# RESTORATION PLAN AND ENVIRONMENTAL ASSESSMENT FOR THE JANUARY 19, 1996 *NORTH CAPE* OIL SPILL

## REVISED DRAFT FOR PUBLIC COMMENT

**March 31, 1999**

**Prepared By:**
**National Oceanic and Atmospheric Administration**
**Rhode Island Department of Environmental Management**
**U.S. Department of the Interior**
**and**
**U.S. Fish and Wildlife Service**

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**INTRODUCTION AND SUMMARY** **CHAPTER 1**

## 1.1 INTRODUCTION

This Revised Draft Restoration Plan and Environmental Assessment (Revised Draft RP/EA) has been prepared by state and federal natural resource Trustees to address restoration of natural resources and resource services injured by the barge *North Cape* oil spill on January 19, 1996. This Revised Draft RP/EA considered and, where appropriate, incorporated public comments and information obtained from Trustee and Responsible Party (RP) experts regarding the September 14, 1998 Draft RP/EA. The purpose of restoration, as outlined in this Revised Draft RP/EA, is to make the public whole for injuries to natural resources and natural resource services resulting from the *North Cape* oil spill by returning injured natural resources and natural resource services to their pre-spill, or "baseline", conditions and compensating for interim losses of natural resources. For this spill, the Rhode Island Department of Environmental Management, the National Oceanic and Atmospheric Administration, and the U.S. Department of the Interior have the responsibility as natural resource Trustees to determine natural resource injuries, plan for appropriate restoration projects, prepare the draft and final restoration plans, and implement or oversee restoration. Throughout this document, these agencies are referred to as the "Trustees."

The regulations for conducting a sound natural resource damage assessment which will achieve restoration are found at 15 C.F.R. Part 900 *et seq.*, which were promulgated pursuant to the Oil Pollution Act of 1990 ("OPA"), 33 U.S.C. § 2701 *et seq*. These regulations set forth a process for developing a restoration plan with input from both the public and the parties responsible for the spill, who are Odin Marine Corp., Thor Towing Corp., and Eklof Marine, collectively referred to in this document as the "RP."

This Revised Draft RP/EA is intended to inform members of the public and solicit their comments on the results of natural resource injury studies and proposed restoration actions. The restoration alternatives described herein are based on conceptual plans for which the costs have not been calculated in detail. The size and design of recommended restoration alternatives may change substantially based on public input and/or additional scientific findings. The Trustees believe that public input at this stage is essential to the restoration process. Comments received by the Trustees will be considered by the Trustees prior to incorporation into a Final Restoration Plan. This Draft RP/EA also serves as an Environmental Assessment as defined under the National Environmental Policy Act (NEPA), 42 U.S.C. § 4321 *et seq.*, and addresses the potential impact of proposed restoration actions on the quality of the physical, biological, and cultural environment.

The Final Restoration Plan will be presented to the RP for funding, or for the RP to implement the restoration projects set forth in the final plan. If, within 90 days of a Trustee demand, as defined at 15 C.F.R. § 990.56(b)(2), the RP does not agree to fund or implement restoration, the Trustees may file a judicial action for damages pursuant to Section 1002 of OPA, 33 U.S.C. § 2702 or seek funding of the restoration plan from the Oil Spill Liability Trust Fund pursuant to section 1013 of OPA, 33 U.S.C. § 2713.

### 1.1.1 Process

During the Preassessment Phase, the Trustees determined that the provisions of the Oil Pollution Act applied to this spill, that natural resources under their jurisdiction were affected by the spill, that response actions would not eliminate injury to those resources, and that feasible restoration alternatives exist to address injuries to those natural resources. On the basis of those determinations, the Trustees began the Restoration Planning Phase. In this phase, the Trustees evaluated and quantified the nature and extent of injuries to natural resources and services, and determined the need for, type of and scale of appropriate restoration actions. Using the information developed during the Restoration Planning Phase, the Trustees developed this Draft RP/EA.

The first component of the Restoration Planning Phase is injury assessment. The Trustees formed four technical working groups, or "TWGs", to evaluate injury to: (1) the offshore marine environment, including lobsters; (2) salt ponds; (3) birds; and (4) human uses. As provided at 15 C.F.R. § 990.14(c)(1), the Trustees invited the RP to participate in the injury assessment component of the natural resource damage assessment. Consequently, members of the TWGs included Trustee staff and experts, as well as representatives of the RP. The Responsible Party was involved in the design, performance, and funding of many studies completed through the Technical Work Groups (TWGs). The TWGs produced studies which the Trustees considered in determining the nature and extent of injuries to natural resources. As required by the regulations at 15 C.F.R. § 990.14(c)(4), the Trustees retained final authority to make determinations regarding injury and restoration. The studies considered by the Trustees considered, along with Trustee and RP comments on them, are part of the Administrative Record.

The second component of the Restoration Planning Phase is restoration selection. Considering the nature and extent of injuries to natural resources caused by the *North Cape* oil spill, the Trustees developed a plan for restoring the injured resources and services, which is set

forth in this Draft RP/EA. In it, the Trustees identify a reasonable range of restoration alternatives, evaluate those alternatives, and using the criteria at 15 C.F.R § 990.54, select the preferred alternatives from among them.[1]

In selecting their preferred restoration alternatives, the Trustees considered all of the criteria outlined in the regulations, including the cost of carrying out each alternative. As required by these criteria, the Trustees have selected the least expensive alternative when two or more alternatives are expected to provide the same restoration benefit. In addition, the Trustees also considered whether the cost of a preferred alternative was commensurate with the value of the injured resource and service. The OPA Damage Assessment regulations do not expressly require natural resource Trustees to make this determination. However, as NOAA recognized when the OPA regulations were promulgated, "the evaluation and selection of restoration alternatives according to the factors provided in the rule will ensure that the preferred actions are commensurate with the value of the natural resource losses." 61 Fed. Reg. 490 (1996). After considering the extent of the injuries, as well as the cost of the preferred restoration alternatives, the Trustees determined that the cost of the preferred alternatives is commensurate with the value of the lost resources. Additionally, the estimated costs associated with the preferred restoration alternatives are generally consistent with costs incurred in other similarly situated restoration projects.

In selecting and scaling the preferred restoration alternatives, the Trustees considered, as required at 15 C.F.R. § 990.53(d)(4), the risk that a restoration project will not work as expected. In part to account for this risk, the Trustees have included a contingency amount in the anticipated costs of restoration conducted by the Trustees. In addition, the Trustees will establish performance standards and require monitoring to measure whether those standards have been met. If those standards are not met, additional restoration actions will be implemented until the standards are achieved.

Consistent with the OPA regulations (15 C.F.R. § 990.54(a)(5)), the Trustees also considered the extent to which restoration alternatives provide benefits to more than one natural resource and/or service. As described in more detail in Chapter 5 of this Draft Restoration Plan, several of the restoration alternatives selected by the Trustees benefit multiple resources and/or resource services. When scaling and evaluating restoration alternatives, the Trustees focused on the resources and resource services that were injured by the *North Cape* oil spill. Although some restoration projects may provide "collateral" benefits to resources and resource services that were not injured by the spill, these benefits were considered secondary to the primary goal of restoring injuries caused by the *North Cape* spill.

[1] The selection criteria for determining preferred restoration alternatives are described in more detail in Chapter 5.

## 1.2 OVERVIEW OF THE INCIDENT

At approximately 6:00 p.m. on Friday, January 19, 1996, the tank barge *North Cape*, carrying 94,000 barrels (3.9 million gallons) of two blends of No. 2 home heating oil, struck ground off Moonstone Beach in South Kingstown, Rhode Island and began to leak oil into the surrounding water. Winds reaching 50 knots formed large, breaking waves that dispersed the oil. These waves, combined with shallow waters at the site of the grounding dispersed oil throughout the water column and into contact with bottom sediments. Oil skimming and booming operations began on Saturday, January 20 in an effort to control surface oil sheens, remove oil from the water column and protect sensitive offshore and salt pond ecosystems. In total, an estimated 828,000 gallons of the two blends of No. 2 fuel oil were released into the coastal and offshore environments before the *North Cape* was refloated and moved to Newport, Rhode Island on Friday, January 26, one week after the grounding.

Emergency response teams reported preliminary indications of biological injury from the combined effects of the severe weather and spill. Nearly 2.9 million dead and moribund lobsters were removed from southern Rhode Island beaches following the spill. These stranded lobsters represent a fraction of the actual mortality throughout the entire marine environment. As a result of public health concerns associated with consumption of potentially contaminated lobsters, areas of Block Island Sound remained closed to lobster harvesting for five months following the spill. In the nineteen days following the spill, 405 oiled birds (of which only thirteen survived) were recovered along with large numbers of dead surf clams, crabs, and fish. In addition, United States Fish and Wildlife Service (USFWS) staff surveying Cards Pond reported a large mortality of amphipods, small crustaceans that represent a critical component of coastal food webs.

## 1.3 NATURAL RESOURCE INJURIES

The Trustees reviewed the results of over 30 studies of potential resource injuries caused by the *North Cape* spill and consulted with a variety of experts in relevant scientific and technical disciplines. Based on this work, the Trustees believe that the spill caused significant injuries to biota in the offshore and salt pond environments and to a variety of birds.

Losses in numbers and biomass (direct kill and production foregone) were largest in the offshore environment. Approximately 19.4 million surf clams (970,000 kilograms) and 9.0 million lobsters (direct kill only, totaling 312,000 kilograms) were lost as a result of the spill (French 1998, Cobb and Clancy 1998, Cobb *et al.* 1998). Large numbers (4.9 billion) of worms and amphipods died from spill effects, although their relatively small size (0.01 gram each) resulted in a biomass loss of 800,000 kg (French 1998). Losses of rock and hermit crabs totaled 7.6 million animals, with a biomass of 97,000 kilograms. Fish losses, primarily skates, cunner and Atlantic sea herring, totaled 4.2 million animals (111,000 kilograms).

In the salt ponds, injury to worms and amphipods via contaminated sediment pore water totaled approximately 6.6 billion organisms, with an associated biomass loss of 164,000 kilograms. In addition, approximately 7,100 kilograms of crabs and shrimp, 12,400 kilograms of soft-shell clams and oysters, and 5,000 kilograms of forage fish also were lost due to the spill.

Trustee analysis indicates that 1996 productivity of the piping plover, a federally-listed threatened species, was reduced by approximately five to ten fledged chicks. Mortality to birds is estimated at 2,292 birds, responsible for an estimated interim loss of 7,105 bird-years. Losses of loons (414), eiders (354), and grebes (228) were largest and were responsible for 5,307 bird-years lost.

Recovery time for these injuries also has been estimated by the Trustees. In the offshore environment, recovery of surf clams is expected to take approximately three to five years, similar in duration to lobster recovery (four to five years). Offshore fish and crabs will likely recover within one to three years. Amphipods and worms recovered within five months. In the salt ponds, recovery of injured species was expected within two years. For seabirds and wintering waterfowl, estimated recovery time varies for different species, ranging from approximately one to six years. Because piping plovers are a federally-recognized threatened species, the injury to fledged chicks may delay management efforts to restore this population to self-sustaining levels.

Boat-based recreational fishing was the only human use activity for which the Trustee assessment confirmed and quantified a loss. Trustee analysis indicates that 3,305 party/charter boat fishing trips were lost. Fishing activity returned to baseline levels within approximately six months after the spill.

### 1.3.1 Injury Quantification Issues

The Trustees recognize that there is some degree of "uncertainty" associated with their injury determinations, and that actual injuries caused by the *North Cape* spill may have been greater or less than the injury estimates set forth in this Revised Draft RP/EA. However, the Trustees do not believe that this uncertainty is a basis for rejecting the injury estimates, as some degree of uncertainty is inherent in any process of estimating injuries caused by an oil spill. The Trustees have endeavored to arrive at the most accurate estimate of the injuries caused by the *North Cape* oil spill, based upon the best scientific information available.

The Responsible Party has expressed concern about the use of a model to quantify injuries. The Trustees submit that injury determinations based on "field data" generally involve some degree of extrapolation and modeling, and that injury determinations based upon a model generally rely upon a certain amount of field data, and that both methods of determining injury involve inherent uncertainties. In assessing the injuries caused by the spill, the Trustees sought to rely on the most reliable methodologies available -- which involved the use of both field data and modeling -- to determine the extent of the injuries.

## 1.4 PROPOSED RESTORATION ALTERNATIVES

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

Compensatory restoration is any action taken to compensate for interim losses of natural resources and services. The scale of the required compensatory restoration will depend both on the scale of 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.

The Trustees evaluated 25 restoration alternatives with the potential to enhance the recovery of natural resources injured by the spill and to provide additional resources to compensate for the losses pending recovery. As indicated in Exhibit 1-1, the Trustees propose restoration actions directed at injuries to lobsters, surf clams, piping plovers, loons and sea ducks. In addition, the Trustees propose to enhance the water quality and biological productivity of the area affected by the *North Cape* spill through actions such as land acquisition and shellfish restoration. Projects to improve human access to the shoreline and to enhance anadromous fish runs also are proposed to compensate for recreational fishing opportunities lost because of the spill. If implemented by the Trustees, the total cost of these restoration actions is estimated to be $27.6 million. This cost estimate is preliminary and will be refined in the final RP/EA. The total cost of these projects may be different if they are implemented by the RP.

**Exhibit 1-1**

**PREFERRED RESTORATION ALTERNATIVES**

| Injured Resource/ Service | Primary Restoration | Compensatory Restoration | Estimated Project Costs |
|---|---|---|---|
| **Offshore** | | | |
| Lobsters | Natural Recovery | Adult lobster restocking | $9,915,625 |
| Surf Clams | Natural Recovery | Shellfish Restoration | included in shellfish restoration |
| Other Benthic Organisms/Fish | Natural Recovery | Land Acquisition<br>Shellfish Restoration | included in salt pond land acquisition and shellfish restoration |
| **Salt Ponds** | | | |
| Worms/Amphipods<br>Crabs/Shrimp<br>Shellfish<br>Forage Fish/Winter Flounder | Natural Recovery | Shellfish Restoration<br>Land Acquisition | $5,954,110<br>$1,782,500 |
| **Birds** | | | |
| Piping Plovers | Habitat Protection and Monitoring | Habitat Protection and Monitoring | $232,706 |
| Loons | Natural Recovery | Loon Habitat Protection | $7,485,170 |
| Marine Birds other than Loons | Natural Recovery | Sea Duck Habitat Protection | $631,250 |
| Pond Birds | Natural Recovery | Land Acquisition | included in salt pond land acquisition |
| **Human Use** | | | |
| Party and Charter Boat Fishing | Natural Recovery | Shore Access<br>Anadromous Fish Runs | $281,685 |
| Subtotal | | | $26,283,046 |
| Project Oversight | | | $1,314,152 |
| **Total** | | | $27,597,198 |

## 1.5 PLAN OF THIS DOCUMENT

The remainder of this document presents further information about the natural resource injury studies and proposed restoration actions for the *North Cape* oil spill.

> Chapter 2 briefly summarizes the spill incident, the legal authority and regulatory requirements of the Trustees, and the role of the Responsible Party and the public in the damage assessment process.
>
> Chapter 3 provides a brief description of the physical and biological environments affected by the spill, as required by NEPA (42 U.S.C. Section 4321, *et seq.*), and describes the cultural and economic importance of Block Island Sound and Rhode Island salt pond natural resources.

Chapter 4 describes and quantifies the injuries caused by the spill, including an overview of Preassessment activities, a description of assessment strategies employed by the Trustees and a presentation of assessment results.

Chapter 5 provides a discussion of restoration options, and determines the appropriate scale of preferred options based on the nature and extent of injury presented in Chapter 4.

Appendix A provides a list of the documents designated for submission to the Administrative Record as of the printing of this Draft RP/EA.

Appendix B provides a list of Federal and State Endangered or Threatened Species in Rhode Island.

## EXPERT REPORTS CITED

Cobb, J.S. and M. Clancy. January 5, 1998. *North Cape* Oil Spill: Assessing Impact on Lobster Populations.

Cobb, J.S., M. Clancy, and R.A. Wahle. 1998. Habitat-based Assessment of Lobster Abundance: A Case Study of an Oil Spill.

French, D.P., 1998. Updated Estimate of Injuries to Marine Communities Resulting from the *North Cape* Oil Spill Based on Modeling of Fates and Effects. Report to NOAA Damage Assessment Center, Silver Spring, MD, September 1998.

**PURPOSE OF AND NEED FOR RESTORATION CHAPTER 2**

## 2.1 THE *NORTH CAPE* OIL SPILL: SUMMARY OF INCIDENT

At approximately 2:30 p.m. on Friday, January 19, 1996, the U.S. Coast Guard (USCG) station in Point Judith, Rhode Island was contacted by the captain of the tug *Scandia*, who reported that the tug was on fire and the crew were abandoning ship. The tug was towing the tank barge *North Cape*, which contained 94,000 barrels (3.9 million gallons) of two blends of No. 2 home heating oil. Efforts to anchor the barge were unsuccessful, and at approximately 6:00 p.m. the barge and tug struck Nebraska Shoal just off Moonstone Beach in South Kingstown, Rhode Island. The location of the grounding is identified in Exhibit 2-1.

The barge grounded in the vicinity of several public and private beaches, salt ponds and two National Wildlife Refuges. Immediately to the north of the spill site are Moonstone Beach, and Trustom and Cards Ponds. Trustom Pond is part of the Trustom Pond National Wildlife Refuge (NWR). To the west of the spill lies a second Refuge, Ninigret. Several public and private beaches lie both to the east and to the west of the spill. Dominant shoreline types in the area are mixed sand and gravel beaches, sand beaches, and exposed rocky shores. The subtidal zone consists of both sandy bottom and hard bottom glacial deposits of gravel and boulders. A more detailed map of the area impacted by the spill is provided in Chapter 3 as Exhibit 3-1.

Wind direction and speed played a critical role in the drift of surface oil from the site of the grounding. Exhibit 2-2 summarizes the maximum extent of ocean surface sheens as recorded by overflight observations for the first six days after the incident. Winds were over 50 knots from the SSE during the storm on the day of the spill. Although dispersants were available, they were not used because of the high rate of natural dispersal associated with the storm event on the day of the spill.

**Exhibit 2-1**

**LOCATION OF THE GROUNDING OF THE BARGE *NORTH CAPE***
**OFF THE COAST OF SOUTHERN RHODE ISLAND**

**Exhibit 2-2**

The following afternoon NW winds were blowing at 10 to 15 knots. The winds continued to shift in a clockwise direction on January 21, causing the newly released oil to spread widely. Sheens reached the southern side of Block Island by 8:00 a.m. On Tuesday, January 23, the winds shifted to the SW. Winds from the SSW reached 40 knots during a second storm on January 24, driving the oil back onto shore. The following day NW winds returned at 20 to 25 knots.

Storm conditions and the resulting heavy surf entrained (mixed) most of the oil into the water column overnight on January 19-20. Larger droplets of entrained oil resurfaced on January 20 when the winds and surf subsided to form the sheens observed. Small droplets and dissolved oil remained in the water column. Since the tidal currents run along the beach near the grounding site, the subsurface oil plume was retained in shallow waters for several days following the spill. This resulted in prolonged exposure to high concentrations of the oil's most toxic components (polynuclear aromatic hydrocarbons or PAHs) in the shallow water near the beach, which caused significant injuries to water column and bottom-dwelling organisms.

Oil skimming and booming operations began on Saturday, January 20 in an effort to control oil sheens and protect sensitive offshore and salt pond ecosystems. The west entrance to the Harbor of Refuge was boomed on January 20, but the east entrance was left open to accommodate vessel traffic from the harbor and Point Judith Pond. Booms were placed at Charlestown Breachway on January 21. Booms also were deployed in several areas within Point Judith Pond and across the channel between Point Judith Pond and Potter Pond. Contractor skimming vessels joined the USCG cleanup effort on Sunday, January 21. USCG skimming was terminated on January 23 because of low recovery rates.

Overall, an estimated 828,000 gallons of the two types of home heating oil were released into the coastal and offshore environments before the *North Cape* was refloated and moved to Newport on January 26, one week after the initial spill. Oil sheens were observed in several of the salt ponds bordering the area of the spill. The breachway to Cards Pond opened during the storm, allowing oil to enter the pond. The breachway to Trustom Pond was overwashed, but did not breach. The sand in the washover area was oil-stained, and there were patches of sheen at the pond edge against the ice, which covered most of the pond surface. Shoreline survey teams also reported areas of oil contamination in Point Judith and Potter Ponds.

Response teams reported initial indications of biological injury from the combined effects of the severe weather and spill. A total of 405 oiled birds were recovered in the nineteen days following the spill, and all but 13 died or were euthanized. Nearly 2.9 million dead and moribund lobsters were removed from southern Rhode Island beaches following the spill, with the heaviest concentration of dead lobsters found at sites adjacent to Matunuck Deep Hole. Over 18,000 of these lobsters were sexed and measured by research teams. The stranded lobsters represent a fraction of total lobster mortality throughout the entire offshore environment. Large numbers of dead surf clams and fish also were reported on the beach. In addition, United States Fish and Wildlife Service (USFWS) staff surveying Cards Pond reported a large mortality of amphipods.

Only small sheens of surface oil were reported in the vicinity of Block Island. Emergency response teams reported no trace of *North Cape* oil on Block Island beaches. Nevertheless, the inlet to the Great Salt Pond on the island was boomed to protect the pond. Other than recovery of oiled birds from the surrounding marine environment, however, no evidence of injury was recorded on the island.

The Rhode Island Department of Environmental Management (RIDEM) closed coastal pond and state offshore water fisheries on January 22. The area of closure was expanded to the northeast the following day. By January 26, federal offshore waters were closed officially for all fishing and shellfishing (61 FR 3602). Areas of the lobster fishery remained closed for five months as a result of concerns regarding consumption of potentially contaminated lobsters.

## 2.2 AUTHORITY AND LEGAL REQUIREMENTS

This Revised Draft Restoration Plan and Environmental Assessment (Revised Draft RP/EA) has been prepared jointly by the National Oceanic and Atmospheric Administration (NOAA), the Rhode Island Department of Environmental Management (RIDEM), and the U.S. Department of the Interior (DOI) (represented by the U.S. Fish and Wildlife Service (FWS)) (collectively, "the Trustees"). Each of these agencies is a designated natural resource Trustee under the Oil Pollution Act of 1990 (OPA), 33 U.S.C. §2706(b), and the National Contingency Plan, 40 CFR Section 300.600, for natural resources injured by the *North Cape* oil spill. As a designated Trustee, each agency is authorized to act on behalf of the public under state and/or federal law to assess and recover natural resource damages, and to plan and implement actions to restore natural resources and resource services injured or lost as the result of a discharge of oil.

### 2.2.1 <u>Overview of OPA Requirements</u>

A natural resource damage assessment, as described under Section 1006 of OPA (33 U.S.C. §2706(c)) and the regulations for natural resource damage assessments under OPA at 15 CFR Part 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. Injury is defined as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service" (15 CFR § 990.30).

Based on information collected during the Preassessment Phase, Trustees make a preliminary determination whether natural resources or services have been injured and/or are threatened by ongoing injury. Through coordination with response agencies (e.g., the USCG), Trustees next determine whether response actions will eliminate injury or the threat of ongoing injury. If injuries are expected to continue, and feasible restoration alternatives exist to address such injuries, Trustees may proceed with the Restoration Planning Phase. Restoration planning also may be necessary if injuries are not expected to continue but are suspected to have resulted in interim losses of natural resources and services from the date of the incident until the date of recovery.

The purpose of the Restoration Planning Phase is to evaluate potential injuries to natural resources and services, and use that information to determine the need for and scale of restoration actions. Natural resources are defined as "land, fish, wildlife, biota, air, 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" (15 CFR § 990.30). This phase provides the link between injury and restoration and has two basic components: injury assessment and restoration selection. The goal of injury assessment is to determine the nature and extent of injuries to natural resources and services, thus providing a factual basis for evaluating the need for, type of and scale of restoration actions. As the injury assessment progresses, Trustees develop a plan for restoring the injured natural resources and services. Trustees must identify a reasonable range of restoration alternatives, evaluate and select the preferred alternative(s), develop a Draft Restoration Plan presenting the alternative(s) to the public, solicit public comment on the Plan, and consider those comments before issuing a Final Restoration Plan.

During the Restoration Implementation Phase, the Final Restoration Plan is presented to the Responsible Parties to implement or to fund the Trustees' costs of implementing the plan. Should the Responsible Parties decline to fund or implement the plan, OPA authorizes Trustees to bring a civil action against Responsible Parties for damages or to seek disbursement from the Oil Spill Liability Trust Fund to implement preferred restoration projects. Components of damages are specified in sections 1002(b) and 1001(5) of OPA and include the costs of damage assessment.

### 2.2.2 <u>NEPA Compliance</u>

Any restoration of natural resources under OPA must comply with the National Environmental Policy Act (NEPA) (40 CFR Section 1500, *et seq*.) and the Council on Environmental Quality (CEQ) regulations implementing NEPA. In compliance with NEPA and the CEQ regulations, this Revised Draft RP/EA summarizes the current environmental setting, describes the purpose and need for action, identifies alternative actions, assesses their applicability and environmental consequences, and summarizes opportunities for public participation in the decision process.

## 2.3 COORDINATION WITH THE RESPONSIBLE PARTY

The OPA regulations require the Trustees to invite Responsible Parties to participate in the damage assessment process. Although Responsible Parties may contribute to the process in many ways, final authority to make determinations regarding injury and restoration rests solely with the Trustees.

Accordingly, the Trustees delivered a formal invitation pursuant to the OPA regulations for participation in the damage assessment to Eklof Marine, the Responsible Party for the *North Cape* oil spill, on June 13, 1996.[1] A Trustee-Responsible Party Memorandum of Understanding

[1] Eklof Marine owns Odin Marine Corp. and Thor Towing Corp., the two other Responsible Parties for the *North Cape* oil spill.

was signed by the Responsible Party on October 25, 1996. The designated technical representatives of Eklof Marine participated actively in the damage assessment following the spill; they were involved in the design, performance and funding of many studies completed as part of this assessment. They also participated actively in Technical Work Groups (TWGs), which were created to design and interpret the studies and evaluate potential injuries. Coordination between the Trustees and the Responsible Party helped reduce duplication of studies, increase the cost-effectiveness of the assessment process, and increase sharing of information and experts. Input from the Responsible Party was sought and considered throughout the damage assessment and restoration planning process.

## 2.4 PUBLIC PARTICIPATION

The original Draft RP/EA was placed in the Administrative Record on September 14, 1998. Since publication of the Draft RP/EA, the Trustees have received comments from the public as well as additional information from Trustee and RP technical experts. In response to this input, the Trustees have made several changes to underlying technical reports and the Draft RP/EA.

Public review of the Draft and Revised Draft RP/EA is an integral component of the restoration planning process. Through the public review process, the Trustees seek public comment on the analyses used to define and quantify natural resource injuries and the methods proposed to restore injured natural resources or replace lost resource services. The Draft and Revised Draft RP/EA provide the public with current information about the nature and extent of the natural resource injuries identified and restoration alternatives evaluated.

Following a public notice, the Revised Draft RP/EA will be available to the public for a 21 day comment period. Written comments received during the public comment period will be considered by the Trustees before finalizing the document. Public review of the Revised Draft RP/EA 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 §4371, *et seq.*) and the regulations implementing NEPA (40 CFR Part 1500, *et seq.*).

The deadline for submitting written comment on the Revised Draft RP/EA will be specified in one or more public notices issued by the Trustees to announce the document's availability for public review and comment. Comments on this draft should be sent to Sarah Thompson at Industrial Economics, Incorporated, at the address provided below. Industrial Economics, Incorporated is assisting the Trustees in the preparation of this RP/EA.

Industrial Economics, Incorporated
2067 Massachusetts Avenue
Cambridge, MA 02140

### 2.4.1 Administrative Record

The Trustees have maintained records to document the information considered by the Trustees as they have planned and implemented assessment activities and addressed restoration and compensation issues and decisions. These records are compiled in an administrative record, which is available for public review at either of the addresses listed below. 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 that have been designated for the administrative record to date is attached as Appendix A to this document. Additional information and documents, including public comments received on the Draft and Revised Draft RP/EA, the Final RP/EA and restoration planning documents will be included in the administrative record at a later date.

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

Office of Waste Management
Rhode Island Department of Environmental Management
235 Promenade Street
Providence, RI 02908
Contact: Warren Angell, (401) 277-3872, and

Pell Marine Science Library
University of Rhode Island
South Ferry Road
Narragansett, RI 02882
Contact: Eleanor Uhlinger, (401) 874-6161

Arrangements should be made in advance to review the record at the Rhode Island Department of Environmental Management or to obtain copies of documents in the record by contacting Warren Angell at the listed address or calling him at (401) 277-3872. The Pell Marine Library is open to the public, and operates during regular business hours and most evenings and weekends. The administrative record is kept on the reserve shelf of the library for in-library use only. To inquire about hours of operation call (401) 874-6161.

# AFFECTED ENVIRONMENT CHAPTER 3

This chapter presents a brief description of the physical and biological environment affected by the *North Cape* oil spill, as required by NEPA (40 U.S.C. Section 4321, *et seq*.). The physical environment includes the offshore waters of Block Island Sound and associated coastal salt pond and salt marsh habitat. The biological environment includes a wide variety of fish, shellfish, birds and other organisms. The federally-recognized threatened piping plover is one example of a particularly sensitive species residing in the southern Rhode Island region. Black ducks, loons and eiders also are of special interest to state and federal wildlife managers. The area affected by the spill includes Trustom Pond and Ninigret National Wildlife Refuges (NWRs), two nationally-designated natural areas. The NWRs have been created to preserve the natural floral and faunal diversity of the salt pond region, with particular attention given to the protection of vulnerable migratory bird resources.

The natural resources of Block Island Sound are of significant economic and cultural importance. Travel and tourism is the second largest employer in the state of Rhode Island, employing over 26,000 workers in 1995. Total sales receipts within the state reached $1.6 billion in 1995 (Tyrrell and McNair 1996). Commercial fish landings within the state totaled over 57 million kilograms in 1995 worth an estimated $70 million as reported in the National Marine Fisheries Service annual landings data (NMFS 1997). Recreational anglers spend an additional $100 million a year on fishing equipment alone within the state (Williams and Corey 1994). These activities depend on a healthy offshore and coastal ecosystem in the Block Island Sound region.

## 3.1 PHYSICAL ENVIRONMENT

The state of Rhode Island is located along the southern coast of New England. The state's 420 miles of coastline are influenced heavily by ocean climatic patterns. As a result of the moderating influence of the ocean, Rhode Island typically experiences mild summers and temperate winters. Temperatures in January average 31°F on Block Island (U.S. DOC 1992). The shoreline landscape is influenced by the high frequency of hurricanes which strike, on average, once every seven years (Olsen and Lee 1985).

Coastal and offshore habitats are valuable commercial and recreational resources to the state (Olsen and Seavey 1983). Oil from the *North Cape* spill spread over a considerable section of these resources in south-central Rhode Island. The barge struck Nebraska Shoal off Moonstone Beach (41°21.8N, 71°34.8W), about 3 miles west of Point Judith and about 12 miles north of Block Island. The shoreline in the area of the spill is comprised of mixed sand and gravel beaches, sand beaches, man-made structures and exposed rocky shore. The high wind and wave action at the time of the spill mixed the oil throughout the water column and into contact with the bottom sediment layer.

A band of coastal lagoons (salt ponds) and salt marsh lies along the southern Rhode Island coastline. The eight salt ponds located within the spill area are pictured in Exhibit 3-1 and described in Exhibit 3-2. The barge grounded immediately south of Trustom and Cards Ponds. Point Judith and Potter Ponds to the east and Ninigret and Green Hill Ponds to the west are within the region of the observed oil sheen. Quonochontaug and Winnapaug Ponds lie farther west of the spill, but also were impacted.

Local salt ponds can be grouped into three categories depending on whether they are directly breached to offshore waters, indirectly breached or unbreached for the majority of the year. Prior to 1800, all of these ponds were seasonally open to ocean waters; however, in the late 1800s, a permanent breachway was constructed in Point Judith Pond. Permanent breaching of Ninigret Pond followed in 1952. Ocean and pond water is exchanged through these two breachways at a rate of approximately five percent per day (Olsen and Lee 1985). Potter and Green Hill Ponds are indirectly linked to offshore waters through permanent openings in Point Judith and Ninigret Ponds, respectively. Only Cards and Trustom Ponds remain closed to the ocean for much of the year. As a consequence of this isolation from ocean water and tides, the water in Cards and Trustom Ponds is more brackish and less saline than the other salt ponds. The salinity differences between the ponds is presented in Exhibit 3-2. Cards and Trustom Ponds also differ from the other ponds in total area and average depth. An ice covering is not unusual on the shallower, lower salinity ponds during the winter months.

The physical environment of southern Rhode Island is impacted by human development. Surrounding the salt marsh and coastal preserves are the towns of Charlestown, South Kingstown and Narragansett. These communities contribute to the pollution of some of the area's ponds through fertilizer, pet fecal matter and individual sewage disposal systems (ISDS) contamination of surface and ground waters. These contaminants have caused bacterial contamination and elevated concentrations of nitrogen in some salt pond waters. High nitrogen levels have led to increased risk of eutrophication, decreased eelgrass bed area, increased sediment anoxia and other detrimental effects on fish and wildlife habitats (Olsen and Lee 1985, Short *et al*. 1996). Storm-water runoff containing gasoline and fuel oils also has been identified as a potential threat to the salt pond ecosystem (Olsen and Lee 1985). The port of Galilee, situated at the entry to Point Judith Pond, supports a fleet of commercial fishing vessels. Fishing has eroded once- abundant harvests of fish and shellfish in the salt ponds, as has habitat destruction caused by such activities as breachway management, dredge and fill operations, and damming of brooks and rivers (Crawford 1984, Lee *et al*. 1985, Nixon 1982, Olsen and Lee 1993).

## Exhibit 3-1

## THE SALT PONDS OF SOUTHERN RHODE ISLAND

**Exhibit 3-2**

**CHARACTERISTICS OF RHODE ISLAND'S SOUTH SHORE PONDS (FROM LEE 1980)**

| Pond Names | Area (acres) | Average Depth (meters) | Breachway | Average Salinity (ppt) |
|---|---|---|---|---|
| Point Judith (Saugatucket Estuary) | 1,530 | 1.8 | Permanent to Block Island Sound | 30 |
| Potter | 329 | 0.6 | Permanent to Point Judith Pond | 28 |
| Cards | 43 | 0.4 | Intermittent to Block Island Sound | 10 |
| Trustom | 160 | 0.4 | Intermittent to Block Island Sound | 4 |
| Green Hill | 431 | 0.8 | Permanent to Ninigret Pond | 24 |
| Ninigret (Charlestown) | 1,711 | 1.2 | Permanent to Block Island Sound | 28 |
| Quonochontaug | 732 | 1.8 | Permanent to Block Island Sound | 31 |
| Winnapaug (Brightmans) | 446 | 1.5 | Permanent to Block Island Sound | 30 |

## 3.2 BIOLOGICAL ENVIRONMENT

The offshore waters of Block Island Sound are home to a diversity of fish species including cod, cunner, flounder, skates, tautog and herring. Marine mammals are represented in the Block Island ecosystem by harbor seal communities on Point Judith, Newton Rock and possibly other remote rocky areas. Lobsters, surf clams, starfish, and crabs dominate the marine benthic community. Mussels, sea urchins and sea cucumbers also are resident benthic megafauna. These species are allied with an abundant and diverse benthic microfauna population in the offshore environment.

Moonstone Beach, the site of the grounding, is part of the Trustom Pond NWR, a highly productive brackish pond and wetland system. Cordgrasses (*Spartina* spp.) dominate the salt marsh environment in the salt ponds of Rhode Island, but are accompanied by other plant species such as seaside gerardia and salt marsh bulrush (NAWMP 1988). The marsh vegetation plays an essential role in the coastal ecosystem by generating primary production, trapping sediment, fixing nitrogen and providing habitat to fish, shellfish and other benthos.

Rhode Island's salt ponds are a critical part of the coastal ecosystem, serving as essential spawning, nursery and growth areas for coastal fish and shellfish, including the commercially and recreationally important winter flounder (Baczenski *et al*. 1979, Crawford and Carey 1985, Ganz *et al*. 1992, Crawford 1990). Other commercially and recreationally important species include striped bass, bluefish, quahogs, scallops, oysters and lobsters. Like most estuaries, the ponds are also important links between terrestrial and marine environments, converting terrestrial nutrients into marine biological production; in the shallow, well-lit waters of the salt ponds, benthic activity is an important component of this process (Nixon 1982, Nowicki and Nixon 1985). Silversides, striped killifish, mummichogs, sheepshead minnows, polychaetes and amphipods are important components of the complex food web of the salt ponds.

The salt pond and offshore habitats of the Block Island Sound coastal ecosystem also provide valuable habitat for a host of resident and migratory bird species. During the winter months, marine waters support seabird and waterfowl populations including loons and grebes, sea ducks (e.g., eiders and scoters), and diving ducks (e.g., goldeneye, bufflehead and scaup). Winter diving ducks and dabbling ducks such as scaup, American black duck and mallard also inhabit the area's salt ponds. Over 200 species of migratory birds use Block Island Sound resources during the spring and autumn months. Several species of birds (e.g., black ducks and loons) are of special importance to wildlife managers because their populations are declining and/or their ranges are retracting. Loons are recognized as a species of management concern by the USFWS, and are highly sensitive to human disturbance and have low nesting and hatching success in habitats encroached upon by human development (Crowley *et al*. 1996). They are listed by the state of Vermont as an endangered species and as a threatened species by the state of New Hampshire. Black duck populations have been declining over the past 100 years due to habitat degradation (Kirby 1988).

## 3.3 ENDANGERED AND THREATENED SPECIES

The Endangered Species Act of 1973 instructs federal agencies to carry out programs for the conservation of endangered and threatened species and to conserve the ecosystems upon which these species depend. The Rhode Island Natural Heritage Program also lists species that are of special concern to the state. Appendix B provides a list of federal and state recognized endangered or threatened species reported to reside in or migrate through the state of Rhode Island.

The Block Island Sound ecosystem provides particularly valuable habitat for the piping plover, a bird included on the federal list of threatened species. The southern beaches of Rhode Island contain the largest piping plover nesting area in the state. In the summer of 1996, nine pairs of these migratory birds nested on Moonstone Beach near the site of the *North Cape* grounding, and five pairs nested on Ninigret Beach. Plovers typically arrive at Rhode Island beaches in mid-March or early April. By mid-April, they have established pairs and begin construction on their nests. The birds feed on invertebrates in intertidal pools, washover areas, mudflats, sandflats, wracklines and shorelines of coastal ponds, lagoons and salt marshes. Maximum foraging distance averages 200 meters. Special management activities at Trustom Pond enhance the nesting success of piping plovers during the spring and summer months.

Common loons rely on the Block Island Sound ecosystem for wintering habitat. Experts believe that loons wintering off the coast of Rhode Island breed in northern New England and/or southern Canada. Although Rhode Island is not a historical breeding location for loons, the state of Vermont has listed common loons as an endangered species; in New Hampshire they are listed as a threatened species; and in Massachusetts, Connecticut and New York they are listed as a species of special concern. Loons are also a species of management concern to the U.S. Fish and Wildlife Service.

