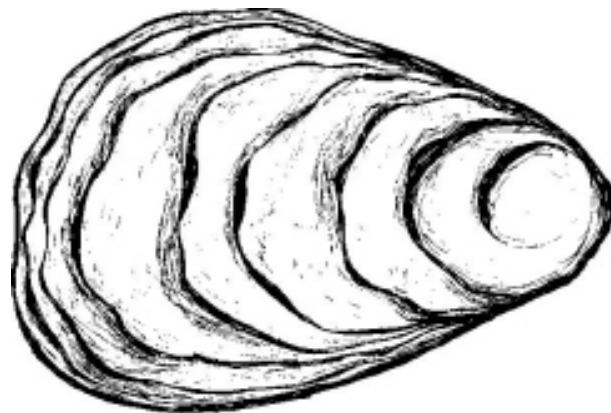




**US Army Corps of Engineers
Philadelphia District**

**DELAWARE BAY OYSTER RESTORATION
PROJECT
DELAWARE AND NEW JERSEY
FINAL Environmental Assessment**



July 2008

DELAWARE BAY OYSTER RESTORATION PROJECT DELAWARE AND NEW JERSEY

Finding of No Significant Impact

The proposed project seeks to continue oyster restoration with a shell-planting program. The Delaware Estuary is an ecologically valuable area. The Philadelphia District Army Corps of Engineers seeks to address the habitat degradation and the ensuing significant losses to an indigenous natural resource. From 1990 to 1995, the oyster industry provided little in jobs or revenue in Delaware Bay. Oystering reopened in 1996 in New Jersey but did not reopen until 2001 in Delaware. Since 2001, the condition of the oyster resource has deteriorated on both sides of the bay despite careful management and a limited controlled fishery, increasing the urgency for establishing a recruitment and enhancement program based on shell planting. The primary goal was to enhance recruitment by enhancing natural seed supply through the planting of shell (cultch) to provide habitat for recruitment of juvenile oysters (spat). The planting of clean shell has increased oyster habitat, expanded oyster abundance, and revitalized the natural resource with concomitant improvements in bay habitat quality from increased habitat complexity as well as increased water clarity brought about by the increased filtration by an abundant shellfish resource.

The proposed work is a continuation of the shell-planting project initiated in 2005. For the fourth consecutive year, shell planting will take place in portions of the natural oyster beds of Delaware Bay in the states of Delaware and New Jersey, as selected by the New Jersey Department of Environmental Protection (NJDEP) and Delaware's Department of Natural Resources and Environmental Control (DNREC) based on bottom surveys that occur annually. Approximately 286,000 bushels of shell were planted on several existing oyster bed locations within Delaware Bay in July 2005. In 2006, approximately 500,193 bushels of shell were planted. In addition to direct shell planting, a portion of previously planted shell with spat were transplanted upbay. In 2007, approximately 554,790 bushels of shell were planted. Post construction monitoring results from the 2007 program indicated extraordinary bay-wide recruitment rates (spat set in 2007 was the highest since 1999 bay-wide). New shell plants have typically equaled or exceeded the recruitment rates of native shell. Over the course of the three years of shell budget assessments in the bay, shell plantings have resulted in substantial reductions in shell losses (2005-2007) and has reduced the yearly deficit by at least two-thirds. The 2007 plant was the first time in eight years (since 1999) that New Jersey oyster beds were relatively in equilibrium. Older shell plants continue to attract recruitment, thus demonstrating the long-term biological benefit of the addition of shell beyond each one-year increment. The 2007 shell planting program contributed incalculably to maintaining the ecological services provided by the bay's oyster beds.

For the 2008 program, available funding remaining under the current Section 1135 authority limits the extent of shell planting that can be achieved. Direct shell planting program of approximately 287,000 bushels will be accomplished. NJDEP may transplant approximately 50,000 bushels of spatulated cultch upbay. As in 2005, 2006, and 2007, roughly 25-acre plots will be planted in Bay waters of both states in June/July 2008. Local clam companies generate large quantities of ocean quahog and surf clam shells and these shells provide an adequate substitute for oyster shell. Hence, the project will recycle a waste product into a useful commodity.

The shell planting program was designed to specifically address the issue of low recruitment and the inability of recruitment rates on natural oyster beds to sustain population abundance over time. It is vital to reduce the amount of shell loss using the shell planting program in order to reestablish oyster beds of sufficient size and health to offset losses due to disease that low abundances limit the amount of shell added to the beds through natural mortality. A concomitant monitoring program will acquire the data necessary to evaluate the success of the shell-planting program.

As a result of the funding constraints under the Section 1135 authority, the monitoring program established in previous years has been reduced for the 2008 year plant to obtain information minimally necessary to

evaluate the success of the shell planting program. The increment in abundance achieved by the program over the abundance that would have been present in the absence of the program at present will be used to establish the degree of success. The 2008 Monitoring and Assessment Program will consist of four of the seven previous components: (1) monitoring of shell plants in the event that the states of New Jersey or Delaware pursue future transplants; (2) periodic tracking of trends in growth and disease exposure for the shell plants (in previous years accomplished monthly but reduced to only a few select months this year; (3) a quantitative evaluation in October to determine the overall success of each year's program at season's end; and (4) a survey of targeted oyster beds to improve bed areal estimates, where required. A shell budget has been calculated to evaluate the efficacy of the shell planting program from the 2007 data. A public outreach program will be implemented as part of the selected plan. Activities include press releases, development of informational brochures and products, and participation in Delaware Bay conservation public events.

The proposed action was reviewed in accordance with ER-200-2-2 Environmental Quality Procedures for Implementing the National Environmental Policy Act (NEPA). The Environmental Assessment for this project is being coordinated with the U.S. Environmental Protection Agency, the U.S. Fish and Wildlife Service, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, Delaware's Department of Natural Resources and Environmental Control and all other known interested parties.

The Environmental Assessment has determined that the proposed activity is not likely to jeopardize the continued existence of any species or the critical habitat of any fish, wildlife, or plant that is designated as endangered or threatened, pursuant to the Endangered Species Act of 1973 as amended by P.L. 96-159.

A Section 401 Water Quality Certificate and a Coastal Zone Consistency Determination has been obtained from the New Jersey Department of Environmental Protection (NJDEP) for the proposed project. Under a current agreement with the State of Delaware, the proposed action meets the requirements for Nationwide Permit #27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities) and therefore, the Environmental Assessment, Section 404(b)(1) Compliance Review and Statement of Findings for Nationwide Permit #27 apply to this action. However, at the request of DNREC, a Section 401 water quality certification application was submitted and water quality certification was received. A Delaware Coastal Zone Management Federal consistency determination was also requested and received.

The proposed project has been coordinated with both New Jersey's and Delaware's State Historic Preservation Offices. There are no known properties listed on, or eligible for listing on, the National Register of Historic Places that would be adversely affected by the proposed project. The proposed project will avoid areas suspected of containing archaeologically sensitive sites and is therefore not expected to impact any cultural resources.

Because the Environmental Assessment concludes that the proposed project is not a major Federal action significantly affecting the human environment, I have determined that an Environmental Impact Statement is not required.



THOMAS J. TICKNER
Lieutenant Colonel, Corps of Engineers
District Commander

22 JUL 08

Date

Delaware Bay Oyster Restoration Project
Delaware and New Jersey
2008
FINAL ENVIRONMENTAL ASSESSMENT

Table of Contents

1.0. INTRODUCTION	1
1.1. Authority	1
1.2. Environmental Compliance	1
2.0. NEEDS AND OBJECTIVES	3
3.0. ALTERNATIVES	6
3.1. No Action	6
3.2. Selected Plan	7
3.2.1. Delaware	8
3.2.2. New Jersey	8
4.0. EXISTING ENVIRONMENT	9
4.1. Physiographic Setting	9
4.2. Climate	10
4.3. Surficial Deposits	10
4.4. Subsurface Geology	10
4.5. Bottom Substrate	11
4.6. Water Quality	11
4.7. Aquatic Invertebrates	12
4.7.1. Parasitism and Health	13
4.7.2. Predators	14
4.7.3. Fouling Organisms	14
4.7.4. Oyster Population Characteristics	15
4.8. Fish	16

4.9. Threatened and Endangered Species	17
4.10. Cultural Resources	17
5.0. ENVIRONMENTAL EFFECTS	17
5.1. Water Quality	18
5.2. Air Quality	19
5.3. Threatened and Endangered Species	19
5.4. Essential Fish Habitat	20
5.5. Monitoring	25
5.5.1. Monitoring Results	27
5.6. Socioeconomic Resources	30
5.7. Cultural Resources	30
5.8. Unavoidable Adverse Environmental Impacts	31
5.9. Short-term Uses of the Environment and Long-term Productivity	31
5.10. Irreversible and Irretrievable Commitments of Resources	31
5.11. Cumulative Effects	31
6.0. COORDINATION	32
7.0. LITERATURE CITED	33
8.0. EVALUATION OF 404(b)(1) GUIDELINES	35
APPENDIX	

**Delaware Bay Oyster Restoration Project
Delaware and New Jersey**

FINAL ENVIRONMENTAL ASSESSMENT

List of Tables

Table 1-1	Environmental Statutes and Regulations.....	1
Table 5-1	10 minute x 10 minute squares that contain Essential Fish Habitat (NOAA, 1999)	20
Table 5-2	Summary of species with EFH designation in the 10 minute by 10 min squares of 31, 38, 39, 48, 49, 60, 61, 70, 80, 90 and Mixing Zone (NOAA, 1999).....	21
Table 5-3	Habitat utilization of identified EFH species and a summary of species with EFH designation in the 10 minute x 10 minutes squares of 31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, and Mixing Zone (NOAA, 1999).....	22

List of Figures

Figure 2.1	Map of Delaware Bay showing the locations of oyster beds.....	4
------------	---	---

1.0. INTRODUCTION

The U.S. Army Corps of Engineers implemented a multi-year program to revitalize the population of the Eastern oyster *Crassostrea virginica* in Delaware Bay—a unique and ecologically valuable area. This Environmental Assessment evaluates environmental concerns relative to the problem of habitat degradation and the ensuing significant losses to an indigenous natural resource. The proposed project seeks to continue an established successful shell-planting program in July 2008 that has demonstrated in the previous three years to have substantially contributed to improvements in oyster populations in Delaware Bay, which in turn, will improve water quality, enhance benthic habitat diversity, and promote the economies not only of the Delaware Bay oyster fishery itself, but that of the Delaware Bay region as a whole.

