DRAFT DAMAGE ASSESSMENT AND RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT

For the November 26, 2004, M/T *Athos I* Oil Spill on the Delaware River near the Citgo Refinery in Paulsboro, New Jersey.

January 2009

National Oceanic and Atmospheric Administration
U.S. Fish and Wildlife Service
New Jersey Department of Environmental Protection
Delaware Department of Natural Resources and Environmental Control
Pennsylvania Department of Conservation and Natural Resources, Department of Environmental Protection, Fish and Boat Commission, Game Commission

This Draft Damage Assessment and Restoration Plan/Environmental Assessment was prepared by the natural resource Trustee agencies: the National Oceanic and Atmospheric Administration; U.S. Fish and Wildlife Service; New Jersey Department of Environmental Protection; Delaware Department of Natural Resources and Environmental Control; and Pennsylvania Department of Conservation and Natural Resources, Department of Environmental Protection, Fish and Boat Commission, and Game Commission. These agencies have conducted a natural resource damage assessment (NRDA) for the 26 November 2004, spill of more than 263,000 gallons of oil from the M/T *Athos I* into the Delaware River and nearby tributaries. The goal of the NRDA is to restore the public's natural resources injured by the oil spill. This document also serves as an Environmental Assessment to analyze the potential effects of the actions and alternatives on the quality of the human environment, in accordance with the National Environmental Policy Act.

Contact:

Linda Burlington
NOAA Office of General Counsel for Natural Resources
GCNR
1315 East-West Highway, Bldg. 3
Silver Spring, Maryland 20910
(301) 713-1217; Fax (301) 713-1229
Linda.B.Burlington@noaa.gov

http://www.darrp.noaa.gov/northeast/athos/index.html

TABLE OF CONTENTS

List of Figures

List of Tables

List of Appendices

Executive Summary

On 26 November 2004, the M/T *Athos I* (*Athos*) struck a large, submerged anchor while preparing to dock at a refinery in Paulsboro, New Jersey. The anchor punctured the vessel's bottom, resulting in the discharge of more than 263,000 gallons of crude oil into the Delaware River and nearby tributaries.

Under the federal Oil Pollution Act (OPA), two federal government agencies—the National Oceanic and Atmospheric Administration (NOAA) and U.S. Fish and Wildlife Service (USFWS)—and the three affected states—New Jersey, Pennsylvania, and Delaware—are responsible for restoring natural resources injured by the *Athos* spill. Under OPA, funding will be made available through the responsible party (RP) or, where an RP does not exist or exceeds its limit of liability, the Oil Spill Liability Trust Fund (OSLTF) administered by the U.S. Coast Guard (USCG).

The two federal agencies and the three affected states, acting as Trustees on the public's behalf, have conducted a natural resource damage assessment (NRDA) to determine the nature and extent of natural resource losses resulting from this incident and the restoration actions needed to restore these losses. The NRDA was conducted using the OPA NRDA regulations.

This draft Damage Assessment and Restoration Plan/Environmental Assessment (draft Plan) was prepared by the *Athos* Trustees to inform the public about the NRDA and restoration planning efforts conducted following the incident. The Trustees seek comments on the proposed restoration alternatives presented in this draft Plan, and will consider written comments received during the public comment period before developing the final Restoration Plan (final Plan).

What was injured?

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

- Shoreline – 1,729 acres were very lightly, lightly, moderately, or heavily oiled.
- Tributaries – Six tributaries, with a total area of 1,899 acres, were exposed to very light to moderate oiling.
- Aquatic – 412 acres were exposed to *Athos* oil.
- Birds – 11,869 estimated dead (includes direct and indirect losses, a majority of which were swans and geese).
- Recreational services – An estimated 41,709 trips on the river were affected by the spill, with an estimated lost value of $1,313,239.

How were restoration alternatives evaluated and identified as preferred projects?

The Trustees considered numerous restoration alternatives to compensate the public for spill-related injuries. Each proposed project was evaluated using criteria in the OPA NRDA regulations, in addition to site-specific criteria developed by the Trustees for this incident.

Consideration of an appropriate range of alternatives also addressed National Environmental Policy Act (NEPA) requirements.

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

Freshwater tidal wetlands restoration at John Heinz National Wildlife Refuge (Pa.)
Restore 7.0 acres of freshwater tidal wetland to benefit 56 acres within John Heinz National Wildlife Refuge to compensate for tributary losses. This project would restore tidal exchange to the proposed site through tidal channels, shallow pools, and scrub/shrub wetland habitat.

Create oyster reefs (N.J., Del.)
Create roughly 78 acres of oyster reef in the Delaware River to compensate for injuries to aquatic resources, diving birds, and gulls. 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.

Darby Creek dam removal and habitat restoration (Pa.)
Remove three dams and a remnant bridge pier from Darby Creek in southeastern Pennsylvania to open up an additional 2.6 miles of habitat to anadromous fish, and restore about 10 acres of riparian habitat along the creek edges. Dam removal and riparian habitat projects would compensate for tributary losses.

Habitat restoration at Mad Horse Creek (N.J.)
Restore 62.5 acres of degraded wetland and create 35 acres of wet meadow and 100 acres of grassland at state-owned property on Mad Horse Creek (N.J.). The proposed wetland restoration would compensate for non-tributary shoreline losses and a portion of the bird loss. The increase in upland vegetation (wet meadow and grassland habitat) would serve as food sources that can reasonably be expected to enhance bird biomass, thereby compensating for a portion of the total bird loss.

Shoreline restoration at Lardner's Point (Pa.)
Restore shoreline through the demolition of existing structures, import of fill material, grading of a 0.9 acre site to restore tidal inundation, and creation of intertidal marsh and wet meadow habitat. This shoreline restoration project would have multiple benefits in the urban part of the river that was heavily impacted by the spill.

Blackbird Reserve Wildlife Area Pond and Pasture Enhancement (Del.)
Excavate two shallow wetland ponds in former agricultural areas, convert 16 acres of agricultural lands to cool-season grass pasture, and establish approximately 24 acres of food plots by modifying existing agricultural practices. Conversion of existing agricultural land to pond and pasture habitat and modification of existing agricultural practices would provide resting and foraging areas targeted to migratory geese.

Improve recreational opportunities (Pa., N.J., Del.)
Implement three projects to address the estimated 41,709 river trips that were affected by the spill:

- Improve the Stow Creek (N.J.) boat ramp;
- Construct an additional breakwater at Augustine Boat Ramp (Del.) to address ongoing shoaling immediately offshore of the boat ramp; and
- Enhance the recreational trail on Little Tinicum Island (Pa.).

Who will fund implementation of the restoration projects?

The U.S. Coast Guard (USCG) has determined that the RP has exceeded its limit of liability under the Oil Pollution Act (USCG 2005a). Therefore, the final Plan will be submitted to the Oil Spill Liability Trust Fund (OSLTF) as part of a claim for funds to implement the preferred restoration projects. The OSLTF is administered by the USCG. It was established and is primarily maintained by a five cent per barrel tax from the oil industry on oil produced in or imported to the U.S.

CHAPTER 1.0 - Introduction

1.1 - Overview of the Incident

The *Athos* departed Venezuela, South America, for the Citgo Asphalt Refinery in Paulsboro, N.J., on 26 November 2004, carrying approximately 13 million gallons of Bachaquero Venezuelan crude oil. The single-bottom, double-sided vessel was registered under the flag of Cyprus, owned by Frescati Shipping Company, Ltd., and operated by Tsakos Shipping & Trading, S.A., who was designated as the Responsible Party (RP).

At approximately 9:30 p.m. on 26 November 2004, tug operators assisting the *Athos* with docking at the refinery notified the U.S. Coast Guard (USCG) that the tanker was leaking oil. The vessel had struck several submerged objects while maneuvering through Anchorage #9 to its berth (Figure 1). Within minutes, the ship lost power and listed approximately 8 degrees to the vessel's port side (USCG 2005b) (Figure 2).

Surveys of the river bottom following the incident found several objects in the area, including an 18,000-pound anchor, large concrete block, and pump casing (Figure 3). USCG determined that the anchor punctured the vessel's number seven center cargo and port ballast tanks (USCG 2006). The bulkhead between the cargo and ballast tanks was also damaged, allowing oil to migrate into the ballast tank and then into the river (USCG 2005b).

Initial reports indicated that the vessel released 30,000 gallons of the heavy crude oil. Later reports on 30 November suggested an increase in the volume spilled to a maximum potential of 473,500 gallons. The final estimate of 263,371 gallons became known after lightering of the remaining oil from the vessel and comprehensive analysis (USCG 2006).

At the time of the release, the tide was incoming, and the current was approximately 1-1/2 to 2 knots (USCG 2005b). Within the first few hours, thick oil covered the Delaware River and moved upriver with the flood tide to the vicinity of the Walt Whitman Bridge, approximately 6 miles north (Figure 1). Over the following weeks and months, oil from the ruptured tanker spread downriver, threatening natural resources over 115 river miles (280 miles of shoreline), as well as its tributaries (Figure 4), from the Tacony-Palmyra Bridge to south of the Smyrna River in Delaware. The incident also forced USCG to close the River to commercial traffic for over a week, and submerged oil resulted in contamination of water intakes and the closure of the Salem Nuclear Power Plant.

Figure 1. Approximate location of the *Athos* incident on the Delaware River. East of the river, Camden, Gloucester, and Salem Counties are in New Jersey. West of the river, Philadelphia and Delaware Counties are in Pennsylvania; New Castle County is in Delaware.

Figure 2. Aerial view of the *Athos* listing to its port side following the grounding incident.

Figure 3. Submerged objects recovered from the *Athos* grounding location.

Figure 4. Key resources exposed to *Athos* oil. a. Heavy oil stranded in the intertidal area, south side of Little Tinicum Island; b. Heavily oiled rip-rap shoreline at Fort Mifflin, near Philadelphia; c. Heavily oiled coarse substrate beach; and d. Oiled waterfowl.

Federal, state, and local agencies responded to the incident to supervise and assist in cleanup and begin to assess the impact of the spill on natural resources. The USCG and states of New Jersey, Delaware, and Pennsylvania created a Unified Command for directing cleanup efforts. The National Oceanic and Atmospheric Administration (NOAA), U.S. Fish and Wildlife Service (USFWS), natural resource agencies within Delaware, New Jersey, and Pennsylvania (collectively referred to as the natural resource Trustees), and the RP began collecting "preassessment" data to determine whether natural resource damage assessment (NRDA) actions under the Oil Pollution Act of 1990 (OPA) (33 U.S.C. §2706(b)) were justified. With the preassessment data, involved agencies made preliminary determinations regarding the type of injury assessment and restoration actions that might be pursued.

Cleanup activities ended on 22 April 2005, when the USCG reported that 221,910 gallons of oil and oily liquid had been recovered and 17,761 tons of oily solids (cleanup material and oil) had been collected. Damage assessment concluded in 2007, while restoration planning is continuing into 2009.

1.2 - Summary of Preassessment Activities

Under OPA, state and federal agencies are designated as natural resource Trustees, responsible for assessing natural resource losses and restoring those losses to baseline conditions (i.e., the conditions that would have existed had the incident not occurred). Regulations promulgated under OPA provide a framework for conducting a NRDA, including preassessment, restoration planning, and restoration implementation (15 C.F.R. Part 990). Funds to assess losses and to plan and implement appropriate restoration are provided by either the RP or, if an RP does not exist or exceeds its limit of liability, the OSLTF[1] established under OPA.[2]

The *Athos* Trustees and RP initiated preassessment activities on 27 November 2004, immediately following notification of the incident. These efforts included shoreline (aerial and ground) and resource (i.e., birds and wildlife, horseshoe crab) surveys and collection of ephemeral data, including water, sediment, and fish and shellfish tissue samples.

Preassessment data collection efforts and findings are detailed in the Trustees' Preassessment Data Report (NOAA 2006). As summarized in Chapter 4 of this draft Plan, preassessment activities provided evidence of injury or potential injury to shoreline, aquatic, bird, wildlife, and recreation resources, and supported the Trustees' decision to initiate a NRDA pursuant to Section 1006 of OPA.

---

[1] The OSLTF is administered by the USCG. It was established and is maintained by the collection of a tax on the petroleum industry. See the NPFC's Web site (www.uscg.mil/npfc).

[2] Under OPA, the limits of liability are based on the vessel's gross tonnage (GT). The gross tonnage of the *Athos* is 37,895 GT. Accordingly, the limit of liability is $47,474,000 ($1,200 per GT) (USCG 2005b). Following the *Athos* incident, the Delaware River Protection Act of 2006, amended (i.e., increased) the limits of liability under OPA. See the NPFC's Web site (www.uscg.mil/npfc) for current applicable limits.

The Trustees' NRDA focused on determining the nature and extent of natural resource losses. An overview of each injury assessment is presented in Chapter 4 of this draft Plan; Table 1 summarizes the findings.

1.3 - Summary of Injury Assessment

Injuries to natural and recreational resources were assessed by the Trustees beginning shortly after the spill. Natural resource injuries were divided into three main categories: shoreline, aquatic, and bird and wildlife resources. Shoreline injury comprised seawalls, sand/mud substrate, marsh, and coarse substrates which affected approximately 1,729 acres. Shorelines also encompassed tributaries which affected nearly 1,900 acres. Aquatic injury applied to subtidal benthic habitat and affected 412 acres. The bird and wildlife category covered injuries to dabbling ducks, diving ducks, diving birds, gulls, shorebirds, wading birds, swans/geese, and kingfishers. 11,869 adult and fledged young birds were injured as a result of the *Athos* spill. Recreational resources affected by the spill were lost and diminished trips and were estimated to be 41,709 trips valued at $1,313,239.

1.4 - Summary of Alternatives Analysis and Identification of Preferred Restoration Alternatives

Restoration actions under OPA are termed primary or compensatory. Primary restoration accelerates the return of injured natural resources and services to baseline conditions. Trustees may elect to rely on natural recovery rather than primary restoration actions where feasible or when 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 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. Therefore, the natural recovery alternative was chosen for primary restoration.

The Trustees identified and evaluated a wide range of project alternatives capable of compensating the public for injuries resulting from the *Athos* oil spill incident. Restoration ideas and alternatives were evaluated, with the preferred restoration alternatives scaled to ensure that their size appropriately compensates for the injuries resulting from the spill. Chapter 5 of this draft Plan presents OPA-based selection criteria developed by the Trustees for this spill and how these criteria were applied to identify the reasonable alternatives for compensatory restoration, referred to as the "action alternatives" for purposes of NEPA. Chapter 5 provides the evaluation and comparison of action alternatives that led to the Trustees' identification of the nine projects that are considered the preferred alternatives to meet the purpose and need for action. In addition, as required by NEPA regulations, Chapter 5 presents the “No Action” alternative in which no restoration would be conducted.

Based on the Trustees’ evaluation of potential restoration projects, the proposed action consists of the implementation of all nine currently preferred alternatives. These alternatives are described in Chapter 5. If the result of comments received or other information indicates that one of the preferred alternatives is no longer viable or that more than nine alternatives are needed to meet the purpose and need of the action, the Trustees may pursue alternatives that are currently non-preferred or solicit the public for additional alternatives. Table 1 presents each of the Trustees’ preferred compensatory restoration alternatives and the compensatory loss that each is scaled to restore.

Table 1. Summary of injuries resulting from the *Athos* incident and preferred restoration alternatives. ***COSTS ARE NOT FINAL***

Resource Category		**Injury**	**Primary Restoration**	**Preferred Compensatory Restoration Alternative**		**Project Cost**
Aquatic	subtidal benthic habitat	412 acres	Natural Recovery	4.5 acres	Oyster reef enhancement and restoration (Del. and N.J.)	$528,647
Bird and Wildlife	gulls	2,946 birds (direct and indirect)	Natural Recovery	73.5 acres		
	diving ducks, diving birds, wading birds, kingfishers	464 birds (direct and indirect)				
	dabbling ducks and shorebirds	2,503 birds (direct and indirect)	Natural Recovery	25.4 acres	Mad Horse Creek (N.J.) marsh restoration	$11,333,175
	swans and geese	5,956 birds (direct and indirect)	Natural Recovery	35 acres	Mad Horse Creek (N.J.) wet meadow	
				100 acres	Mad Horse Creek (N.J.) grassland restoration	
				41.8 acres	Blackbird Reserve Wildlife Area pond and pasture enhancement (Del.)	$91,268
Shoreline	seawalls, sand/mud substrate, marsh, coarse substrate	1,729 acres	Natural Recovery	38.1 acres	Mad Horse Creek (N.J.) marsh restoration	$7,154,875
				0.9 acre	Lardner's Point (Pa.) shoreline restoration	$567,137
	tributaries	1,899 acres	Natural Recovery	56 acres	John Heinz (Pa.) habitat restoration	$2,396,559
				2.6 miles	Darby Creek (Pa.) dam and remnant bridge pier removal and habitat restoration	$1,040,820
Recreation	Trips affected (lost and diminished value)	41,709 trips	Natural Recovery	$460,045	Stow Creek (N.J.) boat ramp improvements	$1,313,239
				$808,152	Augustine (Del.) boat ramp breakwater installation	
				$45,042	Little Tinicum Island (Pa.) trail and habitat improvements	
					TOTAL	**$24,425,720**

CHAPTER 2.0 – Purpose and Need for Restoration

The purpose of the proposed actions is to restore natural resources injured, lost, or destroyed within and in habitats adjacent to the Delaware River in Philadelphia and Delaware counties, Pennsylvania, New Castle and Kent counties, Delaware, and Salem and Cumberland counties, New Jersey, due to the discharge of oil on 24 November, 2004. The need to pursue such actions is based upon the implementing regulations of OPA which establish liability for the injury to, destruction of, or loss of natural resources caused by discharges of oil. Damages recovered for these losses must be used to restore, replace, rehabilitate, or acquire equivalent natural resources or services, in accordance with a restoration plan developed by designated natural resource trustees.

2.1 - Authorities and Legal Requirements for NRDA Under OPA

The natural resource Trustees for this oil spill include two federal agencies and three states: 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 states of New Jersey, Delaware, and Pennsylvania, which have responsibilities for natural resources and their supporting ecosystems belonging to, managed by, controlled by, or appertaining to their respective state. These agencies are designated as Trustees 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.). The Trustees also have complied with key federal statutes, regulations, and policies which can be found in Appendix 2. As a designated Trustee, each is authorized to act on behalf of the public to protect and restore natural resources that have been injured by a discharge or substantial threat of oil.

2.1.1 - Overview of the Oil Pollution Act

OPA provides the statutory authority for natural resource Trustees to assess and restore injuries resulting from oil spill incidents. OPA, codified at 15 CFR Part 990, defines injury as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service." Restoration, under the OPA regulations, means "restoring, rehabilitating, replacing, or acquiring the equivalent of injured natural resources and services" and includes both primary restoration conditions and compensatory restoration.

A NRDA, as described under Section 1006 of OPA (33 U.S.C. §2706), and its implementing regulations (15 C.F.R. 990), consists of three phases: (1) preassessment; (2) restoration planning; and (3) restoration implementation. 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 phase, 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 USCG for the

Athos incident), the Trustees next determine whether the oil spill response actions will 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. Even if degradation from injuries is not expected to continue, restoration planning may be necessary if injuries 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, type of, and scale of restoration actions. OPA defines natural resources 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 (33 U.S.C. 2701(20))." Services (or natural resource services) are functions performed by a natural resource for the benefit of another natural resource and/or the public.

Restoration planning under OPA has two 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. Restoration selection involves identifying a reasonable range of restoration alternatives; evaluating and selecting the preferred alternative(s); developing a draft Restoration Plan/Environmental Assessment (EA); presenting the alternative(s) to the public; soliciting public comment on the draft Restoration Plan/EA; and considering those comments before issuing a final Restoration Plan/EA.

During the restoration implementation phase, the final Restoration Plan is presented to the RPs to implement or to fund the Trustees' cost of implementing the Plan, 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. If a viable RP does not exist, or where an RP has exceeded its limit of liability, Trustees can seek damages from the OSLTF for the assessment and restoration costs. Components of damages are specified in sections 1002(b) and 1001(5) of OPA and include the cost of conducting damage assessments.

2.1.1.1 - Coordination among the Trustees

Throughout the damage assessment process (i.e., preassessment and restoration planning) for the *Athos* incident, the federal and state Trustee agencies worked together to meet their respective natural resource Trustee responsibilities under OPA and other applicable federal law, as well as state statutory and common law. A Memorandum of Agreement (MOA) signed by all of the Trustees provided a framework for coordination by establishing a Trustee Council responsible for all NRDA activities. The Trustee Council met on a regular basis, with NOAA serving as the Federal Lead Administrative Trustee (LAT) and the overall NRDA coordinator at the request of the other Trustees. All injury assessment and restoration planning 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 (16 USC 990.44). Accordingly, the Trustees and the RP initiated cooperative assessment activities immediately following the spill. Cooperative work groups were formed, consisting of Trustees and the RP, to assist with the design of studies and interpretation of data. The Trustee Council also met periodically with the RP to review aspects of the NRDA.

To formalize the cooperative assessment, the Trustees and the RP initiated discussions on an MOA outlining the terms of the cooperative assessment. The Trustees also sent a letter to the RP[3] inviting their participation in a formal cooperative assessment, and requesting agreement to pay reasonable assessment costs incurred by the Trustees, consistent with OPA. The RP responded on 24 May 2005[4], accepting the Trustees' invitation to participate in a cooperative assessment, but declining to pay the Trustees' assessment costs, based on their belief that they were entitled to a limitation of liability pursuant to Section 1004(a) of OPA, and possibly exoneration, pursuant to Section 1003(a)(3) of OPA. Based on this response, and because a determination regarding a limit of liability and/or exoneration had not been made, the Trustees determined that it would not be appropriate to continue with a formal cooperative assessment[5] and ended discussions with the RP about the MOA. The Trustee technical working groups (TWGs)[6] did, however, continue to meet jointly with the RP to share and discuss information collected. While this coordination between the Trustees and the RP 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.

2.1.1.3 - Coordination with the Public

Throughout the NRDA process, the Trustees have provided the public with information on the status of injury assessment and restoration planning efforts. The Trustees published a Notice of Intent to Conduct Restoration Planning in the *Federal Register* (Vol. 71, No. 127, pgs. 37908 – 37910: 3 July 2006) stating that, based on preassessment findings, they were proceeding with restoration planning under OPA and opening an Administrative Record (AR) to facilitate public involvement in the restoration planning process. The Trustees also placed information about the spill on their Internet sites, including an electronic copy of the AR on the NOAA Web site (http://www.darrp.noaa.gov/northeast/athos/index.html). Through the above-mentioned efforts, the public was able to obtain reports, injury assessment studies, and agency contacts to obtain more information.

---

[3] http://www.darrp.noaa.gov/northeast/athos/pdf/Sharon_Shutler_letter_dated_03.09.05.pdf

[4] http://www.darrp.noaa.gov/northeast/athos/pdf/Timothy_Bergere_letter_dated_05.24.05.pdf

[5] http://www.darrp.noaa.gov/northeast/athos/pdf/Sharon_Shutler_letter_dated_06.21.05.pdf

[6] Technical working groups (TWGs) were formed for each major injury category, e.g., marsh destroyed, birds killed, recreational use denied, and were responsible for the assessment of that particular injury. TWGs were formed from members of each trustee agency that had injured resources of concern, and may have included a representative of the responsible party.

Public review of this draft Plan is also considered an integral component of the restoration planning process. Through the process of public review, the Trustees are seeking public comment on the projects being proposed to restore injured natural resources or replace services provided by those resources.

While preparing the final Restoration Plan, the Trustees will review and consider comments received during the public comment period. An additional opportunity for public review will be provided in the event that the Trustees decide to make significant changes to the draft Plan based on the initial public comments.

Comments received during the public comment period will be considered by the Trustees before finalizing the document. Public review of the draft Damage Assessment and Restoration Plan and Environmental Assessment is consistent with all state and federal laws and regulations that apply to the natural resource damage assessment process, including Section 1006 of OPA, the regulations for Natural Resource Damage Assessment under OPA (15 CFR Part 990), NEPA (42 USC Section 4371, et seq.), and the regulations implementing NEPA (40 CFR Part 1500, et seq.). The deadline for submitting written comment on the draft Plan is 20 February 2009.

Comments on the draft Plan should be sent to:

NOAA Office of General Counsel for Natural Resources
GCNR
1315 East-West Highway, Bldg. 3
Silver Spring, Maryland 20910
(301) 713-1217; Fax (301) 713-1229

Or can be emailed to:

NOS.AthosComments@noaa.gov

2.1.1.4 - Administrative Record

The administrative record contains documents considered and/or prepared by the Trustees as they have planned and implemented the NRDA and addressed restoration and compensation issues and decisions. The administrative record is now available for public review at http://www.darrp.noaa.gov/northeast/athos/admin.html. Although the record is still being updated, it presently contains the information that the Trustees relied upon to make the decisions described in the draft DARP/EA. The administrative record facilitates public participation in the assessment process and will be available for use in future administrative or judicial review of Trustee actions to the extent provided by federal or state law. A list of those documents submitted to the administrative record through December 2008, is included in Appendix 1 of this document. Additional information and documents, including public comments received on the draft DARP/EA, the final DARP/EA, and restoration planning documents, will be included when completed.

Hard copies of the documents within the administrative record may be obtained by contacting the individual listed below. Documents will be made available to disabled readers. Arrangements should be made in advance to review the record or to obtain copies of documents in the record by contacting:

Linda Burlington
NOAA Office of General Counsel for Natural Resources
GCNR
1315 East-West Highway, Bldg. 3
Silver Spring, Maryland 20910
(301) 713-1217; Fax (301) 713-1229
Linda.B.Burlington@noaa.gov

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, this draft Plan also serves as an Environmental Assessment (EA). As such, it includes a summary of the current environmental setting, describes the purpose and need for action, and identifies alternative actions and their potential environmental consequences.

The Trustees will use information contained in this assessment 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).

CHAPTER 3.0 - Affected Environment

This chapter briefly describes the physical, biological, economic, and cultural environment within which restoration actions might occur. The affected environment for restoration follows the Delaware River and the lower reaches of its tributaries, extending from the Tacony-Palmyra Bridge near Philadelphia, Pennsylvania, to the Bombay National Wildlife Refuge, near Dover, Delaware—a total distance of approximately 115 river miles (280 miles of shoreline). This area contains many tidal tributaries, marshes, and shoreline habitats, as well as the river bed itself. The biological environment includes a wide variety of fish, birds, mammals, and other organisms, including the endangered shortnose sturgeon (*Acipenser brevirostrum*) (NOAA 2005; USFWS 2006). The economic and cultural environment includes shipping and port activities, as well as fishing and other recreational uses of the River. Additional detail regarding the affected environment also is presented in Chapter 4 of this draft DARP/EA, as an understanding of the environment affected by a spill is integral to conducting an injury determination and evaluating potential restoration projects.

3.1 - Physical Environment

The Delaware River extends approximately 330 miles from Hancock, New York, to the mouth of the Delaware Bay, and includes 216 tributaries (DRBC 2005). In the vicinity of the spill, the Delaware River separates Pennsylvania and New Jersey in the north and Delaware and New Jersey in the south. The physical environment of the Delaware River and its environs is impacted greatly by human development, including draining and filling of wetlands. Perhaps 50 percent of the natural marshes in the estuary have been lost to development, conversion, or degradation associated with human activities. Losses have been most severe in the urban corridor where perhaps only 5 percent of pre-settlement acreage of the nationally rare freshwater tidal marsh remains. In addition, there are many natural threats to the wetlands ecosystem such as subsidence (including the rise of sea level), droughts, hurricanes, and biotic effects (Tiner and Burke 1995). Although there are some natural areas nearby, the area immediately surrounding the spill is heavily industrialized with commercial enterprises and marinas scattered along the shoreline (USCG 2005b). The industrial shoreline is mostly riprap and seawall (USCG 2005b).

Three reaches located north of the *Athos* spill site are included in the National Wild and Scenic Rivers System, while the Delaware Bay and the tidal portion of the river lie within the Delaware National Estuary Program (DRBC 2005). Most of the creeks off of the Delaware River have vegetated banks and marshes (USCG 2005b). Tributaries to the Delaware River that support sensitive wetlands include: Mantua Creek, Darby Creek, Raccoon Creek, Oldmans Creek, and Big Timber Creek (USCG 2005b). Chester Island, Little Tinicum Island, and Monds Island support shorelines of freshwater marsh. Many of the wetlands in the area are vegetated intertidal areas (RCG/Hagler, Bailly, Inc. and Environmental Consulting Services, Inc. 1990), along with estuarine emergent wetlands, estuarine intertidal flats, and small areas of palustrine shrub-scrub wetlands (Hess et al. 2000). Wetlands in the area are particularly important to bird species, providing breeding grounds, over-wintering areas, and feeding grounds for migratory waterfowl and numerous other birds.

This stretch of the river is tidally influenced. Salinities of the Delaware River and its tidal creeks vary with distance from the Atlantic Ocean, seasonally, and according to precipitation events. Salinity is zero parts per thousand (ppt) near Philadelphia, and increases downstream to approximately 28-30 ppt at the mouth of the estuary (Hess et al. 2000). Salinities of 10 ppt are normally found adjacent to the C&D Canal (Kraft 1988).

The river bottom is composed mostly of mud along with some clay and fine grained sediments; gravel and sand are found closer to the shoreline (Kraft 1988; Hess et al. 2000). The river and estuary are major depositional areas (Kraft 1988), and regular dredging of the main channel occurs for shipping traffic.

A total of approximately 280 miles of shoreline were exposed to oil during the *Athos* spill, which extended from the Tacony-Palmyra Bridge in northern Philadelphia to the Smyrna River in Delaware, north of Dover. Natural areas affected included: Little Tinicum Island, Supawna Meadows National Wildlife Refuge, Fort Delaware State Park (Pea Patch Island), Fort DuPont State Park, and the Augustine and Cedar Swamp Wildlife Areas in Delaware.

3.2 - Biological Environment

This reach of the Delaware River provides year-round habitat for a host of fish, birds, mammals, and other organisms. However, the upper thirty or so miles of the affected area are highly industrialized, so much natural habitat in this area has been converted to other uses. Farther downstream, below Wilmington, Delaware, are more natural areas including wetlands and tributaries.

3.2.1 – Birds

The Delaware River between Philadelphia and Wilmington lies along the migration route of the Atlantic Flyway. Nesting Great Blue Herons (*Ardea herodias*) are found on Monds Island, and it is an important resting area for migrating songbirds in the spring and fall (Stiles 2005). Pea Patch Island, home of Fort Delaware State Park, contains the largest heron rookery north of Florida and is home to breeding herons, egrets, and ibises (DNREC 2005). There are high concentrations of waterfowl in the marsh areas and tributaries of the river adjacent to the spill, including American Black Ducks (*Anas rubripes*), Canada Geese (*Branta canadensis*), and Northern Pintails (*Anas acuta*) (USCG 2005b).

3.2.2 - Fish

The shortnose sturgeon (*Acipenser brevirostrum*) is a federally endangered species known to use the Delaware River as an over-wintering area (USFWS 2006). Juvenile fish species and larvae such as juvenile American shad (*Alosa sapidissima*) may over-winter in the estuary and Atlantic (*Acipenser oxyrhynchus*) and shortnose sturgeon spend their first year in the estuary (Price et al. 1988). Southern areas of the river affected by the spill are spawning grounds for white perch (*Morone americana*) and striped bass (*Morone saxatilis*) (RCG/Hagler, Bailly, Inc. and Environmental Consulting Services, Inc. 1990). Other species in the river include: American eel

(*Anguilla rostrata*), common carp (*Cyprinus carpio*), striped bass, gizzard shad (*Dorsoma cepadianum*), Atlantic menhaden (*Brevoortia tyrannus*), and catfish.

3.2.3 – Plants

The Pennsylvania Bureau of Forestry contracted with the University of Pennsylvania to carry out an assessment of oil damage to tidal marshes of Little Tinicum Island after the *Athos* incident (Rhoads 2004). Species of special concern found on Little Tinicum Island include wild rice (*Zizania aquatica*), water hemp ragweed (*Amaranthus cannabinus*), and Walter's barnyard grass (*Echinochloa walteri*) (PA DCNRa). Marsh fleabane (*Pluchea odorata*) is a rare species found on the island growing at the high tide line (Rhoads 2004). Other rare, threatened, or endangered species known to occur at Little Tinicum Island include: spike-rush (*Eleocharis obtusa* var. *peasii*), dwarf spike-rush (*Eleocharis parvula*), mud-plantain (*Heteranthera multiflora*), long-lobed arrowhead (*Sagittaria calycina* var. *spongiosa*), strap-leaf arrowhead (*Sagittaria subulata*), and Smith's bulrush (*Scirpus smithii*) (Rhoads 2004).

3.3 - Economic and Cultural Environment

The Delaware Estuary's geographical location makes it a major transport corridor and a thriving industrial center. Because of its commercial value and unique and abundant biodiversity, the Delaware Estuary has become a cultural resource of historical significance, and a recreational resource for millions of residents and visitors.

The Delaware Bay and River are home to the nation's sixth largest port and third largest petrochemical port. Approximately 3,000 deep draft vessels arrive each year, and it is the largest receiving port in the U.S. for very large crude carriers (tank ships greater than 125,000 deadweight tons). Nearly 42 million gallons of crude oil are moved daily on the Delaware River. The port system generates approximately $19 billion in annual revenue and is home to five of the nine largest east coast refineries.

The Delaware River and Estuary has been a cultural resource for thousands of years. The Lenape Indians settled the watershed in more than 40 communities and lived there peacefully until European arrival (Weslager and Heite 1988). Dutch, Swedish, English, and Finnish colonists were the first Europeans to settle in the watershed (Sutton et al. 1996) and since then, the area has been an important port for moving goods. The construction of Fort Delaware, now a Delaware state park, began on Pea Patch Island during the War of 1812, but it was not used until the Civil War when it became a federal prison (Weslager and Heite 1988).

Although fish and oyster populations have declined from historical levels, both commercial and recreational fishing are still significant economic and popular activities in the Delaware River. Shad, sturgeon, and oyster fisheries were once big business: the shad fishery brought in $10 million/year (2008 dollars) in 1896; in 1887, 1,400 sailing vessels harvested 22 million pounds of oysters. Around the turn of the century, harvest pressure combined with deteriorating water quality and habitat to depress populations significantly. Today, shad cannot reach historical spawning grounds because hundreds of small unused dams still stand. Since 1991, however, fish ladders have opened approximately 165 river miles for fish migration in the Delaware River

Estuary, and dam removal projects are receiving increasing attention. With improved water quality since the Clean Water Act in the 1970s, commercial shad fishing is viable again in the Delaware, although no estimates of its magnitude were found. In 1996, the economic value of the shad sport fishery in the Delaware was estimated at $3.2 million. All sturgeon harvesting was halted in 1998 because populations were not rebounding. Although oyster populations are a fraction of their historic size in the 19th and early 20th centuries, populations in Upper Delaware Bay remain relatively robust. Therefore, it is likely the oyster population will continue to support commercial harvests.

As a recreational resource, the Delaware River is important to thousands of people who enjoy a variety of water-related activities, including boating, rowing, picnicking, bird watching, and hunting. Rural areas of the watershed support a large hunting contingent, particularly for waterfowl (Sutton et al. 1996).

CHAPTER 4.0 - Injury Determination

This chapter describes the Trustees' efforts to quantify the nature and extent of injuries to natural resources and recreational uses resulting from the *Athos* incident. It begins with an overview of the data collected immediately following the spill as part of the "preassessment," followed by the Trustee determination to proceed with injury assessment and restoration planning. The remainder of this chapter describes the Trustees' damage assessment, with summaries of the injury assessment methods and results. The affected environment, for purposes of this proposed action, includes not only the waterways and shorelines that were oiled, but the larger regional watersheds, habitats, and ecosystem services affected by the spill. Geographically, the affected environment is generally considered the geographic region of the Delaware River and the lower reaches of its tributaries. For purposes of identifying potential compensatory restoration projects, the team focused within this same geographic area; the affected environment is that geographic area depicted in Figure 5. Broadly, the focus within that geographic area is on the physical and biological resources affected by the spill, i.e., the Delaware River, the primary tributaries to the Delaware River within that region, the riparian (streamside) habitats adjacent to those tributaries, and regional habitat areas that support resources affected by the spill. Section 4.3 provides a detailed description of the components of the affected environment considered in assessing injury and evaluated for identifying potential compensatory restoration projects. The information presented in this chapter provides a broad overview of the areas and services affected by the spill and how these guide the affected environment considered for restoration action. In order to achieve the objectives of compensating for interim losses and services pending recovery of injured resources, compensatory restoration projects are identified within this affected environment and are areas not directly impacted by the spill.

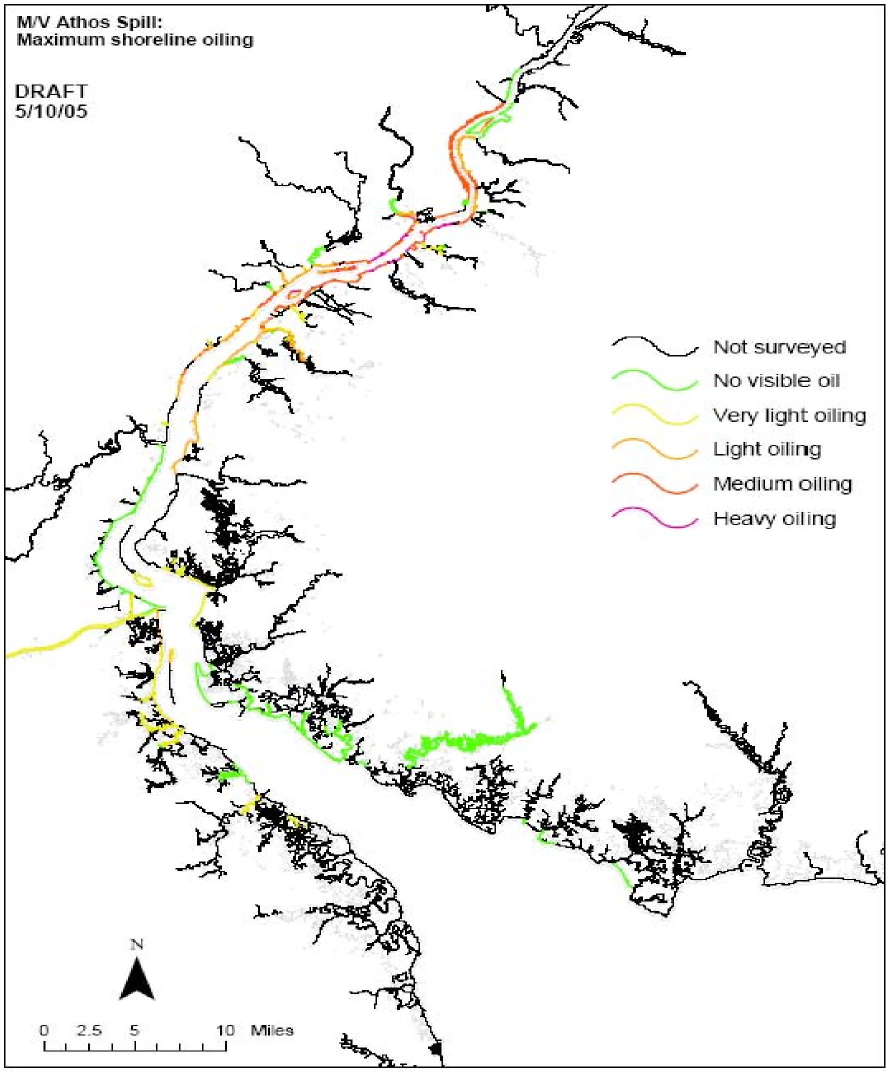


Figure 5. Maximum extent of shoreline oiling in the Delaware River and its tributaries.
Vegetative Assessment of Little Tinicum Island

4.1 - Overview of Preassessment Activities and Findings

The Trustees initiated preassessment activities on 27 November 2004, 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.

Preassessment efforts for the *Athos* incident included characterization of the spilled oil; water, sediment, and biological resource sampling and analyses; and shoreline and aerial surveys. These efforts were conducted cooperatively with the RP. The Trustees' Preassessment Data Report (NOAA 2006; http://www.darrp.noaa.gov/northeast/athos/index.html) details these efforts and findings. This section provides a general overview of the preassessment efforts.

Characteristics of the Spilled Product

Source oil samples taken from the *Athos* were analyzed to identify the composition of the oil and allow for comparison of its chemical "fingerprint" to oil collected in the Delaware River environment. In general, the data and analyses indicated that the *Athos* was carrying a heavy Venezuelan crude oil (Bachaquero), a slightly buoyant, very viscous, and sticky cargo that weathers slowly and has high asphalt content. On a wet weight mass basis, specific polycyclic aromatic hydrocarbons (PAHs) in the source oil represented 0.5 percent of the total oil mass (NOAA 2006). Thus, 99.5 percent of the source oil, on a mass basis, was something other than specific target PAHs, presumably, asphaltenes and other high molecular weight refractory organics. These compounds, which have limited aqueous solubility and, therefore, toxicity, were present as a non-aqueous phase liquid that became dynamically attached to the bottom (see following section describing subsurface oil observations). This inhibits oxygen transfer to the bottom, and benthic aquatic life can smother and die.

While the percentage of specific PAH compounds in the source oil was low, the PAHs in the oil were inherently toxic and capable of harming aquatic life. The estimated potency of the PAH mixture was 41.9 acute toxic units and 213 chronic toxic units. About 33 percent of this toxicity was due to naphthalenes, 37 percent was due to fluorenes and phenanthrenes, 17 percent was due to dibenzothiophenes, and the balance was due to other specific PAHs (R. Greene, personal communication; NOAA 2006).

Subsurface Oil Observations

Sonar, coring, sorbent probes, "snare samplers"[7], and a Vessel-Submerged Oil Recovery System (V-SORS)[8] were used to search for subsurface oil. Pooled stranded oil was found at the collision site in two trenches, with a total volume estimated between 3,390 and 3,610 gallons (NOAA 2006). Subsurface oil suspended off the bottom (and mobile) was detected around Little Tinicum Island and, intermittently, in the middle spill zone area below the island. No, or less than 1 percent, oil was observed on any of the snare samplers in the upper Delaware Bay (NOAA 2006).

Water Column Sampling

In the first 2 weeks following the incident, 66 surface water and 13 bottom water samples were collected to characterize PAH concentrations and assess potential injuries to aquatic resources. The Final Preassessment Data Report (NOAA 2006) presents sample locations and PAH concentrations found in the water column samples. Total PAH in the samples ranged from 25 to 26,634 ng/L (parts per trillion) total PAHs. Only two samples (at Marcus Hook and downstream

---

[7] Snare samplers are crab pots with oil adsorbents attached and consist of an anchor, 50 feet of oleophilic snare on a rope, and a float.

[8] V-SORS consist of a pipe with attached chains and snare material. They are towed behind a vessel on the bottom.

of the mouth of the Schuylkill River) exceeded chronic toxicity thresholds (Neff et al. 2005), both for alkylated chrysenes and alkylated phenanthrene/anthracenes. No volatile organics were detected within the reporting limits (NOAA 2006). The Trustees' final Aquatic Injury Assessment Report (Aquatic TWG 2007) addresses determination of the source of PAHs (background existing PAHs versus those contributed by the *Athos* spill).

Subtidal and Intertidal Sediment Sampling

From 9 December through 17 December 2004, 28 subtidal and 11 intertidal sediment samples were collected throughout the river and analyzed to characterize PAH concentrations and assess the potential injuries to benthic aquatic organisms. Subtidal sediment samples were also collected from three Delaware River Estuary sites included in NOAA's National Status and Trends Program Mussel Watch Project on 2 January 2005 to compare post spill and historical data. Sample locations and PAH concentrations found in the sediment samples are presented in NOAA (2006). Total PAHs in subtidal samples ranged from 209 to 23,985 ng/g dry parts per billion (ppb); intertidal samples ranged from 948 to 44,022 ng/g dry (NOAA 2006). Sourcing of PAHs between background and *Athos* PAHs is considered in the Trustees' final Aquatic Injury Assessment report (Aquatic TWG 2007).

Sediment Toxicity Triad

The Delaware Department of Natural Resources & Environmental Control (DNREC) collected whole sediment samples from the vicinity of Little Tinicum Island, Claymont/Oldmans Point, and Pea Patch Island to assess potential injury to sediment-dwelling organisms. Surficial (0-2 inches) sediment grabs were analyzed with a sediment quality triad approach that included measuring PAHs and total organic carbon concentrations, evaluating the toxicity of whole sediment samples to the amphipod *Leptocheirus plumulosus* in 10-day toxicity tests, and assessing benthic aquatic invertebrate community structure (EA Engineering 2005a, 2005b, 2005c; R. Greene, personal communication). The results of the toxicity tests indicated that the samples collected in the vicinity of Little Tinicum Island were toxic to amphipods on 15 December 2004 and 17 February 2005.

Oyster Tissue Analyses

The Trustees and RP collected oyster samples to determine potential risks to: (1) human health from consumption; (2) oysters based on contaminant body burden; and (3) piscivorous animals that might consume tainted oysters. Sample locations and PAH concentrations found in the oyster tissue samples are presented in NOAA (2006). Oyster tissue PAH ranged from 13.2 to 28.9 ng/g wet weight (ppb), below thresholds of concern for human health and bioaccumulation in piscivorous mammals (Sample et al. 1996).

Fish Tissue Analyses

The Trustees and RP collected perch, catfish, and gizzard shad from the river for tissue analysis (fillet and whole-body) from 9 December through 16 December 2004 and adult striped bass in May and July 2005. Sample locations and PAH concentrations found in the fish tissue samples are presented in NOAA (2006). Samples ranged from 88.9 to 464.3 ng/g wet weight (whole body, catfish); 72.1 to 238.9 ng/g wet weight (fillet, perch, and shad); 205.6 to 1143.6 ng/g wet weight (carcass, perch and shad); 9.7 to 130.6 ng/g wet weight for striped bass fillets; and 11.5 to 291.5 ng/g wet weight for striped bass carcasses. Lipid-normalized concentrations of PAHs were below the threshold for PAH-induced narcosis in fish (DiToro et al. 2000), the benzo[a]pyrene threshold of concern for bioaccumulation in piscivorous mammals (Sample et al. 1996), and the threshold that would trigger a fish advisory when using EPA guidance numbers (cancer health endpoint).

Horseshoe Crabs and Whelk Surveys

Twenty-three dredge tows were made in the upper bay on 18 March 2005 by DNREC to collect and observe horseshoe crabs (*Limulus polyphemus)* and knobbed whelks (*Busycon carica*) (NOAA 2006). A total of 136 horseshoe crabs and 477 knobbed whelks were examined. No oil was observed on these animals.

DNREC and the New Jersey Department of Environmental Protection (NJDEP) also conducted horseshoe crab spawning surveys in May and June 2005. Thirteen beaches in Delaware (130 kilometers of shoreline) and 11 beaches in New Jersey (80 kilometers of shoreline) were surveyed, with no observations of oil on the beaches or the horseshoe crabs.

Monitoring also indicated no oil on the exoskeleton of the approximately 8,700 horseshoe crabs collected from the U.S. Geological Survey tagging surveys conducted in the bay between March and May 2005.

Shoreline Cleanup Assessment Surveys

Shoreline Cleanup Assessment Teams (SCAT) surveyed shorelines within and adjacent to the spill zone on a nearly continuous basis from 29 November 2004 to 13 February 2005 to document the extent and magnitude of oiling (i.e., length and width of oiling, percent of oil coverage, oil character and thickness, and habitat conditions). Approximately 550 miles of shoreline were surveyed with about 280 miles oiled to varying degrees (Figures 6a-e). Table 2 and Figure 5 summarize shoreline oiling information.

a. b.

c. d.

e.

Figure 6. Representative examples of shoreline oiling observation: a. Oiled seawall; b. Oiled sand beach; c. Oiled coarse substrate beach; d. Oiled intertidal mud flat; e. Oiled marsh.

Table 2. Approximate length in miles of shoreline habitat by oiling degree (excluding tributaries). See Shoreline Assessment Team (2007) for definition of oiling categories.

Habitat	Very Light	Light	Moderate	Heavy	Total
Seawalls	13	24	37	4	78
Sand/Mud Substrate	18	11	10	6	45
Coarse Substrate	37	18	9	5	69
Marsh	70	20	4	2	96
Total	138	73	60	17	288[a]

[a] The total length is greater than the total length of oiled shoreline because some segments have two habitat types present.

On 16 December 2005, Dr. Ann Rhoads with the Morris Arboretum of the University of Pennsylvania surveyed the tidal mud flats and lagoons of Little Tinicum Island. Plants on the tidal flats included dormant leaves of spatterdock (*Nuphar advena*), sweetflag (*Acorus calamus*), arrowhead (*Sagittaria rigida*), arrow-arum (*Peltandra virginica*), and dwarf spike-rush (*Eleocharis parvula*). The leaves of many, but not all, of these plants exhibited black deposits of oil. Oil deposits were also observed on vegetation, rocks, debris, and the sand along the high tide line; the intensity of the deposits varied depending on the exposure of each section of shoreline. Those areas most open to the east (upstream direction) were the most severely affected. Thick black oil coated the lower 1 to 3 feet of dead stems of common reed (*Phragmites australis*), purple loosestrife (*Lythrum salicaria*), swamp-mallow (*Hibiscus moschuetos*), and smartweed (*Polygonum sp*.). Stems and exposed roots of woody plants, including shrubs such as arrow-wood (*Viburnum dentatum*), groundsel-tree (*Baccharis halimifolia*), black elderberry (*Sambucus canadensis*), false indigo (*Amorpha fruticosa*), and trees were also coated to a height of about 12 inches at the base. In a few areas near the east (upstream) end of the island, oil had soaked into the sand and gravel surface just below the high tide line forming an asphalt-like crust.

