Kayak Paddle-In Campsites	$16,750
	ADA-Accessible Kayak/Canoe Launch	$95,485
	Maxwell Hall NRMA Recreational Improvements	$97,986
	Forest Landing Boat Ramp	$106,281
	King's Landing Boardwalk and River Education Project	$44,340
	Cedar Haven Fishing Pier	$65,481
	Nan's Cove Boat Access	$27,175
	Subtotal (Lost Recreational Use Projects)	$453,498
	Total (All Restoration Projects)	**$2,710,498**

5.7 Non-Preferred Alternatives

The Trustees considered a number of alternative restoration projects to replace ecological and recreational losses resulting from the spill (Appendix 3). Projects considered, but not selected as preferred projects for implementation are listed in this section. While many of these non-preferred restoration alternatives were expected to be beneficial, the Trustees ultimately concluded that either the alternative did not meet one or more of the evaluation criteria discussed in Section 5.2, or better alternatives existed. Alternatives considered, but not selected as preferred, include:

- **Integrated Wetland Restoration at Battle Creek, Calvert County, MD**: This project would stabilize approximately 1100 feet of eroding bank along Battle Creek by creating fringe marsh and protecting the shoreline with a combination of breakwaters, an artificial reef, riprap and sills. The offshore reef would be seeded with oysters, which would protect the fringe marsh by attenuating wave energy from the river and provide habitat for benthic and aquatic organisms. This project was not selected because the Trustees believe that the Washington Creek Tidal Marsh Creation Project is a more cost-effective alternative for restoring wetlands injured by the Chalk Point oil spill.

- ***Phragmites* Control**: This project would fund efforts to remove and control *Phragmites australis*, thereby restoring native wetland plant communities. While this plant species has expanded in marshes along the northern and middle Atlantic coasts at a rate and pattern that is perceived as invasive, the available literature presents conflicting data on potential net gains in productivity generated by its removal. This makes it difficult, if not impossible, to scale the ecological restoration benefits that would be generated by removal of *Phragmites*. In addition, the Trustees determined that most of the large stands of *Phragmites* exist outside of the spill zone (i.e., upriver).

- **Cooperative Oyster Restoration**: This project would prepare and seed four private oyster leases in the upper Patuxent River. This project has the potential to provide similar ecological benefits to those described under the Trustees' preferred alternative for restoring fish and shellfish, benthic communities, and non ruddy duck bird injuries (as described under Sections 5.5.2, 5.5.3, and 5.5.5). The significant difference is that by allowing the harvesting of the oysters, the restoration potential per unit area of created reef, as compared to a sanctuary, is considerably lower. Further, the reduced restoration potential resulting from the harvesting of the oysters requires a greater area of reef be created to generate the same benefit as a sanctuary, making this a much less cost-effective restoration alternative.

- **Hatchery Production of American Shad**: This project would increase hatchery production of American shad (*Alosa sapidissima*) for release into the Patuxent River. Although this project could provide positive environmental benefits and is not expected to have any adverse environmental or economic impacts, the Trustees determined that restoration of fish and shellfish in the form of oyster creation and seeding (Section 5.5.2) is more consistent with federal, state, and local restoration goals established for the Patuxent River and Chesapeake Bay.

- **Sandy Point Integrated Ecosystem Restoration Project**: This project focuses on 63 acres of degraded aquatic habitat at the mouth of the Patuxent River. It calls for planting about five acres of submerged aquatic vegetation (SAV), and constructing about three acres of oyster bars just offshore of the SAV plantings to reduce wave energy directed at the SAV plantings. The Trustees did not select this project because of the uncertainty over the success of the SAV component. While this project was not selected, the Trustees recognize the restoration potential of the proposed oyster reef. As part of the site review and selection process described under Section 5.5.2, the Trustees will work with interested individuals or groups to review this site as a potential location for a new sanctuary that could be created with a portion of the oysters that would be planted under this final Restoration Plan/ EA

- **Submerged Aquatic Vegetation (SAV) Restoration**: SAV provides habitat critical to aquatic life in the Chesapeake Bay. Over the past several decades, the amount of SAV in the Bay has declined dramatically. This project would compensate for the losses resulting from the spill by restoring SAV in the Patuxent River and its tributaries.