1.1. Authority

The project is located in the 1st New Jersey Congressional District and the at-large Delaware Congressional District. The project bill was authorized in the FY 05 Energy and Water portion of the omnibus appropriations bill under Section 1135 of the Water Resources Development Act of 1986, as amended, Continuing Authorities Program. The non-Federal co-sponsors are the Delaware Department of Natural Resources and Environmental Control (DNREC) and the New Jersey Department of Environmental Protection (NJDEP). The proposed project is supported by the U.S. Fish & Wildlife Service (USFWS), the Partnership for the Delaware Estuary (PDE), Delaware Bay Section Shellfisheries Council (NJ), Governor’s Council on Shellfisheries (DE), the Delaware River Basin Commission (DRBC), the Delaware River and Bay Authority (DRBA), the National Marine Fisheries Service (NMFS), the Delaware Bay Shell Fisheries Council of New Jersey, the Cumberland County, New Jersey Empowerment Zone, (CCEZ), and the U.S. Environmental Protection Agency, Delaware National Estuary Program (USEPA). Rutgers University Haskin Shellfish Research Laboratory provides management and monitoring support for this project.

1.2. Environmental Compliance

Coordination with federal and state agencies is ongoing and will insure environmental compliance. All environmental requirements for this project, including permit acquisition, is completed. Table 1-1 provides a summary of the proposed project’s relationship with environmental statutes and regulations.

Table 1-1: Environmental Statutes and Regulations.

Federal Statutes	Compliance w/Proposed Plan
Archaeological Resources Protection Act of 1979, as amended	Full
Clean Air Act, as amended	Full
Clean Water Act of 1977	Full

Safe Drinking Water Act	N/A
Coastal Zone Management Act of 1972, as Amended	Full
Endangered Species Act of 1973, as amended	Full
Estuary Protection Act	Full
Federal Water Project Recreation Act, as Amended	N/A
Fish and Wildlife Coordination Act	Full
Land and Water Conservation Fund Act, as Amended	N/A
Magnuson-Stevenson Act – Essential Fish Habitat	Full
Marine Mammal Protection Act	Full
Marine Protection, Research and Sanctuaries Act	Full
National Historic Preservation Act of 1966	Full
National Environmental Policy Act, as amended	Full
Rivers and Harbors Act	Full
Watershed Protection and Flood Prevention Act	N/A
Wild and Scenic Rivers Act	N/A
Coastal Barrier Resources Act	N/A

Executive Orders, Memorandums, etc.

Compliance w/Proposed Plan

EO 11988 Floodplain Management	N/A
EO 11990 Protection of Wetlands	N/A
EO 12114 Environmental Effects of Major Federal Actions	Full

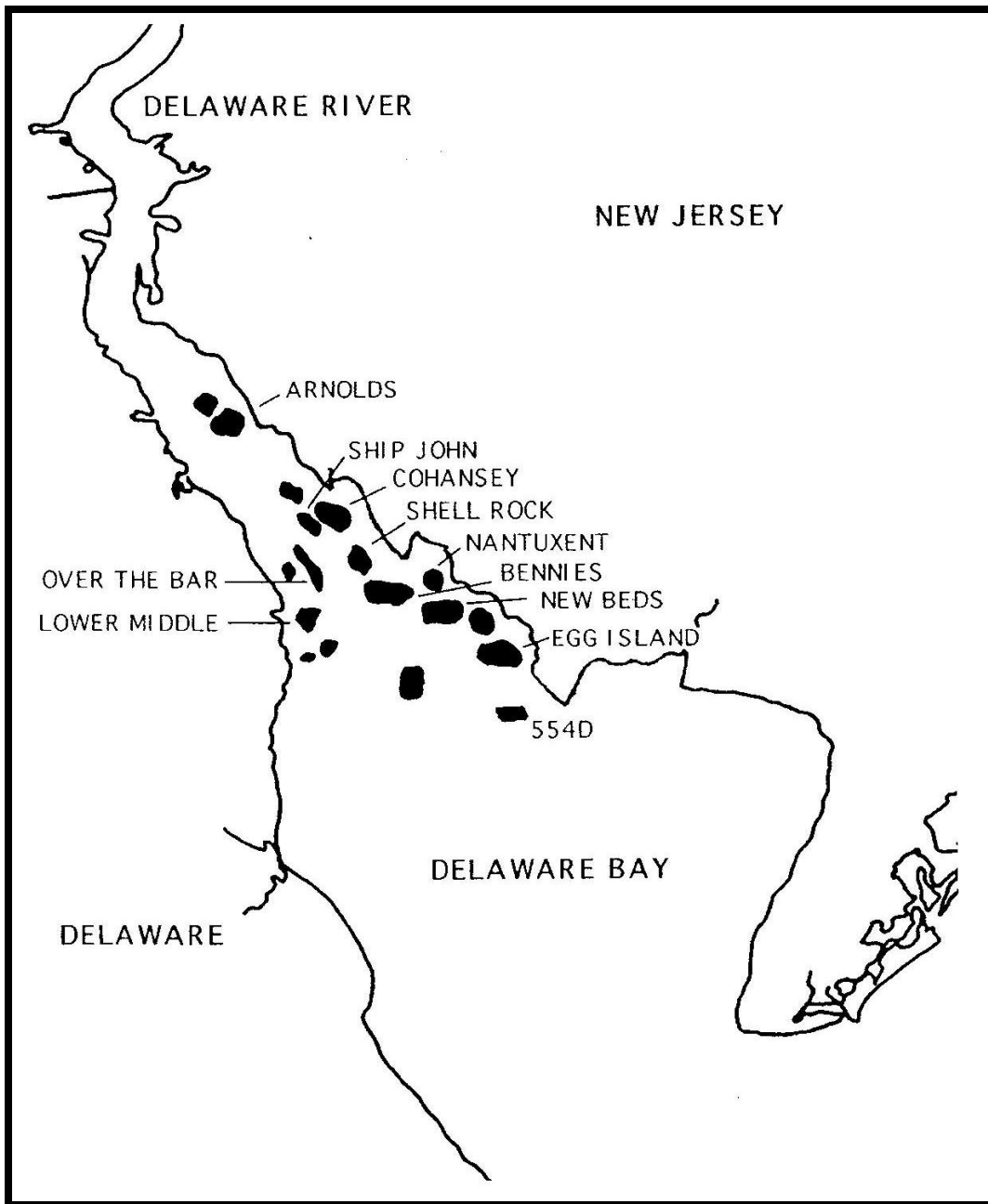
2.0. NEEDS AND OBJECTIVES

Oysters inhabit Delaware Bay from the mouth to Bombay Hook on the western side (Delaware) of the estuary, and to just below Artificial Island on the eastern (New Jersey) side, a distance of about 50 miles (Figure 2.1). Oysters have provided a sustainable food supply and contributed to the local economy of Delaware and New Jersey for centuries. From the days of the native American settlements along the shores the American (or Eastern) oyster *Crassostrea virginica* has been an important resource. With the coming of the European settlers, oystering increased dramatically and commercial harvesting towns and markets grew. In 1880, oyster harvesting reached its pinnacle with 2.4 million bushels.

Before the turn of the century, over 500 vessels and over 4,000 people worked in the commercial oystering industry in Cumberland County, New Jersey alone. By 1950, the harvest had dropped to around 1 million bushels. An oyster disease MSX (multinucleated sphere unknown), a protozoan parasite (*Haplosporidium nelsoni*), began to impact oyster populations by the late 1950s. Oyster harvests from planted beds dropped 90-95% while oysters in seed beds suffered a 50% mortality. Oyster harvests fell from 711,000 bushels in 1956 to 49,000 bushels in 1960. The oyster industry recovered during the 1970s and through the mid-1980s, to provide steady employment along the Delaware bayshore of both states. In 1990, a second oyster disease struck. Dermo (*Perkinus marinus*), also a protozoan parasite, invaded the oyster population that had developed a resistance to MSX, and the oyster industry nearly disappeared. A suite of other parasites were observed in a study conducted by Versar, Inc. in 2002. These include gill ciliates, large and small ciliates in the gut and digestive gland, *Bucephalus* trematodes, xenomas, and rickettsial bodies. Rare parasites observed included the trematode *Proctoeces*, nematodes, and parasitic copepods. However, none of these parasites significantly affected the oyster population dynamics or caused significant mortality like Dermo. Today in the Delaware Bay, Dermo disease is the overwhelming cause of adult oyster mortality. Mortality attributed to predation (mostly oyster drills, but also including crabs and dredge damage) was high in higher salinity areas (25%-50%) from Egg Island to Bennies but about 15% or less elsewhere (Versar, Inc. 2001). Recent improved estimates put an annual mortality of juvenile oysters at about 25% bay-wide, with higher estimates down-bay (HSRL, 2005).