Wildlife Response and Rescue Operations

Immediately following the spill, search teams began patrolling oiled shoreline areas and coordinating observations of dead and oiled wildlife with response/cleanup crews, wildlife ground survey crews, and Tri-State Bird Research and Rescue in Delaware. Wildlife rehabilitation was conducted at the Frink Center for Wildlife in Newark, Delaware, and the John Heinz Wildlife Refuge in Philadelphia. By May 2005, a number of oiled birds were observed (Figure 7); 206 birds were collected dead or died at the rehabilitation center, and 337 birds were rehabilitated and released alive (E. Marek, personal communication) (Table 3). Other dead wildlife recovered included three turtles, one squirrel, one opossum, one red fox, and one woodchuck (E. Marek, personal communication). Search teams also recovered 23 dead fish, oiled to varying degrees, including two bullhead catfish (*Ameiurus nebulosus)*, two striped bass (*Morone saxatilis*), 15 white perch (*Morone americana)*, and one gizzard shad (*Dorosoma cepadianum*) (E. Marek, personal communication).

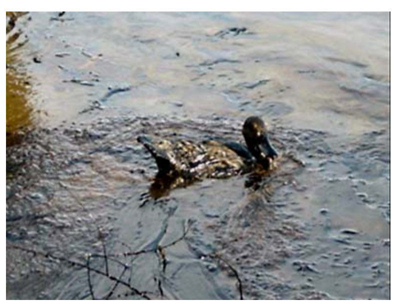


Figure 7. Observed oiled birds.

Table 3. Summary of recovered birds from the rehabilitation center.		
Species	**Rehabilitated/Released**	**Dead**
American black duck	2	1
Blue-winged teal	-	1
Duck *sp*.	-	2
American coot	-	1
Mallard	11	25
Bufflehead	3	1
Canvasback	-	1
Long-tailed duck	-	1
Ruddy duck	-	1
Black scoter	-	1
Double-crested cormorant	-	9
Northern gannet	-	1
Great black-backed gull	-	2
Gull *sp*.	-	22
Herring gull	7	26
Ring-billed gull	25	17
Belted kingfisher	-	3
Canada goose	287	80
Mute swan	-	1
Snow goose	2	6
Great blue heron	-	2
Unidentified	-	2
Total Wild	**337**	**206**
Domestic geese	32	1
Domestic ducks	36	1

Wildlife Ground Surveys

Trustees and the RP conducted more than 3,400 ground surveys between 30 November 2004 and 10 January 2005 to estimate the extent and degree of oiling of non-recovered wildlife (NOAA 2006). Nearly 157,500 birds were counted; about 16,500 (10 percent) had some degree of oiling. About 72 percent of all oiled birds observed had trace or light oiling; 19 percent of oiled birds were moderately oiled; and 9 percent of oiled birds were heavily oiled.

The most common species observed are reported in Table 4. Geese represented nearly half of all observed oiled birds. Canada geese, mallards, and gulls made up 91 percent of observed oiled birds.

Table 4. Most common birds observed oiled during ground surveys.		
Species Name	**Total Oiled Birds Observed**	**Percent of all Oiled Birds**
Canada Goose	8041	49
Great black-backed gull	469	3
Herring gull	915	6
Mallard	447	3
Ring-billed gull	5422	33

Aerial Bird Surveys

Trustees and the RP conducted 11 aerial surveys between 28 November 2004 and 28 December 2004 to assess the species composition and abundance of birds in the spill area (NOAA 2006). The number of birds observed during each of these surveys, along with the general location of the flight, is presented in Table 5. Total observed birds ranged from about 2,600 on 3 December 2004 to nearly 100,000 on 5 December 2004. While these counts do not reflect a standard flight time or area covered, in general, more birds moved into the area in December as it became colder.

Table 5. Aerial bird survey summary. Counts by species are presented in NOAA (2006).			
Date	**Number of Birds Observed**	**Predominant Species Observed**	**Area Surveyed**
28-Nov	3,392	Black ducks, mallards, buffleheads, gulls, Canada geese	Portion of north N.J. shoreline
29-Nov	7,555	Black ducks, gulls, Canada geese	Portion of north N.J. shoreline
30-Nov	5,030	Black ducks, mallards, ruddy ducks, buffleheads, gulls, Canada geese	N.J. and Pa. shorelines
2-Dec	59,123	Black ducks, green-winged teal, mallards, ruddy ducks, buffleheads, gulls, Canada geese, snow geese	Del. and N.J. shorelines
3-Dec	2,577	Mallards, gulls, Canada geese	Pa. shoreline
5-Dec	98,245	Black ducks, gadwall, green-winged teal, mallards, pintails, buffleheads, ruddy ducks, scaup, gulls, gannet, Canada geese, snow geese, swans	N.J., Pa., and Del. shorelines
9-Dec	12,716	Black ducks, green-winged teal, mallards, pintails, ruddy ducks, gulls, Canada geese	Portions of N.J. and Pa. shoreline
13-Dec	17,825	Black ducks, green-winged teal, mallards, pintails, gulls, Canada geese	North N.J. and Pa. shoreline
15-Dec	70,209	Black ducks, green-winged teal, mallards, gulls, Canada geese, swans, snow geese	Del. and south N.J. shorelines
16-Dec	51,096	Black ducks, green-winged teal, mallards, pintails, gulls, Canada geese, greater white-fronted geese	Del. and south N.J. shorelines
21-Dec	19,516	Black ducks, mallards, pintails, canvasback, merganser, gulls, Canada geese	North N.J. and Pa. shorelines

Lost Recreational Use

Following the incident, the states of Delaware and New Jersey closed certain areas to hunting and the USCG closed portions of the Delaware River to boat traffic. State lands in Delaware were closed to hunting as far south as Cedar Swamp Wildlife Area. In New Jersey, most areas within 5 miles of the river—from the Tacony-Palmyra Bridge to the nuclear power facility in Salem, New Jersey—were closed to hunting. The closures were in effect for about 2 weeks.

As part of the preassessment effort, the Trustees and RP collected data to determine the potential for loss of human uses, including hunting, boating, fishing, crabbing, and beach and other shoreline use. Shoreline use was documented during several overflights. Interviews with marina owners were conducted to determine the potential impacts to recreational boating. In general, the level of recreational boating at the time of the incident appeared low, although some boat-based fishing typically continues throughout the year. Sporadic problems with oil were also reported at marinas in the area.

4.2 - Trustee Determination Based on Preassessment Findings

Based on findings summarized in Section 4.1 and detailed in the Trustees' Final Preassessment Data Report (NOAA 2006), the Trustees determined that the following four types of natural resources or services were injured, or were likely to be injured, by the *Athos* incident: (1) shorelines; (2) birds and wildlife; (3) aquatic resources; and (4) recreational use. The Trustees also determined that a number of potential restoration actions exist to compensate for the losses and, consistent with the OPA regulations (15 CFR 990), proceeded with injury assessment and restoration planning efforts.

4.3 - Injury Assessment Strategy

The goal of injury assessment is to determine the nature and extent of injuries to natural resources, thus providing the technical basis for evaluating and scaling restoration actions. OPA defines injury as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service." "Loss of use of natural resources," i.e., diminished quantity and/or quality of recreational use of natural resources, is also a compensable injury under OPA.

The Trustees worked cooperatively with the RP to assess losses in each of the four categories of injury – shorelines, birds and wildlife, aquatic resources, and recreational use. Assessments focused on determining both the magnitude of the injury and the time to full recovery. This analysis was accomplished for birds by multiplying the number of lost animals[9] by the recovery period to generate the units of bird-years. For shoreline, intertidal, and benthic 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 1 year. Recreational 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. All injury estimates in future years were discounted at 3 percent per year (NOAA 1999), summed, and added to the injury in the year of the spill, yielding an estimate of total injury. People have a rate of time preference and prefer to use or consume goods and services in the present rather than postpone their use or consumption to some future time. Discounting is used to make dollars, resource service flows, and other units that occur in different time periods comparable. The discounted values from different time periods are then in a common unit and can be summed. All of these methods produce an estimate of direct plus interim (from the time of injury until full recovery) losses of resources resulting from the oil.

Federal and state scientists and consultants with damage assessment experience conducted the injury assessments. Each assessment was conducted in full cooperation with the RP, with the goal of reaching consensus among all parties. In the end, each assessment concluded with consensus among the Trustee representatives. Where technical disagreement with the RP occurred, the Trustees placed the RP comments, along with Trustee responses, in the Administrative Record (AR), where they are available for public review (see Section 2.1.1.4).

---

[9] The number of birds killed included both the direct (i.e., dead adults) and indirect losses (i.e., lost productivity due to mortality and reproductive failure of fledged young, see Section 4.3.2).

Prior to finalizing the four assessments, the Trustees retained outside experts to peer review the injury reports, the RP comments, and Trustee responses to those comments. Where appropriate, the Trustees modified each report to address peer review comments prior to final approval. Final injury reports and peer review comments were then placed into the AR, where they are available for public review (see Section 2.1.1.4).

The Trustees recognize that there is some uncertainty inherent in the assessment of impacts from oil spills. While in certain instances collecting more information may increase the precision of the Trustees' assessment of the *Athos* impacts, the Trustees believe that the type and scale of restoration actions would not substantially change as a result of further study. Throughout the assessment process, the Trustees sought to balance the desire for more information with the reality that further study would delay the implementation of the restoration projects, at the expense of the local environment and those who use and enjoy the area's natural resources. As part of the planned restoration efforts, the Trustees will conduct a comprehensive monitoring effort to evaluate the effectiveness of the restoration projects.

The following sections of this draft Plan summarize each of the four injury assessments.

4.3.1 - Shoreline Injury Assessment

The shoreline injury assessment focused on (1) determining the geographic extent and degree of oiling by habitat type and (2) quantifying ecological service losses based on the degree of initial injury and rate of recovery of mainstem shoreline, intertidal, subtidal areas, and tributary systems. Shorelines specifically include seawall, sand/mud substrate, coarse substrate, and marsh habitats. Tributaries, which were treated as one system or habitat type, include shorelines, wetlands, intertidal flats, and shallow benthic habitats. SCAT survey data, Trustee follow-up surveys, chemical analyses of the oil and sediment, information on cleanup methods and chronic oil exposure after cleanup, life histories of the associated fauna and flora, and relevant studies from past spills were used to delineate oiled shoreline areas and determine the ecological service losses resulting from this incident.

Geographic Extent and Degree of Oiling

SCAT surveys and supplemental ground and aerial observations indicated that about 280 miles of shoreline (see Section 4.1) and nearly 1,400 acres of intertidal and tidal habitat (Table 6) were exposed to *Athos* oil. The river shoreline consisted of four general habitat types: seawalls, sand/mud substrates, coarse substrates, and marshes. The majority of shoreline habitats exposed to oil were coarse substrate (137 acres) and marshes (116 acres). The intertidal areas, which were delineated off heavily and moderately oiled shorelines, consisted of sand/mud substrate. The degree of shoreline and tidal flat oiling ranged from very light, to light, moderate, and heavy. Intertidal oiling was either light or very light (Table 6).

Table 6. Total estimated shoreline and tributary area (acres) exposed to *Athos* oil.

Habitat	Oiling Level	Shoreline	Lower Intertidal	Tidal Flat	Total by Habitat	Percent of Total Oiling
Seawalls	Very Light	8.66			8.66	0.50
	Light	17.72			17.72	1.02
	Moderate	30.46			30.46	1.76
	Heavy	2.54			2.54	0.15
Subtotals		**59.38**			**59.38**	**3.43**
Sand/Mud Substrate	Very Light	7.39	55.69	677.43	740.51	42.83
	Light	9.98	26.94	279.54	316.46	18.30
	Moderate	9.94		205.48	215.42	12.46
	Heavy	8.24		135.20	143.44	8.30
Subtotals		**35.55**	**82.63**	**1,297.65**	**1,415.83**	**81.89**
Coarse Substrate	Very Light	16.23			16.23	0.94
	Light	66.08			66.08	3.82
	Moderate	36.91			36.91	2.13
	Heavy	18.01			18.01	1.04
Subtotals		**137.23**			**137.23**	**7.94**
Marsh	Very Light	51.83			51.83	3.00
	Light	40.89			40.89	2.36
	Moderate	17.22			17.22	1.00
	Heavy	6.53			6.53	0.38
Subtotals		**116.47**			**116.47**	**6.74**
TOTAL MAINSTEM HABITATS					**1,728.91**	
Tributaries	Very Light	583.25			583.25	30.71
	Light	1,216.08			1,216.08	64.03
	Moderate	99.90			99.90	5.26
TOTAL TRIBUTARY HABITATS					**1,899.23**	

Six tributaries were also exposed to *Athos* oil. SCAT data for these areas, however, were more limited, and degree of oiling was generally less than mainstem shoreline areas. Consequently, oiled tributaries were treated as entire systems (i.e., one habitat type), where open water, isolated wetlands, wetland fringe along the shoreline, and associated tidal flats were assigned an appropriate oiling category based on aerial observations of the extent and thickness of sheens, SCAT surveys, and other ground observations. The six tributary systems exposed to *Athos* oil totaled nearly 1,900 acres, with the degree of oiling ranging from very light to moderate (Table 6).

Table 6 summarizes the estimated shoreline and tributary area exposed to *Athos* oil. More information on the methods to estimate the area of exposure for each habitat type and degree of oiling is provided in the final Shoreline Injury Assessment (Shoreline Assessment Team 2007).

Quantification of Losses

Mainstem shoreline, intertidal, subtidal, and tributary injuries were quantified as service acre-years, where a service acre-year is the flow of benefits that 1 acre provides over the period of 1 year. For each habitat type, a Habitat Equivalency Analysis (HEA) model was developed to calculate the loss of ecological services, expressed in discounted service-acre years (DSAYs). HEA is a resource-to-resource scaling method to determine compensation for lost services based on the quantification of incident-related natural resources injuries. The following summarizes the injury quantification for each oiled habitat type, including the Trustees' determination of the initial impact and rate of recovery.

Seawalls

Approximately 59 acres of seawalls were oiled and/or affected by cleanup operations, with the majority observed as moderately oiled (30 acres) (Table 6). Oil attached to the dry, rough surface of the seawalls in a band above the high tide line. Shoreline cleanup consisted of high-pressure, hot-water flushing of the oil.

Table 7 presents the recovery over time and the number of DSAYs lost for each seawall oiling category. Initial losses of very lightly and lightly oiled seawalls were estimated to be at 5 and 15 percent of baseline, respectively. Few of these areas were subject to cleanup efforts, and the majority of the oil was removed by natural weathering processes within the first year. Very light and light oiling could have removed some habitats as suitable settling locations for invertebrates, however the majority of the seawalls functioned normally.

Seawalls that were moderately or heavily oiled experienced a much higher loss of primary production as well as a loss of invertebrates that depend on the algae for food. Initial loss of services due to moderately and heavily oiled seawalls was estimated to be 100 percent through the first 6 months after the spill because of the initial oiling and the effects of high-pressure, hot-water flushing cleanup operations. One year following the spill, the loss of services was estimated to be at 15 percent, reflecting the rapid recruitment of short-lived species. Because both moderately and heavily oiled seawalls were mostly treated with high-pressure, hot-water flushing in the spring of 2005, they have the same loss of services and recovery rates. Services provided by moderately and heavily oiled seawalls were estimated to have recovered by 2 years following the spill.

Based on the HEA parameters described above, total injury to the 59 acres of oiled seawalls was calculated as 30.3 DSAYs (Table 7). A full description of the assessment of seawall losses is provided in the final Shoreline Injury Assessment (Shoreline Assessment Team 2007).

Table 7. Estimated recovery rate and number of DSAYs lost for oiled seawalls.					
Oiling Degree	**Acres**	**Services Present Post Spill**			**DSAYs**
		0.5 yr	**1 yr**	**2 yrs**	
Very Light	8.66	0.95	1		0.32
Light	17.72	0.85	1		1.97
Moderate	30.46	0	0.85	1	25.87
Heavy	2.54	0	0.85	1	2.16
Total	**59.38**				**30.32**

Sand/Mud Substrates

Approximately 1,416 acres of sand/mud substrates—including shoreline, intertidal, and tidal flats—were exposed to oil, of which 677 acres, or 48 percent, were very lightly oiled tidal flats (Table 6). On seawalls and other hard substrates, the effluent from flushing exposed the entire intertidal zone to oil. On beaches, the viscous oil coated the sediments, particularly gravel, and penetrated sandy sediments where it accumulated. Small tar balls that readily spread into sheens continued to be released from heavily oiled beaches throughout 2005. As late as September 2005, oil droplets and larger deposits of oil were observed in the sandy and muddy intertidal sediments at multiple locations along heavily oiled shorelines in Pennsylvania. This chronic release was a significant source of fouling to intertidal communities.

Table 8 presents the recovery over time, and the number of DSAYs lost for each sand/mud substrate oiling category. The loss of services for very lightly and lightly oiled areas was estimated to be 50 percent of baseline for the first 6 months after the spill. This category is dominated by tidal flats fronting heavily and moderately oiled shorelines that were constantly exposed to oil slicks, droplets, and sheens released from the shoreline. One year following the spill, the loss of services was estimated to be at 25 percent of baseline, based on the observations of oil droplets and sheens on all such tidal flats visited in September 2005, and the relatively short life history of most species associated with these habitats in the lower river. By the third year following the spill, services were expected to have recovered, assuming that the stranded oil would have weathered enough to prevent significant releases after year two, which would allow affected resources to recover by year three.[10]

Moderately and heavily oiled sand/mud substrates were estimated to have 100 percent loss of services 6 months after the spill. Based on best professional judgment, the stranded oil would have directly smothered and killed intertidal organisms, and the intensity of cleanup required to remove the viscous, persistent oil would have affected any remaining organisms and restricted use until termination of cleanup activities. Similar to the lighter oil categories, these two categories were estimated to recover within 3 years; however, the rate of return of services to baseline was estimated to be slower, leading to higher overall interim losses.

[10] A full site visit has not been undertaken since 2005.

Based on the HEA parameters described above, total injury to the 1,416 acres of sand/mud substrates was calculated as approximately 1,117 DSAYs (Table 8). A full description of the assessment of sand/mud substrates losses is provided in the final Shoreline Injury Assessment (Shoreline Assessment Team 2007).

Table 8. Estimated recovery rate and number of DSAYs lost for oiled sand/mud substrates.

Oiling Degree	Acres	Services Present Post Spill				DSAYs
		0.5 yr	1 yr	2 yr	3 yr	
Very light	740.51	0.5	0.75	0.95	1	443.02
Light	316.46	0.5	0.75	0.9	1	204.24
Moderate	215.42	0	0.5	0.8	1	278.06
Heavy 143.	44	0	0.5	0.75	1	191.91
Total	**1,415.83**					**1,117.24**

Coarse Substrate

Approximately 137 acres of coarse substrate were exposed to oil, with the majority being lightly oiled (66 acres) (Table 6). This habitat was dominated by riprap, where cleanup was difficult and often involved intensive high-pressure, hot-water flushing. In September 2005, tarry oil layers and oil droplets in the underlying sediments were observed in all heavily oiled riprap areas visited.

Table 9 presents the recovery over time, and the number of DSAYs lost for each coarse substrate oiling category. Very lightly oiled areas were estimated to have a 25 percent loss of services 6 months after the spill, a 15 percent loss after 1 year, a 5 percent loss after 2 years, and complete recovery 3 years following the spill. For lightly oiled coarse substrates, the injury was estimated at a loss of 50 percent of services 6 months after the spill, a 25 percent loss after 1 year, a 10 percent loss after 2 years, and full recovery after 3 years. These recovery estimates were based on direct smothering effects of the oil and the short life history of fauna associated with these mostly man-made habitats.

Heavy and moderately oiled coarse substrates were estimated to have 100 percent loss of services until 6 months after the spill. All fauna was predicted to be smothered in oil and likely experience high mortality from both the oil and subsequent high-pressure, hot-water flushing during cleanup. The habitat would not be available for shorebirds until termination of cleanup activities. Lost services were estimated to be at 50 percent of baseline at 1 year following the spill, reflecting both the recovery of some services after the initial impacts and on-going impacts resulting from persistent oil on the riprap blocks and chronic exposures to oil released during 2005. Lost services were estimated to be 25 percent at 2 years and 10 percent by the third year. Moderately oiled coarse substrate shorelines were estimated to fully recover after 4 years. Heavily oiled coarse substrate would likely have minor injuries extending out to 5 years after the spill.

Based on the HEA parameters described above, total injury to the 137 acres of oiled coarse substrates was calculated as approximately 127 DSAYs (Table 9). A full description of the assessment of coarse substrate losses is provided in the final Shoreline Injury Assessment (Shoreline Assessment Team 2007).

Table 9. Estimated recovery rate and number of DSAYs lost for oiled coarse substrates.

Oiling Degree	Acres	Services Present Post Spill						DSAYs
		0.5 yr	1 yr	2 yr	3 yr	4yr	5yr	
Very light	16.23	0.75	0.85	0.95	1			5.53
Light	66.08	0.5	0.75	0.9	1			42.65
Moderate	36.91	0	0.5	0.75	0.9	1		52.76
Heavy	18.01	0	0.5	0.75	0.9	0.99	1	25.90
Total	**137.23**							**126.84**

Marsh

Approximately 116 acres of marsh were exposed to oil, with about 93 acres, or 80 percent, very lightly or lightly oiled (Table 6). Oil that stranded in the marshes mostly coated the intertidal vegetation and debris and, along moderately and heavily oiled shorelines, stranded and persisted on the sediments. In September 2005, the Trustees observed oil released from marsh soils when disturbed, indicating on-going oil exposure to both epifauna and infauna in these habitats (Shoreline Assessment Team 2007).

Table 10 presents the recovery rate over time and the number of DSAYs lost for each marsh oiling category. Very lightly oiled marsh was estimated to have lost 25 percent of services 6 months after the spill occurred, as a result of the oil coating vegetation. After 1 year, services would have recovered to 95 percent of pre-spill conditions, reflecting the return of most associated fauna. Full recovery was expected within 2 years after the spill. Lightly oiled marshes followed a similar pattern but had an estimated 50 percent of services lost and 25 percent lost 1 year after the spill.

For moderately and heavily oiled marshes, service losses were estimated to be 100 percent for the first 6 months, until new vegetation emerged to replace oiled vegetation. Oil would have smothered most organisms within the oil band and wildlife would not have been able to use the area for feeding. Moderately oiled marshes were estimated to lose 25 percent of services 1 year after the spill, 5 percent loss of services after 2 years, and recover after 3 years. Heavily oiled marshes were estimated to have a 50 percent loss of services 1 year after the spill, 25 percent loss of services after 2 years, 10 percent loss of services after 3 years, and recover after 4 years.

Based on the HEA parameters described above, total injury to the 116 acres of oiled marsh was calculated as approximately 60 DSAYs. A full description of the assessment of marsh losses is provided in the final Shoreline Injury Assessment Report (Shoreline Assessment Team 2007).

Table 10. Estimated recovery rate and number of DSAYs lost for oiled marsh.							
Oiling Degree	**Acres**	**Services Present Post Spill**					**DSAYs**
		0.5 yr	**1 yr**	**2 yrs**	**3 yrs**	**4yrs**	
Very light	51.83	0.75	0.95	1			11.47
Light	40.89	0.5	0.75	1			22.54
Moderate	17.22	0	0.75	0.95	1		16.68
Heavy	6.53	0	0.5	0.75	0.9	1	9.33
Total	**116.47**						**60.02**

Tributaries

Six tributaries in New Jersey—totaling approximately 1,899 acres of shorelines, wetlands, intertidal flats, and shallow benthic habitats—were exposed to *Athos* oil (Table 6). The majority of tributaries were lightly oiled (1,216 acres), described as extensive dull to rainbow sheens on the water. Oil slicks that stranded on the intertidal areas coated the habitat and any organisms using the shoreline. Oil sheens and slicks on the water surface impacted water quality and reduced the use of these habitats by wildlife such as birds and aquatic mammals. The shallow benthic habitats commonly used by fish and crabs for feeding, protection from predators, and spawning were also affected by floating oil, naturally dispersed oil, and submerged oil. Because some of the oil became submerged, oil may have contaminated the benthic resources at the mouths of these tributaries by attaching to particulate matter in the water column, becoming heavier and sinking in these low-energy habitats. In that situation, both smothering effects and chronic toxicity effects from PAHs could impact sediment biota.

Table 11 presents the recovery rate over time, and the number of DSAYs lost for each tributary oiling category. The initial service losses in the tributaries extended for the first 3 months following the spill, when floating oil was present. The floating oil had fouling and coating impacts to the shoreline, water surface, and upper water column resources. The tributaries have low dilution and flushing rates, thus oil in these systems affects a significant percentage of the resources present. Moderately oiled tributaries were estimated to have a service loss of 65 percent. These areas had black oil slicks on the surface and moderate shoreline oiling that could be a source of chronic releases of oil. Lightly oiled tributaries were estimated to have a service loss of 50 percent due to the light and very light shoreline oiling and the presence of extensive oil sheen. Very lightly oiled tributaries were estimated to have a service loss of 25 percent because of the presence of oil sheen on the water surface.

While the sediment samples in the tributaries were limited, the results of the preassessment (NOAA 2006) and September 2005 sediment analyses (Aquatic TWG 2007) are generally consistent with a finding of moderate impacts in the tributaries immediately following the spill, and recovery within 1 year. Additionally, no oil was observed along the shorelines or released from subtidal sediments during the 2005 site visits. Therefore, all oiled tributaries were assumed to have completely recovered within 1 year.

Based on the HEA parameters described above, total injury to the 1,899 acres of tributaries oiled as a result of the spill was calculated as approximately 524 DSAYs. A full description of the assessment of tributary losses is provided in the Final Shoreline Injury Assessment (Shoreline Assessment Team 2007).

Table 11. Estimated recovery rate and number of DSAYs lost for oiled tributaries.

Oiling Degree	Acres	Services Present Post Spill		DSAYS
		0.25 yr	1 yr	
Very light	583.25	0.75	1	108.16
Light	1,216.08	0.5	1	375.29
Moderate	99.9	0.35	1	40.08
Heavy	0			
Total	**1,899.23**			**523.53**

In summary, the resource injuries to shoreline, which included seawalls, sand/mud substrate, coarse substrate, marshes, and tributaries, totaled approximately 3,628 acres. Approximately 1,858 DSAYs were lost due to the spill.

4.3.2 - Bird and Wildlife Injury Assessment

The preassessment survey data indicate that a wide variety of birds was oiled by the *Athos* spill, and many died as a result of this exposure (see Section 4.1). Table 3 provides the list of the 206 birds that were collected dead, died at the rehabilitation center, or were not returned to the wild, as well as the 337 birds that were rehabilitated and released alive.

Because the number of birds recovered typically represents a fraction of the total loss, the Trustees and RP conducted an assessment to estimate the total number of birds that died and the loss of future production (Bird and Wildlife TWG 2007). This risk-based assessment used data from ground and aerial surveys to determine the full extent of bird and wildlife losses resulting from the *Athos* incident.

Ground surveys were conducted between 30 November 2004 and 21 January 2005. Nearly 157,500 birds were observed during the ground surveys, with about 16,500 (10 percent) having some degree of oiling. About 72 percent of all oiled birds observed had trace or light oiling; 19 percent of oiled birds were moderately oiled; and 9 percent of oiled birds were heavily oiled. Geese, dabbling ducks, and gulls made up nearly 98 percent of oiled birds observed, and 96 percent of all birds observed.

Eleven aerial surveys were conducted between 28 November 2004 and 21 December 2004 to assess the species composition and abundance of birds in the spill area (Table 5). The spill occurred during late autumn, when birds were immigrating, emigrating, and/or remaining to winter in the impact area. While this turnover of individuals is difficult to quantify precisely, more birds were present in the area later in December as it became colder.

In general, the total number of non-recovered birds present in the area was estimated from detectability-adjusted aerial survey data for each of nine guilds or species in three time periods. The number of birds in different oiling categories for each of these same guilds and time periods was estimated from ground survey data. This oiling information, with mortality rates derived from the literature and expert opinion, was then used to estimate the number of non-recovered birds that were oiled and died in the field, or that survived with potentially sublethal impacts. These estimates, combined with data on recovered birds from the wildlife rescue effort, were used to determine the total number of birds impacted.

Indirect injury in terms of production forgone due to the loss of future generations was included in the estimation of total injury. For the three guilds with the largest injury, lost production models were developed based on the characteristics of a representative species. These three guilds—dabbling ducks, swans/geese, and gulls—represented 94 percent of the direct mortality. The indirect injury was composed of two parts: (1) the discounted loss of production from dead individuals, projected 7 or 9 years from the time of the spill based on one-third of life expectancy; and (2) the discounted loss of production due to individuals that were oiled and survived, but failed to breed in the subsequent spring, calculated for one additional generation. Demographic and reproductive statistics for model species from each guild were used to estimate this loss with simple age-structured population models. Lost production in the remaining guilds was calculated based on the model for the most appropriate representative species.

A full description of the assessment of bird losses is presented in the final Bird and Wildlife Injury Report (Bird and Wildlife TWG 2007). Table 12 summarizes total estimated injury to birds, in individuals, from the spill by species guild. Direct injuries totaled 3,308 adult birds, the majority (75 percent) of which were gulls and geese. Additional estimated lost production from mortality and reproductive failure was 8,561 fledged young.

Table 12. Total (direct and indirect) estimated bird injury from the *Athos* spill by guild.				
Guild	**Direct Injury (Dead Adults)**	**Discounted Indirect Injury (Fledged Young)**		**TOTAL (Adults and Fledged Young)**
		Lost Productivity (Mortality)	**Lost Productivity (Reproductive Failure)**	
Dabbling ducks	605	1,187	577	2,369
Diving ducks	82	163	24	269
Diving birds	64	92	2	158
Gulls	1,072	1,543	331	2,946
Shorebirds	55	79	0	134
Wading birds	10	14	3	27
Swans/geese	1,416	3,369	1,171	5,956
Kingfishers	4	6	0	10
Total	**3,308**	**6,453**	**2,108**	**11,869**

The Trustees also considered potential injuries to other wildlife. Separate assessments of potential injuries to muskrats, otters, and bald eagles concluded that there was no recorded mortality and little or no overall impacts (Bird and Wildlife TWG 2007). In addition, the Trustees concluded that there was no sufficient evidence of potential injuries to any other non-fish vertebrate wildlife species in the Delaware River spill area.

4.3.3 - Aquatic Injury Assessment

Preassessment data and findings (see Section 4.1) indicated that the oil from the *Athos* was a heavily biodegraded crude oil that had the potential to adhere to sediments and lose buoyancy (NOAA 2006). The characteristics of the spilled oil and its behavior in the environment suggest potential pathways of injury to aquatic organisms associated with the (1) physical smothering and fouling effects from oil, and (2) toxicity (including impacts on survival, reproduction, and growth) due to various constituents of the oil. Preassessment data did not, however, provide evidence of significant fish kills or significant water column losses.

The assessment of benthic losses was developed from intertidal and subtidal sediment samples, and information from V-SORS and use of snares. Of the 28 subtidal sediment samples collected during the preassessment[11], the highest total PAH concentration observed was 12.9 mg/kg dry weight (DW) in Woodbury Creek. Subtidal sediment samples collected near Little Tinicum Island (west and south of the island) had total PAH concentrations between 0.3 and 5.9 mg/kg

[11] Four subtidal samples were collected near Little Tinicum Island, 10 at Marcus Hook and points south, five above the Tacony-Palmyra Bridge, and nine in tributaries.

DW. Eleven intertidal sediment samples[12] were collected. Intertidal samples collected at Little Tinicum (on the eastern edge of the island) had total PAH concentrations between 15.0 and 24.4 mg/kg DW (NOAA 2006).

Subtidal sediment samples were also collected for the sediment quality triad study at Little Tinicum Island, Claymont, and Pea Patch Island approximately 1 and 3 months after the incident (NOAA 2006). The sediment samples collected in the vicinity of Little Tinicum Island on both dates presented both sheening and odor and were toxic to amphipods (as indicated by control-adjusted survivals of amphipods of 39 and 62 percent, respectively), while samples collected at the locations more distant from the spill origin did not exhibit toxicity that was significantly different from control samples. Chemical analysis on the two sediment samples from Little Tinicum Island indicated total PAH levels of 14.0 mg/kg DW and 6.8 mg/kg DW at 1 and 3 months after the incident. Based on PAH toxicity, neither sample was predicted to be acutely toxic, while the earlier sample was predicted to exhibit chronic toxicity to benthic biota. The sediment toxicity test does not specify the cause of mortality, which could arise from physical impacts, toxicity due to PAHs, unresolved complex mixture (UCM), other components of the spilled oil, and/or some other cause.

Additional subtidal sediment sampling was conducted in September 2005 to evaluate the potential extent of oiling 10 months after the release, and to evaluate the potential for longer-term ecological injuries (Aquatic TWG 2007). In total, 162 sediment samples (random stratified sampling plan) were collected between upstream of the Schuylkill River and downstream of the Delaware Memorial Bridge, covering approximately 20,000 acres (30 square miles). Screening PAH concentrations were determined for all samples using an ultraviolet fluorescence method, and, for 20 of the sediment samples, complete laboratory PAH and total organic carbon analyses were conducted. The results from the laboratory were used to estimate total PAH concentrations (i.e., based on the levels of the 13 parent PAHs) from the screening PAH concentrations for the remaining dataset. These levels were compared to estimates of the chemistry-toxicity relationship identified from prior sets of matched sediment chemistry and toxicity data.

The Trustees used a multi-step process to apply the HEA methodology to aquatic resource injury quantification for this spill. First, the spatial extent of injury was estimated, based on the simplifying assumption that subtidal impacts were most likely to occur in areas adjacent to heavy shoreline oiling, which is consistent with available V-SORS and sediment toxicity data. This approach resulted in a total injury area of 412 acres. Next, based on background contamination and toxicity data from prior studies, the Trustees identified a baseline service loss of 10 percent. Recovery rate and service losses for the affected area were then estimated for different periods following the spill based on toxicity tests, PAH levels, and benthic community information. Based on this approach, the Trustees believe that baseline conditions (i.e., no spill-associated service losses) were reached in 14 months, with a substantial impact on productivity in the months immediately following the spill. A HEA model was then developed using relevant inputs from the above analyses to estimate aquatic resource losses using a discounted service acre-years (DSAY) metric. Table 13 presents the HEA parameters and the total discounted injury to

[12] Eleven intertidal samples were collected from Crosswicks Creek, New Jersey, at the Tacony-Palmyra Bridge, in Raccoon Creek, New Jersey, and on Little Tinicum Island, Pennsylvania.

subtidal resources (97 DSAYs). A full description of the HEA model and injury assessment approach is provided in the Final Aquatic Injury Assessment (Aquatic TWG 2007).

Table 13. HEA parameters for estimated subtidal injury.

Injury Parameter	Value	Source/Notes
Injury area: acres with substantial subtidal oiling	412	Subtidal zones adjacent to heavily oiled shoreline (to 18' depth contour)
Background service loss	9.9%	Hartwell et al. 2001, mid-river region
Duration of injury	14 Months	
Recovery curve shape	Linear	Non-continuous at Month 3
Discount rate	3%	Standard rate used in NRDA analyses
Service loss anchor points		(*Athos*-related injury)
Month 1 (Day 19)	51%	Triad sample at Little Tinicum Island
Month 3 (Day 83)	28%	Triad sample at Little Tinicum Island
Month 10 (Day 295)	10%	September 2005 sediment sampling results
Results	Total DSAYs of Injury (subtidal) = 97 DSAYs	

During discussion of the available PAH chemistry data, the RP provided the Trustees with forensic petrochemistry analysis. The RP claimed that, based on PAH distributions, samples collected 10 months after the spill had less than 10 percent *Athos* oil in them (although one sample is estimated to have 15-20 percent *Athos* oil contributing to its PAH profile). After considering this information, the Trustees did not undertake additional fingerprinting analyses because: 1) available information suggests that multiple pathways contributed to estimated injuries, including physical effects as well as toxicity from PAHs, UCM, and/or other components of the oil; 2) estimated spill-related injuries are low 10 months after the spill (i.e., 10 percent), consistent with a modest contribution from *Athos* oil as suggested by RP fingerprinting analysis; and 3) few (four) subtidal samples were collected in earlier post-spill periods from the heavily oiled geographic areas that are the focus of this injury analysis. In the Trustees' judgment, further analysis on this or other topics is not warranted given the relatively modest injury quantification estimated in this analysis and the limited likelihood that additional time, effort, and expense will substantially improve the precision of associated estimates.

4.3.4 - Lost Recreational Use Injury Assessment

The Trustees and RP conducted an assessment of lost recreational uses resulting from the *Athos* incident (*Athos*/Delaware River Lost Use TWG 2007), determining that detailed evaluation of recreational fishing (shore and boat) and crabbing, waterfowl hunting, and pleasure boating was warranted. The assessment of these losses employed techniques common in the economic analysis of recreation. Surveys of recreational users were the primary source of information. Hunters were reached by telephone based on a list of people who purchased a hunting license.

Boaters, anglers, and crabbers were contacted in onsite surveys because no license is required for these activities (a fishing license is not required on saltwater portions of the river). In all of the surveys, respondents were asked to estimate the number of trips they took to the river during the season following the spill, and whether the spill affected their hunting, fishing, crabbing, or boating activities.

Affected trips were estimated in three categories. The term "lost" trips refers to a decline in trips to the river due to the spill. "Substitute" trips were those where there was a change in the location of trips to the river. "Degraded" trips refer to a decline in the quality of recreation trips.

Affected trips reported by survey respondents were extrapolated to account for the total number of trips potentially affected by the spill. For recreational fishing and crabbing, information on the total number of trips was estimated based on comprehensive surveys conducted for management purposes. The extrapolation included adjustments to correct for a potential problem in onsite surveys, namely, that people who lost trips due to the spill are less likely to be contacted. The survey could not account for those individuals who may have stopped using the river entirely, leading to a potential underestimate of affected trips.

For hunting, extrapolation to total trips used surveys conducted annually by the USFWS. For boating, extrapolation relied on estimates of total use derived from the number of boats moored at area marinas. The typical rate of boating use for moored boats was multiplied by the number of pleasure boats moored in the spill impact area.

The net benefit of a recreational activity refers to the public's willingness to pay to participate in the activity net of any actual monetary expenses. This type of "surplus value" (also known as "consumer surplus") is a measure of compensable losses under the NRDA regulations. For the *Athos* spill, the lost value associated with affected trips was estimated using benefit transfer methods. Benefit transfer involves the selection of appropriate per-trip values from previous studies of recreation in the economics literature. A report for the U.S. Department of Agriculture (Rosenberger and Loomis 2001) analyzes numerous such studies and presents values for a variety of recreational activities in specific regions of the United States. Values for the northeast region were available for recreational fishing[13] and waterfowl hunting[14] and were applied to the estimates of affected trips. Crabbing values were not available but were assumed to be the same as values for recreational fishing, an assumption that has minimal impact on damage estimates because the estimated number of affected crabbing trips was small. A nationwide value for motor boating was used in the assessment of pleasure boating.[15] While original data collection and site-

[13] Values for recreational fishing and crabbing were determined at $42.60/lost or substitute trips and $8.52/diminished trips in October 2008 dollars.

[14] Values for waterfowl hunting were determined at $43.88/lost or substitute trips and $8.78/diminished trips in October 2008 dollars.

[15] Values for pleasure boating were determined at $47.51/lost or substitute trips and $9.50/diminished trips in October 2008 dollars.

specific studies of recreational value are preferred, it was determined in this case that losses were not significant enough to warrant the expense of an original valuation study.

A summary of affected trips and lost value is presented in Table 14. Affected trips include lost, substituted, and degraded trips. Lost value is calculated by multiplying affected trips by the benefit transfer values noted above (*Athos*/Delaware River Lost Use TWG 2007). The number of recreational fishing/crabbing trips affected by the spill was estimated to be 20,652 leading to a loss in value of $688,067. The number of waterfowl hunting trips affected was 15,559 leading to a loss of $406,325. The number of pleasure boating trips affected was 5,498 causing a loss of $95,530. The estimate of the total number of affected trips was 41,709, and the estimate of total recreational use losses was $1,313,239. A discount factor has also been applied to account for the time between when damages occurred and when compensation is expected.[16]

Table 14. Summary of recreational use losses (October, 2008 dollars).

Measure of Loss	Recreational Fishing/Crabbing	Waterfowl Hunting	Pleasure Boating	Total
Affected trips	20,652	15,559	5,498	41,709
Raw lost value	$688,067	$406,325	$95,530	$1,189,922
Discount factor	1.104	1.104	1.104	1.104
Lost value	$759,374	$448,434	$105,430	$1,313,239[a]

[a] Numbers may not equal totals due to rounding.

The results in Table 14 are derived for the purpose of recovering funds in the amount of the total lost value. The funds will be used to implement projects that enhance recreational opportunities on the Delaware River, thus compensating lost value with future recreation benefits. This approach to damage assessment and restoration is known as "value to cost," because restoration projects are selected as preferred so that the cost of projects equals the value of losses. This approach is less preferred than the "value to value" approach, whereby the value of restoration projects is determined and projects are selected as preferred so that restored value is equivalent to lost value. Valuing restoration projects is more difficult than valuing recreational losses due to the limited availability of previous research on the topic, and it was determined that the expense of a restoration valuation exercise was not warranted in this case. The Trustees believe that the monetary valuation obtained in the recreational use assessment will provide sufficient guidance in determining the appropriate compensatory restoration.

[16] The discount factor of 1.104 was used for this analysis to account for the passage of time between the losses from the spill and the date compensation is received. The assumed date for compensation is 1 November 2008, and the midpoint of 2005 is used as the date for recreational losses.

4.4 - Summary of Injuries

A summary of the injury assessment results, as described in the preceding sections, is provided in Table 15.

Table 15. Summary of injury estimates.

Injury		Estimate	
Resource Injury Category	Resource	Acres or Trips	DSAYs[a] or Value
Shoreline	Seawalls	59.38	30.32
Sand/m	ud substrate	1,415.83	1,117.24
Coarse	substrate	137.23	126.84
	Marsh	116.47	60.2
	Tributaries	1,899.23	523.53
Aquatic	Subtidal benthic habitat	412	97
Bird and Wildlife	Dabbling ducks, diving ducks, diving birds, gulls, shorebirds, wading birds, swans/geese, kingfishers	20,027.5 kg of birds lost	
Recreation	Lost and diminished value trips	41,709 trips	$1,313,239

[a]DSAYs for shoreline and aquatic injuries are not equivalent across resource categories.

CHAPTER 5.0 - Restoration Planning Process and Analysis of Alternatives

The goal of restoration planning under OPA is to identify actions appropriate to restore, replace, or acquire natural resources or services equivalent to those injured by oil spills to the condition that they would have been if the incident had not occurred. This goal is achieved through the restoration, rehabilitation, replacement, or acquisition of equivalent natural resources and/or services (33 U.S.C. §2706(b)). The development and consideration of alternatives also is appropriate to fulfill the intent of NEPA. NEPA requires consideration of a No Action alternative as well as identification of appropriate alternative approaches that would fulfill the purpose and need for the action.

The restoration planning process may involve two components: primary restoration and compensatory restoration. Primary restoration actions are designed to assist or accelerate the return of a resource, including its services, to pre-injury or baseline conditions. In contrast, compensatory restoration actions serve to compensate for the interim loss of resource services due to injury, pending the return of the resource to baseline conditions or service levels. The scale of a compensatory restoration project depends on the nature, extent, severity, and duration of the resource injury. Primary restoration actions that speed resource recovery reduce interim losses, as well as the amount of restoration required to compensate for those losses.

In this instance, response actions undertaken following the discharge are expected to protect natural resources from further or future harm and to allow resources to return to pre-injury or baseline conditions within a reasonable period of time. Under these circumstances, it is unnecessary for the Trustees to consider or plan for primary restoration actions. Accordingly, this draft DARP/EA focuses only on defining appropriate compensatory restoration actions.

5.1 - Restoration Strategy

In accordance with the NRDA regulations, the Trustees identified and evaluated a wide range of project alternatives capable of restoring ecological services comparable to those lost due to injury to shoreline, aquatic, birds and wildlife, and recreational resources at or in the vicinity of the discharge. These alternatives were identified by first searching for potential projects within the watershed, including a public request for project proposals solicited via a letter to non-governmental organizations, and local and state stakeholders. The project alternatives were subject to screening to narrow to a field of reasonable project alternatives considered in this Draft Restoration Plan. The "No Action" alternative was also included for consideration, as required by NEPA and the OPA NRDA regulations. These reasonable alternatives were then evaluated more carefully by the Trustees based on the criteria outlined in Section 5.2. These criteria include consideration of whether sufficient information is available to assess the environmental consequences of the proposed action and support a comparison of alternatives in accordance with the requirements of NEPA. Sections 5.4 and 5.5 of this draft DARP/EA outlines each alternative, the results of the Trustees' evaluation of proposed projects, and the environmental consequences of the restoration actions considered for implementation. Specifically, Section 5.6 summarizes the Trustees' current preferred alternatives for compensatory restoration.

When developing and screening alternatives, Trustees identified their preferred strategy for effecting restoration to compensate for natural resource and service losses under this plan. 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.

Among the proposed restoration proposals are a variety of habitat restoration projects intended to compensate for bird losses caused by the spill. The majority of bird losses were to migratory species. For that reason, bird scaling calculations are based on the incremental forage expected to be provided by these near spill-area projects and their corresponding ability to support the numbers and types of birds needed to compensate for quantified bird losses (accounting for trophic transfer efficiencies). It would be inappropriate to also credit these projects against spill-related habitat losses since such an approach would double count project benefits (e.g., incremental productivity). In addition, while it is reasonable to expect that mammals, amphibians, reptiles, and/or other biota would derive some benefit from restoration projects intended to compensate for bird losses, spill-related injuries to these categories of biota were not quantified. The Trustees made the reasonable, simplifying assumption that spill-related losses and restoration gains offset each other, so adjustments to scaling calculations were not deemed to be warranted.

5.2 - Restoration Evaluation Criteria

All of the potential restoration project alternatives identified by the Trustees were reviewed to narrow the list of potential projects and focus information-gathering efforts on the most likely alternatives to meet the purpose and need for action (see Section 2.0). The Trustees considered 61 different restoration ideas ranging from fish blockage removals, land acquisition, wetland restoration, shellfish restoration, and recreational enhancements that are potentially capable of providing compensatory restoration for injuries resulting from the *Athos* oil spill. These were provided to the Trustees by appropriate federal and state officials, members of the public, and non-governmental organizations familiar with the Delaware River system.[17]

---

[17] Potential restoration project ideas were solicited from the general public, including: the Partnership for the Delaware Estuary, Delaware Riverkeeper, Pennsylvania Environmental Council, Philadelphia Water Department - Office of Watersheds, DelCo Anglers, Pennsylvania B.A.S.S. Federation, Schuylkill Center for Environmental Education, Academy of Natural Sciences of Philadelphia, Darby Creek Valley Association, Fairmount Park Commission, Audubon Pennsylvania, The Nature Conservancy – Pennsylvania Chapter, The Nature Conservancy – Delaware Chapter, Brandywine Conservancy, New Jersey Green Acres Program, American Rivers, Trout Unlimited, Fairmount Park Commission, American Littoral Society, Pennypack Ecological Restoration Trust, Ducks Unlimited, Schuylkill Action Network, Delaware River Basin Commission, New Jersey Marine Science Consortium, Delaware Audubon, Delaware Nature Society, Delaware Wild Lands, Inc., Delmarva Ornithological Society, Ducks Unlimited – Mid-Atlantic Field Office.

The initial Tier 1 screening criteria that applied to all proposed projects were: (1) does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to the injury); and (2) is there sufficient information about the project available to allow evaluation with the OPA and NEPA criteria and enable implementation within 12 months of the finalization of the Restoration Plan. The project lists, as well as the result of the application of the Tier 1 screening criteria appear below in Table 16:

Table 16. Tier 1. List of Restoration Ideas and Alternatives Considered by the Trustees.