Numerous other endangered and threatened species are seasonal or occasional visitors to the offshore environment of Block Island Sound. Although these species are members of the ecosystem affected by the *North Cape* spill, available information indicates they were not directly impacted. Several species of sea turtles may be present from June through November. These include the threatened Atlantic loggerhead (*Caretta caretta)* and green sea turtle (*Chelonia mydas*), and the endangered Atlantic leatherback (*Dermochelys coriacea*) and Atlantic Kemp's ridley (*Lepidochelys kempi*) (D. Beach, pers. comm. 1998, Gould and Gould 1992). The loggerhead, Kemp's ridley and green sea turtles are mostly juvenile and subadult individuals foraging in nearshore coastal waters. The Kemp's ridley appears to prefer estuarine areas where green crabs and mussels are found. Loggerheads feed on benthic organisms found in large bay systems and leatherbacks forage in the open waters in search of jellyfish. Several whale species (humpbacks, finback and right whales) transit Rhode Island and Block Island Sounds.

Management programs also exist to reduce disturbance to roseate terns at Trustom Pond. Roseate terns, federally-recognized as an endangered species, are frequently found resting and feeding around the Trustom and Cards Pond breachways. Migrating bald eagles and American peregrine falcons, federally-listed threatened and endangered species, respectively, also utilize the salt ponds of southern Rhode Island as an occasional stopover site.

## 3. 4 NATIONAL WILDLIFE REFUGE LANDS

Trustom Pond and Ninigret NWRs are located on the south coast of Rhode Island in the Towns of South Kingstown and Charlestown, Rhode Island. They are two of over 500 NWRs in the United States comprising the National Wildlife Refuge System. Trustom Pond NWR was established in 1974 and encompasses 640 acres of diverse habitat. The approved land acquisition boundary includes another 360 acres that potentially can be protected as wildlife habitat. Ninigret NWR was established in 1970 and encompasses 407 acres.

These NWRs were acquired under the Migratory Bird Conservation Act of 1929. This act provides for the federal protection of all migratory birds and the acquisition of land and water for conservation of migratory bird resources. In addition to serving as important nesting and foraging habitat for resident and migrant waterfowl, shorebirds and songbirds, the NWRs provide valuable services to other flora and fauna of the region. Management objectives include maintaining a natural diversity and abundance of fauna and flora on refuge lands and preserving organisms and ecosystems represented on the refuge which are rare or threatened in the region. Trustom and Ninigret NWRs also provide wildlife-oriented outdoor recreation and education for the local community.

## 3.5 CULTURAL ENVIRONMENT AND HUMAN USE

The Rhode Island coast enjoys a rich history dating back thousands of years. Historic resources from prehistoric civilizations to the colonial and more recent industrial eras are protected by the Historical Preservation and Heritage Commission.

In addition to valuable cultural resources, Rhode Island waters offer considerable economic resources. Lobsters, quahogs and winter flounder comprise a sizable portion of the annual fish and shellfish catch. These species are harvested extensively in the Block Island Sound and associated salt pond communities (Olsen and Seavey 1983). The state's economy also is heavily dependent on summer tourism as a source of revenue. Travel and tourism is the second largest industry in the state, generating 26,655 jobs and $1.6 billion in total sales in 1995 (Tyrrell and McNair 1996). The coastline along Block Island Sound harbors an extensive network of town and state beaches to accommodate these tourists. Recreational dive trips and charter boat fishing also contribute to the local economy. All of these human activities are dependent upon the condition of the coastal and offshore habitats.

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# INJURY DETERMINATION AND QUANTIFICATION CHAPTER 4

This chapter describes and quantifies the injuries caused by the *North Cape* oil spill. The chapter begins with an overview of data collected during the Preassessment Phase of the damage assessment process, followed by a description of the Trustees' assessment strategy, including the approaches used to identify, determine, and quantify potential injuries. The remainder of this chapter presents the results of Trustee injury assessments for the specific resources affected by the *North Cape* spill. Chapter 5 addresses the identification, selection, and scale of restoration options to restore injured resources and services.

## 4.1 OVERVIEW OF PREASSESSMENT ACTIVITIES AND FINDINGS

Three requirements identified in the Oil Pollution Act of 1990 (OPA) must be met before Restoration Planning can proceed:

> Injuries must have resulted, or be likely to result from, the incident;
>
> Response actions must not have adequately addressed, or not be expected to address, the injuries resulting from the incident; and
>
> Feasible primary and/or compensatory restoration actions must exist to address the potential injuries.

All of the information collected during the Preassessment Phase of the *North Cape* oil spill is contained in the Preassessment Data Report (RPI 1996a). Using this information, the Trustees found that this spill met all three criteria.

### 4.1.1 <u>Nearshore and Offshore Impacts</u>

The two blends of oil released in the *North Cape* spill were both home heating oils. These oils, which are essentially the same as No. 2 fuel oil, are particularly toxic to aquatic organisms under the conditions of release in the *North Cape* incident. Daily beach surveys taken by the Rhode Island Department of Environmental Management (RIDEM) during the two week period following the spill (January 20 to February 2) recorded substantial mortality of lobsters, surf clams and other benthic invertebrates, including starfish, blue mussels, and several species of crabs. Several species of dead fish also washed ashore; skates, grubby, rock gunnel, cunner and tautog were found in the greatest frequency. Because stranded organisms were too numerous to count, RIDEM personnel focused their assessment efforts on lobsters and surf clams. Surveyors systematically sampled the beaches to estimate total lobster strandings. Surf clam strandings also were recorded, but the level of effort involved with this sampling was smaller and less systematic. The results of these sampling efforts are not included in the Preassessment Data Report but are provided in separate injury quantification reports (Gibson *et al*. 1997, Gibson 1997).

### 4.1.2 Bird Impacts

United States Fish and Wildlife Service (USFWS) data indicate that 405 oiled birds were retrieved on Rhode Island and Block Island beaches during the 19 days immediately following the spill. While 114 of these birds were recovered alive, all but 13 died or were euthanized, resulting in a total observed mortality of 392 birds. The types of birds found most frequently include common loons (67), diving ducks (common eiders (59), goldeneyes (32) and red-breasted mergansers (34)), gulls (great black-backed (33) and herring (40)) and grebes (horned (21), red-necked (16) and unidentified grebe (1)). Overall, 41 different species of birds were recovered by spill response personnel. As a consequence of the bird mortality described above, bird productivity was also lost due to the spill.

### 4.1.3 Salt Ponds Exposure

Surface oil was observed in Point Judith, Potter, Cards, Trustom, Green Hill and Ninigret Ponds. Persistent oil sheens were observed during overflights and ground surveys undertaken the first week after the spill in Point Judith, Potter, and Cards Ponds. Trustom Pond was generally covered with ice for several weeks following the spill, but sheens were frequently observed in open water, even after the pond was breached by USFWS personnel on March 5. Sheens also were reported in Ninigret Pond from January 21 to 23. In Point Judith and Potter Ponds, the prevailing winds generally concentrated the surface sheen against the shoreline in a narrow band of silver sheen. In some areas, the sheen was much wider and rainbow in color. In addition to surface sheens, measurement of in-water and sediment oil concentrations indicate oil exposure of the salt pond water column, sediment and marsh substrate. Observers also noted shoreline oiling in Cards and Trustom Ponds.

### 4.1.4 Shoreline Exposure

An initial shoreline survey was conducted by joint Trustee and Responsible Party teams on January 22 and 23. The teams surveyed 75 percent of the 54.7 miles of ocean and salt pond shoreline between Charlestown Beach and Point Judith. Approximately 85 percent of the surveyed shoreline was oiled. The outer beach sediments, extending from inside the Harbor of Refuge eastern breakwater to Charlestown Breachway, were described by response personnel as having an oily smell. Visible oil was observed in portions of the surf zone, and sheens were reported on the water table in three trenches.

### 4.1.5 Ocean Water and Sediment Impacts

Dispersed oil could readily be detected in nearshore waters, based on fifteen bottom water samples collected by University of Rhode Island (URI) scientists on January 21 from depths as great as 21 meters. Within 0.5 miles from shore, total petroleum hydrocarbons (TPH) levels were between 3.3 ppm and 6 ppm; at 1.0 mile from shore, 1.3 to 1.6 ppm; and at 2.0 miles from shore, 0.09 to 5.5 ppm. On January 25, these stations were resampled at both the water surface and 1meter off the bottom. Concentrations ranged from 0.02 to 4.24 ppm of TPH, of which 0.2-54 ppb (0.0002-0.054 ppm) were the polynuclear aromatic hydrocarbons (PAHs), the most toxic components of the spill oil. These observations indicate that the dispersed oil plume was retained near the grounding site for at least six days after the spill, and that it was mixed throughout the water column, reaching the bottom sediments.

Water samples collected January 23-26 in more remote offshore locations did not show significant concentrations of oil. The Connecticut Department of Environmental Protection collected 47 water column samples from Fishers Island Sound, Watch Hill, the Connecticut portion of Block Island Sound and the Race. Samples were collected from the top of the water column, one meter below the surface, and one meter off the bottom. All sample results were below the TPH detection limit of 0.05 ppm indicating that the oil had not entered these waters. These data are described in detail in French (1998a).

Nearshore sediment samples provide additional documentation of bottom oiling. Most of the 17 sediment samples collected on January 21 between 0.5 and 1.0 miles from shore, at locations between Point Judith and the grounding site, show evidence of contamination from *North Cape* oil that had undergone very limited weathering. The four sediment samples collected on January 25 show evidence of further weathering.

### 4.1.6 Human Use Impacts

To alleviate potential seafood quality concerns, RIDEM closed coastal pond and state offshore water fisheries on January 22. The area of closure was expanded to the northeast the following day. By January 26, federal offshore waters were closed officially (61 FR 3602). The offshore fishery reopened for selected types of gear on March 13. Other fish and shellfish restrictions were lifted during the next three weeks, although in some areas the lobster fishery remained closed for five months. In addition to fishery restrictions, recreational fishing impacts occurred in the aftermath of the spill. Based on Technical Working Group analysis, the Trustees believe that the *North Cape* oil spill adversely impacted party and charter boat recreational anglers from January 20, 1996 through June 30, 1996.

## 4.2 ASSESSMENT STRATEGY

The goal of injury assessment under OPA is to determine the nature and extent of injuries to natural resources and services, thus providing a technical basis for evaluating the need for, type of, and scale of restoration actions. The assessment process occurs in two stages: injury determination and injury quantification.

Injury determination begins with the identification and selection of potential injuries to investigate. In a manner consistent with the OPA regulations, the Trustees considered several factors when making this determination, including:

The natural resources and services of concern;

The evidence indicating exposure, pathway and injury;

The mechanism by which injury occurred;

The type, degree, spatial and temporal extent of injury;

The adverse change or impairment that constitutes injury;

Available assessment procedures and their time and cost requirements;

The potential natural recovery period; and

The kinds of restoration actions that are feasible.

A list of the potential injuries investigated for the *North Cape* spill is provided in the first column of Exhibit 4-1. As indicated in the exhibit, the Trustees evaluated possible injuries to 14 categories of ecological and economic resources. These categories were selected based on input from preassessment activities, local, state, and federal government officials, the Responsible Party and academic and other experts knowledgeable about the affected environment.

For each potential injury, the Trustees determine whether an injury has occurred, identify the nature of the injury and a pathway linking the injury to the incident. Injury is defined by the OPA regulations as "an observable or measurable adverse change in a natural resource or impairment of a natural resource service. Injury may occur directly or indirectly to a natural resource and/or service" (15 CFR Section 990.30). The assessment methodologies used for the *North Cape* spill are described in the second column of Exhibit 4-1.

In selecting appropriate assessment procedures, the Trustees consider: (1) the range of procedures available under section 990.27(b) of the OPA regulations; (2) the time and cost necessary to implement the procedures; (3) the potential nature, degree, and spatial and temporal extent of the injury; (4) the potential restoration actions for the injury; and (5) the relevance and adequacy of information generated by the procedures to meet information requirements of

**Exhibit 4-1**

***NORTH CAPE* OIL SPILL: ASSESSMENT METHODS FOR POTENTIAL RESOURCE AND SERVICE INJURIES**

| Potential Injuries Assessed | Injury Assessment Method(s) |
|---|---|
| 1. Lobster Mortality | 1. Estimate lower bound mortality based on lobster beach strandings data.<br>2. Estimate total mortality based on sampling of impact and reference areas.<br>3. Estimate recovery time based on population modeling. |
| 2. Surf Clam Mortality | 1. Estimate lower bound mortality based on strandings analysis.<br>2. Estimate total mortality based on fate and effects modeling.<br>3. Estimate recovery time based on normal survival rates, assuming return to normal recruitment levels from plankton. |
| 3. Loss of Primary Production in the Offshore Water Column | 1. Estimate lost production based on fate and effects modeling.<br>2. Assume complete recovery shortly after toxicity gone (based on historical observations). |
| 4. Mortality of Offshore Benthic Fauna Other than Lobsters and Surf Clams | 1. Estimate mortality based on fate and effects modeling.<br>2. Use available sampling data to show species exposed, abundances, and evidence of injury.<br>3. Estimate recovery time based on normal survival rates, assuming return to normal recruitment levels. |
| 5. Fish Mortality | 1. Estimate mortality based on fate and effects modeling.<br>2. Use available sampling data to show species exposed, abundances, and evidence of injury.<br>3. Estimate recovery time based on normal survival rates, assuming return to normal recruitment levels. |
| 6. Loss of Piping Plover Production | 1. Compare impact area plover productivity with historical and reference area data. |
| 7. Seabird and Wintering Waterfowl Acute Mortality | 1. Estimate minimum mortality based on beach strandings data.<br>2. Estimate total mortality by applying a multiplier to the strandings estimate, to account for dead birds that were not recovered.<br>3. Estimate recovery time using model of expected survival, based on survival rate data from the literature and the best professional judgment of bird experts.<br>4. Estimate lost fledgling production for bird species with recovery times greater than one year. |
| 8. Waterfowl Habitat Degradation | 1. Evaluate the results of salt pond injury assessment for potential impacts to waterfowl habitat and food supply. |
| 9. Mortality of Salt Pond Water Column and Sediment Biota | 1. Assess injury to resources exposed to oil in the water column and sediments based on: a) estimation of acute exposure by comparing time-series water column and sediment sampling data with appropriate toxicity thresholds for different species; b) pre-spill species abundance data; c) population and damage assessment studies conducted for winter flounder and shellfish resources; and d) bioassay data.<br>2. Estimate recovery time from pre-spill mortality rates, assuming return to normal recruitment levels. |
| 10. Loss of Salt Pond Vegetation | 1. Assess vegetative injury based on: a) general visual surveys and detailed pre-/post spill biomass studies at one marsh; and b) an available chemical analysis of marsh substrate to determine sediment toxicity potential. |
| 11. Lost Beach Use | 1. Compare attendance data from impact area beaches with historical and reference area data. |
| 12. Lost Party and Charter Boat Fishing Trips | 1. Develop estimate of lost trips based on interviews with boat captains and owners. |
| 13. Lost Recreational Diving Trips | 1. Assess the likelihood of injury through interviews with divers and dive shop owners. |
| 14. NWR Refuge Visitation Reduction | 1. Compare visitation data since the spill with historical and reference area data. |

restoration planning. Accordingly, depending on the injury category, the Trustees rely on information and methodologies from the relevant scientific literature, literature-based calculations and models and/or field injury determination and quantification studies in assessing injury. Selected methodologies reflect the Trustees' efforts to use cost-effective procedures and methods to document resource injuries.

If the Trustees determine that a resource has been injured, the injury must be quantified. The injury quantification process determines the degree and spatial and temporal extent of injury relative to baseline, and therefore forms the basis for scaling restoration actions. Baseline refers to the condition that the resource would have maintained but for the effects of the oil spill.

## 4.3 SUMMARY OF INJURIES

A summary of injury assessment results is provided in Exhibit 4-2 and described in the following sections.

### 4.3.1 Summary of Methodology

Injury quantification for offshore, salt pond and bird resources begins with estimates of the number of animals killed as a result of the incident, as well as information describing the size and age of these animals. As appropriate, the Trustees also consider the number of young that these individuals would have produced. Finally, possible sublethal injuries also are considered if the Trustees determined that evaluation of these injuries would be appropriate under the criteria provided in the OPA regulations (15 CFR Part 990).

Once the magnitude of injury is established, Trustees estimate the recovery time required for the resource to return to baseline condition. In general, species that are limited by food or habitat availability and/or enjoy rapid reproduction cycles may recover relatively quickly if the loss of some animals eases food or habitat constraints and/or new animals are reproduced quickly. On the other hand, species with slower reproductive cycles or environmental constraints not eased by the loss of some animals may recover more slowly. The actual biological processes that determine recovery from an oil spill are more complex than these simple examples suggest, and the knowledge and data to estimate recovery times precisely are difficult and costly to obtain.

The Trustees have reviewed available information presented to them about population dynamics for the injured species and relied on straightforward calculations and best professional judgment to determine the estimated recovery time for each injured resource. For many injured species, the Trustees make the simplifying assumption that the recovery period is equal to the additional amount of time these biota would have lived in the absence of the spill. This period is estimated using information on lifespans and mortality rates obtained from scientific experts and the literature.

**Exhibit 4-2**

***NORTH CAPE* OIL SPILL: SUMMARY OF INJURIES**

**OFFSHORE**

| Injured Resource/Service | Injury Quantification | | | | Recovery Time |
|---|---|---|---|---|---|
| | Number Killed | Biomass Killed (kg) | Production Foregone (kg) | Total Injury[1] (kg) | |
| Lobsters | 9,039,200 | 312,400 | --[2] | --[2] | 4-5 years |
| Surf Clams | 19,402,300 | 547,600 | 422,800 | 970,400 | 3-5 years |
| Other Marine Benthic Organisms: | | | | | |
| Worms/Amphipods | 4,890,219,000 | 489,000 | 310,000 | 800,000 | 5 months |
| Crabs (Rock, Hermit) | 7,619,500 | 45,500 | 51,700 | 97,200 | 1-3 years |
| Mussels | 20,246,800 | 880 | 1,200 | 2,100 | 1 year |
| Fish | 4,200,000 | 30,000 | 81,000 | 111,000 | 1-2 years |

**SALT PONDS**

| Injured Resource/Service | Injury Quantification | | | | Recovery Time |
|---|---|---|---|---|---|
| | Number Killed | Biomass Killed (kg) | Production Foregone (kg) | Total Injury (kg) | |
| Worms/Amphipods | 6,591,836,000 | 66,000 | 98,000 | 164,000 | 5 months |
| Crabs and Shrimp | 642,000 | 3,300 | 3,800 | 7,100 | 1-2 years |
| Softshell Clams and Oysters | 648,500 | 7,600 | 4,800 | 12,400 | 1-2 years |
| Forage Fish | 533,400 | 2,700 | 2,400 | 5,000 | 1-2 years |
| Winter Flounder | 1,600 | 1,400 | 1,100 | 2,500 | 1 year |

**BIRDS**

| Injured Resource/Service | Injury Quantification | Recovery Time |
|---|---|---|
| Piping Plovers | Lost production of 5-10 fledged chicks | Federally-listed threatened species: population not currently self-sustaining |
| Seabirds and Wintering Waterfowl: | | |
| Common Loons | 402 loons killed: 3,641 loon-years | 6 years |
| Grebes | 228 grebes killed: 705 grebe years | 2 years |
| Other (primarily sea ducks) | 1,452 birds killed: 2,549 bird-years | Between 1 and 3 years, depending on species |
| Pond Birds | 198 birds killed: 476 kg biomass lost[2] | 1 year |

**HUMAN USE**

| Injured Resource/Service | Injury Quantification | Recovery Time |
|---|---|---|
| Party and Charter Boat Fishing | 3,305 trips lost, with a value of $281,685 | Approximately 6 months |

[1] Total injury may not equal the sum of biomass killed plus production foregone due to rounding.

[2] Production foregone is not calculated for lobsters and bird-years lost are not calculated for pond birds because restoration scaling for these resources are based on different methods. This is explained further in Chapter 5.

As described in later sections of this document, this assumption reflects the finding that in many cases the spill did not have an effect on the production of young in the year following the spill, nor are reproductive impacts expected in the future. Thus, for these species, the loss is generally limited to the individuals that died as a result of the spill. By estimating the amount of time these individuals would have lived, the Trustees are able to assess the duration of the loss caused by the spill.

Overall, both the magnitude of the injury and the recovery time must be considered in the injury quantification process. This is accomplished for some resources, such as birds, by multiplying the number of lost animals by the recovery period to generate a number denominated in units such as bird-years. For other resources, such as benthic fauna, it is more appropriate to express the injury in terms of weight of biomass lost, in kilograms or similar units. To compensate for the loss of services before a resource is fully restored, the Trustees calculate the "production foregone" for animals killed by the spill during each year of the recovery period. In concept, production foregone includes the growth in biomass that would have occurred in the absence of the spill, assuming normal mortality rates and lifespans, as well as lost production of young, as appropriate. The importance of each of these components of production foregone will vary by species, and will reflect several factors, including the age of the organisms killed, mortality rates, reproduction rates and timing, population size and species position in the ecological community. For most injured offshore and salt pond species, production foregone calculations include lost biomass growth. Reproductive losses for these species (except lobster) are expected to be insignificant given the magnitude of injury relative to local population size. For most injured bird species, "production foregone" includes reproductive losses when recovery periods exceed one year (i.e., for loons and grebes). Reproductive losses associated with shorter term injuries are expected to be insignificant. For most bird species, the loss in biomass growth due to the spill is also expected to be insignificant.

All of these methods produce an estimate of direct plus interim loss of resources resulting from the injury. Injury estimates in later years are discounted at three percent per year, summed, and added to the injury in the year of the spill to generate an estimate of total injury.[1] Also, since restoration of the resource will not occur until some time in the future, the total injury estimate is increased by three percent for each year between the injury and the date of expected restoration. The calculations for each resource are described in more detail later in this section and in Chapter 5.

Injury quantification for lost human uses is measured in units appropriate to the activity. As indicated in Exhibit 4-2, party and charter boat fishing losses are quantified in terms of lost trips. The Trustees also have quantified the value of this injury in dollars. This estimate is a measure of the value lost by recreational anglers who were either unable to fish because of the spill, spent additional money traveling to alternative sites and/or experienced a reduction in trip quality.

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[1] The annual discount rate of three percent approximates the additional amount of a good or service required by society as compensation for delaying consumption of the good or service by an additional year (15 CFR Part 990.53).

### 4.3.2 Summary of Results

Exhibit 4-2 summarizes the injuries from the *North Cape* spill. Losses are presented as numbers of organisms killed and total biomass lost (direct kill and production foregone). Losses were largest in the offshore environment. Approximately 19.4 million surf clams (970,000 kilograms) and 9.0 million lobsters (direct kill only, totaling 312,000 kilograms) were lost as a result of the spill (French 1998b and c, Cobb and Clancy 1998).[2] Large numbers (4.9 billion) of worms/amphipods died from spill effects, although their relatively small size (0.01 gram each) resulted in a biomass loss of 800,000 kilograms (French 1998b). Losses of rock and hermit crabs totaled 7.6 million animals, with a biomass of 97,000 kilograms (French 1998b, 1999b). Fish losses, primarily skates, cunner and Atlantic sea herring, totaled 4.2 million animals (111,000 kilograms) (French 1998b).

In the salt ponds, injury to worms/amphipods via contaminated sediment pore water totaled approximately 6.6 billion organisms, with an associated biomass loss of 164,000 kilograms (French and Rines 1998). In addition, approximately 7,100 kilograms of crabs and shrimp, 12,400 kilograms of soft-shell clams and oysters, and 5,000 kilograms of forage fish also were lost due to the spill (French and Rines 1998).

Expert analysis indicates that 1996 productivity of the piping plover, a federally-listed threatened species, was reduced by approximately five to ten fledged chicks. Mortality to birds is estimated at 2,292 birds (Sperduto *et al*. 1999). Losses of common loons, eiders, and grebes were largest, totaling 402, 354, and 228 birds, respectively, and responsible for 5,199 of the 7,105 bird-years lost (Sperduto *et al*. 1999).

Approximate estimates of recovery time for these injuries are also provided in Exhibit 4-2. For marine and salt pond fish and invertebrates, recovery time is assumed to be equal to the additional time injured biota would have lived in the absence of the spill. The expected number of years an animal would have lived depends on its age at the time of the spill, typical life-span, and survival rates. The estimated recovery time in Exhibit 4-2 encompasses the life-span of the majority of animals killed. In the offshore environment, recovery of surf clams is expected to take approximately three to five years, similar in duration to lobster recovery (4 to 5 years). Fish, crabs, and starfish will likely recover within one to three years. Amphipods and worms in the offshore and coastal environment likely recovered within five months. In the salt ponds, recovery of other injured species is expected within two years of the spill. For seabirds and wintering waterfowl, recovery time varies for different species, ranging from approximately one to six years. Because piping plovers are a federally-listed threatened species, the injury to fledged chicks will delay management efforts to restore this population to self-sustaining levels.

As indicated in the exhibit, boat-based recreational fishing was the only human use activity for which the Trustee assessment was able to estimate a loss that could be measured and documented. Trustee analysis indicates that 3,305 trips were lost (Curry and Meade 1997). Fishing activity returned to baseline levels within approximately six months after the spill.

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[2] Production foregone is not calculated for lobsters because restoration scaling for this resource is based on a different method. This is explained further in Chapter 5.

## 4.4 INJURIES TO SPECIFIC RESOURCES

The following sections of this chapter describe the results of injury determination and quantification efforts for the *North Cape* spill. Potential injuries are organized into four categories: offshore; salt ponds; birds; and human uses.

### 4.4.1 Offshore Communities: Overview of Data and Strategy

#### 4.4.1.1 Determination of Injury

Clear evidence of injury to offshore communities is provided by beach strandings data. Rhode Island Division of Fish and Wildlife (DFW) staff identified 26 species of fish and large invertebrates (e.g., lobsters, crabs, and clams) that washed up dead on shore between Charlestown Breachway and Point Judith during the days immediately following the spill (Gibson 1997). A list of these species is provided in Exhibit 4-3 below, ranked in approximate order of beach strandings abundance. Due to the enormous volume of fish and invertebrates stranded on the beach, investigators could count only the more abundant higher level organisms.

**Exhibit 4-3**

**OFFSHORE ORGANISMS IDENTIFIED IN POST-SPILL BEACH STRANDINGS RANKED BY ABUNDANCE[1] (GIBSON 1997)**

| | | | |
|---|---|---|---|
| 1. American Lobster | 8. Spider Crabs | 15. Atlantic Razor Clam | 22. Striped Killifish |
| 2. Atlantic Surf Clam | 9. Hermit Crabs | 16. Cunner | 23. Atlantic Herring |
| 3. Green Crabs | 10. Grubby | 17. Blue Crabs | 24. Windowpane Flounder |
| 4. Starfish | 11. Mud Crabs | 18. Little Skate | 25. Atlantic Silverside |
| 5. Lady Crabs | 12. Rock Gunnel | 19. Tautog | 26. Sea Cucumber |
| 6. Blue Mussel | 13. Sea Urchins | 20. Longhorn Sculpin | |
| 7. Rock Crabs | 14. Northern Moonsnail | 21. Winter Flounder | |

[1] Species are listed in decreasing order of abundance (i.e., most frequent first, least frequent last) based on data provided by RIDEM (Gibson 1997).

Several sources of data trace the path of spilled oil through the offshore environment. Relevant data applicable to all offshore communities include:

> Overflight maps from January 20 to 25, 1996 document the presence and location of oil sheens, streamers and patches over several square miles of ocean surface (RPI 1996a).
>
> Concentrations of total petroleum hydrocarbons (TPH) and component polynuclear aromatic hydrocarbons (PAH) were measured in the water column from January 21 to 28, 1996. The aromatic composition shows that significant portions of the aromatic hydrocarbons were contamination from the *North Cape* spill rather than pyrogenic (fuel burning, i.e., from boat engines) sources. Concentrations recorded in samples were above standard reference toxicity thresholds (RPI 1996a and b).

> Concentrations of TPH and component aromatics were measured in bottom sediments on selected dates from January 21 to March 21, 1996. The aromatic composition shows that significant portions of the aromatic hydrocarbons contamination were from the *North Cape* spill rather than pyrogenic (fuel burning) sources (RPI 1996a and b).

#### 4.4.1.2 Injury Quantification Strategy

The Trustees relied on a combination of methods to quantify injury to offshore community natural resources. For lobsters, the Trustees used field data collected from impact and reference areas to quantify losses due to the spill. For other offshore resources, the Trustees used a combination of field data and modeling.[3] Where available, field data were used to document the abundance of biota in impact and reference areas and concentrations of TPH and PAH in sediment, water and biota. These data are combined with information about oil fate and toxicity, and species abundances, to estimate the magnitude of injury through the use of a fates and effects model. Based on analysis of information collected during the Preassessment Phase, the Trustees determined that comprehensive field sampling of offshore species other than lobster (e.g., benthic, planktonic and fish communities) was not feasible given the difficulty of implementing a program of the required size.

The fates and effects model used by the Trustees (SIMAP) is based on the Natural Resource Damage Assessment Model for Coastal and Marine Environments (NRDAM/CME, Version 2.4, April 1996), which is included in the Code of Federal Regulations (43 CFR Part II) for performing natural resource damage assessments for spills under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, 42 USC 9601 *et seq*.). The model is described briefly below and in more detail in the associated report by French (1998a).

SIMAP estimates the distribution of spilled oil (as mass and concentrations) on the water surface, on shorelines, in the water column and in the sediments. The model is three-dimensional, using a latitude-longitude grid to map environmental data. Algorithms based on state-of-the-art published research account for spreading, evaporation, transport, dispersion, emulsification, entrainment, dissolution, volatilization, partitioning, sedimentation and degradation of the oil. Acute mortality of water column and benthic resources is estimated as a function of temperature, concentration of dissolved aromatics and the length of exposure. Acute mortality of other wildlife is estimated as a function of area swept by oil, dosage and vulnerability. Chronic effects of long-term exposure to sediment concentration of oil or via ingestion are not considered by this model.

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[3] The model also estimates lobster injury. Because substantial lobster field data were collected for this case, the Trustees relied on these data for the quantification of lobster loss.

SIMAP, as opposed to the NRDAM/CME, is designed to use site- and incident-specific data if such data are available. In this instance, extensive site- and incident-specific data either were available or had been collected during the spill as part of response activities. Thus, the Trustees chose to use SIMAP, rather than the NRDAM/CME with its default databases, to estimate injuries resulting from this spill. The types of data used include: fine resolution (300 meter grid) shoreline, habitat types and water depths; water temperature and salinity; wind data measured hourly during January and February 1996 near Ninigret Pond; tidal current data based on current atlases for Block Island Sound; biological abundances based on observations near the spill site (i.e., at references sites outside the area of impact) in 1996, or on historical data where 1996 data were not available; and oil characteristics taken from current databases on home heating (No. 2) fuel and from measurements of samples taken from *North Cape* cargo. In addition, because SIMAP originally modeled oil spills as occurring on the water surface and did not account for large entrainment by high waves in the surf zone, a surf entrainment algorithm was added to more closely simulate the conditions for this spill.

Over the course of the *North Cape* damage assessment, the Trustees concluded that two types of home heating oil were spilled, with different PAH concentrations. Based on several laboratory analyses and discussions with parties involved with barge loading operations, spill response, and salvage operations, the Trustees determined that the weighted average PAH concentration of spilled oil was 4.5 percent (Morin and Donlan 1998). This average PAH content was used in the fates and effect model.

The results and output of the fates portion of the model are validated by comparison with overflight maps made during the response to the spill and with the measured concentrations of TPH and PAH in samples taken during the week following the spill. A complete description of the modeling is available in French (1998a).

### 4.4.2 Offshore Communities: Individual Resource Injuries

#### 4.4.2.1 Lobsters

1. **Determination of Injury**

Several sources of data, in addition to those described for the offshore community in general, confirm the exposure of lobsters to the spilled oil:

> Trap sampling and diver surveys showed lobsters were present in the waters where oil concentrations were measurable, and were exposed to oil by these pathways.
>
> Existing juvenile lobster habitat was mapped in the areas affected by significant water concentrations of *North Cape* oil. Divers observed juvenile lobsters in these habitats.

> In the fishery closure monitoring program, chemical measurements and visual assessment were performed on lobster samples collected from the fishery closure area. Contamination of lobsters was documented both for areas where oil was observed following the spill and for areas outside of the observable sheen.

Evidence of lobster injury is summarized below. This evidence is for direct injury caused by exposure to aromatic concentrations in the water and sediments. Evidence of indirect injury (e.g., caused by reduced food resources) is treated in other injury categories (e.g., mortality of marine benthic fauna other than lobsters).

> Strandings: Daily surveys of dead and moribund lobsters stranded on beaches were made, recording numbers per unit area, size and sex for 18,000 of the estimated 2.9 million stranded lobsters collected. Collections were conducted on beaches from Point Judith to Charlestown Beach between January 21 and February 2, 1996. Very few lobsters were found during daily surveys at reference beaches outside the affected areas. These data indicate that in the absence of oil exposure, the storm itself was not sufficient to cause the observed strandings (Gibson *et al*. 1997).
>
> Depleted abundances: Diver surveys showed that abundances of juvenile lobsters in impacted cobble and boulder habitats were significantly lower than in nearby reference sites (Cobb and Clancy 1998).
>
> Approximately one-half the lobsters found in traps by URI researchers in the spill-impacted area during January and February 1996 were lethargic, moribund or dead (French 1999a).

Additional information was collected to assess injury to lobster recruitment. These results, outlined below, suggest that this particular impact was limited.

> Egg counts on berried (egg-bearing) female lobsters collected in the winter of 1996 showed no significant differences associated with exposure to oil.
>
> Planktonic postlarval counts over 10 weeks in the summer of 1996 showed that 1996 abundances were at the low end of the previously-observed range in Rhode Island coastal waters. From observations made in Connecticut and Maine, 1996 appears to have been a low recruitment year all over New England.

### 2. Quantification of Injury

The Trustees and the RP collected data to estimate total lobster losses and the expected time of natural recovery. The studies were designed to evaluate and quantify lobster losses resulting from the acute toxicological effects (immediate mortality) of the spill, delayed mortality and factors affecting the natural recovery of the local lobster population, including migration, larval abundance and egg production.

The lobsters stranded on the beaches in the spill impact area provide a lower bound estimate of lobster mortality caused by the spill, as it is likely that substantial numbers of lobsters killed by the spill did not wash up on the beaches where counts were made. To estimate the total number of stranded lobsters, transects were set up by RIDEM on beaches from Point Judith to Charlestown Beach. Sample quadrats along those transects were counted daily, classifying lobsters by sex and size. The areas sampled were swept so that lobsters coming ashore on subsequent days could be identified. The statistical analysis of the data provided an estimate of cumulative (summing daily counts up to February 2 when new strandings had tapered off to negligible levels) abundance of lobsters on the beach in the affected area. Corrections were made for sampling biases, including lack of observations on the smallest (young-of-the-year) lobsters. Details are provided in Gibson *et al*. (1997).

Based on this analysis, the Trustees estimate that 2.92 million of the lobsters killed by the spill washed up on the beach (Gibson *et al*. 1997). The majority of these lobsters (by number) were less than 40 millimeters in carapace length, although about 6,000 legal lobsters (greater than 82.6 millimeters or 3.25 inches carapace length) were included in the strandings. Again, this number is a lower bound estimate of mortality, as it is extremely unlikely that all lobsters killed by the spill washed ashore.

In order to estimate total lobster mortality, diver surveys of lobster abundances were performed directly in their habitat (Cobb *et al*. 1998). The sampling stations were classified as impact (nearest the site of the spill), control (clearly unaffected by oil), and transitional (between control and impact areas) based on reported records of beach strandings of lobsters and results of model simulations of the trajectory of the oil in the sediments. Specifically, impact sites are located between 71° 36.00' and the west wall of the Harbor Refuge and offshore. Sampling stations just east of the Charlestown Breachway and the east end of Green Hill Beach (between 71° 39.15' and 71° 36.00') are classified as transitional sites. Sampling sites west of the Charlestown Breachway and to the east of Point Judith are located in areas where no oil was observed (Cobb and Clancy 1998).

By comparing lobster densities in impact and reference areas, the Trustees and the Responsible Party developed estimates of acute mortality that include both immediate and delayed impacts. Based on habitat maps developed in the fall of 1996 using side-scan sonar, the Trustees and the Responsible Party determined that roughly 12 square kilometers of the nearshore benthic habitat along the Rhode Island south coast in the affected area are suitable for lobsters (Golder Associates, Inc. 1996). During the spring, summer and fall of 1996, diver surveys were made at 21 stations in spill impact and reference lobster habitat (Cobb and Clancy 1998, Cobb *et al.*

1998). Historical survey data were available from 1991 to 1995 at six sites, three of which were included in the reference sites sampled in 1996. The diver surveys were of two types: airlift samples, used to count the smallest lobsters (less than 60 millimeters carapace length); and visual counts, used for larger (greater than 20 millimeters carapace length) lobsters. Abundance by size class was derived from these data for each sample station. Abundances were interpolated to all affected habitat areas, and estimates were made of total lobsters missing from the affected area.

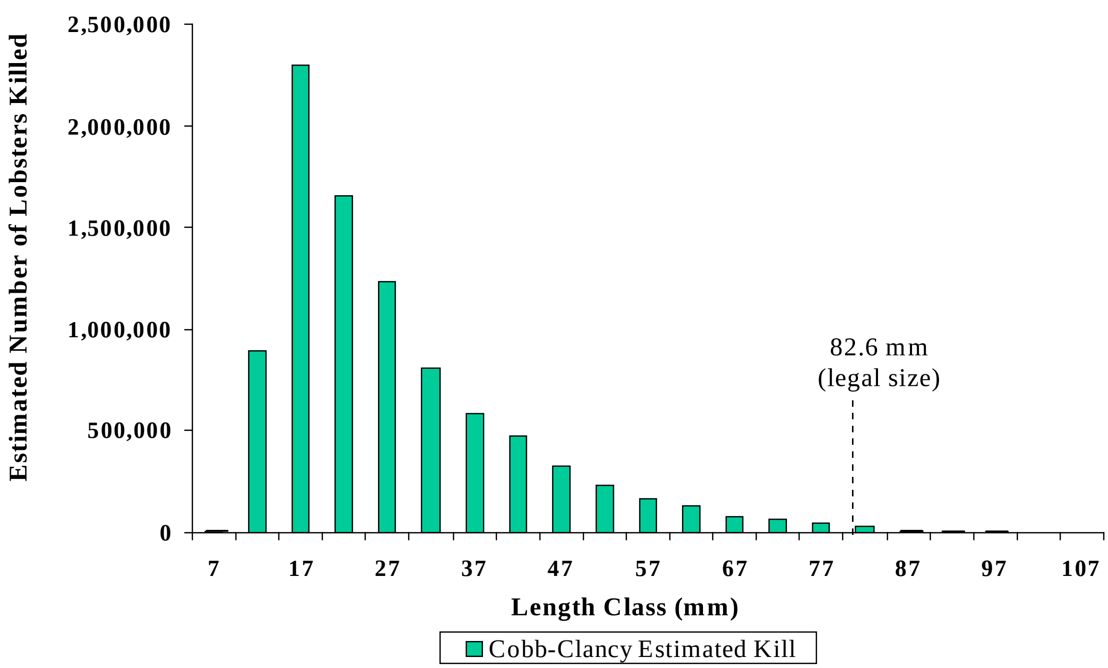
Based on these data, the Trustees estimate that approximately 9.0 million lobsters were killed by the spill. Exhibit 4-4 presents the estimated size distribution of the killed lobsters. Roughly 82 percent of the lobsters were in their first or second year of life. Legal lobsters, which are five or more years old, accounted for about 15,300 of the killed lobsters (French 1999a).