From 1990 to 1995, the industry provided little in jobs or revenue in New Jersey. Oystering began again in 1996 under a carefully monitored direct market program. Oystering in Delaware did not reopen until 2001. Recognizing the need to address the decline in the oyster resource, the New Jersey Legislature passed a joint resolution (SJR-19, 1996) establishing the “Oyster Industry Revitalization Task Force” (OIRTF) to develop recommendations that could lead to revitalization of the oyster industry and its associated economic benefits in the Delaware Bay. In 2001, representatives from both Delaware and New Jersey, including state regulatory agencies, the Delaware River and Bay Authority, the Delaware River Basin Commission, and interested citizens developed an oyster revitalization

Figure 2.1. Map of Delaware Bay showing the locations of oyster beds.



initiative based on the OIRTF. The primary goal was to enhance recruitment by enhancing natural seed supply through the planting of shell (cultch) to provide habitat for recruitment of juvenile oysters (spat). This will increase oyster habitat, expand oyster abundance, and revitalize the natural resource with concomitant improvements in Bay habitat quality from increased habitat complexity brought about by shell planting as well as increased water clarity brought about by the increased filtration by an abundant shellfish resource.

The OIRTF began addressing the oyster population problem in the Delaware estuary in 1996. It was concluded that culture practices need to be modernized to change management of the resource (DRBA, 1999). Analysis of long-term time series data suggest that enhanced abundance can stabilize natural mortality (HSRL, 2005). Recent work has shown that low abundance leads to degradation of the shell bed and eventual loss of the unique habitat of the oyster reef. Thus, a recruitment enhancement program is important for four reasons: 1) recruitment enhancement is needed immediately to stabilize stock abundance imperiled by seven consecutive years of recruitment failure; 2) recruitment enhancement is needed to permit continuation and expansion of the oyster industry; 3) recruitment enhancement leading to increased abundance produces the shell necessary to maintain the bed; and 4) recruitment enhancement is needed to minimize the control of the oyster population dynamics by oyster disease and thereby stabilize stock abundance at a level that will permit the oyster to fulfill its keystone ecological role in the estuary as a filterer.

Since 1999, the condition of the oyster resource has deteriorated despite careful management and a limited controlled fishery, increasing the urgency for augmenting recruitment and providing habitat for oyster spat through a shell planting program. In 2005, Delaware Bay was in its sixth year of below average recruitment (less than 0.5 spat per oyster per year). Six such consecutive years is unprecedented from the perspective of the 54-year record for which detailed survey data are available (1953-2005). Consistent recruitment failure has resulted in the decline of oyster stocks, endangering the species population dynamics, the continuance of the fishery, and the habitat quality of the oyster beds.

This shell planting program was initiated by the U. S. Army Corps of Engineers in 2005 as a result of a successful pilot shell-planting program conducted by the New Jersey Department of Environmental Protection (NJDEP). The NJDEP had planted roughly 40,000 bushels of clamshell along the western shore of the Cape May peninsula in Delaware Bay in 2003. Approximately one month later, 16,000 bushels of newly set oyster seed were transplanted upbay (Bennies Sand), an area that has supported the majority of the 1990s oyster harvest. Monitoring results indicated that this small pilot-scale planting (only 6 acres) provided more than half of the marketable oysters harvested from this entire seed bed (approximately 600 acres in size) for the 2006 oyster season (2006 NJ Oyster Stock Assessment Report). This small-scale initiative in 2003 increased New Jersey's 2006 oyster harvest allocation by 26 percent.

In 2005, surveys showed that oyster abundance declined slightly to the lowest level since the onset of Dermo disease circa 1989 and to one of the lowest levels in the 1953 to 2005 record. The number of spat was 0.340; insufficient to sustain the present population. The 2005 shell planting program was designed to specifically address the issue of low recruitment and occurred at a critical time (i.e. 2005 was the sixth consecutive year of low recruitment). In 2005, the Corps of Engineers (USACE) Philadelphia District planted 286,000 bushels of shell on approximately 180 acres of existing oyster beds in both New Jersey and Delaware waters of the Delaware Bay. Post construction monitoring results of the 2005 program on beds within New Jersey waters indicated that oyster recruitment was increased by 10% bay-wide (with just 100 acres in NJ planted). On one bed (Shell Rock) shell plants accounted for 52.4% of total recruitment. In Delaware waters, recruitment success was measured on a per-bushel basis. Data indicated that shell planting successfully enhanced recruitment (average spat/bushel on two Delaware beds were 8.1 (Ridge/Jigger) and 23.3 (Middle). In both New Jersey and Delaware, direct shell plants had higher recruitment of spat per bushel than native shell (8th SAW report, 2006).

In 2006, the USACE Philadelphia District more than doubled the volume of shell planted (500,193 bushels) on approximately 275 acres of existing oyster beds. Post construction monitoring results showed that although the rate of attraction was about the same for planted shell and native shell, the net addition of shell resulted in an increase in the number of recruits for a second year, indicating the long-term biological benefit of planting shell. The 2006 program increased recruitment by 25% bay-wide and doubled recruitment on the most productive beds. Although Delaware Bay oyster beds continued to incur a net loss of shell annually, in just two years of shell planting the net loss of shell was reduced to the lowest value during the 1999-2006 time period.

In 2007, the program continued with more success by stabilizing the shell resource in Delaware Bay that had been declining due to low oyster abundance. In 2007, the Philadelphia District planted 554,790 bushels of shell on approximately 253 acres of existing oyster beds. Post construction monitoring indicated extraordinary bay-wide recruitment rates (spat set in 2007 was the highest since 1999 bay-wide). Over the course of the last three years (2005-2007) of shell budget assessments, shell planting had resulted in the substantial reduction in shell loss and has reduced the yearly deficit by at least two-thirds. The 2007 shell plant was the first time in eight years (since 1999) that New Jersey oyster beds were relatively in equilibrium.

It is vital to reduce the amount of shell loss through a shell planting program in order to reestablish oyster beds of sufficient size and health to offset the losses due to disease when abundance is so low that it limits the amount of shell added to the beds through natural mortality. The 2007 shell planting program contributed incalculably to maintaining the ecological services provided by the bay's oyster beds (discussed in Section 3.0). The USACE intends to plant additional shell in 2008 and monitor the results.

3.0. ALTERNATIVES

3.1. No Action

The no action alternative will result in continued deterioration of the oyster stocks, loss of the fishery, and substantial deterioration of habitat quality and water quality in Delaware Bay. Projections of oyster abundance by the 10th SAW (2007 Stock Assessment Workshop), presented by the Haskin Shellfish Research Laboratory, summarized the condition of the oyster stock in Delaware Bay in New Jersey waters. The data were evaluated over the period 1989-2007 as this period coincides with the advent of Dermo as a major influence on population dynamics. During the period average mortality rates and epizootic frequencies were up. Although the last three years of shell budget assessments have demonstrated that shell planting has reduced the yearly deficit by at least two-thirds, and bay-wide spat set in 2007 was the highest since 1999, average oyster abundances are down, and average recruitment rates are down relative to the 1953-1988 data collection period.

Oyster beds are sustained, as is the high diversity and complexity of this habitat, by continued addition of shell; without an active abundant oyster population, the quality of this Essential Fish Habitat (EFH) will assuredly also decline until eventually complete loss of the structural dimension of the shell bed will occur. Population dynamics modeling of abundances this low suggest only a limited possibility of

recovery without active intervention through recruitment enhancement. Shellfish play a significant role in water quality of the bay by improving water clarity, controlling plankton or algal blooms, as well as provide valuable structural diversity necessary for a healthy estuarine habitat. Since populations of oysters are near historic lows and showed promising signs after just two years of the shell-planting, restoring some portion of this lost filter-feeding capacity is identified as a direct improvement on water and habitat quality. Oyster shell degrades over time. Since 2001, estimates show a reduction of native cultch on New Jersey beds by as much as 50%. In just three years, the shell planting program has demonstrated its potential to reach an eventual stabilized equilibrium, in the face of low abundance and disease.

3.2. Selected Plan

Attempts to enhance the seed supply have been made sporadically in the form of shell plantings, to catch natural oyster sets on the seed beds. Oyster harvesters themselves were once required to replace a portion of the shell from oysters they harvested, but this practice was eliminated in 1979. Federal funds were available during the 1960s and early 1970s and several significant shell plantings were made in the bay at this time. The value of planting clean shell at the right time (i.e. when larvae are ready to set) is illustrated by results recorded in 1966 when clean planted shell received a set of 5,000 spat per bushel whereas old shell on the same bed received only 90 spat per bushel (records of D.E. Kunkle, Haskin Shellfish Research Laboratory). Most plantings did not receive this kind of set, but there was little attempt to regularly place the shells in areas of historical good setting. Rather, cultch went to areas that had been recently harvested, which were not necessarily very good setting areas. Prior to 2003, very little clean shell had been replaced on the seed beds since the early 1970s because the only source of funds has been the Oyster Resource Development Account. This account receives fees from oyster growers, but due to low harvests, rarely has sufficient funds for a significant planting (DRBA, 1999).