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Augustine Boat Ramp	Address sedimentation issue by reengineering breakwater.	Yes	Yes	Yes
Benthic Mapping	Map benthic habitat resources to increase understanding of the Delaware Bay and its living marine resources, including shellfish.	No	Yes	No
Blackbird Reserve	Restoration of agricultural lands into a combination of forested areas, shallow wetland ponds, wildlife pastures, and agricultural food plots.	Yes	Yes	Yes
Boeing Facility	Crum Creek and Little Crum Creek are enclosed underneath parking lots at Boeing. Day lighting the streams and providing fringing tidal wetlands is a possibility.	Yes	No	No
Brandywine Creek Shad Restoration Project (Dam Removal)	Dam removal opportunities exist along the Brandywine Creek for restoration of anadromous fish habitats. The Brandywine Creek Conservancy, in partnership with NOAA and NFWF has prepared a feasibility study for fish passage at 13 of the blockages along the creek. DNREC will be removing three of the 13 dams this year.	Yes	Yes	Yes
Camden Greenways	There are many projects on the Cooper and Newton Rivers within the City of Camden (tidally influenced) and up-river in the non tidal portions. Projects could focus on stormwater management, public access, and habitat enhancement. Another project could include erosion and sediment control or invasive plant removal at Farnham Park (Camden Greenway).	Yes	No	No
Chester Creek Dam Removal	Remove a series of small, low-head dams on the Chester Creek which significantly block fish passage for migratory species.	Yes	No	No
Christina Boat Ramp: Fishing Pier and Public Access Restoration	Restore boat ramp, fishing pier, and public access at the 7th Street ramp, located on the Christina River, just above the Brandywine.	Yes	Yes	Yes
Daniels Pond Repair and Restoration (Cedar Swamp)	This project would repair and restore a 4.7 acre pond in the Cedar Swamp Wildlife Area. Muskrat burrowing damage to an existing dike has weakened the dike sufficiently to have caused a breach during a severe storm event. Repairs would involve installing a water control structure to double as an emergency outflow, repairing the dike breach, and burying chain link fence along the toe of the dike to deter future muskrat burrowing damage.	No	Yes	No

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Darby Creek Dam Removal and Stream Restoration	The creek currently has three low dams and a remnant bridge pier that interfere with stream flow and the movement of anadromous fish. The project will remove the four obstructions and implement in-stream and riparian restoration for up to 1,000 feet upstream and downstream of the current obstructions. Floodplain restoration projects are also planned for a 10-acre site adjacent to the Kent Park dam.	Yes	Yes	Yes
Delaware Bay Shoreline Restoration Project	Shoreline habitat debris removal and restoration project. This project would enhance and re-establish breeding habitat for horseshoe crabs along the shoreline of the Delaware Bay.	Yes	No	No
Delaware City Wetland Enhancement	Eight acres in Delaware City along Branch Canal. Project would involve excavation of ponds and ditches to improve heterogeneity of marsh system, *Phragmites* control, installation of a water control structure, and reestablishment of an existing berm that has eroded and is causing flooding of a portion of Delaware City.	Yes	No	No
Delaware River Shoreline Restoration/ Acquisition Projects	Three potential projects in the Port Penn area ranging in size 10 to 30 acres. Restoration technique would be primarily habitat enhancement (shoreline erosion control and *Phragmites* control) and acquisition.	Yes	No	No
Delaware Watershed Open Space Project (General Project Type)	Acquisition of high-quality habitats and environmentally-sensitive open space lands throughout the Delaware Watershed. Habitats to purchase, acquire, and protect could include riparian zones lands, floodplains, streambanks, river-reaches, marshes/wetlands, and other associated finfish and shellfish habitats. Options for acquisition include partnering with The Nature Conservancy, Partnership for the Delaware Estuary, and others.	Yes	No	No
Delaware Tributary Mussel Restoration	The goal of this project was to restock two species of mussels that appear to have been extirpated from the Brandywine River near Wilmington, Delaware.	Yes	Yes	Yes
Denton Property - Ecological Restoration	31-acre parcel along the Delaware River. A portion of this site was formally used as a landfill.	Yes	No	No
Dravo Marsh Restoration Project	This project consists of acquisition, restoration and enhancement of degraded, emergent tidal freshwater wetland habitat and upland scrub/shrub-forested buffer habitat on the Christina River in Wilmington, Delaware known as the Old Wilmington (Dravo) Marsh.	Yes	Yes	Yes

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Fairmount Fish Ladder Rehabilitation	Repair existing, or install new, fish ladder at Fairmount Dam. Currently a degraded fish ladder structure prevents many migratory fish from passing the dam successfully to access upstream spawning habitats. This project is a priority of the USACE.	Yes	Yes	Yes
Floodplain Restoration	Restoring floodplain areas on the main stem and along tributary streams – including buyouts of existing structures, removal of fill, and reforestation.	Yes	No	No
Fox Point State Park (Edgemoor, Delaware) - Shoreline Restoration	Restoration can be performed at Fox Point proper for invasive species, shoreline stabilization, tidal wetlands, etc.	Yes	Yes	Yes
Freshwater Tidal Marsh Enhancement and/or Restoration	Particular focus on tidal tributaries in the upper estuary (e.g., Ridley, Chester, Woodberry, Mantua Creeks; Schuylkill, Brandywine, Christina Rivers).	Yes	No	No
Gandy's Beach Acquisition and Preservation	Acquisition/preservation of a large tract of high quality habitat along the Delaware River which could provide habitat for birds and intertidal habitat for marine resources.	Yes	Yes	Yes
Grass Dale Wetlands Ecological Restoration	Control of invasive plant species and maintenance of walking trail.	Yes	Yes	Yes
Green Acres Program Habitat Acquisition Program	The NJDEP has a Green Acres Program that actively acquires land parcels for preservation and possible future restoration projects. Desired land parcels were assumed to be located in areas that would be proximal to the spill and/or Delaware Bay, provide habitat or restoration potential, and could be on or near tidal waters.	Yes	No	No
Habitat Restoration: John Heinz NWR	Restore wetland habitat within the John Heinz National Wildlife Refuge.	Yes	Yes	Yes
Horseshoe Crab Fishery Buyout	Buyout the horseshoe crab fishery to restore populations of horseshoe crabs and the avian species which feed upon their eggs.	Yes	No	No
Hydrological Restoration at Repaupo Creek	Repaupo Creek is currently bermed and gated from the flow of the tide. The berm and the tide gate could be removed to restore tidal flow to the creek and surrounding wetlands. The result of removing the obstructions to the tide would result in a large increase in freshwater wetlands. Tidal freshwater wetlands are critically important in this part of New Jersey and would result in an increase in habitat value for waterfowl, wading birds, fish, raptor foraging, and other injured resources.	Yes	No	No

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Kelly Island Shorebird and Horseshoe Crab Project	Restoration, enhancement, and protection of critical horseshoe crab and shorebird nursery, foraging, and breeding habitats on Kelly Island. Restoration techniques could include shoreline protection, marine debris removal, beach enhancement, shoreline restoration, public access enhancement, and creation of buffer zones.	Yes	Yes	Yes
Land Acquisition - Philadelphia Area	Acquire one or more of four parcels along the west side of the Delaware River in Philadelphia (Milnor St., 3101 E. Hedley, 3100 Orthodox, 500 Richmond St.).	Yes	Yes	Yes
Lardner's Point Riparian Restoration	Restore habitat and create a park on the 4.5 acre riverfront site at the former coal holding facility for the Lardner's Point Pump Station.	Yes	Yes	Yes
Little Tinicum Island Marsh Restoration	Restore tidal wetland areas previously filled with dredge spoil. Up to 12 feet of filled spoil exists in parts of this former wetland area.	Yes	Yes	Yes
Mad Horse Creek Habitat Restoration	Habitat restoration on state owned property along Mad Horse Creek (N.J.).	Yes	Yes	Yes
Mannington Meadows Wetland Restoration	Mannington Meadow is a brackish estuary located on the Salem River drainage, Salem County, New Jersey. Potential exists to restore this degraded marsh to a functional, tidal brackish, and freshwater ecosystem. Keys to this restoration include increasing the incoming freshwater flow from Salem River and reducing the coverage of *Phragmites* in these degraded wetlands.	Yes	Yes	Yes
Milford Neck Tidal Marsh Restoration Project	Salt marsh hydrology restoration - restoring natural drainage to those marshes previously ditched for mosquito control. There is at least one area near Milford Neck in Delaware.	Yes	Yes	Yes
Misc. Boat Ramps	The NJDEP Fish and Wildlife Program has a list of eight possible boat launch projects. At this time many of the projects are still in the planning/feasibility stage. Most of these locations are also in the lower Delaware River/Delaware Bay region.	Yes	No	No
Misipillion Horseshoe Crab and Shorebird Project: Beach Improvements/Dune Stabilization	Restoration and enhancement of horseshoe crab and shorebird habitats on the Misipillion River shoreline, including beach restoration, dune stabilization, marine debris removal, and shoreline protection.	Yes	No	No
Mt. Holly Fish Passage	Remove a large dam (previously used for power generation) that blocks diadromous fish passage on the Rancocas Creek. Options include dam removal and/or fish passage.	Yes	No	No

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
New Camden Park Education Project	Create tidal wetlands to filter stormwater runoff, provide outdoor/hands on education, wildlife habitat, and access for new greenways trails.	Yes	No	No
Oyster Monitoring: Bayshore Discovery Project	The Bayshore Discovery Project, a non-profit conservation and education organization in Southern N.J., in partnership with the NOAA Restoration Center and Rutgers Universities Haskins Shellfish Laboratory, proposes to monitor oysters in the Delaware Bay (Bivalve, New Jersey). The partnership with Rutgers allows for in-depth restoration monitoring and research, and the Discovery project currently has access to a broad range of volunteers and boat vessels in which to implement oyster reef restoration.	No	Yes	No
Oyster Reef Restoration	Create oyster reef in Delaware Bay based on NJDEP Multiphase shell planting program.	Yes	Yes	Yes
P.O.R.T.S. – Oyster Reef Education Project	Rutgers University is proposing to develop curriculum and education projects to enhance the public's knowledge of the importance and dynamics of oyster reefs and oyster populations. In addition, opportunities exist to enhance an existing oyster gardening program in the Bay.	No	Yes	No
Pennypack Creek Dam Removal and Habitat Restoration	Remove dams and enhance in-stream, riparian, shoreline and streambank habitat on Pennypack Creek in Pennsylvania. Examples include in-stream fish enhancements, such as resting pools, rock vanes, cover enhancements, and riffles, and riparian restorations such as streambank stabilization, plantings, and shoreline softening projects.	Yes	No	No
Perkiomen Creek Dam Removal and Fish Passage Restorations	A series of small low-head dams significantly blocks migratory fish passage along the creek. A total of four dams are in need of removal.	Yes	No	No
Philadelphia Sludge Lagoon Restoration	Tidal wetland restoration at the old sludge lagoon (not used at present) near Philadelphia's Southwest STP.	Yes	No	No
Phragmites Control	Remove *Phragmites*, an invasive plant species, from sites along the Delaware River and its tributaries.	Yes	Yes	Yes
Prime Hook NWR (Horseshoe Crab/Avian Restoration)	Purchase 64 acres of Fowlers Beach, adjacent to Prime Hook NWR. It is the last undeveloped beach stretch in the area and is used by horseshoe crabs, red knots, and piping plovers. The Refuge owns the property around these parcels and some of the owners would like to develop their property.	Yes	Yes	Yes

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Saddlers Woods	Saddlers Woods (Haddon Twp., New Jersey): This old growth forest is in desperate need of stormwater management projects, including bank stabilization, created wetlands, swales, etc.	Yes	No	No
Salem County, New Jersey Wetland Restoration	Acquire and/or restore a large (300+ acre) area bordered by AID, the Killcohook Site, and the Delaware River. This land is under multiple ownership The land use is currently non-production agriculture.	Yes	No	No
Shellfish Restoration in the Middle and Upper Delaware Estuary	Use of brackish and freshwater species of mussels or clams to enhance water quality and essential habitat and food for fish and crabs; in addition, opportunities exist to utilize shellfish and their habitats to control erosion in tidal marsh areas.	Yes	Yes	Yes
Shorebirds Stewards & Survey/Gull Exclusion	Train stewards to patrol the beaches of Delaware Bay during the peak migration period to ensure that nesting and foraging shorebirds are not disturbed; perform shorebird surveys from the water to reduce human disturbance and achieve greater integrity of data when used with data from aerial surveys; and install gull exclusions to further address the impact of gull predation on horseshoe crab eggs.	Yes	Yes	Yes
Stipson's Island Mitigation Bank	Tidal and freshwater wetland bank in southern New Jersey.	Yes	Yes	Yes
Stow Creek Boat Ramp	Improve Stow Creek boat ramp to enhance recreational use.	Yes	Yes	Yes
Stow Creek Wetland Enhancement	This site consists of a large, unused agriculture field that is available for restoration to its former tidal marsh condition. Activities could include restoring/enhancing two individual marshes on each edge of the site, restoring/creating riparian buffers, and installing a public access boat ramp on the site.	Yes	No	No
Streambank Stabilization	Streambank stabilization, floodplain, and in-stream restoration in Easton, Pennsylvania.	Yes	No	No
Sturgeon Habitat Restoration	Restore sturgeon spawning habitat (creation of hard bottom, cobble habitat in the mainstem Delaware River, N.J.).	Yes	No	No
Supawna Meadows NWR	General habitat acquisition and restoration.	Yes	No	No
Thousand Acres/ Appoquinimink Wetland Enhancement	Tidal wetland restoration/acquisition projects – three projects ranging in size from 233 to 56 acres in the Thousand Acres/Appoquinimink Watershed. Restoration technique would be primarily habitat enhancement/*Phragmites* control and acquisition.	Yes	Yes	Yes
Tinicum Island Recreational Trail	Enhance recreational trail on Tinicum Island.	Yes	Yes	Yes

Project	Project Description	Does the project have the potential to result in a quantifiable increase in one or more of the injured resources (i.e., nexus to injury)?	Is there sufficient information about the project (planning, etc.) available to (a) evaluate the project and (b) enable implementation within the next 12 months?	Retained for Detailed Analysis
Tinicum Township Salt Marsh Restoration	The Township has acquired property just downstream from the airport runways, adjacent to river tidal marsh (former Westinghouse Property), that has the potential for wetland creation or enhancement. At present, it appears to be historical fill in tidal wetlands with some depression wetlands on top.	Yes	No	No
Trenton Fishing Wharf	Opportunities exist to enhance the public access and fishing piers along the Delaware River in Trenton, New Jersey.	Yes	Yes	Yes
University of Delaware Oyster Survey	This project is a reconnaissance of tributaries in the Lower Delaware Bay with the goals of (1) locating live oyster bars in the tributaries, (2) determining whether recruitment or "set" has occurred in recent years, and (3) characterizing water quality parameters at these bars. Moreover, this is an initial assessment of tributary bars as potential "refuge" and seed areas for oyster restoration in the Delaware Bay.	No	Yes	No

Of the 61 project ideas considered by the Trustees, 29 met the initial screening requirements and were brought forward for a closer evaluation, represented as Tier 2 Evaluation. Table 17 presents the second tier of project screening for the 29 alternatives that met the criteria of the first tier. These projects were screened to narrow the list of alternatives and focus information-gathering efforts on the most feasible alternatives. The criteria applied to all proposed projects were: (1) OPA regulations (15 CFR § 990.54) , and (2) "Factors to evaluate proposed restoration alternatives under the Oil Pollution Act, Delaware River/M/T *Athos I* oil spill" (*Athos* Trustee Council 2006). Projects that met these criteria were subject to a closer evaluation.

The OPA regulations (15 CFR § 990.54) identify the following six criteria that were used to evaluate the 29 alternatives:

A) Cost to carry out the alternative;
B) 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;
C) Likelihood of success of each alternative;
D) 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;
E) Extent to which each alternative benefits more than one natural resource and/or service; and
F) 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, Delaware River/M/T *Athos I* oil spill" (*Athos* Trustee Council 2006). In addition to the items below, proximity to the oil spill site was considered, pursuant to Criterion B for OPA (above) regarding compensation for interim losses.

A) Compliance with applicable federal and state laws and policies;
B) Possibility for integration with existing management programs that are consistent with the Trustees' restoration goals under OPA;
C) Evaluation of the adjacent or nearby affecting land uses;
D) Site ownership;
E) Logistical considerations;
F) Consistency with local, regional, and national restoration goals and initiatives; and
G) Longevity of the project.

Based on the application of the evaluation criteria listed above, the list of potential restoration locations was narrowed down from the 29 potential restoration sites in Table 17 (Tier 2) to 15 action alternatives. This streamlined list provided a reasonable range of alternatives (Table 18) to meet the stated purpose and need.

Table 17. Tier 2. List of narrowed restoration projects.

Projects Determined from Tier 1	OPA Selection Criteria							Additional Trustee Selection Factors									
	Cost	Restores Injury Resources	Likelihood of Success	Avoids Additional Injury	Multiple Benefits	Public Health and Safety	TOTAL	Integration with Existing Programs	Adjacent/ Nearby Land Uses	Site Ownership	Logistics	Consistent with Established Goals and Objectives	Project Longevity	Long term O&M	TOTAL	Combined TOTAL	Recommended*
Augustine Boat Ramp	0	1	1	0	-1	1	2	1	1	2	2	2	2	1	11	13	Yes
Blackbird Reserve	2	2	2	2	1	1	10	2	2	2	2	2	2	2	14	24	Yes
Brandywine Creek (multiple dams)	-1	1	0	2	2	1	5	1	1	2	2	1	1	1	9	14	Yes
Christina Boat Ramp, Fishing Pier, and Public Access	0	1	1	0	-1	1	2	0	0	0	0	-1	0	0	-1	1	No
Darby Creek Dam (multiple dams)	1	2	2	2	2	2	11	2	2	2	2	2	2	-1	11	22	Yes
Delaware Tributary Mussel Restoration	0	1	1	1	2	1	6	1	1	1	1	1	1	1	7	13	Yes
Dravo Marsh Restoration Project	0	1	2	2	2	1	8	1	1	2	1	1	2	1	9	17	Yes
Fairmount Fish Ladder Rehabilitation	2	1	2	2	2	1	10	1	1	1	1	1	1	2	8	18	Yes
Fox Point State Park (Edgemoor, Delaware) - Shoreline Restoration	0	2	0	0	2	1	5	1	1	1	1	1	1	1	7	12	No
Gandy's Beach Acquisition and Preservation	2	1	1	1	1	1	7	-1	1	1	0	-1	0	0	0	7	No
Grass Dale Wetlands Ecological Restoration	0	1	1	1	1	1	5	1	1	1	1	1	1	1	7	12	No
John Heinz National Wildlife Refuge	1	1	1	0	1	0	4	2	2	2	2	2	2	1	13	17	Yes
Kelly Island Shorebird and Horseshoe Crab Project	0	1	1	-1	1	1	3	1	1	1	1	1	1	1	7	10	No
Land Acquisition - Philadelphia Area	0	1	1	2	2	2	8	-1	-1	-1	0	-1	0	0	-4	4	No
Lardner's Point Riparian Restoration	1	2	2	2	2	2	11	2	2	2	2	2	2	1	13	24	Yes
Mad Horse Wetland Restoration	1	2	2	2	2	2	11	2	2	2	2	2	2	2	14	25	Yes
Mannington Meadows Wetland Restoration	0	1	1	0	1	1	4	0	1	0	1	1	1	1	5	9	No
Milford Neck Tidal Marsh Restoration Project	0	1	1	1	1	1	5	2	1	1	1	1	1	1	8	13	Yes
Oyster Reef Restoration	2	-1	1	2	2	1	7	2	1	2	2	2	2	2	13	20	Yes
Phragmites Control	0	-1	-1	1	-1	-1	-3	-1	-1	1	0	-1	0	2	0	-3	No
Prime Hook NWR Acquisition (Horseshoe Crab/Avian Restoration)	-1	-1	2	2	2	1	5	1	-1	-1	0	-1	0	0	-2	3	No
Shellfish Restoration	1	2	1	1	2	1	8	2	1	1	2	2	1	2	11	19	Yes

Projects Determined from Tier 1	OPA Selection Criteria							Additional Trustee Selection Factors									
	Cost	Restores Injury Resources	Likelihood of Success	Avoids Additional Injury	Multiple Benefits	Public health and safety	Total	Integration with Existing Programs	Adjacent /Nearby Land Uses	Site ownership	Logistics	Consistent With Established Goals and Objectives	Project Longevity	Long Term O&M	Total	Combined Total	Recommended*
Shorebirds Stewards & Survey/Gull Exclusion	0	0	0	0	0	0	0	0	1	1	1	1	0	1	5	5	No
Stipson's Island Mitigation Bank	0	-1	-1	1	1	1	1	-1	-1	-1	0	-1	-1	0	-5	-4	No
Stow Creek Boat Ramp	1	1	1	2	1	1	7	2	1	2	2	2	2	2	13	20	Yes
Thousand Acres/Appoquinimink Wetland Enhancement	0	0	0	0	0	0	0	1	1	1	1	1	1	1	7	7	No
Tinicum Island Marsh Restoration	0	1	1	1	1	1	5	1	1	1	1	1	1	1	7	12	No
Tinicum Township Recreational Trail	1	1	2	2	1	1	8	2	1	2	2	2	2	2	13	21	Yes
Trenton Fishing Warf	0	0	0	0	0	0	0	0	0	1	0	1	1	1	4	4	No

* The projects with scores above 13 were recommended.

Scoring 2 highly likely, 1 likely, 0 don't know, -1 not likely

Out of the 29 restoration projects listed under Tier 2, 15 projects were identified, listed in Table 18, as the range of reasonable project alternatives for further evaluation. This evaluation is provided in Section 5.4, below.

Table 18. Reasonable Project Alternatives.

Projects Determined from Tier 2
Augustine Boat Ramp
Blackbird Reserve
Brandywine Creek (multiple dams)
Darby Creek Dam (multiple dams)
Delaware Tributary Mussel Restoration
Dravo Marsh Restoration Project
Fairmount Fish Ladder Rehabilitation
John Heinz National Wildlife Refuge
Lardner's Point Riparian Restoration
Mad Horse Wetland Restoration
Milford Neck Tidal Marsh Restoration Project
Oyster Reef Restoration
Shellfish Restoration
Stow Creek Boat Ramp
Tinicum Township Recreational Trail

5.3 - Reasonable Project Alternatives

The following alternatives fall under the category of compensatory restoration actions. These projects would compensate for the interim loss of resource services due to injury, pending the return of the resource to baseline conditions or service levels.

5.3.1 Alternative 1: No Action/Natural Recovery

Under the No Action alternative, no restoration, rehabilitation, replacement, or acquisition actions would occur. This alternative costs the least because no action would be taken. If selected, there would be no restoration or replacement of the lost resources and their services and the public would not be made whole for past injuries. The No Action Alternative cannot be the preferred alternative since compensatory restoration is already required, but is retained for comparative purposes.

5.3.2 Alternative 2: Augustine Boat Ramp

This project involves installing a rock jetty to the north of the Augustine boat ramp to prevent shoaling that is affecting the use and safety of this facility.

The existing boat ramp at Augustine Beach is located on the Delaware River in New Castle County, Delaware, about 1 mile south of Port Penn on Del. Route 9. The site, owned and maintained by DNREC, includes two handicapped-accessible ramps, two courtesy docks, and 100 parking spots, and is a popular site for boating, waterfowl hunting, and both commercial and recreational fishing.

5.3.3 Alternative 3: Blackbird Reserve

This project entails enhancement and creation of pond, pasture, and avian agricultural food plot areas on agricultural lands within the state-owned Blackbird Reserve Wildlife Area in southern New Castle County, Delaware. In an effort to maintain habitat heterogeneity and provide wildlife habitat value, the Division of Fish and Wildlife proposes restoration of these agricultural lands into a combination of forested areas, shallow wetland ponds, wildlife pastures, and agricultural food plots. The latter three habitat types (shallow wetland ponds, pastures, and agricultural food plots) would be restored to provide suitable migratory goose wintering habitat.

5.3.4 Alternative 4: Brandywine Creek (multiple dams)

Dam removal opportunities exist along Brandywine Creek near Wilmington, Delaware, for restoration of anadromous fish habitat. The Brandywine Creek Conservancy, in partnership with NOAA and the National Fish and Wildlife Foundation (Delaware Estuary Grants Program), has prepared a feasibility study for fish passage at 11 of the blockages along the creek. DNREC will be removing two of the 11 dams in 2009-2010. In addition, DuPont is investigating the potential of removing a dam at their experimental station. This tributary is extremely important to fisheries of the Delaware River and Estuary and would open up significant spawning and breeding habitat should passage be completed.

5.3.5 Alternative 5: Darby Creek Dam (multiple dams)

This project involves the removal of three dams and a remnant bridge pier on Darby Creek in southeastern Pennsylvania, as well as associated in-stream and riparian restoration and enhancement. The obstructions currently interfere with anadromous fish passage, stream flow, and bank stability. The restoration plans include dam removal, removal of impounded sediments, regrading of in-stream and riparian areas, and shoreline vegetation.

5.3.6 Alternative 6: Delaware Tributary Mussel Restoration

The goal of this project is to restock two species of mussels that appear to have been extirpated from the Brandywine River near Wilmington, Delaware. While the numerous dams on the River may have contributed to the decline of these animals, the particular species targeted are not dependent on migratory fish and the success of this project therefore would not be contingent on fish passage restoration projects being planned concurrently for the lower Brandywine (i.e., Alternative 4).

5.3.7 Alternative 7: Dravo Marsh Restoration Project

This project consists of acquisition, restoration, and enhancement of 190+ acres of degraded, emergent tidal freshwater wetland habitat, and 12 acres of upland scrub/shrub-forested buffer habitat on the Christina River in Wilmington, Delaware, known as the Old Wilmington (Dravo) Marsh.

5.3.8 Alternative 8: Fairmount Fish Ladder Rehabilitation

The U.S. Army Corps of Engineers (USACE) has completed design work for a project to restore the fish ladder at the Fairmount Dam along the Schuylkill River in Pennsylvania. Currently a degraded fish ladder structure prevents many migratory fish from passing the dam to access upstream spawning habitats. In addition, the access point to the fish ladder is currently in a degraded condition, preventing proper maintenance and significantly preventing efficient fish passage.

5.3.9 Alternative 9: John Heinz National Wildlife Refuge (NWR)

At the John Heinz NWR, several former freshwater tidal wetlands have been used historically as dredge material disposal sites. This project involves excavating a series of channels and pools through one former tidal wetlands area to restore tidal connectivity and flushing. Removal of invasive vegetation (*Phragmites*) would be included, to enhance export of productivity to the tributary with the restored tidal flushing.

5.3.10 Alternative 10: Lardner's Point Riparian Restoration

The goal of this project is the creation of functional riparian habitat at Lardner’s Point, adjacent to the Tacony-Palmyra Bridge in north Philadelphia. The 4-acre lot is a barren industrial site, consisting of a deteriorating concrete pad in the north section, with a dilapidated ferry dock and boat ramp on the eastern shoreline. The remainder of the site is vegetated with invasive species. The site is currently owned by the City of Philadelphia. The shoreline restoration includes demolishing existing structures, removing debris, importing fill material, grading the site to restore tidal inundation, and creating and planting intertidal marsh and wet meadow habitat.

5.3.11 Alternative 11: Mad Horse Wetland Restoration

The proposed Mad Horse Creek restoration would manipulate nearly 200 acres of the Mad Horse Creek Wildlife Management Area to address injuries to shoreline and bird resources. NJDEP and NOAA are proposing a tidal wetland restoration project that would allow construction of *Spartina alterniflora* habitat at the appropriate elevations. Restoration would be accomplished through the removal of fill material to lower the marsh elevation and allow tidal inundation. Additional projects on the site include creation of wet meadow and grassland areas on former agricultural lands.

5.3.12 Alternative 12: Milford Neck Tidal Marsh Restoration Project

This project involves restoring natural drainage to a marsh previously ditched for mosquito control near Milford Neck (Delaware). Specific restoration techniques for this project include restoration of tidal marsh hydrology, removal of constructed dikes to allow increased tidal exchange, and salt marsh restoration and enhancement.

5.3.13 Alternative 13: Oyster Reef Restoration

Both NJDEP and DNREC propose projects to create and enhance oyster beds either by direct placement of shell for natural spat settlement or a two-step process whereby shell is placed in high spat recruitment areas and then moved to areas that exhibit higher spat growth and survival. These projects are intended to enhance subtidal productivity both through increased oyster populations and increased non-oyster biota associated with oyster bed habitat.

5.3.14 Alternative 14: Shellfish Restoration

This project would rebuild and stabilize an eroded marsh edge with an intertidal, mussel-dominated community in a brackish region of the Delaware Estuary. This would be accomplished by installing hardened structures into the intertidal section of the marsh (concrete posts), to create additional surface area and habitat for restored mussels, allowing subsequent stabilization of the marsh edge and a mechanism to allow natural backfill of new sediment and marsh vegetation to existing, eroding marsh edge habitat.

5.3.15 Alternative 15: Stow Creek Boat Ramp

This project would improve the Stow Creek boat ramp, a New Jersey–owned site located on the former Wosniak property in Stow Creek Township, Cumberland County, New Jersey. The existing ramp is extremely narrow and short, does not have a dock, and overall is in poor condition. The proposed improvements include widening and lengthening the ramp, removing the existing asphalt and replacing it with concrete, and constructing a small courtesy dock so that boats can be safely boarded, loaded, and unloaded.

5.3.16 Alternative 16: Tinicum Island Recreational Trail

The proposed restoration project is to install a permanent trail, two observation decks and a "breakaway bridge" to cross a small wetland area on Tinicum Island, a former dredge spoil site. The trail would be a loop on the berm of the large spoil cell with a feeder trail that would allow viewing of the existing inlet wetland and lead to a permanent duck blind. Along the trail, invasive plant species would be controlled and revegetated with native plants to prevent further spread of invasives by recreational users.

5.4 – Identification and Environmental Consequences of the Restoration Alternatives

In accordance with NEPA, the No Action alternative and the reasonable alternatives are evaluated in this section and 5.5, respectively, to assess the potential significance of the actions on the human environment. Project-specific environmental consequences for each reasonable project are provided in this section. NEPA calls for consideration of potential, direct, indirect, and cumulative impacts when evaluating the significance of impacts.

5.4.1 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 natural 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, as it does not meet the purpose and need for action. Losses were suffered and impacts continue during the period of recovery from this spill. Technically feasible, cost-effective alternatives exist to compensate for these losses.

5.4.2 Evaluation and Environmental Consequences for Non-Preferred Restoration Alternatives

The Trustees identified 15 reasonable projects using the evaluation criteria presented in Section 5.2. Three of the restoration alternatives identified in Table 18—Brandywine Creek, Dravo Marsh Restoration, and Fairmount Fish Ladder Restoration—were dropped from further consideration during development of this draft DARP/EA when the Trustees were notified that each project had received alternate funding and was proceeding with plans to restore these areas. The projects listed below were found to meet the purpose and need for compensatory restoration, but are not currently preferred by the Trustees.

5.4.2.1 Delaware Tributary Mussel Restoration

The goal of this project was to restock two species of mussels that appear to have been extirpated from the Brandywine River near Wilmington, Delaware. Numerous dams on the River may have contributed to the decline of these animals but, because the particular species are not dependent on migratory fish, the success of this project would likely not be contingent on fish passage restoration projects being planned concurrently for the lower Brandywine. This project would have been suitable to compensate for aquatic injuries, and injuries to birds and other wildlife.

Evaluation of Alternative
Of the projects that currently meet the purpose and need of the action, specifically, the portion of the injury able to be compensated via the implementation of a shellfish restoration project, this alternative was deemed to have a high capacity to compensate for injuries to resources by providing multiple benefits. The project, however, is a less cost-effective approach to shellfish restoration than the preferred project (oyster restoration), because the scale of the preferred alternative shellfish restoration project is significantly greater and would provide enhanced substrate and habitat for natural shellfish spat settlement. A larger project would need to be constructed to provide natural resource services equivalent to the preferred, further increasing project costs.

Ecological and Socioeconomic Impacts
Stocking of native mussels in tributaries of the Delaware River would immediately re-establish more productive populations of shellfish within the Delaware Estuary system, in areas where they have become extirpated from the community. This project would be expected to increase and/or improve the overall ecology of the river system, and to increase and/or improve the ecological services of the area of influence as foraging habitat for estuarine resources. It would also increase the filtering capacity of the stream to improve water quality. The effects would benefit a wide variety of fish and wildlife, including those of recreational and commercial importance. Construction may disturb or displace resources within the footprint and immediate vicinity of the project area, but these impacts would be minimal, largely temporary and result in no long-term effects other than the positive effects associated with the future functioning of the enhanced riverine system.

Summary
While innovative in design, this project was not proposed for further analysis because it was not based on proven, quantified restoration techniques within the Delaware system. This project is more of a pilot-scale research effort that needs to be replicated numerous times (in-situ) and shown to provide successful results in order to determine the feasibility and likelihood of success as a compensatory restoration alternative.

5.4.2.2 Milford Neck Tidal Marsh Restoration Project

This project involves restoring natural drainage to a marsh previously ditched for mosquito control near Milford Neck (Delaware). Specific restoration techniques for this project include restoration of tidal marsh hydrology, removal of constructed dikes to allow increased tidal exchange, and salt marsh restoration and enhancement. This project would have been suitable to compensate for shoreline and tributary injuries and injuries to birds and other wildlife.

Evaluation of Alternative
Of the projects that currently meet the purpose and need of the action—specifically, the portion of the injury able to be compensated via the implementation of a salt marsh restoration-related project—this alternative was deemed to have a high capacity to compensate for injuries to

resources by providing multiple benefits. The project, however, is a less cost-effective approach to salt marsh restoration than the preferred project (in New Jersey) because the preferred alternative is closer in proximity to the spill and resulting injured resources. Therefore, the preferred alternative salt marsh restoration project has a higher likelihood of success for restoration of natural resources injured as a result of the spill. Further, final details on the project area that would benefit from this alternative are still unknown. It would be necessary to establish and provide for future protection and management of the restored area in order for the public to realize the goal of restoration under this plan; the feasibility of providing such protections and future management techniques is not known at this time. Last, the project is less cost-effective than the preferred alternative due to the differences in project scales and the limited projected benefits as compared to the preferred restoration alternative. A larger project would need to be constructed to provide natural resource services equivalent to the preferred, further increasing project costs.

Ecological and Socioeconomic Impacts
Restoration of tidal marsh hydrology and enhancement of salt marshes would immediately re-establish more productive estuarine habitat in what is presently degraded, ditched, and diked remnant brackish marsh habitat. Implementation of this project would be expected to greatly increase and/or improve the overall ecology of wetlands in this area, and to greatly increase and/or improve the ecological services of the area of influence as nursery habitat for estuarine resources. The effects would benefit a wide variety of fish and wildlife, including those of recreational and commercial importance. Re-establishment of tidal hydrology and restoration of degraded salt marsh systems may disturb or displace resources within the footprint and immediate vicinity of the project area, but these impacts would be minimal, largely temporary, and result in no long-term effects other than the positive effects associated with the increased tidal hydrology and exchange resulting from the restoration project, as well as the enhanced salt marsh habitat available for natural resources injured by the spill.

Summary
This project was not proposed by the Trustees because other more cost-effective projects in closer proximity to the spill site were available. Therefore, it was difficult to assess its likelihood of success in restoring injuries resulting from this spill when compared to the preferred alternative projects.

5.4.2.3 Shellfish Restoration

This project would rebuild and stabilize an eroded marsh edge with an intertidal, mussel-dominated community in a brackish region of the Delaware Estuary. This would be accomplished by installing hardened structures into the intertidal section of the marsh (concrete posts), to create additional surface area and habitat for restored mussels, allowing subsequent stabilization of the marsh edge and a mechanism to allow natural backfill of new sediment and marsh vegetation to existing, eroding marsh edge habitat. This project would have been suitable to compensate for aquatic injuries and injuries to birds and other wildlife by providing enhanced aquatic habitat and bird and wildlife foraging resources.

Evaluation of the Alternative
Of the projects that currently meet the purpose and need of the action, specifically, the portion of the injury able to be compensated via the implementation of a shellfish-related project, this alternative was deemed to have a high capacity to compensate for injuries to resources by providing multiple benefits. The project, however, is a less cost-effective approach to shellfish restoration than the preferred project because the infrastructure requirements make the project costs significantly higher at the onset. Further, the project area that would benefit from this alternative is privately owned. It would be necessary to establish and provide for future protection and management of the restored area in order for the public to realize the goal of restoration under this plan.

Ecological and Socioeconomic Impacts
Construction of a marsh platform at an appropriate elevation would immediately re-establish more productive estuarine habitat in what is presently an open water habitat. Although some services associated with open water habitat would be lost, implementation of this project would be expected to greatly increase and/or improve the overall ecology of wetlands in this area, and to greatly increase and/or improve the ecological services of the area of influence as nursery habitat for estuarine resources. The effects would benefit a wide variety of fish and wildlife, including those of recreational and commercial importance. Construction may disturb or displace resources within the footprint and immediate vicinity of the project area, but these impacts would be minimal, largely temporary, and result in no long-term effects other than the positive effects associated with the future functioning of the re-established marsh. At the end of the project life the area would return to open water, and with it, the return of existing resources and services.

Summary
This project was not proposed for further analyses because at the time alternatives were reviewed, insufficient information was available on the additional biomass provided by the project to scale it. Therefore, it was difficult to assess its likelihood of success in restoring injuries resulting from this spill.

5.4.3 Evaluation and Environmental Consequences for Preferred Restoration Alternatives

As described below, six of the nine preferred restoration projects were scaled to restore ecological injuries; the remaining three were scaled to address recreational losses. Below is an analysis of each preferred restoration project. Accordingly, for each of these preferred action alternatives, an evaluation of the environmental consequences associated with the implementation of that alternative is provided here to assess the potential for significant impacts. Appendix 2 discusses potential impacts to the coastal zone and to endangered and threatened species. Consultation is underway in concurrence with the public comment period for compliance with the Coastal Zone Management Act and Section 7 of the Endangered Species Act.

5.4.3.1 Mad Horse Creek and Lardner's Point

Environmental Impacts
Marshes are widely recognized as providing numerous ecological functions, including habitat for juvenile finfish 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 the potential for enhanced recreational use of the area through increases in the number of aquatic species.

Physical
A temporary increase in turbidity would be expected during construction, and would be timed (through best management practices (BMPs) and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. In addition, sediment erosion controls such as turbidity curtains would be used to minimize or prevent sediments from entering the water column. These projects would not have long-term negative water quality impacts.

Biological
The projects would have no adverse long-term impacts on low marsh, transitional high marsh, wet meadow, or grassland vegetation. Excavation of these sites would increase the duration and frequency of tidal inundation and develop more favorable conditions for the spread of typical low marsh species (*Spartina alterniflora*, etc.), and produce benefits to the vegetative community as well as to wildlife with the excavation of wet meadows and the seeding of grasslands. The establishment of low marsh would radically alter the dominance of particular species but would not significantly affect the diversity of species. Positive impacts of the *Spartina alterniflora* dominated wetland include increased fisheries productivity and benefits to resident estuarine fish species such as mummichog and striped killifish. Fisheries-dependent avian species and guilds, such as wading birds, gulls, terns and ospreys, would also benefit. Increased production of small resident fish would provide positive off-site trophic benefits towards larger commercial and recreational fish species, such as bluefish and striped bass, which are dependent on small prey.

<u>Essential Fish Habitat</u>
The Mad Horse Creek restoration would occur in areas that are designated as Essential Fish Habitat (EFH), as determined by NMFS.

The Trustees conclude, based on informal consultation with the NOAA Habitat Conservation Officer (Appendix 5), that the Delaware Estuary does provide Essential Fish Habitat (EFH) as defined under the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq.) for a number of marine species. Impacts would be avoided/mitigated by the use of BMPs, including installation of erosion mats, turbidity curtains, and the implementation of time-frame construction avoidance windows. No construction activities would occur directly adjacent to the river and creeks during potential periods of anadromous fish usage: March 1 through June 30.

While there may be some temporary, short-term impacts to EFH, there would not be any long-term adverse effects on Essential Fish Habitat. By restoring and enhancing wetlands and shoreline habitats, EFH would be enhanced by creating more and better habitat for prey species, forage and refuge habitat for juvenile managed species, and improving water quality. The Trustees believe that the restoration as proposed would not adversely impact, but should enhance the quality of the EFH in this area in the long-term (See informal EFH consultation: Appendix 6).

The Lardner's Point project would not occur in an area designated as Essential Fish Habitat (EFH), as determined by NMFS. There would be no adverse impacts to EFH.

Threatened and Endangered Species

No federally listed rare, threatened, or endangered species under the jurisdiction of NMFS are known to occur within the Mad Horse Creek proposed project area, nor would any be disturbed by the additional actions necessary to carry out the proposed plan.

At Lardner's Point, the shortnose sturgeon (*Acipenser brevirostrum*) is a federally endangered species known to use the Delaware River as an over-wintering area (USFWS 2006). The Atlantic sturgeon is listed as endangered in Pennsylvania and Delaware (PA DCNRb; DNREC 2004) and may be present in the project area at certain times of the year. The Atlantic sturgeon is not a federally listed species; however, it is listed as a candidate species. Once project plans are developed, the lead Federal Agency would contact the NMFS Protected Resources Division to initiate coordination of this project.

The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction however, none are known to occur within the proposed project area.

Socioeconomic

There would be no long-term socioeconomic impacts under the habitat restoration at Mad Horse Creek and Lardner's Point. Lands intended for restoration are government-owned, and the Trustees do not expect the project to have any significant long-term adverse economic impacts. Restoration at both sites would, however, provide lasting socioeconomic benefits to the surrounding community by enhancing aesthetic and scenic qualities. Following construction, Lardner's Point would become part of the larger proposed North Delaware Riverfront Greenway envisioned to encompass an approximately eleven-mile trail system along the Delaware River through Philadelphia, Pennsylvania. This project would enhance recreational fishing opportunities that currently exist on-site.

Evaluation

The identified projects are consistent with the Trustees' evaluation criteria, and restore the same or similar types of injury (i.e., wetland/intertidal habitat loss) in the same geographic area of the spill. Both projects would provide many of the same ecological services, are readily available, have a high likelihood of success, and can be scaled to quantified injuries. Marsh restoration and enhancement is also consistent with state, federal, and local restoration goals established for the Delaware River.

Overall, these projects are a cost-effective method to address injuries to multiple habitat types along the Delaware River. Accounting for productivity differences between injured shoreline habitat, many of which are relatively small, into a single type of restoration project, provides cost and planning efficiencies. The estimated overall cost per acre for Mad Horse Creek is $188,000, which is below per acre costs for nearby wetland restoration projects (e.g., Woodbridge Creek, as discussed above). Although the Lardner's Point per acre cost is above $500,000 per acre, the small size of the project (0.9 acres) and its location within the spill zone make it reasonable to include. The Lardner's Point shoreline restoration project would provide multiple benefits in the urban part of the river that was heavily impacted by the spill. These benefits include providing public access for a large population density to an ecologically restored site in the vicinity of the impacted area (although this project is not included as compensation for recreational losses); habitat restoration for estuarine fish, avian, and mammalian species; contributing to proposed networks of habitat restoration projects to provide connectivity between the upper and lower estuary; and localized water quality, sediment attenuation, and nutrient recycling benefits. Although the project cost per acre is somewhat high, the benefits of the project are also high due to the location and potentially significant improvement from baseline conditions.

The Trustees expect that any adverse effects for these projects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the projects would be beneficial and contribute to restoration. Best Management Practices (BMPs) would be used in adherence to all federal, state, and local regulations.

5.4.3.2 Darby Creek Dam Removal and John Heinz NWR Habitat Restoration

Environmental Impacts
Downstream of the lowest dam in Darby Creek, a variety of anadromous fish are found, including alewife, striped bass, and shad (NOAA 2003). Dam removal is expected to restore normal stream channel flows and facilitate passage of anadromous fish into the upper watershed. Creating channels and pools in the John Heinz NWR would return the area to its tidal wetland status, restoring habitat for many anadromous fish species.

Physical
A temporary increase in turbidity would be expected during construction of these projects, and would be timed (through BMPs and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. These projects would have no long-term negative water quality impacts. Mitigation to prevent water-quality impacts would include the use of BMPs and sediment erosion controls such as turbidity curtains to minimize or prevent sediments from entering the water column and possible dredging of the sediment behind the dam prior to removal.

Biological
Restoration activities associated with these projects would not adversely impact any naturally occurring aquatic life. However, these projects would improve aquatic organism use within the system. To comply with NMFS recommendations, no activity resulting in discharges would

occur in or directly adjacent to the Delaware River or adjacent creeks during the period of potential fish migration or spawning: March 1 through June 30.

<u>Essential Fish Habitat</u>
The proposed restoration projects would not occur in an area designated as Essential Fish Habitat (EFH), as determined by NMFS (Appendix 5). There would be no adverse impacts to EFH.

<u>Threatened and Endangered Species</u>
No Federally listed rare, threatened, or endangered species under the jurisdiction of NMFS are known to occur within the proposed project area, nor would any be disturbed by the additional actions necessary to carry out the proposed plan.

The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction however, none are known to occur within the proposed project area.

Socioeconomic
There would be no negative long-term socioeconomic impacts from habitat restoration on Darby Creek or the John Heinz NWR. Lands intended for restoration are government-owned, county–owned, or owned by SEPTA, and the Trustees do not expect the projects to have any significant long-term adverse economic impacts. Restoring these two sites should provide lasting socioeconomic benefits to the surrounding community by enhancing aesthetic and scenic qualities.

Evaluation
The Darby Creek dam removal project is consistent with the Trustees' evaluation criteria. It is cost-effective and restores the same type of habitat as that injured in tributaries in the same geographic area of the spill. Dam removal and tributary enhancement projects are also consistent with state, federal, and local restoration goals established for the upper estuary watershed of the Delaware River Basin. The project addresses objectives defined in conservation plans by both the Darby Creek Valley Association and the Delaware Estuary Program.

The habitat restoration project at John Heinz NWR is also consistent with the Trustees' evaluation criteria. It is cost-effective and restores the same or similar types of injury (i.e., tributary habitat) in the same geographic area of the spill. Marsh restoration and enhancement are also consistent with state, federal, and local restoration goals established for the Delaware River and for John Heinz NWR.

The Trustees expect that any adverse effects of these projects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the projects would be beneficial and contribute to restoration. Best Management Practices (BMPs) would be used in adherence to all federal, state, and local regulations.

5.4.3.3 Blackbird Reserve

Environmental Impacts
Wildlife species attracted to constructed shallow water ponds (depending on size) include waterfowl, songbirds, shorebirds, wading birds, amphibians, and reptiles, as well as some upland birds and mammals. These ponds, along with adjacent pasture lands, would provide feeding and roosting (resting) areas for waterfowl, specifically migratory geese.

Physical
A temporary increase in turbidity would be expected during construction, and would be timed (through BMPs and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. In addition, sediment erosion controls such as turbidity curtains would be used to minimize or prevent sediments from entering the water column. These projects would not have long-term negative water quality impacts.

Biological
The open agricultural lands are to be restored to something other than "active agricultural" (i.e., farming). In an effort to maintain habitat heterogeneity and provide wildlife habitat values for all species currently utilizing the property, the Delaware Division of Fish and Wildlife proposes restoration of these agricultural lands as a combination of forested areas, shallow wetland ponds, wildlife pastures, and agricultural food plots. The latter three habitat types would be restored to provide suitable goose habitat. Existing lowland areas would be excavated to create two shallow wetland ponds surrounded by managed pastures designed to attract migratory geese. In addition, areas adjacent to the pastures would use agricultural practices to create wildlife food plots also designed to attract migrating geese.

<u>Essential Fish Habitat (EFH) Impacts</u>
The estuarine waters of Blackbird Creek have been designated as Essential Fish Habitat (EFH), as determined by NMFS for one or more species. Restoration activities at the site, which does not connect with Blackbird Creek, would have no effect on EFH and federally managed species. Since there are no proposed impacts of the project, further EFH consultations would not be necessary as required as part of the federal permit process.

(See informal EFH consultation: Appendix 5).

<u>Threatened/Endangered Species and Critical Habitat Impacts</u>
No federally listed rare, threatened, or endangered species under the jurisdiction of NMFS are known to occur within the proposed project area. ESA Consultation by NMFS is completed (see informal ESA consultation: Appendix 5). The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction however, none are known to occur within the proposed project area.

Socioeconomic
There would be no negative long-term socioeconomic impacts under the habitat restoration at Blackbird Reserve. Lands intended for restoration are government-owned, and the Trustees do

not expect the project to have any significant long-term adverse economic impacts. Restoration of Blackbird Reserve, however, should provide lasting socioeconomic benefits to the surrounding community.

Evaluation
The identified projects are consistent with the Trustees' evaluation criteria, and result in restoration of the same or similar types of injury (i.e., bird biomass) in the same geographic area of the spill. The preferred projects provide many of the same ecological services, are readily available, have a high likelihood of success, and can be scaled to quantified injuries.

Migratory goose habitat creation on Blackbird Reserve is a cost-effective means of compensating for this injury. This project adds forage and resting areas desirable to geese to an important corridor for migratory waterfowl. The project is on state-owned land and would require minimal restoration, resulting in a cost-effective approach to addressing a portion of the goose injury.

The Trustees expect that any adverse effects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the project would be beneficial and contribute to restoration. BMPs would be used in adherence to all federal, state, and local regulations.

5.4.3.4 Oyster Restoration

Environmental Impacts
The preferred compensatory restoration alternative for restoring 4,637 kg of benthic biota is to create 4.5 acres of oyster reef in the Delaware River. The preferred compensatory restoration alternative for restoring 1,770 kg of piscivorous and omnivorous birds is to create 73.5 acres of oyster reef in the Delaware River. Both NJDEP and DNREC have established programs that create and enhance oyster beds either by direct placement of shell for natural spat settlement or a two-step process whereby shell is placed in high spat recruitment areas and then moved to areas that exhibit higher spat growth and survival.