### 3. Recovery Time

Available information indicates that the affected lobster population will naturally return to baseline levels within four to five years after the spill. Analysis of the lobster recovery rate is contained in the reports by Gibson (1997) and French (1998c, 1999a). In general, this estimate reflects the fact that juvenile lobsters grow to legal size within four to five years. After lobsters reach this size, most are quickly caught by lobstermen.

**Exhibit 4-4**

**SIZE DISTRIBUTION OF LOBSTERS LOST IN THE NORTH CAPE SPILL**



#### 4.4.2.2 Surf Clams

**1. <u>Determination of Injury</u>**

The following sources of data, in addition to those described for the offshore community in general, confirm the exposure of surf clams to the spilled oil:

> From benthic surveys, surf clams are known to inhabit nearshore sediments of Block Island Sound in areas affected by oil.

Evidence of exposure causing injury to surf clams is summarized below. Available evidence is for direct injury, caused by exposure to aromatic concentrations in the water and sediments.

> Strandings: Daily surveys of dead and moribund surf clams stranded on beaches were made, recording numbers per unit area and shell size. Trustees estimate that at least 330,491 dead surf clams were stranded on beaches from Point Judith to Charlestown Beach in the first week after the spill. Surveys of strandings at control beaches within the area affected by the storm but outside the area affected by the oil spill observed significantly fewer surf clams (0.04 clams/square meter as opposed to 3.65 clams/square meter in the affected area), demonstrating that the storm alone was not sufficient to cause the observed mortality to surf clams. Control beach data were used to correct the estimated kill of clams for storm-induced strandings (Gibson 1997).

**2. <u>Quantification of Injury</u>**

The strandings surveys documented a small fraction of the total surf clam mortality and were not designed to quantify total injury to surf clams within the assessment area. Because of resource limitations, sampling of stranded clams was only performed for a few days following the spill. In addition, sampling was difficult because dead clams appeared in various forms, including whole closed clams, whole opened clams, empty paired shells and meats without shells. Dead clams counted were not removed from the beaches, so some of them may have been recounted on subsequent days. The strandings data do provide information about the size structure of the larger affected clams. The majority of the clams washed ashore and counted were 4 to 5 years old (75 to 95 millimeter shell width), but substantial numbers of smaller and larger clams were killed as well.

At approximately 18 months and 2 years after the spill, the RP conducted sampling in impact and reference areas to gather additional information about surf clam densities and size structure (Beak Consultants 1997, DeAlteris 1998). These data show exceptional recruitment of young-of-the-year surf clams in 1996 and 1997 in the area impacted by the spill, as compared to non-impacted sites further west from the grounding site. However, the sampling was insufficient to quantify the abundance of older surf clams or to determine the areal extent of the impact, and does not account for fishing mortality that may have taken place during the period between the spill and sampling. Thus, data from the non-impacted sites, as well as abundance data from previous studies in the literature were used to estimate pre-spill abundance of surf clams. Areal extent of injury was estimated by modeling.

The SIMAP computer model that was used by the Trustees was used to quantify the surf clam injury. Surf clam exposure modeling accounted for all surf clams injured in the spill, not just those clams that washed up on shore. The modeling was based on exposure to dissolved aromatic compounds in water at the bottom. Effects considered were acute toxicity as a result of this exposure. Chronic effects of long-term exposure to sediment concentrations of oil or via ingestion were not assessed in this analysis (French 1998a).

Based on the model results, the Trustees estimate that a total of 19.4 million surf clams of all sizes were killed by the spill, with a combined weight of 550,000 kilograms. Production foregone for all surf clams killed by the spill amounted to 420,000 kilograms, for a total injury of 970,000 kilograms. Approximately 65 percent of this total injury (630,000 kilograms, including production foregone) were young-of-the-year surf clams (YOY).

**3. <u>Recovery Time</u>**

The Trustees estimate that the injured surf clam population will return to baseline levels through natural recovery within 3 to 5 years after the spill. This period of time encompasses the expected lifespan of the surf clams killed by the spill. Thus, based on information currently available to the Trustees, there is no indication that surf clam larval abundance (and therefore future generations of surf clams) will be affected significantly in future years. In the absence of the spill, these surf clams would have lived up to three to five additional years.

This estimate of recovery time is intended to provide a general approximation of the duration of the injury to surf clam populations. As discussed in Chapter 5, restoration scaling is based on more detailed calculations.

### 4.4.2.3 Other Marine Benthic Organisms

**1. <u>Determination of Injury</u>**

The following sources of data, in addition to those described for the offshore community in general, confirm the exposure of marine benthic organisms (other than lobsters and surf clams) to the spilled oil:

> Trawls by the *R/V Albatross* and *R/V Cap't Bert* in January 1996 showed several benthic species in the area contaminated by oil (RPI 1996a).

> In the fishery closure monitoring program, chemical measurements were performed on samples from the closed area. Contamination of ocean quahogs and blue mussels was documented for the area where oil was observed after the spill.

Evidence of exposure causing injury to benthic organisms (other than lobsters and surf clams) is summarized below. Available evidence is for direct injury, caused by exposure to aromatic concentrations in the water and sediments.

> Strandings surveys: As previously described, daily surveys of dead and moribund shellfish and other large benthic species stranded on beaches were made. Numerous benthic organisms were observed and recorded. In surveys at reference beaches outside the affected area, far fewer benthic organisms were observed, demonstrating that the storm alone would not have caused the strandings (Gibson 1997).
>
> Observations of smaller benthic species stranded on the beaches from Point Judith to Ninigret Pond also were made. The species killed by the spill were primarily those which inhabit nearshore (shallow-water) hard-bottom habitats, in this case amphipod crustaceans, as opposed to those typical of deeper muddy sediments of Block Island Sound (Pratt 1996a). The absence of the common amphipod *Amphiporeia virginiana* in beach surveys also may be indicative of oil exposure effects (SAIC 1996).
>
> Bioassays of sediment samples off Moonstone Beach showed evidence of toxicity to benthic invertebrates (RPI 1996a).
>
> Depleted abundances: Diver surveys of large benthic species abundances were made in September 1996 to determine whether these species were significantly lower in abundance nine months after the spill in the affected area as compared to reference sites nearby. Evidence of lower abundances would indicate that recovery from the impact was not complete at that time. While abundances were not statistically different at oiled versus control sites, the size distribution of rock crabs at the impact sites showed smaller individuals, indicating recent recruitment, consistent with recolonization after oil-induced mortality (Witman 1997).

### 2. Quantification of Injury

The SIMAP computer model was used to estimate injury to benthic organisms. The physical fates model quantified exposure to these organisms. The model assumed contact with dissolved aromatic compounds in bottom water to be the main pathway of exposure of benthic epifauna (animals on the sediment surface). The main exposure pathway of benthic infauna was contact with dissolved aromatics in sediment pore water. The model evaluated the effects of exposure on acute toxicity. Chronic effects of long-term exposure to sediment concentrations of oil or via ingestion were not considered because they were not expected to be significant (French 1998a).

A summary of model results is provided in Exhibit 4-5. These estimates indicate that approximately 4.9 billion worms/amphipods were killed by the spill, totaling approximately 800,000 kilograms of lost biomass (including direct kill and production foregone). Approximately 3.9 million rock crabs also were killed, with an associated loss in biomass of 91,000 kilograms. Fish injuries (primarily cunner and skates), totaled 4.2 million animals. However, most of these individuals were small, such that the total injury amounted to 111,000 kilograms.

**Exhibit 4-5**

**ESTIMATES OF OFFSHORE INVERTEBRATE KILL AND FISH (All Age Classes Summed)**

| Species Category | Numbers Killed | Biomass Killed (kg) | Production Foregone (kg) | Total Injury (kg) |
|---|---|---|---|---|
| Total fish | 4,193,167 | 30,067 | 80,509 | 110,576 |
| Herrings, river | 10 | 3 | 3 | 6 |
| Herring, sea (Atlantic) | 391,796 | 3,044 | 4,193 | 7,237 |
| Hakes (red, white) | 1,705 | 125 | 824 | 949 |
| Cod | 35,970 | 350 | 1,253 | 1,604 |
| Dogfish | 460 | 1 | 194 | 195 |
| Haddock | 5 | 4 | 3 | 7 |
| Pollock | 236 | 2 | 3 | 4 |
| Searobins, sea raven | 12,156 | 94 | 130 | 225 |
| Whiting (silver hake) | 4,957 | 39 | 53 | 92 |
| Eels, eelpouts | 45,229 | 351 | 484 | 835 |
| Flounders | 554 | 480 | 398 | 879 |
| Sculpin | 28,627 | 222 | 306 | 529 |
| Skates | 1,947,847 | 15,133 | 20,845 | 35,978 |
| Tautog | 16,493 | 459 | 544 | 1,004 |
| Cunner | 1,739,494 | 9,758 | 51,274 | 61,033 |
| Crabs, rock (Cancer spp.) | 3,887,756 | 41,734 | 49,275 | 91,008 |
| Crabs, hermit | 3,731,715 | 3,732 | 2,426 | 6,157 |
| Quahog (Mercenaria spp.) | 37,454 | 7 | 798 | 805 |
| Clams, surf | 19,402,290 | 547,579 | 422,776 | 970,355 |
| Mussels | 20,246,750 | 879 | 1,203 | 2,082 |
| Benthic macrofauna | 4,890,219,000 | 489,022 | 310,480 | 799,502 |

### 3. <u>Recovery</u>

The Trustees estimate that affected worm/amphipod populations returned to baseline levels through natural recovery within five months after the spill. This estimate reflects their short lifespan and the Trustee expectation that a new generation of these organisms was produced in that time frame (S. Pratt, pers. comm. 1997).

Injured rock crab populations are expected to return to baseline levels through natural recovery within 2 to 3 years after the spill. This period of time encompasses the expected lifetime of the rock crabs killed by the spill. Thus, in the absence of the spill, these rock crabs would have lived up to two to three additional years. Based on information currently available to the Trustees, there is no indication that rock crab reproduction (and therefore future generations of rock crabs) will be affected significantly.

Injured hermit crab, starfish, quahog, and mussel populations are expected to recover through natural recovery within one year, reflecting the fact that the injuries are small relative to total populations of these organisms in the assessment and near-by unaffected areas.

These estimates of recovery time are intended to provide a general approximation of the duration of the injury to these species. As discussed in Chapter 5, restoration scaling is based on more detailed calculations.

#### 4.4.2.4 Offshore Water Column (Plankton)

1. **<u>Determination of Injury</u>**

The following data, in addition to that described for the offshore community in general, confirm the exposure of water column organisms (phytoplankton and zooplankton, including fish and shellfish eggs and larvae) to the spilled oil:

> Plankton tows by the National Marine Fisheries Service on the *RV Albatross* in January 1996 showed that larval stages of several fish and invertebrate species, as well as zooplankton common to Block Island Sound, were present in the area contaminated by oil (RPI 1996a).

2. **<u>Quantification of Injury</u>**

The SIMAP computer model was used to estimate injury to water column organisms. The physical fates model quantified exposure to these organisms. The model assumed contact with dissolved aromatic compounds in water at the depths these organisms inhabit to be the pathway of exposure of water column organisms. The model evaluated acute toxicity resulting from exposure to spilled oil. Chronic effects of long-term exposure to resuspended sediment concentrations of oil or via ingestion were not considered (French 1998a).

Injuries to planktonic fish eggs and larvae are included in the total fish injury, described below. Injuries to benthic invertebrate larvae in the plankton were insignificant because very few larvae are present in the plankton in the winter season. Injuries to phytoplankton and zooplankton were estimated, but are insignificant relative to total production of Block Island Sound in winter.

**3. Recovery Time**

As described above, injury to the offshore water column was minimal. Natural recovery of phytoplankton and zooplankton was estimated to be complete by the spring of 1996.

### 4.4.2.5 Fish

**1. Determination of Injury**

The following data, in addition to that described for the offshore community in general, confirm the exposure of fish to the spilled oil:

> Trawls by the *RV Albatross* and by the *RV Cap't Bert* in January 1996 showed several fish species in the area contaminated by oil (RPI 1996a).

Evidence of exposure causing injury to fish is summarized below. Available evidence is for direct injury, caused by exposure to aromatic concentrations in the water and sediments.

> Strandings: As previously described, dead and moribund fish of several species were observed stranded on beaches during daily surveys (Gibson 1997).

**2. Quantification of Injury**

The SIMAP model was used to estimate injury to fish. The pathway of exposure to fish was quantified in the physical fates model, and was assumed to be through contact with dissolved aromatic concentrations in water at the depth the species inhabits (either in the water column or on the bottom). Movements of fish in and through the affected area were accounted for according to species' behavior. Effects considered were acute toxicity from exposure. Chronic effects of long-term exposure to sediment concentrations of oil or via the ingestion pathway were not assessed in this analysis because these impacts were not expected to be significant relative to the acute toxicity (French 1998a).

Fish injuries estimated by the model are summarized in Exhibit 4-5. The largest fish injury (including direct kill and production foregone) was for cunner (61,000 kilograms), followed by skates (36,000 kilograms), and Atlantic herring (7,200 kilograms). Total fish injury was approximately 110,600 kilograms (French 1998b).

### 3. Recovery Time

The Trustees estimate that affected fish populations will return to baseline levels through natural recovery within 1 to 2 years after the spill. This estimate reflects the fact that the injury is small relative to the total fish population in the spill-impacted area, and is intended to provide a general approximation of the duration of fish injury. As discussed in Chapter 5, restoration scaling is based on more detailed calculations.

## 4.4.3 Salt Pond Communities: Overview of Data and Strategy

Rhode Island's coastal salt ponds are a critical part of the South Shore Coastal ecosystem, serving as essential spawning, nursery and growth areas for coastal fish and shellfish (Baczenski *et al*. 1979, Crawford and Carey 1985, Ganz *et al*. 1992). Like most estuaries, the ponds also are important links between terrestrial and marine environments, converting terrestrial nutrients into marine biological production; in the shallow, well-lit waters of the salt ponds, benthic activity is an important component of this process (Nixon 1982, Nowicki and Nixon 1985).

The ponds' ability to sustain this contribution to the South Shore coastal ecosystem has been reduced over time, and is further threatened by a number of human impacts. Fishing has eroded once-abundant harvests of fish and shellfish in the ponds, as has habitat destruction caused by such activities as breachway management, dredge and fill operations, and damming of brooks and rivers (Crawford 1984, Lee *et al*. 1985, Nixon 1982, Olsen and Lee 1993). Habitats also have been lost or degraded as a result of human impacts on water quality. In particular, increased nutrient loadings to the ponds from residential development have caused eutrophication, leading to declines in eelgrass, increased sediment anoxia, and other detrimental effects to fish and wildlife habitats (Lee *et al.* 1985, Short *et al*. 1996).

Because of the salt ponds' importance to the regional ecosystem and potential susceptibility to human impacts, the Trustees and RP completed more than a dozen studies designed to evaluate the effects of the *North Cape* oil spill on the salt pond environment. The results of these studies are described in the following sections of this chapter.

### 4.4.3.1 Determination of Injury

Oil from the *North Cape* entered the salt ponds as surface slicks and exchange with oil-contaminated water through breachways, as well as via beach overwash and aerial deposition during the high winds and water at the time of the release, resulting in significant exposure of water column and benthic resources in the salt ponds.

The Trustees documented exposure of resources in the ponds to oil from the *North Cape* at levels and durations which are of ecological significance, as estimated by the technical working group. This finding is based on several sources of information, including chemical analysis of water and shellfish tissue samples and oil fate modeling. All available data were used to delineate the area of each pond exposed to *North Cape* oil, as reported in Michel (1997a) and shown graphically in Exhibits 4-6 through 4-8. The percentages shown on Exhibits 4-6 through 4-8 are the percent of the area of each pond exposed to oil.

### 1. <u>Shellfish Tissue Sampling</u>

As part of the seafood safety monitoring program, the Trustees and RP collected 28 samples of oysters, mussels, quahogs and soft shell clams in early March and April from all of the ponds with permanent breachways (i.e., Winnapaug, Quonochontaug, Ninigret, Potter and Point Judith ponds). Bivalves are excellent indicators of water-column exposures because they concentrate oil in their tissues by up to 10,000 times the concentration in the water (Scott *et al*. 1984).

The Trustees and Responsible Party measured the levels of PAHs in the bivalve samples and interpreted the PAH distributions in bivalve tissues to apportion the PAHs found in the samples to various sources (Boehm *et al*. 1996). Based on chemical analysis of *North Cape* oil, the Trustees and Responsible Party determined that most of the 2- and 3-ringed PAHs came from oil released during the spill. Exhibit 4-9 shows the mean total PAHs for the 28 bivalve samples taken from the ponds as part of the Trustee monitoring program. At least 85 percent of the PAH concentrations listed in the exhibit are due to *North Cape* oil (Boehm *et al*. 1996).

**Exhibit 4-9**

**MEAN CONCENTRATION OF TOTAL PAHS IN BIVALVE TISSUES COLLECTED FROM SALT PONDS (BOEHM *ET AL*. 1996)***

| Pond | Soft Shell Clam | Oyster | Blue Mussel | Ribbed Mussel |
|---|---|---|---|---|
| Point Judith (Mar) | 18,400 (4)** | 13,500 (2) | | |
| Point Judith (Apr) | 10,250 (2) | 7,800 (2) | | |
| Potter (Mar) | | 3,240 (2) | | 8,300 (1) |
| Potter (Apr) | | 1,400 (2) | | 4,200 (2) |
| Ninigret | 8,500 (2) | 2,550 (1) | | |
| Quonochontaug | 10,000 (2) | 1,400 (1) | | |
| Winnapaug | | | 24,300 (1) | |

* Measurements are in ppb, wet weight.
** Number in parenthesis indicates the number of samples in the mean.

The levels and sources of PAHs in bivalves showed differences among species, ponds and over time. Quahogs contained relatively low levels of total PAHs (44 to 1,780 ppb wet weight) and none allocated to oil from the *North Cape*. Quahogs are temperature-sensitive and stop feeding when water temperatures fall below 6°C (Stanley 1985), while soft shell clams have a wider temperature tolerance range (Abraham and Dillon 1986). It is therefore likely that the quahogs had slowed or stopped feeding during the very cold conditions at the time of the spill, and thus did not take in significant amounts of oil from the water column. Therefore, the PAHs in quahog tissues are likely representative of background levels.

**Exhibit 4-6**

**AREAS OF PT. JUDITH AND POTTER PONDS EXPOSED TO *NORTH CAPE* OIL**
**(The percentages shown on this exhibit are the percent of the area of each pond exposed to oil.)**

**Exhibit 4-7**

**AREAS OF TRUSTOM AND CARDS PONDS EXPOSED TO *NORTH CAPE* OIL**
**(The percentages shown on this exhibit are the percent of the area of each pond exposed to oil.)**

## Exhibit 4-8

### AREAS OF OTHER PONDS EXPOSED TO *NORTH CAPE* OIL
**(The percentages shown on this exhibit are the percent of the area of each pond exposed to oil.)**

Based on the bivalve sample locations and North Cape PAH concentrations, it appears that oil entered the breachway at Winnapaug Pond, but very little oil mixed into the body of the pond. Both Quonochontaug and Ninigret Ponds received about the same level of exposure with soft shell clams averaging 10,000 and 8,500 ppb, respectively, and oysters averaging 1,400 and 2,550 ppb. In Quonochontaug Pond, tissues from the western ends of the pond did not have elevated levels of PAHs, indicating that the oil did not reach the extreme ends of the pond. Oil spread throughout the main body of Ninigret Pond, but apparently did not spread into the two northern arms of the pond (Foster and Fort Neck coves).

In Point Judith Pond, PAH levels in soft shell clams collected in March averaged 18,400 ppb (twice as high as the other exposed ponds) and oysters averaged 13,500 ppb. By April, these levels had dropped by about half. A similar trend was observed in Potter Pond, where oysters averaged 3,240 ppb on March 9 and 1,400 ppb on April 2, and ribbed mussels dropped from 8,300 ppb to 4,200 ppb over the same period. The fact that PAH levels in tissue were elevated above background levels between 7 to 11 weeks after the spill suggests that there were still sources of *North Cape* oil which were bioavailable, most probably from contaminated sediments.

### 2. Water Sampling and Oil Fate Modeling

Several groups conducted water sampling in the salt ponds, with most of the samples collected over the period of January 22 to 26, 1996. A few samples were collected during February and March in Point Judith Pond. These results were used in a model developed by Hinga (1997) to estimate the water column concentrations of oil in each salt pond over time. Parameters used in the model were the measured values (used to initiate the model), mixing and exchange rates for the ponds, and hydrocarbon loss rates based on previous studies at URI on the behavior of No. 2 fuel oil in mesocosms (Olsen *et al*. 1982). These studies were used to predict the behavior of *North Cape* oil in Rhode Island salt ponds since they were conducted with a similar oil type, included winter experiments and were composed of similar habitat settings.

Hinga (1997) estimated the concentrations over time for the aromatic fraction of the oil only, for two reasons. Hinga used a simple flushing model and collected data on the degradation rate of No. 2 fuel oil to estimate concentrations over time. Unfortunately, samples for most of the ponds were only analyzed for total petroleum hydrocarbons (TPH), so it was necessary to convert the results to total aromatics. Based on detailed analyses of selected samples, Hinga estimated that aromatic compounds from *North Cape* oil were 22.3 percent of the TPH as measured in the salt pond water samples for Point Judith Pond and Potter Ponds, 4.5 percent for Cards and Trustom Ponds, and 10.8 percent for Ninigret, Quanochantaug, Winnapaug, and Green Hill Ponds. Analyses conducted by Reddy and Quinn (1996) and Boehm *et al*. (1996) confirm that PAH levels in the water column are attributable to the *North Cape* source oil. The basis for these assumptions are discussed in Hinga (1997).

Hinga (1997) estimated oil concentrations over time for each pond. Where available, data from field samples were used to verify his estimates. There was general agreement between the calculated and measured concentrations.

#### 4.4.3.2 Quantification of Injury

To quantify the injury to salt pond communities resulting from exposure to oil from the *North Cape* spill, concentrations of oil in the water column and sediment over time (Hinga 1997) are compared to acute toxicity levels for different species and species groups found in the salt ponds. Injury is then quantified by applying the results of this analysis to species abundance data. These calculations are made using the same toxicity data and sub-model used in the offshore water column injury assessment (SIMAP) (French 1998a, French and Rines 1998). This sub-model calculates the acute (short-term) toxicity, accounting for the effects of temperature and time of exposure on mortality.

### 4.4.4 <u>Salt Pond Communities: Individual Resource Injury Determination</u>

#### 4.4.4.1 Winter Flounder

Impacts to winter flounder from the *North Cape* oil spill were of great concern because of their reduced population levels and because these fish migrate into several of the coastal ponds (Potter, Point Judith, Ninigret, Quonochontaug, Winnapaug and Green Hill) during the early winter and spawn from January to April (Klein-McPhee 1978). The adult females spawn in multiple waves throughout this period (i.e., one group of adult fish moves into the ponds, spawns and moves out, to be replaced by a new group of spawning adults). The eggs are deposited on the bottom sediment, hatch to larvae and then develop to young-of-the-year (YOY) within the ponds. Therefore, winter flounder spawning adults, eggs, larvae and juveniles were potentially at risk of exposure to high levels of oil via both water-column and sediment pathways.

Few other commercially or recreationally important fish are present in the ponds during winter. Therefore, the Trustees focused salt pond fishery impact assessment on winter flounder. Five related studies were conducted on various life stages:

Sublethal effects on embryos (Hughes 1997);

Sampling of larval abundance during and following the spill (M. Gibson, pers. comm. 1997);

Abundance, growth and survival of YOY juvenile fish (Gibson and Gray 1997);

Assessment of the levels of exposure of adult fish (Collier *et al*. 1997); and

Modeling of injury to greater than one year old fish from acute exposures (French and Rines 1998).

Based on the results of these studies, the Trustees determined that injury to winter flounder was minimal. Adult fish, egg, and larvae exposures may have resulted in limited acute mortality and adversely affected one or two of the spawning waves that occurred soon after the spill. However, monitoring of juvenile fish abundances indicates that later spawning efforts were successful and likely offset any early season losses.

#### 4.4.4.2 Shellfish

Substantial populations of quahog, soft shell clam, American oyster, bay scallop and blue mussel occur in the salt ponds affected by the *North Cape* oil spill. RIDEM has published shellfish surveys for each of the ponds (Grey *et al*. 1971, Reardon and S.C.C.A.P. 1979, Baczenski *et al*. 1979, Constas *et al*. 1980, Delancey and Ganz 1981, Ganz 1988, Ganz *et al*. 1992).

RIDEM conducted a salt pond shellfish mortality survey in Point Judith Pond on 20 February, Potter Pond on 8 February, Ninigret Pond on 1 April and Quonochuntaug Pond on 26 March (RIDEM 1996). One survey per pond was conducted. Survey sites included intertidal and subtidal communities with documented shellfish populations. The approach was to first conduct visual inspections for the presence of oil and evidence of recent mortality (dead shellfish having gaped valves with viscera remaining or gaped valves free of sediment or fouling). Buried clams and scallops were collected using a clam rake, whereas intertidal areas were visually surveyed.

No significant shellfish mortality was observed in any of the sample locations, except for juvenile scallops held in cages suspended from the docks at the RIDEM Coastal Fisheries Laboratory in Jerusalem (RIDEM 1996). Disruption of the sediments during sampling released significant oil sheens only in Point Judith Pond. Because the surveys were conducted three to ten weeks after the spill, however, it is likely that any dead shellfish tissues were scavenged. RIDEM conducted follow-up visits at several sites in the salt ponds between April and June, in response to reports of shellfish mortality and/or tainting. In all cases, samples were collected for organoleptic and chemical analyses and met applicable safety guidelines.

To further assess the potential for shellfish injury, the Trustees compared water column concentrations of oil over time with acute toxicity thresholds for shellfish described in French *et al*. (1996). Quahogs were not included in the list of injured species because, as discussed in Section 4.4.3.1, monitoring of PAHs in quahog tissues showed that they were not exposed (they had stopped feeding during the very cold water temperatures). On the other hand, soft shell clams (which are also buried in the sediments) contained very high levels of PAHs in their tissues, indicating that they were feeding and exposed to the oil in the water column. The results of this analysis indicate a low level of adult shellfish injury, primarily to soft-shell clams.

Based on these data, the Trustees conclude that there was limited acute adult shellfish mortality in salt ponds attributable to the *North Cape* oil spill. The shellfish surveys did not assess the potential for acute injury to juvenile shellfish, which are more sensitive than adults to both lethal and sub-lethal effects of exposure to No. 2 fuel oil (Scott *et al*. 1984).

Impacts from the spill to shellfish eggs and larvae are not expected to be significant because oil concentrations in the water column are believed to have dropped to below toxic levels prior to the onset of spawning. The timing of spawning depends on water temperature and occurred in 1996 during the period June through August, with peaks in July (J. Karlsson, pers. comm. 1997).

#### 4.4.4.3 Worms/Amphipods

Early in the spill there was evidence that intertidal and subtidal sediments were contaminated by the spilled oil. Since contaminated sediments can provide a long-term pathway of exposure to benthic communities, the Trustees undertook several studies to determine the extent and duration of sediment contamination and the impacts to benthic communities. Very little pre-spill data on the abundance and diversity of benthic communities were available. Thus, the injury quantification approach consisted of:

> Sediment chemical analyses and modeling to determine the degree and duration of exposure;
>
> Bioassay testing as an indicator of sediment toxicity;
>
> Limited sampling to characterize the benthic communities and identify general trends in relative abundance and species diversity; and
>
> Use of literature values to indicate the contamination levels at which biological effects occurred.

Exposure of benthic communities to oil from the *North Cape* was documented through sediment sampling. USFWS collected sediment samples from the edges of all seven ponds in January and April. These samples were analyzed for PAHs and fingerprinted to allocate the percent of contamination by *North Cape* oil by Boehm *et al*. (1996). NMFS collected and analyzed sediment samples from the deeper parts of Point Judith and Ninigret Ponds. Boehm *et al*. (1996) also interpreted these results for percent *North Cape* oil. Because sediments are sinks for petroleum hydrocarbons from many sources, it is important to distinguish between *North Cape* oil and other sources of petroleum hydrocarbons. *North Cape* oil contained only trace amounts (about one percent) of the 4- and 5-ringed PAHs, while combustion-sourced petroleum hydrocarbons contain very few 2- and 3-ringed PAHs. Thus, it can be assumed that nearly all 2- and 3-ringed PAHs represented *North Cape* oil and all 4- and 5-ringed PAHs represented background contamination. This approach was used by Boehm *et al*. (1996) in their fingerprinting work.

Sediment samples collected from the salt ponds contained from 5 to 100 percent background petroleum hydrocarbons (Boehm *et al*. 1996). All but one of the sediment samples from Winnapaug and Quonochontaug Ponds contained mostly background oil. The four samples collected by NMFS from Ninigret Pond in late February contained elevated total PAHs (3,300 to 33,000 ppb) with 80 to 95 percent allocated to *North Cape* oil. Samples from Point Judith Pond contained 0 to 39,000 ppb PAHs, with 67 to 95 percent from the *North Cape*. By July, PAHs in sediments from Ninigret and Point Judith Ponds had decreased by more than 80 percent, indicating rapid degradation of the *North Cape* oil.

Hinga (1997) estimated the concentrations over time of oil in the salt ponds. By summer, low-molecular weight PAHs in most pond sediments had decreased by 80 to 95 percent, with only three stations in middle Point Judith Pond remaining at elevated levels (5,700 to 6,000 ppb).

Based on these estimates, the areal extent of sediment contamination in the ponds may be summarized as: no sediment contamination in Winnapaug, Quonochontaug, Green Hill, Trustom and upper Point Judith Ponds; two segments of contamination in Central Ninigret (see Exhibit 4-6) with the western segment averaging 3,900 ppb and the eastern segment averaging 30,000 ppb; contamination throughout all of Potter Pond (averaging 230 ppb) and Cards Pond (averaging 3,200 ppb); and four areas of varying levels of contamination in Point Judith Pond, ranging from an average of 3,400 to 44,000 ppb (Michel 1997b).

The Trustees undertook several studies to further evaluate injury to salt pond benthic organisms. Bioassay testing (sea urchin fertilization tests) of elutriates from pond edge sediments collected in January and April showed greatest toxicity in sediments from Point Judith, Potter and Trustom Ponds. Studies of benthic communities in the ponds documented extensive mortality of infauna (primarily amphipods) in Cards and Trustom Ponds (Michael 1996, Pratt 1996b). The Audubon Society sponsored a study of Cards Pond which indicated a normal and healthy benthic community by summer and early fall (Beatty *et al*. 1997), suggesting that benthic impacts were most likely short-term. These results are consistent with the rapid degradation of *North Cape* oil in surficial sediments. Thus, the Trustees have focused on injury quantification for the acute mortality of benthic communities in the salt ponds.

#### 4.4.4.4 Other Species

The salt ponds support a variety of other benthic organisms that may have been affected by the oil spill, including zooplankton, fish, and shellfish. USFWS response teams observed dead and moribund forage fish, clams, crabs, shrimp, squid, worms, and amphipods in both Trustom and Card ponds (Sperduto 1996). The shoreline assessment teams noted dead and dying forage fish on several of the survey forms. The available field evidence and modeling analyses, however, indicate that the magnitude of these injuries was small. Therefore, the Trustees did not undertake additional studies to determine injury for these benthic species other than those described for the salt pond community in general. Substantial numbers of birds that utilize the salt pond environment were injured. These injuries are described in the seabird and wintering waterfowl section of this chapter.

### 4.4.5 Salt Pond Communities: Individual Resource Injury Quantification

As previously described, the Trustees quantify injury to salt pond resources by comparing concentrations of oil in the water column over time (Hinga 1997) to acute toxicity levels for different species and species groups identified in the literature. Injury then is quantified by applying the results of this analysis to species abundance data. These calculations are made using the same toxicity data and model used in the offshore water column injury assessment (French 1998a and b, French and Rines 1998). This model calculates the acute (short-term) toxicity, accounting for the effects of temperature and time of exposure on mortality. The results of this analysis are shown in Exhibit 4-10 below.

**Exhibit 4-10**

**QUANTIFICATION OF SALT POND WATER COLUMN AND SEDIMENT INJURY**

| Species or Group | Numbers Killed | Biomass Killed (kg) | Production Foregone (kg) | Total Injury (kg) |
|---|---|---|---|---|
| Winter flounder | 1,589 | 1,377 | 1,142 | 2,519 |
| Forage fish | 533,357 | 2,667 | 2,370 | 5,037 |
| Soft shell clam | 499,102 | 5,712 | 3,888 | 9,600 |
| Oyster | 149,367 | 1,857 | 905 | 2,762 |
| Bay scallop | 159 | 5 | 0 | 5 |
| Crabs | 318,111 | 3,181 | 3,756 | 6,937 |
| Shrimp | 323,844 | 81 | 88 | 169 |
| Zooplankton | 5,397,186 | 229 | - | 229 |
| Benthic macrofauna | 6,591,836,102 | 65,918 | 81,904 | 147,822 |

These results indicate that an estimated 6.6 billion worms/amphipods were killed by the spill, with an associated biomass (including direct kill and production foregone) of148,000 kilograms. Large kills of amphipods were observed after the spill in Cards Pond (Pratt 1996b), although the dead amphipods only were observed once the water level dropped after the pond was breached. Michael (1996) observed unusually low abundances of benthic organisms in several of the ponds, but reference data from before the spill were not available for comparison.

Other injuries in the salt ponds were substantially smaller. Total injury to crabs (7,000 kilograms), forage fish (5,000 kilograms), and soft shell clams (9,600 kilograms) were the largest of the remaining injuries. Numerous dead mummichogs and northern silver-sides were observed, and a liter container of dead mummichogs was collected and frozen. Impacts on winter flounder and other shellfish were slight. These findings are consistent with the field data addressing injury to winter flounder and shellfish discussed above.

The Trustees estimate that populations of worms/amphipods naturally recovered to baseline conditions within five months. This estimate is based on the rapid recovery of these organisms in Cards Pond documented by Beatty *et al*. (1997), who found a normal benthic community by late summer of 1996, and the Trustee expectation that a new generation of these organisms was produced within five months of the spill (S. Pratt, pers. comm. 1997).

For the other species injured in the salt ponds, the Trustees estimate a recovery period of 1 to 2 years. This estimate reflects the life history characteristics of injured species and the relatively small magnitude of the injuries compared to the size of local populations.

Injuries to both water column and benthic resources in the salt ponds can be summarized as follows. There were minimal or no impacts to water column and benthic resources in Winnapaug, Quonochontaug, Ninigret West, and Trustom Ponds because of either very low exposures or low abundances of organisms present at the time of exposure. There were minor impacts to the water column resources in Green Hill, Cards, and Potter Ponds, and Potter Pond also had a small (1 percent) mortality of benthic crustaceans. Most of the impacts occurred in central Ninigret Pond and lower and middle Point Judith Pond, where both water and sediment concentrations were high enough to cause acute mortality to relatively abundant organisms.

### 4.4.6 <u>Intertidal Wetlands</u>

There were two types of intertidal wetlands potentially affected by the *North Cape* oil spill; salt marshes in the permanently breached ponds, primarily in Point Judith and Potter, and brackish to fresh water marshes in Cards and Trustom Ponds. No. 2 fuel oil is the most acutely toxic type of oil to wetland vegetation (Webb 1995), often resulting in death of the roots and loss of habitat under heavy loading (Hampson and Moul 1978, Matsil 1996). However, overflight maps and shoreline surveys indicate that the amount of floating oil which entered the salt ponds during the spill was very small.

To determine if there had been injury to intertidal wetlands, two types of studies were conducted: visual assessment of the degree of oiling along the most heavily oiled wetland shorelines in Point Judith Pond and Potter Pond; and a detailed vegetation study of the Bluff Hill Cove marsh in Point Judith Pond for which there were pre-spill (1992 and 1994) data.

The visual surveys included the shoreline assessment conducted on January 22 and 23, 1996 as part of the shoreline assessment work during the emergency response operations. At that time, the shoreline assessment teams reported visible oil in the marshes occurring as rainbow sheens at the water's edge along the shoreline and in a few ponds on the marsh surface, and as sheens that could be released by disturbing the nearshore sediments and the marsh scarp. The shoreline assessment observations are included in the Preassessment Data Report (RPI 1996a).

The Preassessment survey teams were concerned that the oil penetrated the organic, peat-like sediments at the marsh scarp, because rainbow sheens could be released by compressing the marsh edge under water. The sections of the marsh with the greatest oil exposure reported in January were revisited on March 21 and 22, when 31 sediment cores were taken for later analysis and study quadrats were established (Michel 1996). Further study of individual sites and chemical analysis of sediment coves were postponed until an assessment was made of the extent of vegetation injury in the summer.

A summer shoreline assessment was conducted by the Trustees on June 7, 1996. The survey team did not visually detect any differences in the growth patterns or relative abundance of the above-ground vegetation between areas known to have been exposed to oil from the *North Cape* and areas with little or no oil exposure. They recommended that a detailed field study of the impacts to salt marsh vegetation would not be necessary at this time (Michel 1996). The survey team did observe the presence of sheens in the substrate in many marsh and tidal flat areas originally reported as oiled. Some of these sites were re-visited again on October 17, 1996; very little or no oil was released from the marsh scarp at this time (Hebert 1996).

Vegetation studies at Bluff Hill Cove marsh repeated the methods and sites of a long-term study as part of the Galilee Bird Sanctuary restoration project (Myshrall and Golet 1996). Measurements of stem density, stem height, and total biomass were collected at 61 quadrats in *Spartina alterniflora* and compared to similar data for 1994. The results, summarized in Raposa (1996), indicated that there were no significant differences in these characteristics of the marsh at Bluff Hill Cove pre- and post-spill.

Two sediment cores collected from the Bluff Hill Cove marsh interior on January 26, 1996 contained total PAHs of 1.7 and 2.0 ppm, mostly attributed to background sources of petroleum hydrocarbons (Quinn 1996). These levels are well below those known to cause acute mortality to marsh vegetation. For example, no regrowth of salt marsh vegetation occurred where the sediment concentrations of No. 2 fuel oil were greater than 2,000 ppm at the *Florida* spill in Buzzards Bay (Burns and Teal 1979). At a No. 2 fuel oil spill in the Arthur Kill, New York, salt marsh vegetation died and did not regrow in areas where the oil levels remained elevated (40 samples taken four months after the spill had a mean TPH concentration of 6,400 ppm; Matsil 1996).