There is little doubt of the value of shell planting, as long as it is done at the appropriate time, in the areas most likely to catch a set, is of sufficient size, and the resulting set is managed effectively. Long-term records of the Haskin Shellfish Research Laboratory show clearly delineated areas of high set potential on the inshore areas along the New Jersey shore. In 2003, the NJDEP planted downbay and subsequently transplanted upbay two months later 16,000 bushels of clamshell as part of a pilot program. The project resulted in the recovery of 1800 spat per bushel during a year when the average recruitment on the natural beds was below 50 spat per bushel. Two years later, this transplanted shell contributed 58% of the marketable oysters on the receiving bed (Bennies Sand). Thus, the setting potential can be very high given that the spat have adequate substrate and a doubling of abundance on reproductive beds is readily achieved. For shell planting to be successful in the Delaware estuary, it must be done regularly, on a much larger scale, and closer to setting time than it has been in the past. At present, sources of surf clam and ocean quahog are being obtained from New Jersey and Delaware shucking houses and oyster shell mining operations.

The shell planting program serves multiple benefits that extend beyond the oysters. Not only do oysters play a major role in improving water quality through filtration, but their biogenic habitats provide refugia, nesting sites, and foraging grounds for a variety of resident and transient marine species. Numerous studies have revealed greater biodiversity associated with oyster reefs than with adjacent sedimentary habitats. Species richness and abundance of organisms in oyster reef habitats are

generally comparable to those found in seagrass meadows. Oyster reefs in estuaries provide hard substrate that supports unique assemblages of organisms, and there is further evidence that oyster reefs contribute to enhanced production, not merely a concentration, of finfish and decapod crustaceans.

The shell-planting project was proposed to continue annually for several consecutive years in portions of the natural oyster beds of Delaware Bay in the states of Delaware and New Jersey, as well as the leased beds of both states, as selected by NJDEP and DNREC. Shell-planting location selection criteria include condition of the existing oyster beds to support exposed shell without significant sediment accumulation, probability of spat settlement above the bay-wide average, and ease of recovery of spat shell for potential subsequent transplanting.

The approach taken in the two states will differ somewhat to maximize use of local conditions. Approximately 360,000 bushels of clean crushed ocean quahog, and surf clam shell has been purchased from several private sources. Due to the allowable limited funds remaining under the existing authority (Section 1135 program) only about 287,000 bushels of the purchased shell can be planted in 2008. The areas to be planted will range in size from 25 to 50 acres in size, consistent with monitoring efforts of previous year plants. The shellfish managers of both New Jersey and Delaware will identify and mark those oyster beds determined to be optimum sites. Twenty-five acres is the recommended size because it encompasses a 0.2" latitude x 0.2" longitude rectangle, so the design facilitates navigation and survey. This is the minimum sized rectangle needed for vessel maneuverability during planting. It is also equivalent to the size of the sampling unit used in the New Jersey stock survey, thereby facilitating evaluation of project success in comparison to bay-wide oyster production. The proposed shell-planting program is based on the premise that planted shell density will average 2,000 bu/acre overall or 50,000 bushels per 25-acre plot.

3.3.1. Delaware: Shell planting in Delaware sites will provide needed shell cultch on state-owned natural oyster beds. These beds historically have suffered loss in production due to siltation. The shell planting is designed to increase productive area by adding to bed height while expanding available cultch. Latitude and longitude coordinates for each corner of the planting sites will be recorded using the Global Positioning System. These location data will be converted to Delaware Plane Coordinates using Corpscon software and then inputted into Arc View for calculating total acreage of the planting site.

Previous shell-planting experiences on Delaware's natural oyster beds have demonstrated that a planting density of 2,000 bushels per acre, in general, provides an excellent shell base for promoting oyster larval attachment. Plots may or may not be contiguous based on results from the pre-plant bottom survey. In addition, shell plantings will occur just prior to the oyster spawning season (~ late June/early July) to ensure that shell surfaces remain clean in order to maximize larval retention.

3.3.2. New Jersey: The appropriate shell planting time (i.e., in unison with the oyster's prime spawning period) will be determined by plankton sampling, which will commence approximately in mid-June by NJDEP and University of Rutgers staff. The 2008 Stock Assessment Workshop for the New Jersey Delaware Bay Oyster Bed report recommends targeting Shell Rock, Bennies Sand, Nantuxent Point, Hog Shoal, Hawk's Nest, Beadons, and Strawberry. Replants should target Ship John and Cohansey. NJDEP may relocate approximate 50,000 bushels of spat shell by suction vessel to portions of existing natural oyster beds for the purpose of enhancing survivorship in areas where disease and predation levels are lower.

As is currently the case with New Jersey's ongoing oyster enhancement programs, NJDEP staff will record site coordinates using a Trimble Differential Global Positioning System (NJ State Plane Coordinates - NAD83). Coordinates will be mapped using Arc View Geographic Information System, from which acreages can easily be calculated. Cultch planting densities will vary depending on bottom hardness or condition, but will typically range from 1,500 to 2,500 bushels per acre.

1). Shell Planting: Approximately 287,000 bushels of approximately 400,000 bushels of ocean quahog and clam shell previously purchased and stockpiled will be placed on existing natural oyster beds within Delaware Bay in both Delaware and New Jersey. Available remaining funding under the current Section 1135 authority limits the extent of shell planting that can be achieved.

2). Monitoring: The shell planting program was designed to specifically address the issue of low recruitment and the inability of recruitment rates on natural oyster beds to sustain population abundance over time and the need to maintain the shell beds while natural addition of shell is low due to low abundance. Due to funding constraints, the monitoring program established in previous years has been reduced for the 2008 year plant to obtain information minimally necessary to evaluate the success of the shell planting program. The increment in abundance achieved by the program over the abundance that would have been present in the absence of the program at present will be used to establish the degree of success. The Monitoring and Assessment Program will consist of four of the seven previous components: (1) monitoring of shell plants in the event that the state of New Jersey, Division of Shellfisheries pursues future transplants; (2) periodic tracking of trends in growth and disease exposure for the shell plants (in previous years accomplished monthly but reduced to only a few select months this year; (3) a quantitative evaluation in October to determine the overall success of each year's program at season's end; and (4) a survey of targeted oyster beds to improve bed areal estimates, where required. A shell budget has been calculated to evaluate the efficacy of the shell planting program from the 2007 data.

3). Public Outreach: A public outreach program will be implemented as part of the selected plan. Activities include press releases, development of informational brochures and products, and participation in Delaware Bay conservation public events.

4.0. EXISTING ENVIRONMENT

Estuarine environments like Delaware Bay are among the most productive on earth, creating more organic matter each year than comparably-sized areas of forest, grassland, or agricultural fields. It is the productivity of the estuary and the variety of its habitats that fosters such a wide abundance of wildlife and aquatic resources. These organisms are linked to one another through a complex food web. An estuary is critical to many species of aquatic creatures, birds, fish and other wildlife.

4.1. Physiographic Setting

The Delaware estuary lies at the seaward end of the Delaware River, which drains a 12,380 square mile area of the northeastern United States. The study area lies entirely within the Atlantic Coastal Plain Physiographic Province. This coastal area is a relatively flat plain with surface elevations rarely

exceeding 100 feet above mean sea level.

4.2. Climate

The climate is considered subtropical in the Delaware Bay region, producing mild summer and winter seasons with only a few short hot, humid periods in summer, and cold, windy periods in winter. The summer weather is dominated by maritime tropical air masses which remain stable for several days at a time, creating high pressure systems. Continental, polar air masses in the winter produce rapidly moving fronts and intense weather patterns. The bay's coastlines are susceptible to strong beach erosion storms as a result of these weather patterns. Noreasters have a frequency of once every 2.5 years, and hurricanes occur about once every 5.5 years, producing an average of one storm every two years. Spring and fall are milder and are dominated by quickly changing air masses. The mean annual temperature in the bay region is a range of 55 to 57 degrees Fahrenheit. The annual precipitation for the area is about 45 inches, with the average monthly rainfall amounting to three or more inches. Temporary droughts, however, are not uncommon in summer.

4.3. Surficial Deposits

Medium-to-coarse sands dominate the mouth of the bay and extend upbay in narrow linear bands that coincide with the axes of the major tidal channels. Generally, the coarsest sands occur in the bottom of the estuary channels. Within any channel, the median grain diameter decreases in the upbay direction and away from the center of the channel. Very fine sands characterize the linear sand shoals, the channel margins, most of the Lower Jersey Platform and the area between Mispillion River and Lewes Harbor. Major departures from the upbay and shoreward fining pattern occur on the Upper Jersey Platform and the Cape May Shoal Complex, where sediments become coarser in the shoreward direction.

The mouth of the bay and the lower bay channels are characterized by poorly sorted medium-to-coarse sands with a low mud content. Sediments of this type also occur near shore along the Upper Jersey Platform. Finer sands with a highly variable mud content are found in most areas of the upper and middle bay and along the margins of the lower bay. Patches of very poorly sorted fine sands with a very high mud content occur throughout the bay, but occur most commonly along the Delaware shoreline of the middle and upper bay.

4.4. Subsurface Geology

The Delaware estuary extends approximately 133 miles from the head of tide at the Fall Line near Trenton, New Jersey to the Atlantic Ocean at Cape May, New Jersey and Cape Henlopen, Delaware. Between Trenton, New Jersey and New Castle, Delaware, the estuary parallels the Fall Line with early metamorphic rocks of the Piedmont on the west and unconsolidated coastal plain sediments on the east. South of New Castle, the lower tidal river and Delaware Bay are underlain by sediments of the Atlantic Coastal Plain. In the vicinity of the bay, a veneer of fluvial Pleistocene sands and gravels up to approximately 100 feet thick covers the older sediments of the Coastal Plain. The Pleistocene sediments form the Columbia Group in Delaware and the Cape May, Pennsauken and Bridgeton Formations in New Jersey. In most cases, Pleistocene sediments form the basal substrate upon which sediments of the Holocene marine transgression have been deposited. However, subsurface data suggest that sediments of the Cohansey Formation and Upper Chesapeake Group (Miocene) may

possibly outcrop in Delaware Bay.