However, based on the results of other SAV restoration in this region of the Patuxent River, the likelihood of a successful project was uncertain.

- **Shoreline Beach Enhancement at Cremona Farm, St. Mary's County, MD**: This project would stabilize shoreline and enhance terrapin nesting habitat at a site located between the mouth of Persimmon Creek and the pier in front of Cremona Farm, located on the western shore of the Patuxent River just south of Chalk Point, redirecting currents or wave energy. The Trustees selected a similar type of project at Washington Creek, determining that the selected site was a more cost-effective approach for this type of project.

- **Protection of Terrapin Nests from Natural Predation**: This restoration alternative focuses on compensating for the terrapin injury by protecting nests from predation, thereby increasing hatchling survival. While the project appears consistent with the Trustees' evaluation criteria, terrapin experts have advised the Trustees that the preferred alternative for terrapins (see Section 5.5.6) has the potential to provide substantially more benefits to both terrapins and the environment.

- **Paddle-Trail Guidebook at Jefferson Patterson State Park**: This project would fund the creation of a guidebook for a canoe and kayak paddle-trail under development on St. Leonard's Creek in Calvert County, Maryland. Officials at Jefferson Patterson State Park plan to implement and maintain the trail, and the guidebook would inform those using the trail about historical and geological sites along the water. While the paddle trail would increase water-based recreation near the spill impact zone, the creation of the guidebook would not be essential to the project and would not directly generate additional recreational use.

- **Boardwalk and Foot Trail at Jefferson Patterson State Park:** The Trustees considered a proposal to create a boardwalk and foot trail along part of the northeast shore of the Patuxent River in Jefferson Patterson State Park. The boardwalk would be about 600 feet long and provide views of the marsh and wooded areas along the Patuxent River. While the trail would enhance shoreline uses such as walking and wildlife viewing, a considerable array of similar recreational opportunities are already available at the same location and throughout the area. The expense of the project and the potential disruption of shoreline vegetation and wildlife weighed against the project in the Trustees' selection process. Also, the Trustees believe that the boardwalk and trail would not directly enhance water-based recreation as effectively as the preferred projects described above.

- **Solomons Boardwalk Lighting:** The Trustees considered a proposal to install lighting on a boardwalk on Solomon's Island, located on the eastern shore of the Patuxent River south of the spill impact zone. The Trustees determined that other proposed projects restored lost recreational services more effectively. In particular, other projects were located closer to the spill impact zone and provided more direct access to water-based recreation.

- **Golden Beach Boat Ramp:** Because Golden Beach is a private community, recreational "benefits" of a restoration project in this community would be limited to its residents. Regulations under the OPA require the Trustees to seek cost-effective restoration projects (i.e., projects that provide the greatest benefit for a given expenditure). Recreational projects at public facilities best meet this objective since they are available to all members of society, including residents of Golden Beach.

- **Upgrade Public Boat Ramp at Cape St. Mary's Marina:** The Trustees reviewed a proposal to fund repairs to the boat ramp at Cape St. Mary's Marina in Mechanicsville, Maryland. The marina is located on an inlet next to Cat Creek, on the west shore of the Patuxent. The county currently owns an easement for public use of the boat ramp, but county officials have not supported access to the ramp because it is in need of repair. County officials proposed the use of restoration funds to widen the ramp and repair large cracks in the ramp. The project would improve access for boats in an area with few nearby boat launch sites. However, there are uncertainties about the future status of both ownership of the property and the county's easement for use of the ramp. For these reasons, this project was not selected.