Oysters are a keystone species in the Delaware Bay, providing a basis for a vast community of benthic organisms. Oysters and the reefs they create increase habitat and faunal diversity; through their high filtration capacity, they can also improve water quality. Thus, the proposed project would improve habitat quality; the shell planting would increase habitat complexity, and the increased filtration by a restored shellfish resource would improve water clarity.

Oysters are also a harvestable resource and economically important in the area. While oyster harvesting would not be allowed during the project's expected 5-year lifespan, 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.

Any impacts to existing habitats from project construction are expected to be temporary and minimal. Best Management Practices (BMPs) would be used in adherence to all federal, state and local regulations.

Physical
A temporary increase in turbidity is expected during construction, and would be timed (through BMPs and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. Enhancing the oyster sites would create a temporary increase in suspended solids and turbidity, resulting in a reduction of water quality, and decrease in dissolved oxygen and light penetration of the adjacent water bodies during construction. This project is anticipated to have no long-term negative water quality impacts. Mitigation to prevent water-quality impacts would include the use of BMPs and sediment erosion control such as turbidity curtains to minimize or prevent sediments from entering the water column.

Biological
The project would have no adverse long-term impacts on low marsh or transitional high marsh vegetation.

Essential Fish Habitat (EFH) Impacts
This proposed restoration is occurring in areas that are designated as Essential Fish Habitat (EFH), as determined by NMFS. Based upon the nature of the work proposed, it does not appear that the project would have an adverse effect on these species.

(See informal EFH consultation: Appendix 5).

Threatened/Endangered Species and Critical Habitat Impacts
Several species of sea turtles are seen throughout the area each year including threatened loggerhead (*Caretta caretta*), endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green (*Chelonia mydas*) sea turtles, mainly during late spring, summer, and early fall when water temperatures are relatively warm. The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction.

Socioeconomic
There would be no negative long-term socioeconomic impacts under the habitat restoration of the oyster reefs in Delaware Bay. The Trustees do not expect the project to have any significant long-term adverse economic impacts. Restoration of oyster reefs, however, should provide lasting socioeconomic benefits to the surrounding community.

Evaluation
This alternative is consistent with the Trustees' evaluation criteria. It is cost-effective, reasonably compensates for lost benthic biomass attributable to the *Athos* spill, and would be implemented in the Delaware River in areas as close to spill-affected locations as conditions needed for oyster survival allow. Creating and enhancing oyster reefs is also a cost-effective, low risk restoration approach, and is consistent with existing federal, state, and local restoration goals for the Delaware River and Bay.[18] The likelihood of project success is high, as this effort would augment an existing, successful program for oyster reef creation.

---

[18] In 2001, representatives of Delaware and New Jersey—including both state regulatory agencies (DNREC/NJDEP), the Delaware River Basin Commission (DRBC), the Delaware

The Trustees expect that any adverse effects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the project would be beneficial and contribute to restoration.

5.4.3.5 Stow Creek and Augustine Boat Ramps

Environmental Impacts
These boat ramp improvements would expand boating access to Stow Creek and the Delaware River and provide safer conditions for boaters in the Augustine Boat area. The Trustees believe that the project would help facilitate recreational boating opportunities of the type that were lost during the spill.

Physical
A temporary increase in turbidity would be expected during construction of these projects, and would be timed (through BMPs and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. Mitigation to prevent water quality impacts would include the use of BMPs and sediment erosion controls such as turbidity curtains to minimize or prevent sediments from entering the water column. These projects would have no long-term negative water quality impacts.

Biological
The following may be present in the Stow Creek project area: resident, forage, and benthic species including winter flounder, summer flounder, windowpane, bay anchovy, bluefish, weakfish, river herring, striped bass, oysters, horseshoe crabs, and blue crabs. The following may be present in the Augustine project area: resident, forage and benthic species including summer flounder, bay anchovy, bluefish, weakfish, river herring, striped bass, and blue crabs. Restoration activities associated with these projects would not adversely impact aquatic organisms long-term.

Essential Fish Habitat
Both the Stow Creek and the Augustine projects would occur in areas that are designated as Essential Fish Habitat (EFH), as determined by NMFS. Based upon the nature of the work proposed at Stow Creek, there would be no significant adverse impacts to EFH. Further EFH consultations would not be needed as part of the federal permit process for Stow Creek. Depending on the final design of the new stone jetty at the Augustine project site, additional consultation may be required as part of the federal permit process.

(See informal EFH consultation: Appendix 5).

Estuary Program, the Shellfish Councils for both states, USFWS, and interested citizens—began developing a bi-state oyster revitalization initiative.

Threatened and Endangered Species
No federally listed rare, threatened, or endangered species under the jurisdiction of NMFS are known to occur within the Stow Creek project area, nor would any be disturbed by the additional actions necessary to carry out the proposed plan.

Several species of sea turtles are seen throughout the area near the Augustine project site each year including threatened loggerhead (*Caretta caretta*), endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*), and green (*Chelonia mydas*) sea turtles, mainly during late spring, summer, and early fall when water temperatures are relatively warm. Shortnose sturgeon have been found in deeper water in the vicinity of the project but are not anticipated to be impacted by the project. The activities proposed would be covered under the no effect letter issued to the Philadelphia District Army Corps of Engineers in December 2004.

The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction.

Socioeconomic
The Stow Creek boat ramp and surrounding 186-acre property is owned by NJDEP. The ramp, despite its poor condition, is heavily used for fishing, hunting, and ecological tours. With proposed improvements, the boat ramp and courtesy dock would accommodate more hunters, fisherman, and ecological tourists. People who use the Stow Creek facility would be able to more safely launch their watercraft and it would be more compatible for people with disabilities.

These boat ramp improvements would expand boating access to Stow Creek and the Delaware River, and provide safer conditions for boaters. The Trustees believe that the projects would help facilitate recreational boating opportunities of the type lost during the spill.

Evaluation
The Trustees believe the projects would improve boating access on Stow Creek and the Delaware River by enhancing the utility and safety of the existing sites. As state-owned property, both ramps are open to all and serve residents throughout the region. There is limited boating access along the western shore of the Delaware River in much of the spill zone, so both sites are important for those wishing to access the spill zone from the south, as well as for emergency response needs. The Trustees expect that any adverse effects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the project would be beneficial and contribute to restoration. Best Management Practices (BMPs) would be used in adherence to all federal, state, and local regulations.

5.4.3.6 Little Tinicum Island Recreation Trail

Environmental Impacts
The proposed restoration project is to install a permanent trail, two observation decks, and a "breakaway bridge" to cross a small wet area. The trail would be a loop on the berm of the large spoil cell with a feeder trail that would allow viewing of the existing inlet wetland and lead to a permanent duck blind. Along the trail, invasive plant species would be controlled and

revegetated with native plants to prevent further spread of invasives by recreationalists using the trail.

The project would provide recreational opportunities similar to those lost during the spill, including shoreline activities such as wildlife viewing, hiking, fishing, and picnicking.

Physical

A temporary increase in turbidity is expected during construction, and would be timed (through BMPs and a time-of-year restriction) to occur during periods of reduced or non-critical usage by fisheries resources. Enhancing the boat ramp would create a temporary increase in suspended solids and turbidity, resulting in a reduction of water quality and decrease in dissolved oxygen and light penetration of the adjacent water bodies during construction. This project is anticipated to have no long-term negative water quality impacts. Mitigation to prevent water-quality impacts would include the use of BMPs and sediment erosion control such as turbidity curtains to minimize or prevent sediments from entering the water column.

Biological

The project would have no adverse long-term impacts on low marsh or transitional high marsh vegetation.

<u>Essential Fish Habitat</u>

The Delaware River provides a valuable nursery and forage habitat for a number of species of concern to NMFS including anadromous fish such as striped bass, alewife, blueback herring, and American shad. From the project description it does not appear that the project would have an adverse effect on these species. Wetlands fill should be avoided. Areas where walkways cross over the wetlands should be minimized and limited to a width of 4 feet, if possible. Height of walkways over the wetlands should be at least 4.5 feet to minimize the effects of shading the wetland vegetation.

(See informal EFH consultation: Appendix 5).

<u>Threatened and Endangered Species</u>

Endangered shortnose sturgeon may be present in the project area at certain times of the year. Since work is proposed below the mean high water line of the Delaware River, the lead federal action agency would contact NMFS Protected Resources Division to initiate coordination on this project.

The Trustees are in consultation with USFWS for threatened and endangered species under their jurisdiction.

Socioeconomic

There would be no negative long-term socioeconomic impacts under the habitat restoration at Little Tinicum Island. Lands intended for restoration are government-owned, and the Trustees do not expect the project to have any significant long-term adverse economic impacts. Restoration of the trails and habitat enhancement at Little Tinicum Island, however, should provide lasting socioeconomic benefits to the surrounding community.

Evaluation

The site's proximity to the spill zone in an area of limited shoreline access makes this a desirable restoration project. The project would encourage low-impact recreational activities of the kind lost during the spill. The creation of the trail may reduce ecological or personal harm resulting from trampling. Ecological impacts of the recreational improvements would be minimized. The Trustees expect that any adverse effects would be temporary and minor, primarily associated with disturbance during construction activities, and that long-term impacts of the project would be beneficial and contribute to restoration. Best Management Practices (BMPs) would be used in adherence to all federal, state, and local regulations.

5.4.4 Cumulative Impacts

The environmental consequences in this section focus on direct and indirect effects of the alternatives. For this draft DARP/EA, a specific detailed assessment of cumulative impacts is not presented because the goal of the preferred restoration projects is to improve environmental conditions over time. The preference for certain projects is based on their capacity to compensate for prior injury and their likelihood of success (section 5.5). While some short-term impacts to resources are anticipated, the factors considered in this EA reduce the impact of the *Athos* spill on each of the four resource areas over the long-term, and therefore reduce the potential for cumulative significant impacts over time.

5.5 – Description of Preferred Restoration Alternatives

For purposes of the restoration planning process and public comment on the proposed restoration plan, this section is organized by the category of injury to provide detailed project descriptions for each of the currently preferred restoration alternatives evaluated in section 5.4.3.

5.5.1 Alternatives to Address Shoreline Resource Injuries

The Trustees determined that 1,729 acres of seawalls, sand/mud substrate, marsh, and coarse substrate, and 1,899 acres of tributaries were exposed to *Athos* oil. As described below, the Trustees identified two projects to compensate for the non-tributary losses and two projects to compensate for the tributary losses.

5.5.1.1 Restoration of Non-Tributary Losses: Restoration of Freshwater Tidal Wetlands at Mad Horse Creek and Lardner's Point

The Trustees determined that 1,729 acres of shoreline habitat (primarily tidal flats) injured by the *Athos* spill resulted in a loss of approximately 1,335 DSAYs. Table 19 displays the injury by habitat type. To compensate for this loss, the Trustees propose two habitat restoration projects: (1) restore 38.1 acres of brackish tidal wetland at Mad Horse Creek in New Jersey; and (2) restore 0.9 acre of freshwater tidal wetland/wet meadows at Lardner's Point in Pennsylvania. Both projects are located on the Delaware River, with Lardner's Point being directly exposed to oil from the spill (Figure 8).

Table 19. Non-tributary shoreline injury by habitat type.			
Habitat type	**Description**	**Acres**	**DSAYs**
Marsh	Brackish and freshwater marsh	116	60
Sand/Mud substrates	Mixed sand/gravel beaches, natural banks	36	35
Lower Intertidal Zone		83	51
Tidal Flats	Mud and sand flats adjacent to beaches, banks, and marshes	1,298	1,032
Coarse Substrates	Rip-rap	137	127
Seawalls	Exposed man-made structures	59	30

Project Description - Mad Horse Creek

The proposed Mad Horse Creek restoration would manipulate nearly 200 acres of the Mad Horse Creek Wildlife Management Area to address injuries to shoreline and bird resources. The Mad Horse Creek Wildlife Management area located in Lower Alloway Creek Township, Salem County, New Jersey, is owned by the State of New Jersey and contains salt marshes, transitional wetlands (*Phragmites* dominant), agricultural lands, and associated buildings. Past agricultural practices on this property included altering and filling the brackish marsh fringe.

NJDEP and NOAA are proposing a tidal wetland restoration project that would allow construction of *Spartina alterniflora* habitat at the appropriate elevations. Restoration would be accomplished through the removal of fill material to lower the marsh elevation and allow tidal inundation. A more detailed description of the Mad Horse Creek site is provided in Section 5.5.3.

The State of New Jersey would serve as the Lead Implementing Trustee (LIT), with Trustee Council oversight.

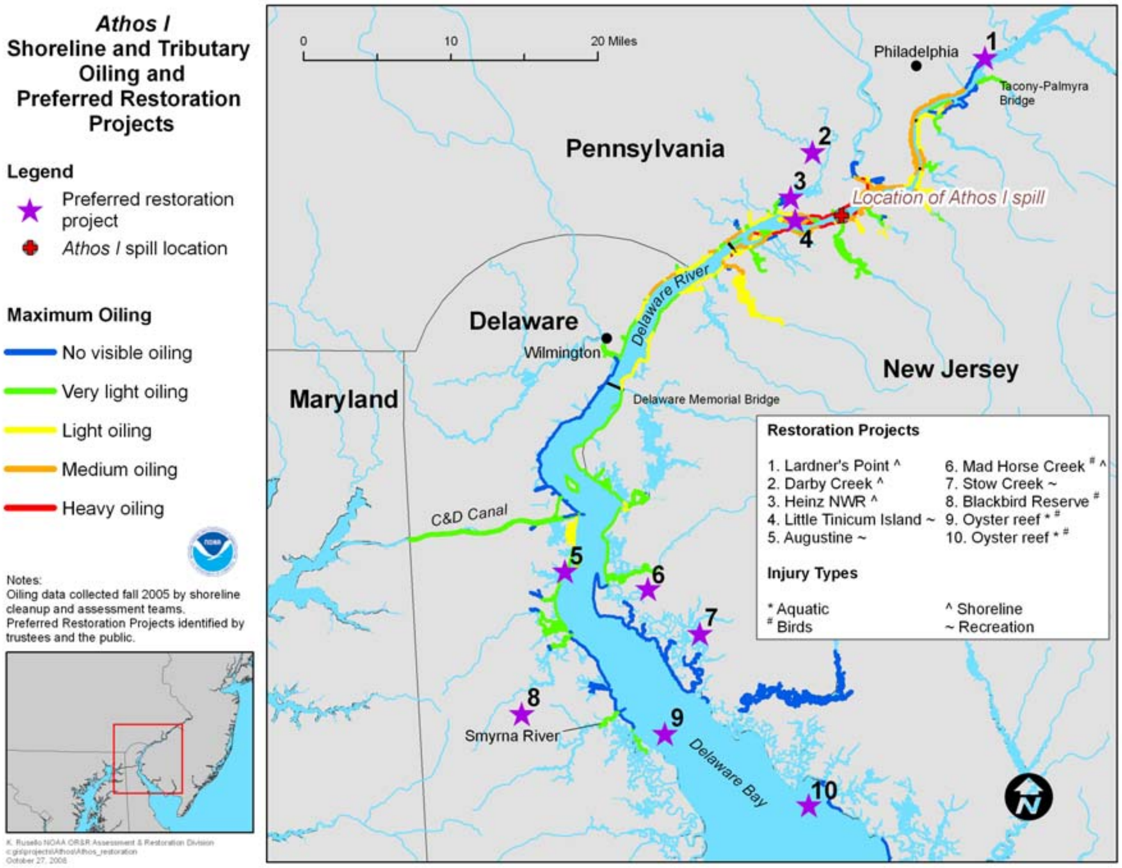


Figure 8. Approximate location of restoration projects and origin of the *Athos* oil spill.

Project Description - Lardner's Point

The Lardner's Point proposed restoration site is located in the greater Philadelphia region, at the northern end of the area oiled by the *Athos* spill. Just west of the Tacony-Palmyra Bridge, the site is situated in the Tacony neighborhood of Philadelphia, bordering the west bank of the Delaware River. Lardner's Point is the former home of a river ferry that provided service between Tacony and Palmyra, prior to the construction of the Tacony-Palmyra Bridge in 1929. Following the completion of this bridge, ferry service ceased and the land remained inactive under the ownership of the City of Philadelphia and associated entities. Today, the 4-acre lot, still under city ownership, is a barren industrial site, consisting of a deteriorating concrete pad in the north section, with a dilapidated ferry dock and boat ramp on the eastern shoreline. The remainder of the site is vegetated with invasive species.

Conceptual restoration plans for the site (Figure 9) have been developed jointly by the Delaware River City Corporation, Pennsylvania Environmental Council, and Fairmount Park Commission, and include multiple shoreline, upland, and recreational components. The project is a key access point for the North Delaware Riverfront Greenway, which would enhance riverfront access. The shoreline restoration component proposed to compensate for a portion of the *Athos* losses involves demolishing existing structures, removing debris, importing fill material, grading the site to restore tidal inundation, and creating and planting intertidal marsh and wet meadow habitat. A "living shorelines" approach would be used, with excavated rock forming a toe sill at the marsh edge to stabilize the area and protect it from erosion. A total of 0.9 acres of intertidal marsh and wet meadow would be restored.

The State of Pennsylvania would serve as the LIT, with Trustee Council oversight.

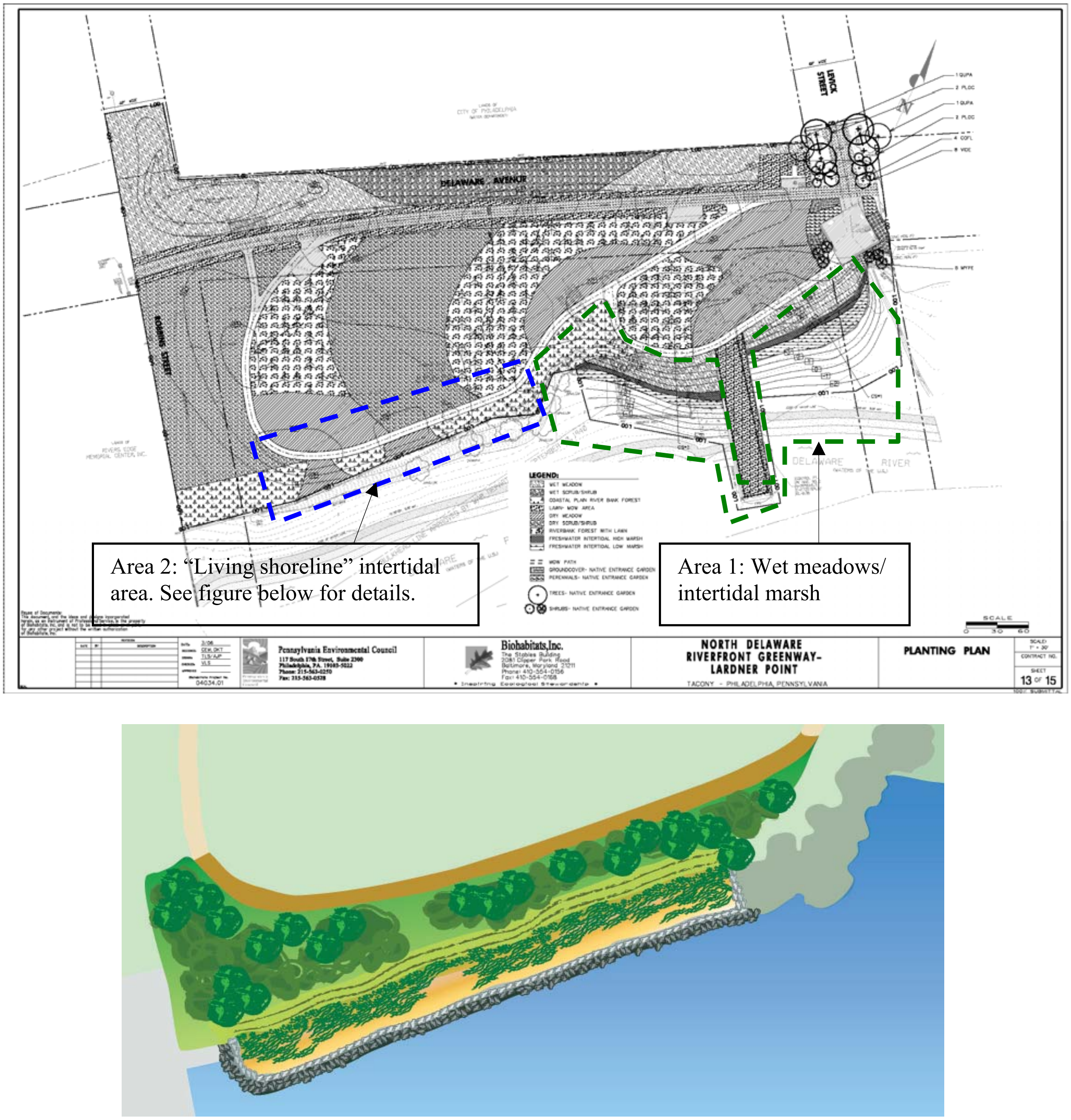


Figure 9. Lardner's Point conceptual restoration plan. Approximate areas proposed as part of the *Athos* restoration plan are outlined. Additional details for "living shoreline"/intertidal area shown in bottom image.

Restoration Objective

The objective of these two restoration projects is to provide 1,335 DSAYs of shoreline habitat to compensate for the lost shoreline services resulting from the spill.

Scaling Approach

The Trustees quantified a spill-related resource loss of approximately 1,335 DSAYs of shoreline habitat (Shoreline Assessment Team 2007), consisting primarily of injury to tidal flats (1,032 DSAYs) (Table 19). Given the lack of suitable tidal flat projects, the Trustees scaled injuries to tidal flats (and other non-marsh shoreline injuries) using marsh habitat, taking into account differences in the biogenic structure (generally represented as primary productivity) provided by the habitat.[19] The first step in scaling the injury is to therefore estimate all non-tributary shoreline injuries, in terms of marsh habitat, as marsh DSAYs. Created marsh would provide some of the same services as tidal flats, including habitat for benthic infauna and a site for primary and secondary production. Marsh would also provide many additional services, benefiting a wide-range of resources, above and beyond that provided by tidal flat habitat. Based on estimates of structural habitat provision from a range of studies on the east coast, an appropriate habitat equivalency ratio between intertidal flat and marsh is approximately 2.5:1 (Peterson et al. 2007).[20] Injuries to other mud/sand substrates (shorelines and the lower intertidal zone) are converted using the same ratio, due to similar characteristics and their relatively small contribution to shoreline injuries.

Rip-rap (the primary constituent of the "coarse substrate" injury) and seawalls are a relatively minor component of the total shoreline injury (157 DSAYs). Created marsh habitat would provide erosion protection, refuge for organisms, and a site for primary and secondary production. While rip-rap and seawalls can reasonably be expected to generate substantially less productivity per unit area than marsh, the Trustees have been unable to identify quantitative data that can be used to develop a "rip-rap and seawall to marsh" equivalency ratio. In the absence of such data, the Trustees adopt a 10:1 equivalency ratio between these habitats, based on qualitative comparisons and professional judgment applied to similar injuries in a past NRDA case (LOSCO et al. 2001).

Based on the above assumptions, shoreline injuries total 522.9 “marsh” DSAYs (Table 20).

---

[19] Structured habitats (e.g., marsh, oyster reef) have significantly higher levels of productivity at multiple trophic levels than do unstructured habitats (e.g., unvegetated tidal flat) (Peterson et al. 2007). The methodology compares relative productivity of the habitats and evaluates the contribution of physical structure (e.g., plants, reefs) to productivity.

[20] The ratio of 2.5:1 is based on productivity ratios derived from the level of structural provision (Peterson et al. 2007). The habitat equivalency ratio indicates that 2.5 acres of intertidal flat provides similar service to one acre of marsh. Therefore, to calculate the intertidal injury in terms of marsh DSAYs, the intertidal injury is divided by 2.5.

Table 20. Compensatory restoration acreage by habitat type.				
Habitat Classification	**Acres**	**DSAYs**	**Marsh DSAYs**[a]	**Marsh Restoration Acres**[b]
Marsh	117	60	60.0	4.5
Sand/Mud substrates	36	35	14.0	1.0
Lower Intertidal Zone	83	51	20.4	1.5
Tidal Flats	1,298	1,032	412.8	30.8
Coarse Substrates	137	127	12.7	0.9
Seawalls	59	30	3.0	0.2
Total	1,730	1,335	522.9	39

[a] Marsh DSAYs are calculated by dividing DSAYs by habitat equivalency factor (1 for marsh; 2.5 for sand/mud substrates, intertidal, and tidal flats; and 10 for seawalls and coarse substrates).
[b] Marsh restoration acres are calculated by dividing marsh DSAYs by the weighted average per-acre credit for restored marsh (13.4 DSAYs/acre).

The HEA method was used to determine the amount of marsh restoration needed to compensate for the losses resulting from the spill (NOAA 1999). 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 maximum 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, data from other damage assessment cases, and information in the scientific literature. The Trustees assume that marsh construction for Lardner's Point would begin in 2009, while Mad Horse Creek would begin in 2010.[21] Ecological services are expected to develop following a logistic model, reaching maximum service in 15 years (French McCay and Rowe 2003).[22] For Mad Horse Creek, a baseline ecological service of 10 percent is used. This reflects the minimal level of service provided by the current area of *Phragmites*-dominated, disturbed wetlands.[23] At Lardner's Point, a baseline ecological service of zero is used, reflecting the current state of the property, which is abandoned industrial upland, covered in invasive plants such as knotweed,

[21] The projected 2010 construction date for Mad Horse Creek is due to the scale of the project.

[22] Maximum ecological service for restored wetlands is generally considered to be less than 100 percent, due to the difficulties in creating a complex natural system. For example, the Chalk Point NRDA estimated the maximum potential service for restored wetlands to be 80 percent (NOAA et al. 2002). The differences in natural versus created marshes are discussed in Strange et al. (2002).

[23] Roughly 38 acres of the current Mad Horse Creek site targeted for restoration is a degraded *Phragmites* marsh. The remaining target area is more substantially filled and does not provide significant wetland services.

with a steep riverbank. The maximum service level for this project is estimated to be 85 percent, reflecting Trustee experience that restored marshes generally do not reach productivity levels associated with natural, fully functional marsh habitat. The maximum service of 85 percent is based on monitoring metrics, which require 85 percent coverage of desired vegetation, as well as additional hydrologic requirements. The project life span is estimated to be 50 years.[24] Based on these inputs and using the 3 percent annual discount rate typically applied in HEA calculations, each restored acre at Mad Horse Creek provides a credit of 13.4 service acre-years and each acre at Lardner's Point provides 15.6 service acre-years (see Appendix 3 for calculations). The 0.9 acre site at Lardner's Point provides 14 DSAYs; therefore, an area of 38.1 acres at Mad Horse Creek would compensate for the remaining 509 marsh DSAYs estimated above (Table 20). For the overall 39 acres of restoration, the average credit is 13.4 service acre-years.

Probability of Success

Mad Horse Creek and Lardner's Point restoration projects involve feasible and proven techniques with established methodologies and documented results. Local, state, and federal agencies have successfully implemented similar wetland creation projects in this region of the Delaware River. Thus, the Trustees believe that the projects have a high likelihood of success.

The Mad Horse Creek and Lardner's Point projects are located on land already owned by the government (NJDEP and City of Philadelphia, respectively). While final details of the marsh restoration projects remain to be fully developed, the Trustees would carefully monitor plant handling and installation to ensure that appropriate guidelines are being followed. With respect to revegetation efforts, all plant material would be inspected to ensure that it is healthy and vigorous, and would be protected during mobilization from drying and physical damage. Plants intended for use in these projects would be correctly labeled with scientific name and be native to the area. Furthermore, plants would be provided by certified nurseries that have been inspected by state and/or federal agencies, and seed shall have a designated percentage of pure live seed. Container grown plants would be treated with a slow-release fertilizer at the time of planting. Replanting would occur if a significant number of plants die. For these reasons, the Trustees believe that these projects have a high likelihood of success.

These projects are consistent with existing federal, state, and local restoration goals (as found in DRBC 2005; Partnership for the Delaware Estuary 2005; Kreeger et al. 2006; and Westervelt et al. 2006) for the Delaware River. Lardner's Point is a key public access point for the North Delaware Riverfront Greenway currently being developed by the Delaware River City Corporation. The Greenway projects involve broad support from various government partners (City of Philadelphia, State of Pennsylvania, National Park Service) as well as public officials and local civic associations and non-profit groups.

[24] The project lifespan is estimated based on the historic rate of sea level rise near the proposed sites. The rate for the Delaware River at Philadelphia is 3 mm/yr based on tidal gauges. A similar rationale was used for a 50-year marsh lifespan in the marsh restoration following the Chalk Point spill (NOAA et al. 2002), where historic rates of sea level rise in the mid-Chesapeake near the Patuxent River are also 3 mm/yr.

Performance Measures and Monitoring

Project performance at Mad Horse Creek and Lardner's Point would be assessed by comparing quantitative monitoring results to predetermined performance standards. These standards would be based on guidelines established by NJDEP for assessing wetland mitigation projects (Appendix 3). Restored habitats would be monitored twice a year, in early spring and fall, for five full growing seasons. Monitoring assessments would include documentation of hydrologic regime, soil characteristics, plant species present, and confirmation of planned site grading and elevation. At the end of the monitoring period, a survival rate of 85 percent of planted vegetation (and/or similar native vegetation) should be documented; less than 10 percent of plant species should be characterized as non-native, invasive, or noxious. At the conclusion of monitoring, the created wetland areas should be delineated using federal standards and the final acreage corroborated with compensatory requirements.[25]

The monitoring program for these two projects would use the standards described above to determine whether the project goals and objectives have been achieved, and whether corrective actions are required to meet the goals and objectives. In the event that performance standards are not achieved, or monitoring suggests unsatisfactory progress toward meeting established performance standards, corrective actions would be implemented. Possible corrective actions include regrading the area to proper elevations and replanting appropriate vegetation. Any necessary corrective actions would be funded by the contingency component of the project costs.

Approximate Project Costs

Table 21 provides a summary of expected costs for restoring 38.1 acres of marsh habitat at Mad Horse Creek and 0.9 acres at Lardner's Point. Estimated project costs of $188,000 per acre for Mad Horse Creek reflect site characteristics and Trustee experience with similar restoration projects in New Jersey. Following the design phase, a more detailed cost estimate would be available. The current estimate is based on similar projects conducted in the New Jersey/New York area, particularly the Woodbridge Creek marsh restoration project. The Woodbridge restoration consisted of 23.6 acres of wetland restored by the U.S. Army Corps of Engineers as mitigation for harbor dredging; an additional 8.7 acres at the site was restored for compensation following the 1990 Exxon Bayway spill. Overall, the project scope is similar to the proposed marsh restoration at Mad Horse Creek. The Woodbridge Creek site was dominated by *Phragmites*, requiring dredging and regrading to restore tidal flow and re-create the native salt marsh. The project included extensive planting of marsh plants and native vegetation. Final implementation costs at the Woodbridge Creek site are roughly $250,000 per acre, with a total project implementation cost of roughly $6.4 million.

Estimated costs for the Lardner's Point project were obtained from site-specific planning work performed by Biohabitats, Inc. Monitoring costs for both projects reflect New Jersey monitoring

[25] Specifically, wetlands will be delineated using the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation 1989).

experience for similar restoration projects, consistent with monitoring requirements identified in the Performance Measures and Monitoring section. A 25 percent contingency (Table 47) is included to cover the risk that (1) the costs of the project turn out to be higher than expected; and/or (2) the project does not result in the expected magnitude of benefits and needs augmentation. As shown, estimated project costs total $7,154,875 for the Mad Horse Creek Project and $567,137 for the Lardner's Point project.

Table 21. Summary of project costs: Mad Horse Creek and Lardner's Point restoration projects. ***COSTS ARE NOT FINAL***

Cost Element	Cost
MAD HORSE	
Planning and Design	$107,040
Construction	$6,862,057
Monitoring	$155,587
Operation and Maintenance	$30,191
TOTAL*	**$7,154,875**
LARDNER'S POINT	
Planning and Design	$95,702
Construction	$359,520
Monitoring	$69,346
Operation and Maintenance	$42,569
TOTAL*	**$567,137**
Notes:	
* Total project costs do not include contingencies of 25% which are shown in Table 47.	

5.5.1.2 Restoration of Tributary Losses: Dam Removal and Riparian/In-stream Habitat Restoration on Darby Creek and Habitat Restoration at John Heinz National Wildlife Refuge

The Trustees determined that approximately 1,899 acres of tributary habitat—shorelines, extensive wetlands, intertidal flats, and shallow benthic habitats—injured by the *Athos* oil spill equaled a spill-related resource loss of approximately 524 DSAYs. To compensate for this loss, the Trustees propose two restoration projects. The first is removal of three dams and a remnant bridge pier from Darby Creek in southeastern Pennsylvania, followed by restoration of the in-stream and riparian areas. In addition to habitat improvement, this project would open approximately 2.6 miles of the creek to anadromous fish. The second project would be undertaken at John Heinz National Wildlife Refuge (NWR), located near the mouth of Darby Creek, and would create a series of tidally connected channels, shallow pools, and fringing wetlands functionally similar to tributary habitat in a currently unproductive portion of the Refuge dominated by heavy stands of the invasive species *Phragmites australis*.

Project Description: Darby Creek

Darby Creek, in southeastern Pennsylvania, (Figure 10) currently has three low dams and a remnant bridge pier that interfere with stream flow and the movement of anadromous fish (Sara Strassman, American Rivers, personal communication) (Table 22). The first proposed project would remove the four obstructions and implement in-stream and riparian restoration for up to 1,000 feet upstream and downstream of the current obstructions.

Table 22. Description and location of Darby Creek obstructions.

Obstruction	Location (River Mile)	Owner	Height (feet)
Colwyn bridge pier	7.31		n/a
Dam 1: Darby Borough	7.91	Borough of Darby	6
Dam 2: Hoffman Park	9.63	SEPTA[a]	4
Dam 3: Kent Park	10.1	Delaware County	6
End of Reopened Stream Reaches	10.51		

[a] Ownership of the Hoffman Park dam is historically uncertain, but the Pennsylvania Department of Environmental Protection (PADEP) is satisfied that Lansdowne Borough would take responsibility.

Downstream of the first dam, a variety of anadromous fish are found, including alewife, striped bass, and shad (NOAA 2003). Dam removal is expected to restore normal stream channel flows and facilitate passage of anadromous fish into the upper watershed. Riparian restoration and enhancement following dam removal would improve the general health of the creek and provide highly functional tributary habitat.

The first obstruction is the Colwyn bridge pier. The remnant bridge pier is the remainder of an abandoned railroad bridge. The steel and concrete pier interferes with sediment transport and creates debris jams, which caused localized flooding, leading to damages to riparian and in-stream habitat. Surrounding the pier footings are accumulated debris and an impounded area, covering roughly 0.2 acres. The restoration consists of removing the center and right bank piers to below grade, excavating the impounded sediments and debris, and regrading the streambed. Due to the very steep embankments in the area, limited riparian restoration is planned. At the Colwyn Pier location, the majority of sediment upstream of the structures was predominantly a sand bar behind the central pier. The maximum depth recorded by the land surveyor was 1.7 feet; however, the maximum sediment depth on the downstream reach was 1.6 feet. Once the pier is removed, this sand bar should be redistributed with little to no impact to downstream natural resources. It is estimated that the delta upstream of the piers contains 770 cubic yards of coarse grained sediment. Based on our field observations and sediment analysis, the sediment delta that formed upstream of this structure will redistribute over time and not put an undo loading on downstream resources.

The Darby Borough dam is currently partially breached, as one half of the dam has been largely washed away. The habitat has been degraded due to sediment trapping and undercutting of the banks, with an artificially straightened channel. The design plans call for creation of additional stream length in the portions of the straightened channel, as well as the creation of bed topography and habitat that would be sustained by the restoration of dynamic flows. Extensive grading and reconstruction of the streambed and floodplain are planned. The riparian landscape plan includes a combination of wetland seeding, lowland and upland shrubs, and meadow seeding. To the extent possible, existing trees would be incorporated into the design, and additional trees are planned, such as maples, river birch, and viburnum. The sediment volume is estimated to be 600 cubic yards and will require removal to access the concrete structures for demolition. This material could be disposed just outside of the streambed, within Bartram Memorial Park. The remaining sediment upstream of the dam structure would not require mitigation or management due to it similar grain size distribution to the upstream and downstream reference reaches. Therefore, it is expected that this material will redistribute over time, without negative impacts to downstream resources.

Following removal of the Hoffman Park dam, the impounded sediments would be removed from the streambed and the site restructured. A small portion of the dam would remain on one side to allow fishing access. Removal of a portion of the structure will require the excavation of sediment immediately behind the dam. Due to the granular nature of the impounded sediment, it is expected that only the removal of sediment that impedes the demolition of the dam (180 cubic yards) will be required. This sediment would likely be disposed of within the adjacent Hoffman Park fields. The remaining impounded sediment which consists of a grain size distribution and low organic content similar to the overall stream could remain in place and allow for riverine processes to redistribute the materials. One bank would be contoured with a boulder toe and coir blocks with rooted live cuttings, covering more than 500 linear feet.

Following dam removal at the Kent Park dam, the channel would be regraded and lined with river stone. The current open grass area adjacent to the creek would be graded and vegetated with a combination of wetland seeding, lowland and upland shrubs, and meadow seeding. Due to the highly organic nature of the material and its relatively fine grain size distribution, when compared to the reference reach samples, the impounded material would be dredged prior to complete dam removal. It has been quantified that this reach contains up to 3,000 cubic yards of sediment behind the structure, extending to the North Marple Street bridge. However, due to the existence of an open field adjacent to the impoundment, the sediment could be simply placed within this open area. Based on measurements obtained during the survey, this sediment could be distributed within the field at a wet depth of 1.2 feet. It is anticipated that due to the organic nature of the material and its high moisture content (77%), the final height of material after dewatering would reduce less than 12 inches.

The state of Pennsylvania would serve as the LIT, with Trustee Council oversight, for the Darby Creek project.

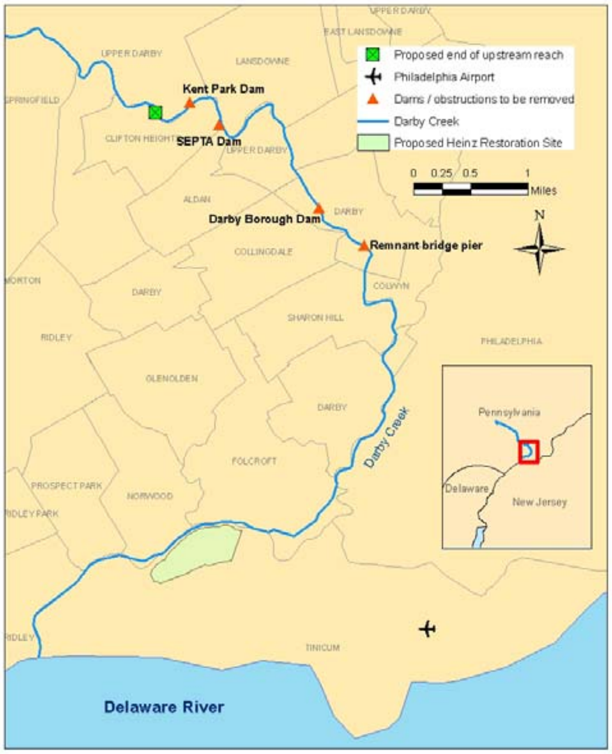


Figure 10. Location of Proposed Restoration Projects for Tributary Injuries.

Project Description: John Heinz National Wildlife Refuge (NWR)

The Henderson Dike Area (Figure 11) at John Heinz NWR, also known as FL-4 in the Refuge's restoration plan, was historically a freshwater tidal wetland, but was used as a dredge material disposal site by the U.S. Army Corps of Engineers (USACE) until the mid-1960s. Recent mitigation projects (the Blue Route Mitigation Site (1992) and the Philadelphia International Airport Mitigation Site (1996)) have begun to return the area to its tidal wetland status. Both of these projects involved the removal of organic fill and the restoration of tidal exchange. The remaining unrestored area on-site comprises 56 acres and contains approximately 2 to 4 feet of fill. This area is currently minimally affected by tidal influence and is dominated by an invasive plant species, *Phragmites,* which severely limits its habitat value for wildlife. To restore this area, former restoration plans called for the removal of several feet of fill and restoration of tidal exchange. This plan was considered; however, the excessive costs and placement of the spoils presented difficulties.

On further consideration, a proposal to excavate a series of channels and pools and place the material adjacent to the pools to form saturated scrub/shrub wetlands was developed. The 7 acres of channels and pools would restore tidal flow to the area and allow wild rice seed and other native plants to be transported into the wetland interior with the tide. Indirect benefits to the remainder of the 56-acre parcel would result from occasional flooding/flushing during storm surges and/or other high tide events, leading to modest ecological improvements throughout the entire site. The channels would also provide habitat for numerous anadromous fish species. A detailed alternatives analysis will be conducted to determine the most cost-effective design to increase tidal exchange to the site including various channel alignments, breaching of the dike, and alternative disposal options. While flooding as a result of increased tidal exchange would potentially lead to decreased stands of *Phragmites*, the affected areas would require periodic treatment into the future. The proposed scrub/shrub wetland areas would also enhance the habitat functions of the marsh by creating potential nesting sites for reptiles and waterfowl, and roosting sites for wading birds.

The U.S. Fish and Wildlife Service would serve as the LIT, with Trustee Council oversight, for the John Heinz NWR project.

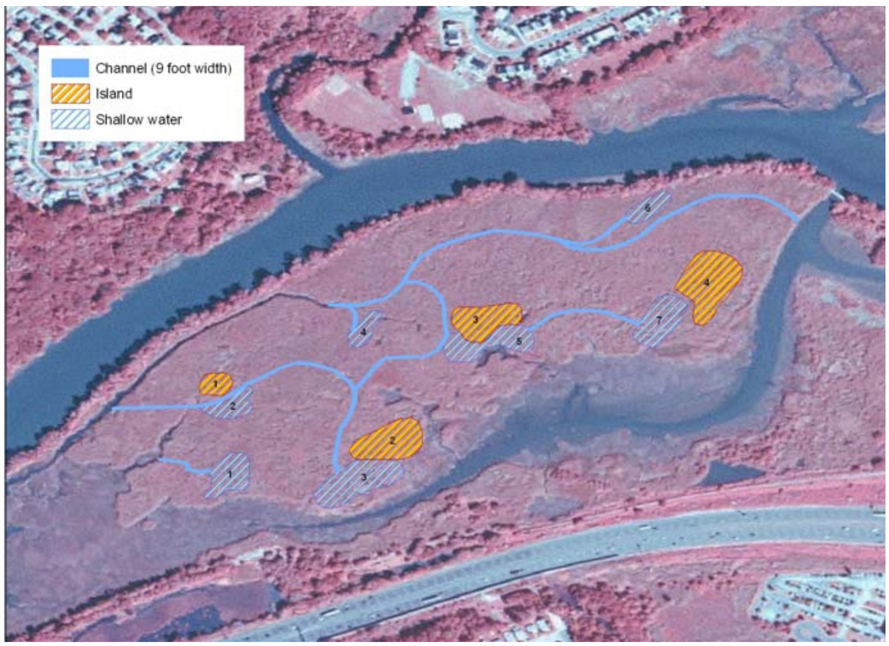


Figure 11. Conceptual plan for the John Heinz NWR Restoration Project. Blue lines represent proposed channels. Yellow and blue shaded areas are proposed shallow ponds.

Restoration Objectives

The objective of the two restoration projects is to provide 524 DSAYs of ecological benefit to tributary resources. Dam removal would allow use by anadromous fish, similar to those found in unobstructed reaches injured by the *Athos* oil spill, and would improve the in-stream conditions for other fish. Restoration of normal stream channels through removal of the dams and remnant bridge pier also would enhance sediment transport and reduce sediment deposition, providing ecosystem enhancement. Riparian and in-stream habitat projects would improve habitat for diamondback terrapins, wading birds and shorebirds, and other fauna that make use of shoreline habitat (Shoreline Assessment Team 2007). Marsh restoration at John Heinz NWR would restore habitat similar to the tributary wetlands and intertidal habitat injured in the spill.

Scaling Approach

The Trustees calculated a spill-related tributary resource loss of approximately 524 DSAYs (Shoreline Assessment Team 2007). The injury to tributaries is scaled to a stream restoration project in Darby Creek and to a habitat restoration at John Heinz NWR. As described in more detail below, the Darby Creek restoration project is quantified as generating approximately 234 DSAYs of tributary ecological benefit, and the NWR restoration project is expected to generate approximately 222 DSAYs of tributary ecological benefit, for a quantified total of approximately 457 DSAYs. Although less than the quantified tributary resource loss (524 DSAYs), the Darby Creek project provides additional benefits to anadromous fish that are not quantifiable on the acre scale on which the injury was calculated. Given the desirability of these outcomes, the Trustees believe that the proposed restoration projects are appropriately sized to offset *Athos*-related tributary injuries.

Darby Creek Dam Removal

The first proposed restoration project—Darby Creek dam removal and riparian/in-stream restoration—would result in increases in diadromous fish, particularly the American shad, as well as likely improvements in vegetation and macroinvertebrates and a decrease in localized flooding near dams during high water events. While not completely prohibiting the movement of migratory fish, the remnant bridge pier and the Darby Borough dam interfere with stream flow and streambed structure and cause flooding events (D. Kristine, personal communication); their removal is essential to realize the in-stream ecological improvements from dam removal. General habitat improvements from the removal of the four obstructions would include an increase in occasionally inundated riparian areas (i.e., an increase in fringing wetland) in upstream areas (Shafroth et al. 2002). Species shifts in macroinvertebrates and fish species from slow to fast moving water are also generally observed in the former impoundments upstream of small dams (Hart et al. 2002).

Recent research on the effects of small dam removal has resulted in several models of ecosystem improvements. Doyle et al. (2005) synthesized several small dam removal studies in Wisconsin to examine how the physical effects of dam removal (e.g., changes in channel form, habitat type) affected riparian vegetation, fish, macroinvertebrates, and nutrient dynamics.[26] Different

[26] While the dams studied in the paper are located in Wisconsin, the Trustees expect similar responses in Pennsylvania due to similarities in dam type and age and stream width. Those reviewed in Doyle et al. (2005) are also century-old dams on small channels with declining structural integrity. Impoundments are reasonably small but have silted in considerably over the past hundred years. Widths were similar, with 30-130 ft for Darby Creek and 40-90 ft in Wisconsin. The most significant difference in the potential dam removal projects is the prevalence of mussels in the Wisconsin waterways, which can be detrimentally affected by dam removal, and the potential for diadromous fish passage following dam removal, which is not relevant in the Wisconsin creeks. Mussels are not prevalent in Darby Creek. Similar dam removal projects have been undertaken by the Pennsylvania Fish and Boat Commission (PFBC) and other federal, state, and non-profit organizations in Pennsylvania (e.g., Wyomissing Creek, Schuylkill River, Conestoga River). These projects demonstrate

components of the ecosystem recovered at different rates. Riparian vegetation appeared to require the greatest time to reach a new equilibrium, while macroinvertebrates required the shortest time.

To evaluate the effect of dam removal on fish communities, Doyle et al. (2005) used habitat index values to estimate the relative value of habitat following dam removal. The index uses quantitative habitat characteristics such as riffle occurrence, cover for fish, and substrate type to value habitat on a 100-point scale in regions upstream and downstream of a small dam removal (Kanehl et al. 1997). In areas upstream of the dam removal, particularly in the impounded area, the study authors observed a significant improvement over a 5-year period in habitat value (increase of 40 percentage points in the first mile, 55 percentage points in the next half mile, and 10 percentage points for the following half mile, Table 23).[27] The first two reaches are representative of impounded areas, while the third reach upstream represents habitat upstream of the impoundment. While only a small reach downstream of the dam was evaluated (0.8 miles), an increase of 15 percentage points occurred in that area (Doyle et al. 2005).

Table 23. Increase in habitat index values 5 years after dam removal.

	0-0.8 miles downstream	0-1 mile upstream	1-1.5 miles upstream	1.5-2.1 miles upstream
Habitat Index Increase over Five Years	15	40	55	10

Habitat Index values are based on a 100-point scale. Source: Doyle et al. 2005

For scaling purposes, the Trustees applied similar habitat index improvements to those found in Doyle et al. (2005) following dam removal (Table 23) to the Darby Creek restoration project. Based on the size of observed impoundments upstream of the obstructions, the Trustees would not expect to see improvements for the length upstream indicated by Doyle et al. (2005). Therefore, they rely on the physical characteristics of the creek and recommendations of local experts (e.g., PFBC and American Rivers) to identify the likely areas of major instream improvement. These areas of "major" improvement are considered comparable to the first two upstream zones described by Doyle et al. (2005). Therefore, a habitat improvement of 50 percent

significant improvements to biotic communities and stream flow, although not providing a quantitative estimate of ecological improvement. Return of anadromous fish (Conestoga, Schuylkill), improvements in growth and survival of wild or stocked fish (Wyomissing, Conestoga), and increases in macroinvertebrate diversity and abundance (Conestoga) have all been noted (PFBC 2007).