Based on the results of the marsh assessment studies, the Trustees conclude that there has been no significant injury to salt marsh vegetation as a result of the *North Cape* oil spill. The lack of pre-spill data and low exposure levels prevented assessment of other impacts to the salt marsh community, such as the effects on algal, invertebrate, and fishery populations. No further injury assessment studies are recommended for the intertidal wetlands.

### 4.4.7 <u>Birds/Foreshore</u>

#### 4.4.7.1 Piping Plover

Moonstone Beach consistently provides nesting and brood habitat for the piping plover, a federally-listed threatened species (USFWS 1985). In the summer of 1996, nine pairs of piping plovers nested on Moonstone Beach near the site of the *North Cape* grounding. Piping plovers typically arrive at Rhode Island beaches by early April. By mid-April, they establish pairs and begin construction of their nests. Egg laying and chick rearing generally take place from May through July, with the majority of chicks fledging in July. The birds feed on invertebrates in intertidal pools, washover areas, mudflats, sandflats, wracklines of barrier beaches and shorelines of coastal ponds, lagoons and salt marshes.

The Trustees completed several studies to determine if Moonstone Beach piping plovers were adversely affected by the spill. Moonstone Beach piping plover behavior and productivity were studied after the spill, and compared with similar data from prior years at Moonstone Beach and other piping plover sites in Rhode Island and Connecticut (Casey 1996). Another study monitored piping plover behavior and productivity at nesting locations on the coast of Rhode Island that were not impacted by the spill (McGourty 1997). Two analyses were conducted to assess the impact of the spill on piping plover prey (Gould 1996, SAIC 1996).

### 1. Injury Determination

To assess piping plover injury, the Trustees compared Moonstone Beach piping plover behavior and productivity during 1996 to historical and reference area data. These comparisons support the following conclusions:

> Less food was available to Moonstone Beach piping plovers in 1996 than at a control beach (East Beach). Invertebrate pit-trap samples indicate that the wrack at the control beach had 8.5 times more organisms by weight and 6.5 times more organisms by volume than the beach at Trustom Pond NWR (Gould 1996).
>
> Moonstone Beach chicks foraged further in 1996 than in previous years. The average daily distance traveled by 1996 chicks was two to three times the distance traveled in 1994 and 1995 (Casey 1996). This finding is consistent with reduced food availability.
>
> Oil contamination of Rhode Island beaches was highest at Moonstone Beach in the high tide and storm high tide sands (Mulhare and Therrien 1996). This is the same area where most piping plovers nested (Casey 1996).
>
> Moonstone Beach piping plovers abandoned four of nine initial nest attempts (25 percent of all their nests) in 1996, the highest rate since management activities were initiated in 1992 (Casey 1996). This abandonment rate also is higher than observed rates at reference area piping plover nests (Casey 1996).
>
> Abandonment of 44 percent of first nest attempts delayed the chick rearing period from May to June. Between the years of 1992 and 1995, the two years of lowest productivity corresponded to years when chick rearing was delayed until late May. Highest productivity was observed when chick rearing occurred earlier in May (Casey 1996).
>
> Finally, Moonstone Beach piping plover productivity (number of chicks fledged per pair) dropped 37 percent in 1996, after steadily increasing for five years (Casey 1996). Piping plover productivity at Rhode Island reference area sites <u>increased</u> six percent in 1996 (Casey 1996).

These observations indicate that Moonstone Beach piping plovers experienced lower productivity than expected after the spill and exhibited unusual behavior consistent with reduced food supply and reproductive impairment. By comparing Moonstone Beach piping plover activity after the spill to historical and reference area data, the Trustees have attempted to control for causal factors unrelated to the spill. Because 1996 piping plover productivity at Rhode Island reference areas increased slightly from 1995, it is unlikely that changes in weather are responsible for the 1996 productivity decline at Moonstone Beach. Likewise, historical data from Moonstone Beach suggest that productivity in 1996 was lower than expected, and do not identify any non-spill factor unique to this site that might explain the 1996 decline.

### 2. Injury Quantification

To quantify lost piping plover productivity on Moonstone Beach, the Trustees assume that in the absence of the spill, productivity in 1996 would have at least equaled productivity in 1995. Productivity steadily improved from 1992 to 1994, and increased dramatically in 1995. USFWS biologists attribute the improvement in 1995 to a new management program that expanded predator controls. This same management program was in place during 1996, and was expected to sustain the productivity gains realized in 1995.

Based on these assumptions, lost piping plover productivity in 1996 can be calculated using the following equation:

(1995 productivity - 1996 productivity) * number of plover pairs in 1996 = lost chicks
(1.56 chicks per pair - 1.00 chicks per pair) * 9 pairs = 5.0 fledged chicks

The future production from these chicks also is lost. Assuming a chick over-winter survival rate of 48 percent (Melvin *et al.* 1992), two or three of the five chicks likely would have survived the winter and returned to breed the following year, in the absence of the spill.[4] Assuming a 1997 fledging rate equal to that in 1995 (1.56 chicks per pair), the chicks lost because of the spill likely would have produced one or two fledgings of their own in 1997.[5] Based on this analysis, the Trustees conclude that five chicks is the minimal loss attributable to the spill; depending on actual over-wintering survival rates and future fledging rates, the Trustees estimate a total loss over time of between five and ten piping plover chicks.

### 3. Recovery Time

The Rhode Island piping plover population has had difficulty maintaining its size, as evidenced by its federal listing as a threatened species and state protection efforts. Thus, the Trustees conclude it is unlikely that the local piping plover population will naturally compensate for this loss, delaying efforts to restore this population to self-sustaining levels.

---

[4] 5.0 fledged chicks * 0.48 over-winter survival rate = 2.4 surviving breeders

[5] 1 plover pair * 1.56 chicks per pair = 1.6 fledged chicks

1.5 plover pairs * 1.56 chicks per pair = 2.3 fledged chicks

#### 4.4.7.2 Seabird and Wintering Waterfowl Acute Mortality

The salt pond and offshore habitats of the Block Island Sound coastal ecosystem are valuable wintering habitats for a variety of bird species. Marine waters support regionally important waterfowl populations including loons, grebes, sea ducks (e.g., eiders and scoters) and diving ducks (e.g., goldeneye, bufflehead and scaup). Winter diving ducks and dabbling ducks such as scaup, American black duck and mallard inhabit area salt ponds. Great black-backed gulls, herring gulls, ruddy ducks, Canada geese, red-breasted mergansers, great blue herons and mute swans also are common to this area.

Substantial numbers of these birds died from the effects of the spill. Within nineteen days after the initial release of oil, 405 oiled birds were recovered by rescue workers. Although 114 birds were alive when collected, all but 13 died or were euthanized. Based on this information, observed mortality is 392 birds. All of these birds are assumed to have died as a direct response to oil exposure. Total mortality attributable to the spill is substantially greater, as a large number of birds were never found because they sank, drifted out to sea, or were scavenged (Hlady and Burger 1993).

**1. <u>Injury Determination</u>**

The Preassessment data clearly indicate that birds were oiled by the *North Cape* spill and died as a result of this exposure. Oiling of the feathers can cause matting and loss of insulating and water-repellent properties, leading to hypothermia, starvation or drowning (Leighton 1995). Oil ingestion, primarily from preening behavior, also can cause mortality (Leighton 1995). Although ingestion can lead to non-lethal bird injuries, such as reproductive impairment and behavioral abnormalities (White 1991, Grau *et al*. 1977, Coon and Dieter 1981), given the low temperatures during the *North Cape* spill, virtually all of the birds exposed to oil died.

Oil spills also can injure birds indirectly through habitat loss and disruption of nesting and foraging activities. The potential impacts of the *North Cape* spill on birds that utilize offshore or salt pond habitats for nesting or foraging are addressed in the next chapter of this document.

**2. <u>Injury Quantification</u>**

To arrive at an estimate of total bird mortality, the Trustees applied a multiplier, based on a qualitative analysis of the factors influencing oil spill-related bird mortality, to the number of water birds known to have died as a result of the oil spill (12 of the recovered birds were non-water birds, for which the use of a multiplier was not appropriate). This multiplier accounts for birds that were never found because they sank, drifted out to sea or were scavenged (Hlady and Burger 1993).

The Trustees examined the literature to identify a range of multipliers applied to past spills and the evidence supporting these estimates (see Sperduto *et al*. 1997 for a list of these studies). In poorly documented spills, total mortality often is assumed to be ten times the number of birds retrieved (Burger 1993). The mean estimate from an analysis of 45 spills was four to five times the number of birds retrieved. Based on this information and a preliminary assessment of the conditions during the *North Cape* oil spill, the Trustees assumed a range of 1 to 10 for the *North Cape* multiplier. Additional analysis was undertaken to determine a specific multiplier for the spill.

Based on a review of the literature, the Trustees identified 17 factors that can affect the magnitude of an acute mortality multiplier. These factors are listed in Exhibit 4-11. The Trustees then evaluated the importance and likely impact of each factor. The results of this analysis, summarized below, are described in detail in Sperduto *et al*. (1997).

Two of the most important parameters affecting the likelihood that birds were oiled and that oiled birds washed ashore were wind direction and the location of the spill. The nearshore location of the spill increased the likelihood that oiled birds would make it to shore. However, beginning five hours after the spill, offshore winds blew for approximately 60 hours, increasing the spatial extent of oiling, therefore increasing the probability of exposure, and likely preventing birds which died at sea from reaching shore. Considered together, these factors suggest that a multiplier in the middle of the 1 to 10 range may be appropriate.

The combined impact of other significant factors slightly increase the multiplier. Thousands of birds winter off the Rhode Island coast and frequently move between Point Judith and Newport. Data from before, during and after the spill indicate that common eider and loons in particular may have been present in large numbers compared to historical averages, although the exact location and number of birds during the spill are uncertain. The volume of oil spilled was substantial. Finally, the cold water temperatures increased the likelihood that birds exposed to oil quickly died of hypothermia. Partly mitigating these factors is the fact that the extensive search and collection effort and the predominantly sand shorelines contributed to nearly 100 percent collection of beached birds within the extent of the spill, a finding that is generally consistent with lower multiplier estimates. While these two factors are critical in determining the percentage of beached birds retrieved, they do not address the number of birds that sank or drifted to sea.

**Exhibit 4-11**

**CHARACTERISTICS AFFECTING THE *NORTH CAPE* BIRD ACUTE MORTALITY MULTIPLIER**

| | | |
|---|---|---|
| **Characteristics of the Spilled Oil** | | |
| Volume | Evaporation potential | Dispersal |
| **Characteristics of the Biological Resources** | | |
| Location of birds during spill | Number of birds present during the spill | Types of birds (buoyancy, size, etc.) |
| Mobility | Search and collection effort | Location birds were found |
| **Environmental Conditions** | | |
| Wind direction | Wind speed | Current direction |
| Current speed | Water temperature | Tidal stage |
| Location of spill | Type of shoreline | |

The Trustees also note that currents and wind speed likely increased the extent of oiling and contributed to the transport of dead birds to sea. The locations where birds were found also suggest that birds may have drifted out to sea; approximately 20 percent of beached birds were collected from Block Island, where birds would be expected to drift based on winds and currents.

Based on their analysis of relevant parameters, the Trustees estimate a multiplier of six for the *North Cape* spill. Thus, in the best judgment of the Trustees, approximately 2,292 birds were killed directly by the spill. The number of birds by species are indicated in Exhibit 4-12. As shown, gulls were killed in the greatest numbers (444), followed by common loons (402), eider (354), grebes (228), mergansers (204) and goldeneye (192).

To estimate interim losses, the Trustees multiply the number of birds killed by species-specific estimates of recovery periods. Recovery time estimates are based on life history and population information for the primary groups of birds injured: non-water birds (owls, doves); pond birds (black duck, geese, herons); and marine birds (sea ducks, loons, grebes, alcids, gulls, cormorants).

Available data on fledging rates, survival rates, and population abundances indicate that non-water birds, pond birds, and alcids (murres, dovekies, gannets, and razorbills) likely were restored through natural recovery during the first breeding season following the spill. Relatively few individuals of each of these species were estimated to have been killed (less than 40 of any one species) and natural compensatory mechanisms are expected to quickly restore the affected bird populations to baseline levels.

In the best judgment of the Trustees, natural compensatory mechanisms also quickly restored populations of gulls and cormorants to baseline levels. While these species were estimated to have been killed in larger numbers (444 gulls and 96 cormorants), populations of these species are known to be increasing in size, and therefore natural recovery was assumed complete after the first post-spill breeding season.

Recovery time for sea ducks, loons, and grebes was determined to continue beyond the first breeding season following the spill. Sea duck, loon and grebe mortality was greatest among all birds injured by the *North Cape* spill; the TWG estimated that 1,476 of these birds were killed (834 sea ducks, 402 common loons, 12 red-throated loons, and 228 grebes). While regional breeding populations of these species may be adequately large to quicken natural recovery, the Trustees believe that life history traits of these species, including the relatively late age of first breeding and their low reproductive success, combined with the large number of these birds killed by the spill, are sufficient to prolong natural recovery beyond one breeding season.

The Trustees estimate recovery times for sea ducks, loons and grebes that approximate their expected remaining lifetimes in the absence of the spill. This calculation requires information on the age of birds killed by the spill and natural mortality rates. Because recovery teams were unable to age birds found during the recovery effort, the Trustees assume that birds killed by the spill were the average age of their respective populations. Survival rates and maximum age data were obtained from a review of available literature cited in the NRDAM/CME (French *et al*. 1996) and other relevant literature and species experts (Eadie *et al*. 1995, Neuchterlein 1998, Johnsgard 1987).

As described in Sperduto *et al*. (1999) this information was combined to develop the recovery times listed in Exhibit 4-12. Multiplying the recovery time by the number of individuals affected by the spill provides an estimate of the total direct bird injury. The total direct bird injury for each species group is as follows: marine birds with recovery period greater than one year (4,025 bird-years), marine birds with recovery period equal to one year (606 bird-years), non-water birds (12 bird-years), and pond birds (198 bird-years).

In addition, for marine birds with recovery periods greater than one year (scoters, mergansers, goldeneye, bufflehead, eider, loons, and grebes), the Trustees also estimated the lost bird-years associated with the first generation of fledglings that would have been produced by the birds killed by the spill. Details of this calculation are also provided in Sperduto *et al*. 1999.

**Exhibit 4-12**

**INJURY QUANTIFICATION FOR BIRDS KILLED BY THE *NORTH CAPE* SPILL**

| Species | Number Collected | Multiplier | Total Kill | Recovery Time (years) | Total Bird-Years Lost |
|---|---|---|---|---|---|
| Marine Birds-Long Term Impacts Likely | | | | | |
| Scoters | 3 | 6 | 18 | 2.8 | 111 |
| Mergansers | 34 | 6 | 204 | 1.4 | 337 |
| Goldeneye | 32 | 6 | 192 | 1.7 | 408 |
| Bufflehead | 11 | 6 | 66 | 1.4 | 125 |
| Eider | 59 | 6 | 354 | 2.1 | 853 |
| Common Loons | 67 | 6 | 402 | 6.4 | 3,641 |
| Grebes | 38 | 6 | 228 | 1.6 | 705 |
| Red-Throated Loons | 2 | 6 | 12 | 6.4 | 109 |
| Total | 246 | 6 | 1476 | -- | 6,289 |
| Marine Birds-Long Term Impacts Unlikely | | | | | |
| Murres | 5 | 6 | 30 | 1 | 30 |
| Dovekie | 1 | 6 | 6 | 1 | 6 |
| Gannet | 3 | 6 | 18 | 1 | 18 |
| Razorbill | 2 | 6 | 12 | 1 | 12 |
| Cormorants | 16 | 6 | 96 | 1 | 96 |
| Gulls | 74 | 6 | 444 | 1 | 444 |
| Total | 101 | 6 | 606 | 1 | 606 |

**Exhibit 4-12 (Continued)**

**INJURY QUANTIFICATION FOR BIRDS KILLED BY THE *NORTH CAPE* SPILL**

| Species | Number Collected | Multiplier | Total Kill | Recovery Time (years) | Total Bird-Years Lost |
|---|---|---|---|---|---|
| Pond Birds-Long Term Impacts Unlikely | | | | | |
| Black Duck | 5 | 6 | 30 | 1 | 30 |
| Coot | 1 | 6 | 6 | 1 | 6 |
| Mallard | 3 | 6 | 18 | 1 | 18 |
| Pintail | 2 | 6 | 12 | 1 | 12 |
| Ruddy Duck | 2 | 6 | 12 | 1 | 12 |
| Geese | 6 | 6 | 36 | 1 | 36 |
| Swans | 4 | 6 | 24 | 1 | 24 |
| Scaup | 4 | 6 | 24 | 1 | 24 |
| Herons | 6 | 6 | 36 | 1 | 36 |
| Total | 33 | 6 | 198 | -- | 198 |
| Non-Water Birds | 12 | 1 | 12 | 1 | 12 |
| Grand Total | 392 | -- | 2,292 | | 7,105 |

In the final step of the bird interim loss analysis, lost bird-years in the future are discounted using an annual rate of three percent and summed to develop a present value estimate of lost bird-years. Based on this approach, the Trustees estimate a total bird loss of 7,105 bird-years. Losses are greatest for loons (3,749 bird-years) and eider (853 bird-years).

### 3. <u>Recovery Time</u>

For the pond birds, non-water birds and a subset of marine birds identified in Exhibit 4-12, available data on fledging rates, growth rates, natural mortality rates, population abundances and similar information suggest that recovery likely will take place within one year. In the best judgment of the Trustees, impacts longer than one year are only likely for the other marine birds identified in Exhibit 4-12 (e.g., scoters, mergansers, goldeneye). The recovery time for these species approximates the expected remaining life of the birds killed by the spill.

## 4.4.7.3 Waterfowl Habitat Degradation

Assessment of spill impacts on offshore and salt pond communities indicate that waterfowl intertidal habitat was not injured significantly. As previously described, intertidal wetlands were not injured by the spill. Although some waterfowl prey species were injured, there is no indication that these impacts had an appreciable effect on waterfowl food supplies.

#### 4.4.7.4 Tiger Beetle

The Trustees and RP also investigated the potential impact of the *North Cape* oil spill on the roughnecked tiger beetle *Cicindela hirticollis* (Nothnagle 1996). *Cicendela hirticollis* is a small (12-15 mm) predatory beetle that lives in sandy habitats near coastal areas, lakes and rivers. This beetle was of concern to the State Natural Heritage Program because of recent declines in abundance. Populations of this beetle inhabit two areas of Moonstone Beach; one in front of Trustom Pond, and the other in front of Cards Pond. Based on the results of censuses of tiger beetle densities in impact and control areas after the spill (Nothnagle 1996), the Trustees determined that there was no injury to this resource.

## 4.5 IMPACTS ON HUMAN USE

The following sections describe natural resource damages associated with human-use impacts of the *North Cape* oil spill. These damages include lost consumer surplus experienced by users of resources affected by the spill. Under the provisions of the Oil Pollution Act of 1990, wages and other income lost by private individuals are not included in Trustee claims for damages. These may be the subject of lawsuits brought by the individuals suffering the loss. The Trustees have determined that boat-based recreational angling is the only category of human use for which there was a measurable loss of consumer surplus.

### 4.5.1 Boat-Based Recreational Angling

Trustee analysis indicates that the *North Cape* oil spill had a direct adverse impact on party and charter boat recreational anglers fishing in and around Block Island Sound. For the period of January 20, 1996 to June 30, 1996 the Trustees estimate spill-related losses of approximately 3,305 party and charter boat angler-trips. Based on a value of $85.23 per party and charter boat angler-trip, and adjusting for time between January 20, 1996 and the date of the study, the Trustees value these losses at $281,685.[6] The data and methodology used to develop this estimate are summarized in the following sections, and described in Curry and Meade (1997).

#### 4.5.1.1 Estimation of Lost Trips

To estimate lost angler-trips, the Trustees interviewed party and charter boat captains in Rhode Island, New York, and Connecticut. Based on these interviews, the Trustees estimate the total number of lost angler-trips attributable to the *North Cape* oil spill. The analysis only considers the *North Cape* oil spill's impacts on party and charter boat recreational anglers. We do not calculate impacts on private boat or shore-based recreational anglers.

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[6] 3,305 trips x $85.23 per trip = $281,685.

The Trustee analysis measures oil spill impacts for the period of January 20, 1996 through June 30, 1996. This time frame reflects the following factors:

> ***Fishery Closures.*** As a result of the *North Cape* oil spill, the State of Rhode Island and the National Marine Fisheries Service closed a portion of the commercial fishery in Block Island Sound from January 22 through April 9, 1996. This closure was widely publicized and may have contributed to a perception that the fishery was severely impacted by spill. In addition, party and charter boat anglers typically live at some distance from the area and they may not have direct knowledge regarding the quality of fishing in Block Island Sound subsequent to the oil spill. Since these anglers may perceive long-term fishery impacts, it is reasonable to assume that the effects of the closure extended through June of 1996.
>
> ***Winter/Spring Cod Fishing Season.*** The *North Cape* oil spill primarily impacted Block Island Sound's winter/spring cod fishery. The cod fishing season typically runs from January through late spring. During this period, party and charter boat anglers limit their activity to nearshore waters and the associated winter/spring cod fishery due to weather and sea conditions.

The interviews of party and charter boat captains (respondents) took place over a seven-month period, September 1996 through March 1997. The respondents did not appear to have any difficulty recalling the impact of the spill on their party/charter boat fishing operations, probably due to the uniqueness of the event and the singular importance of the spill's adverse impacts on the party/charter boat businesses in the area.

Respondents were interviewed individually and informed that their identity would be kept confidential. They were also told that any information they provided during the interview would be used only in the Trustee's natural resource damage claim and would not affect any private claims made by third parties (e.g., boat captains and/or owners). Thus, respondents would not realize any personal gain from information conveyed to Trustee experts.

The Trustees requested that respondents take account of the possible effects of weather when providing estimates of the number of lost party/charter boat fishing trips caused by the *North Cape* oil spill. Uniformly, the respondents stated that inclement weather (cold, rain, snow, etc), short of strong winds or fog, does not usually affect their clients decisions on whether or not to take a fishing trip. The fishermen often face cold, inclement weather when fishing for winter cod during the typical winter cod fishing season in Block Island Sound. Most respondents reported that the 1996 winter cod fishing season experienced normal weather conditions and each one indicated that their estimates of lost fishing trips caused by the oil spill did not include any weather-related lost trips.

Finally, respondents also were asked about substitute fisheries/locations for fishermen who canceled trips to Block Island Sound for winter cod fishing due to the *North Cape* spill. Their responses indicated that only party/charter boats located in RI and Long Island ports provide party/charter services for the Block Island Sound winter cod fishery. Furthermore, the respondents stated that their clients are dedicated winter cod fishermen who do not have an alternative/substitute fishery to turn to when Block Island Sound winter cod fishing is adversely affected by an event such as the *North Cape* oil spill.

Based on the consistency of responses obtained from interviews with different party/charter boat operators and the fact that their responses would not affect any private claims, the Trustees believe that the estimates of the number of lost trips provided by each party/charter boat operator are accurate and unbiased.

### Party Boats

To assess the impact of the *North Cape* oil spill on party boat anglers, the Trustees contacted six of the seven captains or owners of party boats from New York or Rhode Island operating in Block Island Sound.[7] Through these interviews, the Trustees identified three spill-impacted party boats in Rhode Island and two in New York. For each boat, the Trustees collected information on dates of operation, vessel capacity and the number of lost vessel-trips. The Trustees also asked each captain to estimate the average number of anglers per vessel-trip. Based on this information, the Trustees estimate that Block Island Sound party boat anglers lost a total of 2,225 angler-trips between January 20 and June 30, 1996 because of the *North Cape* oil spill, as shown in Exhibit 4-13.

**Exhibit 4-13**

**PARTY BOAT IMPACTS**
**LOST ANGLER-TRIPS DUE TO THE *NORTH CAPE* OIL SPILL**

| State | Party Boat | Impact Dates | Lost Vessel-Trips Per Vessel | Average Anglers Per Trip | Lost Angler-Trips |
|---|---|---|---|---|---|
| Rhode Island | 1 | January - June | 16 | 25 | 400 |
| | 2 | January - June | 20 | 45 | 900 |
| | 3 | April - June | 8 | 25 | 200 |
| New York | 1 | January - June | 15 | 45 | 675 |
| | 2 | January - June | 5 | 10 | 50 |
| TOTAL | 5 | January - June | | | 2,225 |

### Charter Boats

To assess the impact of the *North Cape* oil spill on charter boat anglers, the Trustees contacted a sample of charter boat captains operating in Block Island Sound. Through these interviews, the Trustees identified 15 to 20 spill-impacted charter boats in Rhode Island and 12 to 15 in New York. In addition to identifying specific impacted boats, information obtained during the interviews indicates that the vessel capacity, dates of operation, and fishing destination of

[7] The Trustees were unable to reach the seventh New York/Rhode Island captain. The Trustees also contacted captains in Connecticut, but these individuals fish primarily in Long Island Sound and therefore did not report any spill-related impacts. Based upon discussions with RI operators, Massachusetts-based boats were assumed not to operate in Block Island Sound.

charter boats fishing for Winter/Spring cod are relatively similar throughout Block Island Sound. The Trustees used this information to develop a standard charter boat profile to estimate lost angler-trips, which was applied to all charter boats impacted by the oil spill. Exhibit 4-14 summarizes the lost trip calculations for charter boats. Based on this information, the Trustees conclude that Block Island Sound charter boat anglers lost a total of 1,080 angler-trips between March 15 and June 30, 1996 as a result of the *North Cape* oil spill.

**Exhibit 4-14**

**CHARTER BOAT IMPACTS**
**LOST ANGLER-TRIPS DUE TO THE *NORTH CAPE* OIL SPILL**

| State | Number of Impacted Charter Boats | Lost Vessel-Trips Per Vessel | Average Anglers Per Trip | Lost Angler-Trips |
|---|---|---|---|---|
| Rhode Island | 15 | 8 | 5 | 600 |
| New York | 12 | 8 | 5 | 480 |
| TOTAL | 27 | 8 | 5 | 1,080 |

The Trustees found no evidence that anglers employing two other popular recreational fishing modes common to Block Island Sound, fishing from shore and from private boats, were adversely affected by the *North Cape* oil spill. Because of the cold weather and seasonal absence of many of the most sought-after sport fish species, few private boat and shore-based angler trips are taken during a typical winter and early spring in Block Island Sound. By mid-April, all areas closed to commercial fishing and most of the areas closed to shellfishing were reopened. This coincides with the beginning of the early private boat and shore-based recreational fishing season in the area, so few if any such trips were likely affected by the spill and associated closures. Nonetheless, it is possible that some private boat and shore-based anglers avoided taking trips to Block Island Sound for a period of time in the spring/summer of 1996 because of the possible perception that recreational fishing there had suffered a reduction in quality. However, lacking evidence to the contrary, the Trustees assume that private boat and shore-based recreational fishermen were not adversely affected by the *North Cape* oil spill.

### 4.5.1.2 Valuation of Lost Trips

The Trustees use the benefits transfer method to quantify the per-occasion value of party and charter boat angler-trips in Block Island Sound. To identify angler-trip values relevant to the Block Island Sound fishing experience, the Trustees reviewed more than 100 recreational value economic research papers and reports. Based on this review, the Trustees estimate a mean annual willingness to pay per angler-trip of $58.52 in 1988 dollars as reported in McConnell and Strand (1994). For the purposes of this analysis, the Trustees use the equivalent 1999 value of $85.23.

Several per angler-trip values are provided in McConnell and Strand (1994), representing different types of fisheries in each Mid-Atlantic and Southeastern coastal state in the U.S. and alternative methods for estimating angler-trip values. The Trustees chose the $58.52 per angler-trip value ($85.23 in 1999 dollars) from McConnell and Strand (1994) because the type of fishing and the geographical location of the fishing activities from which that value was derived most closely matches the winter cod fishery in Block Island Sound. The $58.52 figure was based on New York State recreational fishermen, some of whom were party/chart boat fishermen in Long Island Sound (which is adjacent to Block Island Sound). Furthermore, the economic methodology used to estimate that value, the random utility model/travel cost method, is a well-accepted, frequently-used approach for estimating the value of outdoor recreational activities, such as sport fishing, hunting, wildlife viewing, etc.

The value of party and charter boat anglers' lost interim use resulting from the *North Cape* oil spill is calculated in Exhibit 4-15. The Trustees quantify this loss by multiplying the number of lost angler-trips by an $85.23 per trip value, which is the $58.52 figure inflated to 1999.[8] Therefore, based on 3,305 lost trips and a value of $85.23 per trip, the Trustees calculate that the *North Cape* oil spill is responsible for $281,685 in lost use value to Block Island Sound party and charter boat anglers for the period January 20 through June 30, 1996.

**Exhibit 4-15**

**TOTAL INTERIM LOST USE VALUE**
**BLOCK ISLAND SOUND PARTY AND CHARTER BOAT ANGLERS**

| State | Party/Charter Angler-Trips Lost Due to the *North Cape* Oil Spill | Value Per Angler-Trip | Interim Lost Use Value Due to the *North Cape* Oil Spill |
|---|---|---|---|
| Rhode Island | 2,100 | $85.23 | $178,983 |
| New York | 1,205 | $85.23 | $102,702 |
| TOTAL | 3,305 | $85.23 | $281,685 |

### 4.5.2 Recreational Diving

Rhode Island contains a large number of popular dive sites, including wrecks and rock formations. The shallow depths of many sites, relatively warm water temperature and convenience combine to make Rhode Island an attractive dive destination. Primary users of the resource reside in Rhode Island, Massachusetts, Connecticut and New York. As a result of the *North Cape* spill, recreational divers may have reduced the number of dives taken in Rhode Island and/or experienced a reduction in dive quality.

To determine if the *North Cape* oil spill adversely affected service flows to recreational divers, the Trustees explored two primary sources of information. First, the Trustees interviewed divers, dive shop owners and dive boat captains. Second, the Trustees contacted industry trade organizations and regional equipment dealers. The Trustees contacted these two groups to evaluate responses from direct users of the resource as well as evaluate aggregate diving trends across New England.

[8] We adjust values to 1998 dollars using the Consumer Price Index in the *Economic Report of the President*, February 1998 and assume a three percent inflation rate for 1999.

The interviews were designed to collect information on the characteristics of Rhode Island diving, diver preferences, and diver reaction to the spill. Between October 24 and December 6, 1996, the Trustees conducted a total of 18 in-person and telephone interviews, each of which lasted approximately 45 minutes to one hour. Exhibit 4-16 lists the number of individuals interviewed by group and state of residence. The results of these interviews, summarized below, are described in more detail in a separate report (Curry 1997).

**Exhibit 4-16**

**RECREATIONAL DIVING INTERVIEW PARTICIPANTS**

| Group | Number of Interviews | States of Residence |
|---|---|---|
| Divers | 8 | Rhode Island -- 2<br>Connecticut -- 2<br>Massachusetts -- 3<br>New York -- 1 |
| Dive Shop Owners | 6 | Rhode Island -- 6 |
| Dive Boat Captains | 4 | Rhode Island -- 3<br>Massachusetts -- 1 |

The majority of divers interviewed did not believe the oil spill affected their decision to dive in Rhode Island. Some evidence, however, does suggest that the *North Cape* oil spill had the potential to reduce the number of dive trips taken in Rhode Island during 1996. These impacts are associated with a small minority of divers that either canceled planned January trips or avoided the spill area later in the year because of a perception of substandard conditions. Available evidence from the interviews suggests that the oil spill did not actually reduce dive quality.

The available data are not sufficient to quantify the number of trips that may have been lost as a result of the spill. In addition, there are no other easily accessible data sources that would significantly improve the Trustee's ability to estimate potential spill-related losses to recreational divers. Further, developing reliable estimates of trip reductions and then apportioning those reductions to the *North Cape* spill would require research funds that could exceed the value of the potential lost trips. The Trustees conclude that it would not be cost-effective to pursue additional quantification of recreational diving losses resulting from the *North Cape* oil spill.

### 4.5.3 Beach Use

Charlestown, East Matunuck, Roger Wheeler, Salty Brine and South Kingstown public beaches all lie within the immediate area of the spill (see Exhibit 4-17). RIDEM surveys conducted in January, February and April 1996 detected oil from the *North Cape* spill on these five beaches (Mulhare and Therrien 1996). Although it is likely that all physical traces of oil were gone by the beginning of the beachgoing season in mid-May, some members of the public may have canceled trips to these beaches or visited other areas because of uncertainty about spill impacts or adverse perceptions about beach quality.

To evaluate this potential injury, the Trustees compared attendance at the five assessment beaches to both in-state and out-of-state controls. Oil from the spill did not reach Misquamicut, Scarborough South, Scarborough North or Fort Adams beaches in Rhode Island. The Trustees refer to these four beaches as Rhode Island control beaches. The Trustees also compare attendance records from the assessment beaches to two northern Connecticut state beaches (Rocky Neck and Hammonasset) and two southern Massachusetts state beaches (Horseneck and Demarest Lloyd).

Comparison of data from the summer of 1996 with data from the summer of 1995 does not suggest a decline in beach attendance due to the effects of the *North Cape* spill in January 1996. Although attendance decreased on many beaches oiled by the spill in 1996, attendance decreased by an equal or greater amount on Rhode Island beaches that were not oiled and on nearby beaches in Connecticut and Massachusetts. Combined attendance at all assessment beaches dropped 7.3 percent from 1995 to 1996, compared to a 12.8 percent decrease at Rhode Island controls and a 8.3 percent decrease at out-of-state controls.

To further evaluate the general, area-wide decrease in attendance at control and assessment beaches, the Trustees compare attendance to temperature and precipitation patterns. While water temperature, vacation scheduling and other factors also will influence beach attendance, weather is an important parameter that may partly explain area-wide attendance trends. Weather data indicate a 2.5 °F decrease in average maximum daily temperature from the summer of 1995 to the summer of 1996 (Lookingbill *et al*. 1996). Also, the number of days without precipitation between 10:00 a.m. and 6:00 p.m. decreased from 86 over the summer of 1995 to 79 over the summer of 1996 (Lookingbill *et al*. 1996). The cooler, rainier weather during 1996 helps explain the observed, region-wide decreases in 1996 beach attendance.

Based on these data, the Trustees conclude that the *North Cape* oil spill did not adversely affect beach attendance during the summer of 1996. These results are described in more detail in a separate report (Lookingbill *et al*. 1996).

### 4.5.4 Refuge Visitation

The Ninigret National Wildlife Refuge Complex contains six separate refuges: Ninigret NWR, Block Island NWR, Pettaquamscutt Cove NWR, Sachuest Point NWR, Stewart B. McKinney NWR, and Trustom Pond NWR. Portions of the Trustom Pond NWR were oiled during the *North Cape* spill. In addition to the ecological injuries described in other sections of this chapter, public visitation to the refuge might have been adversely affected by the spill.

In an October 15, 1996 telephone interview, the Ninigret Complex staffer who compiles visitation data indicated that there have been no reported cancellations of group visits to the refuge complex attributable to the oil spill (Charbonneau 1997).

**Exhibit 4-17**

Analysis of historical and reference area data from fiscal years 1994 through 1996 support the finding that visitation to the Trustom Pond NWR was not affected by the oil spill.[9] In fiscal year 1995, visitation at the Ninigret Complex as a whole and Trustom Pond NWR in particular decreased substantially from fiscal year 1994 levels. In fiscal year 1996 (which includes the spill), there was a resurgence in visitation to a level below the fiscal year 1994 level but well above the fiscal year 1995 level.

Based on these data, the Trustees conclude that the *North Cape* oil spill did not adversely affect Trustom Pond NWR visitation. These results are described in more detail in a separate report (Charbonneau 1997).

[9] Visitation data for the Ninigret complex are available on a fiscal year basis. The USFWS fiscal year runs from October 1 through September 30 of the following calendar year. For example, fiscal year 1996 begins October 1, 1995 and ends September 30, 1996.

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**RESTORATION ALTERNATIVES CHAPTER 5**

## 5.1 RESTORATION STRATEGY

The goal of the Oil Pollution Act of 1990 (OPA) is to make the public whole for injuries to natural resources and services resulting from oil spills. OPA requires that this goal be achieved by returning injured natural resources to their baseline conditions and by compensating for any interim losses of natural resources and services which occur during the period of environmental recovery (15 CFR Part 990.53).

Restoration actions under OPA are termed primary or compensatory. Primary restoration is any action taken to enhance the return of injured natural resources and services to their baseline condition. Trustees may elect to rely on natural recovery rather than primary restoration actions in situations where feasible or cost-effective primary restoration actions are not available, or where the injured resources will 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 severity and extent of resource injury and how quickly the resource and associated service returns to baseline. Primary restoration actions that speed resource recovery will reduce the requirement for compensatory restoration.

To plan restoration for injuries resulting from the *North Cape* oil spill, the Trustees first consider possible primary restoration actions for each injury and determine whether primary restoration should be implemented. The Trustees then consider the type and scale of compensatory restoration that can best compensate for lost resources and services during the recovery period.

Restoration alternatives must be scaled to ensure that their size appropriately reflects the magnitude of injuries resulting from the spill. Where feasible, the Trustees employ a resource-to-resource scaling methodology. Under this approach, the Trustees determine the scale of restoration actions that will provide natural resources and/or services of the same type and quality and comparable value to those lost.[1]

Scaling compensatory restoration alternatives is more complex in situations where it is not feasible or cost-effective to directly replace the injured resource or service with similar resources or services. When restoration provides different resources or services from those injured, Trustees must determine the appropriate trade-off between the injured resources and those provided by restoration.

The scaling calculations set forth in this chapter are based on ecological models that use the available data and the best professional judgment of the Trustees. The precision of scaling calculations often is uncertain due to incomplete knowledge of the relevant physical and biological processes, as well as important project-specific scaling parameters. Out of necessity, the calculations utilize many simplifying assumptions while seeking to fairly estimate the magnitude of restoration required to compensate for injuries resulting from the *North Cape* spill. The Trustees invite comment on the adequacy of these calculations and suggestions for cost-effective improvements to scaling for all restoration alternatives. Specific scaling assumptions and calculations are described later in this chapter and in referenced documents in the Administrative Record.

The restoration alternatives included in this chapter are based on conceptual designs rather than on detailed engineering design work or operational plans. Details of specific projects and monitoring plans may require additional refinement and adjustments or changes to suit site conditions or other factors. Restoration project and monitoring program designs also may change to reflect public comments and further Trustee analysis.

The Trustees assume that implementation of restoration projects will begin in 2000. To the extent that actual implementation occurs after this date, the Trustees will appropriately revise the scaling calculations.

The Trustees estimate the major cost elements for each restoration alternative on a preliminary basis, using unit costs in effect in April 1998. Because of limited significance, no adjustment is made for cost inflation to reflect the assumption that restoration actions will be implemented in 2000. If project implementation is delayed beyond this date, the Trustees may increase cost estimates to account for inflation.

The enclosed cost estimates were developed in accordance with the prices and charges the Trustees would face if they were to implement the projects themselves. These cost estimates

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[1] Under specific circumstances, OPA regulations also allow the Trustees to use a valuation scaling approach that determines the scale of restoration actions needed to produce resources and/or services equal in value to those lost because of the spill, or that cost an amount equal in value to those lost because of the spill (15 CFR Part 990.53).

are the Trustee's best current estimates. After estimating the cost elements associated with each preferred restoration alternative, the Trustees add a contingency factor of 25 percent to account for the uncertainties inherent in these preliminary costs. This 25 percent contingency is intended to cover the risk that the costs of the projects will turn out to be higher than expected and/or the risk that the projects will not result in the expected magnitude of benefits and may need augmentation.

