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

[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** Adult Lobster Stocking (1) Hatchery Stocking (2) Transplanting (3) Habitat Enhancement (4) Sanctuary (5)	**Adult Female Lobster Restocking and Protection (1)** Hatchery Stocking (2) Transplanting (3) Habitat Enhancement (4) Sanctuary (5)
Surf Clams	**Natural Recovery** Hatchery Stocking **(6)** Transplanting (7)	Hatchery Stocking (6) Transplanting (7) **Shellfish Restoration (9)**
Other Benthic Organisms/Fish	**Natural Recovery**	**Land Acquisition (8)** **Shellfish Restoration (9)** Package Treatment Plants (17) Salt Marsh Creation (18) Fish Stocking (19) Breachway Dredging (20) Anadromous Fish Runs (16) Eelgrass Restoration (21) Phragmites Removal (10)
Salt Ponds		
Worms/Amphipods Crabs/Shrimps Forage Fish/Winter Flounder	**Natural Recovery** Fish Stocking (18)	**Land Acquisition (8)** Shellfish Restoration (9) Package Treatment Plants (17) Salt Marsh Creation (18) Fish Stocking (19) Breachway Dredging (20) Anadromous Fish Runs (16) Eelgrass Restoration (21) Phragmites Removal (10)
Shellfish	**Natural Recovery**	Land Acquisition (8) **Shellfish Restoration (9)** Package Treatment Plants (17) Salt Marsh Creation (18) Fish Stocking (19) Breachway Dredging (20) Anadromous Fish Runs (16) Eelgrass Restoration (21) Phragmites Removal (10)
Birds		
Piping Plovers	Natural Recovery **Plover Protection (11)**	**Plover Protection (11)**
Loons	**Natural Recovery** Loon Habitat Protection (12) Loon Nest Site Enhancement (13) Loon Public Outreach/ Education (14)	**Loon Habitat Protection (12)** Loon Nest Site Enhancement (13) Loon Public Outreach/Education (14)
Marine Birds other than Loons	**Natural Recovery** Marine Bird Habitat Protection (15)	**Marine Bird Habitat Protection (15)**
Pond Birds	**Natural Recovery**	**Land Acquisition (8)** Shellfish Restoration (9) Package Treatment Plants (17) Salt Marsh Creation (18) Fish Stocking (19) Breachway Dredging (20) Eelgrass Restoration (21) Phragmites Removal (10)
Human Use		
Party and Charter Boat Fishing	**Natural Recovery**	**Anadromous Fish Runs (16)** Public Rights of Way (22) **Shore Access (23)** Boat Ramps (24) 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 <u>No-Action Alternative</u>

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 <u>Lobster Restoration</u>

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

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

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.

Probability of Success

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

[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.

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

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.

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

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.

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

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 <u>Bivalve Restoration</u>

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.

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

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	

<u>Project Description</u>

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.

<u>Restoration Objectives</u>

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.

<u>Scaling Approach</u>

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

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

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.

Environmental and Socio-Economic Impacts

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.

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

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.

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

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.

Environmental and Socio-Economic Impacts

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 Lost Recreational Fishing Restoration

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.

[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.

Performance Criteria and Monitoring

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.

Approximate Project Costs

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

Environmental and Socio-Economic Impacts

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.

Evaluation

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

Project Description

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