[27] The current impoundments on Darby Creek may not extend to 1.5 miles upstream of the obstructions; however, benefits in the third category (1.5 to 2.1 miles upstream) are representative of improvements to the habitat index above the impoundments. Additionally, substantial benefits were recorded for fish (a greater than 10 times increase in biomass for the indicator species, smallmouth bass) in the area above the impoundment (Kanehl et al. 1997). Therefore, we maintain the same distances and improvements used in Doyle et al. (2005).

is assigned to the "major" improvement areas. Adjacent creek areas are expected to have smaller but measurable benefits; given the difficulty in determining this area, an estimated area of half the "major" improvement zone is used. A habitat improvement of 15 percent, comparable to the 1.5 to 2.1 miles upstream zone, is used for the minor improvement areas.

The HEA method was used to determine the scope of restoration necessary to compensate for the losses resulting from the spill (NOAA 1999). 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, data from other dam removals in Pennsylvania, and information in the scientific literature. The Trustees assumed that the dam removal would take place in 2009. Linear improvements to the levels described above and shown in Tables 24 and 25 were assumed to occur over a 5-year period following project implementation.[28] Benefits were assumed to accrue in perpetuity, given that most of the restoration would occur in areas adjacent to or on parklands and in areas unlikely to be affected by sea level rise. Based on these inputs and using the 3 percent annual discount rate typically applied in HEA calculations, an acre of streambed with 5 percent uplift would provide a credit of 1.48 DSAYs.[29] Values for each restoration area, reflecting length, width, and ecological uplift, are shown in Table 24 (see Appendix 3 for detailed calculations). Overall, removal of the bridge pier and the three dams and associated in-stream restoration projects are expected to provide a credit of 108 DSAYs.

[28] Based on Doyle et al. (2005), the Trustees presume that most habitat improvements occur within 1 to 5 years.

[29] Five percent is used as a basis for calculations. Therefore, a 1-acre area with 10 percent uplift would provide 2.96 DSAYs (2 * 1.48).

Table 24. Characteristics and ecological benefits of obstruction removal and in-stream improvements for each site on Darby Creek.

	Anticipated Area of In-stream Improvements			**Primary Benefit[d]**	**Secondary Benefit**
Obstruction	*Width (ft)[a]*	*Length (ft)[b]*	*Acres[c]*	*DSAYs*	*DSAYs*
Colwyn Bridge Pier	72	960	1.59	23.5	3.5
Darby Borough Dam	66	1280	1.94	28.7	4.3
Hoffman Park Dam	56	680	0.87	12.9	1.9
Kent Park Dam	80	1067	1.96	29.0	4.3
Total			**6.36**	**94.1**	**14.1**

[a] Width is calculated from the "top of bank" line and/or "ordinary high water line" on engineering schematics provided by American Rivers.
[b] Length of major improvement area is estimated from stream structure and professional judgment (American Rivers).
[c] In-stream acreage is calculated as segment length (in feet) multiplied by average segment width (feet), divided by 43,560 square feet per acre.
[d] Primary benefit occurs in the “major improvement area” and is estimated at 50 percent improvement. Secondary benefit occurs in an area half the size of the major improvement area and is estimated at 15 percent improvement. Parameters for DSAY calculations are provided in Appendix 3.

Improvements to the riparian buffer zone would provide additional ecological benefits. As described above, a portion of the *Athos* spill-related injuries occurred in shoreline and wetlands areas along the six affected tributaries. The current riparian zone is minimally functional in many areas of Darby Creek, particularly where obstructions in the river have washed out adjacent banks and loaded debris onto floodplains. Several areas are covered in invasive plants such as Japanese knotweed. Dam removal would naturally enhance these areas due to creation of wetlands and reductions in extreme flooding events (Shafroth et al. 2002). Additionally, direct riparian restoration would take place in the vicinity of the dams after removal. Based on current landscape plans for the project, the expected direct restoration/enhancement area is approximately 4.5 acres (Table 25). Anticipated work includes stream bank stabilization, grading, riparian vegetation, and in-stream vegetation. (Additional information for each obstruction is provided in the project description.) The projects would be converting minimally functional riparian habitat into fully-functioning riparian buffer zones.

For restoration scaling purposes, uplift assumptions applied to the wetlands revegetation projects are applied to the riparian improvements. Similar to *Phragmites*-dominated, degraded wetlands, a baseline ecological value of 10 percent is applied, reflective of the invasive species and minimal connectivity. A maximum ecological service of 85 percent is used, comparable to values used for Mad Horse Creek and Lardner’s Point, for a net improvement of 75 percent. Similar to the in-stream restoration, a smaller improvement in areas adjacent to the direct major improvements is assumed, due to the improved seed bank and the reduced bank erosion and siltation as a result of in-stream improvements. The Trustees assume an area half the size of the direct revegetation area, and with half the overall improvement (i.e., a net improvement of 37.5

percent). Overall, the dam removal project would create 4.5 acres of direct buffer habitat restoration (primary benefit), with an additional 2.3 acres of indirect improvement (secondary benefit), which would provide 126 DSAYS (Table 25). The combination of riparian restoration (126 DSAYs) with the calculated benefits for dam removal on Darby Creek (108 DSAYs, Table 24) would provide approximately 234 DSAYs of quantified ecological benefit. As noted previously, additional benefits are expected to accrue from the restoration of diadromous fish; however, these benefits are not quantifiable on the DSAY scale used to calculate injury.

Table 25. Ecological uplift approximations for riparian buffer enhancement.

	Riparian Improvement[a]	**Primary Benefit**	**Secondary Benefit**
	Acres	*DSAYs*	*DSAYs*
Colwyn Bridge Pier	none	0.0	0.0
Darby Borough Dam	2.66	59.1	14.8
Hoffman Park Dam	0.19	4.3	1.1
Kent Park Dam	1.69	37.5	9.4
Total	**4.54**	**100.8**	**25.2**

[a] Riparian improvement areas are calculated from landscaping plans provided by American Rivers. Primary benefit applies to entire area; secondary benefit applies to an additional 50 percent.
[b] DSAY calculations are described in Appendix 3.

John Heinz NWR Habitat Restoration

The scaling approach for the NWR habitat restoration includes two components: 1) the calculation of ecological benefits (measured in DSAYs) directly resulting from the creation of tidally connected channel and pool habitat; and 2) the calculation of (relatively modest) indirect benefits to the remainder of the site resulting from occasional flooding/flushing during storm surges and/or other high tidal events. These calculations are summarized below.

Final project design would reflect the results of a detailed alternatives analysis and final design plan to be undertaken in the future. However, a planning-level design (Figure 11) has been developed by the Trustees based on site visits, site-specific technical data, and consideration of various restoration design alternatives. This design would result in the creation of approximately 4.5 acres of shallow pools, 1.2 acres of channels, and 1.3 acres of channel buffer habitat.[30] For scaling purposes, this would result in restoration of approximately 7.0 acres of restored habitat that is expected to be functionally similar to tributary habitat. This approach is consistent with Trustee tributary injury calculations, which combined tributary subtidal, intertidal, and a small width of adjacent shoreline acreage into a total acreage of injured "tributary habitat."

[30] For scaling purposes, ecological benefits of channel creation are assumed to extend 5 feet to either side of the excavated channel. This approach is consistent with tributary injury calculations, which included 5 feet of shoreline on both sides of injured tributaries.

Scaling calculations for the 7.0 acres that would directly benefit from restoration activities assume an ecological uplift of 70 percent. This assumption reflects the fact that much of the site is currently covered by a mat (several inches to greater than 12 inches) of *Phragmites*, which exports minimal productivity to the tributary system. The site has been in this condition for several years; recovery of the native vegetation has been very slow due to the presence of the *Phragmites* and a lack of tidal flushing. This mat would be removed in excavated channel and pool areas, and elevations lowered sufficiently to turn these 7.0 acres into what the Trustees expect would be fully functioning, tributary-like habitat. A rapid improvement in ecological services is expected for the Heinz project following the physical creation of channels and ponds. Similar to improvements following dam removal, the Trustees expect to see rapid improvement in the first few years following project implementation. For benefit calculations, a linear improvement in the first 3 years is used. Baseline ecological services for the site as tributary habitat are estimated at 10 percent. Following restoration, the Trustees estimate maximum ecological services of 80 percent. Restoration is assumed to begin in 2010, and provide a 23 percent uplift in 2010, 47 percent uplift in 2011, and 70 percent uplift in 2012 (and future years). Restoration benefits are summed through 2059, reflecting the expectation that ecological benefits are likely to be sustained for several decades. Consistent with standard practice in scaling calculations, future benefits are discounted at an annual rate of 3 percent. Based on these parameters, the "direct" benefits of creating approximately 7.0 acres of channel and shallow pool habitat total approximately 114 DSAYs (see Appendix 3 for detailed calculations).

Scaling calculations also include "indirect" benefits expected to accrue to the remaining 49 acres at the site. Creation of tidally connected channels and shallow pools throughout the site would occasionally expose this larger area to tidal inundation during storm surges and/or other high tide events. The areas surrounding the channels and ponds would experience increased flooding and seed distribution, resulting in general improvements to the tributary services provided by the area. Areas closest to the channels may experience significant improvements, possibly doubling in service levels, but improvements would lessen with distance from the channelizations. Due to the uncertain nature of the coverage of the improvements, a general uplift of 10 percent is used for the entire parcel surrounding the new channels and ponds. More specifically, scaling calculations assume 3-percent uplift in 2010, 7 percent uplift in 2011 and 10 percent uplift in 2012 (and future years). Benefits are summed through 2059 and discounted at an annual rate of 3 percent, consistent with scaling calculations for the 7.0 site acres proposed for excavation. Based on these parameters, the "indirect" benefits of the proposed project to the remaining 49 site acres total approximately 114 DSAYs (see Appendix 3 for detailed calculations).

Probability of Success

Dam removals are frequently undertaken in Pennsylvania. Since 2000, the Pennsylvania Fish and Boat Commission (PFBC), Pennsylvania Department of Environmental Protection (PADEP), American Rivers, USFWS, NOAA, and other partners have implemented the removal of 15 dams and currently have over 35 active dam removal projects in the Delaware Basin. All three dams proposed for this project are currently owned by public entities (Borough of Darby, Southeastern Pennsylvania Transportation Authority (SEPTA), or Delaware County). PFBC has maintained an extensive hatchery program for American shad over the last 20 years and now includes hickory shad as well, and has stocked millions of fry in the Delaware River/Estuary watershed. Given the extensive experience that PFBC, American Rivers, and other agencies have in the area with dam removal and fish re-introduction, the Trustees believe that this project has a high likelihood of success.

The John Heinz NWR habitat restoration project is located within a previously established national wildlife refuge. Similar projects have already been undertaken within the refuge and have met with success. The restoration approach (i.e., excavation of channels and pools) is straightforward and highly likely to be implemented successfully and substantially improve ecological conditions at the site through removal of thick mats of dead *Phragmites* and improvements in tidal connectivity at the site.

Performance Measures and Monitoring

For the dam removal project, project performance would be assessed based on changes in physical habitat, presence and absence of fish species and numbers, and macroinvertebrate populations. Monitoring for these parameters would be conducted before removal and at 1-year intervals for the first 5 years following completion of the project. The protocols for monitoring would be tailored to be site-specific and a detailed monitoring plan will be developed prior to the removal of the dams. Completion of this monitoring program would indicate whether the project goals and objectives have been achieved, and whether corrective actions are required to meet the goals and objectives.

In the event that performance standards are not achieved, or monitoring suggests unsatisfactory progress toward meeting established performance standards, corrective actions would be implemented. Possible corrective actions include (but are not limited to) regrading riparian fringes and replanting appropriate vegetation. These corrective actions would be funded by the contingency component of the project costs (Table 47).

For the habitat restoration at John Heinz NWR, project performance would be assessed through both construction performance and vegetation performance. Channel/pond area, flow, and depth would be measured to ensure that they are sufficient for tidal exchange. Buffer plantings would be monitored to ensure biodiversity and plant survival. Restored habitats would be monitored once a year at the end of the growing period for five full growing seasons. Monitoring assessments would include documentation of hydrologic regime, soil characteristics, plant species present, and confirmation of planned site grading and elevation. At the end of the monitoring period, a survival rate of 85 percent of planted vegetation (and/or similar native vegetation) should be documented; less than 25 percent of plant species should be characterized as non-native, invasive, or noxious. If the area contains greater than 25 percent non-native, invasive, or noxious plant species, the area would be treated and a second monitoring period would be conducted to determine the effectiveness of the action. Any corrective actions would be funded by the contingency component of the project costs (Table 47).

Approximate Project Costs

Table 26 provides a summary of expected costs for removing three dams and one remnant bridge pier from Darby Creek and restoring 4.5 acres of riparian habitat to compensate for injuries to tributaries. The Trustees have determined dam removal and riparian restoration cost estimates based in part on preliminary plans developed by American Rivers. Monitoring costs include PFBC staff time, equipment use, and subcontractor identification of macroinvertebrate species. Contingency values of 25 percent are shown in Table 47.

Table 26. Summary of project costs: Darby Creek restoration project. ***COSTS ARE NOT FINAL***

Cost Element	Cost
Planning and Design	$101,828
Construction	$734,349
Monitoring	$202,051
Operations and Maintenance	$2,592
TOTAL*	**$1,040,820**

Notes:
* Total project costs do not include contingencies of 25% which are shown in Table 47.

Table 27 presents estimated project costs for the improvement of 56 acres at John Heinz NWR. USFWS has prepared a detailed cost estimate for the project based on considerable past experience in wetlands restoration on NWRs. In the event that the alternatives analysis or permitting process indicates that on-site disposal is not allowable based on contamination, hydrology, or other concerns, a disposal contingency is included. A project contingency of 25 percent is included in Table 47.

Table 27. Summary of project costs: John Heinz National Wildlife Refuge Restoration project. ***COSTS ARE NOT FINAL.***

Cost Element	Cost
Planning and Design	$348,487
Construction	$1,922,996
Monitoring	$87,836
Operation & Maintenance	$37,240
TOTAL*	**$2,396,559**

Notes:
*Total project costs do not include contingencies of 25% which are shown in Table 47.

5.5.2 Alternatives to Address Aquatic Resource Injuries: Creating an Oyster Reef

The Trustees quantified injuries to the 412 acres of aquatic habitat exposed to *Athos* oil as a spill-related aquatic resource loss of 97 DSAYs (see Section 4.3.3). As described below, this quantification corresponds to a loss of 4,637 kg of benthic biota.

Project Description

The preferred compensatory restoration alternative for restoring 4,637 kg of benthic biota is to create 4.5 acres of oyster reef in the Delaware River. Both NJDEP and DNREC have established programs that create and enhance oyster beds either by direct placement of shell for natural spat settlement or a two-step process whereby shell is placed in high spat recruitment areas and then moved to areas that exhibit higher spat growth and survival. As described below, this project includes both methods to reduce the risk of project failure.

The direct placement method is proposed at the "Over the Bar" oyster beds on the Delaware side of the river (Figure 12). Shell would be placed in this historic seed bed, which currently has limited shell bottom and, as a result, low natural spat settlement rates and few adult oysters. Placement of shell during the spring and early summer would enhance the area, allowing settlement of oyster spat and recruitment of other reef-associated epifauna. Consistent with established methods employed by DNREC, the site would be seeded at a rate of 2,000 bushels/acre.

The two-step process is proposed in New Jersey portions of the River. Consistent with established oyster enhancement techniques in New Jersey, about 1,500 bushels of shell per acre would be placed in historic oyster bed areas with high spat recruitment/settlement rates (Figure 12). Three to six months following initial shell placement, spatted cultch would be harvested and transported upstream to *Athos* spill-exposed areas (e.g., the "Middle Seed" bed) (Figure 12) with lower natural mortality rates (particularly lower disease rates due to lower salinity). Shell density for replanting would be 1,000 bushels/acre. Due to constraints on available sites in the high spat area, this project would be implemented in roughly equal parts over three years, from 2009-2011. This would also decrease the likelihood of substantial project losses due to a "low" recruitment year.

Scaling calculations for both project types assume project implementation prior to mid-July of 2009 to 2011, oyster survival on the transplanted reef would be 5 years, and no harvesting of the oysters would be allowed during the initial 5-year period.

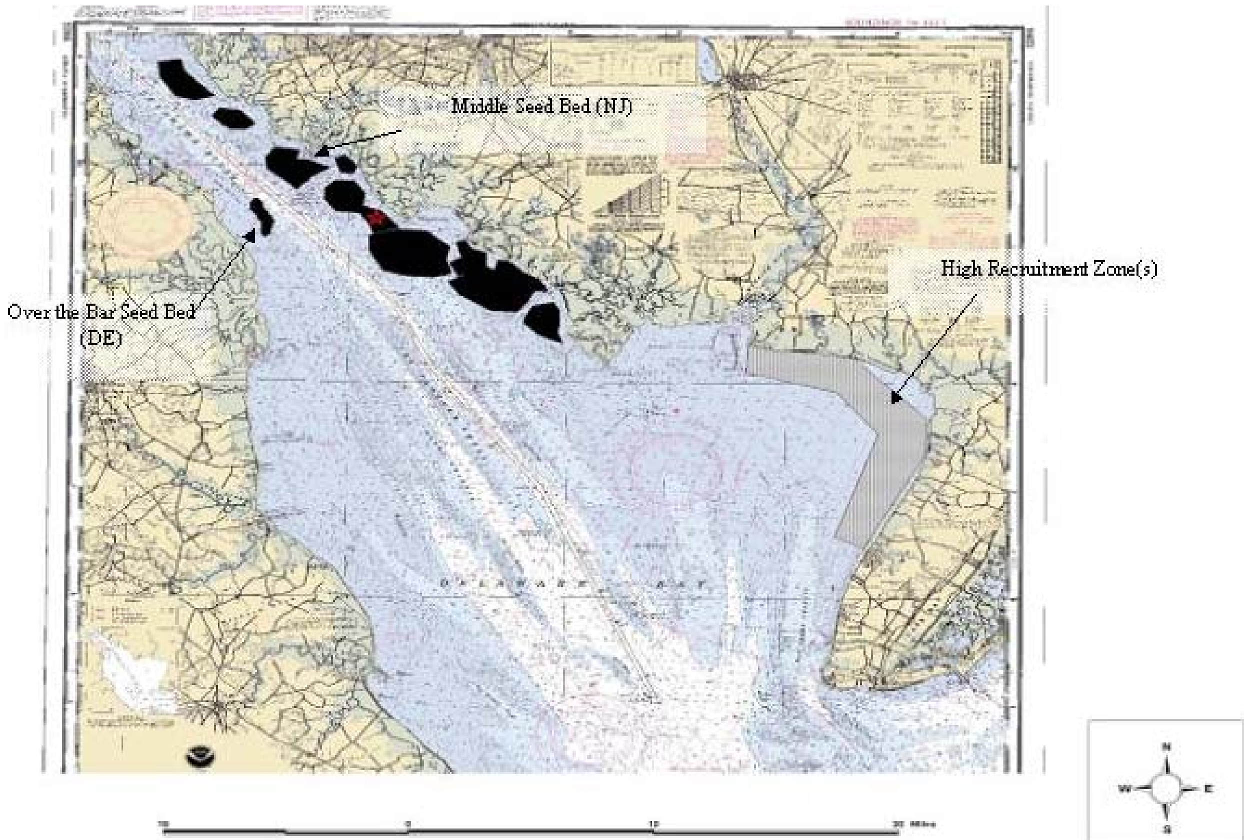


Figure 12. Locations of proposed oyster reef creation projects in Delaware and New Jersey, including location of the initial recruitment area and replanting area (Middle Seed beds) in New Jersey.

The states of Delaware and New Jersey would be the LITs for reef creation, respectively, with Trustee Council oversight.

Restoration Objectives

The objective of this project is to restore 4,637 kg of lost benthic biomass through the enhancement of equivalent benthic biomass associated with a created oyster reef. Placing shell and seeding oyster beds would directly enhance benthic habitat, with increased biomass generated by the seeded oysters and associated reef biota.

Scaling Approach

The Trustees quantified a spill-related aquatic resource loss of 97 DSAYs of benthic habitat (Aquatic TWG 2007). This estimate of lost area was converted to units of benthic macrofaunal biomass using an average benthic biomass density of 10.5 grams wet weight (ww) per m^2 (ECS

1993).[31] The ECS (1993) data were then converted to ash free dry weight (afdw), and multiplied by a productivity factor, which accounts for predation and the fact that many benthic biota are short-lived and replace their populations multiple times within each year (Howe and Leatham 1984). The resulting annual benthic productivity estimate is 47.8 kg (afdw) per acre per year. Therefore, a subtidal injury of 97 DSAYs translates to a benthic biomass loss of 4,637 kg (Table 28).

[31] ECS (1993) describes a 1-year comprehensive survey of the benthic macroinvertebrate communities of the Delaware River between the C&D Canal and Trenton, New Jersey. The survey evaluated the extent of recovery in benthic communities as a result of improved water quality following implementation of the Clean Water Act of 1972.

Table 28. Conversion of subtidal injury from DSAYs to biomass.			
Step	**Description**	**Value**	**Source**
1	Estimated Delaware River benthic biomass (g ww) per unit area (m^2)[a]	10.5 grams per m^2 ww	ECS 1993
2	ww to afdw conversion factor[b] 15%		Nichols 1975 Soltwedel 2000
3	Estimated Delaware River benthic biomass (g afdw) per m^2)[c]	1.6 grams per m^2 afdw	Calculated
4	Productivity to biomass ratio[d] 7.5		Howe and Leatham 1984
5	Estimated Delaware River benthic biomass (g afdw) per unit area (m^2) per year[e]	11.8 grams per m^2 afdw per year	Calculated
6	Square meters to acres conversion	4,046.86 m^2 per acre	Unit Conversion
7	Estimated Delaware River benthic biomass (g afdw) per acre per year[f]	47,804 grams per acre (afdw) per year	Calculated
8	Estimated Delaware River benthic biomass (kg afdw) per acre per year	47.8 kilograms per acre (afdw) per year	Unit Conversion
9	Estimated Delaware River benthic biomass (kg afdw) per acre per year for 97 acres[g]	4,636.9 kilograms (afdw) for 97 DSAYs	Calculated

[a] Value averages: a) the benthic biomass density estimate for the "Schuylkill River to Del./Pa. border" area (reported as a combined value for intertidal, shallow subtidal, and channel); and b) the shallow subtidal category (reported as average value for Delaware River from Trenton to C&D canal).
[b] Conversion values from literature most commonly ranged between 12 to 17 percent.
[c] 1.6 g (afdw) per m^2 = 15% * 10.5 g (ww) per m^2
[d] Value is for Delaware Bay. This ratio accounts for the fact that observed biomass densities (e.g., grams per square meter) do not capture the productivity of an area over time (e.g., grams per m^2 per year).
[e] 11.8 g (afdw) per m^2 per yr = 7.5 * 1.6 g (afdw) per m^2
[f] 47,804 g (afdw) per acre per yr = 4,046.9 * 11.8 g (afdw) per m^2 per yr
[g] 4,636.9 kg (afdw) = 47.8 kg per acre yr * 97 acre yrs

To estimate the amount of additional benthic biomass from the oyster reef, the Trustees rely on the model developed for an oyster reef restoration project in the Patuxent River, Maryland (French McCay et al. 2002, Appendix 3), augmented by site-specific data from the New Jersey and Delaware oyster restoration programs.[32] Parameters for mortality rates, average shell length

[32] The salinity range for the Patuxent River site (mesohaline, between 5-18 ppt) is similar to that of the likely nursery areas in the Delaware River (the “Middle Seed” bed in New Jersey and

by age class, and shell length to tissue weight ratio are based on values for the target beds or similar locations in the Delaware River (Powell 2005; Powell et al. 2007; DDFW 2007). The size and mortality parameters used for the Delaware River are presented in Table 29. The expected lifetime of the oyster reef in a low-salinity area is approximately 5 years, due in substantial part to substrate loss and lack of recruitment. Therefore, productivity calculations are summed over a 5-year period; oysters remaining through year 5 are assumed to be contributed to the ecosystem over the following year.

---

the "Over the Bar" bed in Delaware), indicating likely similarities in oyster growth and predation rates and in associated reef species.

Table 29. Created oyster reef: Oyster mortality and size parameters by age class.

Age Class[a]	Mortality[b]	Average shell length (mm)[c]	Average tissue weight (g dry)[d]	Average tissue weight (g afdw)[e]	Mid-year average tissue weight (g afdw)[f]
New Jersey – Middle Seed Bed					
0 (spat)	50%	20	0.45	0.36	0.38
1	12%	45	0.51	0.41	0.44
2	12%	51.6	0.58	0.47	0.50
3	12%	58.2	0.66	0.53	0.56
4	12%	64.8	0.73	0.59	0.62
5	100%	71.4	0.81	0.65	0.68
Delaware – Over the Bar Bed					
0 (spat)	50%	20	0.45	0.36	0.38
1	19%	45	0.51	0.41	0.44
2	19%	51.6	0.58	0.47	0.50
3	19%	58.2	0.66	0.53	0.56
4	19%	64.8	0.73	0.59	0.62
5	100%	71.4	0.81	0.65	0.68

[a] Age class refers to the "birthday" of the organisms. Age class 0 (from transplant in 2009 to first birthday) are spat. Age class 1 (from first birthday until second) are juveniles. Age class 2 and above are adults.

[b] For initial year, mortality is based on average first-year values for N.J. beds (Powell, 2005). After the initial year, mortality is based on the 2004-2006 average mortality for the Middle Seed Bed (Powell et al. 2007, Table 4) and the 2004-2006 average mortality for Delaware oyster beds (DDFW 2007). A 5-year functional lifetime for the reef is assumed, due in substantial part to current rates of shell loss and low recruitment (shell half-life, Powell et al. 2007, Table 10). During the last year (after year 5), mortality of remaining oysters occurs.

[c] Shell length is estimated at beginning of age class. Shell length for age class 0 and 1 is based on estimates from the Delaware River. Growth to age class 2 and above is 6.6 mm/yr, based on annual growth for adults on "medium mortality beds" in N.J. (Powell et al. 2007, Table 6). Comparable rates for Del. are not available.

[d] The oyster tissue weight for age class 1 through 5 (juvenile/adult) is assumed to be 0.0113 times the shell length. This is the 2004-2006 average weight:length ratio for adults at Middle Seed beds (Powell et al. 2007, Table 4). Age class 0 weight data are not available for the Delaware River, therefore we utilize spat weight data from the Patuxent River, Maryland.

[e] Ash free dry weight is estimated as 80 percent of dry weight (Bahr and Lanier 1981).

[f] A mid-year average tissue weight is used for determination of the predated or scavenged biomass. Productivity at the end of the first year is the average of age classes 0 and 1, given growth throughout the year. The same ratio is used for later years.

For the “Middle Seed” bed, spat settlement is calculated from the average settlement rate in the high recruitment zone (1,500 spat per bushel) and the projected shell planting density at the “Middle Seed” bed (1,000 bushels per acre). This results in 1.5 million spat per acre, or 371 spat per square meter.

For the “Over the Bar” bed, natural spat settlement on new cultch is estimated at 50 spat per bushel, based on a projected planting density of 2,000 bushels per acre (Powell 2005). This analysis results in 100,000 spat per acre, or 25 spat per square meter.

Natural spat settlement following transport to the “Middle Seed” beds is measured as a ratio of the number of adult oysters (ratio of spat: adults is 0.235; median value medium mortality beds for 1996 to 2006; Powell et al. 2007). For the “Over the Bar” beds, natural spat settlement on existing cultch is estimated at 50 percent of the “Middle Seed” bed (ratio of spat: adults of 0.118).[33] Table 30 presents the expected oyster density by age class for each year.

[33] The spat settlement rate has minimal impact on overall productivity.

Table 30. Oysters by age class.

	# of oysters by age class[a] (oysters per m^2)						Consumed Production (g afdw per m^2)[b]	Discounted Production (g afdw per m^2 in 2006)[c]
Year	**0**	**1**	**2**	**3**	**4**	**5**		
New Jersey – Middle Seed bed								
0	371						53.3	47.3
1	0	185					7.1	6.1
2	38 0		164				12.6	10.6
3	34 19		0 145				12.7	10.3
4	34 17 17			0 128			13.2	10.4
5	34 17 15 15				0 113		64.0	49
							Total	133.8
Delaware – Over the Bar bed								
0	25						3.6	3.2
1	0	12					0.8	0.7
2	1	0	10				0.9	0.8
3	1	1 0 8					0.8	0.7
4	1	0 0 0 7					0.8	0.7
5	1	0 0 0 0 5					2.9	2.6
							Total	8.6

[a] Age class 0 indicates spat settlement. Beginning in Year 2, additional spat are assumed to settle on the reef and are observed in a spat:oyster ratio of 0.235 for the Middle Seed bed and half that for the Over the Bar bed. In each year following, spat are assumed to settle at the same ratio relative to adult oysters present. The same growth and mortality patterns are assumed as are present for the initial class of settled oysters.

[b] Consumed production for each year is calculated as predated oysters multiplied by the mid-year average weight for each age class. The percentage of tissue consumed by predators and scavengers is 75 percent. Predated oysters for a given age class are calculated as oysters in age class*mortality rate*75 percent, using the age class mortality rates from Table 29 above. Annual consumed production is the sum of (predated oyster biomass)*(mid-year average tissue weight (g afdw)) for each age class.

[c] Discounted production is calculated assuming that reef implementation occurs in 2009, using a discount rate of 3 percent and a base year of 2006 (injury estimates are discounted to 2006). For New Jersey, one third of placement (to address both subtidal and bird injuries) will occur in 2010 and one third in 2011. Discounted productivity values for 2010 and 2011 are 3 percent and 6.1 percent lower, respectively, than for 2009 and are not shown in this table.

Approximately 75 percent of the annual oyster mortality is assumed to be consumed by predators or scavengers, resulting in energy transfer to higher trophic levels (R. Babb, personal communication). Therefore, productivity transferred to higher trophic levels is calculated as: oysters in age class * mortality rate * 75 percent, using the age class mortality rates and weights from Table 29. Each year's production is discounted to 2006, the year to which injury calculations are scaled, and then summed to provide a total estimate of oyster productivity generated by the reef.

In addition to oysters, reef-enhanced epifauna (e.g., mud crabs, grass shrimp, and other small crustaceans such as amphipods, tanaids, and isopods) are expected to be recruited to the reef (Dove and Nyman 1995). For the reef-associated species besides oysters, productivity is assumed to be entirely transferred to higher trophic levels through predation (French McCay et al. 2002).

Table 31 provides the annual cumulative production for both oysters and epifauna (French McCay et al. 2002). The estimated baseline productivity of these species in the potential reef area (shell bottom substrate) is subtracted from the calculations. Detailed assumptions underlying the productivity values are provided in French McCay et al. (2002) (Appendix 3). The estimated recruited annual productivity (above baseline) from French McCay et al. (2002) for grass shrimp, mud crabs, and small crustaceans are 17.94, 18.18, and 2.62 g afdw/m^2, respectively. Over the first year following reef establishment, 50 percent of the recruitment estimate is used. For the following years, the entire recruitment estimate is included.

Total discounted productivity is the sum of the oyster and reef-associated organism productivities (Tables 30 and 31). For the "Middle Seed" beds, the discounted cumulative productivity for the expected lifetime of the reef seeded in 2009 is 309 grams afdw per m^2 (sum of 133.8 g/m^2 and 174.8 g/m^2, or 1,249 kilograms/acre). For 2010 seeding, the productivity is 1,213 kilograms/acre. For 2011 seeding, the productivity is 1,177 kilograms/acre. For the "Over the Bar" beds, the discounted cumulative productivity for the expected lifetime of the reef is 183 grams afdw per m^2 (sum of 8.0 g/m^2 and 174.8 g/m^2, or 748 kilograms per acre). The Trustees propose to split project acreage in a 2:1 ratio between the "Middle Seed" beds and the "Over the Bar" beds, given the higher expected productivity of the "Middle Seed" beds. Given the benthic biomass loss of 4,637 kg and the relative productivities of the two sites (average 1,213 kg afdw/acre for the 2009 to 2011 placements in the "Middle Seed" beds and 748 kg afdw/acre for the "Over the Bar" bed, for a 2:1 weighted average of 1,055 kg afdw/acre), the appropriate scaling for the oyster reef restoration project is 4.5 acres, split as 3 acres in the "Middle Seed" beds (1 acre each in 2009, 2010, and 2011) and 1.5 acres in the "Over the Bar" beds. For project feasibility, it is assumed that these acreages are part of a larger oyster restoration project, as specified under injuries to birds (Section 5.5.3).

Table 31. Discounted annual production of reef-associated organisms transferred to higher trophic levels (g afdw per m^2).

	Year 1 2010[a]	Year 2 2011	Year 3 2012	Year 4 2013	Year 5 2014	Year 6 2015	Cumulative Total
Mud Crabs	8.0	15.5	15.0	14.6	14.2	13.7	81.0
Grass Shrimp	8.1	15.7	15.2	14.8	14.4	13.9	82.1
Small Crustaceans	1.2	2.3	2.2	2.1	2.1	2.0	11.8
Total Prey	17.2	33.4	32.4	31.5	30.6	29.7	174.8

[a] Productivity is calculated based on prey/scavenger consumption for that entire year. These values are for the 2009 start date. Reef-associated biota for the 2010 and 2011 shell placement in New Jersey are estimated to be 3 percent and 6.1 percent lower, respectively, due to discounting.

Probability of Success

While oyster populations in the Delaware River and Bay have decreased over the last several decades, the proposed project would be located in areas of the Delaware River where state agencies have established shell-planting programs that have resulted in large increases in oyster numbers. The site locations would balance salinity and growth requirements with disease and predation, based on the experience and expertise of the state agencies. To avoid accidental or illegal harvest, the likely locations would also be outside of prime commercial oyster areas.

Oyster bed enhancement is generally considered to be the most effective method for supplementing oyster populations and the services they provide (including their role as prey for higher trophic level organisms). Based on the success of existing state oyster programs, the Trustees believe that the probability of success for this project (i.e., the likelihood of successfully producing a functioning oyster reef) is high. By employing both the direct placement and two-step methods, the Trustees are further reducing the risk of project failure associated with use of a single approach.

Performance Measures and Monitoring

Performance measures and monitoring would focus on confirming that the intended acreage (3.0 total acres in the Middle Seed beds and 1.5 acres in the Over the Bar beds) and spat/oyster densities (Table 30) meet the intended target. Confirmation of the size of the created oyster reefs would be a "one-time" monitoring event, occurring as soon as practicable after project implementation. Monitoring of spat/oyster densities would occur annually, beginning immediately following placement of transplanted, seeded cultch (Middle Seed beds) and at the expected peak of natural setting on cultch (Over the Bar beds). Monitoring of spat/oyster densities would continue for a total of 5 years, corresponding to the 5-year project life span assumed in scaling calculations.

If measured spat/oyster densities do not meet the levels assumed in scaling calculations (Table 30), the Trustees would use contingency funds to create additional reef areas and/or relocate the existing reefs to offset the observed shortfall (or to make up for as much shortfall as possible if contingency funds are insufficient to offset it entirely). Although scaling calculations also include the productivity of other benthic invertebrates expected to be enhanced by oyster reef creation (e.g., mud crabs, grass shrimp, and small crustaceans), the Trustees make the simplifying assumption that the density of these biota would track the size of the bed, since their density is assumed in calculations to correspond to the acreage of reef habitat. Thus, confirmation of the area of created oyster reef and oyster densities (and corresponding corrective action, if necessary) would provide sufficient measures of project success, reasonably balancing the need for monitoring with the costs of such efforts.

Approximate Project Costs

Table 32 provides a summary of the costs for creating 3.0 acres of new oyster reef in the Middle Seed beds.[34] Two barge plantings of clam shell, initially in the seed beds and then transferred to the nursery beds, are included. Spatted shell recovery of roughly 67 percent from the initial shell planting is assumed based on past New Jersey projects. A project contingency of 25 percent is shown in Table 47.

Table 32. Summary of project costs: Creating a 3.0 acre oyster reef in "Middle Seed" bed area (N.J.). ***COSTS ARE NOT FINAL***

Cost Element	Per Bushel	Per acre	Cost
Planning and Design			$1,309
Implementation			
Project Oversight			$980
Spat planting at seed beds (1,500 bushels per final acre)			
Clam Shell	$0.85	$1,275	$3,825
Loading Fee	$0.10	$150	$450
Planting (Tug + Barge)	$1.00	$1,500	$4,500
Spat transplant (1,000 bushels recovered per 1,500 planted; planted at 1,000 bushels per acre)			
Re-harvest/Transplant	$1.50	$1,500	$4,500
		Subtotal	*$13,275*
Monitoring			$2,256
		TOTAL*	**$17,820**

* Total project costs do not include contingencies of 25% which are shown in Table 47. Costs assume project is undertaken in conjunction with a larger reef enhancement (Table 41).

Table 33 provides a summary of the costs for creating 1.5 acres of enhanced oyster reef in the "Over the Bar" beds. One barge planting of oyster shell is included. Costs are based on 2006 shell planting costs in nearby Delaware beds.[35] A 25 percent contingency is shown in Table 47.

34 Written Communication from Russell M. Babb, Jr., Principal Fisheries Biologist, New Jersey Division of Fish and Wildlife, July 21, 2006. These costs assume that the project is part of a larger effort (>20 acres).

35 Personal communication, Richard Cole, Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife. These costs assume that the project is part of a larger effort (>20 acres).

Table 33. Summary of project costs: Creating a 1.5 acre oyster reef in "Over the Bar" beds (Del.). ***COSTS ARE NOT FINAL***			
Cost Element	**Per Bushel**	**Per acre**	**Cost**
Planting at Over the Bar Beds (2,500 bushels per acre)			
Planning and Design			$1,529
Implementation			
Construction Oversight			$730
Oyster Restoration	$2.05	$5,125	$7,687
		Subtotal	$8,417
Monitoring			$1,327
		TOTAL*	**$11,273**
* Total project costs do not include contingencies of 25% which are shown in Table 47. Costs assume project is undertaken in conjunction with a larger reef enhancement (Table 42).			

5.5.3 Restoration of Bird Losses: Habitat Enhancement—Mad Horse Creek, Blackbird Reserve, and Oyster Reef

Trustee estimates of bird injuries attributable to the *Athos* oil spill are summarized in Table 34. Direct injuries totaled 3,308 adult birds, the majority (75 percent) of which were gulls and geese. Additional estimated lost production from mortality and reproductive failure (indirect injury) was 8,561 fledged young.

Table 34. Total (direct and indirect) estimated bird injury from the *Athos* oil spill by guild**.**

Guild	**Direct Injury (Adults)**	**Discounted Indirect Injury (Fledged Young)**		**Total (Adults and Fledged Young)**
	Died	**Lost Prod. (Mortality)**	**Lost Prod. (Reproductive Failure)**	
Dabbling ducks	605	1,187	577	2,369
Diving ducks	82	163	24	269
Diving birds	64	92	2	158
Gulls	1,072	1,543	331	2,946
Shorebirds	55	79	0	134
Wading birds	10	14	3	27
Swans/geese	1,416	3,369	1,171	5,956
Kingfishers	4	6	0	10
Total	**3,308**	**6,453**	**2,108**	**11,869**

For restoration scaling, guilds are grouped by primary diet (invertebrates, fish/omnivorous, and plants). Invertebrate-consuming guilds include dabbling ducks and shorebirds. Piscivorous or omnivorous consumers include diving ducks and birds, gulls, wading birds, and kingfishers. Primarily herbivorous birds include the swans and geese guild. To compensate for losses to species consuming primarily invertebrates, the Trustees propose restoration of 25.4 acres of wetland habitat in Mad Horse Creek (Figure 13), located in Lower Alloway Creek Township, Salem County, New Jersey. To compensate for losses to piscivorous or omnivorous birds, the Trustees propose creation of approximately 73 acres of oyster reef in the Delaware River. To compensate for losses to primarily herbivorous birds, the Trustees propose creation of 35 acres of wet meadow habitat and 100 acres of grassland habitat at Mad Horse Creek, as well as 41.8 acres of migratory goose habitat in the Blackbird Reserve Wildlife Area in New Castle County.

This restoration approach would benefit coastal bird communities in areas affected by the spill; is consistent with existing federal, state, and local restoration goals for the Delaware River and Bay; and is appropriate in light of the substantial spill-related injuries to birds. This combination of projects also is cost-effective. At Mad Horse Creek and Blackbird Reserve, the land is already government-owned, therefore eliminating the need for easement payments or land purchase. Available information indicates that sediment to be excavated in the marsh habitat targeted for restoration at Mad Horse Creek has low contaminant levels, eliminating the need for expensive treatment and/or off-site disposal. Grassland restoration would take place at Mad Horse Creek, and make use of sediments excavated as part of wetland and wet meadow restoration activities. The oyster reef project takes advantage of a program and resources already in place for on-going oyster restoration efforts throughout the Delaware River.

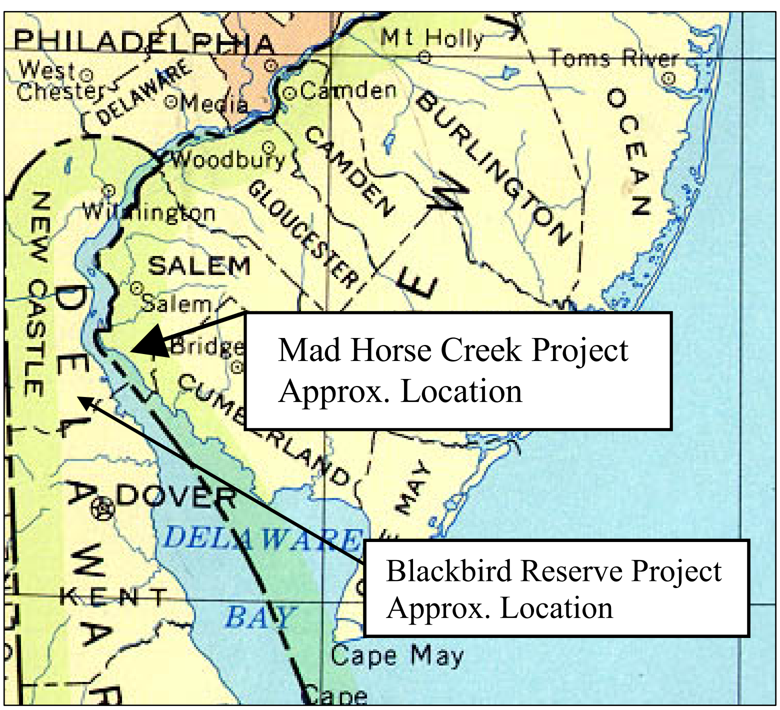


Figure 13. Approximate location of the Mad Horse Creek restoration project.

Project Description - Mad Horse Creek

The proposed restoration site is on the Mad Horse Creek Wildlife Management Area. The 260-acre property contains salt marshes, transitional wetlands (*Phragmites* dominant), agricultural lands, and associated buildings. Past agricultural practices on this property included altering and filling the brackish marsh fringe. These alterations have resulted in a *Phragmites* invasion of the wetland.

NJDEP's Office of Natural Resource Restoration (ONRR) and NOAA are now in the design phase of a tidal and freshwater wetland restoration project (Figure 14). The site location near the Delaware Bay, within tidal waters, would allow for the construction of *S. alterniflora* habitat at appropriate elevations. Restoration would be accomplished through the removal of fill material and lowering the marsh elevation so that tidal inundation can occur. Wet meadow habitat also would be created through excavation at upland locations on-site. Options for disposal of the excavated sediment from restored marsh and wet meadow areas include on-site and off-site placement, with on-site being the most cost effective. On-site disposal also creates grassland habitat that would help compensate for *Athos* bird injuries.[36]

The State of New Jersey would serve as the LIT for this project, with Trustee Council oversight.

[36] While the Mad Horse Project also will involve the creation of woodland habitat, this project component will not generate benefits that compensate for *Athos*-related injuries. Costs for woodland habitat creation therefore are excluded from cost estimates developed for *Athos*-related restoration at Mad Horse Creek.

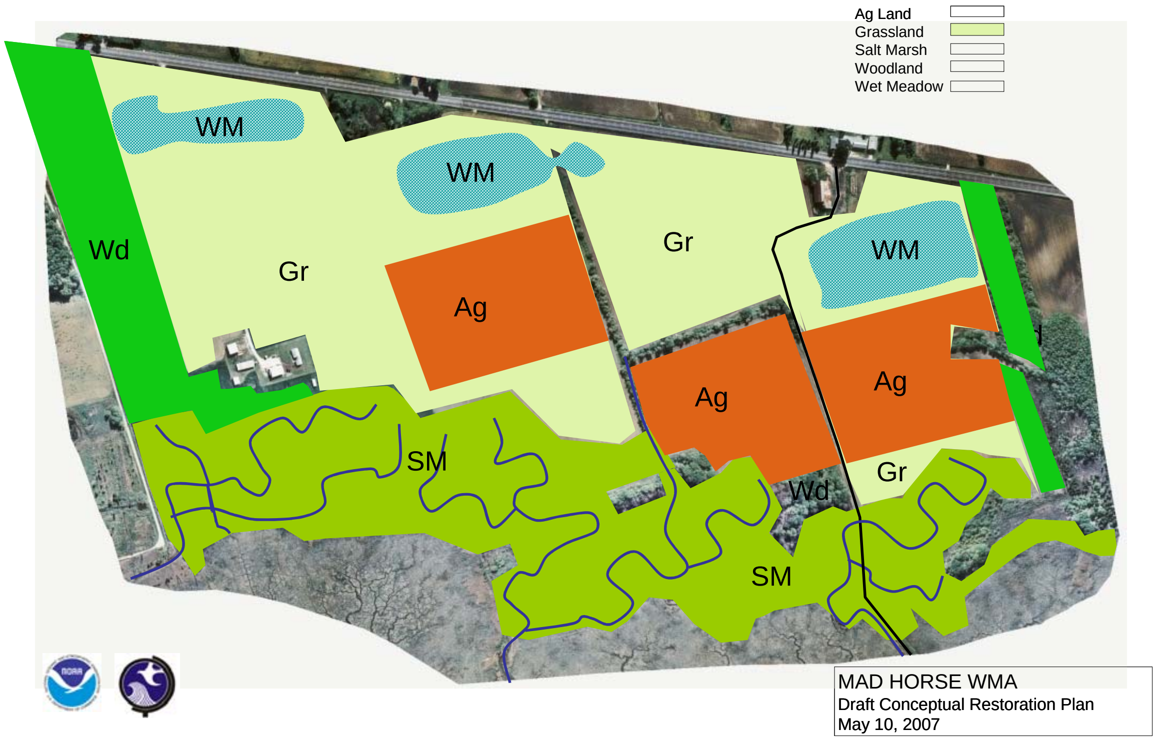


Figure 14. Mad Horse Creek conceptual restoration plan.

Project Description – Blackbird Reserve

The proposed site of this pond, pasture, and agricultural food plot project is within the state-owned Blackbird Reserve Wildlife Area in southern New Castle County, Delaware. The 535-acre site is predominantly forested (71.4 percent), with 152.9 acres (28.6 percent) in open agricultural lands. In an effort to maintain habitat heterogeneity and provide wildlife habitat value, the Division of Fish and Wildlife proposes restoration of these agricultural lands into a combination of forested areas, shallow wetland ponds, wildlife pastures, and agricultural food plots. The latter three habitat types would be restored to provide suitable migratory goose habitat as part of *Athos* restoration efforts (Figure 15). Existing lowland areas would be excavated to create two shallow wetland ponds surrounded by managed pastures designed to attract migratory geese. In addition, areas adjacent to the pastures would use agricultural practices to create wildlife food plots also designed to attract migrating geese. In total, approximately 2.2 acres of ponds, 16 acres of pasture, and 23.6 acres of food plots would be established.[37]

The slopes of the shallow wetland ponds would be planted in beneficial wetland plants and the pastures would be planted with cool season grasses, including white clover and a fescue mix (creeping red and chewing). The wildlife food plots would be established using agricultural practices and would be planted in corn, soybean, or winter wheat; however, no more than 80 percent of the crop would be removed, providing both food and feeding habitat for migrating geese. The remaining 20 percent of crop left standing (4.7 acres) would be distributed along the

[37] The active agriculture component is 23.6 acres; 20 percent, or 4.7 acres, will be left unharvested as standing crop for geese.

perimeter of the fields to improve vegetative erosion control, as well as in thin strips or small blocks within the fields providing ideal winter feeding habitat for migrating geese.

The State of Delaware would serve as LIT for this project, with Trustee Council oversight.