The Trustees estimate that $1.3 million will be needed for Trustee oversight of *North Cape* restoration projects. These funds will be used by the Trustees to review data and reports assessing the progress and results of *North Cape* restoration projects, participate in Trustee meetings and conference calls and otherwise ensure that restoration objectives are met. This estimate of oversight costs was calculated by multiplying total project costs ($26.3 million) by five percent. It is important to note that oversight costs are distinct from project implementation costs, which are included in the project costs described in more detail later in this chapter.

All of the cost estimates developed in this chapter assume that the associated restoration alternatives are implemented by the Trustees. Project costs may be different if one or more projects are implemented by the RP. In addition, RP implementation may affect estimates of Trustee oversight costs, as Trustee oversight requirements may change.

## 5.2 SUMMARY OF POTENTIAL RESTORATION ALTERNATIVES

The Trustees have identified 25 alternatives potentially capable of restoring natural resources injured as a result of the *North Cape* spill.

Many of the restoration alternatives could serve either as primary or compensatory restoration, or as both. While some alternatives are directed at a specific resource injury (e.g., adult lobster restocking), other alternatives such as land acquisition would result in general water quality and habitat improvements that would benefit a number of injured resources or services. Exhibit 5-1 shows the primary and compensatory alternatives, including preferred alternatives, considered for each of the major resource or service injuries set forth in Chapter 4.

Exhibit 5-1 shows relatively few primary restoration alternatives for most injuries, because the relatively rapid rate of natural recovery for many resources injured by this spill suggests that they may be best served by restoring themselves. The Trustees conducted only a limited review of primary restoration options for resources with short natural recovery periods (less than two or three years).

Exhibit 5-1 shows many more compensatory alternatives for restoration of injured or equivalent resources for most injuries. As noted above, some alternatives would provide similar resources to those injured, while other alternatives would compensate by providing a related or equivalent resource enhancement. The logic for selecting alternatives that provide an equivalent resource or service as compensation, and the scaling of these alternatives, is described in detail later in this chapter and in referenced documents in the Administrative Record. Brief descriptions of each option are provided in Exhibit 5-2.

**Exhibit 5-1**

***NORTH CAPE* OIL SPILL: RESTORATION ALTERNATIVES CONSIDERED FOR EACH INJURY**

| Injured Resource/ Service | Primary Restoration Alternatives[1] | Compensatory Restoration Alternatives[1] |
|---|---|---|
| **Offshore** | | |
| Lobsters | **Natural Recovery**<br>Adult Lobster Stocking (1)<br>Hatchery Stocking (2)<br>Transplanting (3)<br>Habitat Enhancement (4)<br>Sanctuary (5) | **Adult Female Lobster Restocking and Protection (1)**<br>Hatchery Stocking (2)<br>Transplanting (3)<br>Habitat Enhancement (4)<br>Sanctuary (5) |
| Surf Clams | **Natural Recovery**<br>Hatchery Stocking **(6)**<br>Transplanting (7) | Hatchery Stocking (6)<br>Transplanting (7)<br>**Shellfish Restoration (9)** |
| Other Benthic Organisms/Fish | **Natural Recovery** | **Land Acquisition (8)**<br>**Shellfish Restoration (9)**<br>Package Treatment Plants (17)<br>Salt Marsh Creation (18)<br>Fish Stocking (19)<br>Breachway Dredging (20)<br>Anadromous Fish Runs (16)<br>Eelgrass Restoration (21)<br>Phragmites Removal (10) |
| **Salt Ponds** | | |
| Worms/Amphipods<br>Crabs/Shrimps<br>Forage Fish/Winter Flounder | **Natural Recovery**<br><br>Fish Stocking (18) | **Land Acquisition (8)**<br>Shellfish Restoration (9)<br>Package Treatment Plants (17)<br>Salt Marsh Creation (18)<br>Fish Stocking (19)<br>Breachway Dredging (20)<br>Anadromous Fish Runs (16)<br>Eelgrass Restoration (21)<br>Phragmites Removal (10) |
| Shellfish | **Natural Recovery** | Land Acquisition (8)<br>**Shellfish Restoration (9)**<br>Package Treatment Plants (17)<br>Salt Marsh Creation (18)<br>Fish Stocking (19)<br>Breachway Dredging (20)<br>Anadromous Fish Runs (16)<br>Eelgrass Restoration (21)<br>Phragmites Removal (10) |
| **Birds** | | |
| Piping Plovers | Natural Recovery<br>**Plover Protection (11)** | **Plover Protection (11)** |
| Loons | **Natural Recovery**<br>Loon Habitat Protection (12)<br>Loon Nest Site Enhancement (13)<br>Loon Public Outreach/ Education (14) | **Loon Habitat Protection (12)**<br>Loon Nest Site Enhancement (13)<br>Loon Public Outreach/Education (14) |
| Marine Birds other than Loons | **Natural Recovery**<br>Marine Bird Habitat Protection (15) | **Marine Bird Habitat Protection (15)** |
| Pond Birds | **Natural Recovery** | **Land Acquisition (8)**<br>Shellfish Restoration (9)<br>Package Treatment Plants (17)<br>Salt Marsh Creation (18)<br>Fish Stocking (19)<br>Breachway Dredging (20)<br>Eelgrass Restoration (21)<br>Phragmites Removal (10) |
| **Human Use** | | |
| Party and Charter Boat Fishing | **Natural Recovery** | **Anadromous Fish Runs (16)**<br>Public Rights of Way (22)<br>**Shore Access (23)**<br>Boat Ramps (24)<br>Fishing Reef (25) |

| |
|---|
| [1]Preferred alternatives are indicated in bold text. Number in parentheses is alternative number in Exhibit 5-2. |

**Exhibit 5-2**

***NORTH CAPE* OIL SPILL: DESCRIPTION OF POTENTIAL RESTORATION ALTERNATIVES**

| | Restoration Alternative* | Description |
|---|---|---|
| 1 | **Adult Female Lobster Restocking and Protection** | An adult female lobster restocking program would increase the number of female adult lobsters in the impact area, leading to increased egg production and expected increases in future juvenile and adult lobster populations. |
| 2 | Hatchery Stocking of Lobsters | Stocking hatchery-reared post-larval or juvenile lobsters into the impact area would replace the lost lobsters. |
| 3 | Transplanting of Juvenile Lobsters | Transplanting lobsters from another location to the impact area would replace the lost lobsters. |
| 4 | Lobster Habitat Enhancement/Creation | Creation of cobble/rocky reefs in selected areas at or near the impact area would provide additional habitat for lobsters and increase their population. |
| 5 | Creation of a Lobster Sanctuary | Restricting the harvest of adult lobsters in a sanctuary near the impact area would increase the number of eggs produced by protected females, leading to increases in future juvenile and adult lobster populations. |
| 6 | Hatchery Stocking of Surf Clams | Surf clams would be seeded from hatchery stock to replace lost surf clams. |
| 7 | Transplanting of Surf Clams | Surf clams would be transplanted from another location to replace lost surf clams. |
| 8 | **Water Quality Improvement Through Land Acquisition** | Residential development of land in the salt pond watershed area would be prevented by acquiring properties. Preventing development would reduce future nitrogen loading to the ponds, thereby sustaining water quality and biological productivity. |
| 9 | **Shellfish Restoration** | Shellfish would be added to the coastal salt ponds, Great Salt Pond on Block Island, and/or Narragansett Bay to address shellfish injuries. |
| 10 | Phragmites Removal | Removing the common reed *Phragmites australis* and altering existing hydrologic regimes would improve the quality of wetland habitat. |
| 11 | **Piping Plover Habitat Protection and Monitoring** | Piping plover reproductive success would be increased by protecting and monitoring off-refuge sites. |
| 12 | **Loon Habitat Protection** | Protecting loon breeding and nesting grounds would increase loon survival and reproductive success. |
| 13 | Loon Nest Site Enhancement | Artificial nesting sites would be created in areas of poor shoreline nesting habitat or fluctuating water levels to improve nesting success. |
| 14 | Loon Public Outreach and Education | Existing outreach and education efforts would be expanded to reduce human impacts on loon productivity. |
| 15 | **Marine Bird Habitat Protection and Enhancement** | Protecting breeding and nesting grounds would increase survival and reproductive success. |
| 16 | **Anadromous Fish Run Restoration** | Existing dams or other obstructions would be modified to allow passage of alewives and herring, resulting in increased stocks of these fish in future years. |
| 17 | Package Treatment Plants | Sewage treatment technologies would be used to reduce nitrogen loadings to the salt ponds from existing homes with conventional septic systems. |
| 18 | Salt Marsh Creation | A four acre upland parcel adjacent to Succotash Marsh would be restored to its former condition as salt marsh. |
| 19 | Fish Stocking | Juvenile fish would be raised in a hatchery and introduced into the salt ponds. |
| 20 | Breachway Dredging | The Charlestown breachway and portions of the Ninigret Pond tidal delta would be dredged to improve flushing and water quality and planted with eelgrass. |
| 21 | Eelgrass Restoration | Eelgrass would be transplanted to locations in Pt. Judith and Ninigret Ponds to provide habitat. |
| 22 | Maintenance of Public Rights of Way | Historic public rights of way would be identified, posted and monitored to maintain public access. |
| 23 | **Shore Fishing Access** | Land would be acquired and/or public stairways, walkways and piers would be reconstructed or enhanced to improve access to users. |
| 24 | Boat Ramp Construction and Enhancement | Construction of additional boat ramps or enhancement of existing ramps would ease access or create new access to the water for fishing and diving user-groups. |
| 25 | Artificial Fishing Reef Creation | An artificial reef would provide habitat for fish and shellfish to enhance access to resources for fishing and diving user-groups. |

* Preferred alternatives are indicated in bold text.

## 5.3 EVALUATION CRITERIA

OPA regulations require Trustees to develop a reasonable range of primary and compensatory restoration alternatives, then identify preferred restoration alternatives based on the following criteria:

> The 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;
>
> The likelihood of success of each alternative;
>
> The 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;
>
> The extent to which each alternative benefits more than one natural resource and/or service;
>
> The effect of each alternative on public health and safety; and
>
> The cost to carry out the alternative.

Based on a thorough evaluation of a number of factors, including those listed above, the Trustees have selected preferred restoration alternatives for primary and compensatory restoration of natural resources. Information supporting the Trustees' selection of restoration alternatives is provided throughout the remainder of this chapter.

In practice, the Trustees seek to restore injured natural resources in kind, while working to maximize ecosystem benefit, benefit to human uses of the environment (such as fisheries), and cost-effectiveness of restoration as a whole. Where practical and beneficial, restoration actions are selected that restore the species killed by the oil spill at the geographic location of the injury. In some cases, however, restoration of species killed may not be possible or beneficial and enhancement of alternative species may provide similar services. In other cases, increased benefits and improved cost-effectiveness may be provided by addressing several injured species or classes of injury with a single restoration project. The restoration alternatives considered by the Trustees to address injuries caused by the *North Cape* spill are described in detail in the following subsections.

## 5.4 EVALUATION OF RESTORATION ALTERNATIVES

### 5.4.1 No-Action Alternative

The National Environmental Policy Act (NEPA) requires that the Trustees evaluate the "no-action" alternative, which is also an option that can be selected under OPA. Under this alternative the Trustees would take no direct action to restore injured natural resources or compensate for lost services pending environmental recovery, and so would rely only on natural recovery. While natural recovery would occur over varying time scales for the various injured resources, the interim losses suffered would not be compensated under the no-action alternative.

The Trustee's responsibility to seek compensation for interim losses pending environmental recovery is clearly set forth in OPA, and can not be addressed through a no-action alternative. While the Trustees have determined that natural recovery is appropriate as a primary restoration decision for all injuries except piping plovers, the “no-action” alternative is rejected for compensatory restoration because significant losses were suffered during the period of recovery from the *North Cape* spill, and technically feasible and cost-effective alternatives exist to compensate for these losses.

### 5.4.2 Lobster Restoration

The Trustees estimate that approximately 9.0 million lobsters were killed by the spill, of which roughly 67 percent were less than 30 millimeters carapace length (CL) and in their first or second year of life. Legal sized lobsters, which are more than 82.6 millimeters (3.25 inches) CL and generally five or more years old, accounted for about 15,300 of the killed lobsters (French 1998b). As described below, the adult female restocking project is the Trustees' preferred restoration alternative for this injury. Through this alternative, female adult V-notched lobsters will be introduced into the environment to produce lobster eggs in numbers sufficient to replace the distribution of lobsters killed by the spill (French 1999a). “V-notching” refers to the practice of cutting a V-shaped notch in a lobster’s tail to mark the animal for conservation.

The Trustees considered restocking programs for lobsters both with protection (by V-notching) and with no protection. However, because of the heavy fishing pressure on adult lobsters, restocked animals under no protection would have a very high probability of being caught again before eggs could be produced. Thus, the number of lobsters needed for restocking under no protection is higher than those needed if they are protected, so the V-notching approach is more cost-effective.

#### 5.4.2.1 Preferred Alternative: Adult Female Lobster Restocking and Protection

**Project Description**

In its simplest form, adult female lobsters from inshore Southern New England populations are purchased from local dealers, "V-notched", and reintroduced into the environment. State legislation or regulatory changes throughout the region have been enacted recently to prohibit lobster harvesters from landing V-notched lobsters. Educational outreach to lobstermen, buyers, distributors and other affected parties is needed to inform them about the program and its requirements. Enforcement efforts are necessary to evaluate compliance rates and encourage adherence to harvest restrictions. Finally, a monitoring program will be needed to measure progress towards restoration objectives. Application of external tags to the V-notched lobsters would be a critical component, as it would allow the Trustees to measure parameters related to project success (e.g., adult survival, V-notch duration, and egg production) and gather additional information of scientific value from recaptured V-notched lobsters.

**Restoration Objectives**

An adult female restocking and protection program using inshore, Southern New England lobsters would increase the number of adult female lobsters in the impact area, leading to increased egg production, which in turn is expected to increase future juvenile and adult lobster populations. Trustee calculations indicate that restocking and "V-notching" an estimated 1.248 million adult female lobsters (from 2000 through 2004) is expected to produce approximately 23 billion eggs, which should be sufficient to restore the 9.0 million lobsters lost due to the spill.[2] Given the rate of natural recovery and the time required for a restocking project to produce juvenile lobsters, this project would not accomplish primary restoration, and therefore would be compensatory in nature.

**Scaling Approach**

To appropriately scale this project, it is first necessary to determine the number of eggs needed to produce a size distribution of lobsters equivalent to those lost due to the spill. Trustee analyses indicate that the 9.0 million lobsters killed were produced from approximately 17.2 billion eggs into the offshore environment (French 1999a, Gibson 1998). This estimate was developed using available information on lobster mortality rates, growth rates, sexual maturation and fecundity-size relationships in female lobsters. If, as believed, lobster populations are relatively stable over time (i.e., "in equilibrium"), it is expected that replacement of 17.2 billion eggs would eventually produce the same distribution of approximately 9.0 million lobsters.

The next step in the scaling analysis involves estimation of the number of adult females needed to produce the 17.2 billion eggs. This estimate relies on projections of the length of time lobsters will be protected by the V-notch (V-notches only last between 1-2 molts), program compliance rates and handling loss. With regard to the likely duration of V-notch protection, the Trustees assume two years. This two year protection assumption reflects certain identification of the V-notch after one molt and partial recognition after two molts, and an average intermolt period of approximately 1.6 years (Gibson 1998).

[2] If the project is begun in 1999, the v-notch requirement would be 1.211 million female lobsters. Early implementation reduces the impact of the three percent annual discount rate applied to account for the difference in timing between injury and restoration.

Program non-compliance losses are expected to be 50 percent, which is an average over the proposed five-year period. Rhode Island lobstermen will not be accustomed to considering the presence of v-notched lobsters in their harvest and adaptation to the new program will require education, effort, and time. Therefore, the Trustees estimate that 50 percent of restocked lobsters will be harvested inadvertently because of this learning process. Based on the egg equivalence calculation and the program assumptions described above, the Trustees estimate that 0.97 million adult females would be needed to meet restoration objectives.

The preceding analysis does not account for the lag between the date of injury and restoration. Assuming the restocking program occurs in equal proportions each year from 2000 through 2004, adult female lobsters will be reintroduced between four and nine years after the spill. Furthermore, there will be a lag before the restocked females produce eggs, and these eggs mature to the sizes of the lobsters killed by the spill. To account for these timing differences, the required number of lobsters is increased by three percent per year for the appropriate number of lag years, resulting in a total of 1.26 million female V-notched lobsters, which are expected to produce 23 billion eggs. These discounting calculations are described in more detail in French (1999a).

In the final step of the scaling calculations, the Trustees slightly reduce the 1.26 million female lobster total to account for adult lobsters already introduced into the environment by the Responsible Party. By prior agreement with the RP, the Trustees allow restoration "credit" for lobsters purchased by the RP immediately after the spill, tested, and returned to the environment after meeting all state and federal standards. Trustee records indicate that approximately 12,300 lobsters were purchased by the RP for this purpose. Therefore, the Trustees reduce the V-notching requirement from 1.26 million to 1.248 million female lobsters from the inshore, Southern New England population.

**<u>Probability of Success</u>**

The most certain benefit of this project is an increase in the number of adult females in the affected area, which will lead to increases in egg production. The impact of this project on egg and larval production may be greatest if restocked female lobsters are harvested from inshore waters. Available information indicates that average lobster size at sexual maturity can vary substantially between offshore and inshore populations in Southern New England (T. Angel, pers. comm. 1997). Because inshore lobsters typically reach sexual maturity at a smaller size, the likelihood of restocking sexually immature females would be reduced if inshore populations were used to supply the project.

The fate of the additional eggs produced by restocked adult females is uncertain. The dispersal of lobster larvae by currents makes it difficult to predict settlement locations. In addition, it would be difficult to disentangle the effects of the restocking program from other environmental and behavioral factors that affect local larval abundances and lobster populations. However, current and proposed lobster management efforts by state and federal agencies are focused on increasing egg production. Therefore, the proposed restocking project is consistent with current lobster management measures.

In compliance with the Atlantic States Marine Fisheries Commission's Amendment 3 to the Lobster Fishery Management Plan, Massachusetts, Rhode Island, Connecticut, and New York have each passed a prohibition on the possession of v-notched, female lobsters. In addition, lobster harvesters holding a permit to fish in Federal waters are prohibited from possessing v-notched lobsters. Given the lobsters' migratory behavior and the movement of harvesters, enforcement of these regulatory measures is critical to the success of the project.

**Performance Criteria and Monitoring**

For reasons previously described (e.g., the wide geographic dispersal of larvae and the varying impacts of environmental and behavioral factors) it is unlikely that a monitoring program could directly measure the effect of the restocking program on local lobster populations. Therefore, it is unlikely that the Trustees will be able to directly determine if the appropriate number of juvenile lobsters are produced by the restoration. However, the Trustees will be able to measure the egg production of the 1.248 million adult, female, V-notched lobsters. Therefore, the performance standard for this project is production of the 23 billion eggs that Trustee calculations indicate are necessary to replace the 9.0 million lobsters killed by the oil spill.

As described above in the scaling section, several important assumptions were used to calculate the number of V-notched females needed to produce the 23 billion eggs. These include: V-notch duration, survival rate of the V-notched lobsters (expressed as a 50% loss), and fecundity of legal-sized lobsters. To determine if the project is meeting the goal of producing 23 billion eggs, the Trustees must evaluate the validity of these assumptions. Therefore, the monitoring program will have two interrelated objectives: (1) to determine the survival rate of female, V-notched lobsters; and (2) to determine the reproductive output of V-notched female lobsters. The monitoring program will provide information for evaluation of the restoration project on an annual basis thereby allowing mid-course corrections to be implemented if required.

The Trustees will document that 1.248 million female lobsters come from the inshore Southern New England populations, are purchased, V-notched, and released in a healthy condition to Block Island Sound. Second, a sample of V-notched lobsters will carry an external tag visible to lobster harvesters when caught. An at-sea sampling effort modeled after the existing Rhode Island Department of Environmental Management's lobster monitoring program will be used to sample V-notched, tagged lobsters. This effort will record the total number of lobsters V-notched, tagged, and released per trip per day and the date, location, tag identification number, size, and reproductive status of each V-notched lobster before returning it to the water. The specific parameters to be monitored to verify the success of the restocking project are:

(1) Tag number;
(2) Carapace length;
(3) Molt stage;
(4) Presence of eggs;
(5) Age of eggs;
(6) Presence of sperm plug;
(7) Cement gland stage;

(8) V-notch status;
(9) Release/recapture date; and
(10) Release/recapture location (latitude/longitude coordinates).

Other parameters to be recorded by the scientific sea sampling program include:

Total number of V-notched lobsters caught per trip;
Total number of tagged V-notched lobsters caught per trip; and
Total number of "wild" legal lobsters caught (non tagged/non V-notched) per trip

The purpose of tagging a portion of the V-notched lobsters is to estimate the mortality rate of the restocked V-notched lobsters. Once survival is estimated, the reproductive output (fecundity) of the V-notched females can be calculated from the proportion of ovigerous individuals and their associated size (carapace length). Generally, survival estimates from tag-recapture studies compare the proportion of non-tagged individuals to tagged individuals between specified time intervals. If the ratio changes from one time period to the next the change can be attributed to a difference in survival (all else equal). Collecting data on the reproductive status (e.g., presence of sperm plug, cement gland state, egg color, etc.) of the tagged, V-notched lobsters both before they are returned to the water and at the time of recapture will provide the Trustees with evidence that the lobsters are reproducing at expected levels during the period of protection provided by the V-notch.

The goal of the V-notching project is to produce 23 billion eggs, from which the 9.0 million "replacement" lobsters will eventually develop. As data is compiled and analyzed on an annual basis, adult survival and egg production estimates will be calculated. If the data indicate that the egg production goal is not being achieved, mid-course corrections will be implemented (i.e., if egg production falls short more females can be V-notched or, conversely, if egg production exceeds the goal fewer individuals will be V-notched in later years of the project).

**Approximate Project Cost**

The cost estimate of restocking 1.248 million female lobsters includes six major elements: the cost of adult lobsters; the handling cost of V-notching purchased lobsters and returning them into the water; the cost of a monitoring program; the cost of education and outreach for lobster harvesters; project implementation costs; and a 25 percent contingency cost. These costs are summarized in Exhibit 5-3. As shown, total costs for this alternative are estimated to be $9.9 million[3] for this five-year project.

[3] If the Adult Lobster Restocking and Protection alternative is implemented in 1999, the total cost for the five-year project will be $ 9.63 million.

**Exhibit 5-3**

**LOBSTER V-NOTCHING APPROXIMATE PROJECT COSTS**

| Cost Element | Total Cost |
|---|---|
| **Purchase of Lobsters** | |
| (1.248 million lobsters x 1.25 lb per lobster x $3.83 per lb ex-vessel price) | $5,974,800 |
| **Handling Cost** | |
| (780 days @ $1,000 per day) | $780,000 |
| Labor Cost (312 laborer days/year x $120/day x 5 years) | $187,200 |
| **V-notch Monitoring** | |
| Tag Cost (200,000 lobsters @ $350 per 1,000 tags) | $70,000 |
| At-Sea Sampling and Data Analysis (5 years) | $525,500 |
| **Education and Outreach** | $20,000 |
| **Project Implementation** (five years) | $375,000 |
| **Contingency (25%)** | $1,983,125 |
| **Total** | $9,915,625 |

The largest cost associated with this project is the purchase of adult female lobsters, estimated to cost $5,974,800. This estimate was calculated using the following equation:

1.248 million lobsters x 1.25 lb per lobster x $3.83 per lb ex-vessel price = $5,974,800.

The estimate of lobster price per pound is equal to the 1998 average ex-vessel price in Rhode Island. This analysis assumes that the Trustees will be able to purchase lobsters at prices very close to the ex-vessel price, although the Trustees will likely buy from dealers. Because of the volume and predictability of Trustee demand, it is expected that their purchase price from dealers will be very close to the ex-vessel prices.

To calculate handling costs, the Trustees assume that three lobster boats could V-notch and replace a total of 6,000 pounds of lobsters per day. At this rate, 52 days of total effort per boat will be required for each of five years, for a total effort of 780 boat-days. The Trustees estimate a cost of $1,000 per boat-day, which equals $780,000. Trustees also estimate costs for labor to V-notch the lobsters. The estimate is as follows:

2 laborers/boat x 3 boats x 52 days/year = 312 laborer days/year
312 laborer days/year x $120/day ($15/hour) = $37,440/year
$37,440/year x 5 years = $187,200

Thus, total handling costs for V-notched lobsters are estimated to be $967,200. Monitoring costs are estimated to be $595,500 for the five-year duration of the project. The monitoring program cost includes tagging costs, tag retrieval and data collection and analysis. This cost assumes that the monitoring program will be folded into the Rhode Island Department of Environmental Management's existing lobster monitoring program. The cost of education and outreach of lobster harvesters is expected to be $20,000. Project implementation costs are expected to be $375,000 for the five-year duration of this project; these costs reflect management and personnel expense needed to manage the activities described above.

### Environmental and Socio-Economic Impacts

The Trustees believe that the harvesting, V-notching and reintroduction of lobsters from Block Island Sound will provide positive social and economic benefits and will have minimal negative impacts on the environment. The lobsters used for the project will be harvested using standard lobster traps and purchased either directly from lobster harvesters or from lobster dealers onshore. Once purchased, a V-shaped notch about 1/4" deep will be cut into the lobster's tail. The incision is small and is not likely to harm the animal. This technique is routinely practiced in Maine and has not caused adverse impacts to lobsters in the Gulf of Maine fishery (J. Krouse, pers. comm. 1997).

V-notching raises a potential concern for the transmission of gaffkemia, a fatal bacterial disease that can be transferred to lobsters through an open incision. However, with appropriate precautions in program design, the risks of gaffkemia infection should be minimal. Handling of the lobsters from the initial harvesting until V-notched release back into Block Island Sound is expected to result in mortality of a small percentage of lobsters. With proper precautions, this loss can be kept to a minimum.

While the goal of the adult female lobster restocking program is to produce juvenile lobsters, the project will provide additional benefits to the local fishery. After one or two molts the V-notch will no longer be present on lobsters, at which point they will become eligible for harvesting. Because natural mortality rates for adult lobsters are low, it is likely that most of the restocked lobsters will eventually be harvested by lobstermen. In addition, the two years of protection provided by the V-notching program will increase the average size of restocked lobsters.

Finally, this project may have an impact on the price of lobster in Rhode Island. Assuming a project duration of five years, 249,600 female lobsters will have to be purchased annually. Based on average size of 1.25 pounds per lobster, this project will require the purchase of 312,000 pounds of lobsters per year. It is possible that purchases of this magnitude could raise demand enough to affect lobster prices. This problem may be minimized or avoided altogether by careful planning and timing of purchases to coincide with periods of relatively low demand (e.g., early spring, autumn), although biological factors must also be considered before finalizing the timing of purchases.

### Evaluation

Trustee analysis indicates that an adult female lobster restocking and protection program is the most cost-effective means available to compensate for the interim loss of 9.0 million lobsters killed by the *North Cape* oil spill. Although it is unlikely that the Trustees will be able to directly measure the project's impact on lobster populations, the monitoring of restocked lobsters will allow the Trustees to evaluate their survival and growth and compare expected and actual values for V-notch duration and female reproductive frequency. The limited information available from the literature suggests that a restocking and protection program using V-notching may be effective in increasing egg production (Daniel *et al*. 1989). Restocking and protection will not have an adverse impact on the environment and will not affect public health and safety.

### 5.4.2.2 Non-Preferred Alternative: Hatchery Stocking of Lobsters

Stocking of hatchery-reared lobsters requires the harvesting of egg-bearing females, hatching of their eggs in a controlled hatchery setting, rearing of the larval lobsters to a specified size in circulating water tanks, and then releasing them in the wild. Technology is available to rear and stock lobsters at a variety of different phases of the animal's early life-history. To enhance the chances of survival in the wild, research has been focusing on the rearing and releasing of larger lobsters (Addison and Bannister 1994). Costs and logistical difficulties, however, have limited most efforts to rearing lobsters to the post-larval stage (stage IV--about 4 millimeters carapace length).

Facilities capable of producing up to one million stage IV lobsters per year have been identified by the Trustees.[4] Other options for rearing lobster larvae would require either the construction of a new hatchery in the state of Rhode Island or the expansion of an existing bivalve hatchery in the region to include the production of lobsters.

Hatchery-reared lobsters must be transported in seawater tanks or cool, moist sieves from the hatchery location to the seeding site. The seeding location should be in cobble habitat which provides the necessary protection from predators (Wahle and Steneck 1991, Wahle and Steneck 1992). The Nebraska Shoals area off Moonstone Beach is an appropriate seeding location since this area was directly affected by the spill and contains the necessary type of bottom habitat. Seeding the lobsters with the aid of a SCUBA diver is probably the most effective method as the diver can ensure that the lobsters are seeded directly in cobble habitats, thus improving their chances of survival.

Since lobsters cannot be cost-effectively reared and released in the same size classes that were killed by the spill, the Trustees use survival rates for stocked post-larval lobsters to calculate the number required to generate, after normal growth and survival, the size-frequency distribution of those killed. In the first step of this analysis, the Trustees estimate the number of seven millimeter lobsters needed to compensate for the lobster loss. This calculation is made because the Trustees were able to develop site-specific survival rates for lobsters 7 to 85 millimeters in length using *North Cape* damage assessment data (Gibson *et al*. 1997a and b, Saila 1997, French 1998c, 1999a). The Trustees estimate that approximately 354 million 7-millimeter lobsters would be required to fully compensate for the lobster loss caused by the spill. Based on analysis in French (1998c, 1999a), approximately 52% of Stage IV lobsters are expected to survive to seven

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[4] It is unclear at this time whether one of the facilities identified will continue to operate as a hatchery for lobsters. If this hatchery closes maximum production capacity would be cut in half, to about 500,000 per year.

millimeters in carapace length. Therefore, approximately 681 million stage IV lobsters would be required to fully meet restoration objectives. Given a maximum production capacity of one million stage IV lobsters per year, the Trustees could annually stock less than 0.20 percent of the number required to compensate for the injury.

In concept, hatchery stocking could be used alone or in combination with V-notching to restore the lobster loss caused by the *North Cape* spill. However, production constraints limit annual stocking capacity to less than 0.20 percent of the number required to compensate for injury. Because this alternative cannot contribute significantly to lobster restoration, it is not a preferred option.

**Environmental and Socio-Economic Impacts**

Stocking hatchery-reared lobsters could potentially increase local lobster populations without adversely impacting the coastal waters of Rhode Island. If survival of the hatchery-reared lobsters were high, then local catches of lobsters would be expected to increase, providing a limited positive benefit to local lobster harvesters.

#### 5.4.2.3 Non-Preferred Alternative: Lobster Habitat Enhancement/Creation

For this project, a combination of cobble and boulders would be placed on areas of sand or mud bottom in Block Island Sound to create additional lobster habitat. The range of substrate size would provide refuge for lobsters in all age and size classes. Juvenile lobsters in particular prefer to live in shelter-providing habitats such as rocks and cobbles (Hudon 1987, Wahle and Steneck 1991, Wahle 1993).

If local lobster populations are limited by available habitat, the creation of rocky/cobble reefs should increase the local lobster population. Based on information obtained from the literature and lobster experts, it is unclear if lobster population growth in Rhode Island Sound is currently constrained by habitat availability. If, for example, harvesting of adult females has made egg production a constraining factor, additional habitat would not lead to significant increases in the lobster population.

Practical project constraints make it unlikely that enough habitat could be created to restore the lobster loss, even if it is assumed that existing populations are habitat-limited. Based on lobster density sampling in multiple locations in Block Island Sound and in control areas in Narragansett Bay (Cobb and Clancy 1998, Cobb *et al*. 1998), the Trustees estimate that a rock/cobble reef would provide additional habitat for approximately 1.76 lobsters per square meter per year. Assuming a three percent discount rate, a 50 year project life and approximate estimates of annual mortality rates, natural recovery time and project completion, approximately 324,000 square meters (~80 acres) of reef would be needed to compensate for the 9.0 million lobsters lost in the spill.

Based on available information, the Trustees determine that lobster habitat enhancement/ creation is not feasible at the scale required to restore the injury. Moreover, the overall benefit of additional lobster habitat is questionable given the possibility that local populations are not habitat-constrained. Therefore, lobster habitat enhancement/creation is not a preferred restoration option.

**Environmental and Socio-Economic Impacts**

At the scale necessary to compensate for the injured lobsters, a rock/cobble reef could substantially alter the bottom characteristics of the offshore environment off Rhode Island’s coast. A rock/cobble reef would most likely be located on a sandy, featureless bottom, thereby displacing the existing flora and fauna that depend upon that type of habitat and replacing it with one that relies upon a hard substrate. A large rock/cobble reef could also displace commercial trawlers that fish for a variety of species in Rhode Island’s coastal waters. A lobster reef may provide socio-economic benefits by increasing the local population of lobsters and providing additional lobster grounds for the commercial fishery.

### 5.4.2.4 Non-Preferred Alternative: Transplanting of Juvenile Lobsters

Under this option, the Trustees would identify a transplant source capable of providing lobsters in the number and size structure needed to meet restoration objectives. Once identified, the lobsters would be procured, transported to the impact area, and released. Trustee analysis identified several major problems with this approach. Most significant is the uncertain net environmental benefit of this type of transplanting project. While local lobster populations would increase, populations at the transplant source would experience a corresponding decrease. Thus, "relocation" of existing lobsters would not add significantly to the overall environmental stock of lobsters.

A variety of practical problems would adversely affect the likelihood of project success. Existing fishery protection efforts, including harvest restrictions for juveniles, would make it difficult to find a jurisdiction that would allow juvenile lobsters under its protection to be transplanted in appropriate numbers. Current regulations make it illegal to transport juvenile lobsters across state lines and international borders. Transplants from habitats with different environmental conditions (e.g., water temperature, bottom depth, predators) may not acclimate well to the new environment, resulting in low survival rates following transplantation. In addition, transplants from foreign environments may introduce disease or have negative impacts on the genetic composition of the indigenous population.

Based on this information, the Trustees determine that transplanting of juvenile lobsters would not restore the injury to lobsters caused by the *North Cape* spill. Therefore it is not a preferred restoration option.

**Environmental and Socio-Economic Impacts**

Transplanting juvenile lobsters is not likely to cause significant adverse impacts. However, as stated previously, the lobster populations at the transplant source could decrease and could upset the ecological balance in those locations. This alternative is unlikely to have any significant socio-economic impacts.

### 5.4.2.5 Non-Preferred Alternative: Creation of a Lobster Sanctuary

Development of a sanctuary would require Rhode Island to restrict the harvesting of adult lobsters in a defined area for a period of time sufficient to restore the lost lobster population. In theory, a lobster sanctuary could accomplish restoration objectives by increasing the number of adult females in the population, leading to increased larval production and greater numbers of juvenile lobsters in the future. In practice, the effectiveness of fisheries refugia in coastal fisheries management is difficult to measure. Direct evidence of impacts are generally restricted to short-term studies in small areas where harvest was prohibited or restricted, and the majority of studies make comparisons inside and outside refuges, rather than before and after harvest was restricted (Dugan and Davis 1993, Addison and Bannister 1994).

While establishing a sanctuary may benefit local lobster populations, scaling this restoration option to determine an appropriate size and duration would be difficult. One major factor complicating the development of sanctuary boundaries is lobster mobility. Fishing pressure would likely increase along the sanctuary edges, and so any lobsters that even temporarily ventured outside the confines of the sanctuary would likely be caught.

Enforcement of sanctuary restrictions could also be difficult. Moreover, this approach would face opposition from fishermen and other users of marine resources who might seek compensation for any new restrictions imposed on their use.

Based on this information, the Trustees determine that creation of a lobster sanctuary is not a preferred restoration option.

**Environmental and Socio-Economic Impacts**

The environmental impacts of a lobster sanctuary are likely to be minimal. The socio-economic impacts could be substantial. To be effective, a sanctuary would need to be located in existing lobster fishing grounds, thereby preventing harvesters from using their traditional fishing areas.

### 5.4.3 Bivalve Restoration

Trustee analysis indicates that approximately 19.4 million surf clams were killed by the *North Cape* oil spill, with a total biomass lost of roughly 970,000 kilograms (including initial kill and production foregone). Roughly 65 percent of the loss (by weight) was surf clams less than one year old, averaging about 15 millimeters in length. The remaining 35 percent of lost biomass was more than one year old (greater than 30 millimeters). The area of impact was primarily in the Nebraska Shoal area from Point Judith to Charlestown Beach (French 1998a).

In past years, surf clams were harvested commercially in the Harbor of Refuge and on Nebraska Shoal for human consumption and for use as codfish bait. At present, there is a small commercial fishery for surf clams in Rhode Island waters, and there is reported to be light recreational taking of this resource (A. Ganz, pers. comm. 1997). However, surf clams provide important ecological services, such as water filtration and benthic-pelagic coupling from feeding activity, food for fish and invertebrates that prey upon molluscan larvae and seed, benthic biomass, and habitat value.

The Trustees estimate that injured surf clam populations will naturally recover to baseline condition in three to five years. Natural recovery is therefore expected to be quicker and more cost-effective than active primary restoration alternatives, such as hatchery stocking or transplantation of surf clams, which would likely require several years to implement. Thus, natural recovery is the preferred alternative for primary restoration of the injured surf clam resource.

As compensatory restoration for the injury to surf clams caused by the *North Cape* oil spill, the Trustees considered several alternatives:

> Shellfish restoration: Restoration in the salt ponds, Great Salt Pond, and adjacent waters of Narragansett Bay of shellfish that provide ecological services similar to those lost as a result of the spill.
>
> Hatchery stocking of surf clams: Small surf clams or "seed" would be grown at an aquaculture facility, then released within the area of impact.
>
> Surf clam transplant: Movement of wild surf clams to relieve population density, thereby enhancing growth and reproduction.

#### 5.4.3.1 Preferred Alternative: Shellfish Restoration in the Salt Ponds

Shellfish restoration in the salt ponds, Great Salt Pond, and adjacent waters of Narragansett Bay is the Trustees' preferred alternative for surf clams killed by the *North Cape* oil spill. Shellfish provide ecological services similar to those lost due to the surf clam injury (e.g., water filtration, benthic-pelagic coupling from feeding activity; food for fish and invertebrates that prey upon molluscan larvae and seed, benthic biomass; and habitat value). Since shellfish have declined relative to their historic populations (primarily due to fishing pressure), it is reasonably certain that their restoration would result in enhanced ecological services in the area of spill impact, thus providing a net ecological benefit to compensate for the oil spill's injury to natural resources. Finally, shellfish restoration in the salt ponds, Great Salt Pond, and adjacent waters of Narragansett Bay is a feasible and proven technique, since restoration of shellfish has a long history in Northeastern estuaries, with well-developed methodologies and reasonably well-documented results.