4.5. Bottom Substrate

Versar, Inc. (2001) conducted an oyster and water quality monitoring study in the Delaware Bay for the Philadelphia District USACE for the proposed Main Channel Deepening Project. In this study Versar was tasked to characterize the pre-construction conditions of the Delaware Bay through evaluation of water quality and existing oyster population health. The study was completed in collaboration with Rutgers University, Haskin Shellfish Research Laboratory. Nine existing oyster beds in Delaware and New Jersey were monitored on historic oyster beds and selected to cover a range of salinity gradients of naturally occurring oyster beds in both New Jersey and Delaware, thus they represented beds typical of high and low rates of mortality from predation and disease

Sediment grain size ranged from pebbles on the surface of medium-sand to medium-coarse sand to stiff clayey sediments. Versar, Inc. conducted a sediment profile study in 2001 using imagery at 50 stations. The predominant sediment type throughout the study area was fine-sand and occurred at 38% of the sampling stations.

4.6. Water Quality

In the Versar, Inc study (2001) water quality was monitored to assess physical/chemical data for the interpretation of oyster population and habitat health in the bay. The study also served a dual purpose in providing a means to evaluate predictions made using a three-dimensional hydrodynamic model of the estuary's salinity regime.

Water quality monitoring was conducted for nine months (May through November 2000 and March through April 2001) for temperature, pH, dissolved oxygen, salinity, turbidity, TSS (total suspended solids) and nutrient oyster "food" content (chlorophyll concentrations, organic nitrogen proteins, carbohydrates, and lipids). Water temperature was relatively consistent throughout the bay over the 2000/2001 monitoring period. Seasonal changes in water temperature progressed expectedly with spring warming into summer followed by cooling in the fall months.

Salinity was relatively stable in the bay during this same time period within particular sites. Measurements at each station varied within a 5-ppt range throughout the 9-month monitoring period. Although stable on a monthly scale, salinity did follow a seasonal pattern with lower measurements occurring in the warmer months. From May through mid-October, salinity generally ranged from 10 to 20 ppt depending on the station location. Differences in salinity between stations were consistent and reflected relative location in the salinity gradient of the bay. For the most part, salinity throughout the monitoring period was 10 ppt higher in the lower stations than the uppermost stations.

Measurements of pH were very stable in the bay over the 9-month monitoring period. From May to November 2000, pH closely averaged about 8 for the nine stations. In March and April 2001, measures were consistently higher and averaged 8.5 among the stations. Throughout the monitoring period, a slight gradient was apparent along the length of the bay with lower pH measured farther upstream.

Dissolved oxygen levels varied mostly according to season in the bay. From May through July, as

water temperatures increase, DO concentrations decreased steadily from about 9 to 7 mg/L. Toward the end of August 2000 through November 2000, concentrations steadily increased to about 10 mg/L and ranged from 11 to 19 mg/L.

Turbidity in the bay was relatively stable over the monitoring period, although occasionally exceedingly high measures of turbidity were recorded. Concentrations at most stations ranged less than 50 NTU. Throughout the summer months (June through September) measures commonly ranged upwards to 100 NTU. During October and November 2000 and March and April 2001, turbidity was usually less than 100 NTU.

Delaware Bay is typically characterized by a strong early spring phytoplankton bloom, followed by low summer concentrations and then occasionally a fall bloom. In the Versar (2001) study, chlorophyll in Delaware Bay remained uniformly low over the summer growing season. Chlorophyll typically ranged less than 20 ug/L in May through November 2000. In contrast, much higher levels were recorded in early spring (2001). In March 2001 overall measures averaged close to 80 ug/L. By April, the number had halved. Thus, 2001 was considered a typical year. Throughout the monitoring period consistent differences were not readily apparent between stations.

Organic constituents of TSS, defining oyster food supply, were measured at four oyster bed monitoring stations. The sediment load supported by the waters of Delaware Bay was largely uniform throughout the bay and all seasons monitored. Concentrations of total suspended solids (TSS) measured in the lower water column ranged roughly less than 40 mg/L. Higher concentrations were more often measured at the two upper Bay stations and may reflect the higher current velocities present in the narrower portion of the estuary as well as their closer proximity to the turbidity maximum zone near the C&D Canal where salt and freshwater meet. Suspended particles tend to flocculate and fall out of the water column in this area. In early June, TSS measured at these two stations averaged 75-mg/L; in August and early September concentrations ranged from 60 to 120 mg/L; and in March of the following year the two stations averaged 60 mg/L.

Organic nitrogen (Total Kjeldahl Nitrogen) varied as chlorophyll concentrations in the lower water column. Higher concentrations were observed during early spring. The concentrations of lipids, proteins, and carbohydrates followed similar patterns over the nine month sampling period. Concentrations of lipids were usually several times greater than other nutrients and averaged around 5 mg/L. Concentrations were variable and reflected a peak in productivity (around 10 mg/L in summer). Proteins averaged around 2.5 mg/L. Carbohydrates were consistently at or below 1 mg/L throughout the nine month monitoring period. The highest concentrations were measured at an upper bay station during mid-summer and ranged to 3.5 mg/L. These data are important for oysters for two reasons: 1) Oyster larvae require high lipid content food and the lipid:protein:carbohydrate ratio observed demonstrates a good food resource; and 2) The concentrations are highest during late summer when reproduction taxes adult oysters and when oyster larvae require high food concentrations for success (Versar, 2001).

4.7. Aquatic Invertebrates

Other than the American oyster (*C. virginica*) notable benthic aquatic organisms in the study area include the blue crab (*Callinectes sapidus*), and the horseshoe crab (*Limulus polyphemus*). A number of studies have been conducted on benthic invertebrate communities in Delaware Bay (Maurer *et al.*,

1978; Kinner *et al.*, 1974; Howe and Leathem, 1984; Leathem and Maurer, 1980; Howe *et al.*, 1988). As is common in marine benthic systems, there is considerable spatial and temporal heterogeneity in species composition and organism density. Bottom type and salinity are primary determining factors in community structure. Other commonly occurring species are *Tellina agilis* (bivalve), *Ensis directus* (bivalve), *Glycera dibranchiate* (polychaete), *Heteromastus filiformis* (polychaete), *Gemma gemma* (bivalve), *Nethtys picta* (polychaete), *Mulinia lateralis* (bivalve), *Neomysis americana* (crustacean), *Nucula proxima* (bivalve), and *Protohaustorius wegleyi* (crustacean).

Hard clams (*Mercenaria*) are distributed from Port Mahon to Cape Henlopen. They are currently not commercially harvested in Delaware Bay. The blue crab (*C. sapidus*) is ubiquitous in Delaware Bay and functions as a predator in the estuarine ecosystem. Blue crabs support a commercial industry in the bay. A pot fishery occurs in the near shore region north of Port Mahon, primarily during the warmer months (May to October). A winter crab dredging fishery takes place in the lower bay when the crabs have dug into the sediments in deeper waters to over-winter (U.S. Fish and Wildlife Service).

A small lobster fishery is located primarily on the outer breakwater near Cape Henlopen. The lobsters find favorable cover among the rocks, and the associated fish and invertebrates are a good source of food. Harvesting occurs mostly during the summer and to a lesser extent during the cooler seasons. This is a cyclic fishery that has been low during most recent years (Delaware Division of Fish and Wildlife).

Four species of mud crab were collected in the Versar, Inc. study (2001). *Rithropanopeus harrisii* was relatively uncommon. The other three species *Dyspanopeus sayi*, *Eurypanopeus depressus*, and *Panopens herbstii* were more common. *D. sayi* and *P. herbstii* were collected from the higher salinity beds from Bennies downbay. *E. depressus* was more widespread in abundance across the salinity gradient. Mud crab abundance increased with increasing salinity. Seasonal cycles in abundance were not dramatic or consistent among sites.

Horseshoe crabs (*L. polyphemus*) are ancient arthropods that play a very prominent and vital role in Delaware Bay. Each spring, horseshoe crabs migrate into the bay to spawn within the intertidal zone of sandy beaches. Eggs are laid in tightly bundled clumps in nests dug 2-8 inches below the sand surface. The high concentration of horseshoe crab eggs is vital to migratory shorebirds, who feed on the eggs unintentionally excavated by other spawning horseshoe crabs, to fuel the remainder of their trip to Arctic nesting grounds.

4.7.1. Parasitism and Health

Common oyster parasites include two disease-causing organisms, *Haplosporidium nelsoni* (MSX) and *Perkinsus marinus* (Dermo), and the relatively benign *Nematopsis*. A suite of other less common parasites were also identified (Versar, 2001). These include gill ciliates, large and small ciliates in the gut and digestive gland, *Bucephalus* trematodes, xenomas, and rickettsial bodies. Rare parasites include the trematode *Proctoeces*, nematodes and parasitic copepods. In addition to parasites, ceroid bodies were also observed in abundance. Ceroid bodies are thought to be indicative of stress, although cause and effect is not well established.

At one time, *H. nelsoni* was the principal cause of mortality in market-size oysters in Delaware Bay.

Prevalences of this parasitic infection have been low however, since 1990. Delaware Bay oysters are believed to have built up immunity to this disease. In 2000, prevalence rarely exceeded 20%, and typically at sites with the highest salinity. Generally, prevalences peaked in early spring and again in June. This pattern is typical of the life history dynamics of this organism (Ford *et al.*, 1999).