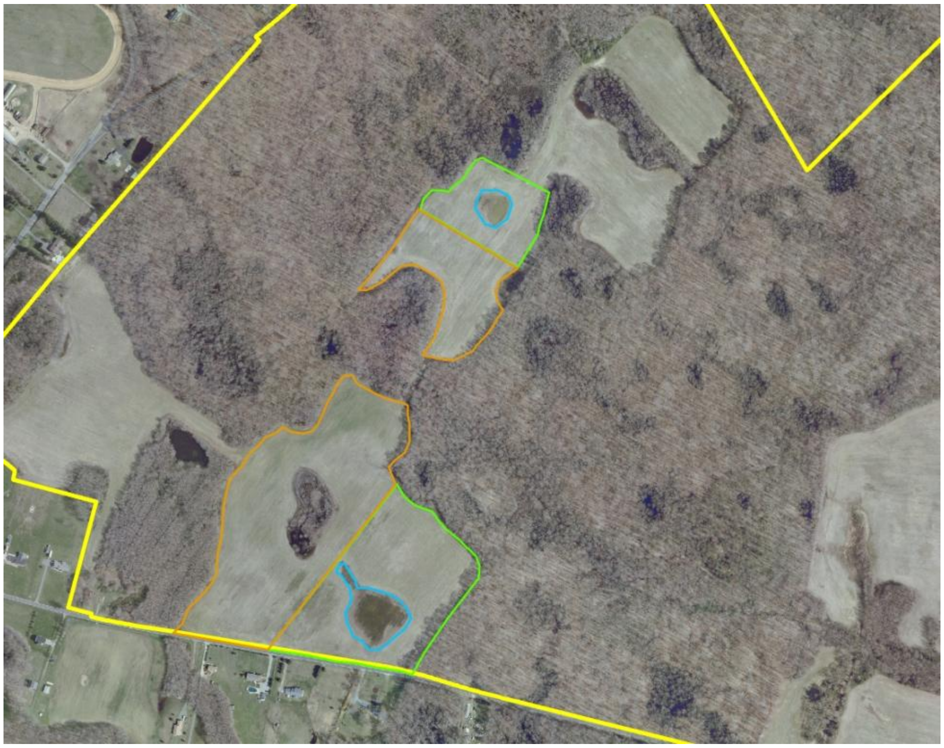


Figure 15. Proposed restoration projects at Blackbird Reserve. The targeted ponds are outlined in blue, the pasture areas in neon green, and the agricultural fields/wildlife food plots in orange.

Project Description - Oyster Reef

The Trustees propose to create 73.5 acres of oyster reef through both a direct placement project at a rate of roughly 2,000 bushels/acre in the Over the Bar beds on the Delaware side of the river and a recruitment/placement project in New Jersey waters on the Delaware River (see Section 5.5.2). Both NJDEP and DNREC have established programs that create and enhance oyster beds either by direct placement of shell for natural spat settlement or a two-step process whereby shell is placed in high spat recruitment areas and then moved to areas that exhibit higher spat growth and survival. As described below, this project includes both methods to reduce the risk of project failure.

The direct placement method is proposed at the "Over the Bar" oyster beds on the Delaware side of the river (Figure 12). Shell would be placed in this historic seed bed, which currently has limited shell bottom and, as a result, low natural spat settlement rates and few adult oysters. Placement of shell during the spring and early summer would enhance the area, allowing settlement of oyster spat and recruitment of other reef-associated epifauna. Consistent with established methods employed by DNREC, the site would be seeded at a rate of 2,000 bushels/acre.

The two-step process is proposed in New Jersey portions of the River. Consistent with established oyster enhancement techniques in New Jersey, about 1,500 bushels of shell per acre would be placed in historic oyster bed areas with high spat recruitment/settlement rates (Figure 12). Three to six months following initial shell placement, spatted cultch would be harvested and transported upstream to *Athos* spill-exposed areas (e.g., the "Middle Seed" bed) (Figure 12) with lower natural mortality rates (particularly lower disease rates due to lower salinity). Shell density for replanting would be 1,000 bushels/acre.

The Delaware project would be implemented in the spring or early summer of 2009. The New Jersey reef creation would be divided between 2009, 2010, and 2011, with 17 acres created the first year and 16 in each of the two subsequent years. Oyster survival on the transplanted reef would be 5 years, and no harvesting of the oysters would be allowed during the initial 5-year period.

The States of Delaware and New Jersey would serve as LITs for this project, with Trustee Council oversight.

Restoration Objectives

The objective is to implement habitat restoration projects to restore an equivalent number of adult and juvenile birds lost due to the spill (Table 34) through the enhancement or creation of wetland, pond, wet meadow, grassland, food plot, and oyster reef habitat. The resulting increase in invertebrate and fish biomass (wetland habitat, oyster reef) and upland vegetation (wet meadow, food plot, and grassland habitat) would serve as food sources that, once adjusted to account for trophic levels and ecological transfer efficiencies, can reasonably be expected to enhance bird biomass by an amount sufficient to offset documented bird losses.

Scaling Calculations – General

Scaling calculations include both direct and indirect injuries (i.e., direct mortality from the spill as well as indirect mortality due to lost productivity). Injuries are scaled by guild based on approximate weight and diet of the birds (Table 35).

To estimate the amount of restored habitat required to offset documented injuries, using the approach in French McCay and Rowe (2003), bird loss must first be converted from an "individuals lost" metric to a biomass basis (i.e., kilograms of bird biomass lost). This conversion is made by multiplying the numbers of birds lost by the estimated weight per bird. For direct injury, the adult weight is used. For indirect injuries (lost fledgling production), the juvenile weight is used.[38] Bird biomass lost is then "transferred" into an equivalent amount of estuarine wetland secondary productivity (for dabbling ducks and shorebirds), oyster reef secondary

[38] For several of the smaller guilds, representative juvenile weights were not available; however, these species represent a very small fraction of the overall biomass.

productivity (for piscivorous/omnivorous birds), or vegetative primary productivity (for geese and swans) based on energy transfer efficiencies between trophic levels (i.e., between productivity generated by the restored marsh or oyster reef and the potential contribution of this productivity to bird biomass, taking intervening consumers into account). Transfer ratios were obtained from French McCay et al.'s (2002) review of relevant ecological efficiency literature. Transfer ratios used for *Athos* scaling calculations also are consistent with ratios used in the Final Restoration Plan and Environmental Assessment developed for the 7 April 2000 oil spill at Chalk Point on the Patuxent River, Maryland (NOAA et al. 2002). In the final step of the scaling analysis, the area of enhanced oyster reef, restored wetland, wet meadow, food plot, or grassland habitat required to offset specified injuries is calculated based on productivity information per unit area for these habitats obtained from relevant scientific literature. Species-specific scaling calculations are described in more detail below.

Table 35. Overview of restoration scaling for bird losses.

Guilds	Direct Injury	Indirect Injury	Selected Species[a]	Weight[b] (kg) [Adult/ Juvenile]	Total Biomass[c] (kg) [Adult/ Juvenile]	Primary Diet	Restoration Project
Dabbling ducks	605	1,764	Mallard	1.21/1.09	732/1,923	Inverte-brates	Marsh
Diving ducks	82	187	Bufflehead	0.37	100	Fish	Oyster Reef
Diving birds	64	94	Double-crested cormorant	2.3	363	Fish	Oyster Reef
Gulls	1,072	1,874	Ring-billed gull	0.53/0.36	568/675	Fish/ Omnivor-ous	Oyster Reef
Shorebirds	55	79	Sanderling	0.06	8.0	Invertebr ates	Marsh
Wading birds	10	17	Great blue heron	2.3	62	Fish	Oyster Reef
Swans and geese	1,416	4,540	Canada goose	3.96/2.20	5,607/9,988	Plants	Wet Meadow/ Grassland
Kingfishers	4	6	Belted kingfisher	0.15	1.5	Fish	Oyster Reef

[a] The representative species is selected based on the most prevalent species for each guild represented in the recovered oiled birds following the spill, as reported in the Preassessment Data Report (NOAA 2006). For shorebirds, for which no oiled birds were recovered, the sanderling is chosen as a mid-weight bird spotted during bird observations.
[b] Weights are based on data from the British Trust for Ornithology (BTO), with the exception of great blue herons, which are based on data from the Cornell Lab of Ornithology. When both male and female weights are available, an average is used. For mallards, gulls, and Canada geese, juvenile weights are available and included in indirect injury biomass calculations. Ring-billed juvenile weight is assumed equal to BTO juvenile weight estimates for common gulls (adult common gulls average 0.41 kg, slightly smaller than ring-billed gulls). Juvenile (fledgling) weight for Canada geese is the average reported in LeBlanc (1987) for Moffit's Canada Goose (*B. c. moffitti*), a subspecies similar in size to the Atlantic Canada Goose (*B. c. canadensis*)
[c] Total Biomass is calculated as the sum of direct injury multiplied by adult weight and indirect injury multiplied by juvenile weight (if available). If juvenile weight is not available, total biomass is weight per bird multiplied by the sum of direct and indirect injury.

Scaling Calculations - Invertebrate Consumers

Scaling calculations for dabbling ducks and shorebirds are summarized in Table 36. Estimates of average adult and juvenile bird weights were based on data available from the British Trust for Ornithology.[39] For these guilds, the Trustees used secondary production as the "base" measure of productivity, from which adjustments for trophic transfer efficiencies are made. From a trophic level perspective, secondary production is "closer" to invertebrate consumers and so is an appropriate starting point for the scaling analysis. For these guilds, use of primary production as the "base" measure of productivity is less preferable since this would require an additional set of assumptions regarding transfer efficiencies from primary to secondary production. The invertebrate production of an improved Mad Horse Creek marsh is also a reasonable approximation of the prey that these species consume.

As indicated in Table 36, the Trustees assumed an ecological efficiency "transfer ratio" of 2 percent for birds feeding on invertebrate prey (i.e., 50 kg of invertebrate prey biomass is needed to generate 1 kg of bird biomass). As noted above, this assumption is consistent with estimates developed in French McCay et al.'s (2002) review of relevant ecological efficiency literature and scaling calculations conducted in the Final Restoration Plan and Environmental Assessment developed for the 7 April 2000 oil spill at Chalk Point on the Patuxent River, Maryland.

Table 36. Scaling calculations: Invertebrate consumers.

Guild	Selected Species	Biomass (kg) (Table 35)	Ecological Efficiency[a]	Compensatory Secondary Production Required[b] (kg dw)	*Spartina* Marsh Secondary Productivity[c] (kg dw per acre)	*Spartina* area required (acres)
Dabbling Ducks	Mallard (Adult/ Direct Injury)	732 2%		8,053	1,153	7.0
Dabbling Ducks	Mallard (Juvenile/ Indirect Injury)	1,923	2%	21,150	1,153	18.3
Shorebirds	Sanderling	8.0	2%	88	1,153	0.1
					Total	**25.4**

[a] Ecological efficiencies are calculated relative to benthic infaunal detritivores and omnivores, as summarized in French McCay and Rowe (2003) and their review of relevant literature.
[b] Compensatory Production Required (kg dw) = Weight of Birds Lost (kg ww)*0.22 (kg dw/kg ww) / Ecological Efficiency (%). Conversion from dry weight to wet weight assumes dry weight = 22% of wet weight (French McCay and Rowe 2003).
[c] As estimated in French McCay and Rowe (2003), assuming a benthic faunal productivity of 20.8 (g dw/m ^{2}-yr), 50-year functional life for the created marsh, restoration beginning 3 years after the spill, and 15 years for the created marsh to reach maximum functionality (following a logistic recovery path), discounted at 3 percent annually. Injury is discounted to 2006, with restoration planned to begin by 2010. The calculations are modified for a maximum service level of 85 percent based on monitoring requirements that at least 85 percent of the project area be successfully colonized with either targeted species or similar, native species consistently over a 3-year period (NJDEP 2000). French McCay and Rowe (2003) is based on a broad review of *Spartina* marsh secondary productivity, primarily from southern New England. *Athos* scaling calculations assume negligible contributions to benthic productivity from the existing habitat targeted for restoration. Conversion from hectares based on 1 hectare = 2.47 acres.

[39] For more information on the British Trust for Ornithology, see Robinson (2005). Data for the great blue heron are from the Cornell Lab of Ornithology (2003) (http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/).

Application of this 2 percent ecological efficiency transfer ratio to duck and shorebird injuries and conversion from wet weight to dry weight (assuming dry weight is 22 percent of wet weight as applied in French McCay and Rowe (2003)) results in a restoration requirement of 29,239 kg (dry weight) of compensatory benthic production needed to address duck and shorebird losses.[40]

The Trustees assumed that a restored *Spartina* marsh would produce approximately 1,153 kg (dry weight) of discounted benthic productivity per acre, consistent with French McCay and Rowe (2003). This estimate assumed a 50-year functional life for the restored marsh, with restoration beginning in 2009 and maximum functionality achieved in 15 years (following a logistic recovery path prior to that point).[41] French McCay and Rowe (2003) estimates are based on a broad review of *Spartina* marsh secondary productivity, primarily from marshes in southern New England. Trustee scaling calculations conservatively assumed negligible contributions to benthic productivity from the existing degraded and filled habitat targeted for restoration.

As shown in Table 36, the calculated biomass requirement (29,239 kg dw) divided by the productivity per acre (1,153 kg dw/acre) results in a restoration requirement of 25.4 acres to offset dabbling duck and shorebird guild losses.

Scaling Calculations – Piscivorous/Omnivorous Species

Piscivorous and omnivorous species were scaled based on trophic transfer of the invertebrate productivity of an oyster reef. French McCay and Rowe (2003) provide a basis for scaling piscivorous and omnivorous species to invertebrate productivity, with an ecological efficiency of 0.4 percent.[42] To estimate the amount of additional benthic macroinvertebrates available to predators such as fish through creation of an oyster reef, the Trustees relied on the productivity model created for an oyster reef restoration project in the Patuxent River (French McCay et al. 2002), augmented by site-specific data from the N.J./Del. oyster restoration program.[43] Scaling calculations for piscivorous and omnivorous species are summarized in Table 37. The total biomass requirement of 77,851 kg afdw was split between the 2009-2011 Middle Seed bed projects and the 2009 Over the Bar project. Given the average productivity of 1,055 kg afdw/acre, a final reef size of 73.5 acres is required, split into 49 acres at the Middle Seed bed project and 24.5 at the Over the Bar bed.

---

[40] 29,239 kg dw secondary prod. = ((732 kg ww + 1,923 kg ww + 8.0 kg ww) / 0.02 transfer efficiency) * 0.22 kg dw/kg ww.

[41] The French McCay and Rowe (2003) productivity estimate assumes restoration begins 3 years after the spill. For the *Athos* spill, all injuries and restoration projects are discounted to 2006. Restoration is assumed to begin in 2009, 3 years after injury, as in the calculations in French McCay and Rowe (2003).

[42] The ecological efficiency represents a two-step trophic transfer. Birds consuming fish have an ecological efficiency of 2 percent; fish consuming invertebrates have an ecological efficiency of 20 percent (French McCay et al. 2002). The product of the efficiencies (0.4 percent) represents birds scaled to invertebrate production.

[43] For more detailed calculations on oyster reef productivity, please see Section 5.5.2.

Table 37. Scaling calculations: Piscivorous/omnivorous consumers.				
Guild	**Selected Species**	**Biomass (kg) (Table 35)**	**Ecological Efficiency[a]**	**Compensatory Secondary Production Required[b] (kg afdw)**
Gulls	Ring-billed gull (Adult/ direct injury)	568 0.4%		24,999
Gulls	Ring-billed gull (Juvenile/ indirect injury)	675 0.4%		29,684
Diving Ducks	Bufflehead 100		0.4%	4,379
Diving Birds	Double-crested cormorant	363 0.4%		15,990
Wading Birds	Great blue heron	62	0.4%	2,732
Kingfishers	Belted kingfisher	1.5	0.4%	66
Total Compensatory Biomass				**77,851[c]**
Average discounted cumulative productivity (kg afdw/acre) [based on 2:1 split between Middle Seed bed and Over the Bar bed]				1079
Acres of Oyster Reef				**72**
Acres at Middle Seed bed /Over the Bar bed				**48/24**

[a] Ecological efficiencies are calculated relative to benthic infaunal detritivores and omnivores, as summarized in French McCay and Rowe (2003) and their review of relevant literature. Birds consuming fish have an ecological efficiency of 2 percent; fish consuming invertebrates have an ecological efficiency of 20 percent. The product of the efficiencies (0.4 percent) represents piscivorous birds scaled to invertebrate production.
[b] Compensatory Production Required (kg afdw)= Weight of Birds Lost (kg ww)*0.22 (kg dw/kg ww)*0.8 (kg afdw/kg dw) / Ecological Efficiency (%). Conversion from dry weight to wet weight assumes dry weight = 22 percent of wet weight (French McCay and Rowe 2003). Conversion from dry weight to ash free dry weight (afdw) assumes afdw = 80 percent of dry weight (Bahr and Lanier 1981).
[c] Values do not exactly sum to total due to rounding.

Scaling Calculations – Herbivorous Species

The Trustees modified the scaling approach used for other guilds to estimate compensation required to offset geese losses. Estimates of average adult Canada geese weights were obtained from information provided by the British Trust for Ornithology (Robinson 2005). Average juvenile weights were obtained from Leblanc (1987).[44] Geese are herbivores and consume plant biomass directly. While wetland restoration is an appropriate and effective approach for generating secondary (benthic) productivity utilized by coastal bird communities, there are more cost-effective approaches for generating the primary production (i.e., vegetation) likely to be consumed by geese, particularly since they frequently feed in more upland areas. In light of these

[44] Juvenile (fledgling) weight is the average reported in LeBlanc (1987) for Moffit's Canada Goose (*B. c. moffitti*), a subspecies similar in size to the Atlantic Canada Goose (*B. c. canadensis*).

considerations, the Trustees scaled geese losses to restoration of wet meadow, pond, and pasture/grassland habitat.

For these reasons, the Trustees used primary production as the "base" measure of productivity, from which adjustments for trophic transfer efficiencies are made. As indicated in Table 38, the Trustees assumed an ecological efficiency "transfer ratio" of 0.03 percent for birds feeding on a mixture of *Spartina* and microalgae typical of northeast salt marshes (French McCay et al. 2002), i.e., approximately 3,333 kg of plant biomass is needed to generate 1 kg of bird biomass. This assumption is consistent with a review of relevant ecological efficiency literature conducted in the Final Restoration Plan and Environmental Assessment developed for the 7 April 2000 oil spill at Chalk Point on the Patuxent River, Maryland. Application of this 0.03 percent ecological efficiency transfer ratio to geese injuries and conversion from wet weight to dry weight (assuming dry weight is 22 percent of wet weight as applied in French McCay and Rowe (2003)) results in a restoration requirement of approximately 4.1 million kg and 7.3 million kg (dry weight) of compensatory primary production needed to address direct and indirect injuries to geese and swans, respectively.

Because of the magnitude of geese injuries and size limitations inherent to specific projects, compensation for injuries to geese is spread over several suitable projects. The first is a wet meadows project at Mad Horse Creek (35 acres); the second is a pond/pasture/food plot enhancement project in New Castle County, Delaware (41.8 acres), and the third is a grasslands project at Mad Horse Creek (100 acres).

The Mad Horse Creek areas for wet meadows and grassland projects, as well as the proposed area at Blackbird Reserve, are currently in active agriculture. The baseline productivity—the productivity currently consumed by herbivorous birds—is assumed to be the agricultural waste following harvest. Several studies have investigated the availability of this material to birds, specifically migratory waterfowl and geese. Corn is chosen as the proxy species for agricultural areas, given its prevalence and readily available data. The average of three reported values of waste corn following standard harvest practices is 131 kg per acre (Baldassarre and Bolen undated; Warner et al. 1989; Ringelman 1990). The discounted net productivity is 3,170 kg per acre, for the 50-year lifespan used for other herbivorous bird projects. This value is subtracted from the discounted net productivity for each of the following habitats, in order to estimate the additional productivity that will result from the projects.

For the wet meadows project at Mad Horse Creek, the Trustees assumed that restoration would begin in 2010, and that a restored wet meadow habitat would cumulatively produce approximately 129,536 kg (dry weight) of additional primary productivity per acre over the 50-year project duration assumed for scaling purposes. To develop this estimate, wet meadow annual primary productivity was calculated based on the average net annual productivity of several sedges and rushes in the United States (Mitsch and Gosselink 1986). Four common species (*Carex atheroides, Larex lacustris, Juncus effusus,* and *Scirpus fluviatilis*) were included, for a net annual productivity of 7,155 kg per acre. Scaling calculations assume that a maximum vegetation productivity of 85 percent is reached in 5 years, based on NJDEP mitigation requirements that specify a target vegetation requirement of 85 percent, with less than 10 percent invasive plants, at the end of the 5-year monitoring program.[45]

The proposed site of the pond/pasture/food plot project is the Blackbird Reserve Wildlife Area in New Castle County. Restoration would begin in 2009 and is expected to produce an average increase in primary productivity of 100,909 kg (dry weight) per acre over the lifetime of the project, averaged across all habitat types. The pasture section would be planted with white clover, creeping red fescue, and chewing fescue. For scaling purposes, the productivity of the pasture areas is assumed to be the average of the three species, resulting in an increase in net primary productivity of 112,387 kg per acre for pasture. According to published values, the productivity range for white clover is between 1,800 and 2,800 kg per acre (average 2,300), while creeping red fescue ranges from 6,110 to 6,920 kg per acre (average 6,440) and chewing fescue from 5,670 to 6,440 kg per acre (average 5,790).[46] The three species are averaged to provide a productivity of 4,860 kg per acre of pastureland. The net productivity over the project lifetime is calculated assuming a 50-year project lifespan, 50 percent productivity in the first year, and 100 percent in the following 49 years.

For the pond/wetland component, the Trustees average the estimated primary productivity of small ponds with wet meadows, to account for ecological benefit arising from phytoplankton, algae, and aquatic vegetation in the pond as well as vegetation on the shallow sloped banks. For the wetland vegetation on the sloped banks, the wet meadow value derived above for Mad Horse Creek is applied. For ponds, a primary productivity of 1,805 kg per acre is used, which incorporates phytoplankton and submerged macrophytes (Russo 1978). The net pond productivity over the project lifetime is calculated assuming a 50-year project lifespan, 50 percent productivity in the first year, and 100 percent in the following 49 years, resulting in an additional lifetime productivity of 86,648 kg per acre.

In the agricultural area, 23.6 acres of agricultural food plots would be planted. Of the acreage, 20 percent (4.7 acres) would be left unharvested. For the agricultural standing crop component, corn is chosen as a proxy crop. The 2003-2007 average yield for corn in New Castle County is 137.7 bushels per acre (USDA NASS undated). Given a standardized weight of 56 pounds per bushel (7 CFR §810.404) and average moisture of 15.5 percent, the net annual productivity is 3,320 kg per acre. The additional productivity above baseline over the lifetime of the project is 68,508 kg per acre. The net productivity over the project lifetime is calculated assuming a 50-year project lifespan and 100 percent productivity beginning in the first year since the land is currently in agricultural use.

For the grassland component of Mad Horse Creek, the lifetime additional productivity is estimated as 45,727 kg per acre, based on a 2010 start date. The yearly productivity estimate of 2,120 kg per acre is based on annual aboveground net primary production from a grassland site in Osage, Kansas, most similar in rainfall and average temperature to southern New Jersey during a multi-year study (Sims and Singh 1978). Grassland scaling calculations assume 50

[45] Because this restoration project is focused solely on producing herbaceous vegetation suitable for geese and swans, not complete marsh structure or benthic invertebrate communities, the scaling calculations assume maximum productivity by the end of the 5-year monitoring program.
[46] White clover: Duke 1983 and UCSAREP undated; Red chewing fescue and creeping fescue: Chastain et al. 2002.

percent of "full" productivity in the first year followed by full productivity for the ensuing 49 years.

Table 38. Scaling calculations: Herbivorous consumers.

Guild	Selected Species	Biomass (kg) (Table 35)	Ecological Efficiency[a]	Compensatory Primary Production Required[b] (kg dw)
Swans and geese	Canada geese (Adult/Direct Injury)	5,607	0.03%	4,112,064
Swans and geese	Canada geese (Juvenile/Indirect Injury)	9,988	0.03%	7,324,533
			Total	**11,436,597**

[a] Ecologic al efficiencies ar e c alculated re lative to benthi c infaunal detr itivores and om nivores, as summarized in French McCay et al. (2002).

[b] Compensatory Production Required (kg dw)= Weight of Bi rds Lost (kg ww)*0.22 (kg dw/kg ww) / Ecological Efficien cy (%). Conversion from dry weight to wet weight assumes dry weight = 22% of wet weight (French McCay and Rowe 2003).

Project	Net Productivity (kg dw/acre)[c]	Available Acreage (acres)	Available Primary Production (kg dw)
Wet Meadow (Mad Horse Creek)[d]	129,536 35		4,533,761
Managed Pasture (Blackbird Reserve)[e]	112,387 16		1,798,195
Pond (Blackbird Reserve)[f]	86,648 2.	2	190,625
Agricultural Crops (Blackbird Reserve)[g]	68,508 4.	7	321,990
Grasslands (Mad Horse Creek)[h]	45,727 10	0	4,572,664
	Total Primary Productivity		**11,412,855**

[c] All calculations assume 50 years of productivity and a discount rate of 3 percent annually. The baseline productivity for all areas is set to waste corn , due to current agr icultural use, and the discounted n et productivity (3,170 kg dw/acre) has been subtracted from the net productivity for each habitat type. Discounted net productivity calculations are shown in Appendix 3.
[d] Wet meadow annual p rimary productivity is based on r epresentative sedges and rushes (Mitsch and Gosselink, 1986). Scaling calculations assume that a m aximum vegetation productivity of 85 perc ent is reach ed in 5 y ears, based on NJDEP mitigation requirements. Project start date is 2010.
[e] Managed pasture is calcu lated as the average annual produ ctivity of th e three species planted in the area (wh ite clover, creeping red fes cue, and chewing fescue). Pa sture scaling calculations assume 5 0 percent of "full" productiv ity in the first year followed by full productivity for the ensuing 49 years. Project start date is 2009.
[f] Pond productivity is calculated as the average of pond productivity (phytoplankton and aquatic vegetation) and wet meadow productivity, due to the combination of pond and vegetated banks. For the pond productivity, the first year is calculated at 50 percent of full productivity, followed by full productivity for the ensuing 49 years. Project start date is 2009.
[g] Agricultural pr oductivity is based on corn as a proxy, given that it is a likely crop in the ar ea. Annual productivity of corn per acre for Delaware agricultural lands is used, along with standardized assumptions regarding the weight of corn per bushel and the moistur e content. For the agricultur al p roductivity, fu ll productivity is assumed for the entir e 50 years, given th e current use as agricultural lands. Project start date is 2009.
[h] Grassland primar y productivity is conservatively assumed equ al to th e highest annual produ ctivity observed at a grassland site (Osage, Kansas) most similar in rainfall and average temperature to southern New Jersey during a multi-year study (Sims and Singh 1978) . Grassland scaling calculations assume 50 percent of "full" prod uctivity in the first year fo llowed by fu ll productivity for the ensuing 49 years. Project start date is 2010.

Probability of Success

Restoration of wetlands, meadows, food plots, and grasslands 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. The Mad Horse Creek and Blackbird Reserve projects are located on land already owned by the government. For these reasons, the Trustees believe that this project has a high likelihood of success.

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

Oyster bed enhancement is generally considered to be the most effective method for supplementing oyster populations. The ongoing program in the Delaware River has resulted in large increases in oyster numbers, particularly based on the size of the projects relative to the overall area of nursery beds. The probability of success for this project (i.e., the likelihood of successfully producing a functioning oyster reef) is high.

Performance Measures and Monitoring

Mad Horse Creek

Project performance at Mad Horse Creek would be assessed by comparing quantitative monitoring results to predetermined performance standards. These standards would be based on guidelines established by the NJDEP for assessing wetland mitigation projects (Appendix 3). Restored habitats would be monitored twice a year, in early spring and fall, for five full growing seasons. Monitoring assessments would include documentation of hydrologic regime, soil characteristics, plant species present, and confirmation of planned site grading and elevation. At the end of the monitoring period, a survival rate of 85 percent of planted vegetation (and/or similar native vegetation) should be documented; less than 10 percent of plant species should be characterized as non-native, invasive, or noxious. At the conclusion of monitoring, the created wetland areas should be delineated using federal standards and the final acreage corroborated with compensatory requirements.[47]

The monitoring program for this project would 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. In the event that performance standards are not achieved, or monitoring suggests unsatisfactory progress toward meeting established performance standards, corrective actions would be implemented. Possible corrective actions include regrading the area to proper elevations and replanting appropriate vegetation. Any necessary corrective actions would be funded by the contingency component of the project costs (Table 47).

Blackbird Reserve Wildlife Area

Project performance at Blackbird Reserve would be assessed by evaluation of the acreage allocated to each use (pasture, agricultural, pond). For the pasture plantings, monitoring would include documentation of the acreage and evaluation of the species. A survival rate of 85 percent

[47] Specifically, wetlands will be delineated using the Federal Manual for Identifying and Delineating Jurisdictional Wetlands (Federal Interagency Committee for Wetland Delineation 1989).

of planted vegetation (and/or similar native vegetation) should be documented; less than 10 percent of plant species should be characterized as non-native, invasive, or noxious; and the entire area should be vegetated. For the agricultural area, monitoring would include documentation of the acreage left unharvested for wildlife use at the end of the season. In the pond area, monitoring would entail documentation of the overall acreage and evaluation of the bank vegetation. An assessment would be made to determine whether sufficient vegetation is present to stabilize the banks. If the acreages are less than specified in the plan, modifications would be made to planting and to the agreement with the farmer for the agricultural lands, as necessary. Any necessary corrective actions would be funded by the contingency component of the project costs.

<u>Oyster Reef</u>

Performance measures and monitoring for the oyster reef would focus on two key parameters that function as a trigger for use of contingency funds (if necessary). First, the Trustees would confirm that the intended acreage of oyster reef is successfully created. As noted previously, scaling calculations suggest that approximately 73.5 acres of created oyster reef (approximately 49 acres in the Middle Seed beds and 24.5 acres in the Over the Bar beds) are needed to offset *Athos*-related injuries to piscivorous and omnivorous birds. Second, the Trustees would measure spat/oyster densities on created oyster reefs. This parameter also is a key driver of scaling results.

Confirmation of the size of the created oyster reefs would be a "one-time" monitoring event, occurring as soon as practical after project implementation. Monitoring of spat/oyster densities would occur annually, beginning immediately following placement of transplanted, seeded cultch (Middle Seed beds) and the expected peak of natural setting on cultch placed by the Trustees (Over the Bar beds). Monitoring of spat/oyster densities would continue for a total of 5 years, corresponding to the 5-year project lifespan assumed in scaling calculations.

Annual monitoring would be performed by Dr. Powell and colleagues at Haskins Laboratory of Rutgers University. The *Athos* sites would be integrated into regular monitoring conducted by the laboratory, affording cost efficiencies while securing the professional expertise of Dr. Powell and his staff. The number of spat or oysters would be determined using divers over a 3-day period each year. For every 25 acres of created reef, 3 transects would be established, with 12 quarter-meter quadrat collection sites per transect. Divers would collect shell and established biota within each of these quadrats and place them in bags. The specimens would then be transported on-shore where they would be counted and identified in the laboratory. The total cost of spat/oyster monitoring is estimated at $760 per acre and includes diver time, boat operations, and staffing for the laboratory identification component (Tables 41 and 42).

If measured spat/oyster densities do not meet the levels assumed in scaling calculations as described under scaling for subtidal injuries, the Trustees would utilize contingency funds to create additional reef areas and/or relocate the existing reefs to offset the observed shortfall (or to make up for as much shortfall as possible if contingency funds are insufficient to offset it entirely). Although scaling calculations also include the productivity of other benthic invertebrates expected to be enhanced by oyster reef creation (e.g., mud crabs, grass shrimp, and small crustaceans), the Trustees make the simplifying assumption that the density of these biota would track the size of the bed, since their density is assumed in calculations to correspond to the acreage of reef habitat. Thus, confirmation of the area of created oyster reef and oyster densities (and corresponding corrective action, if necessary) would provide sufficient measures of project success, reasonably balancing the need for monitoring with the costs of such efforts.

Approximate Project Costs

Table 39 provides a summary of expected costs for restoring 25.4 acres of wetland habitat, 35 acres of wet meadow habitat, and 100 acres of grassland habitat at Mad Horse Creek to compensate for injuries to invertebrate-consuming and herbivorous birds. Table 47 shows the 25 percent contingency calculated for each project. The location and disposition of Mad Horse Creek would make the construction costs low relative to most other potential restoration sites. Relatively low project costs result from the fact that both properties are government-owned (thus no need to purchase property or easements) and the expectation, based on available information, that sediment contamination levels are low enough to allow placement of excavated sediment on-site (and to be used for grassland habitat restoration).

Detailed design and planning efforts are currently underway, and may result in modifications to the information presented. Grassland restoration costs are included in the unit costs for wetland and wet meadows restoration. As noted previously, grassland restoration is an essential project component and would take place even in the absence of injuries that can be scaled to it, as it serves as a means for on-site, upland disposal of excavated sediments. Contouring and revegetation of such excavated sediments is standard practice. For these reasons, there is no additional cost associated with the grassland restoration project component.

Table 39. Summary of project costs: Mad Horse Creek Restoration. ***COSTS ARE NOT FINAL***

Cost Element	Cost
Planning and Design	$169,550
Construction	$10,869,357
Monitoring	$246,447
Operations and Maintenance	$47,822
TOTAL*	**$11,333,175**

Notes:

This table represents costs for 25.4 acres of wetland, 35 acres of wet meadow and 100 acres of grassland habitat restoration. Grassland restoration costs are included in the unit costs for wetland and wet meadows restoration. Grassland restoration is an essential project component and would take place even in the absence of injuries that can be scaled to it, as it serves as a means for on-site, upland disposal of excavated sediments. Contouring and revegetation of such excavated sediments is standard practice. For these reasons, there is no additional cost associated with the grassland restoration project component.

* Total project costs do not include contingencies of 25% which are shown in Table 47.

Table 40 provides a summary of project costs for the pond and pasture project in New Castle County, Delaware. The costs include excavation of a 2.2-acre pond, planting and maintenance for 16 acres of pasture, and oversight of 23.6 acres of the agricultural lands. Maintenance costs reflect semi-annual mowing of the pasture areas throughout the lifespan of the project, to ensure suitability to geese.

Table 40. Summary of project costs: Blackbird Reserve Wildlife Area pond and pasture restoration. ***COSTS ARE NOT FINAL***

Cost Element	Cost
Planning and Design	$9,079
Construction	$27,345
Monitoring	$4,843
Operations and Maintenance	$50,000
TOTAL*	**$91,268**

Notes:

* Total project costs do not include contingencies of 25% which are shown in Table 47.

Tables 41 and 42 provide a summary of the costs for enhancing 73.5 acres of oyster reef.[48] For the Middle Seed bed project, two barge plantings of shell, initially in the seed beds and then transferred to the nursery beds, are included, with a total bed size of 49 acres over 3 years. For the Over the Bar bed, one barge planting of shell is included, with a total bed size of 24.5 acres.

[48] Written communication from Russell M. Babb, Jr., Principal Fisheries Biologist, New Jersey Division of Fish and Wildlife. 21 July 2006; Personal communication, Richard Cole, Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife.

Table 41. Summary of project costs: Creating a 49 acre oyster reef in "Middle Seed" bed area (N.J.). ***COSTS ARE NOT FINAL***

Cost Element	Per Bushel	Per acre	Cost
Planning and Design			$30,159
Implementation			
Project Oversight			$24,286
Spat planting at seed beds (1,500 bushels per final acre)			
Clam Shell	$0.85	$1,275	$62,475
Loading Fee	$0.10	$150	$7,350
Planting (Tug + Barge)	$1.00	$1,500	$73,500
Spat transplant (1,000 bushels recovered per 1,500 planted; planted at 1,000 bushels per acre)			
Re-harvest/Transplant	$1.50	$1,500	$73,500
		Subtotal	*$216,825*
Monitoring			$48,085
		TOTAL*	**$319,355**

* Total project costs do not include contingencies of 25% which are shown in Table 47.

Table 42. Summary of project costs: Creating a 24.5 acre oyster reef in "Over the Bar" beds (Del.). ***COSTS ARE NOT FINAL***

Cost Element	Per Bushel	Per acre	Cost
Planting at Over the Bar Beds (2,500 bushels per acre)			
Planning and Design			$24,392
Implementation			
Oyster Restoration	$2.05	$5,125	$123,000
Construction Oversight			$11,636
Monitoring			$21,171
		TOTAL*	**$180,199**

* Total project costs do not include contingencies of 25% which are shown in Table 47.

5.5.4 Alternatives to Address Lost Recreational Uses

Trustee analysis indicates that the *Athos* oil spill had a direct adverse impact on recreational use of the Delaware River and its tributaries. Recreational losses occurred from the outset of the spill in November 2004 through October 2005, when recreational activity appeared to return to normal. An estimated 41,709 trips to the river were affected (*Athos*/Delaware River Lost Use TWG 2007), amounting to $1,313,239 in lost value (see Section 4.3.4).

Using the evaluation criteria described in Section 5.2, the Trustees are proposing three projects to restore recreational losses resulting from this spill. The Trustees have scaled these projects using a "value-to-cost" approach, such that the total value of recreational losses ($1,313,239) is approximately equal to the total cost of implementing the projects ($1,313,239).

The three projects preferred by the Trustees to restore lost recreational uses are described below.

5.5.4.1 Stow Creek Boat Ramp

Project Description

This project would improve the Stow Creek boat ramp, a New Jersey-owned site located on the former Wosniak property in Stow Creek Township, Cumberland County, New Jersey (Figure 16). The existing ramp is extremely narrow and short, does not have a dock, and is in poor condition.

The boat ramp and surrounding 186-acre property is owned by NJDEP. The ramp, despite its poor condition, is heavily used for fishing, hunting, and ecological tours. The proposed improvements include widening and lengthening the ramp, removing the existing asphalt and replacing it with concrete, and constructing a small courtesy dock so that boats can be safely boarded, loaded, and unloaded. With proposed improvements, the boat ramp and dock would accommodate more hunters, fishermen, and ecological tourists. People using the facility would also be able to more safely launch their watercraft, and it would be more accessible for people with disabilities.

The proposed improvements would be constructed and managed by the State of New Jersey. The state would serve as the LIT for this project, with oversight by the Trustee Council.

Figure 16. Location of the Stow Creek boat ramp at the end of Stow Creek Road (marked by red star).

Restoration Objective

These boat ramp improvements would expand boating access to Stow Creek and the Delaware River and provide safer conditions for boaters. The Trustees believe the project would help facilitate recreational boating opportunities of the type lost during the spill.

Probability of Success

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

Performance Measures and Monitoring

The performance measure for this project is completion of the boat ramp improvements and construction of a courtesy dock. State officials will maintain the site, though no further monitoring of the project is anticipated.

Approximate Project Costs

The total estimated project cost will exceed the amount allocated through this injury assessment. The Trustees have allocated a total of $100,000 for design and $360,045 for construction activities. The remainder of the project costs will be funded by the State of New Jersey.

Table 43. Summary of project costs: Stow Creek boat ramp improvements. ***COSTS ARE NOT FINAL***	
Cost Element	**Cost**
Planning and Design	$100,000
Construction	$360,045
Monitoring	$0
Operation and Maintenance	$0
TOTAL*	**$460,045**
Notes: Total costs for this project are expected to exceed the amount allocated through this injury assessment. * Total project costs do not include contingencies of 25% which are shown in Table 47.	

5.5.4.2 Augustine Boat Ramp

Project Description

This project involves installing a rock jetty to the north of the Augustine boat ramp to prevent shoaling that is affecting the use and safety of this facility.

The existing boat ramp at Augustine Beach is located on the Delaware River in New Castle County, Delaware, about 1 mile south of Port Penn on Del. Route 9 (Figure 17). The site, owned and maintained by DNREC, includes two handicapped-accessible ramps, two courtesy docks and 100 parking spots, and is a popular site for boating, waterfowl hunting, and commercial and recreational fishing.

Figure 17. Location of the Augustine boat ramp, located in New Castle County, Delaware.

In 1987, a stone breakwater/jetty was constructed immediately south of the boat ramp to protect the existing ramp from excessive wave action. Following construction of the breakwater, shoaling was reported immediately in front of and offshore of the ramp. This shoaling has made boat launching and navigation through the area difficult and even impossible during certain tide conditions. This ramp is also an important emergency response location for local and state agencies responding to boating accidents, oil spills, and Homeland Security issues associated with the nearby nuclear power plant. As funds have permitted, DNREC has periodically dredged the area but this activity is becoming an annual event, and potential impacts associated with this dredging activity have become a concern.

The State of Delaware would serve as the LIT for this project, with oversight by the Trustee Council.

Restoration Objective

The objective of this project is to eliminate the existing shoaling problem at the Augustine site, by installing a rock jetty on the north side of the boat ramp thereby eliminating littoral transport of sediment into the channel associated with the ramp. This activity would enhance boat use and safety at this popular fishing, hunting, and boating launch area and increase access to the Delaware River.

Probability of Success

DNREC has completed a study modeling tidal circulation, sediment, and wind data to identify the source of shoaling and evaluate alternatives to reduce or eliminate the shoaling. The study concluded that the existence of a single breakwater is causing the shoaling, and recommended the installation of a northern breakwater over modifying or removing the existing breakwater as a long-term solution. Based on this information, the Trustees believe that installing an additional breakwater would reduce shoaling and that there is a high probability that this project would provide increased opportunities for Delaware River boating by enhancing the utility and safety of the current boat ramp facility.

Performance Measures and Monitoring

The performance measure for this project is completion of the installation of an additional rock jetty to meet design specifications. Local officials will maintain the site, though no further monitoring of the project is anticipated.

Approximate Project Costs

Based on the initial study, site visits, and consultations with coastal engineers, the cost of the breakwater construction is estimated at $903,240. The exact cost would be based on the final project design currently being developed by DNREC.

The Trustees are allocating $808,152 for this project (Table 44). The State of Delaware has agreed to cover any additional costs above the $808,152 total. If this agreement is not fulfilled, and sufficient funding for construction is not provided, the state would be responsible for all project costs incurred to that point (i.e., hydrodynamic and sediment transport analyses and final design costs) and the Trustees would initiate a public process to identify an appropriate alternative project. With the NPFC's concurrence, the $808,152 would then be applied to this new project.

Table 44. Summary of Project Costs: Augustine boat ramp improvements. ***COSTS ARE NOT FINAL***

Cost Element	Cost
Planning and Design	$75,940
Construction	$732,212
Monitoring	$0
Operations and Maintenance	$0
TOTAL	$808,152

Notes:
Total costs for this project are estimated at $903,240. The State of Delaware will supply the additional funds for this project.
* Total project costs do not include contingencies of 25% which are shown in Table 47.

5.5.4.3 Little Tinicum Island Trail and Habitat Enhancement

Project Description

Little Tinicum Island is an approximately 200-acre island located on the Delaware River in Tinicum Township, Delaware County, Pennsylvania (Figure 18). Much of the island's shoreline was moderately to heavily oiled during the *Athos* incident.

Figure 18. Location of Little Tinicum Island on the Delaware River. The red star is the approximate site of the spill.

Little Tinicum Island is a designated Natural Area, owned by the Pennsylvania Bureau of Forestry. An estimated 3,500 to 4,000 people access Little Tinicum Island on a yearly basis (S. Insalaco, personal communication) but there are no maintained trails on the island. Instead, visitors cross the island on make-shift trails worn down by frequent use or struggle through the thick vegetation. Island visitors contribute to erosion by hiking on steep dredge spoil cell berms, disturbing rare mudflat habitat and plants, trampling ground-nests, and constructing illegal viewing/hunting blinds.

The proposed restoration project is to install a permanent trail, two observation decks, and a “breakaway bridge” to cross a small wet area. Figure 19 shows the location of the trail, which would be a loop on the berm of the large spoil cell with a feeder trail that would allow viewing of the existing inlet wetland and lead to a permanent duck blind. Along the trail, invasive plant species would be controlled and revegetated with native plants to prevent further spread of invasives by recreationalists using the trail. Figure 20 shows the location for the breakaway bridge and a proposed site for a wildlife observation deck.

The State of Pennsylvania would serve as the LIT for this project, with oversight by the Trustee Council.

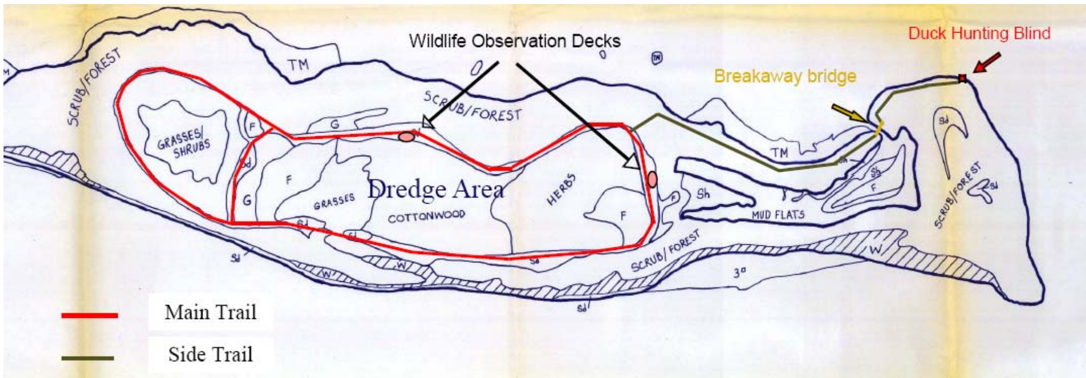


Figure 19. Little Tinicum Island Restoration site map showing location of the proposed trail (red line), breakaway bridge, and wildlife observation decks.


a.


b.

Figure 20. Little Tinicum Island restoration site: a. Location for breakaway bridge; b. Location of one of two wildlife observation decks.

Restoration Objective

The Trustees believe this project would provide recreational opportunities similar to those lost during the spill, including shoreline activities such as wildlife viewing, hiking, fishing, and picnicking.

Probability of Success

Given the current use of the island with limited access, and its scenic nature, the Trustees believe this project would likely provide highly desirable and appropriate opportunities for increased shoreline use.

Performance Measures and Monitoring

The performance measure for this project is construction of the trail, observation decks, and breakaway bridge. State officials will maintain the site, though no further monitoring of the project is anticipated.

Approximate Project Costs

Estimated costs total $45,042 (Table 45). Major components of the costs include construction ($20,656) and operations and maintenance ($14,000).

Table 45. Summary of project costs: Little Tinicum Island trail and habitat restoration. ***COSTS ARE NOT FINAL***

Cost Element	Cost
Planning and Design	$10,387
Construction	$20,656
Monitoring	$0
Operations and Maintenance	$14,000
TOTAL*	**$45,042**

Notes:
* Total project costs do not include contingencies of 25% which are shown in Table 47.

5.6 – Preferred Restoration Alternatives Summary

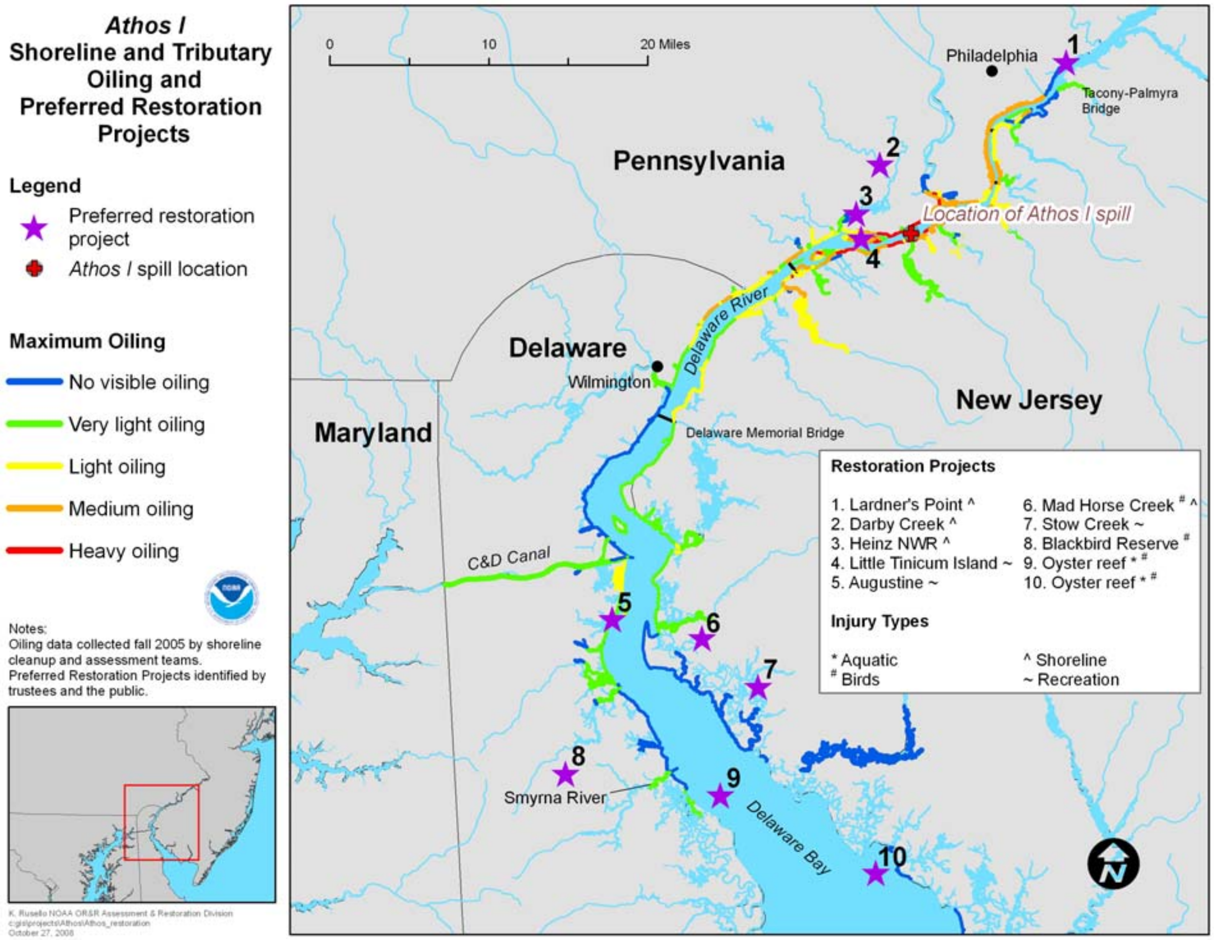
The preferred projects are based primarily on their benefit to the environment and their capacity to compensate the public for injuries to natural resources and services. The Trustees believe that the projects currently preferred for the restoration plan will not cause significant adverse impacts to natural resources or the services they provide.