A complete description of the shellfish restoration in salt ponds, Great Salt Ponds, and adjacent waters of Narragansett Bay is provided in Section 5.4.7.1. The following two sections discuss each of the non-preferred restoration alternatives considered by the Trustees as compensation in part for the *North Cape* oil spill's injury to the surf clam resources.

### 5.4.3.2 Non-Preferred Alternative: Surf Clam Hatchery Stocking

Stocking of hatchery-reared surf clams in Block Island Sound has been identified as a potential restoration action to provide compensation for injuries to bivalves caused by the *North Cape* oil spill. Recruitment of surf clams appears to be limited primarily by predation on young-of-the-year. If adequate habitat is available, then stocking of larger seed clams (~30mm) could raise surf clam populations in the environment during the lifespan of the stocked animals. Nevertheless, it is highly unlikely that the project would improve subsequent recruitment, since existing surf clams in the area produce billions of larvae which seem to be well-distributed along the coast.

While such a project could potentially succeed in increasing the number of surf clams living in Block Island Sound, the Trustees have identified several problems that likely will substantially reduce or eliminate project benefits. First, surf clam populations are expected to recover from the effects of the spill by the time that *North Cape* restoration activities are underway. There is no indication that the level of surf clams in the environment will be artificially low after the recovery period, since there is no significant fishery or other anthropogenic factor to depress the baseline level of surf clams in the environment. It is, therefore, unclear if a project intended to elevate surf clam populations above this baseline or carrying-capacity level would provide significant ecological benefits.

Second, such a project would be largely experimental, since hatchery stocking of surf clams into the environment (as opposed to aquacultural grow-out in bags or cages) has not been undertaken or documented in the Northeast at significant scales. Third, it is unlikely that the Trustees would be able to document the success of the restoration project through a monitoring program. If such a project were to be implemented, surf clam seed would be dispersed off the southern Rhode Island coast in waters about five to ten meters (15-30 feet) deep. This stretch of Rhode Island's coastal waters is a very high energy environment with a shifting and mobile sandy bottom, making it highly unlikely that the small hatchery-reared surf clam seed could be located and measured to determine growth and survival rates. In one experiment off the coast of New Jersey, surf clam seed and brightly painted empty shells were very carefully placed in known locations by SCUBA divers. Within weeks after planting the researchers were unable to locate any seed or shells (G. Taghon, pers. comm. 1998).

Finally, the Trustees have determined that a surf clam hatchery stocking project would be significantly more costly than the preferred alternative of seeding oysters in the coastal salt ponds. Seed planting and monitoring costs would be greater for a surf clam project in the high energy offshore environment given the need for larger vessels and greater labor costs. For all of these reasons, the Trustees do not believe this project would successfully meet restoration goals, and therefore it is not preferred as a means of providing compensatory restoration for injury to surf clams.

**Environmental and Socio-Economic Impacts**

The addition of hatchery-reared surf clam seed should have minimal adverse impacts on the coastal waters of Rhode Island. Localized surf clam population increases could result from the stocking. Since the existing surf clam fishery in the nearshore waters of Rhode Island is small, there is not likely to be any significant economic impact.

### 5.4.3.3 Non-Preferred Alternative: Surf Clam Transplant

Surf clam transplanting (the movement of naturally-spawned, rather than hatchery-reared, shellfish) has been identified as a potential restoration action in response to the *North Cape* oil spill. This technique has been employed with soft-shelled clams in areas where seed clam densities are high, but the potential for growth and survival is low (e.g., typically in the upper portion of the intertidal zone). By moving the seed clams into lower parts of the intertidal zone, growth and survival rates are improved, leading to increased harvests. Oysters and quahogs are also transplanted, although typically for a slightly different reason. Often, these shellfish are removed from areas that are closed to harvest due to bacterial contamination, and transplanted to cleaner waters for depuration and/or grow-out prior to harvest.

There are indications that surf clams may sometimes settle in such high numbers that growth and spawning are density-limited. However, since there is no significant fishery for surf clams in Rhode Island waters, the usual logic behind transplanting (i.e., grow-out prior to harvest) is absent. Moreover, there is no indication that such an action would provide ecological benefits, because of the expectation that injured surf clam resources will recover by the time restoration begins and because recruitment does not appear to be limited by spawner biomass. Finally, this approach would also be largely experimental, since transplantation of surf clams has not been undertaken or documented in the Northeast at significant scales. Since transplantation of surf clams is not expected to yield significant ecological benefits, this approach is not preferred as a compensatory restoration alternative in response to the *North Cape* spill's injury to surf clams.

**Environmental and Socio-Economic Impacts**

Transplanting surf clams from a location of high density to one of low density is likely to have minimal impacts on the environment. The physical movement and handling of the surf clams could cause some mortality, either directly or indirectly through shell breakage, which makes these animals more susceptible to predation. This project would not be expected to have any significant socio-economic impacts.

### 5.4.4 Piping Plover Restoration

Trustee analysis indicates that Moonstone Beach piping plovers experienced lower reproductive success than expected due to the spill, and estimate a first generation loss of approximately five fledged chicks. As described below, habitat protection and monitoring is the Trustees' preferred restoration option for this injury.

#### 5.4.4.1 Preferred Alternative: Habitat Protection and Monitoring

**Project Description**

This project will enhance piping plover reproductive success through management practices that have proven to be highly successful over the past six years in Rhode Island (Fontes 1996, McGourty 1996). Human disturbance and predation are two main causes of reproductive failure. This project will increase reproductive success by reducing disturbance and predation at piping plover nesting sites. Specifically, project implementation will include the cost to employ biologists during the piping plover nesting season from mid-March to mid-September to:

1. Identify new piping plover nesting areas;
2. Protect nesting areas with rope fencing and signs where nesting activity is observed;
3. Construct predator exclosures around actual piping plover nests;
4. Monitor piping plover nesting activities;
5. Eliminate 4-wheel drive vehicle destruction of nests;
6. Reduce pet disturbance to nesting birds by educating pet owners about impacts;
7. Reduce human disturbance by educational outreach to the public at nesting sites; and
8. Identify additional factors that may be limiting nesting and productivity on each site.

Piping plovers nest on barrier beach fronts and sand overwash areas (Dyer *et al*. 1982, Haig 1992). Piping plovers arrive in the spring and select nest sites that meet their nesting habitat requirements. Plovers usually select the same nest site year after year. As piping plover populations slowly expand, new nest sites are selected on beaches where plovers perhaps have not nested in several years. Selection of new nest sites cannot be determined by biologists in advance.

The Nature Conservancy, RIDEM Division of Fish, Wildlife, and Estuarine Resources, and the USFWS currently are managing all known nesting sites in Rhode Island. The proposed project will focus on increasing productivity at new and/or existing nesting sites. Piping plover nesting sites on mainland beaches and Block Island will be protected and monitored for five breeding seasons. The proposed project is very similar to a project that was created for the *World Prodigy* oil spill restoration.

**Restoration Objectives**

This project will improve the productivity of local piping plover populations by enhancing their reproductive success, thereby replacing productivity lost due to the spill. Because the piping plover is a federally-listed threatened species, the lost productivity has delayed its recovery. The Atlantic Coast Piping Plover Revised Recovery Plan (U.S. Fish and Wildlife Service 1995) identified several recovery tasks aimed at meeting the objectives of the Recovery Plan including;

1. Manage breeding piping plovers and habitat to maximize survival and productivity;

2. Reduce disturbance of piping plovers from humans and pets; and

3. Reduce predation.

The proposed restoration project will not address all issues identified in the Atlantic Coast Piping Plover Revised Recovery Plan. However, the Trustees believe that the proposed project will effectively address the three specific recovery tasks listed above. This project would help speed species recovery to historical levels, and therefore would address primary and compensatory restoration.

**Scaling Approach**

Although experts indicate that the *World Prodigy* piping plover restoration has been successful, it is difficult to quantify productivity improvements because of the many factors that affect reproductive success. Reproductive success is different at each beach where nesting occurs and will certainly be different at new nesting sites. Reproductive success depends on several variables, including the level of human caused disturbance, predation, food availability, and other beach and/or human dynamics. Without information specific to new nesting sites, the Trustees are unable to precisely estimate the number of nests and project duration necessary to restore the five chicks (and subsequent offspring) lost due to the spill. Instead, the Trustees propose a project similar in size and scope to the *World Prodigy* project, extended over a five year period. In the best judgment of the Trustees, this scale of project would likely restore at least five chicks (and subsequent offspring) to the piping plover population.

### Probability of Success

The probability of success for this project is very high. Piping plover experts indicate that the *World Prodigy* restoration project for Moonstone Beach piping plovers has successfully increased productivity (McGourty 1996). Similar methods have been successfully used at other Rhode Island nesting areas as well. By applying this habitat protection and monitoring approach to piping plover nesting sites on mainland beaches and Block Island, it is likely that similar success will be achieved.

### Performance Criteria and Monitoring

The performance criteria would be establishment of this program at nesting sites on Block Island or other local beaches, as determined by the Trustees. As part of this restoration project, the Trustees would monitor productivity of the protected piping plovers.

### Approximate Project Cost

Exhibit 5-4 presents approximate project costs for a five year piping plover restoration project. Plover protection, which includes supplies, personnel and a vehicle, is estimated to cost $150,000. Predation control expenditures will cost approximately $5,800. Project implementation costs are expected to be $30,000 for the five-year duration of this project; these costs reflect the management personnel expense needed to manage the activities described above. Adding a 25 percent contingency brings the total estimated project cost to $232,700.

**Exhibit 5-4**

**APPROXIMATE COST ESTIMATE FOR PIPING PLOVER HABITAT PROTECTION AND MONITORING RESTORATION PROJECT**

| Expenditure | Quantity | Unit Cost | Total Cost |
|---|---|---|---|
| **Plover Protection** | | | |
| Protection Supplies (e.g., rope, posts, signs) | five years | $2,690/ year | $13,450 |
| Piping Plover Protection Personnel | five years | | $120,390 |
| Vehicle | one vehicle | $16,500 | $16,500 |
| **Predator Control** | | | |
| Nest Exclosures (e.g., wire, netting, rebars) | five years | $1,165 | $5,825 |
| **Project Implementation** (five years) | | | $30,000 |
| **Contingency (25%)** | | | $46,541 |
| **Total** | | | $232,706 |

**Environmental and Socio-Economic Impacts**

Because it benefits a federally-listed threatened species, this project would have positive environmental impacts. As noted in McGourty (1996), management efforts in Rhode Island are beginning to increase the number of nesting pairs and nesting sites in the state. With this success, it becomes more important to expand seasonal monitoring efforts to protect and enhance piping plover populations. This project is not expected to have any significant adverse environmental or economic impacts. While nest site protection will restrict human use of the beach in a very small area surrounding protected nests, the economic impacts are expected to be negligible.

**Evaluation**

Habitat protection and monitoring is the only practical method available to improve piping plover productivity, and has been successfully implemented at several nesting sites in Rhode Island. The intensive biological monitoring built into the proposed project will allow biologists to determine reproductive success of new nesting areas. Past experience with piping plovers in Rhode Island has shown that reproductive success is very low without management actions similar to the proposed project. Although precise quantification of the benefits of this project is difficult, piping plover and bird management experts indicate that this scale of project will likely meet restoration goals.

### 5.4.5 Loon Restoration

As described in Chapter 4, Trustee analysis indicates that approximately 414 loons (402 common loons and 12 red-throated loons) were killed by the *North Cape* spill. Common loons winter along the Rhode Island coast and are believed to breed in northern New England and southern Canada, while red-throated loons breed in northern Canada. This restoration project focuses on common and red-throated loons, with a total injury of 3,749 loon-years (including direct kill and associated losses of future fledglings).

Loon restoration is of particular importance to *North Cape* Trustees because of scientific concern about the status of loon populations in the northeastern United States and strong public interest in and support for this species. In recognition of these issues, the State of Vermont has listed common loons as an endangered species; in New Hampshire they are listed as a threatened species, and in Massachusetts, Connecticut and New York they are listed as a species of special concern. Loons are also a species of management concern to the U.S. Fish and Wildlife Service (Office of Migratory Bird Management 1995).

Concerns about the stability of loon populations in the northeastern United States reflect the large number of specific threats to breeding and wintering populations of loons. Shoreline development on loon breeding lakes is a major concern because it eliminates use of historical nesting territories and increases human disturbance at nest sites, which results in lower productivity. Contaminant loading from mercury and lead-poisoning (from eating lead shot and fishing sinkers) are also major causes of mortality. These problems are compounded by the low reproductive rates and late breeding age of common loons.

Evidence of public interest in this species is widespread. Nationally, the North American Loon Fund (NALF) is an umbrella organization founded in 1979 to promote the preservation of loons and their lake habitats. Current membership includes 15 private and four state organizations. In 1997, available data indicate that volunteers associated with six of these organizations donated 25,579 hours of time to loon preservation activities. The NALF also reports that loon products/items sold by the organization are very popular, and generate $30,000 per year in revenue. The New Hampshire Science Center's loon boat tours are estimated to generate approximately $60,000 per year in revenue.

Regionally, the New Hampshire Loon Preservation Committee has 1,200 members and 1,000 volunteers. To protect loons against threats posed by lead sinkers, the New Hampshire state legislature recently passed a bill (House Bill 1196) that prohibits the use of lead sinkers in the year 2000 and establishes an education program for recreational anglers. The bill itself states that "the legislature finds that the loon population of New Hampshire is a unique and popular threatened species and is an integral part of the economic and social fabric of our citizenry and of our natural environment."

Many Maine citizens demonstrate their support for loons and general conservation causes through purchase of a license plate decorated with the picture of a loon. In 1997, 12.3 percent of all passenger vehicles had this plate, generating approximately $1.6 million for state conservation and recreation projects. In addition, the Maine Audubon Society reports frequent phone calls from prospective homeowners interested in finding out which lakes have resident loons.

Rimmer (1992a) estimated the total loon population in 1990 to be 5,276 adults in Maine, New Hampshire, Vermont, Massachusetts and New York. The 402 common loons killed by the *North Cape* spill were wintering on the coast of Rhode Island. Experts believe that loons injured in the *North Cape* spill nest in New England, the Canadian Maritimes, or southern Ontario and therefore may represent a significant portion of New England loons.

Although the Trustees considered a wide range of potential loon restoration options to address this injury, practical constraints quickly eliminated some from consideration. For example, it is not possible to directly replace lost loons, as researchers have been unable to successfully breed them in captivity (D. Major, pers. comm. 1997). In concept, new loon breeding habitat could be created; in practice, it is not feasible for the Trustees to create new stretches of lake shoreline in the quantities needed for restoration.

Because direct replacement of loons and/or the creation of new breeding habitat are not possible, Trustee restoration efforts focus on enhancing the survival rate and/or productivity of existing loons in the wild. Loon populations in New England are primarily limited by nesting success; improved or increased forage on wintering grounds does not address threats facing loons on their breeding grounds. Rhode Island is only a wintering destination for loons; as a result, Trustee experts are unable to identify appropriate in-state restoration options. Because development pressure and its related impacts are more severe in New England nesting areas than in the Canadian Maritimes and southern Ontario, the Trustees have focused on enhancing breeding populations in the northeast United States. Specific restoration alternatives are discussed in more detail below.

#### 5.4.5.1 Preferred Alternative: Loon Habitat Protection

**Project Description**

This project would involve the purchase of land and/or land development rights along the shoreline of lakes with existing loon populations. By acquiring this land, future reductions in loon productivity due to development and associated human recreational activities would be avoided. Specifically, available information indicates that loon productivity on undeveloped lakes is 0.5 fledglings per year greater than on developed lakes, when coupled with education efforts. Appropriate restoration credit will be given for purchases of land or development rights on lakes threatened with development. The existence of development pressure is an important project condition, as purchases of non-threatened sites will have no impact on loon productivity rates.

The Trustees identified several potential acquisition projects, and based on evaluation criteria described in more detail later in this section, have selected two for implementation. The first involves the purchase of development and timber rights for a 300 foot buffer zone around nesting territories within a 9.7 mile stretch of lake shoreline in the State of Maine. This buffer zone is presently susceptible to logging and development and degradation of associated loon habitat. This area encompasses the territory of nine loon breeding pairs, and the owner has expressed a willingness to sell.

The Trustees also identified a second, different project in Maine involving the purchase of easement rights along a portion of 16.6 miles of privately-owned Maine lake shoreline to protect 14 nests. The land will remain in private ownership, although the public will continue to have access for traditional recreational uses (e.g., hunting, fishing, hiking and snowmobiling) and conservation activities for key resources.

The Trustees note that other sites in the northeastern United States or Canada may be appropriate for protection. At the current time, the locations described in this analysis are those that in the judgment of the Trustees best meet project evaluation criteria. As described in more detail later, these projects are not sufficient to meet restoration requirements. Additional projects will need to be identified. Costs for these additional nests are based on the average per-nest cost of existing projects. Nothing in this analysis is intended to preclude implementation of habitat protection at other locations that meet restoration goals.

## Restoration Objectives

The goal of this restoration action is to restore the 3,749 loon-years lost as a result of the spill. The Trustees assume that this restoration alternative will be implemented in the year 2000, which is four years after the spill. Thus, to compensate for the four year delay in restoring the resource, the required number of loon-years is increased by 3 percent per year for four years. The resulting number of loon-years needed for restoration is approximately 4,220 loon-years. This objective will be accomplished by purchasing land and/or development rights to protect existing loon breeding sites from future decreases in productivity associated with development. By purchasing enough land to protect an appropriate number of loon nest sites, future loon productivity can be enhanced sufficiently to compensate for the losses caused by the *North Cape* spill.

## Scaling Approach

As described above, the goal of this restoration is to increase future loon populations by preventing expected decreases in productivity associated with shoreline development. To determine project scale, it is necessary to estimate the number of nest sites that must be protected. Once the required number of nest sites is determined, it is possible to calculate the amount of shoreline required for protection of these nest sites.

For this scaling analysis, project benefits are calculated for a period of 100 years. Although it is likely that the habitat for the two selected projects will be protected in perpetuity, uncertainty about other factors affecting loon breeding beyond 100 years make project benefits uncertain. In addition, the effects of discounting make any benefits beyond this period extremely small. If other projects with shorter durations are proposed, the project scale will need to be adjusted accordingly; all else being equal, shorter projects will require the protection of more loon nests.

To determine the number of nest sites that must be protected, the Trustees estimate the productivity difference between nest sites on developed and undeveloped lake shorelines. Lake shorelines are defined as "developed" when cabins are located within nesting territories of loon pairs. Available information indicates an annual average productivity of approximately 0.7 fledglings per pair at undeveloped lakes in the Northeast (D. Major, pers. comm. 1997). In contrast, annual fledging rates at developed lakes are approximately 0.2 fledglings per pair (D. Major, pers. comm. 1997). Therefore, the Trustees assume an annual benefit of 0.5 fledglings per nest site protected (with accompanying educational efforts).

The fledglings produced by protected loons also will eventually produce offspring of their own. The Trustees estimate an annual rate of 0.54 fledglings per territorial loon pair, based on a review of the literature (Taylor and Vogel 1998, McIntyre and Barr 1997). This rate reflects the fact that some offspring of loons at protected sites will breed on undeveloped lakes, some will breed on developed lakes, and some will not breed at all. The production of these loons also is estimated for a period extending 100 years after project implementation.

To estimate the number of loon-years restored by this option, the Trustees multiply each fledged loon attributable to habitat protection by the expected lifespan of a fledged loon. The Trustees' estimate of the expected lifespan of a fledged loon is 6.0 years, and is based on survival rates reviewed in French *et al*. (1996) and Taylor and Vogel (1998). Future loon-years are discounted using a three percent annual discount rate.

Based on this analysis, the Trustees estimate that each protected breeding pair and associated nest site will generate approximately 129 discounted loon-years. To meet restoration objectives, a total of 33 loon pairs and associated nesting sites must be protected (Sperduto *et al*. 1999).

**Probability of Success**

The protection of loon habitat, coupled with educational efforts, offers a practical, effective means of preventing future losses in loon productivity. For this project to be successful, it is important to protect land that is expected to be developed in the near future. The Trustees believe this is a reasonable assumption for the two projects identified.

**Performance Criteria and Monitoring**

The performance criteria would be successful purchase of project land, development rights or easement rights. A loon protection/monitoring/education program is needed to ensure that the restoration project is meeting established objectives. Field biologists will be hired to protect and monitor the loons during the breeding season, and implement educational efforts. Specific tasks will include (but are not limited to):

> Ensure that there has not been any physical disturbance to the loon habitat (e.g., cabin construction, camping sites, boat launch development, etc.);
>
> Monitor loon biological activity (e.g., nesting behavior, egg production, hatching and fledgling success, etc.); and
>
> Protect nest sites from human disturbance (e.g., by educating local boaters, fishermen, campers, etc.).
>
> Organize and implement educational activities for residents and recreational users of protected lakes.

**Approximate Project Cost**

As described previously, the Trustees have identified a combination of two projects that will most effectively meet restoration goals. For the first project, approximately 9.7 miles of shoreline are needed to protect nine loon pairs and their associated nesting sites. This shoreline protection estimate is based on project specific surveys of territorial pairs and estimates of the length of shoreline protected by loons at individual nest sites. The Trustees estimate that development rights for this property will cost approximately $32 per linear foot, for a total of $1,631,616.

Fourteen nest sites will be protected through a second project. For this second project, approximately 16.6 miles of shoreline will need to be protected, based on a per nest protection requirement of 6,269 linear feet[5]. Estimated costs for this 16.6 miles of shoreline is $2,000,000, based upon estimate of purchase ($23/linear foot).

The two identified acquisition projects only provide for 23 of the required 33 nests for loon restoration. To estimate an average cost for the purchase of the additional 10 nest sites, the Trustees calculated an average cost per nest site based on the two identified projects. Employing this average value of $158,000 per nest site, the total cost for 10 additional nest sites is $1,580,000[6].

The Trustees did identify and consider loon habitat protection projects at three other sites in the Northeast. However, the two projects described above were the most cost-effective given restoration goals and the scale of restoration needed to meet restoration objectives. One potential project in Vermont involved an estimated $2.5 million expenditure to protect existing wildlife habitats (including one loon nest) and for permanent recreational and forestry purposes. A second potential project in Vermont would have cost $5.0 million for the protection of three nests. Finally, a project in Massachusetts may have protected a single nest, although project benefits were uncertain because of restrictions on the development of the land for sale.

Implementation costs for selected projects are expected to total $172,000. Approximately $112,000 will be needed to manage the land acquisition process, which is expected to take two years. The remainder ($60,000) is required for personnel to manage the field biologists during the life of the ten-year protection/monitoring/education program.

Adding a 10-year protection/monitoring program, transaction costs, the $172,000 project implementation cost, and a 25 percent contingency brings the total estimated project cost to approximately $7.5 million. Exhibit 5-5 lists the estimated costs associated with loon restoration, assuming the land purchase will consist of approximately 16 parcels.

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[5] The per nest protection requirement of 6,269 linear feet is an average for all loon nests at the first project site (not just the nine that are currently proposed for protection in this Revised Draft RP/EA). Site-specific data for the second project are not available.

[6] ($3,631,616 / 23 nest sites) yields approximately $158,000 per nest site.

**Exhibit 5-5**

**APPROXIMATE PROJECT COSTS FOR LOON HABITAT PROTECTION**

| Cost Element | Total Cost |
|---|---|
| **Cost of Land** | |
| Land for 9 Loon Pairs and Associated Nest Sites | $1,631,616 |
| Land for 14 Loon Pairs and Associated Nest Sites | $2,000,000 |
| Land for 10 Additional Loon Pairs and Associated Nest Sites | $1,580,000 |
| **Transaction Costs** | |
| Survey (16 parcels @ $12,000) | $192,000 |
| Phase I Assessment (16 parcels @ $10,000) | $160,000 |
| Title Exam (16 parcels @ $2,000) | $32,000 |
| Appraisal (16 parcels @ $3,000) | $48,000 |
| **10 Year Protection/Monitoring Program** | |
| Field Biologists for 10 years | $160,520 |
| 16 foot Work Boat | $12,000 |
| **Project Implementation** | |
| Land Purchase (two years) | $112,000 |
| Project Management (ten years) | $60,000 |
| **Contingency (25%)** | $1,497,034 |
| **Total** | $7,485,170 |

It is possible that similar, lower cost restoration projects may be available in Northern Maine or Canada that could meet loon restoration objectives. The Trustees would support similar projects in New England or Canada if the shoreline habitat to be protected clearly supports loon reproduction and if, in the opinion of the Trustees, the shoreline habitat were under threat of development.

## Environmental and Socio-Economic Impacts

By preventing future decreases in loon productivity, selected habitat protection projects would provide environmental benefits. As previously indicated, loons are of special concern because of specific threats to the stability of breeding populations and widespread public interest in the protection of this species. These projects are not expected to have adverse environmental or economic impacts. Although other species may benefit from the habitat protection, restoration scaling is necessarily focused on resources and resource services injured by the *North Cape* spill. In the best judgment of the Trustees, these projects will not provide measurable, significant benefits to other resources or resource services affected by the spill.

## Evaluation

Given the sensitivity of breeding loons to human disturbance, this alternative could effectively restore the loon injury caused by the *North Cape* spill. The projects identified by the Trustees involve the purchase of land and/or development rights for property that is likely to be developed in the near future. If other habitat protection projects are proposed, the Trustees would need to ensure that the property is likely to be developed and that sufficient land is acquired to properly protect the loon pairs and nest sites identified.

Overall, the Trustees have determined that habitat protection, coupled with educational efforts, is the preferred alternative for loon restoration. Although other restoration alternatives may be less expensive, the Trustees have serious concerns about their ability to provide real benefits to loon populations. These concerns are described in more detail in the following sections. Given the serious threats facing loon populations in the northeastern United States and widespread public support and interest in this species, the Trustees believe that effective, reliable restoration is extremely important.

#### 5.4.5.2 Non-Preferred Alternative: Nest Site Enhancement

On lakes that lack natural islands and have poor shoreline nesting habitat, fluctuating water levels, or a history of low productivity, artificial nesting islands may improve nesting success. These islands rise and fall with water levels and can counteract extreme water level fluctuations on lakes where loons are not considered in water management plans. These artificial islands or platforms may also incur reduced predation and provide more secure nest sites (Rimmer 1992b).

In part because nest site enhancement projects have been successful at increasing loon productivity in areas with extreme water level fluctuation, they have already been implemented at many locations throughout the Northeast. In Vermont, for example, some lakes have more platforms than loon nesting pairs, reflecting the hopeful expectation that future fledglings will use the empty platforms (D. Major, pers. comm. 1997). In addition, the Federal Energy Regulatory Commission (FERC) relicensing requirements for large hydroelectric projects requires assessment and mitigation of water management impacts on loons (Fair and Poirier 1992).

To meet *North Cape* restoration goals, it is likely that hundreds of nest site platforms would be needed. The specific number of nest site platforms required will depend on the productivity benefit attributable to each platform, as well as platform duration. Although the preferred loon habitat protection project requires protection of 33 nests, the associated productivity benefit (0.5 fledglings per nest) and protection duration (100 years) are likely greater than that which would be achieved by nesting platforms. As a result, the number of platforms needed to meet restoration goals would likely be several times the number of nests that must be protected by the preferred loon habitat protection project.

In addition, it is important to identify specific loon pairs and nesting sites that would benefit from such projects. Random placement of artificial nesting sites on lakes is not sufficient, as there can be no assurance that loon pairs will ever use the sites. In addition, productivity benefits associated with occupied platforms are uncertain, because there is no indication that alternative sites that would have been used by the loons were associated with low productivity. Also, artificial nesting sites often are conspicuous in the environment and can draw curious boaters, leading to higher levels of disturbance.

Overall, the Trustees have not been able to identify significant numbers of loon pairs and nesting sites that would benefit from nest site enhancement projects. As stated earlier, many of these opportunities have already been exploited, and the benefits of random placement of artificial nesting sites are extremely uncertain. Finally, nest enhancement projects are not particularly effective at addressing development pressure and lead sinker contamination, two of the most significant threats currently facing loon populations in the northeastern United States.

**Environmental and Socio-Economic Impacts**

The construction of artificial nesting islands on lakes in the Northeast is expected to cause minimal adverse impacts to the environment. The potential exists that the platforms used by nesting loons could attract curious boaters which could lead to a higher rate of disturbance and cause a decrease in productivity. The nest sites would have to be seasonally anchored to the bottom of the water body. In addition, there is some concern about changing loon nesting behavior to use artificial platforms when existing, natural nesting sites are available. Finally, inappropriate nest site location could increase the potential for intra-specific competition for nest sites.

### 5.4.5.3 Non-Preferred Alternative: Public Outreach and Education

Specific causes of adult common loon mortality in New England between 1988 and 1996 include lead poisoning, human-induced trauma, and fishing lines. Because these impacts are directly associated with human activity, development of a public outreach and education program could benefit affected loon populations.

The Vermont Institute of Natural Science (VINS), the Loon Preservation Committee (LPC), the Maine Audubon Society (MAS), the Audubon Society of New York (ASNY) and the Massachusetts Division of Fish and Wildlife (MDFW) already have well established programs to monitor loon populations and to provide basic educational information about the ecology and management of loons to lake residents and visitors. Although undoubtedly beneficial, it is extremely difficult to quantify the benefits of existing programs as well as the marginal benefits generated by additional spending on education and outreach.

As part of an education and outreach program, non-toxic sinkers could be distributed to recreational anglers. While this type of program might help address problems caused by the use of lead sinkers, project benefits would be difficult to measure. In addition, a bill recently passed in the New Hampshire legislature bans the use of lead sinkers and jigs beginning in the year 2000. Other states in the Northeast may introduce similar legislation, which would be an effective means of addressing this problem.

Because the Trustees are unable to determine how effectively the implementation of increased education and outreach activities, without any other type of restoration component, will restore the loon injury caused by the *North Cape* spill, this restoration option is determined to be non-preferred. However, as described in previous sections, the preferred land protection project has an education component that the Trustees believe will capture associated benefits.

**Environmental and Socio-Economic Impacts**

No significant environmental or socio-economic impacts would be expected for a public outreach and educational program to protect loons.

### 5.4.6 Marine Bird Restoration (Excluding Loons)

As described in Chapter 4, several species of marine birds other than loons were affected by the *North Cape* spill. The types and numbers of birds killed are listed in Exhibit 5-6 below, along with Trustee estimates of interim loss, measured in 1996 bird-years and 2000 bird-years (which reflects the expected project implementation date).

In the judgment of the Trustees, development of separate, relatively small restoration projects for each of these species would not be practical, beneficial or cost-effective. Therefore, the Trustees propose a single, combined restoration project for all of the species listed in Exhibit 5-6 except gulls and cormorants. Because of extensive growth in local cormorant and gull populations in recent years, the Trustees do not require restoration for these species. Thus, the Trustees seek restoration for 2,933 lost bird-years, measured in year 2000 bird-years[7].

**Exhibit 5-6**

**INJURY QUANTIFICATION FOR MARINE BIRDS OTHER THAN LOONS**

| Species | Total Kill | Recovery Time (years) | Total 1996 Bird-Years Lost | Total 2000 Bird-Years Lost |
|---|---|---|---|---|
| Marine Birds-Long Term Impacts Likely | | | | |
| Scoters | 18 | 2.8 | 111 | 125 |
| Mergansers | 204 | 1.4 | 337 | 379 |
| Goldeneye | 192 | 1.7 | 408 | 459 |
| Bufflehead | 66 | 1.4 | 125 | 141 |
| Eider | 354 | 2.1 | 853 | 960 |
| Grebes | 228 | 1.6 | 705 | 793 |
| Total | 1,074 | -- | 2,539 | 2,857 |
| Marine Birds-Long Term Impacts Unlikely | | | | |
| Murres | 30 | 1 | 30 | 34 |
| Dovekie | 6 | 1 | 6 | 7 |
| Gannet | 18 | 1 | 18 | 20 |
| Razorbill | 12 | 1 | 12 | 14 |
| Cormorants | 96 | 1 | 96 | 108 |
| Gulls | 444 | 1 | 444 | 500 |
| **Total** | 606 | 1 | 606 | 683 |

[7] 2,933 year 2000 bird-years = (2,539+606-444-96) year 1996 bird-years * ($1.03^4$) = marine bird restoration requirement (excluding gulls and cormorants) assuming project implementation in 2000.

### 5.4.6.1 Preferred Alternative: Marine Bird Habitat Protection

**Project Description**

Because many of the birds killed by the oil spill are seaducks (e.g. scoters, mergansers, golden eye, bufflehead and eider), and the eider kill is the largest among the seaducks, the Trustees focus this restoration alternative on the protection of eiders. While grebes also comprise a large part of the marine bird injury, there is little the Trustees can do to directly compensate for their loss. Grebes impacted from the spill likely breed in Canada and western North America and winter on the east coast. Feasible regional compensation projects are not available; therefore the Trustees have chosen to combine grebe injury with the injury to other marine birds (excluding loons) to scale restoration.

Specifically, this project would involve the purchase of island acreage in the State of Maine to prevent future losses of breeding eider populations due to development. Dozens of privately owned Maine islands support substantial numbers of breeding eiders.

**Restoration Objectives**

The goal of this restoration option is to restore 2,933 marine bird-years lost as a result of the spill. This objective will be accomplished by purchasing land to protect existing eider nest sites from future decreases in productivity associated with development. By purchasing enough land to protect an appropriate number of nest sites, future productivity can be enhanced by enough to compensate for the loss due to the *North Cape* spill.

**Scaling Approach**

The number of acres required to meet restoration objectives will depend on site-specific characteristics of the actual island(s) targeted. As a result, the final scaling calculations will need to incorporate these factors for the specific island(s) targeted for purchase.

An approximate number of acres required can be estimated using likely values for these parameters. Data compiled by Allen (pers. comm. 1997) indicates that diving duck productivity on Maine islands is approximately 0.4 fledglings per nest. If it is assumed that development would eliminate nesting sites on the targeted island and substitute sites were unavailable for these birds, their entire productivity would be lost. Acquiring this land would therefore result in a productivity benefit of 0.4 fledglings per nest.

The Trustees estimate eider production at the protected island(s) for a period of 100 years. Although acquired land would be protected in perpetuity, uncertainty about other factors affecting eider breeding beyond 100 years make project benefits uncertain. In addition, the effects of discounting make any benefits beyond this period extremely small.

The fledglings produced on the acquired land also will eventually produce offspring of their own. The Trustees estimate an annual rate of 0.4 fledglings per pair for these eider as well, and calculate production for a period extending 100 years after project implementation.

To estimate the benefits of eider habitat protection, the Trustees multiply the number of eiders fledged on protected land by the average expected eider lifespan. The Trustee's estimate of average eider lifespan is 0.62 years, and is based on survival rates reviewed in Johnsgard (1975) and Blumton *et al*. (1988). Future eider-years are discounted using a three percent discount rate. Based on this analysis, the Trustees estimate that each protected nest site would generate 9.33 discounted eider-years (measured in year 2000 eider-years). Thus, approximately 315 nest sites must be protected to restore the 2,933 lost eider-years.

To determine the amount of land that must be protected to meet restoration goals, it is necessary to obtain information on eider densities. Trustee analysis of eider densities on several private islands that have been sold in recent years and have high eider densities (including all acreage on an island, not just those acres with eider colonies on them) indicates an average of approximately 13.2 eider pairs (or nests) per acre.[8] Given this information, protection of a typical acre of island habitat would generate 123 eider-years. To restore the 2,933 eider-years lost because of the *North Cape* spill, island(s) totaling 24 acres would need to be acquired, assuming typical eider densities (Sperduto *et al*. 1999).

**Probability of Success**

The protection of eider habitat offers a practical, effective means of preventing future losses of eider productivity. For this project to be successful, however, it is important that an entire island is protected and/or acquired. Recent projects that have allowed development on portions of an island not directly utilized by an eider colony have generally been unsuccessful at protecting targeted populations (B. Allen, pers. comm. 1997). In addition, the existence of development pressure is an important project condition, as purchases of non-threatened sites will have no impact on eider productivity rates.

[8] This estimate is based on island acreage and eider nest density data from several privately owned islands in Maine that have been sold in recent years. The eider nest density on individual islands ranged from 1.2 to 85.7 eiders per acre.

**Performance Criteria and Monitoring**

The performance criterion for this project would be purchase of one or more islands needed to protect the 315 eider nests. A marine bird protection/monitoring program is needed to ensure that the restoration project is meeting established objectives. Field biologists will be hired for ten years to protect and monitor seaducks during the breeding season, and will perform the following specific tasks:

> Ensure that there has not been any physical disturbance to the seaduck habitat (e.g., cabin construction, camping sites, boat launch development, etc.);
>
> Monitor seaduck biological activity (e.g., nesting behavior, egg production, hatching and fledgling success, etc.); and
>
> Protect nest sites from human disturbance (e.g., by educating local boaters, fishermen, campers, etc.).

Compared to the loon restoration described earlier, the level of effort for the seaduck monitoring/protection program has been scaled back to reflect the smaller size of the land acquisition.

**Approximate Project Cost**

The number of acres required to meet restoration objectives will depend on site-specific characteristics of the actual island(s) targeted. Analysis of eider nests per island acre (including all acreage on an island, not just those acres with eider colonies on them) indicates an average of approximately 13.2 eider pairs (or nests) per acre. Given this density estimate, island(s) totaling 24 acres would need to be acquired to protect 315 nesting sites. Although acquisition costs are uncertain, the cost of appropriate island(s) is likely to be less than $10,000 per acre (B. Emory, pers. comm. 1997). Therefore, total acquisition costs are likely to be approximately $240,000.

In addition to the purchase price of the land, implementation of this alternative would require a variety of transaction costs such as surveying, Phase I assessment, title exam, and appraisal costs for each parcel. The Trustees estimate these costs at $21,000 per parcel.

Project implementation costs are expected to total $116,000. Approximately $56,000 will be needed to manage the land acquisition process, which is expected to take one year. The remainder ($60,000) is required for management personnel to manage the field biologists during the life of the ten-year protection/monitoring program.

As indicated in Exhibit 5-7, the total estimated project costs, including a 25 percent contingency cost, are approximately $631,250. Exhibit 5-7 lists approximate project costs to purchase 24 acres of land, assuming the purchase will consist of approximately three parcels (islands). It is important to note that the restoration requirement is to protect 315 breeding pairs and associated nesting sites.

**Exhibit 5-7**

**SEADUCK HABITAT PROTECTION APPROXIMATE PROJECT COSTS**

| Cost Element | Total Cost |
|---|---|
| **Cost of Land** (24 acres @ $10,000/acre) | $240,000 |
| **Transaction Costs** | |
| Survey (3 parcel @ $6,000) | $18,000 |
| Phase I Assessment (3 parcel @ $10,000) | $30,000 |
| Title Exam (3 parcel @ $2,000) | $6,000 |
| Appraisal (3 parcel @ $3,000) | $9,000 |
| **10 Year Protection/Monitoring Program** | $86,000 |
| **Project Implementation** | |
| Land Purchase (one year) | $56,000 |
| Project Management (ten years) | $60,000 |
| **Contingency (25%)** | $126,250 |
| **Total** | $631,250 |

## Environmental and Socio-Economic Impacts

By preventing development on sea duck nesting islands, this project will provide environmental benefits. This project is not expected to have any adverse environmental or economic impacts. Although other species may benefit from eider habitat protection, restoration scaling is necessarily focused on resources and resource services injured by the *North Cape* spill. If it can be demonstrated that purchases of specific islands will provide measurable, significant benefits to other resources or resource services affected by the spill, the Trustees will adjust scaling calculations appropriately.