Perkinsus marinus is presently the primary cause of adult oyster mortality in the bay. Prevalence and infection intensity decline with lower salinities. Prevalence and infection intensity typically peak in late summer and early fall when temperatures are highest (Hofmann *et al.*, 1995). Mortality rates for this disease typically run from <10% up-bay to >50% down-bay with the bay-wide average between 10-35%. Dermo epizootics have occurred in half of the years, on average since 1990.

Nematopsis spp. is the most prevalent oyster parasite on the East and Gulf coasts of the U.S. Although infection intensities can reach hundreds of cells per tissue section, the parasite appears to produce little or no pathological effect. The final host is the mud crab. In 2000 *Nematopsis* was found at all sites (Versar, 2001). Highest infection intensities occurred on Ship John and Bennies. Larger oysters tended to have infection intensities similar to smaller oysters, indicating that infection intensity increased linearly with size. Little seasonality was observed in infection intensity.

Bucephalus trematodes were rare and encountered principally in late summer and early fall (Versar, 2001). Rickettsial bodies were most common in June and in oysters from Ship John, but otherwise, rarely observed. Ciliates were more commonly and consistently encountered. Small gill ciliates were most abundant in spring and in oysters from Bennies and Lease 544D. Large ciliates were found in the gut, gill, mantle and digestive gland. These ciliates were observed through the year on all oyster beds. Small oysters had a disproportionate infection intensity, indicating that infections lessen with age.

4.7.2. Predators

Predation accounts for a significant fraction of total mortality (mostly spat and juveniles) (Versar, 2001). Although identified predatory events never account for the majority of observed deaths, the focus of predators should be on the smaller and more easily overlooked individuals. Thus, emphasizing the importance of disease in controlling adult oyster population dynamics. Nevertheless, predatory mortality accounts for upwards of 30% of the juvenile oyster population annually (E. Powell, pers. comm.). Like the diseases MSX and Dermo, the distribution of predators is consistent with the higher mortality rates down-bay at the higher salinity sites. Predators include mud crabs, blue crabs, and drills. Blue crabs were relatively rare and sporadic in the oyster dredge captures as these were insufficient sampling devices for blue crabs (Versar, 2001). Drills were mostly caught on higher-salinity sites: Bennies, New Beds, Egg Island, and Lease 554D. Numbers tended to be highest in the summer because drills migrate into deeper water or burrow into the sediment as the weather cools. Two drill species captured, *Urosalpinx cinerea* and *Eupleura caudate* were collected at the same sites. *E. caudate* tended to be present in early and late summer. *U. cinerea* tended to be present more uniformly over the year.

4.7.3. Fouling Organisms

Most bionts were observed on the outer surface of the shell (Versar, Inc., 2001). Bionts on the inner

surface were limited to borers. *Polydora* was the most abundant borer species observed. Outer shell bionts included bryozoans, encrusting polychaetes, and sabellariids. Other bionts included egg cases, fungi, green algae, hydroids, and molluscs. Generally, temporal trends were not apparent over all sites. Coverage tended to increase with increasing salinity.

Molluscan epibionts included oysters, ribbed mussels (*Brachidontes* spp.), and *Crepidula* gastropods. Molluscan bionts were most common at the two Delaware sites, Over-the-Bar and Lower Middle. *G. demissa* was also commonly found on New Beds and Bennies. The time series showed distinctively lower coverages during the summer months. Oysters were routinely found as “bionts” on other oysters. Their occurrence was particularly common at the two Delaware sites where the vertical “clump” structure typical of reefs best developed. Temporal trends were not observed.

Encrusting polychaetous bionts include sabellariids, serpulids, and mudtube-dwelling polychaetes such as terebellids. Coverage was highest in spring and declined during the summer months. Mudtubes increased in abundance with increasing salinity in a nearly monotonic fashion. Sabellariid polychaetes were most common at two Delaware sites and a leased bed site. However no time-dependent trends were present. Serpulid tubes were much more common on the lease bed site than elsewhere. Coverage increased with increasing salinity at the other sites and showed a decline in late summer. Barnacles were most abundant at Arnolds, and somewhat more abundant at Ship John and Nantuxent Point than at other sites. Coverage did not show a significant temporal trend.

Bryozoans were both of the encrusting form (e.g. *Electra*, *Membranipora*) and the erect forms (e.g. *Bugula*, *Alcyonidium*, *Amathia*). Total bryozoan coverage was highest at Arnolds, Bennies, Nantuxent Point and Lease 554D. Erect bryozoans were most common at the highest salinity sites, Egg Island and Lease 554D. Encrusting sponges (e.g. *Microciona*) were present in highest abundance at the higher salinity sites but not all of them. Coverage at Bennies, New Beds, and Egg Island was much higher than at other sites. Coverage peaked in late summer in 2000 and then peaked again in March 2001. Hydroids were present in greatest abundance on the New Jersey side of the bay. Abundance was high at five of seven New Jersey sites. A few anemones and tunicates were present. The organisms were present in highest abundance on Lease 554D.

The boring sponges are most significant in impacting habitat complexity because these species rapidly degrade oyster shell over time. Consequently, healthy oyster beds require a resupply of shell by natural mortality or shell planting. This continued need increases down-bay because boring sponges are so abundant, as does the inherent productivity of non-diseased oyster populations that tend to balance shell losses. Disease destabilizes this system by reducing natural shell production in areas where natural shell destruction is greatest, thus resulting in long-term reduction in habitat quality.

It should be noted that of these bionts, mussels are most significant in influencing oyster population dynamics in that they compete with oysters for food. Their abundances are rarely sufficient however, to influence oyster growth and reproduction. Overall, the overwhelming impact of all bionts is the loss of shell area for oyster larval attachment. Most shell surface is already occupied, hence the successful planting of clean shell provides or enhances the available surface area for larval settlement.

4.7.4. Oyster Population Characteristics

Oyster seed beds in Delaware Bay have been recognized as a public resource for over 150 years. They have been regulated as a single entity although it is clear that they have differing characteristics

depending on their location along the salinity gradient. New Jersey natural seed oyster beds are separated into four separate salinity regions. Oysters on the uppermost beds typically survive well because they are rarely affected by predation and do not experience high levels of disease-related mortality. However, upper bed oysters are thin-shelled, and low growing. These oysters frequently grow in clusters, which makes them less desirable for market because of increased handling. Survival on these upper beds (Round Island, Upper Arnolds, and Arnolds) is primarily controlled by low salinities. Mean salinity in this range is approximately 10.8 parts per thousand (ppt). This salinity is below the threshold for predator and MSX disease activity, but within the tolerance limits for Dermo. Because of the general physiological condition of these oysters, they are rarely harvested by the oyster industry for transplanting. The contribution of these beds to the total harvest has been less than 5%. These beds are currently in a long-term state of decline due to recruitment rates that have been below average for more than a decade (HSRL, 2005).

Oysters at the downbay sites are characterized by good growth and market quality. However, stocks in this range are frequently exposed to intense predation and disease activity. During periods of high disease activity, oyster populations on the lowermost beds (Egg Island, Ledge, and to a somewhat lesser extent New Beds) can be severely reduced. Mean salinity in this region is approximately 19.9 ppt. Since 1996, these beds have provided less than 5% of the total oyster harvest as well.

Typically, the majority of the annual oyster harvest comes from the beds distributed within a region classified as the intermediate zone. This zone includes all the beds from New Beds to Upper Middle. Survival, growth, and market quality can vary widely within this region but are best within these beds. These beds account for over 90% of the total harvest in New Jersey. Mean salinity for this bed region ranges from 16.1 ppt in the lower end to 12.8 ppt in the upper portion.

In addition to differences in oyster growth and survival, there are also differences in the setting patterns of oyster larvae over the range of beds. Although setting will occur throughout the range of the seed beds, the most reliable setting areas are along the nearshore. With the greatest set potential below Ben Davis Point.

4.8. Fish

The Delaware estuary is home to over 100 species of finfish, many of which are commercially and recreationally important. This great diversity is the result of the overlap between northern and southern species in the mid-Atlantic coastal region. Many species use the estuary as a breeding ground and nursery area for their young. The warm, shallow, near-shore and marsh nursery waters shelter small fish from predators and provide them with food while the deeper, cooler waters serve as feeding grounds for larger fish. The majority of adult fish species in the Delaware estuary are predators at or near the top of the food web, eating plankton, smaller fish, and invertebrates such as crabs, snails, and worms. Surveys of the finfish of Delaware Bay have been conducted by the Delaware Division of Fish and Wildlife for years. Abundant finfish species in the bay include the red hake (*Urophycis chuss*), northern sea robin (*Prionotus carolinus*), spot (*Leiostomus xanthurus*), windowpane flounder (*Scopthalmus aquosus*), silver hake (*Merluccius bilinearis*), bluefish (*Pomatomis saltatrix*), croaker (*Pogonias cromis*), summer flounder (*Paralichthys dentatus*), clearnose skate (*Raja eglanteria*), hogchoker (*Trinectes maculatus*), and weakfish (*Cynoscion regalis*). Many of these species use oyster beds as a source of food and are directly dependent on the maintenance of shell surface area to support the food resources important to their survival.