Table 46 summarizes the preferred restoration alternatives and restoration costs for the *Athos* oil spill. As indicated below, costs to implement these projects total $24,425,720.

Table 46. Summary of injuries resulting from the *Athos* incident and preferred restoration alternatives. **COSTS ARE NOT FINAL**

Resource Category		**Preferred Compensatory Restoration Alternative**		**Project Cost**
Aquatic	Subtidal benthic habitat	4.5 acres	Oyster reef enhancement and restoration (Del. and N.J.)	$528,647
Bird and Wildlife	Gulls, diving ducks, diving birds, wading birds, kingfishers	73.5 acres		
	Dabbling ducks	25.4 acres	Mad Horse Creek (N.J.) marsh restoration	$11,333,175
	Swans and geese	35 acres	Mad Horse Creek (N.J.) wet meadow	
		100 acres	Mad Horse Creek (N.J.) grassland restoration	
		41.8 acres	Blackbird Reserve (Del.) pond and pasture enhancement	$91,268
Shoreline	Seawalls, sand/mud substrate, marsh, coarse substrate	38.1 acres	Mad Horse Creek (N.J.) marsh restoration	$7,154,875
		0.9 acre	Lardner's Point (Pa.) shoreline restoration	$567,137
	Tributaries	56 acres	John Heinz habitat restoration	$2,396,559
		2.6 miles	Darby Creek (Pa.) dam removal and habitat restoration	$1,040,820
Recreation	Trips affected (lost and diminished value)	$460,045	Stow Creek (N.J.) boat ramp improvements	$1,313,239
		$808,152	Augustine boat ramp stone jetty installation	
		$45,042	Little Tinicum Island trail and habitat improvements	

The location of proposed restoration projects are shown in the figure below (identical to Figure 8).



5.7 – Restoration Contingency Costs

As explained in section 5.1, a contingency factor of 25 percent is included for each of the ecological restoration projects to account for the uncertainties inherent in these preliminary estimates and to cover the risk that the costs of the projects would turn out to be higher than expected, and/or the projects would not result in the expected magnitude of benefits and need augmentation. These contingency costs are presented in Table 47 as a separate category of restoration costs, rather than included in the tables of costs for restoration itself, since they represent expenditures that might not occur.

Table 47. Contingency costs per project, based on 25 percent of the total project cost. ***COSTS ARE NOT FINAL***		
Injury Category	**Project**	**Contingency**
Aquatic	3 acre oyster reef in "Middle Seed" bed area	$4,455
Aquatic	1.5 acre oyster reef in "Over the Bar" beds	$2,818
Aquatic	49 acre oyster reef in "Middle Seed" bed area	$79,839
Aquatic	24.5 acre oyster reef in "Over the Bar" beds	$45,050
Bird and Wildlife	Mad Horse Creek restoration	$2,833,294
Bird and Wildlife	Blackbird Reserve	$22,817
Shoreline	Mad Horse Creek restoration	$1,788,719
Shoreline	Lardner's Point shoreline restoration	$141,784
Shoreline	Darby Creek dam removal and habitat restoration	$260,205
Shoreline	John Heinz habitat restoration	$599,140

5.8 – Trustee Council Oversight Costs

A Trustee Council, consisting of a representative from each of the five trustee agencies, would oversee implementation of each restoration project. The Council would be responsible for all aspects of project implementation, including statements of work, selection of contractors, final designs/plans and work plans, monitoring, ensuring that final projects compensate for losses as scaled, and certifying the completion of each project. NOAA would serve as the lead administrative trustee, with additional responsibilities for the day-to-day administrative affairs of the Council that include: establishing and maintaining a Record for restoration implementation that, at a minimum, includes all restoration implementation decisions and expenditures; disseminating information about each project though the project website; facilitating regular Trustee Council meetings and communication; tracking expenditures for each restoration project; and providing quarterly reports to the NPFC. Table 48 summarizes Trustee oversight costs.

Table 48. Summary of Trustee Council oversight costs. ***COSTS ARE NOT FINAL***

Trustee	Hours/year	Total Cost Year 1	Total Cost Year 2	Total Cost Year 3	Total Cost Year 4	Total Cost Year 5	Total Cost Year 6	Total Cost Year 7
NJDEP	408	$9,642	$9,932	$10,230	$10,537	$10,853	$11,178	$11,514
DNREC	200	$9,272	$9,550	$9,837	$10,132	$10,436	$10,749	$11,071
USFWS	344	$15,671	$16,141	$16,625	$17,124	$17,638	$18,167	$18,712
PADEP	352	$11,242	$11,579	$11,927	$12,285	$12,653	$13,033	$13,424
NOAA	1818 [a]	$229,670	$236,560	$243,657	$250,967	$258,496	$266,251	$308,537

[a] These hours do not include the time that will be needed for case closure in the final year.

6.0 - Literature Cited

Aquatic Technical Working Group (TWG). 2007. Final Report Aquatic Injury Assessment: M/T *Athos I* oil spill, Delaware River System. Available: http://www.darrp.noaa.gov/northeast/athos/index.html.

Athos/Delaware River Lost Use Technical Working Group (TWG). 2007. ATHOS/Delaware River Lost Use Valuation Report. Available: http://www.darrp.noaa.gov/northeast/athos/index.html.

Athos Trustee Council. 2006. Factors to Evaluate Proposed Restoration Projects under the Oil Pollution Act, Delaware River/M/T *Athos I* Oil Spill. Available: http://www.darrp.noaa.gov/northeast/athos/index.html.

Babb, R. Personal communication. New Jersey Department of Environmental Protection, New Jersey Division of Fish and Wildlife, Bivalve Shellfish Office.

Babb, R. 2006. Written communication. 21 July 2006. New Jersey Department of Environmental Protection, New Jersey Division of Fish and Wildlife, Bivalve Shellfish Office.

Bahr, L.N. and W.P. Lanier. 1981. The ecology of intertidal oyster reefs of the South Atlantic coast: a community profile. Available: http://cuadra.cr.usgs.gov/Techrpt/81-15.pdf. U.S. Fish and Wildlife Service, Office of Biological Services, Washington DC. FWS/OBS-81/15. 105 pp.

Baldassarre, G.A. and E.G. Bolen. Undated. Management of Waste Corn for Waterfowl Wintering on the Texas High Plains. Contribution No. T-9-504 of the College of Agricultural Sciences, Texas Tech University (Department of Range, Wildlife and Fisheries Management - Management Notes).

Bird and Wildlife Technical Working Group (TWG). 2007. Final Report Bird and Wildlife Injury Assessment: M/T *Athos I* oil Spill, Delaware River System. Available: http://www.darrp.noaa.gov/northeast/athos/index.html.

Chastain, T.G., W.C. Young, and G. Gingrich. 2002. Differential Response of Fine Fescue Cultivars to Nonthermal Residue Management. Progress Report for FY02; Grass Seed Cropping Systems for a Sustainable Agriculture. Available: http://gscssa.wsu.edu/progress/02/702.htm.

Cole, R. Personal communication, Delaware Department of Natural Resources and Environmental Control, Division of Fish and Wildlife.

Cornell Lab of Ornithology. 2003. All About Birds Bird Guide. Available: http://www.birds.cornell.edu/AllAboutBirds/BirdGuide/. Cornell Lab of Ornithology, Ithaca, NY.

Delaware Department of Natural Resources and Environmental Control (DNREC), Division of Fish & Wildlife – Natural Heritage and Endangered Species Program. 2004. Endangered Species of Delaware. Available: http://www.dnrec.state.de.us/nhp/information/endangered.shtml. Delaware Natural Heritage and Endangered Species Program Division of Fish and Wildlife, Smyrna, DE. Accessed 15 October 2007.

Delaware Department of Natural Resources and Environmental Control (DNREC). 2005. Building Partnerships to Address Environmental Concerns. Available: http://www.dnrec.state.de.us/dnrec2000/Divisions/Soil/dcmp/ppi.htm. DE DNREC, Dover, DE. Accessed 2 January 2006.

Delaware Division of Fish and Wildlife (DDFW). 2007. Oyster Workshop presentation by DDFW staff. Provided by Richard Cole, DDFW.

Delaware River Basin Commission (DRBC). 2005. The Delaware River Basin. Available: http://www.state.nj.us/drbc/thedrb.htm. DRBC, West Trenton, NJ. Accessed 16 February 2006.

Di Toro, D.M., J.A. McGrath, and D.J. Hansen. 2000. Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue. Environmental Toxicology and Chemistry. 19(8):1951-1970.

Dove, L.E. and R.M. Nyman, eds. 1995. Living Resources of the Delaware Estuary. The Delaware Estuary Program. 530 pp. & appendices.

Doyle, M.W., E.H. Stanley, C.H. Orr, A.R. Selle, S.A. Sethi, J.M. Harbor. 2005. Stream Ecosystem Response to Small Dam Removal: Lessons from the Heartland. Geomorphology 71(2005):227-244.

Duke, J.A. 1983. Handbook of Energy Crops [unpublished] Data for *Trifolium repens* presented in the Purdue University New Crop Resource Online Program. Available: http://www.hort.purdue.edu/newcrop/duke_energy/trifolium_pratense.html

EA Engineering, Science, and Technology, Inc. 2005a. Results of Toxicity Testing with *Leptocheirus pumulosus* on Sediment Samples from the Delaware River (EA Report Number 4677, dated 27 January 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.

EA Engineering, Science, and Technology, Inc. 2005b. Results of Toxicity Testing with *Leptocheirus pumulosus* on 17 February 2005 Sediment Samples from the Delaware River (EA Report Number 4750, dated 26 April 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.

EA Engineering, Science, and Technology, Inc. 2005c. Results of Toxicity Testing with *Leptocheirus pumulosus* on 15 December 2005 Sediment Samples from the Delaware River (EA Report Number 4691, dated 4 March 2005). Report prepared for the Delaware Department of Natural Resources and Environmental Control, Division of Air and Waste Management, New Castle, DE.

Environmental Consulting Services, Inc. (ECS). 1993. Final Report of Survey of Benthos: Delaware Estuary: From the Area of the C&D Canal through Philadelphia to Trenton. Prepared for the Delaware Estuary Program, Delaware River Basin Commission, and Environmental Protection Agency.

Federal Interagency Committee for Wetland Delineation. 1989. Federal Manual for Identifying and Delineating Jurisdictional Wetlands. U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, and U.S.D.A. Soil Conservation Service, Washington, DC. Cooperative technical publication. 76 pp. plus appendices.

French McCay, D.P., C. Peterson, and M. Donlan. 2002. Restoration Scaling of Benthic, Aquatic, and Bird Injuries to Oyster Reef and Marsh Restoration Projects. April 16, 2002. Prepared for NOAA for the Chalk Point/Swanson Creek Oil Spill. Available: http://www.darrp.noaa.gov/northeast/chalk_point/pdf/cpar2049.pdf.

French McCay, D.P and J.J. Rowe. 2003. Habitat Restoration as Mitigation for Lost Production at Multiple Trophic Levels. Marine Ecology Progress Series. 264:233-247.

Greene, R. Personal communication. Delaware Department of Natural Resources & Environmental Control.

Hart, D.D., T.E. Johnson, K.L. Bushaw-Newton, R.J. Horwitz, A.T. Bednarek, D.F. Charles, D.A. Kreeger, D.J. Velinsky. 2002. Dam Removal: Challenges and Opportunities for Ecological Research and River Restoration. BioScience 52(8):669-681.

Hess, G.K., R.L. West, M.V. Barnhill III, and L.M. Fleming. 2000. Birds of Delaware. University of Pittsburgh Press, Pittsburgh, PA.

Howe, S. and W. Leathem. 1984. Secondary production of benthic macrofauna at three stations of Delaware Bay and Coastal Delaware. NOAA Technical Memorandum NMFS-F/NEC-32, National Oceanographic and Atmospheric Administration, Rockville, MD.

Insalaco, S. Personal communication. Forester, Pennsylvania Bureau of Forestry.

Kanehl, P.D., J. Lyons, J.E. Nelson. 1997. Changes in the Habitat and Fish Community of the Milwaukee River, Wisconsin, Following Removal of the Woolen Mills Dam. North American Journal of Fisheries Management. 17(2):387-400.

Kraft, J.C. 1988. Geology. In T.L. Bryant and J.R. Pennock (eds.) The Delaware Estuary: Rediscovering a Forgotten Resource. University of Delaware Sea Grant College Program, Newark, DE.

Kreeger, D., R. Tudor, J. Sharp, S. Kilham, D. Soeder, M. Maxwell-Doyle, J. Kraeuter, D. Frizzera, J. Hameedi and C. Collier. 2006. White paper on the status and needs of science in the Delaware Estuary. Partnership for the Delaware Estuary, Report #06-01. 72 pp. Available: http://www.delawareestuary.org/pdf/ScienceReportsbyPDEandDELEP/PDE-Report-06-01-ScienceWhitePaper.pdf. Partnership for the Delaware Estuary, Wilmington, DE. Accessed 26 May 2006.

Kristine, D. Personal communication. Pennsylvania Fish and Boat Commission, Division of Habitat Management.

Leblanc, Y. 1987. Egg mass, position in the laying sequence, and brood size in relation to Canada goose reproductive success. Wilson Bulletin 99(4):663-672.

Louisiana Oil Spill Coordinator's Office (LOSCO), Louisiana Department of Environmental Quality, Louisiana Department of Natural Resources, Louisiana Department of Wildlife and Fisheries, National Oceanic and Atmospheric Administration, and United States Fish and Wildlife Service. 2001. Final Damage Assessment/Restoration Plan And Environmental Assessment, M/V *Westchester* Crude Oil Discharge, Lower Mississippi River, Louisiana. Available: http://www.darrp.noaa.gov/southeast/westchester/admin.html. NOAA Damage Assessment, Remediation, and restoration Program, Silver Spring, MD. December 2001.

Marek, E. Personal communication. USFWS, Office of Law Enforcement, Special Agent, Elizabeth, NJ.

Mitsch, W.J. and J.G. Gosselink. 1986. Wetlands (1st ed.). Van Nostrand Reinhold Co., New York, NY.

National Oceanic and Atmospheric Administration (NOAA). 1999. Discounting and the treatment of uncertainty in natural resource damage assessment. Technical paper 99-1. Available: http://www.darrp.noaa.gov/library/pdf/discpdf2.pdf. NOAA Damage Assessment, Remediation, and Restoration Program, Silver Spring, MD.

National Oceanic and Atmospheric Administration (NOAA), Maryland Department of Natural Resources, Maryland Department of the Environment, U.S. Fish and Wildlife Service. 2002. Final Restoration Plan and Environmental Assessment for the April 7, 2000 Oil Spill at Chalk Point on the Patuxent River, Maryland. November 2002. Available: http://www.darrp.noaa.gov/northeast/chalk_point/admin.html. NOAA Damage Assessment, Remediation, and Restoration Program, Silver Spring, MD.

National Oceanic and Atmospheric Administration (NOAA). 2003. Coastal and Estuarine Hazardous Waste Site Reports: Pennsylvania: Lower Darby Creek Area. CERCLIS No.= PASFN0305521. Available: http://response.restoration.noaa.gov/book_shelf/443_wsr4_lowerdarby.pdf. NOAA Office of Response and Restoration, Silver Spring, MD.

National Oceanic and Atmospheric Administration (NOAA). 2005. M/T *Athos* I Delaware River Oil Spill. Available: http://www.darrp.noaa.gov/northeast/athos/index.html. Damage Assessment, Remediation, and Restoration Program (DARRP), Silver Spring, MD. Accessed 30 December 2005.

National Oceanic and Atmospheric Administration (NOAA). 2006. Final Preassessment Data Report M/T *ATHOS I* Oil Spill, Delaware River. Available: http://www.darrp.noaa.gov/northeast/athos/pdf/PADR.june.pdf. June 2006. NOAA Damage Assessment, Remediation, and Restoration Program, Silver Spring, MD.

Neff, J.M., S.A. Stout, and D.G. Gunster. 2005. Ecological risk assessment of polycyclic aromatic hydrocarbons in sediments: Identifying sources and ecological hazards. Integrated Environmental Assessment and Management 1(1): 22-33.

New Jersey Department of Environmental Protection (NJDEP). 2000. New Jersey Department of Environmental Protection Mitigation Project Monitoring Reports for Tidal Wetland Checklist for Completeness. Available: http://www.state.nj.us/dep/landuse/forms/twmm_checklist.pdf. NJDEP, Trenton, NJ. August, 2000.

Nichols, F.H. 1975. Dynamics and Energetics of Three Deposit-Feeding Benthic Invertebrate Populations in Puget Sound, Washington. Ecological Monographs: 45(1):57-82.

Partnership for the Delaware Estuary (PDE). 2005. What's the Estuary? Description. Available: http://www.delawareestuary.org/whatsthedelawareestuary/description.asp. Accessed 20 September 2005.

Pennsylvania Department of Conservation and Natural Resources (PA DCNRa). William Penn State Forest. Available: http://www.dcnr.state.pa.us/Forestry/stateforests/williampenn.aspx. PA DCNR, Harrisburg, PA. Accessed 2 January 2006.

Pennsylvania Department of Conservation and Natural Resources (PA DCNRb). Endangered and Threatened Species of Pennsylvania. Available: http://www.dcnr.state.pa.us/wrcf/contents.aspx. PA DCNR, Harrisburg, PA. Accessed 15 October 2007.

Pennsylvania Fish and Boat Commission (PFBC). 2007. Impact of Dam Removal on Fish and Macroinvertebrate Populations: Pennsylvania’s Observations. PowerPoint

Presentation by R. Scott Carney, Division Chief, Division of Habitat Management, PFBC.

Peterson, C.H., M. Wong, M.F. Piehler, J.H. Grabowski, R.R. Twilley, and M.S. Fonseca. 2007. Estuarine Habitat Productivity Ratios at Multiple Trophic Levels. NOAA Work Product.

Powell, E. 2005. Shell-Planting Program in Delaware Bay. Report to the U.S. Army Corps of Engineers.

Powell, E., J. Kraeuter, D. Bushek (eds.). 2007. Report of the 2007 Stock Assessment Workshop (9th SAW) for the New Jersey Delaware Bay Oyster Beds. Available: http://www.darrp.noaa.gov/northeast/athos/index.html. Haskin Shellfish Research Laboratory - Rutgers, the State University of New Jersey, Point Norris, NJ. 94 pp.

Price, K.S., R.A. Beck, S.M. Tweed, and C.E. Epifanio. 1988. Fisheries. In T.L. Bryant and J.R. Pennock (eds.) The Delaware Estuary: Rediscovering a Forgotten Resource. University of Delaware Sea Grant College Program, Newark, DE.

RCG/Hagler, Bailly, Inc. and Environmental Consulting Services, Inc. 1990. Natural resource damage assessment for the *Presidente Rivera* oil spill: Phase I: Preliminary damage assessment. Final Draft Report. Prepared for State of Delaware, Department of Natural Resources and Environmental Control.

Rhoads, A.F. 2004. Report to the Pennsylvania Bureau of Forestry on a visit to inspect oil damage to tidal marshes of Little Tinicum Island from the *Athos I* oil spill of November 26, 2004. Available: http://www.darrp.noaa.gov/northeast/athos/pdf/Appendix%20h%20and%20i.pdf. Appendix H5 of the Final Preassessment Data Report M/T *ATHOS I* Oil Spill, Delaware River. NOAA Damage Assessment, Remediation, and Restoration Program, Silver Spring, MD.

Ringelman, J.K. 1990. Managing Agricultural Foods for Waterfowl. Section 13.4.3 in: Cross, D., and P. Vohs, (eds.). 1988. *Waterfowl Management Handbook*. Fort Collins, CO: U.S. Fish and Wildlife Service.

Robinson, R.A. 2005. BirdFacts: profiles of birds occurring in Britain & Ireland (v1.1, Jan 2006). BTO Research Report 407, BTO, Thetford. Available: http://www.bto.org/birdfacts. British Trust for Ornithology, Norfolk, UK.

Rosenberger, R.S. and J.B. Loomis. 2001. Benefit transfer of outdoor recreation use values: A technical document supporting the Forest Service Strategic Plan (2000 revision). Available: http://www.fs.fed.us/rm/pubs/rmrs_gtr72.pdf. U.S. Department of Agriculture, Forest Service, Fort Collins, CO.

Russo, A.R. 1978. Some ecological observations on a permanent pond in southern England: Primary production and planktonic seasonal succession. Hydrobiologia. 60(1)33-48.

Sample, B.E., D.M. Opresko, and G.W. Suter II. 1996. Toxicological benchmarks for wildlife:1996 Revision. ES/ER/TM-86/R3. Available: http://www.hsrd.ornl.gov/ecorisk/tm86r3.pdf. Office of Environmental Management. United States Department of Energy, Oak Ridge, TN.

Shafroth, P.B., J.M. Friedman, G.T. Auble, M.L. Scott, J.H. Braatne. 2002. Potential Responses of Riparian Vegetation to Dam Removal. BioScience 52(8):703-712.

Shoreline Assessment Team. 2007. Final Report Shoreline Injury Assessment M/T *Athos I* Oil Spill. Available: http://www.darrp.noaa.gov/northeast/athos/index.html.

Sims, P.L. and J. S. Singh. 1978. The Structure and Function of Ten Western North American Grasslands. III. Net Primary Production, Turnover and Efficiencies of Energy Capture and Water Use. Journal of Ecology 66:573-597.

Soltwedel, T. 2000. Metazoan Meiobenthos along Continental Margins: A Review. Progress in Oceanography 46:59-84.

Stiles, E. 2005. Delaware River Oil Spill Tragedy. Available: http://www.njaudubon.org/Conservation/Oilspill.html. New Jersey Audubon Society, Bernardsville, NJ. Accessed 2 January 2006.

Strange, E., H. Galbraith, S. Bickel, D. Mills, D. Beltman, and J. Lipton. 2002. Environmental Assessment, Determining ecological equivalence in service-to-service scaling of salt marsh restoration. Environmental Management 29(2): 290-300.

Strassman, S. Personal communication. American Rivers.

Sutton, C.C., J.C. O'Herron II, and R.T. Zappalorti. 1996. The scientific characterization of the Delaware Estuary. The Delaware Estuary Program (DRBC Project No. 321; HA File No. 93.21). 200 pp. plus appendices. Available: http://www.delawareestuary.org/pdf/ScienceReportsbyPDEandDELEP/PDE-DELEP-Report-96-02-SciChar.pdf. Partnership for the Delaware Estuary, Wilmington, DE.

Tiner, R.W. and D.G. Burke, 1995. Wetlands of Maryland. U.S. Fish and Wildlife Service, Ecological Services, Region 5, Hadley, MA, and Maryland Department of Natural Resources, Annapolis, MD. Cooperative Publication, 193 pp. plus appendices.

United States Coast Guard (USCG). 2005a. Delaware River oil spill update #21 and third party claims process for *Athos I* oil spill claims changing. Press Release, Document Number: 88. 16 February 2005.

United States Coast Guard (USCG). 2005b. T/S *Athos I* Evaluation Report. USCG National Strike Force Coordination Center, Preparedness Department, Elizabeth City, NC.

United States Coast Guard (USCG). 2006. Investigation into the striking of submerged objects by the tank vessel *ATHOS I* in the Delaware River on November 26, 2004 with a major discharge of oil. Available: http://www.uscg.mil/hq/g-m/moa/docs/*Athos*I.pdf. USCG, Washington, DC.

United States Department of Agriculture National Agricultural Statistics Service (USDA NASS). Undated. Statistics by State (New Castle County, Delaware, Corn for Grain, 2003-2007). Available: http://www.nass.usda.gov/.

United States Fish & Wildlife Service (USFWSa). John Heinz National Wildlife Refuge at Tinicum. Available: http://www.fws.gov/northeast/heinz/index.htm. John Heinz National Wildlife Refuge, Philadelphia, PA. Accessed 2 January 2006.

United States Fish & Wildlife Service (USFWS). 2006. Threatened and Endangered Species System. Available: http://www.fws.gov/endangered/wildlife.html. USFWS. Accessed 2 January 2006.

University of California Sustainable Agriculture Research & Education Program (UCSAREP). Undated. White Clover. Cover Crop Database. Available: http://www.sarep.ucdavis.edu/ccrop/.

Warner, R.E., S.P. Havera, L.M. David, and R.J. Siemens. 1989. Seasonal Abundance of Waste Corn and Soybeans in Illinois. *The Journal of Wildlife Management*, Vol. 53, No. 1 (Jan., 1989), pp. 142-148.

Weslager, C.A. and L. Heite. 1988. History. In T.L. Bryant and J.R. Pennock (eds.) The Delaware Estuary: Rediscovering a Forgotten Resource. University of Delaware Sea Grant College Program, Newark, DE.

Westervelt, K., E. Largay, R. Coxe, W. McAvoy, S. Perles, G. Podniesinski, L. Sneddon, and K. Strakosch Walz. 2006. A Guide to the Natural Communities of the Delaware Estuary: Version 1. NatureServe. Arlington, VA. Available: http://www.delawareestuary.org/pdf/ScienceReportsbyPDEandDELEP/GuideNaturalComm_v1.pdf. Partnership for the Delaware Estuary, Wilmington, DE.

Appendix 1. File structure and index of the Administrative Record developed by the Trustees for the *Athos* oil spill

1. BACKGROUND INFORMATION
    1.1. OPA
    1.2. OPA NRDA Regulations
    1.3. State laws

2. COORDINATION
    2.1 Among Trustees
        2.1.1 Final MOA among NOAA, DOI, States of Delaware and New Jersey and Commonwealth of Pennsylvania regarding NRDA Restoration and Activities Arising from *Athos I* Spill in the Delaware River, April 11, 2005

    2.2 With Response
        2.2.1 USCG Investigation into the Striking of Submerged Objects by the Tank Vessel *Athos I* in the Delaware River of January 19, 2006
        2.2.2 USCG Press Release, Document Number: 88, Delaware River Oil Spill Update #21 and Third Party Claims Process for *Athos I* Oil Spill Claims Changing, February 16, 2005
        2.2.3 USCG National Strike Force Coordination Center Preparedness Department,
        T/S *Athos I* Evaluation Report of August 25, 2005
        2.2.4 NPFCPOLICY CN05, NRD Contingency Payments, National Pollution Funds Center, USCG, January 24, 2007

    2.3 With Responsible Parties
        2.3.1 Sharon K. Shutler letter to Gene O'Connor and Tim Bergere regarding NRDA upfront funding of January 7, 2005
        2.3.2 Timothy J. Bergere letter to Sharon Shutler, Robert Kuehl, Marcia Gittes, and Joan Olawski-Steiner regarding funding for joint preassessment/assessment activities of January 14, 2005
        2.3.3 Sharon K. Shutler letter to Gene O'Connor and Tim Bergere regarding an invitation to participate in a damage assessment of March 9, 2005
        2.3.4 Timothy J. Bergere letter to Sharon Shutler accepting the invitation to participate in NRDA of May 24, 2005
        2.3.5 Sharon K. Shutler letter to Gene O'Connor and Tim Bergere regarding their acceptance to participate in NRDA of June 21, 2005

    2.4 With Public
        2.4.1 Office of Response and Restoration article on M/T *Athos I* Delaware River Oil Spill of November 2005
        2.4.2 Scoping letter sent to public soliciting ideas; sent on December 16, 2005 by *Athos I* lead administrative trustee

2.4.3 Attachments to scoping letter sent to public soliciting ideas; sent on December 16, 2005 by *Athos I* lead administrative trustee
2.4.4 List of people receiving the scoping letter sent to public soliciting ideas; sent on December 16, 2005 by *Athos I* lead administrative trustee
2.4.5 Copies of scoping letter sent to public soliciting ideas; sent on December 16, 2005 by *Athos I* lead administrative trustee
2.4.6 Response to scoping letter of December 16, 2005 from Maya K. van Rossum, the Delaware Riverkeeper of January 18, 2006
2.4.7 Responses to scoping letter of December 16, 2005 from Tom Witmer – not dated
2.4.8 Responses to scoping letter of December 16, 2005 from Andrew T. Manus, The Nature Conservancy – not dated
2.4.9 Responses to scoping letter of December 16, 2005 from Kathy Klein, Partnership for the Delaware Estuary, Inc. of January 10, 2006
2.4.10 Responses to scoping letter of December 16, 2005 from Nicholas A. DiPasquale, Delaware Audubon Society of January 12, 2006
2.4.11 Department of Commerce Federal Register Notice of Intent to Conduct Restoration Planning of Monday, July 3, 2006
2.4.12 Office of Response and Restoration article on M/T *Athos I* Delaware River Oil Spill of October 2006
2.4.13 T/V *Athos I* Delaware River Oil Spill Fact Sheet of January 2005

3. PREASSESSMENT PHASE
3.1 Map of approximate location of the *Athos* Oil Spill in the Delaware River
3.2 Final Preassessment Data Report M/T *Athos I* Oil Spill, Delaware River of June
2006
3.3 *Athos I* Chemistry Data; Index
3.4 The Scientific Characterization of the Delaware Estuary, The Delaware Estuary Program, Sutton, Herron, and Zappalorti, April 1996
3.5 Commercial Fishing in Delaware 2000, Whitmore and Cole, not dated
3.6 Technical Basis for Narcotic Chemicals and Polycyclic Aromatic Hydrocarbon Criteria. I. Water and Tissue, DiToro, McGrath and Hansen, December 13, 1999
3.7 Ecological Risk Assessment of Polycyclic Aromatic Hydrocarbons in Sediments: Identifying Sources and Ecological Hazard, Neff, Stout and Gunster, June 23, 2005
3.8 Toxicological Benchmarks for Wildlife: 1996 Revision, Sample, Opresko, Suter II, Date Issued – June 1996

4. RESTORATION PLANNING: INJURY ASSESSMENT
4.1 General
4.1.1 Discounting and the Treatment of Uncertainty in Natural Resource Damage Assessment Technical Paper 99-1, NOAA, February 19, 1999

4.2 Shoreline

4.2.1 Final Report Shoreline Injury Assessment M/T *Athos I* Oil Spill, Prepared by Shoreline Assessment Team, 21 March 2007

4.2.2 Response to RP Comments on Draft Shoreline Injury Assessment, Dr. Jim Hoff, January 27, 2006

4.2.3 The University of North Carolina at Chapel Hill, Shoreline and Aquatic Peer Review Comments, Dr. Charles H. Peterson, October 31, 2006

4.3 Aquatic Resources

4.3.1 Final Report, Aquatic Injury Assessment, M/T *Athos I* Oil Spill, Delaware River System, Aquatic Technical Working Group, June 27, 2007

4.3.2 The University of North Carolina at Chapel Hill, Shoreline and Aquatic Peer Review Comments, Dr. Charles H. Peterson, October 31, 2006 (see 4.2.3)

4.3.3 RP Comments on the Draft Aquatic Injury Report, Polaris Applied Sciences, June 8, 2006

4.3.4 Trustee Responses to RP Polaris Applied Sciences Comments on Draft Aquatic Injury Report, 2006

4.3.5 Results of Toxicity Testing with Leptocheirus pumulosus on Sediment Samples from the Delaware River, EA Engineering, January 27, 2005

4.3.6 Results of Toxicity Testing with Leptocheirus pumulosus on 15 December 2005 Sediment Samples from the Delaware River, EA Engineering, March 4, 2005

4.3.7 Results of Toxicity Testing with Leptocheirus pumulosus on 17 February 2005 Sediment Samples from the Delaware River, EA Engineering, April 26, 2005

4.4 Birds and Wildlife

4.4.1 Final Report Bird and Wildlife Injury Assessment M/T *Athos I* Oil Spill, Delaware River System, Prepared by Bird and Wildlife Technical Working Group, 22 June 2007

4.4.2 General Comments on Final Draft Bird & Wildlife Injury Assessment: M/T *Athos I* Oil Spill, Delaware River System, Polaris – Greg Challenger and Gary Mauseth, April 12, 2006

4.4.3 *Athos* Oil Spill Comments on Bird & Wildlife Injury Assessment, Michael Fry, December 21, 2006

4.4.4 Trustee Responses to Polaris April 12, 2006 Comments on the Draft Final Bird & Wildlife Injury Assessment Report, Jim Hoff, June 20, 2006

4.5 Lost Interim Use

4.5.1 *Athos*/Delaware River Lost Use TWG, *Athos*/Delaware River Lost Use Valuation, March 29, 2007

4.5.2 Benefit Transfer of Outdoor Recreation Use Values, Rosenberger & Loomis, 2001

4.5.3 Comments of the Responsible Party to the March 9, 2006 *Athos I*/Delaware River Lost Use Valuation Report, unsigned, April 7, 2006
4.5.4 Comments of the Lost Use Valuation Study, Dr. George Parsons, April 16, 2007
4.5.5 Trustee Response to Comments of the Responsible Party Lost Use Valuation Report, National Oceanic & Atmospheric Administration, October 10, 2006
4.5.6 Valuation of Lost and Substitute Trips for the *Athos I* Assessment, Eric English, March 19, 2007
4.5.7 Response to Review of Dr. George Parsons Regarding the *Athos*/Delaware River Lost Use Valuation Report, Eric English, April 17, 2007
4.5.8 Comments on "Comments of the Responsible Party to the March, 9, 2006 *Athos I*/Delaware River Lost Use Valuation Report", George R. Parsons, May 9, 2007

5. RESTORATION PLANNING: RESTORATION SELECTION

5.1 General

5.1.1 The Scientific Characterization of the Delaware Estuary, The Delaware Estuary Program, Sutton, Herron, and Zappalorti, April 1996 (see 3.4)
5.1.2 Commercial Fishing in Delaware 2000, Whitmore and Cole, not dated (see 3.5)
5.1.3 Factors to Evaluate Proposed Restoration Projects under the Oil Pollution Act, Delaware River/M/T *Athos I* Oil Spill, *Athos* Trustee Council, 2006

5.2 Shoreline

5.2.1 Discounting and the Treatment of Uncertainty in Natural Resource Damage Assessment Technical Paper 99-1, NOAA, February 19, 1999 (see 4.1.1)
5.2.2 Lower Darby Creek Area, Darby Township, PA, EPA Facility ID: PASFN0305521
5.2.3 Impact of Dam Removal on Fish and Macroinvertebrate Populations: Pennsylvania's Observations Power Point Presentation, Pennsylvania Fish & Boat Commission, R. Scott Carney, 2007
5.2.4 Final Damage Assessment/Restoration Plan and Environmental Assessment M/V Westchester Crude Oil Discharge, LOSCO et al., December 21, 2001
5.2.5 Habitat Restoration as Mitigation for Lost Production at Multiple Trophic Levels, French McCay and Rowe, December 15, 2003
5.2.6 A Guide to the Natural Communities of the Delaware Estuary, NatureServe,
June 2006
5.2.7 Restoration Scaling of Benthic, Aquatic and Bird Injuries to Oyster Reef and Marsh Restoration Projects, McCay, Peterson & Donlan, April 16, 2002

5.2.8 Final Restoration Plan and Environmental Assessment for the April 7, 2000 Oil Spill at Chalk Point on the Patuxent River, Maryland, NOAA et al., November 2002

5.2.9 The Ecology of Intertidal Oyster Reefs of the South Atlantic Coast: A Community Profile, Fish & Wildlife Service, DOI, May 1981

5.2.10 Map Index and General Spring Tide Zones, M/T *Athos I* Oil Spill, July 17, 2005

5.2.11 Methodology and Data Supplemental Material for use with the M/T *Athos I* Oil Spill: Shoreline Injury Assessment (CD with referenced data files included)

5.2.12 Shoreline Documentation Data – Table 3 – Length in Miles of Shoreline Habitat by Oiling Degree

5.2.13 Shoreline Documentation Data – Table 4 – Number of Acres Impacted by Oil From the Six Tributary Creeks in New Jersey

5.2.14 Shoreline Documentation Data – Table 5 – Total Estimated Area (Acres) of Exposed Habitat Across All States

5.2.15 Stream Ecosystem Response to Small Dam Removal: Lessons from the Heartland, Doyle, Stanley, Orr, Selle, Sethi and Harbor, April 14, 2005

5.2.16 Dam Removal: Challenges and Opportunities for Ecological Research and River Restoration, Hart et al.., August 2002

5.2.17 Changes in the Habitat and Fish Community of the Milwaukee River, Wisconsin, Following Removal of the Woolen Mills Dam, Kanehl, Lyons and Nelson, 1997

5.2.18 Estuarine Habitat Productivity Ratios at Multiple Trophic Levels, Peterson et al.., In preparation

5.2.19 Potential Responses of Riparian Vegetation to Dam Removal. Shafroth et al.., August 2002

5.2.20 Environmental Assessment – Determining Ecological Equivalence in Service-to-Service Scaling of Salt Marsh Restoration, Strange et al.., 2002

5.2.21 Restoration Scaling Paper for Injuries to Non-Tributary Shorelines: Salt Marsh Restoration at Mad Horse Creek and Habitat Creation and Restoration at Lardner's Point, Pennsylvania, Shellenbarger Jones & Donlan, April 22, 2008

5.2.22 Restoration Scaling Paper for Tributary Injuries: Dam Removal and Riparian/In-stream Habitat Restoration on Darby Creek and Habitat Restoration at John Heinz National Wildlife Restoration, Shellenbarger Jones & Donlan, April 17, 2008

5.3 Aquatic Resources

5.3.1 Restoration Scaling of Benthic, Aquatic and Bird Injuries to Oyster Reef and Marsh Restoration Projects, McCay, Peterson & Donlan, April 16, 2002 (see 5.2.8)

5.3.2 Oyster Workshop Power Point Presentation, Delaware Division Fish & Wildlife, March 8, 2007

5.3.3 Report of the 2007 Stock Assessment Workshop (9th SAW) for the New Jersey Delaware Bay Oyster Beds, Haskin Shellfish Research Laboratory, Rutgers, February 5-6, 2007

5.3.4 2005 Shell-Planting Program in Delaware River, Report to the U.S. Army Corps of Engineers, Eric Powell for the Oyster Group, not dated

5.3.5 Final Report of Survey of Benthos: Delaware Estuary: From the Area of the C&D Canal through Philadelphia to Trenton, Environmental Consulting Services, Inc., December 15, 1993

5.3.6 White Paper on the Status and Needs of Science in the Delaware Estuary, Kreeger et al., January 25, 2006

5.3.7 Progress in Oceanography, Metazoan Meiobenthos along Continental Margins: A Review, Soltwedel, May 11, 2000

5.3.8 Dynamics & Energetics of Three Deposit-Feeding Benthic Invertebrate Populations in Puget Sound, Washington, Frederic H. Nichols, May 15, 1975

5.4 Birds and Wildlife

5.4.1 Restoration Scaling of Benthic, Aquatic and Bird Injuries to Oyster Reef and Marsh Restoration Projects, McCay, Peterson & Donlan, April 16, 2002 (see 5.2.7)

5.4.2 The Ecology of Intertidal Oyster Reefs of the South Atlantic Coast: A Community Profile, Fish & Wildlife Service, DOI, May 1981 (see 5.2.9)

5.4.3 Final Restoration Plan and Environmental Assessment for the April 7, 2000 Oil Spill at Chalk Point on the Patuxent River, Maryland, NOAA et al.,, November 2002 (see 5.2.8)

5.4.4 Mitigation Project Monitoring Reports for Tidal Wetland, Checklist for Completeness, New Jersey Department of Environmental Protection, (8/00)

5.4.5 Nutrient Limitation Along a Productivity Gradient in Wet Meadows, Venterink, van der Vliet and Wasson, April 23, 2001

5.4.6 Egg Mass, Position in the Laying Sequence, and Brood Size in Relation to Canada Goose Reproductive Success, LeBlanc, 1987

5.4.7 Habitat Restoration as Mitigation for Lost Production at Multiple Trophic Levels, French McCay and Rowe, December 15, 2003 (see 5.2.5)

5.4.8 Federal Manual for Identifying and Delineating Jurisdictional Wetlands, An Interagency Cooperative Publication, January 1989

5.4.9 Specifications and Terms for Leasing Agricultural Land , Delaware Division of Fish and Wildlife, date unknown

5.4.10 Project Description – Blackbird Reserve, Delaware Department of Natural Resources and Environmental Control, 2008

5.4.11 Restoration Scaling Paper for Injuries to Birds: Habitat Enhancement at mad Horse Creek and Blackbird Reserve; Oyster Reef Enhancement in the Delaware River, Shellenbarger Jones and Donlan, August 22, 2008

5.4.12 Range, Wildlife and Fisheries Management, Management of Waste Corn for Waterfowl, Wintering on the Texas High Plains, Baldassarre and

Bolen, Department of Range, Wildlife and Fisheries Management, Texas Tech University, not dated
5.4.13 Seasonal Abundance of Waste Corn and Soybeans in Illinois, The Journal of Wildlife Management, Vol. 53, No. 1 (Jan., 1989), pp.142-148
5.4.14 Waterfowl Management Handbook, 13.4.3. Managing Agricultural Foods for Waterfowl, James K. Ringelman, Colorado Division of Wildlife, 1990
5.4.15 Trifolium pratense L., Handbook of Energy Crops, unpublished, James A. Duke, 1983.
5.4.16 Progress Reports FY02, Differential Response of Fine Fescue Cultivars to Nonthermal Residue Management, Chastain, Young, Gingrich, Oregon State University, 2002
5.4.17 UC SAREP Cover Crop Resource Page, University of California Sustainable Agriculture Research & Education Program, not dated
5.4.18 New Castle County, Delaware, Corn for Grain, 2003-2007, U.S. Department of Agriculture National Agricultural Statistics Service
5.4.19 Wetlands, (1st ed.), Mitsch and Gosselink, 1986

5.5 Lost Interim
5.5.1 Augustine Beach Breakwater Shoaling Study, Andrews, Miller & Associates, Inc., November 1989
5.5.2 Little Tinicum Island Trail and Habitat Enhancement Draft Proposal, Pennsylvania Department of Conservation and Natural Resources, January 19, 2006
5.5.3 New Castle County, Prioritized Areas Requiring Attention, New Castle, DE, March 2006
5.5.4 Priority Restoration Site Information, New Jersey Department of Environmental Protection, August 2006
5.5.5 The Diadem Train on Little Tinicum Island in the Delaware River, Pennsylvania Department of Conservation and Natural Resources, not dated
5.5.6 Little Tinicum Island Map, not dated

6.0 RESTORATON PLANNING: RESTORATION PLAN

Appendix 2. Compliance with key Federal statutes, regulations, and policies

Oil Pollution Act of 1990 (OPA), 33 U.S.C. §§2701, et seq., 15 C.F.R. Part 990

OPA establishes a liability regime for oil spills that injure or are likely to injure natural resources and/or the services that those resources provide to the ecosystem or humans. OPA provides a framework for conducting sound natural resource damage assessments that achieve restoration. The process emphasizes both public involvement and participation by the Responsible Party (RP). This draft DARP/EA seeks input from both the public and the responsible parties. The Trustees have conducted this assessment in accordance with OPA regulations.

Compliance: Preparation of a Final Restoration Plan in compliance with the Oil Pollution Act of 1990 (OPA). Full compliance is expected at the time that the Trustees have completed review of comments received on the draft DARP/EA, made any revisions based upon those comments, selected the preferred restoration projects, and completed the Final Restoration Plan.

National Environmental Policy Act (NEPA), 42 U.S.C. §§4321, et seq., 40 C.F.R. Parts 1500-1508

The National Environmental Policy Act (NEPA) (42 U.S.C 4321 et seq.) requires Federal agencies to assess the effects of major Federal actions upon the human environment in the form of an environmental impact statement or EA. This EA is prepared in accordance with NEPA and its implementing regulations (40 CFR 1500-1508) and with the NEPA procedures established by the trustee federal agencies. The analysis describes the level of significance of the impacts expected to result from the proposed Federal action.

Compliance: Full compliance is achieved at the issuance of a Finding of No Significant Impact (FONSI).

Clean Water Act (CWA), 33 U.S.C. §§1251, et seq.

The CWA is the principal law governing pollution control and water quality of the nation's waterways. Section 404 of the law authorizes a permit program for the beneficial uses of dredged or fill material in navigable waters. The U.S. Army Corps of Engineers (USACE) administers the program. In general, restoration projects, which move significant amounts of material into or out of waters or wetlands—for example, hydrologic restoration or creation of tidal marshes—require 404 permits. Under section 401 of the CWA, restoration projects that involve discharge or fill to wetlands or navigable waters must obtain certification of compliance with state water quality standards. The application process to obtain these permits will be initiated and issuance of the required permits is expected at the completion of the process.

Compliance: 1.) The necessary state permits will be applied for by the New Jersey Office of Natural Resource Restoration (within NJDEP), the Delaware Department of Natural Resources and Environmental Control (DNREC), the Pennsylvania Fish and Boat Commission (PAFBC), the Pennsylvania Department of Environmental Protection (PADEP), and USFWS. 2.) Coordination with the Army Corps of Engineers will also be completed pursuant to Section 401 of the Clean Water Act. 3.) A 401 Water Quality Certification Review was will be undertaken by the Army Corps of Engineers. Coordination with the Army Corps will be completed pursuant to Section 401 of the Clean Water Act.

Clean Air Act, as amended, 42 USC 7401 et seq.
The fundamental goal of the Clean Air Act (CAA) is the nationwide attainment and maintenance of National Ambient Air Quality Standards (NAAQS). The Act uses two types of regulatory controls to affect two types of pollutant sources: Health-based standards represent "safe" levels of pollutants in the ambient air; technology-based standards represent the amount of a pollutant reduction within an industry's economic and technological capabilities. The CAA requires the Environmental Protection Agency (EPA) to establish primary and secondary NAAQS. Primary NAAQS are designed to protect human health. Secondary NAAQS are designed to protect the public welfare (e.g., to prevent damage to soils, crops, vegetation, water, visibility and property). The Clean Air Act requires permitting and reporting requirements for sources of air pollutants. Also, EPA reviews the discussion of CAA impacts for environmental impact statement (EIS) documents.

Compliance: If the review and analysis of this draft DARP/EA results in the need to develop an EIS, consultation with EPA will be carried out if impacts to air resources are identified.

Preservation of Historic and Archeological Data Act of 1974, as amended, 16 USC 469 et seq.
The purpose of the Preservation of Historic and Archeological Data Act is to provide for the preservation of historic American sites, buildings, objects, and antiquities of national significance, and for other purposes by specifically providing for the preservation of historical and archeological data (including relics and specimens) which might otherwise be irreparably lost or destroyed as the result of (1) flooding, the building of access roads, the erection of workmen's communities, the relocation of railroads and highways, and other alterations of the terrain caused by the construction of a dam by any agency of the United States, or by any private person or corporation holding a license issued by any such agency, or (2) any alteration of the terrain caused as a result of any Federal construction project or federally licensed activity or program.

Compliance: A consultation on each individual project in Delaware, Pennsylvania, and New Jersey will be initiated with the respective The State Historic Preservation Office (SHPO) as a component of the NJDEP, DNREC, and PADEP permitting process. There are no permit requirements relating to SHPO.

Rivers and Harbors Act, 33 U.S.C. §§401, et seq.
The Rivers and Harbors Act regulates development and use of the nation's navigable waterways. Section 10 of the Act prohibits unauthorized obstruction or alteration of navigable waters and vests the USACE with authority to regulate discharges of fill and other materials into such waters. Restoration actions that comply with the substantive requirements of Section 404 of the CWA will also comply with the substantive requirements of Section 10 of the Rivers and Harbors Act.

Compliance: All projects will apply for Clean Water Act (Section 404) and Rivers and Harbors Act of 1899 permits.

COASTAL ZONE MANAGEMENT ACT (CZMA), 16 U.S.C. §§1451, ET SEQ., 15 C.F.R. 923

The goal of the CZMA is to preserve, protect, develop and, where possible, restore and enhance the nation's coastal resources. The federal government provides grants to states with federally approved coastal management programs. Section 1456 of the CZMA requires that any federal action inside or outside of the coastal zone shall be consistent, to the maximum extent practicable, with the enforceable policies of approved state management programs. No federal license or permit may be granted without giving the state the opportunity to concur that the project is consistent with the state's coastal policies. The regulations outline the consistency procedures that will be followed by the Trustees.