## Evaluation

The acquisition of land to prevent future decreases in eider productivity can effectively restore the "other" marine bird injury (except loons) caused by the *North Cape* spill. Although the size of the island(s) needed to meet restoration objectives will depend on site-specific characteristics, it is likely that approximately 24 acres will be required. In addition, this project will not have adverse environmental or economic impacts, and is expected to be a cost-effective means of meeting restoration goals. For these reasons, marine bird habitat protection is a preferred restoration option.

### 5.4.7 Salt Pond Ecosystem Restoration

Rhode Island's coastal salt ponds are a critical part of the South Shore coastal ecosystem, serving as essential spawning, nursery and growth areas for coastal fish and shellfish (Baczenski *et al*. 1979, Crawford and Carey 1985, Ganz *et al*. 1992). Like most estuaries, the ponds also are important links between terrestrial and marine environments, converting terrestrial nutrients into marine biological production; in the shallow, well-lit waters of the salt ponds, benthic activity is an important component of this process (Nixon 1982, Nowicki and Nixon 1985).

The ponds' ability to sustain this contribution to the South Shore coastal ecosystem has been reduced over time, and is further threatened by a number of human impacts. Fishing pressure has eroded once-abundant harvests of fish and shellfish in the ponds, as has habitat destruction caused by such activities as breachway management, dredge and fill operations, and damming of brooks and rivers (Crawford 1984, Lee *et al*. 1985, Nixon 1982, Olsen and Lee 1993). Habitats also have been lost or degraded as a result of human impacts on water quality. In particular, increased nutrient loadings to the ponds from residential development have caused eutrophication, leading to declines in eelgrass, increased sediment anoxia, and other detrimental effects to fish and wildlife habitats (Lee and Olsen 1985, Short *et al*. 1996).

A variety of organisms injured by the *North Cape* spill depend on Rhode Island's salt ponds directly or indirectly, residing seasonally or permanently in the ponds or feeding on organisms produced by or otherwise dependent on the ponds. Because the salt ponds are an essential component of the South Shore coastal ecosystem, and because they are disproportionately affected by human impacts on the coastal environment, restoration in the ponds can greatly benefit resources injured by the *North Cape* spill -- both inside and outside the ponds. The Trustees, therefore, determined that injuries to fish and benthic organisms (other than lobsters) throughout the affected environment, as well as injuries to birds, shellfish and benthic organisms within the ponds, can best be addressed through salt pond ecosystem restoration. The ponds affected by the *North Cape* spill constitute the geographic area considered for salt pond ecosystem restoration: Ninigret, Green Hill, Trustom, Cards, Potter, Quonochontaug, and Point Judith. Due to the scale of the restoration project other salt ponds (i.e. Winnapaug Pond and Great Salt Pond) and the adjacent waters of Narragansett Bay will also be considered as potential restoration sites.

Salt pond ecosystem restoration requires an approach that focuses on several interconnected issues, including water quality, habitats and living resources in the ponds. The following sections present specific restoration alternatives for the ponds, and assess the ability of each to address problems in these areas. Together, the preferred alternatives of shellfish enhancement and land acquisition constitute an integrated approach toward restoration in the salt ponds. Because the ponds are among the most important and most threatened habitats within the South Shore coastal ecosystem, this approach is expected to provide an effective means of restoring fish, shellfish, other benthic organisms, and inshore birds injured by the *North Cape* spill.

### 5.4.7.1 Preferred Alternative: Shellfish Restoration Using Oysters

The Trustees have determined that approximately 1.0 million kilograms of bivalve biomass were lost as a result of the *North Cape* oil spill (direct mortality plus production foregone). As shown in Exhibit 5-8, the majority of the injury was to surf clams *(Spisula solidissima)*, of which 19.4 million animals were killed, resulting in a loss of 970,400 kg biomass. Limited amounts of blue mussels *(Mytilus edulis)*, quahogs/hard clams *(Mercenaria mercenaria)*, soft-shelled clams *(Mya arenaria)*, oysters *(Crassostrea virginica*), and bay scallops *(Argopecten irradians)* were also killed by the oil spill. The area of impact was both within and outside the salt ponds, although injury to surf clams and other bivalves was primarily in the offshore environment, in the Nebraska Shoal area from Point Judith to Charlestown Beach (French 1998a and b).[9]

**Exhibit 5-8**

***NORTH CAPE* INJURIES RESTORED THROUGH SHELLFISH RESTORATION**

| Injury Category | Total Injury | Primary Species |
|---|---|---|
| 1. Surf Clams | 970,400 kg | — |
| 2. Other Marine Bivalves | 2,900 kg | Mussel |
| 3. Salt Pond Shellfish | 12,400 kg | Soft-shell clam |
| **Subtotal** | 985,700 kg | |

**Project Description**

To fully compensate for the injuries listed in Exhibit 5-8, this project must replace the quantity of biomass lost due to the spill. This replacement biomass is measured as the wet tissue weight of animals added to the system ("stocked") plus weight added by the growth of stocked animals over their lifetimes. The species of bivalves best suited to the project is the Eastern oyster (*Crassostrea virginica)*. Oysters were once prevalent in the ponds (Goode 1884) but populations have declined in recent years (A. Ganz, pers. comm. 1999, Ganz 1997). Narragansett Bay's oyster population has fluctuated historically but has rebounded in certain locations within the last several years (A. Valliere, pers. comm. 1999). However, this population is currently subject to heavy fishing pressure and appears to be declining (A. Valliere, pers. comm. 1999).

The project to restore oysters in the Rhode Island coastal salt ponds, Block Island Sound, and Narragansett Bay will use a technique termed "remote setting." Remote setting involves purchasing hatchery-reared eyed oyster larvae and allowing them to "set" or attach to a substrate in tanks (Bohn *et al.* 1995, Castagna *et al.* 1996). The Trustees will endeavor to use local broodstock for the production of oyster larvae. The most common "set" substrate is clean oyster shell ("cultch"). However, if abundant sources of appropriate oyster shell are not available, clamshell can also be used which is readily obtainable in the Rhode Island area. The cultch is

[9] The shellfish restoration project described in the Draft RP/EA also addressed starfish injury. Because starfish populations are thriving and starfish control is a common method employed to begin and facilitate shellfish restoration, the Trustees do not require restoration for this species in the Revised Draft RP/EA.

packaged into protective mesh bags that are then placed into tanks of seawater. The eyed oyster larvae are typically introduced into the tanks with a food supply. Over a period of 2 to 3 days the oyster larvae will attach to the cultch. Prior experience suggests that approximately 10 to 20 percent of the larvae introduced into the setting tank will successfully attach to the cultch (R. Bohn, pers. comm. 1999, Supan 1992, Supan and Wilson 1993, Supan *et al.* in press).

Once the larvae, now termed spat, have attached to the bagged cultch, the bags will be moved to a protected nursery area in the salt ponds and placed on racks or pallets. Approximately one acre will be needed for the nursery site. It is expected the oyster spat will grow to planting size (~20mm) within one to two months. Once at this size the bags will be opened and the oysters will be planted into the environment at a rate of one million spat per acre in suitable habitat.

Remote setting of oysters is a common practice and the techniques are well developed. Remote setting is the basis for the Washington State oyster industry and is used widely in Louisiana and the Chesapeake Bay (Bohn *et al*. 1995, Supan 1992, Supan and Wilson 1993). Pilot scale projects have been ongoing for several years on Cape Cod and in New Hampshire (R. Langan, pers. comm. 1999, T. Marcotti, pers. comm. 1999, Marcotti and Kraus 1998).

To fully compensate for the injured shellfish biomass and to accomplish the project within a reasonable time frame while minimizing the logistical hurdles, the Trustees propose to plant a total of 119 million cultched oyster spat over 8 years at a density of one million spat per acre. The oyster spat will be planted on multiple small sites of suitable hard bottom habitat. The total areal extent of these multiple planting sites will be approximately 45 acres, with approximately 15 acres planted per year for three years over multiple locations. The Trustees will rotate the annual planting of the spat over these multiple sites. Each year, for the first three years of the project, 15 million spat will be planted. The fourth year's planting will be replanted over the year 1 planting; the fifth year's plantings will be replanted over the year 2 planting; the sixth year's planting will be replanted over the year 3 planting. This cycle will continue to the eighth year of planting. This method reuses the acreage of the previous plantings, thus conserving the available suitable habitat. In addition, replanting over existing oyster beds will mimic the natural oyster reef building process that occurs in estuarine environments.

In year one of the nine-year project, the Trustees will conduct a baseline survey of selected areas of the salt ponds, Block Island Sound, including Great Salt Pond, and Narragansett Bay to determine existing bottom types, habitats, and fish and invertebrate species composition and abundance. These field evaluations will be coupled with discussions with interested members of the public to select appropriate planting sites (firm bottom), and to determine the scale of the restoration at each site. In the event that not enough suitable habitat is available elsewhere, habitat within Narragansett Bay can be enhanced by placing cultch material on the bottom. If it is determined that the bottom habitat needs to be enhanced by the placement of cultch (either clamshell or oyster shell), a rate of 2,000 to 4,000 bushels of cultch will be used per acre. Bottom habitat that supports populations of important commercial and recreational species such as quahogs, winter flounder spawning habitat, and other critical areas will not be cultched. The Trustees will endeavor to use natural suitable bottom for the stocking of oysters whenever possible and will limit cultching of bottom habitat to locations within Narragansett Bay. Oyster restoration will require a multi-year approach because:

> available shellfish hatchery capacity is limited and will require several years to adequately develop;
>
> the amount of material required for the project would adversely impact the existing market for cultch if done over a shorter time scale;
>
> adaptive management needs to be implemented in order to enhance survival and thereby cost-effectiveness of the restoration; and
>
> as the project proceeds, an understanding of the restored animals' fate develops and the possibility of adverse impacts can be reduced.

By implementing the project over nine seasons and adapting the project annually as needed, the probability that the oyster spat would survive to enhance growth and recruitment in the ponds can be improved.

**Restoration Objectives**

The primary goal of this project is to replace the biomass of bivalves lost through direct mortality and production foregone as a result of the *North Cape* spill. The injured biomass amounts to 985,700 kilograms, measured in the year of the injury (1996). As described in more detail in the following section, the restoration objective is 1.2 million kilograms, assuming project initiation in 2000. This goal will have been accomplished when the number and survival of restored shellfish are sufficient to compensate for the lost bivalve biomass. Since natural recovery period for this resource is approximately five years, this project constitutes compensatory restoration.

**Scaling Approach**

To determine the scale of shellfish restoration activities, the Trustees aggregated bivalve injuries caused by the spill. Bivalve species are combined because all provide similar ecological services (water clarity and nitrogen cycling enhanced by feeding activity; food for fish and invertebrates provided by molluscan larvae and juveniles; and benthic biomass and habitat value provided by bivalve communities).

The Trustees used survival rates for shellfish larvae and spat to calculate the number required to generate, after normal growth and survival, a biomass equivalent to that of the bivalves (surf clams, quahogs, mussels, bay scallops, and soft-shelled clams) killed by the spill (see French 1999b). The number of 20mm spat required is 119 million over an eight-year period. The number of eyed oyster larvae to purchase is calculated assuming a 10 percent survival rate from eyed larvae to newly set spat and a 60 percent survival rate for newly set spat to 20mm spat during the nursery phase. The Trustees assume a 70 percent annual survival rate after planting. These survival rates are based on Trustee conversations with several experts who have been conducting oyster remote setting operations (R. Bohn, pers. comm. 1999, R. Langan, pers. comm. 1999, T. Marcotti, pers. comm. 1999, D. Meritt, pers. comm. 1999, D. Webster, pers. comm. 1999, Supan 1992, Supan and Wilson 1993, Supan *et al*. in press). Lost bivalve biomass will be restored on 1:1 basis (e.g., one kilogram of replacement oysters is required to restore one kilogram of lost bivalves). The scaling calculation indicates approximately 985,700 kilograms of lost bivalves need to be replaced, as reported in Chapter Four.

The Trustees assume that oyster restoration will occur in equal proportions during the summer months of 2000 through 2008. Thus, on average, the shellfish resource will be restored in 2004, about eight years after the injury occurred. To compensate for the delay in returning the resource to the environment, the required biomass is increased by 3 percent per year for eight years. The resulting figure is approximately 1.2 million kilograms of bivalves to be restored in the ponds.

To calculate the number of oyster spat required to generate this biomass, the Trustees assume that 100 percent of the required biomass will be produced by oysters. The use of oysters to restore injury is based on an assessment of habitat availability, capacity, longevity of the species, cost, and the probability of success. The Trustees estimate the kilograms of biomass produced by oysters to compute the required number of oyster spat. This estimate takes into account survival and future growth, and is shown in Exhibit 5-9 (see also French 1999b).

**Exhibit 5-9**

**SCALING CALCULATIONS FOR SHELLFISH SEED**

| | **Oyster** |
|---|---:|
| Spat Size (mm) | 20 |
| Percent of Injury to Restore | 100% |
| Biomass to Restore (kg) | 1,212,175 |
| Production Plus Spat Biomass (kg/indiv) | 0.0102 |
| Required Number of Spat (20mm) | 118,840,686 |
| Required Number of Larvae | 1,980,678,105 |

## Probability of Success

Historically, oysters and several other species of bivalves were abundant in the salt ponds (Goode 1884, Olsen and Lee 1985). In recent decades, their numbers have been reduced, primarily by fishing pressure, changing environmental conditions, and disease (Crawford 1984, Ganz 1997, A. Ganz, pers. comm. 1999, Olsen and Lee 1985). With careful site selection and project design, as well as adequate management and enforcement, the Trustees believe that this project can succeed.

The occurrence of high mortality due to disease has been recognized as a problem in the culture of oysters since the early part of the twentieth century (Ford and Tripp 1996). Principle infectious diseases of the adult eastern oyster include "Dermo", and MSX, both caused by protozoan parasites *Perkinsus marinus* and *Haplosporidium nelsoni*, respectively (Ford and Tripp 1996). These parasites are ubiquitous and outbreaks of these diseases are thought to be related to environmental conditions (Ford and Tripp 1996). Additionally, larvae and juveniles in high density culture conditions, such as those found in hatchery situations, may be subject to pathogenic levels of naturally-occurring microorganisms. Juvenile Oyster Disease (JOD) is thought to be caused by such mechanisms (Bricelji *et al*. 1992). To help reduce the impact of disease the Trustees will purchase only certified disease-free stock.

It is not known if MSX is present in Rhode Island's coastal ponds and adjacent coastal waters (M. Gomez-Chiarri, pers. comm. 1999). Dermo is present in some of the salt ponds and in portions of Narragansett Bay (M. Gomez-Chiarri, pers. comm. 1999). In Ninigret Pond the disease has been found in very high levels and is probably the cause of current low densities of oysters in the pond (A. Ganz, pers. comm. 1999, M. Gomez-Chiarri, pers. comm. 1999). The Trustees will not initiate oyster restoration in this pond until the prevalence of disease has diminished. Dermo has been detected in the Great Salt Pond on Block Island (M. Gomez-Chiarri, pers. comm. 1999). At present, Dermo does not appear to be a problem in either Point Judith Pond or Winnapaug Pond, where there are existing small-scale oyster aquaculture operations (A. Ganz, pers. comm. 1999, M. Gomez-Chiarri, pers. comm. 1999). The Trustees will survey the sites selected for restoration for Dermo prior to implementing the oyster restoration project. This survey will provide a baseline level of the disease and will allow the Trustees to implement best management practices. The existence of such diseases does not preclude the accrual of potential benefits from a successful oyster restoration project. However, the Trustees believe it is prudent to include a contingency factor of 100 percent in the project cost estimate to cover the potential for a catastrophic disease-induced oyster mortality (see "Approximate Project Cost" discussion below).

The likelihood of project success can be improved by diversifying the project among several locations. With careful site selection, good project design, and provision of monitoring and enforcement measures, it is highly likely that shellfish restoration in the salt ponds and adjacent Narragansett Bay waters using oysters would succeed in meeting restoration objectives.

**<u>Performance Criteria and Monitoring</u>**

The performance measure for this project is bivalve production. This project will meet its goal when the net production of shellfish biomass resulting from the project equals the loss of shellfish biomass caused by the *North Cape* oil spill. Production of shellfish biomass is calculated as wet tissue weight of stocked animals plus weight gain (growth) of the stocked animals over their lifespans, adjusted for annual survival rates and discounted in future years to arrive at net present value in kilograms of bivalve biomass.

To restore the injury, the shellfish restoration project must produce approximately 1.2 million kg of bivalve biomass in the salt ponds over the life of the stocked animals. Three factors control this production: (1) live weight of shellfish introduced into the environment (stocked); (2) the animals' growth rate; and (3) their rate of survival. Therefore, measurement of these factors is central to monitoring the performance of this project. The project will take place over nine years, which includes eight consecutive years of stocking and monitoring plus an additional start-up year when remote setting equipment will be set up, and field site selection and evaluation will occur. The data collected will be used to make any necessary adjustments and to develop accurate site-specific estimates of bivalve growth, survival and production. Subsequent (post-Year 8) production will be estimated based on the results of the eight years of planting.

The first factor, the amount of shellfish stocked in the ponds, will be determined through measurement or estimation of weight, number, and size of live shellfish seed stocked at each project site. Site surveys will track subsequent growth and survival by measuring density, size, age, and absolute number of shellfish present at site. The precise sampling methodology employed will depend on depth, substrate type, and other factors.

Using these measurements, annual production will be calculated and a running account of restoration results kept year-by-year. If actual survival or growth rates are lower than expected, annual production will be lower than predicted by the scaling calculations and more animals than initially estimated will have to be stocked to produce the total biomass required to restore the injury. Conversely, if survival or growth rates are higher than expected, fewer animals will need to be stocked. If, after eight years of stocking, monitoring results show that production falls short of expectations, then the stocking phase of the project will be extended into subsequent years.

Certain basic environmental parameters must also be measured to maximize the probability of project success, understand project results, and employ adaptive management. These include basic water quality parameters (*e.g.*, temperature, salinity, transmissivity, dissolved oxygen, and chlorophyll *a*), and recruitment, growth, and survival of wild shellfish populations at nearby reference sites.

To select project sites and develop a baseline against which the effects of the project can be measured, a habitat assessment and baseline survey must be undertaken in areas that hold potential for restoration. On-site sampling and observation will be used to assess sediment characteristics, vegetative cover, and characteristics of existing shellfish populations as well as the water quality parameters listed above. Pilot-scale biological tests may also be required to assess potential sites. Use of geographic information systems (GIS) within project areas will facilitate the management and analysis of data, improving the efficiency and effectiveness of restoration actions.

**Approximate Project Cost**

The cost for shellfish restoration includes twelve major elements: planning and project development; the cost of eyed oyster larvae and remote setting equipment; bottom cultch and placement material; other equipment and maintenance; transportation and vehicle costs; a baseline survey; the cost of a monitoring program; data analysis and interpretation; enforcement; infrastructure; labor; project implementation; and a 100 percent contingency. These costs are summarized in Exhibit 5-10. As shown, total costs for this alternative are estimated at $ 5.9 million.

**Exhibit 5-10**

**APPROXIMATE PROJECT COSTS FOR SHELLFISH RESTORATION**

| Cost Element | Total Cost |
|---|---|
| **Planning/Project Development** | $25,000 |
| **Oyster Larvae Purchase and Supplies for Remote Setting** | $489,136 |
| **Bottom Cultch Material and Placement** | $125,000 |
| **Equipment & Maintenance** (vessel and supplies) | $155,000 |
| **Transportation** (vehicle rental & acquisition) | $38,000 |
| **Baseline Survey** | $150,000 |
| **Monitoring** | $300,000 |
| **Data Analysis & Interpretation** | $70,000 |
| **Enforcement** | |
| Seeding Enforcement ($2,189/year for 7 years)[10] | $15,325 |
| Harvesting Enforcement ($8,466/year for 9 years)[11] | $76,193 |
| **Infrastructure** (office space, computers, maintenance) | $80,000 |
| **Labor** (5 seasonals) | $691,468 |
| **Project Implementation** (nine years) | $761,933 |
| **Contingency (100%)** | $2,977,055 |
| **Total** | $5,954,110 |

The cost of eyed oyster larvae is based on unit prices of $200 per one million larvae obtained by the Trustees from several hatcheries. Costs for eyed oyster larvae, equipment for the remote setting phase and the nursery grow-out phase is estimated to be approximately $489,136, and is based on information from several hatcheries and hatchery suppliers. Costs associated with the potential need for cultch bottom enhancement of areas within Narragansett Bay are estimated at $125,000. It is estimated that 5 seasonal laborers will be required for this project over the duration of the project. Labor costs and enforcement are increased 3 percent each year to account for inflation. Project implementation costs are expected to be $761,933 for the duration of this nine-year project; these costs reflect the management personnel expense needed to manage the activities described above.

As described above, several diseases can adversely affect oyster populations and have apparently caused a decline in the Ninigret Pond population (A. Ganz, pers. comm. 1999, M. Gomez-Chiarri, pers. comm. 1999). Given the risk of potential project failure due to disease, the Trustees believe it is necessary to add a contingency factor of 100 percent for this project. This contingency is necessary to cover: 1) the risk that the actual costs for this project are higher than

[10] Seeding enforcement costs based on an initial rate of $2,000 per year increased annually by 3% per year for 7 years to account for inflation.

[11] Harvesting enforcement costs based on an initial rate of $7,500 per year increased annually by 3% per year for 9 years to account for inflation.

the estimated costs shown in Exhibit 5-10; 2) the risk that unforeseen issues arise at the time of implementation of the project and cause an increase in the project costs; 3) the risk that the project fails or results are significantly reduced because of the onset of disease and/or 4) the risk that not enough suitable bottom is available for planting spat in areas that have no disease or negligible levels of disease, which could cause project delays and costs to escalate. If the project fails because of disease or if the Trustees determine that not enough suitable bottom is available the Trustees will use those contingency funds to implement an alternative shellfish restoration project to compensate for the balance of the lost biomass. This project may include enhancing one or more of the following species; quahog, bay scallops or soft shell clams in the salt ponds and adjacent Narragansett Bay waters. The exact species used will be determined by the Trustees at the time the oyster project is either reduced in scale or completely terminated. The scale of the contingency project will depend upon the funds available from the contingency and the amount of biomass accrued by the oyster project until the time that the Trustees determine to either reduce or terminate that project. All biomass accrued from the oyster project will be credited towards the total biomass required to compensate for shellfish injuries. The Trustees are confident that the contingency will be sufficient to fully compensate for the injured shellfish in the event of partial or total project failure.

**<u>Environmental and Socio-Economic Impacts</u>**

The addition of remote set oyster spat should have minimal adverse impacts on the coastal salt ponds. Stocking of various types of shellfish in the coastal ponds has been practiced over the years by the Rhode Island Department of Environmental Management. Oysters reach harvestable size in about two to three years at which time the local landings from the salt ponds could increase thereby benefiting the local fishery.

The one-acre nursery area will have to be managed effectively to ensure the success of the project. Some recreational and commercial activities may have to be temporarily curtailed in the immediate nursery area to avoid any adverse impacts. The location of the nursery will be carefully selected to minimize adverse impacts on the recreational and commercial users of the salt ponds.

The placement of cultch on the bottom to enhance habitat within Narragansett Bay could have both negative and positive environmental impacts. The potential negative impacts may be the displacement of organisms from some bottom habitats. Sensitive habitats such as eelgrass beds and bottom habitats that support populations of important commercial and recreational species such as quahogs and winter flounder spawning habitat will not be cultched. Positive environmental impacts associated with cultched bottoms are an increase in habitat diversity and biomass. Cultched areas tend to attract benthic invertebrates that use the shell surface and interstitial spaces as habitat (Dame 1979, Dame *et al*. 1984).

The impact of mixing genetically distinct shellfish from non-pond populations is a potential concern, but can be obviated by using local animals as brood stock. Moreover, shellfish seed of other species have been transplanted into the ponds in past years, with no apparent adverse affects on the native populations.

The Trustees will consult with all potentially affected stakeholders to minimize conflicts with navigation, dredging, commercial or recreational fisheries, local residents, and other users of the salt ponds and adjacent waters of Narragansett Bay.

**Evaluation**

The productivity of the oyster restoration will be assessed on a yearly basis. If at any time after year 3 of the restocking program the biomass is less than the expected biomass and this is determined to be a result of disease, the Trustees may choose to implement a contingency shellfish plan. If such a determination is made, the Trustees may opt to either continue the oyster restoration at a reduced level and supplement it with an alternative shellfish species restoration; or terminate the oyster restoration in favor of an alternative shellfish species restoration. All biomass accrued up to this point in time will be credited towards the total biomass required as compensation for the bivalve injuries.

Overall, shellfish restoration is a preferred alternative for addressing injury to bivalve resources caused by the *North Cape* oil spill because it provides a practical and cost-effective means of replacing resources and resource services substantially similar to those lost as a result of the spill, and no significant adverse impacts are expected.

### 5.4.7.2 Preferred Alternative: Water Quality Management Through Land Acquisition

**Project Description**

To compensate for the injuries to marine and salt pond crabs, fish, and worms/amphipods, and pond bird resources, the Trustees' preferred option is land acquisition. Under this restoration option, the Trustees would purchase land within the salt pond watershed that is likely to be developed in the near future. The acquisition of land will accomplish this goal by reducing the ecological impacts of future land development, benefiting salt pond water column and benthic resources and the biota dependent on them by preventing increased nutrient loading. The Trustees have identified several properties within the "lands of critical concern" defined by the Coastal Resource Management Council (CRMC) in the Salt Pond Region Special Area Management Plan that would meet *North Cape* land acquisition restoration goals. This land will be managed as part of the U.S. Department of Interior, Rhode Island Wildlife Refuge System, Rhode Island Department of Environmental Management or a local land trust, as appropriate.

Alternatively, development may be prevented by purchasing property development rights, in which case the responsibility of land management remains with the owner. In many cases, however, the cost of acquiring development rights is approximately equivalent to the cost of acquiring the property itself. Total injury, measured in the year of the spill (1996), is indicated in the second column of the exhibit. The third column provides the biomass restoration objectives assuming project implementation in 2000.

### Restoration Objectives

The primary goal of this restoration option is to compensate for the injuries listed in Exhibit 5-11. The acquisition of land will accomplish this goal by reducing the ecological impacts of future land development, benefiting salt pond water column and benthic resources and the biota dependent on them by preventing increased nutrient loading.

Increased nutrient loadings to the salt ponds from residential development (primarily via groundwater discharge) have caused eutrophication, leading to declines in eelgrass, increased sediment anoxia, and other detrimental effects on fish and wildlife habitats (Lee and Olsen 1985, Short *et al*. 1996). Nitrogen is a difficult substance to remove from sewer effluents, particularly in coastal areas due to the seasonal variability of waste quantity and quality (Gorgun *et al*. 1995). The acquisition of land slated for development offers a means of reducing future nutrient loading to the coastal ecosystem without the complications associated with treating urban sewage. Land protection also offers the benefit of decreasing microbial pollution associated with development (P. Peterson, pers. comm. 1997).

**Exhibit 5-11**

***NORTH CAPE* INJURIES RESTORED THROUGH LAND ACQUISITION**

| Injury Category | Total Injury 1996 | Total Injury 2000 | Primary Species |
|---|---|---|---|
| 1. Marine Fish | 110,576 kg | 124,454 kg | Skates, cunner, sea herring |
| 2. Salt Pond Forage Fish | 5,037 kg | 5,669 kg | |
| 3. Salt Pond Winter Flounder | 2,519 kg | 2,835 kg | -- |
| 4. Marine Crabs | 97,166 kg | 109,361 kg | -- |
| 5. Salt Pond Crabs, Shrimp | 7,106 kg | 7,998 kg | -- |
| 6. Marine Benthic Macrofauna (net)[1] | 509,503 kg | 573,450 kg | Polychaetes, amphipods |
| 7. Salt Pond Benthic Macrofauna (net)[1] | 147,822 kg | 166,375 kg | Polychaetes, amphipods |
| 8. Pond birds | 476 kg | 536 kg | Herons, black duck, geese, swans, scaup |
| 9. Zooplankton | 229 kg | 258 kg | |
| **Subtotal** | 880,434 kg | 990,936 kg | |

[1] Biomass killed by the spill was returned to the marine and salt pond ecosystem in the form of food for scavengers. The Trustees have assumed that killed biomass was consumed by benthic macrofauna, many of which are scavengers. Thus, the benthic macrofauna biomass to be restored is equal to the biomass lost because of the spill less the scavenging biomass gained. See French (1998b) for more detailed descriptions of this calculation.

### Scaling Approach

To determine the appropriate acreage of land to acquire, the Trustees have linked scientific evidence that benthic production in eelgrass beds is greater than that of unvegetated bottom (Heck *et al*. 1995) with studies suggesting that loss of eelgrass beds can be averted through land acquisition (Short *et al*. 1996). By preserving eelgrass beds and their associated biota in the salt ponds, land acquisition will yield a net gain in benthic macrofauna production that will compensate for the lost biomass identified in Exhibit 5-11.

Short *et al*. (1996) have shown an inverse correlation between the areal distribution of eelgrass habitat in Ninigret Pond and the number of houses in the pond's watershed. The study reviews evidence indicating that eelgrass bed area in the pond has declined because of algal growth caused by residential sources of nitrogen. Based on their analysis, continued development in the watershed is likely to cause additional losses of eelgrass beds.

The number of houses that need to be precluded from development is calculated using the ratio of 1,300 square meters of eelgrass habitat lost per house.[12] The amount of eelgrass habitat needed to be preserved is based on literature values (Heck *et al*. 1995) for benthic production in eelgrass beds relative to unvegetated bottom. Eelgrass area is scaled to the injury (lost biomass identified in Exhibit 5-11) by estimating the benthic (secondary) production necessary to restore that loss, taking into account that preserved eelgrass habitat will yield benefits in perpetuity.

The total injuries in kilograms are translated into equivalent benthic (secondary) production as follows. Each injured species group is assigned a trophic level relative to that of benthic macrofauna that use eelgrass habitat. If the injured species group is at the same trophic level as the benthic macrofauna, it would presumably have the same ecological value in the food web and, therefore, is restored on a 1:1 basis with the macrofauna (e.g., one kilogram of benthic biomass is required to restore one kilogram of biomass of the same trophic level lost due to the spill). If the injured species is one that preys on benthic macrofauna, the ecological efficiency is that for trophic transfer from prey to predator. Values for production of predator per unit of production of prey (trophic transfer efficiency) are taken from the ecological literature as reviewed by French *et al*. (1996). For fish or invertebrates preying on fish or invertebrates, the Trustees assume a transfer efficiency of 20 percent (e.g., five kilograms of benthic biomass is required to restore one kilogram of its fish or invertebrate predators). For birds and mammals, (which are warm-blooded, and so less efficient) preying on fish or invertebrates, the assumed transfer efficiency is two percent (e.g., 50 kilograms of benthic biomass is required to restore one kilogram of its bird or mammal predators). These calculations are explained in more detail in French (1999b).

The amount of benthic production needed to compensate for the lost biomass caused by the spill is calculated as kilograms of injury divided by ecological efficiency. Benthic production is then translated to the area of eelgrass required by first correcting for dry weight (15% of wet weight) and then dividing by the annual net gain in benthic production in an eelgrass bed on a per square meter basis and again dividing by a discount factor of 31.6.[13] The annual net gain in benthic production is derived from Heck *et al*. (1995) who determined that benthic macrofaunal production in eelgrass beds is about 175 grams dry weight per square meter per year greater than in an unvegetated bottom.

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[12] This ratio is derived from Short *et al*. (1996) using their linear regression analysis of eelgrass area in Ninigret Pond and housing numbers in the Ninigret Pond watershed ($y=6.2670-0.0013x$, $r^2=0.934$).

[13] The Trustees use a discount rate of 3% and calculate benthic production for this restoration project for a period of 100 years. The effects of discounting make any benefits beyond this period extremely small.

The Trustees reduce the amount of secondary production required by an amount that accounts for the biomass produced by scavengers feeding on organisms killed by the spill. The Trustees assume that dead biomass was consumed by benthic macrofauna, many of which are scavengers. Benthic production was obtained from this consumption, which is credited against the production foregone of the benthic macrofauna. The Trustees assume a trophic transfer efficiency of 20 percent for this consumption (i.e., 5 kilograms of biomass killed by the spill produced 1 kilogram of benthic macrofauna scavenger biomass).

Using this methodology, the Trustees determine the amount of secondary production required to restore the injuries addressed by land acquisition. To address the injuries listed in Exhibit 5-11, 54,751 square meters[14] of eelgrass must be saved by preventing future development. Using the previously described ratio of 1,300 square meters of eelgrass saved per house prevented, development of 42 houses[15] must be forestalled. Assuming zoning of between one and two acres per house, a total of 42 to 84 acres must be acquired to meet restoration objectives.

**Performance Criteria and Monitoring**

This project will be complete when enough land has been purchased to prevent the development of 42 houses. No monitoring will be required, although active management of acquired land may be necessary depending on site characteristics and locations.

**Probability of Success**

The acquisition of land slated for development offers a practical, effective means of preventing future increases in nutrient loading to the coastal ecosystem. For this project to be successful, it is important that acquired land is expected to be developed in the near future. To maximize project benefits, it is also important that acquired land is relatively close to the ponds. The Rhode Island Coastal Resources Management Council has designated certain lands adjacent to the salt ponds as priorities for protection because of their proximity to areas of the ponds that are particularly susceptible to eutrophication. Such lands should be targeted for acquisition. Although development in more distant portions of the watershed will likely contribute nitrogen loadings to the ponds through stream and groundwater flows, natural dilution and attenuation will reduce the per-house benefit realized from acquisition of these properties.

**Approximate Project Cost**

Based upon Trustee assessment of the cost to acquire actual house lots, the approximate purchase price of 42 house lots would cost $1,260,000. Available information on property values

[14] The 48,645 square meter area calculated in French (1999b) is discounted for four years to yield the 54,751 square meter area required for restoration implementation in the year 2000.

[15] The 37.4 house lots calculated in French (1999b) is discounted for four years to yield the 42 house lots required for restoration implementation in the year 2000.

suggests that land acquisition costs can be as high as $500,000 per acre for prime, waterfront property (NOAA 1996). However, because non-waterfront development also will increase salt pond nitrogen loadings, it is not necessary for acquired land to be directly alongside the waterfront. The estimated cost of land acquisition is consistent with similar, actual purchases of conservation land made by USFWS and other conservation organizations in the local area during the last three years. In these situations, developable land near the salt ponds has been purchased for approximately $20,000 per acre. The per-acre price reflects several factors, including the "unimproved" condition of the land, the large number of acres purchased, and the fact that all acreage on a property is purchased, which typically includes some low cost, undevelopable land (e.g., wetlands) in addition to the "targeted" acreage that can be developed.

In addition to the purchase price of the land, expense elements for this alternative include project implementation costs, transaction costs, and a 25 percent contingency cost. The Trustees estimate project implementation costs at $124,000; approximately $112,000 to manage the land acquisition process, which is expected to take two years, and $12,000 for boundary posting. Transaction costs are estimated to be $21,000 per parcel.

Exhibit 5-12 summarizes the approximate project costs for the land acquisition alternative, assuming the purchase will consist of approximately two parcels. As shown, total costs for this alternative are estimated at $1,782,500.

**Exhibit 5-12**

**LAND ACQUISITION APPROXIMATE PROJECT COSTS**

| Cost Element | Total Cost |
|---|---|
| **Property Purchase** (42 house lots @ 30,000 per lot) | $1,260,000 |
| **Transaction costs** | |
| Survey (2 parcels @ $6,000) | $12,000 |
| Phase I Assessment (2 parcels @ $10,000) | $20,000 |
| Title Exam (2 parcels @ $2,000) | $4,000 |
| Appraisal (2 parcels @ $3,000) | $6,000 |
| **Project Implementation** | |
| Land Purchase (two years) | $112,000 |
| Boundary Posting | $12,000 |
| **Contingency (25%)** | $356,500 |
| **Total** | $1,782,500 |

## Environmental and Socio-Economic Impacts

No adverse environmental or economic impacts are expected from this project. By preventing development on land in proximity to the salt ponds, this project will provide substantial environmental benefits. Future nutrient loadings into the ponds will be prevented and below the anticipated level if development were to proceed, which will in turn benefit the numerous species that depend on this ecosystem. Although species not listed in Exhibit 5-11 may benefit from this land acquisition, restoration scaling is necessarily focused on resources and resource services injured by the *North Cape* spill. If it can be demonstrated that purchases of specific parcels will provide measurable, significant benefits to other resources or resource services affected by the spill, the Trustees will adjust scaling calculations appropriately.

**Evaluation**

As stated above, the acquisition of land slated for development offers a practical, effective means of preventing future increases in nutrient loading to the coastal ecosystem. To maximize project benefits, the location and development potential of acquired lands must be carefully considered. A variety of organisms injured by the *North Cape* spill, (e.g., fish, shellfish, birds) depend on Rhode Island's salt ponds directly or indirectly, residing seasonally or permanently in the ponds or feeding on organisms produced by or otherwise dependent on the ponds. Because the salt ponds are an essential component of the South Shore coastal ecosystem, and because they are disproportionately affected by human impacts on the coastal environment, land acquisition can greatly benefit the resources injured by the *North Cape* spill.

### 5.4.7.3 Non-Preferred Alternative: Package Treatment Plants

The Trustees evaluated small-scale alternative sewage treatment methods as a means to reduce nitrogen inputs into the coastal ponds and compensate for the injuries listed in Exhibit 5-11. All of the projects in this category involve the construction of a small-scale sewage treatment plant for a limited number of homes in the salt pond watershed. Sewage from the homes would be conveyed via underground sewer pipes to a central collection facility, treated, and discharged to a large leaching field. Land would have to be purchased, sewer pipes installed, and a large leaching field constructed.

Several types of technologies, generally referred to as "package treatment plants", are available to treat and discharge the wastewater. Such systems have the ability to reduce nitrogen by up to 80% (T. Cambareri, pers. comm. 1998). However, conventional septic systems can reduce nitrogen inputs to groundwater on average by about 40% (Valiela *et al*. 1997, J. Costa, pers. comm. 1998).

As discussed in the prior section on land acquisition, 42 house lots need to be purchased to compensate for the loss of selected injured resources. By preventing residential and commercial construction, land acquisition completely eliminates nitrogen loadings associated with development of purchased parcels. In contrast, package treatment plants provide incremental reduction of nitrogen loadings from existing developments. Therefore, more than 42 houses would need to be connected to the treatment system. For example, if a hypothetical house discharged 100 kg of nitrogen into a conventional septic system, 40 kg of nitrogen would be removed and 60 kg would be released into the environment. Given these assumptions, land acquisition of 42 house lots would effectively reduce nitrogen loadings by 2,520 kg per year (60 kg * 42 houses). Connection to a package treatment plant with an 80% nitrogen retention rate would result in the capture of 80 kg of nitrogen and a release of only 20 kg. Per-house reductions in nitrogen loadings would be 40 kg (60 kg - 20 kg). Therefore, 63 houses (2,520 kg / 40 kg) with conventional septic systems would need to be connected to a package treatment plant to meet restoration goals. Although this simple example ignores some additional, more complex factors that would affect scaling calculations, it demonstrates the need for a different project scale.