4.9. Threatened and Endangered Species

The shortnose sturgeon (*Acipenser brevirostrum*), an endangered fish species within the purview of the National Marine Fisheries Service, migrates through the project area in the spring from the sea to spawn in the upper estuary. Most of the fish have been observed in the upper tidal freshwater area of the Delaware River, but they also access the bay, especially during winter months. Atlantic sturgeon (*Acipenser oxyrinchus*) is a candidate species for listing under the Endangered Species Act, as announced in the Federal Register 16 October 2006. The term “candidate species” refers to species that are the subject of a petition to list as threatened or endangered. The Atlantic sturgeon are primarily found in the upstream portion of the Delaware River and its tributaries.

Sea turtles, especially the loggerhead (*Caretta caretta*), the Kemp’s ridley (*Lepidochelys kempii*), green (*Chelonia mydes*), and leatherback (*Dermochelys coriacea*) may occur in the lower Delaware Bay from June to November.

Six species of endangered whales have been observed migrating along the Atlantic Coast, and are occasionally seen in the lower bay. These whales include the sperm whale (*Physeter catadon*), fin whale (*Balaenoptera physalus*), humpback whale (*Megaptera novaeangliae*), blue whale (*Balaenoptera musculus*), sei whale (*Balaenoptera borealis*), and black right whale (*Balaena glacialis*). All marine mammals are protected by Federal law.

4.10. Cultural Resources

There are no known shipwrecks or deeply buried prehistoric or historic archaeological deposits in the project area. Shallow archaeological deposits, if they ever existed, would likely have been removed by past oyster harvesting.

5.0. ENVIRONMENTAL EFFECTS

The goal of this project is to increase Eastern oyster abundance in Delaware Bay. The historical role of the Eastern oyster is widely appreciated as a keystone species in the Delaware estuary. Oysters control phytoplankton abundance and alter estuarine food webs through benthic-pelagic coupling and serve an important role in improving water quality within the system. The Eastern oyster constructs biogenic habitats that provide refugia, nesting sites, and foraging grounds for a variety of resident and transient species. Numerous studies reveal greater biodiversity associated with oyster reefs than with adjacent sedimentary habitats. Species richness and abundance of organisms in oyster reef habitats are generally comparable to those found in seagrass meadows (Coen and Luckenback, 1999). The objective of this project to increase oyster abundance within Delaware Bay is the same as the goal of the Oyster Industry Revitalization Task Force (OIRTF): to enhance recruitment by enhancing natural seed supply through the planting of shell (cultch) in a timely fashion, thus providing habitat for recruitment of juvenile oysters (spat). In 2007, Delaware Bay entered its seventh year of well below average recruitment (less than 0.5 spat per oyster per year). Seven such consecutive years is unprecedented for the 54-year record for which detailed survey data are available (1953-2007). An additional goal is to provide shell to maintain the shell beds. Delaware Bay oyster reefs have lost, on average, about 500,000 bushels of shell per year to dynamic processes and oyster abundance is now

too low to replace this shell naturally, thus endangering the future of the shell bed.

The proposed project will continue the shell-planting program that was initiated in 2005 (USACE 2005, USACE, 2006, USACE, 2007). The plan will have minimal effects on bottom topography and substrate as shells will be planted only on existing oyster shell beds or oyster lease areas. There are significant differences in the setting patterns of oyster larvae over the range of natural seed beds, as well as some inshore areas within state leased grounds. Although setting will occur throughout the range of the seed beds, the most reliable setting areas are nearshore and downbay on the New Jersey side of the bay. The greatest set potential occurs in the nearshore areas below Ben Davis Point. Even greater consistency in yearly recruitment occurs downbay in the Cape Shore area. However, historically consistent setting in these areas does not result in historically high abundances of marketable oysters due to high predator mortalities of spat and juveniles. Hence, some spat recruited to these areas is moved to more productive grounds soon after settlement by the state of New Jersey.

Adequate oyster bottom habitat is available in New Jersey, however habitat quality is low on some beds due to limited oyster abundance. In addition, shell loss has become a significant issue for some beds. These beds offer excellent opportunities for enhancement and simultaneously shell planting can repair the shell deficit that exists. Shell will be planted at the time of maximum setting potential. The 2007 Stock Assessment Workshop for the New Jersey Delaware Bay Oyster Beds recommends the following sites for optimum direct shell plants: Ship John, Cohansey, Bennies Sand, Nantuxent, Hawk's Nest, Beadons, and Strawberry. The 2005-2007 shell plants demonstrated that recruitment can be enhanced by direct addition of shell to existing oyster beds in this region. As management of the New Jersey beds focuses on sustaining and increasing adult abundance, this proposal will also result in a long-term increase in oyster abundance.

The shell planting program in Delaware will provide needed shell cultch on state-owned natural oyster bars: Over the Bar, Lower Middle, Silver Bed, and Ridge. These beds historically have suffered loss in production due to siltation. Recruitment has been at record low levels since 2000 on all natural oyster beds in Delaware. The Ridge was not harvested for 15 years prior to opening in 2001. There has been some limited harvesting on the other beds during the period between 1991 and 1995 but all Delaware beds were closed during the period between 1996 and 2000. The shell planting is designed to increase the productive area by adding to bed height while expanding available cultch.

Planting methodologies entail the use of barges for shell transport and raw-water pumps to spray a thin layer of shell overboard on the beds. Transplant methods entail the use of traditional oyster dredge, suction or dry dredge vessels and a raw-water pump for re-planting. Powell *et al.* (2001, 2004) conducted studies to assess the impact of these dredging mechanisms for shell transplanting. Impacts on both the oyster reef and bay bottom as well as to the viability of the oysters were evaluated. No significant effects could be discerned on oyster growth, disease pressure, and mortality from repeated dredging. With respect to the type of dredging equipment used, although catch rates vary with equipment utilized, neither method proved deleterious to bottom complexity, cultch availability, oyster growth, mortality, or population health.

5.1. Water Quality

The project will generate very limited short-term impacts on water quality and in the long-term, the project will positively affect water quality. An increase in oyster abundance will increase water clarity

through filtration. Short-term, nominal adverse impacts to water quality may result from the actual placement of shell in the immediate area of the placement activities. Placement of shell on the bay bottom will result in a temporary elevation of turbidity during operations but this will dissipate very quickly upon completion because the particle size is large (>20mm) with a high sinking rate. No adverse impacts to water quality, including oxygen depletion or the release of chemical substances are anticipated as shell is a natural substance that is already present in high concentrations within the bay and carries with it a very low oxygen demand and inconsequential levels of contaminant risk. To minimize the impact on oxygen demand, only cured shell will be used: shell stored on land for a sufficient amount of time as to insure that any associated shellfish meat left by the shucking process will have decomposed prior to shell planting. Mobile organisms such as fish and crabs can temporarily vacate the area whereas benthic organisms associated with the existing oyster beds will only be temporarily impacted by the increased turbidity levels during the shell planting procedure. Shell planting for recruitment enhancement requires planting shell in a thin veneer to optimize surface area in contact with the water, consequently burial and mortality of benthic biota will be low; typically near zero. No previous studies, to date, have identified a negative environmental impact of shell planting.

5.2. Air Quality

The Delaware Bay Oyster Restoration Project would take place in Delaware Bay in portions of the States of New Jersey and Delaware. This area is classified as moderate nonattainment for ozone (oxides of nitrogen [NO_x] and volatile organic compounds [VOCs]). Delaware Bay, New Jersey and Delaware is within the Philadelphia-Wilmington-Trenton Nonattainment Area (PA-NJ-DE-MD). The 1990 Clean Air Act Amendments include the provision of Federal Conformity, which is a regulation that ensures that Federal Actions conform to a nonattainment area's State Implementation Plan (SIP) thus not adversely impacting the area's progress toward attaining the National Ambient Air Quality Standards (NAAQS). A General Conformity Analysis for this project is provided in the Appendix.

The total estimated emissions that would result from construction of the Delaware Bay Oyster Restoration Project are 1.85 tons of NO_x and 0.29 tons of VOCs. These emissions are below the General Conformity trigger levels of 100 tons of NO_x and 50 tons VOCs per year. General Conformity under the Clean Air Act, Section 176 has been evaluated for the project according to the requirements of 40 CFR 93, Subpart B. The requirements of this rule are not applicable to this project because the total direct and indirect emissions from the project are below the conformity threshold values established at 40 CFR 93.153 (b) for ozone (NO_x and VOCs) in a Moderate Nonattainment Area (100 tons NO_x and 50 tons VOCs per year). The project is not considered regionally significant under 40 CFR 93.153 (i).

5.3. Threatened and Endangered Species

From June through November, Delaware Bay is inhabited by transient sea turtles, especially the loggerhead (Federally-listed threatened *C. caretta*) or Kemp's ridley (Federally-listed endangered *L. kempii*). The shortnose sturgeon (*A. brevirostrum*), although usually present in the upper freshwater reaches of the estuary, uses the bay for migration in the spring. Sea turtles and the endangered shortnose sturgeon are under the purview of the National Marine Fisheries Service (NMFS). They are very mobile species and would be expected to vacate the immediate area where shell planting will take place and are not expected to be adversely impacted by the proposed project.

5.4. Essential Fish Habitat

Under provisions of the reauthorized Magnuson-Stevens Fishery Conservation and Management Act of 1996, the Delaware River and Bay from New Castle, DE and Pennsville, NJ to the mouth of the Bay at the Atlantic Ocean is designated as Essential Fish Habitat (EFH) for species with Fishery Management Plans (FMP's), and their important prey species. The National Marine Fisheries Service has identified EFH within 10 minute X 10 minute squares (Table 5-1). Since this study encompasses the entire Delaware Bay, in the essence of time, the Essential Fish Habitat assessment for the Delaware River Main Channel Project is provided here for review. The Main Channel Deepening study area contains EFH for various life stages for 26 species of managed fish and shellfish. Table 5-2 presents the managed species and their life stage(s) that EFH is identified for within the 10 x 10 minute squares that cover the study area. The habitat requirements for identified EFH species and their representative life stages are provided in Table 5-3.