Compliance: The Trustees believe that the restoration projects preferred for implementation will be consistent with the New Jersey, Delaware, and Pennsylvania CZMA programs, and will begin the process of seeking concurrence by each state. The necessary permits will be applied for by the Office of Natural Resources Restoration (within NJDEP), Department of Natural Resources and Environmental Control (DNREC), and PADEP, for approval of Waterfront Development/Water Quality Certificate Document, Coastal Zone Management Consistency Permits, and Fresh Water Statewide General Permit #16 for habitat creation and enhancement activities (in each respective state). Permits will be authorized and under compliance with the rules on Coastal Zone Management.

Endangered Species Act (ESA), 16 U.S.C. §§1531, et. seq., 50 C.F.R. Parts 17, 222, 224

The ESA directs all federal agencies to conserve endangered and threatened species and their habitats to the extent their authority allows. Under the Act, the Department of Commerce through NOAA and the Department of the Interior through the U.S. Fish and Wildlife Service (USFWS) publish lists of endangered and threatened species. Section 7 of the Act requires that federal agencies consult with these departments to minimize the effects of federal actions on endangered and threatened species.

Compliance: Coordination with the U.S. Fish & Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) will be completed pursuant to Section 7 of the Endangered Species Act. This approval will be obtained for the ecological restoration projects (tidal marsh creation, shoreline beach enhancement, and oyster reef creation) from USFWS and NMFS for federally listed species.

Fish and Wildlife Conservation Act, 16 U.S.C. §§2901, et seq.

The purpose of the Fish and Wildlife Conservation Act is to protect the 83 percent of fish and wildlife species that were neglected under prior American law, e.g., non-game species that were diminishing due to habitat loss from development and other environmental ills such as pollution.

Compliance: The proposed restoration projects will either encourage the conservation of non-game fish and wildlife, or have no adverse effect. Coordination with the USFWS, NMFS, and the Delaware, New Jersey, and Pennsylvania state fish and wildlife agencies has been completed.

Fish and Wildlife Coordination Act (FWCA), 16 U.S.C. 661, et seq.
The FWCA requires that federal agencies consult with the U.S. Fish and Wildlife Service (USFWS), the National Marine Fisheries Service (NMFS), and state wildlife agencies for activities that affect, control, or modify waters of any stream or bodies of water, in order to minimize the adverse impacts of such actions on fish and wildlife resources and habitat. This consultation is generally incorporated into the process of complying with Section 404 of the Clean Water Act, NEPA, or other federal permit, license, or review requirements. The proposed restoration projects will have either a positive effect on fish and wildlife resources or no effect. Coordination will begin between NMFS and the U.S. Fish and Wildlife Service.

Compliance: Coordination with the USFWS, NMFS, and the State fish and wildlife agencies signifies compliance with the Fish and Wildlife Coordination Act.

Watershed Protection and Flood Prevention Act as amended, 16 U.S.C. 1001 et seq.
The Watershed Protection and Flood Prevention Act (Public Law 83-566) authorizes the Secretary of Agriculture to provide technical and financial assistance to entities of state and local governments and tribes (project sponsors) for planning and installing watershed projects. The U.S. Department of Agriculture agency responsible for program management is the Natural Resources Conservation Service.

Compliance: Floodplain impacts will be considered prior to selection of final project plans.

Magnuson-Stevens Fishery Conservation and Management Act, as amended and reauthorized by the Sustainable Fisheries Act (Public Law 104-297) (Magnuson-Stevens Act), 16 U.S.C. §§1801 et seq.
The Magnuson-Stevens Act provides for the conservation and management of the Nation's fishery resources within the Exclusive Economic Zone (from the seaward boundary of every state to 200 miles from that baseline). The management goal is to identify and manage the commercially important U.S. marine fisheries. Its goal is to achieve optimum sustainable population harvest levels, and to protect essential fish habitat for federally managed species. The Act also established a program to promote the protection of Essential Fish Habitat (EFH) in the review of projects conducted under Federal permits, licenses, or other authorities that affect or have the potential to affect such habitat. Federal agencies are obligated to consult with the Secretary of Commerce with respect to any action authorized, funded, or undertaken, or proposed to be authorized funded, or undertaken by such agency that may adversely affect any EFH.

Compliance: The proposed restoration projects, under OPA, are being undertaken to make the environment and the public whole for injuries to natural resources and natural resource services by returning injured natural resources and natural resource services to their pre-spill, or baseline condition and compensating for interim losses of natural resources. While the overall goal is to restore and enhance the injured habitat, some restoration activities may convert one habitat to another and must be considered as a potential adverse impact to EFH and analyzed appropriately.

The ecological restoration projects have been reviewed for EFH.

Coordination with NMFS and informal EFH consultation has been completed (Appendix 5). NMFS has reviewed and approved the projects. This action signifies compliance with the EFH provisions of the Magnuson-Stevens Act.

Marine Mammal Protection Act, 16 U.S.C. §§1361 et seq.
The Marine Mammal Protection Act provides for long-term management and research programs for marine mammals. It places a moratorium on the taking and importing of marine mammals and marine mammal products, with limited exceptions. The Department of Commerce is responsible for whales, porpoise, seals, and sea lions. The Department of the Interior is responsible for all other marine mammals.

Compliance: The proposed restoration projects will not have an adverse effect on marine mammals.

Migratory Bird Conservation Act, 126 U.S.C. §§715 et seq.
The Migratory Bird Conservation Act establishes a Migratory Bird Conservation Commission to approve areas of land or water recommended by the Secretary of the Interior for acquisition as reservations for migratory birds. Consultation with state and local government is required prior to acquisition.

Compliance: The preferred restoration projects will have no adverse affect on migratory birds. Migratory birds are expected to benefit from creation of new marsh habitat and protection of nesting habitat for ruddy ducks.

Archeological Resources Protection Act, 16 U.S.C. 470 et seq.
The purpose of the Archaeological Resources Protection Act is to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands, and to foster increased cooperation and exchange of information between governmental authorities, the professional archaeological community, and private individuals having collections of archaeological resources and data that were obtained before 31 October 1979.

Compliance: The wetland restoration sites will be surveyed to determine values as archaeological resources, and the oyster restoration sites will avoid any submerged archaeological resources.

Information Quality Guidelines issued pursuant to Public Law 106-554
Information disseminated by federal agencies to the public after October 1, 2002, is subject to information quality guidelines developed by each agency pursuant to Section 515 of Public Law 106-554 that are intended to ensure and maximize the quality of such information (i.e., the objectivity, utility, and integrity of such information).

Compliance: This draft DARP/EA is an information product covered by information quality guidelines established by NOAA and DOI for this purpose. The quality of the information contained herein is consistent with the applicable guidelines.

Section 508 of the Rehabilitation Act

Section 508 (29 U.S.C. 794d) of the Rehabilitation Act requires all Federal agencies must give disabled employees and members of the public access to information that is comparable to the access available to others. Section 508 was enacted partly to eliminate barriers in information technology. For web accessibility under Section 508, a text equivalent must be available for any non-text element such as images, navigation arrows, multimedia objects (audio or video), logos, photographs, or artwork in order to enable users with disabilities to distinguish important content from merely decorative images. Section 508 compliance also includes making accessible other multimedia and outreach materials and platforms, acquisition of equipment and other assistive technologies (phones, PDAs, computers, scanners, etc.) and computer software compliance.

Compliance: The Trustees have complied with their agency's web policies, based on the World Wide Web Consortium Web Accessibility Initiative.

Executive Order 11990 (42 FR 26,961) - Protection of Wetlands

Executive Order 11990 requires each federal agency to take action to minimize the destruction, loss, or degradation of wetlands, and to preserve and enhance the natural and beneficial values of wetlands in carrying out the agency's responsibilities for: acquiring, managing, and disposing of federal lands and facilities; providing federally undertaken, financed, or assisted construction and improvements; and conducting federal activities and programs affecting land use, including but not limited to water and related land resources planning, regulating, and licensing activities

Compliance: The Trustees have concluded that the preferred restoration projects will meet the goals of this executive order.

Executive Order 12898 (59 Fed. Reg. 7,629) – Environmental Justice

Executive Order 12898 requires each federal agency to identify and address, as appropriate, disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority and low-income populations. EPA and the Council on Environmental Quality (CEQ) have emphasized the importance of incorporating environmental justice review in the analyses conducted by federal agencies under NEPA and of developing mitigation measures that avoid disproportionate environmental effects on minority and low-income populations.

Compliance: The Trustees have concluded that there are no low-income or ethnic minority communities that would be adversely affected by the preferred restoration projects.

Executive Order Number 11514 (35 FR 4,247) - Protection and Enhancement of Environmental Quality

The purpose of Executive Order 11514 is to protect and enhance the quality of the Nation's environment to sustain and enrich human life. Federal agencies shall initiate measures needed to direct their policies, plans, and programs so as to meet national environmental goals.

Compliance: An Environmental Assessment (EA) has been prepared as part of this draft DARP/EA and environmental coordination will take place as required by NEPA.

Executive Order Number 12962 (60 FR 30,769) – Recreational Fisheries
The purpose of Executive Order 12962 is to conserve, restore, and enhance aquatic systems to provide for increased recreational fishing opportunities nationwide.

Compliance: The preferred restoration projects will help ensure the protection of recreational fisheries and the services they provide. These projects will have no adverse effects on recreational fisheries.

Executive Order Number 13112 (64 FR 6,183) – Invasive Species
The purpose of Executive Order 13112 is to prevent the introduction of invasive species and provide for their control, and to minimize the economic, ecological, and human health impacts that invasive species cause.

Compliance: The proposed ecological restoration projects will not cause or promote the introduction or spread of invasive species. Annual surveys for invasive species (specifically *Phragmites*) and actions to control them should they be present in the created tidal marshes have been budgeted into costs for these projects. The proposed lost use projects will also not cause or promote the introduction or spread of invasive species.

Appendix 3. Supplemental restoration planning information

HEA Inputs and Results for Salt Marsh Restoration at Mad Horse Creek

Inputs:

Project Implementation	2010
Maximum Ecological Service	85 percent
Baseline Ecological Service	10 percent
Years to maximum service	15
Curve for Service Gain	Logistic
Project life span	50
Discount Rate[1]	3 percent

Results:

1 acre restored marsh provides 13.4 DSAYs of ecological service.

Annual Calculations:

Year	Ecological Service Improvement (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service Improvement (per acre)	Discounted Ecological Service (per acre)
2010	1%	0.01	2035	74%	0.32
2011	2%	0.02	2036	74%	0.31
2012	4%	0.04	2037	74%	0.30
2013	8%	0.06	2038	74%	0.29
2014	13%	0.11	2039	74%	0.28
2015	21%	0.16	2040	74%	0.27
2016	32%	0.24	2041	74%	0.26
2017	43%	0.31	2042	74%	0.26
2018	54%	0.38	2043	74%	0.25
2019	62%	0.42	2044	74%	0.24
2020	67%	0.44	2045	74%	0.23
2021	71%	0.45	2046	74%	0.23
2022	73%	0.45	2047	74%	0.22
2023	74%	0.45	2048	74%	0.21
2024	74%	0.44	2049	74%	0.21
2025	74%	0.42	2050	74%	0.20
2026	74%	0.41	2051	74%	0.20
2027	74%	0.40	2052	74%	0.19
2028	74%	0.39	2053	74%	0.19
2029	74%	0.38	2054	74%	0.18
2030	74%	0.37	2055	74%	0.17
2031	74%	0.35	2056	74%	0.17
2032	74%	0.34	2057	74%	0.16
2033	74%	0.33	2058	74%	0.16
2034	74%	0.32	2059	74%	0.15
				Sum (2010-2059):	**13.4**

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for Marsh Restoration at Lardner's Point

Inputs:

Project Implementation	2009
Maximum Ecological Service	85 percent
Baseline Ecological Service	0 percent
Years to maximum service	15
Curve for Service Gain	Logistic
Project life span	50
Discount Rate[1]	3 percent

Results:

1 acre restored marsh provides 15.6 DSAYs of ecological service.

Annual Calculations:

Year	Ecological Service Improvement (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service Improvement (per acre)	Discounted Ecological Service (per acre)
2009	2%	0.01	2034	84%	0.37
2010	3%	0.03	2035	84%	0.36
2011	5%	0.04	2036	84%	0.35
2012	9%	0.07	2037	84%	0.34
2013	15%	0.12	2038	84%	0.33
2014	24%	0.19	2039	84%	0.32
2015	36%	0.28	2040	84%	0.31
2016	49%	0.36	2041	84%	0.30
2017	61%	0.44	2042	84%	0.29
2018	70%	0.49	2043	84%	0.28
2019	76%	0.52	2044	84%	0.27
2020	80%	0.53	2045	84%	0.27
2021	82%	0.53	2046	84%	0.26
2022	83%	0.52	2047	84%	0.25
2023	84%	0.51	2048	84%	0.24
2024	84%	0.49	2049	84%	0.24
2025	84%	0.48	2050	84%	0.23
2026	84%	0.47	2051	84%	0.22
2027	84%	0.45	2052	84%	0.22
2028	84%	0.44	2053	84%	0.21
2029	84%	0.43	2054	84%	0.20
2030	84%	0.41	2055	84%	0.20
2031	84%	0.40	2056	84%	0.19
2032	84%	0.39	2057	84%	0.19
2033	84%	0.38	2058	84%	0.18
				Sum (2009-2058):	**15.6**

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for Tributary Restoration Via Dam Removal and Riparian Restoration on Darby Creek

Inputs:

Years to full service	5
Curve for Service Gain	Linear
Project life span[1]	In perpetuity
Discount Rate[2]	3 percent

Results:

1 acre of tributary habitat with 100 percent ecological improvement provides 29.64 DSAYs
1 acre of tributary habitat with 5 percent ecological improvement provides 1.48 DSAYs

Annual Calculations (First 50 years):

Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)
2009	0.20	0.18	2034	1.00	0.44
2010	0.40	0.36	2035	1.00	0.42
2011	0.60	0.52	2036	1.00	0.41
2012	0.80	0.67	2037	1.00	0.40
2013	1.00	0.81	2038	1.00	0.39
2014	1.00	0.79	2039	1.00	0.38
2015	1.00	0.77	2040	1.00	0.37
2016	1.00	0.74	2041	1.00	0.36
2017	1.00	0.72	2042	1.00	0.35
2018	1.00	0.70	2043	1.00	0.33
2019	1.00	0.68	2044	1.00	0.33
2020	1.00	0.66	2045	1.00	0.32
2021	1.00	0.64	2046	1.00	0.31
2022	1.00	0.62	2047	1.00	0.30
2023	1.00	0.61	2048	1.00	0.29
2024	1.00	0.59	2049	1.00	0.28
2025	1.00	0.57	2050	1.00	0.27
2026	1.00	0.55	2051	1.00	0.26
2027	1.00	0.54	2052	1.00	0.26
2028	1.00	0.52	2053	1.00	0.25
2029	1.00	0.51	2054	1.00	0.24
2030	1.00	0.49	2055	1.00	0.23
2031	1.00	0.48	2056	1.00	0.23
2032	1.00	0.46	2057	1.00	0.22
2033	1.00	0.45	2058	1.00	0.22
				Total (2009-2508):	**29.64**

1. Ecological benefit is calculated for 500 years, which provides benefits in perpetuity based on the number of significant figures used in these calculations.
2. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for "Direct" Restoration (channels, fringing habitat, and pools) at John Heinz National Wildlife Refuge

Inputs:

Project Implementation	2010
Maximum Ecological Service	80 percent
Baseline Ecological Service	10 percent
Years to maximum service	3
Curve for Service Gain	Linear
Project life span	50
Discount Rate[1]	3 percent

Results:

1 acre restored habitat provides 15.8 DSAYs of ecological service.

Annual Calculations:

Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)
2010	23%	0.21	2035	70%	0.30
2011	47%	0.40	2036	70%	0.29
2012	70%	0.58	2037	70%	0.28
2013	70%	0.57	2038	70%	0.27
2014	70%	0.55	2039	70%	0.26
2015	70%	0.53	2040	70%	0.25
2016	70%	0.52	2041	70%	0.25
2017	70%	0.50	2042	70%	0.24
2018	70%	0.49	2043	70%	0.23
2019	70%	0.47	2044	70%	0.23
2020	70%	0.46	2045	70%	0.22
2021	70%	0.45	2046	70%	0.21
2022	70%	0.43	2047	70%	0.21
2023	70%	0.42	2048	70%	0.20
2024	70%	0.41	2049	70%	0.20
2025	70%	0.40	2050	70%	0.19
2026	70%	0.38	2051	70%	0.18
2027	70%	0.37	2052	70%	0.18
2028	70%	0.36	2053	70%	0.17
2029	70%	0.35	2054	70%	0.17
2030	70%	0.34	2055	70%	0.16
2031	70%	0.33	2056	70%	0.16
2032	70%	0.32	2057	70%	0.15
2033	70%	0.31	2058	70%	0.15
2034	70%	0.30	2059	70%	0.15
				Sum (2010-2059):	**15.8**

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for "Indirect" Restoration Benefits (more frequent wetting of entire site) at John Heinz National Wildlife Refuge

Inputs:

Project Implementation	2010
Increase in Ecological Service	10 percent
Years to maximum service	3
Curve for Service Gain	Linear
Project life span	50
Discount Rate[1]	3 percent

Results:

1 acre restored habitat provides 2.3 DSAYs of ecological service.

Annual Calculations:

Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)
2010	3%	0.03	2035	10%	0.04
2011	7%	0.06	2036	10%	0.04
2012	10%	0.08	2037	10%	0.04
2013	10%	0.08	2038	10%	0.04
2014	10%	0.08	2039	10%	0.04
2015	10%	0.08	2040	10%	0.04
2016	10%	0.07	2041	10%	0.04
2017	10%	0.07	2042	10%	0.03
2018	10%	0.07	2043	10%	0.03
2019	10%	0.07	2044	10%	0.03
2020	10%	0.07	2045	10%	0.03
2021	10%	0.06	2046	10%	0.03
2022	10%	0.06	2047	10%	0.03
2023	10%	0.06	2048	10%	0.03
2024	10%	0.06	2049	10%	0.03
2025	10%	0.06	2050	10%	0.03
2026	10%	0.06	2051	10%	0.03
2027	10%	0.05	2052	10%	0.03
2028	10%	0.05	2053	10%	0.02
2029	10%	0.05	2054	10%	0.02
2030	10%	0.05	2055	10%	0.02
2031	10%	0.05	2056	10%	0.02
2032	10%	0.05	2057	10%	0.02
2033	10%	0.05	2058	10%	0.02
2034	10%	0.04	2059	10%	0.02
				Sum (2009-2058):	**2.3**

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for Grasslands (Mad Horse Creek), Pasture (Blackbird Reserve), and Pond (Blackbird Reserve) Benefits				
Inputs:		**Habitat**	**kg/acre/yr**	**Discounted kg/acre (lifetime)**
Project Implementation	2009	Pasture	4,860	115,557
Maximum Ecological Service	100 percent	Pond	1,805	42,949
Years to maximum service	2	Grasslands	2,120	48,897[2]
Curve for Service Gain	Linear			
Project life span	50			
Discount Rate[1]	3 percent			

Results:

1 kg additional production provides 23.80 discounted kg of ecological service.

Annual Calculations:

Year	Ecological Service (per kg)	Discounted Ecological Service (per kg)	Year	Ecological Service (per kg)	Discounted Ecological Service (per kg)
2009	50%	0.46	2034	100%	0.44
2010	100%	0.89	2035	100%	0.42
2011	100%	0.86	2036	100%	0.41
2012	100%	0.84	2037	100%	0.40
2013	100%	0.81	2038	100%	0.39
2014	100%	0.79	2039	100%	0.38
2015	100%	0.77	2040	100%	0.37
2016	100%	0.74	2041	100%	0.36
2017	100%	0.72	2042	100%	0.35
2018	100%	0.70	2043	100%	0.33
2019	100%	0.68	2044	100%	0.33
2020	100%	0.66	2045	100%	0.32
2021	100%	0.64	2046	100%	0.31
2022	100%	0.62	2047	100%	0.30
2023	100%	0.61	2048	100%	0.29
2024	100%	0.59	2049	100%	0.28
2025	100%	0.57	2050	100%	0.27
2026	100%	0.55	2051	100%	0.26
2027	100%	0.54	2052	100%	0.26
2028	100%	0.52	2053	100%	0.25
2029	100%	0.51	2054	100%	0.24
2030	100%	0.49	2055	100%	0.23
2031	100%	0.48	2056	100%	0.23
2032	100%	0.46	2057	100%	0.22
2033	100%	0.45	2058	100%	0.22
				Sum (2009-2058):	23.80

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.
2. Grassland construction begins in 2010; value is discounted an additional 3 percent.

HEA Inputs and Results for Wet Meadow Restoration Benefits at Mad Horse Creek				
Inputs:		**Habitat**	**kg/acre/yr**	**Discounted kg/acre (lifetime)**
Project Implementation	2010	Wet Meadows	7,155	132,706
Maximum Ecological Service	85 percent			
Years to maximum service	5			
Curve for Service Gain	Linear			
Project life span	50			
Discount Rate[1]	3 percent			
Results:				
1 kg additional production provides 18.55 discounted kg of ecological service.				

Annual Calculations:

Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)	Year	Ecological Service (per acre)	Discounted Ecological Service (per acre)
2010	17%	0.15	2035	85%	0.36
2011	34%	0.29	2036	85%	0.35
2012	51%	0.43	2037	85%	0.34
2013	68%	0.55	2038	85%	0.33
2014	85%	0.67	2039	85%	0.32
2015	85%	0.65	2040	85%	0.31
2016	85%	0.63	2041	85%	0.30
2017	85%	0.61	2042	85%	0.29
2018	85%	0.60	2043	85%	0.28
2019	85%	0.58	2044	85%	0.28
2020	85%	0.56	2045	85%	0.27
2021	85%	0.55	2046	85%	0.26
2022	85%	0.53	2047	85%	0.25
2023	85%	0.51	2048	85%	0.25
2024	85%	0.50	2049	85%	0.24
2025	85%	0.48	2050	85%	0.23
2026	85%	0.47	2051	85%	0.22
2027	85%	0.46	2052	85%	0.22
2028	85%	0.44	2053	85%	0.21
2029	85%	0.43	2054	85%	0.21
2030	85%	0.42	2055	85%	0.20
2031	85%	0.41	2056	85%	0.19
2032	85%	0.39	2057	85%	0.19
2033	85%	0.38	2058	85%	0.18
2034	85%	0.37	2059	85%	0.18
				Sum (2010-2059):	18.55

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

HEA Inputs and Results for Agricultural Waste (Mad Horse Creek and Blackbird Reserve) and Agricultural Crops (Blackbird Reserve)

Inputs:		Habitat	kg/acre/yr	Discounted kg/acre (lifetime)
Project Implementation	2009	Ag. Waste	131	3,170
Maximum Ecological Service	100 percent	Ag. Crops	3,320	71,679
Years to maximum service	1			
Curve for Service Gain	Linear			
Project life span	50			
Discount Rate[1]	3 percent			

Results:

1 kg additional production provides 24.25 discounted kg of ecological service.

Annual Calculations:

Year	Ecological Service (per kg)	Discounted Ecological Service (per kg)	Year	Ecological Service (per kg)	Discounted Ecological Service (per kg)
2009	100%	0.92	2034	100%	0.44
2010	100%	0.89	2035	100%	0.42
2011	100%	0.86	2036	100%	0.41
2012	100%	0.84	2037	100%	0.40
2013	100%	0.81	2038	100%	0.39
2014	100%	0.79	2039	100%	0.38
2015	100%	0.77	2040	100%	0.37
2016	100%	0.74	2041	100%	0.36
2017	100%	0.72	2042	100%	0.35
2018	100%	0.70	2043	100%	0.33
2019	100%	0.68	2044	100%	0.33
2020	100%	0.66	2045	100%	0.32
2021	100%	0.64	2046	100%	0.31
2022	100%	0.62	2047	100%	0.30
2023	100%	0.61	2048	100%	0.29
2024	100%	0.59	2049	100%	0.28
2025	100%	0.57	2050	100%	0.27
2026	100%	0.55	2051	100%	0.26
2027	100%	0.54	2052	100%	0.26
2028	100%	0.52	2053	100%	0.25
2029	100%	0.51	2054	100%	0.24
2030	100%	0.49	2055	100%	0.23
2031	100%	0.48	2056	100%	0.23
2032	100%	0.46	2057	100%	0.22
2033	100%	0.45	2058	100%	0.22
				Sum (2009-2058):	24.25

1. Values are discounted to 2006, the year for which injury DSAYs are calculated.

NEW JERSEY DEPARTMENT OF ENVIRONMENTAL PROTECTION

MITIGATION PROJECT MONITORING REPORTS FOR TIDAL WETLAND

CHECKLIST FOR COMPLETENESS

(8/00)

All mitigation sites must be monitored starting the first full growing season after the construction/planting of the mitigation project is completed. The mitigation project must be monitored for three **full** growing seasons. Below are the submission requirements for a complete monitoring report. Please read each section and check each area after you have fully completed the information for each applicable requirement.

Section A: All monitoring reports must include five copies of the following information

- ☐ 1. A USGS quad map, and a county road map showing the location of the mitigation site, including the lot and block of the mitigation site. Furthermore provide a copy of an aerial photograph of the mitigation site. This information must clearly indicate the point(s) of access to the mitigation site.
- ☐ 2. A copy of the permit that required the mitigation.
- ☐ 3. A brief description of the mitigation project.
- ☐ 4. Photographs of the mitigation site with a location map indicating where they were taken on the site.
- ☐ 5. An assessment of the planted vegetation as well as the species that are naturally colonizing the site. This assessment shall include the location and percent coverage of each species.
- ☐ 6. Documentation demonstrating that the hydrologic regime specified in the mitigation proposal, which proves the mitigation site is a wetland, is present. The documentation shall include, as appropriate, monitoring well data, stream gauge data, photographs and/or field observation notes collected throughout the monitoring period.
- ☐ 7. Data sheets from sampling points, which describe the vegetation present, the percent coverage of the vegetation, soil borings and location of the water table.
- ☐ 8. Documentation, based on field data, that the goals of the wetland mitigation project (including the transition area) as stated in the approved wetland mitigation proposal will be satisfied.
- ☐ 9. A narrative evaluating the success/failure of the site.
- ☐ 10. If problems with the site are identified, identify actions that should be taken which will permanently rectify the situation.

Section B: In addition to the information required in Section A above, all successful first full growing season monitoring reports must include the following information. If any one or more of the below listed parameters are not met then this full growing season monitoring period must be repeated until satisfied.

- 1. Documentation that demonstrates through soil borings that the appropriate soil was used on the site as indicated in the mitigation approval.
- 2. As built plans, which demonstrate that the site was graded and planted in accordance with the approved mitigation plans. Any deviations from the approved mitigation plans must be highlighted and explained to the Program for review and approval.
- 3. Documentation that the hydrologic regime specified in the approved mitigation proposal, which proves the mitigation site is a wetland, appears to be present. Any deviations from the approved proposal must be highlighted and explained to the Program for review and approval.
- 4. Documentation that demonstrates that there is at least 30% areal coverage of the planted vegetation or target hydrophytes which are species native to the area and similar to ones identified on the mitigation planting plan.
- 5. Documentation that demonstrates less than 10 percent of the site is occupied by invasive or noxious species such as but not limited to *Phalaris arundinacea* (Reed canary grass), *Phragmities australis* (Common reed grass), *Pueraria montana* (Kudzu), *Typha latifloia* (Broad-leaved cattail), *Typha angustifolia* (Narrowed leaved cattail), *Lythrum salicaria* (Purple loosestrife), *Ailanthus altissima* (Tree-of-heaven), *Berberis thunbergi* (Japanese barberry), *Berberis vulgaris* (Common barberry*), Elaeagnus angustifloia* (Russian olive), *Elaeagnus umbellata* (Autumn olive), *Ligustrum obtusifolium* (Japanese privet), *Ligustrum vulgare* (Common privet) and *Rosa multiforia* (Multiflora rose).

Section C: In addition to the information required in Section A above, all successful second full growing season monitoring reports must include the following information. If any one or more of the below listed parameters are not met then this full growing season monitoring period must be repeated until satisfied.

- 1. Documentation that the hydrologic regime specified in the approved mitigation proposal, which proves the mitigation site is a wetland continues to appear to be present.
- 2. Documentation that demonstrates that there is at least 60% areal coverage of the planted vegetation or target hydrophytes which are species native to the area and similar to ones identified on the mitigation planting plan.
- 3. Documentation that demonstrates less than 10 percent of the site is occupied by invasive or noxious species such as but not limited to *Phalaris arundinacea* (Reed canary grass), *Phragmities australis* (Common reed grass), *Pueraria montana* (Kudzu), *Typha latifloia* (Broad-leaved cattail), *Typha angustifolia* (Narrowed leaved cattail), *Lythrum salicaria* (Purple loosestrife), *Ailanthus altissima* (Tree-of-heaven), *Berberis thunbergi* (Japanese barberry), *Berberis vulgaris* (Common barberry*), Elaeagnus angustifloia* (Russian olive), *Elaeagnus umbellata* (Autumn olive), *Ligustrum obtusifolium* (Japanese privet), *Ligustrum vulgare* (Common privet) and *Rosa multiforia* (Multiflora rose).

Section D: In addition to the information required in Section A above, all successful third and final full growing season monitoring reports must include the following information. If any one or more of the

below listed parameters are not met then this full growing season monitoring period must be repeated until satisfied.

- 1. Documentation which demonstrates that the goals of the wetland mitigation project (including the required transition area) as stated in the approved wetlands mitigation proposal and the permit, has been satisfied. This documentation must include information concerning invasive/noxious plant species and the percent coverage of these species on the site.

- 2. Documentation which demonstrates that the proposed hydrologic regime as specified in the mitigation proposal, which proves the mitigation site is a wetland has been satisfied. The documentation shall include when appropriate monitoring well data, stream gauge data, photographs and field observation notes collected throughout the monitoring period.

- 3. Documentation that demonstrates that there is at least 85% areal coverage of the planted vegetation or target hydrophytes which are species native to the area and similar to ones identified on the mitigation planting plan.

- 4. A field wetland delineation of the wetlands mitigation project based on techniques specified in the Federal Manual for Identifying and Delineation Jurisdictional Wetlands (1989).

- 5. A plan showing the flagged wetland delineation referenced above for review and approval by the Program. The wetland line must include global positioning system data points.

Appendix 4. Preparers, agencies, and persons consulted

Dr. Jim Hoff, National Pollution Funds Center, formerly with the National Oceanic and Atmospheric Administration

National Oceanic and Atmospheric Administration
Eric English, National Ocean Service, Office of Response and Restoration
Craig Woolcott, National Marine Fisheries Service, Office of Habitat Conservation
Linda Burlington, Office of General Counsel
Kate Clark, National Ocean Service, Office of Response and Restoration
Bethany Bearmore, National Marine Fisheries Service, Office of Habitat Conservation
Kristin Rusello, National Ocean Service, Office of Response and Restoration
Kate Barfield, Office of General Counsel
Anthony Dvarskas, National Ocean Service, Office of Response and Restoration
Mary Andrews, National Marine Fisheries Service, Office of Habitat Conservation

New Jersey
David Bean, New Jersey Department of Environmental Protection
John Sacco, New Jersey Department of Environmental Protection
Lauren Caruso-Garofalo, New Jersey Office of the Attorney General
Kathy Clark, Department of Environmental Protection, Division of Fish and Wildlife
Ted Nichols, Department of Environmental Protection, Division of Fish and Wildlife

Pennsylvania
Stan Sneath, Pennsylvania Department of Environmental Protection
Bill Capouillez, Pennsylvania Game Commission
Mark Hartle, Pennsylvania Fish and Boat Commission
Bill Pouss, Pennsylvania Game Commission
Alan Everett, Pennsylvania Department of Environmental Protection
Autumn Sabo, Pennsylvania Department of Conservation and Natural Resources
John Dunn, Pennsylvania Game Commission
Mike Boyer, Pennsylvania Department of Environmental Protection

Delaware
Rob Hossler, Delaware Department of Natural Resources and Environmental Control
Bob Kuehl, Delaware Office of the Attorney General
Kevin Kalasz, Delaware Department of Natural Resources and Environmental Control
Rick Greene, Delaware Department of Natural Resources and Environmental Control
Stu Michels, Delaware Department of Natural Resources and Environmental Control
Rick Cole, Delaware Department of Natural Resources and Environmental Control

U.S. Department of the Interior
Sherry Krest, U.S. Fish and Wildlife Service
Marcia Gittes, Office of the Solicitor
Al Rizzo, U.S. Fish and Wildlife Service
Brian Marsh, U.S. Fish and Wildlife Service

Fred Pinkney, U.S. Fish and Wildlife Service
Doug Forsell, U.S. Fish and Wildlife Service

U.S. Department of Justice
Rachel Jacobson

Non-Agency Persons
Dr. Jacqui Michel, Research Planning Inc.
Heidi Hinkledey Dunagan, Research Planning Inc.
Zach Nixon, Research Planning Inc.
Dr. Don McDonald, MacDonald Environmental Sciences Ltd.
Dr. Chris Sommerfield, University of Delaware
Greg Douglas, New Fields Environmental Forensics Practices L.L.C.
Dr. D. Michael Fry, American Bird Conservancy
Dr. George R. Parsons, University of Delaware
Dr. Pete Peterson, University of North Carolina at Chapel Hill
Mike Donlan, Industrial Economics
Dr. Ann Jones, Industrial Economics
Greg Challenger, Polaris, Inc.
Gary Mauseth, Polaris, Inc.
Tim Bergere, Esq., Montgomery, McCracken, Walker &Rhoads
Gene O'Connor, Esq., Fowler, Rodriguez & Chalois

Appendix 5. Correspondence with NOAA's National Marine Fisheries Service and NOAA's Coastal and Estuarine Land Conservation Program

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

October 1, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Augustine Boat Ramp –revised plans – rock jetty construction
Augustine Beach, New Castle Co. DE

_____________ Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

Several species of sea turtles are of each year including the threatened loggerhead (*Caretta caretta*), endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) sea turtles are present in Delaware Bay, mainly during the late spring, summer and early fall when water temperatures are relatively warm. Federally endangered shortnose sturgeon (*Acipenser brevirostrum*) may be found in the Delaware River up to at least Lambertville, New Jersey (river km 238). The activities proposed are covered under the no effect letter issued to the Philadelphia District Army Corps of Engineers in December 2004. Should project plans change, or if new information becomes available that changes the basis for this determination, or new species are listed or critical habitat designated, consultation also should be reinitiated.

Fish and Wildlife Coordination Act

The following may be present in the project area: resident, forage and benthic species including winter flounder, summer flounder, windowpane, bay anchovy, bluefish, weakfish, river herring, striped bass, oysters, horseshoe crabs and blue crabs. Based upon the project location and the work proposed, we have no recommendations to offer on this project.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

The Delaware Bay has been designated as Essential Fish Habitat (EFH) for one or more federally managed species. Based upon the location and nature of the work proposed, impacts to EFH are expected to be minimal. As a result, additional consultation as part of the federal permit process will not be necessary. For a listing of EFH and further information please go to our website at: http://www.nero.noaa.gov/hcd. If you wish to discuss this further, please call Karen Greene at 732-872-3023.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

June 4, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed Blackbird Reserve Restoration Site
New Castle Co., DE

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

No threatened or endangered species under the jurisdiction of the NMFS are known to occur in the project area. As a result, further consultation is not required. However should project plans change that would change the basis for determination, or if new species or critical habitat is designated, consultation should be reinitiated.

Fish and Wildlife Coordination Act

A wide variety of resources under NMFS jurisdiction occur within the lower reaches of Blackbird Creek including anadromous and resident fish, forage and benthic species such as alewife, blueback herring, striped bass, weakfish, white perch, bay anchovy and mummichog.. The activities proposed are not likely to impacts these species adversely. Any impacts to water quality during the construction are likely to be temporary and minor. As a result, we have no additional recommendations to offer.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

The estuarine waters of Blackbird Creek have been designated as Essential Fish Habitat (EFH) for one or more species. Restoration activities at the site may have minor temporary impacts of EFH and federally managed species. These can be minimized by using best management practices to protect water quality and reduce sediments entering the creek. The restoration of the site will benefit EFH. Because the impacts of the project are expected to be minor in nature and temporary, further EFH consultation will not be necessary required as part of the federal permit process. Should project plans change that would change the basis for determination, or if new species or EFH are designated, the federal action agency should reinitiate consultation. For a listing of EFH and further information, please go to our website at: http://www.nero.noaa.gov/hcd. If you wish to discuss this further, please call 732-872-3023.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed Darby Creek Restoration Site
Philadelphia, PA

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

No threatened or endangered species under the jurisdiction of the NMFS are known to occur in the project area. As a result, further consultation is not required. However should project plans change that would change the basis for determination, or if new species or critical habitat is designated, consultation should be reinitiated.

Fish and Wildlife Coordination Act

Anadromous fish including striped bass, alewife, blueback herring and American shad may be found in portions of Darby Creek. Removal of the remnant bridge pier, the Darby Borough Dam, the SEPTA dam and the dam at Kent Park and the restoration of the surrounding riparian corridor will benefit these species. Since anadromous fish occur at the most downstream barrier, we recommend that the removals begin at the most upstream blockage and work downstream, or that the dam removals be avoided from 3/1 to 6/30 to minimize impacts to anadromous fish that will congregate and possibly spawn at base of the dam.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

No EFH has been designated in the project area. An EFH consultation by the federal action agency will not be required as part of the permit process. Should project plans change that would modify the basis for this determination, or if new species or EFH is designated, consultation should be reinitiated. For a listing of EFH and further information, please go to our website at: www.nero.noaa.gov/hcd.

If you wish to discuss this further, please call 732-872-3023

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

November 20, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed John Heinz National Wildlife Refuge Site
Philadelphia, PA
Supplemental comments

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

No threatened or endangered species under the jurisdiction of the NMFS are known to occur in the project area. As a result, further consultation is not required. However should project plans change that would change the basis for determination, or if new species or critical habitat is designated, consultation should be reinitiated.

Fish and Wildlife Coordination Act

Freshwater tidal wetlands along the Delaware River provide valuable nursery and forage habitat for a number of species of concern to NMFS including anadromous fish such as striped bass, alewife, blueback herring and American shad. Restoration of this habitat will benefit these and many other species. We support the plans to restore this site.

We understand that portions of the site may contain elevated levels of contaminants. Sediment sampling should be done at the site, if it has not already occurred, to determine the nature and extent of any contamination. The results of the testing should be used to determine how to best design the restoration of the site to avoid exposing contaminated hot spots. .

Anadromous fish including striped bass, alewife, blueback herring and American shad may be found in portions of Darby Creek. To minimize impact to anadromous fish, in-water work within the creek should be avoided from 3/1 to 6/30.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

No EFH has been designated in the project area. An EFH consultation by the federal action agency will not be required as part of the permit process. Should project plans change that would modify the basis for this determination, or if new species or EFH is designated, consultation should be reinitiated. For a listing of EFH and further information, please go to our website at: www.nero.noaa.gov/hcd.

If you wish to discuss this further, please call 732-872-3023

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed Lardner's Point Restoration Site
Philadelphia, PA

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

Threatened and endangered shortnose sturgeon may be present in the project area at certain times of the Once project plans have been developed, the lead federal action agency should contact NMFS Protected Resources Division to initiate coordination on this project. Requests for coordination can be addressed to: Ms. Julie Crocker of NOAA Fisheries Service's Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930-2298.

Fish and Wildlife Coordination Act

Anadromous fish including striped bass, alewife, blueback herring and American shad may be found in the project area. Atlantic sturgeon, a candidate for listing under the ESA also occur in the Delaware River. The restoration of the site will benefit resources of concern to NMFS, but removal and demolition of the dilapidated ferry dock and boat ramp, may affect the migration and spawning of anadromous fish. These actions should be avoided from avoided from 3/1 to 6/30.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

No EFH has been designated in the project area. An EFH consultation by the federal action agency will not be required as part of the permit process. Should project plans change that would modify the basis for this determination, or if new species or EFH is designated, consultation should be reinitiated. For a listing of EFH and further information, please go to our website at: www.nero.noaa.gov/hcd.

If you wish to discuss this further, please call 732-872-3023

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed Little Tinicum Island Trail and Habitat Enhancement
Delaware Co., PA

_____________ Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

Threatened and endangered shortnose sturgeon may be present in the project area at certain times of the year. If any work is proposed below the mean high water line of the Delaware River, the lead federal action agency should contact NMFS Protected Resources Division to initiate coordination on this project. Requests for coordination can be addressed to: Ms. Julie Crocker of NOAA Fisheries Service's Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930-2298.

Fish and Wildlife Coordination Act

The Delaware River provide valuable nursery and forage habitat for a number of species of concern to NMFS including anadromous fish such as striped bass, alewife, blueback herring and American shad. From the project description, it does not appear that the proposed project will have an adverse effect on these species. Wetlands fill should be avoided. Areas where walkways cross over wetlands should be minimized and limited in width to four feet, if possible. Height of walkways over wetlands should be at least 4.5 feet to minimize the effects of shading on wetlands vegetation.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

No EFH has been designated in the project area. An EFH consultation by the federal action agency will not be required as part of the permit process. Should project plans change that would modify the basis for this determination, or if new species or EFH is designated, consultation should be reinitiated. For a listing of EFH and further information, please go to our website at: www.nero.noaa.gov/hcd. If you wish to discuss this further, please call 732-872-3023

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Proposed Mad Horse Creek Restoration Site
Lower Alloway Creek Twp., Salem Co. NJ

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

No threatened or endangered species under the jurisdiction of the NMFS are known to occur in the project area. As a result, further consultation is not required. However should project plans change that would change the basis for determination, or if new species or critical habitat is designated, consultation should be reinitiated.

Fish and Wildlife Coordination Act

A wide variety of resources under NMFS jurisdiction occur within Mad Horse Creek including anadromous and resident fish, forage and benthic species such as alewife, blueback herring, striped bass, weakfish, white perch, bay anchovy, mummichog., and Atlantic croaker. Depending upon the in-water work proposed and the exact location of the restoration, we may recommend seasonal in-water work restrictions within Mad Horse Creek from 3/1 to 6/30 to reduce impacts to anadromous fish.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

The estuarine waters of Mad Horse Creek have been designated as Essential Fish Habitat (EFH) for one or more species. Restoration activities at the site may have minor temporary impacts of EFH and federally managed species. These can be minimized by using best management practices to protect water quality and reduce sediments entering the creek. The restoration of the site will benefit EFH. Because the impacts of the project are expected to be minor in nature and temporary, further EFH consultation will not be necessary required as part of the federal permit process. Should project plans change that would change the basis for determination, or if new species or EFH are designated, the federal action agency should reinitiate consultation. For a listing of EFH and further information, please go to our website at: http://www.nero.noaa.gov/hcd. If you wish to discuss this further, please call 732-872-3023.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Oyster Reef Restoration in Delaware Bay

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

Several species of sea turtles are of each year including the threatened loggerhead (*Caretta caretta*), endangered Kemp's ridley (*Lepidochelys kempii*), leatherback (*Dermochelys coriacea*) and green (*Chelonia mydas*) sea turtles are present in Delaware Bay, mainly during the late spring, summer and early fall when water temperatures are relatively warm. Consultation pursuant to Section 7 of the Endangered Species Act may be necessary for the proposed oyster restoration activities. Please contact Ms. Julie Crocker of our Protected Resources Division at the following address for information on the Section 7 consultation needs for this project. NOAA Fisheries Service's Protected Resources Division, One Blackburn Drive, Gloucester, MA 01930-2298.

Fish and Wildlife Coordination Act

A wide variety of resources under NMFS jurisdiction occur within Mad Horse Creek including anadromous and resident fish, forage and benthic species such as alewife, blueback herring, striped bass, Atlantic sturgeon, winter flounder, summer flounder, windowpane, bluefish, horseshoe crabs, blue crabs, weakfish, bay anchovy, mummichog., and Atlantic croaker.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

The project area has been designated as Essential Fish Habitat (EFH) for one or more species. Based upon the nature of the work proposed, we do not anticipate significant adverse impacts to EFH. As a result, further EFH consultation will be not needed as part of the federal permit process. For a listing of EFH and further information, please go to our website at: http://www.nero.noaa.gov/hcd. If you wish to discuss this further, please call 732-872-3023.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

May 5, 2008

TO: Bethany Bearmore
NOAA Restoration Center
James J. Howard Marine Sciences Laboratory
74 Magruder Road
Highlands, New Jersey 07732

SUBJECT: Stow Creek Boat Ramp
Stow Creek Twp., Cumberland Co. NJ

Karen Greene
(Reviewing Biologist)

We have reviewed the information provided to us regarding the above subject project. We offer the following preliminary comments pursuant to the Endangered Species Act, the Fish and Wildlife Coordination Act and the Magnuson-Stevens Fishery Conservation and Management Act:

Endangered Species Act

No threatened or endangered species under the jurisdiction of the NMFS are known to occur in the project area. As a result, further consultation is not required. However should project plans change that would change the basis for determination, or if new species or critical habitat is designated, consultation should be reinitiated.

Fish and Wildlife Coordination Act

A wide variety of resources under NMFS jurisdiction occur within Stow Creek including anadromous and resident fish, forage and benthic species such as alewife, blueback herring, striped bass, weakfish, white perch, bay anchovy and mummichog. Based upon the information provided, no more than a minimal, temporary impact are expected to occur and no seasonal work restrictions are necessary.

Magnuson-Stevens Fishery Conservation and Management Act
Essential Fish Habitat

The estuarine waters of Stow Creek have been designated as Essential Fish Habitat (EFH) for one or more species. Based upon the nature of the work proposed, we do not anticipate significant adverse impacts to EFH. As a result, further EFH consultation will be not needed as part of the federal permit process. Should project plans change that would change the basis for determination, or if new species or EFH are designated, the federal action agency should reinitiate consultation. For a listing of EFH and further information, please go to our website at: http://www.nero.noaa.gov/hcd. If you wish to discuss this further, please call 732-872-3023.

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL OCEAN SERVICE
OFFICE OF OCEAN AND COASTAL RESOURCE MANAGEMENT
Silver Spring, Maryland 20910

AUG 11 2008

Tom Brosnan
Northeast Branch Manager
NOAA Office of Response and Restoration
1305 East-West Highway, Station 10219 (N/ORR31)
Silver Spring, MD 20910

Dear Mr. Brosnan: Tom

This letter is in reference to the proposal for a restoration project at the Blackbird Reserve Wildlife Area designed to improve habitat for migratory geese. This approximately 535-acre property was acquired in part using a grant to the Delaware Coastal Program from NOAA's Coastal and Estuarine Land Conservation Program (CELCP), and is owned and managed by Delaware Department of Fish and Wildlife (DFW). Because agricultural activities are not allowed on CELCP-funded projects, as part of the grant agreement the State was to discontinue the agricultural uses of the property and undertake restoration of the agricultural area (152.9 acres) to habitat. The purpose of this letter is to address the issue of whether the restoration project, which involves agricultural activities, would be considered permissible or if it would violate the CELCP Guidelines, which is of concern to the Delaware Coastal Program.

It is our understanding that:

- The project would entail restoring 41.8 acres of the 152.9 acres to a combination of forested areas, wetland ponds, wildlife pasture, and "*wildlife food plots*."
- "Wildlife food plots" are in effect agricultural areas in that they are typically planted with crops (for this project, specifically corn, soybean or winter wheat) and managed using standard agricultural practices.
- The overall restoration plan and the specifics of this arrangement provide that in total, 23.6 of the 41.8 acres will be in use as "wildlife food plots" and that this amount of acreage is the minimum size necessary to adequately provide habitat and food for the number of migratory geese anticipated to use the property for such. The wildlife food plot use will affect less than 5 percent of the property's total acreage (23.6 is 4.4% of 535 acres).
- DFW will contract with a local farmer to plant and maintain the food plots. The farmer would be "paid" through an in-kind arrangement: the farmer will be allowed to harvest and sell up to 80% of the planted crops in return for managing the food plots. There is not intent for DFW to derive income from this arrangement.
- The remaining 20% of the standing crop and all crop residue would comprises the food and feeding habitat for the migratory geese.
- The agricultural activities required for this project will be conducted in accordance with (or exceed) the State's management measures to address the impacts of nonpoint source pollution from agricultural activities, as approved (by EPA and NOAA) as part of Delaware's Coastal Nonpoint Pollution Control Program.

Given this context, CELCP staff are prepared to find that this specific project would not violate our Guidelines. This finding is based on the assumptions that the agricultural activities necessary to accomplish this project are intended primarily for habitat management purposes and that any revenues generated are incidental to the restoration project (i.e., the agricultural activities are not intended to be primarily commercial in nature). It is also noted that the use would affect only a very small portion of the property.

This finding is specific to this project only, and should not be construed as a change to CELCP policy regarding agriculture. Comparable projects contemplated for other CELCP-funded projects in Delaware (or elsewhere) would have to be reviewed on their own merit.

Should the approach or other circumstances of this project change in the future, we would appreciate being notified and given the opportunity to review the revised project plan. If you have any questions, please contact me.

Sincerely,

Elisabeth Morgan

Elisabeth Morgan
CELCP Manager

cc: David Carter, Delaware Coastal Program