Conceptually, this technology could be used to meet restoration goals. However, the Trustees have rejected this alternative because current Rhode Island Department of Environmental Management policy prohibits the construction of package treatment plants in the relevant geographic areas.

**<u>Environmental and Socio-Economic Impacts</u>**

The construction of a small-scale sewage treatment plant would create noise, dust, and additional truck traffic during the period of construction. It is likely that such impacts would cause disturbance in the immediate area of construction but would likely be short term in nature. Connecting a number of homes to a sewage treatment plant with inground disposal of effluent would transfer their discharges from many small diffuse sources to one large concentrated source. While the effluent will be treated, careful planning would be needed to ensure that the leach field was sited in an appropriate location. Construction of a plant could encourage increased development as lots that are now not developable because of existing siting criteria for individual septic tanks could be developed if connected to a sewage treatment plant.

### 5.4.7.4 Non-Preferred Alternative: Salt Marsh Creation

Under this project a four-acre upland parcel adjacent to Succotash marsh and East Matunuck State Beach in Narragansett, Rhode Island would be restored to its former condition as salt marsh habitat. This site was filled by road construction activities in the 1950s, and is now vegetated with American beach grass (*Ammophila breviligulata*). The project would involve the removal of approximately 35,000 cubic yards of material (which appears to be sand) and regrading the site to intertidal elevation. Marsh vegetation (*Spartina alterniflora*) would be planted on the site to speed the restoration process. Extension of an existing tidal creek into the regraded area would further encourage tidal exchange and enhance fish and shellfish habitat. Excavated material could potentially be used for beach nourishment or as landfill cover.

The objective of this project would be to restore a formerly functioning salt marsh to compensate for the loss of salt pond birds and benthic productivity due to the *North Cape* spill. Salt marsh ecosystems are among the most productive natural systems on earth and serve as spawning, feeding and nursery areas for fish and shellfish as well as habitat for shorebirds and waterfowl (Teal 1986). This four-acre site has been completely filled and no longer functions as a wetland. Removal of the fill material and restoration of wetland to this site will create four new acres of salt marsh and enhance the production of waterfowl, fish and shellfish.

The key to the success of this project would be the establishment of the proper hydrology at the site to allow the growth of salt marsh vegetation and the use of the marsh by estuarine fish and shellfish. The hydrology would be dictated by the elevation of the new marsh surface, which must be determined based on the elevation of the adjacent, existing marsh surface. Since there is an ample natural seed source adjacent to the site, planting may not be necessary. However, planting *S. alterniflora* seedlings would ensure a more rapid vegetative colonization of the site and provide compensatory benefits sooner.

Success of the project could be hampered by landward migration of the adjacent barrier beach during large storms which could cause the beach to eventually smother the restored site. During a storm of sufficient magnitude, overwash from East Matunuck State Beach could potentially bury the restored site (J. Boothroyd, pers. comm. 1997). The Salt Pond Special Area Management Plan provides information showing the landward migration of the beach over an 80-year period (Olsen and Lee 1985). Despite the potential benefits of this project, the Trustees are concerned about the apparent ongoing landward migration of the barrier beach and its potential to adversely affect the site after restoration. In addition, the four acres available for this project are much less than would be needed to meet restoration goals. The Trustees, therefore, have not selected the Succotash marsh restoration project as a preferred alternative.

**Environmental and Socio-Economic Impacts**

Creation of a salt marsh at this site will require excavation of about 35,000 cubic yards of sandy material, regrading of the site, and planting of *Spartina alterniflora*. Temporary impacts resulting from the construction would include noise, dust, and increased truck traffic in the immediate vicinity of the project. The site would be transformed from an upland site dominated by American beach grass to an intertidal salt marsh. The project would not have any significant socio-economic impacts.

### 5.4.7.5 Non-Preferred Alternative: Fish Stocking

Hatchery stocking of juvenile fish in the salt ponds has been identified as a potential means of addressing injury to commercial and recreational species caused by the *North Cape* oil spill. The idea is attractive because it would provide on-site, in-kind replacement of organisms killed by the spill. Species potentially suitable for hatchery stocking in Rhode Island waters are winter flounder and tautog. Both fish have relatively restricted migratory ranges, but are highly dependent on inshore habitat; both support high-value commercial and recreational fisheries; both were historically abundant in Rhode Island; and populations of both species are currently depressed (Clark 1887, M. Gibson, pers. comm. 1997, G. Klein-MacPhee, pers. comm. 1997, C. Powell, pers. comm. 1997).

There is a great deal of interest among academics and aquaculturists in growing these species and stocking them to the South Shore coastal ecosystem, but the technology for doing so is developmental. Winter flounder are being spawned and grown in tanks to 40 to 50 millimeters, which is thought to be the optimum size for release, and stocking programs have been designed but not, as yet, funded or tested (G. Klein-MacPhee, pers. comm. 1997). Tautog also are being grown and spawned, but survival rates have been low thus far (J. Perry, pers. comm. 1997). Research would be necessary to determine release locations, although the salt ponds are likely to yield suitable sites (D. Bengston, pers. comm. 1997, G. Klein-MacPhee, pers. comm. 1997).

Because of the uncertain probability of success, hatchery stocking of fish is not a preferred alternative for restoration of natural resources injured by the *North Cape* spill.

**Environmental and Socio-Economic Impacts**

Stocking of hatchery-reared fish species such as winter flounder and tautog is likely to have minimal environmental and socio-economic impacts. If successful, such a project could enhance local recreational fishing opportunities.

### 5.4.7.6 Non-Preferred Alternative: Breachway Dredging and Eelgrass Planting

A stabilized breachway was constructed in the 1950s permanently connecting Ninigret Pond to Block Island Sound. The breachway significantly changed the ecology of the pond by increasing salinity and dramatically increasing the rate of sedimentation into the pond (Olsen and Lee 1985). Breachway dredging has allowed a greater volume of water and sand to move into the ponds. The rapid sedimentation in the pond has covered areas of formerly productive benthic habitat, typically occupied by eelgrass (Ganz 1997). As the sedimentation in the pond increased over the years, tidal circulation has decreased, contributing to water quality problems in the pond.

The need to regularly dredge and maintain the breachway was recognized at the time it was constructed. A basin constructed in the middle of the breachway was designed to catch sand on the incoming tide and was to be dredged every few years. However, the sediment basin and the breachway have been dredged only once since original construction. Consequently, the breachway has continued to shoal, creating a navigation hazard and reducing tidal flushing in the pond, and the tidal delta has continued to expand. The Rhode Island Salt Pond Special Area Management Plan estimates that sand flats could extend from the flood-tidal delta at the entrance of the pond to the northern shoreline within 35 years (Olsen and Lee 1985). Water circulation to Green Hill Pond and the east basin would then be severely restricted.

The U.S. Army Corps of Engineers (Corps) currently is carrying out a habitat restoration feasibility study for the South Shore coastal ponds. Based on preliminary information from this and other relevant studies, the Trustees defined and evaluated a salt ponds dredging project. To address relevant *North Cape* restoration objectives in the salt pond environment, the Trustees focused on evaluation of the ecological benefits of dredging, as measured by improvements in water quality and associated impacts on eelgrass bed area. Although dredging may provide navigational, beach nourishment and other benefits, these types of services were not affected by the *North Cape* oil spill, and so are not the primary focus of restoration efforts.

The specific project evaluated by the Trustees involved dredging the Charlestown Breachway and a portion of the Ninigret Pond tidal delta. As part of this project, annual maintenance dredging of the breachway and sediment basin would be required for ten years. To meet *North Cape* restoration objectives, a project of this duration would need to provide 56 new acres (203,489 $m^2$) of eelgrass. Trustee analysis indicates that increases in benthic production attributable to this level of eelgrass enhancement would be sufficient to compensate for relevant losses in benthic biomass due to the spill.[16]

To achieve this restoration goal, 56 acres of the tidal delta would be dredged a depth of one meter and eelgrass would be planted in the dredged "footprint". The dredging activity would substantially improve flushing in the vicinity of the breachway, and resulting water quality improvements should be sufficient to support planted eelgrass populations. Consistent with the Corps study, dredged sand from the tidal delta would be used to nourish local beaches. This approach eliminates disposal costs for dredge spoil and may provide some benefits to the community.

The estimated costs of this project are provided in Exhibit 5-13 below. As indicated in the exhibit, the project total is approximately $7.94 million. The largest individual cost item is eelgrass planting ($3.1 million). Unit cost estimates for this activity ($13.73 per $m^2$) are based on actual costs incurred for a seven acre eelgrass restoration project in the Piscataqua River in New Hampshire. This value includes site surveys, eelgrass collection, transplanting, caging, monitoring, related equipment and project design and implementation costs.

**Exhibit 5-13**

**ESTIMATED DREDGING PROJECT COSTS**

| **Item** | **Cost**[3] |
|---|---|
| Initial Dredging[1] | |
| Tidal Delta (203,489 $m^3$ @ $13.08 per $m^3$) (dredged surface area = 56 acres) | $2,661,537 |
| Breachway (19,600 $m^3$ @ $13.08 per $m^3$) (dredged surface area = 5 acres) | $256,358 |
| Settling Basin (4,886 $m^3$ @ $13.08 per $m^3$) | $63,906 |
| Maintenance Dredging[2] | |
| Annual Cost = $31,950 (4,886 $m^3$ @ $6.54 per $m^3$) | |
| Total Maintenance Cost (summed over 10 years, discounted at 3% per year) | $272,561 |
| Eelgrass Planting (225,432 $m^3$ @ $13.73 per $m^2$) | $3,095,181 |
| Contingency (25%) | $1,587,386 |
| **Total** | $7,936,929 |

[1] Unit costs for initial dredging ($13.08 per $m^3$) are based on Corps estimates that include costs associated with transporting dredged sand for beach nourishment.
[2] Unit costs for maintenance dredging ($6.54 per $m^3$) are based on Corps estimates assuming nearby ocean disposal of relatively small dredging volumes.
[3] Cost estimates may not exactly match supporting calculations due to rounding.

Initial dredging costs for the tidal delta, breachway and settling basin are also substantial ($3.0 million). Dredging volume estimates are based on physical characteristics of the breachway and settling basin and restoration requirements for eelgrass production. Unit costs are based on Corps estimates that include costs associated with transporting dredged sand for beach nourishment. Compared to the scope and cost of the initial dredging effort, maintenance dredging requirements are relatively small. Unit costs for maintenance dredging are also lower, reflecting Corps estimates that assume nearby ocean disposal of these relatively small dredging volumes.

[16] See French (1999b) for a more detailed explanation of the calculations supporting this 51 acre requirement.

Consistent with the costing of other restoration options, the Trustees add a 25 percent contingency to project costs, bringing the total to $7.94 million. This estimate does not include costs associated with NEPA compliance, permitting and general project management, which are likely to be substantial. Even so, the estimated project cost is more than four times the total of the salt pond land acquisition project (see Exhibit 5-12), which addresses the same injuries. Because the benefits related to *North Cape* restoration objectives are similar for both projects, the substantially greater cost of the dredging option makes it non-preferred.

**Environmental and Socio-Economic Impacts**

Dredging the breachway and tidal delta and planting eelgrass within the dredged area would change the bottom characteristics of the dredged area, increase flushing to the salt ponds, likely increase the rate of sedimentation to the ponds, and displace existing biological communities inhabiting the breachway area and the flood tidal delta within the pond. Donor beds for the eelgrass transplants would have to be located and the potential exists to cause adverse impacts within the donor sites given the scale of the project that is necessary to compensate for the impacts from the *North Cape* spill. Improved water quality and restored eelgrass beds would likely enhance the populations of certain species of benthic animals and fish. Dredging the breachway would likely improve navigation as it would ease access to the pond for recreational boaters.

### 5.4.7.7 Non-Preferred Alternative: Eelgrass Restoration

Eelgrass would be transplanted to selected locations within Pt. Judith and Ninigret Ponds to provide fish and shellfish habitat and compensate for the loss of benthic production due to the oil spill. Transplant locations would be identified in areas that are known to have supported eelgrass at some point in the past and that have suitable water quality for its growth and survival.

Eelgrass is an important component of the salt pond ecosystem. Eelgrass meadows serve several important functions, including stabilizing sediment, providing nursery areas for fish and shellfish, filtering suspended particles and nutrients from the water column, and providing an important source of organic matter to the ecosystem (Thayer *et al*. 1984). Eelgrass meadows serve as important habitats for forage fish and numerous commercially and recreationally important marine fish and shellfish, including bay scallops, quahogs, tautog, winter flounder and sticklebacks. (Thayer *et al*. 1984, Heck *et al*. 1989, Peterson *et al*. 1984). Heck *et al*. (1995) estimated that eelgrass macroinvertebrate production is about 5 to 15 times greater than sand-flat or mud-flat habitats. Therefore, successful creation of eelgrass habitat in the coastal salt ponds could adequately compensate for the loss of benthic production.

Over the last 30 to 40 years, eelgrass bed area has declined in Ninigret and other Rhode Island coastal salt ponds, due largely to increases in nutrient levels. Nutrient loading in shallow embayments stimulates the growth of phytoplankton which reduces water clarity and stresses eelgrass, eventually killing it (Short *et al*. 1995, Taylor *et al*. 1995). Increased housing development in the ponds' watershed is likely a major contributor to this problem (Short *et al*. 1996, Lee and Olsen 1985).

The decline in eelgrass bed area indicates that water quality or some other factor is limiting its establishment or survival in affected locations of these ponds. Adequate natural seed sources exist to provide for the natural expansion of eelgrass if water quality conditions were suitable. Until the nutrient loading problem is addressed, it is not likely that eelgrass transplanted to Ninigret or Pt. Judith Pond will survive. Therefore, eelgrass restoration is not a preferred alternative, due to its low likelihood of meeting the Trustees' objectives in compensating for the loss of benthic production from the oil spill.

**Environmental and Socio-Economic Impacts**

Transplanting eelgrass to the selected locations with the coastal salt ponds is likely to cause minimal adverse impacts. However, donor beds for the transplants would have to be located and the potential exists to cause adverse impacts within the donor sites given the scale of the project that is necessary to compensate for the impacts from the *North Cape* spill. Restored eelgrass beds would likely enhance the populations of certain species of benthic animals and fish. This alternative will alter the topography of the bottom. The added vegetation will alter the flow regime and function to stabilize sediments. This will also increase the accumulation of organic and inorganic materials and will reduce erosion as a result of sediments binding with the roots (Fonseca 1992, Kirkman 1992).

### 5.4.7.8 Non-Preferred Alternative: Phragmites Removal

Healthy salt marsh habitat supports a diverse community of plants and wildlife. Typical plant species of Rhode Island salt marshes include salt marsh cordgrass, salt meadow hay, spikegrass, glasswort and black grass (Morgan and Burdick 1996, NOAA 1996). Snails, crabs, shrimp, amphipods, isopods, worms, and insects all inhabit this vegetative community. These species are fed upon by a great variety of fish, small mammals, and birds, including black ducks, wading ducks, herons, egrets, and ibis.

Through construction of roads and railways, dumping of dredge material, and intentional diking of waterways, many areas of salt marsh have been cut off from the ocean environment. Invasive freshwater species have capitalized on the ensuing change in habitat. The common reed (*Phragmites australis*) has flourished in this less saline habitat, outcompeting many of the indigenous salt marsh species and rising to dominance in the new wetland community. *Phragmites* wetlands are characterized by low floral and faunal diversity (Van der Valk 1986, Cowie *et al*. 1992, Vestergaard 1994, Hauber *et al*. 1991, Jones and Lehman 1987). Hauber *et al*. (1991) found that *Phragmites* replaced plant species preferred as food by migratory waterfowl. Wading birds have difficulty in penetrating *Phragmites* stands of up to 200 stems per square meter. Restricted waterways in which *Phragmites* proliferate are not accessible to marine and estuarine fishes that depend on salt marsh refuges as feeding and breeding grounds (NOAA 1996)[17].

Removing *Phragmites* could benefit the salt pond community. *Phragmites* removal may be most effectively accomplished by a two-step process in which vegetation is physically removed through application of the herbicide Rodeo and mulch mowing, and the environmental conditions are altered permanently through modification of the hydrologic flow to increase water salinity levels (Marks *et al*. 1994, Hellings and Gallagher 1992). However a relatively limited amount of *Phragmites* is available for removal, and available information on the expected change in densities of birds and other biota resulting from this project indicates that it would not meet *North Cape* restoration objectives. As a result *Phragmites* removal is not a preferred option to address restoration of salt pond communities.

**<u>Environmental and Socio-Economic Impacts</u>**

Removal of *Phragmites* through application of herbicide, mulch mowing or other physical means, and manipulation of the local hydrologic regime would likely result in a changed vegetative community and its associated animal residents. Depending upon the salinity of the specific site in question, salt marsh species or brackish vegetation would colonize the area denuded of *Phragmites*. Temporary construction impacts of operating heavy machinery within wetland areas would include trampling of existing vegetation. These impacts, however, would rapidly disappear. This project would not have any significant socio-economic impacts.

### 5.4.8 <u>Lost Recreational Fishing Restoration</u>

Trustee analysis indicates that the *North Cape* oil spill had a direct adverse impact on party and charter boat recreational anglers fishing in and around Block Island Sound. For the period of January 20, 1996 to June 30, 1996 the Trustees estimate spill-related losses of approximately 3,305 party and charter boat angler-trips. Based on a 1999 value of $85.23 per party and charter boat angler-trip, the Trustees value these losses at $281,685.

As described below, the Trustees have identified two preferred restoration options for this injury: improvement of shore fishing access and anadromous fish run restoration.

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[17] As obstructed salt marshes lose salinity, the soil oxidizes and loses depth, creating a shallow, two dimensional habitat. Additionally, thick *Phragmites* stands act as a screen, collecting trash and other debris that normally would flow out the drainage ditches. The shallow, segmented waters of *Phragmites* habitat further inhibit fish movement within the wetland.

### 5.4.8.1 Preferred Alternative: Improved Shore Fishing Access

**Project Description**

The Trustees will implement this project located in the town of South Kingstown to improve access to the shoreline for recreational anglers. Currently access for recreational fishing is limited in many areas along the south shore. Public access improvement projects could include construction or repair of public stairways, walkways or piers and land acquisition to provide the public with improved access. One project has been identified to enhance access to surfcasters and other shoreline users in the area affected by the *North Cape* spill. The Matunuck Point Ocean Access project involves the reconstruction of a Town-owned public stairway and walkway down a bluff from Matunuck to the shore.

**Restoration Objectives**

The objective of the project would be to provide additional recreational fishing opportunities on Block Island Sound, to compensate for those lost as a result of the *North Cape* oil spill. The primary benefit would be increased access for recreational fishermen to the ocean waters of the south shore. Secondary benefits are improved safety for shore fishermen and improved access for passive resource users.

**Scaling Approach**

The Trustees are unable to directly scale this project to the injury because of substantial uncertainty associated with the number of recreational fishing trips the project would provide and the relative quality of these opportunities compared to those lost from the *North Cape* spill. Based upon OPA regulations, where Trustees have determined that direct scaling is not possible, Trustees may use the valuation scaling approach. Using this approach, Trustees determine the amount of natural resources and/or services that must be provided to produce the same value lost to the public. If, in the judgment of the Trustees, valuation of the replacement natural resources and/or services cannot be performed at a reasonable cost, Trustees may estimate the dollar value of the lost services and select the scale of the restoration action that has a cost equivalent to the lost value. Thus, a portion of the lost human use value from the lost recreational fishing injury would be applied to project construction and engineering costs. The remaining portion would be applied to the fish run restoration described in Section 5.4.8.2.

**Probability of Success**

Given the lack of adequate access to the Rhode Island south shore, the probability of success for this project is high.

**<u>Performance Criteria and Monitoring</u>**

The performance criterion would be completion of the project to the satisfaction of the Trustees and the local government in whose town the project is located. The project will have to meet design specifications developed prior to construction. No monitoring would be necessary.

**<u>Approximate Project Costs</u>**

Approximate costs for this project are provided in Exhibit 5-14.

**Exhibit 5-14**

**APPROXIMATE COST OF THE MATUNUCK POINT OCEAN ACCESS IMPROVEMENT PROJECT**

| Cost Element | Total Cost |
|---|---|
| Construction | $40,000 |
| Engineering, permitting, supervision | $7,000 |
| Project Implementation | $5,000 |
| Contingency (25%) | $13,000 |
| **Total** | $65,000 |

**<u>Environmental and Socio-Economic Impacts</u>**

Minor impacts (noise, dust, erosion, etc.) as a result of coastal construction activities could be expected, but would be limited and short-lived due to the small size of the project.

**<u>Evaluation</u>**

Improved shore fishing access provides a direct, well-targeted means of addressing lost use of recreational fisheries. Because this approach is simple, cost-effective, highly reliable, and supported by the affected municipality, improved shore fishing access is a preferred alternative for recreational use restoration in response to the *North Cape* spill. Thus, the Trustees propose to undertake the Matunuck Point Access project.

### 5.4.8.2 Preferred Alternative: Anadromous Fish Run Restoration

**<u>Project Description</u>**

Several waterways are used for spawning by anadromous fish in the affected environment (primarily alewives and blueback herring, collectively known as river herring). In spite of recent improvements to fish passageways at dams and road crossings, obstructions continue to limit fish access to spawning habitats.

This project will consist of removing or modifying existing obstructions to fish passage on rivers or brooks that connect with the salt ponds. According to RIDEM's Division of Fish and Wildlife, the priority fish passageway projects in the affected environment are in Factory Pond, which empties into Green Hill Pond, and Cross Mills Brook, which empties into Ninigret Pond. Another area that may be considered is Rum Pond/Smelt Brook, which empties into Point Judith Pond.

A four- to five-year project is necessary to fully establish a run of river herring: fish passage improvement is combined with fish stocking to establish a series of year-classes spawning in the newly accessible habitat.

## Restoration Objectives

Fishway improvements on one or more South Shore rivers would significantly improve numbers of river herring (blueback and alewives) in the affected environment. Larger anadromous fish runs will enhance recreational fishing opportunities by providing forage for predatory freshwater and saltwater fish of recreational and commercial value. Improved fish runs also will supplement local fisheries, which take river herring for use as fishing bait and for personal consumption.

Estimated size of the runs that could be established at each of the sites are identified in Exhibit 5-15.

**Exhibit 5-15**

**OBJECTIVE OF FISH RUN PROJECTS**

| Project | Objective |
|---|---|
| Factory Brook, Green Hill Pond | Fish passage improvement to restore river herring runs |
| Cross Mills Dam, Ninigret Pond | Fish passage improvement to restore river herring runs |
| Rum Pond and Smelt Brook, Point Judith Pond | Fishway and dam improvements to restore river herring runs |

## Scaling Approach

This alternative would serve as partial restoration of the injury to recreational fishing caused by the *North Cape* oil spill. Since the injury was an economic one, valued in dollars for purposes of the damage assessment, the Trustees intend to scale this restoration alternative in dollar rather than biological terms. The dollar value of the injury, $281,685, will be applied toward the shore access alternative and restoration of anadromous fish runs. If these project costs are less than those outlined in the following exhibit, the Trustees will apply the remaining funds towards additional public use based projects in the area of impact.

**Probability of Success**

Fish passage improvement is a proven method of restoring anadromous fish runs impeded by obstructions such as dams. RIDEM has undertaken a number of similar projects throughout the State and all have been successful in restoring anadromous fish runs.

**Performance Criteria and Monitoring**

The performance criteria for this project is completion of the fishway improvements. No monitoring is necessary.

**Approximate Project Cost**

A site visit and feasibility study would be necessary to estimate the cost of the fish run projects. A preliminary cost estimate for one project is provided in Exhibit 5-16.

**Exhibit 5-16**

**APPROXIMATE PROJECT COSTS FOR ONE FISH RUN PROJECT**

| Cost Element | Total Cost |
|---|---|
| Construction | $140,350 |
| Labor for Stocking (4 years @ $2,000/year) | $8,000 |
| Fish purchase (4 years @ $5,000/year) | $20,000 |
| Project Implementation | $5,000 |
| Contingency (25%) | $43,338 |
| **Total** | $216,688 |

**Environmental and Socio-Economic Impacts**

No significant adverse environmental, social or economic impacts are expected, as this project would correct existing adverse impacts of dam construction. Short-term impacts resulting from construction activities (e.g., erosion and noise) are possible; permit requirements should minimize these potential problems.

**Evaluation**

Anadromous fish run restoration provides a highly reliable means of restoring natural resources injured by the *North Cape* spill. By improving runs of forage fish in the affected environment, this alternative would benefit freshwater fish, estuarine sportfish and birds. The project also would provide fishery benefits for bait and personal consumption.

Because this alternative is an effective, long-term repair for existing environmental impacts and because it is highly reliable and will not adversely affect the environment, anadromous fish run restoration is a preferred alternative for natural resource restoration in response to the *North*

*Cape* oil spill. The Trustees will use a portion of available funds recovered as compensation for lost human uses to support construction of anadromous fish run restoration project(s).

### 5.4.8.3 Non-Preferred Alternative: Artificial Reef Construction

Artificial reef construction has been identified as an alternative to restore recreational fishing use lost as a result of the *North Cape* spill. Placement of sunken vessels, pre-fabricated concrete reef units, rubble or the old Jamestown Bridge off the South Shore would provide habitat for epifauna, aggregate recreational fish species, and provide a focus of activity for recreational boat fishermen.

Whether such a project would be biologically beneficial or harmful is unclear. Foster *et al.* (1994) found that the epifauna on a concrete artificial reef in Delaware Bay enhanced gross benthic biomass by a factor of approximately 150-900 relative to adjacent sandy sediments. The study documented utilization of the reef for habitat and forage by tautog, black sea bass, cunner, blue mussel, and other species. A second study suggested that while the bass used the reef for shelter, the importance of reef epifauna in the fish's diet was less clear (Steimle and Figley 1996).

According to Whitmarsh (1997), "artificial reefs have the potential to establish an economically valuable resource capable of generating benefits to fishermen and their communities; however, these benefits will almost certainly be dissipated unless the pressure of fishing on the reefs can be controlled." There is no doubt that an artificial reef could be designed for placement off Rhode Island's South Shore that would locally enhance benthic biomass. Whether such a structure would enhance fish production, or simply exacerbate fishing pressure, depends on site-specific factors as well as reef design and the regulatory context.

Siting would undoubtedly be problematic, as Rhode Island does not have an artificial reef program and most potential reef locations would displace draggers, lobstermen, or other commercial fishermen (S. Cobb, pers. comm. 1997, S. Morin, pers. comm. 1997, D. Satchwill, pers. comm. 1997). There are regulatory impediments as well; Sisson (pers. comm. 1997) has suggested that a feasibility study should be undertaken to examine regulatory and siting considerations before proceeding with design.

Because the benefits of an artificial reef in Rhode Island waters are uncertain, and because siting of such a structure is expected to conflict with other uses of the coastal environment such as commercial fishing, artificial reef construction is not a preferred alternative for addressing injury to recreational fishing caused by the *North Cape* spill.

**Environmental and Socio-Economic Impacts**

Placing an artificial fishing reef within the coastal waters of Rhode Island would displace the existing biological community within the footprint of the reef and would locally enhance benthic and fish populations. The reef would also offer increased opportunities for recreational fishing and could increase opportunities for the local recreational fishing charter fleet.

### 5.4.8.4 Non-Preferred Alternative: Boat Ramp Repair or Improvement

Repair or improvement of existing boat ramps and related facilities to improve coastal access for recreational boat and shore fishermen has been identified as an alternative to restore recreational fishing use lost as a result of the *North Cape* spill. Specific projects identified include the repair of riprap and road at the Quonochontaug Breachway and the addition of a second stationary pier at the boat ramp by Great Island in Point Judith Pond. In both cases the ramps are in good condition.

These projects may provide some additional boat access on summer weekends when use of the launch ramps is at capacity. However, benefits would be minor since all these ramps are currently usable. Because of the limited benefits expected from these projects, and because they consist essentially of maintaining existing State facilities, an existing programmatic responsibility of the state, boat ramp repair or improvement is not a preferred alternative for addressing injury to recreational fishing caused by the *North Cape* spill.

**Environmental and Socio-Economic Impacts**

Minor temporary construction impacts including noise, dust and increased truck traffic could be expected from this non-preferred alternative. In addition, stationary piers can cause impacts to SAV habitat if not properly sited. Increased boating activity could result from access improvements at the proposed locations.

### 5.4.8.5 Non-Preferred Alternative: Maintenance of Public Fishing Rights of Way

Another alternative identified to restore recreational fishing use lost as a result of the *North Cape* spill is maintenance of public fishing rights of way. Local property owners in the South Shore area tend to discourage public use of rights of way by removing signage or placing barriers. While CRMC has a program in place to identify historic rights-of-way to the Rhode Island shore, funding is lacking to fully maintain and enforce public access. Planners and resource users in the South Shore area have suggested a program to establish a position or trust fund, perhaps within CRMC or the URI Coastal Resources Center, to work with CRMC and town planning offices to research, mark and maintain coastal rights of way.

As is the case with the boat ramp alternative, above, this alternative would simply fund an existing programmatic responsibility of the State. As such, the project is not appropriate for restoration in response to the *North Cape* spill. Moreover, since the State is already working to ensure full public access along historic rights of way, expected benefits are marginal.

Because the benefits of this alternative are expected to be slight and because it would impinge on an existing State program, maintenance of public fishing rights of way is not a preferred alternative for addressing injury to recreational fishing caused by the *North Cape* spill.

**Environmental and Socio-Economic Impacts**

This project would likely cause minimal environmental and socio-economic impacts.

## 5.5 RESTORATION SUMMARY

Exhibit 5-17 summarizes the injuries, restoration alternatives and restoration costs for the *North Cape* oil spill. As indicated in the exhibit, the injuries caused by the spill were substantial. The total restoration project and oversight costs presently estimated by the Trustees are approximately $27.6 million. Restoration of the injury to lobsters through the V-notching project accounts for $9.9 million of the total estimated cost. Land acquisition to improve salt pond water quality and biological productivity is projected to cost $1.8 million. Piping Plover protection will cost approximately $232,700. Restoration for the 33 loon nesting sites will require approximately $7.5 million. Restoration of marine birds and human use injuries are estimated at $631,250 and $281,685 respectively. Restoration for shellfish injuries is estimated to cost $6.0 million. Finally, Trustee oversight costs are expected to total approximately $1.3 million.

For each of the preferred restoration projects in the Draft Restoration Plan except shellfish restoration, the Trustees have estimated the cost of project elements and included a 25% contingency. This 25% contingency is intended to cover the risk that the costs for the projects will turn out to be higher than expected and/or the risk that the projects will not result in the expected magnitude of benefits and may need augmentation. For shellfish restoration, the Trustees include a 100% contingency, reflecting additional risks associated with this project.

In addition, the Trustees estimate that $1.3 million will be needed for Trustee oversight of *North Cape* restoration projects. These funds will be used by the Trustees to review data and reports assessing the progress and results of *North Cape* restoration projects, participate in Trustee meetings and conference calls and otherwise ensure that restoration objectives are met. This estimate of oversight costs was calculated by multiplying total project costs ($26.3 million) by five percent. It is important to note that oversight costs are distinct from project implementation costs.

**Exhibit 5-17**

**SUMMARY OF INJURIES, RESTORATION ALTERNATIVES AND COSTS FOR THE *NORTH CAPE* OIL SPILL**

| Injury | Restoration Alternative[1] | Scale of Restoration | Project Costs |
|---|---|---|---|
| **Lobsters**<br>9.0 million killed | **Adult Lobster Restocking**<br>Hatchery stocking of lobsters<br>Lobster habitat enhancement/creation<br>Transplanting of juvenile lobsters<br>Creation of a lobster sanctuary | 1.248 million adult V-notched females | $9,915,625 |
| **Surf Clams**<br>970,400 kg of biomass lost (direct kill & production foregone) | Hatchery stocking of surf clams<br>Surf clam transplanting<br>**Shellfish Restoration** | Included in shellfish restoration | Included in shellfish restoration |
| **Piping Plovers**<br>5-10 chicks | **Habitat protection & monitoring** | | $232,706 |
| **Loons**<br>414 birds killed, 3,749 loon-years lost | **Loon habitat protection**<br>Nest site enhancement<br>Loon public outreach and education | 33 breeding pairs and associated nest sites protected through land acquisition | $7,485,170 |
| **Marine Birds Other than Loons**<br>1,668 birds killed, 2,933 bird-years lost | **Seaduck habitat protection** | 315 breeding pairs and associated nest sites protected through land acquisition | $631,250 |
| **Salt Ponds and Other Marine Injury**<br>Injuries to marine benthos, marine fish, pond benthos and pond birds (approximately 6.6 million kg). | **Shellfish Restoration**<br><br>**Land acquisition**<br>Package Treatment Plants<br>Anadromous fish run restoration<br>Salt marsh creation<br>Fish stocking<br>Breachway dredging<br>Eelgrass restoration<br>Phragmites removal. | 1,980,678,105 oyster larvae (scaled to shellfish injury only)<br><br>42 house lots purchased (assuming 1-2 acre zoning, 42 to 84 acres of land required) | $5,954,110<br><br>$1,782,500 |
| **Party and Charter Boat Fishing**<br>Lost trips valued at $281,685 | **Shore Access**<br>**Anadromous Fish Run Restoration**<br>Artificial reef construction<br>Boat ramp<br>Public Rights of Way | | $281,685 |
| **Project Cost Sub Total** | | | $26,283,046 |
| **Trustee Oversight (5%)** | | | $1,314,152 |
| **Total** | | | $27,597,198 |

[1] Preferred alternatives are indicated in bold text.

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**Information for this document was obtained from the following sources:**

Brad Allen, Maine Department of Inland Fisheries

Thomas Angell, RIDEM Division of Fish and Wildlife

D. Beach, National Marine Fisheries Service

B. Beal, University of Maine

Jim Beatie, RIDEM Division of Coastal Resources

David Bengston, University of Rhode Island

Hillyard Bloom, Talmadge Brothers Company

Richard Bohn, University of Maryland

Jon C. Boothroyd, University of Rhode Island

Denise Breitburg, Benedict Estuarine Research Center

David Burdick, University of New Hampshire

Tom Cambareri, Cape Cod Commission

Paul Capotosto, Connecticut Department of Environmental Protection

Kathy Castro, University of Rhode Island

John Catena, National Oceanic and Atmospheric Administration

Mike Clancy, University of Rhode Island

Stan Cobb, University of Rhode Island

Clark Collins, Town of Narragansett

Joseph Costa, Buzzards Bay Project

Rick Crawford, Waquoit Bay National Estuarine Research Reserve

Joe DeAlteris, University of Rhode Island

Ben Emory, Maine Coast Heritage Trust

Dennis Erkan, RIDEM Division of Fish and Wildlife

Laura Ernst, Rhode Island Coastal Resources Management Council

Mark Finn, Greenwich Bay Clam Company

Mike Fogarty, University of Maryland

Art Ganz, RIDEM Coastal Fisheries Laboratory

Herman Gempp, Block Island Shellfish Commission

Mark Gibson, RIDEM Division of Fish and Wildlife

Ron Goldberg, NOAA National Marine Fisheries Service

Frank Golet, University of Rhode Island

Marta Gomez-Chiarri, University of Rhode Island

Tim Goodger, NOAA National Marine Fisheries Service

Steve Granger, University of Rhode Island

Curtice Griffin, University of Massachusetts

Charlie Hebert, United States Fish and Wildlife Service

Eric Holt, Massachusetts Audubon Society

Chris Judy, Maryland Department of Natural Resources

John Karlsson, RIDEM Coastal Fisheries Laboratory

Grace Klein-MacPhee, University of Rhode Island

John Kraeuter, Rutgers University, Haskin Shellfish Research Laboratory

Dick Krauss, Aquacultural Research Corporation

Jay Krouse, Maine Department of Marine Resources

Tony Lachowicz, Town of South Kingstown

Tracy Lang, Town of Narragansett

Richard Langan, University of New Hampshire

Rich Langton, Maine Department of Marine Resources

Kathy Lauralham, South Kingstown Recreation and Parks Department

Virginia Lee, University of Rhode Island

Mike Ludwig, NOAA, National Marine Fisheries Service

Tim Lynch, RIDEM Divsion of Fish and Wildlife

Drew Major, United States Fish and Wildlife Service

Steve Malinowski, The Clam Farm Incorporated

Roger Mann, Virginia Institute of Marine Science

Thomas Marcotti, Town of Barnstable, Natural Resources Division

Pam McGanty, Massachusetts Department of Environmental Management

Clyde McKenzie, NOAA National Marine Fisheries Service

Donald Merrit, University of Maryland

Dave Meyer, NOAA National Marine Fisheries Service

Bill Mook, Mook Seafarms

Bill Moore, Langinfelder Const. (Cultch supplier)

Steve Morin, RIDEM

R.I.E. Newell, University of Maryland, Horne Point

Scott Nixon, University of Rhode Island

John O'Brien, RIDEM Division of Fish and Wildlife

Bob Orth, Virginia Institute of Marine Science

Scott Oshevsky, RIDEM

Diane Pence, U.S. Fish and Wildlife Service

James Perry, NOAA National Marine Fisheries Service

Pete Peterson, University of North Carolina

Phil Pitzer, Blount Seafood

Lisa Pointeke, RIDEM

Gil Pope, Gil's Bait and Tackle, Wakefield

Chris Powell, RIDEM Division of Fish and Wildlife

Sheldon Pratt, University of Rhode Island

Dick Quinn, United States Fish and Wildlife Service

Walt Quist, United States Fish and Wildlife Service

Carl Rask, The Resource Inc.

Bob Reynolds, Connecticut Department of Environmental Protection, State Parks Division

Bob Rheault, Moonstone Oysters (Pt. Judith Pond)

Dick Satchwill, RIDEM Division of Fish and Wildlife

Dick Sisson, RIDEM

Frank Steimle, NOAA National Marine Fisheries Service

Tom Steinke, Conservation Coordinator, Fairfield, CT

John Stolgitis, RIDEM Division of Fish and Wildlife

Hal Summerson, University of North Carolina

M. Syslo, Massachusetts Division of Marine Fisheries

G. Taghon, Rutgers University

Karen Tammi, Waterworks (Westport, MA)

Brian Tefft, RIDEM

Wayne Turner, Waterworks (Westport, MA)

April Valliere, RIDEM

John Volk, Connecticut Department of Agriculture

Richard Wahle, Bigelow Laboratory for Ocean Sciences

Scott Warren, Connecticut College

Donald Webster, University of Maryland

James Weinberg, NOAA National Marine Fisheries Service

Jim Wesson, Virginia Marine Research Committee

Steven Wright, RIDEM Division of Parks and Recreation

Bill Zinny, United States Fish and Wildlife Service

NOAA, Gloucester, MA (978) 281-9251

NOAA, Silver Spring, MD (301) 713-3038

U.S. Department of Interior, Newton, MA (617) 527-3400

U.S. Fish and Wildlife Service, Arlington, VA (703) 358-2082

U.S. Fish and Wildlife Service, Charlestown, RI (401) 364-9124

U.S. Fish and Wildlife Service, Concord, NH (603) 225-1411