TABLE 5-1. 10 MINUTE X 10 MINUTE SQUARES THAT CONTAIN ESSENTIAL FISH (NOAA, 1999)

Square Number	Coordinates			
	North	East	South	West
31	39° 40.0' N	75° 30.0' W	39° 30.0' N	75° 40.0' W
38	39° 30.0' N	75° 30.0' W	39° 20.0' N	75° 40.0' W
39	39° 30.0' N	75° 20.0' W	39° 20.0' N	75° 30.0' W
48	39° 20.0' N	75° 20.0' W	39° 10.0' N	75° 30.0' W
49	39° 20.0' N	75° 10.0' W	39° 10.0' N	75° 20.0' W
50	39° 20.0' N	75° 00.0' W	39° 10.0' N	75° 10.0' W
59	39° 10.0' N	75° 20.0' W	39° 00.0' N	75° 30.0' W
60	39° 10.0' N	75° 10.0' W	39° 00.0' N	75° 20.0' W
61	39° 10.0' N	75° 00.0' W	39° 00.0' N	75° 10.0' W
70	39° 00.0' N	75° 10.0' W	38° 50.0' N	75° 20.0' W
71	39° 00.0' N	75° 00.0' W	38° 50.0' N	75° 10.0' W
80	38° 50.0' N	75° 10.0' W	38° 40.0' N	75° 20.0' W
81	38° 50.0' N	75° 00.0' W	38° 40.0' N	75° 10.0' W
90	38° 40.0' N	75° 00.0' W	38° 30.0' N	75° 10.0' W

Habitat Areas of Particular Concern (HAPC). A review of EFH designations and the corresponding 10 x 10 minute squares, which encompasses numbers 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 contain areas designated as “Habitat Areas of Particular Concern” (HAPC) for the sandbar shark. HAPC are areas of EFH that are judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation (NOAA, 1999).

Sandbar sharks use the shallows of Delaware Bay as an important seasonal nursery ground. The juvenile sharks (1 to 6 yr. old) return to the Bay from wintering grounds in the Carolinas, in mid May.

Adult females visit the Bay to pup (deliver live-born young) in the first weeks of June. This has not been directly observed yet, many young caught in June bear fresh umbilical cord remnants and all have open umbilical scars indicating very recent birth. Newborns weigh about 1.5 pounds and are about 1.5 feet in length. Tag returns show that they stay in the bay feeding throughout the summer and depart for their winter (secondary) nurseries when the waters turn cool in mid October. Most newborns are found on the shallow flats in the Southwestern Bay although they seem to radiate out and use more of the Bay during the summer, as they get larger. Telemetry studies show that juveniles cross the bay mainly on the bottom. They are bottom feeders, preying on fish, particularly flat fish, crabs (blue crabs and spider crabs) and other benthic organisms.

TABLE 5-2. SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, and 90 and Mixing Zone (MZ) (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILE S	ADULTS
Atlantic cod (<i>Gadus morhua</i>)				81
Red hake (<i>Urophycis chuss</i>)	31,71, 81	31, 71, 81	71, 81	59,60,61,70, 71, 80, 81
Red fish (<i>Sebastes fasciatus</i>)	90			
Winter flounder (<i>Pleuronectes americanus</i>)	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	31, 38,39,48, 49, 50, 59, 60, 61, 70, 71,80, 81, 90, MZ	31, 38,39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	31,38,39,48, 49,50,59,60,661, 70, 71,80,81, 90, MZ*
Windowpane flounder (<i>Scophthalmus aquosus</i>)	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81,90, MZ	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81,90, MZ	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ*
American plaice (<i>Hippoglossoides platessoides</i>)			MZ	
Atlantic sea herring (<i>Clupea harengus</i>)			48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Monkfish (<i>Lophius americanus</i>)	81, 90	81, 90		
Bluefish (<i>Pomatomus saltatrix</i>)			31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ
Long finned squid (<i>Loligo pealei</i>)	n/a	n/a		71
Short finned squid (<i>Illex ilecebrosus</i>)	n/a	n/a		
Atlantic butterfish (<i>Peprilus tricanthus</i>)		59, 60, 61, 70, 71, 80, 81	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	59, 60, 61, 70, 71, 80, 81, 90
Summer flounder (<i>Paralichthys dentatus</i>)		90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ
Scup (<i>Stenotomus chrysops</i>)	n/a	n/a	31, 38, 39, 48, 49, 50,59, 60, 61, 70, 71, 80, 81, 90, MZ	31, 38, 39, 48, 49, 50, 90
Black sea bass (<i>Centropristus striata</i>)	n/a	81	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, MZ	59, 60, 61, 70, 71, 80, 81, 90
Ocean quahog (<i>Artica islandica</i>)	n/a	n/a		
Spiny dogfish (<i>Squalus acanthias</i>)	n/a	n/a	71	81
King mackerel (<i>Scomberomorus cavalla</i>)	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Spanish mackerel (<i>Scomberomorus maculatus</i>)	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Cobia (<i>Rachycentron canadum</i>)	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	31, 38, 39, 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90

Sand tiger shark (<i>Odontaspis taurus</i>)		50, 59, 60, 61, 70, 71, 80, 81, 90		59, 60, 61, 70, 71, 80, 81, 90
Atlantic angel shark (<i>Squatina dumerili</i>)		71, 81, 90	71, 81, 90	71, 81, 90
Dusky shark (<i>Charcharinus obscurus</i>)		48, 49, 50, 60, 61, 70, 71, 80, 81, 90		
Sandbar shark (<i>Charcharinus plumbeus</i>)		HAPC , 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	HAPC , 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90	HAPC , 48, 49, 50, 59, 60, 61, 70, 71, 80, 81, 90
Scalloped hammerhead shark (<i>Sphyrna lewini</i>)			71, 81, 90	
Atl. Sharpnose shark (<i>Rhizopriondon terraenovae</i>)		71, 81, 90	71, 81	71, 81, 90

“n/a”: species either have no data available on designated lifestages, or those lifestages are not present in the species reproductive cycle. **HAPC: (Habitat Areas of Particular Concern): EFH that is judged to be particularly important to the long-term productivity of populations of one or more managed species, or to be particularly vulnerable to degradation.**

TABLE 5-3. HABITAT UTILIZATION OF IDENTIFIED EFH SPECIES AND THEIR SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, and Mixing Zone (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
Atlantic cod (<i>Gadus morhua</i>) (Fahay, 1998)				Habitat: Bottom (rocks, pebbles, or gravel) winter for Mid-Atlantic Prey: shellfish, crabs, and other crustaceans (amphipods) and polychaetes, squid and fish (capelin redfish, herring, plaice, haddock).
Red hake (<i>Urophycis chuss</i>) (Steimle et al. 1998)	Habitat: Surface waters, May – Nov.	Habitat: Surface waters, May –Dec. Abundant in mid- and outer continental shelf of Mid-Atl. Bight. Prey: copepods and other microcrustaceans under floating eelgrass or algae.	Habitat: Pelagic at 25-30 mm and bottom at 35-40 mm. Young inhabit depressions on open seabed. Older juveniles inhabit shelter provided by shells and shell fragments. Prey: small benthic and pelagic crustaceans (decapod shrimp, crabs, mysids, euphasiids, and amphipods) and polychaetes).	
Red fish (<i>Sebastes fasciatus</i>)	n/a			
Winter flounder (<i>Pseudopleuronectes americanus</i>) (NOAA, 1999); Pereira et al, 1998; McClane, 1978)	Habitat: Mud to sand or gravel; from Jan to May with peak from Mar to April in 0.3 to 4.5 meters inshore; 90 meters or less on Georges Bank. 10 to 32 ppt salinity.	Habitat: Planktonic, then bottom oriented in fine sand or gravel, 1 to 4.5 m inshore. 3,2 to 30 ppt. salinity. Prey: nauplii, harpacticoids, calanoids, polychaetes, invertebrate eggs, phytoplankton.	Habitat: Shallow water. Winter in estuaries and outer continental shelf. Equally abundant on mud or sand shell. Prey: copepods, harpacticoids, amphipods, polychaetes	Habitat: 1-30 m inshore; less than 100m offshore; mud, sand, cobble, rocks, boulders. Prey: omnivorous, polychaetes and crustaceans.

Windowpane flounder (<i>Scophthalmus aquosus</i>) (Chang, 1998)	Habitat: Surface waters, peaks in May and October.	Habitat: Pelagic waters.	Habitat: Bottom (fine sands) 5-125m in depth, in nearshore bays and estuaries less than 75 m Prey: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae	Habitat: Bottom (fine sands), peak spawning in May, in nearshore bays and estuaries less than 75 m Prey: small crustaceans (mysids and decapod shrimp) polychaetes and various fish larvae
Atlantic sea herring (<i>Clupea harengus</i>) (Reid et al., 1998)			Habitat: Pelagic waters and bottom, < 10 C and 15-130 m depths Prey: zooplankton (copepods, decapod larvae, cirriped larvae, cladocerans, and pelecypod larvae)	Habitat: Pelagic waters and bottom habitats; Prey: chaetognath, euphausiids, pteropods and copepods.
Monkfish (<i>Lophius americanus</i>) (Steimle et al., 1998)	Habitat: Surface waters, Mar. – Sept. peak in June	Habitat: Pelagic waters in depths of 15 – 1000 m along		

TABLE 5-3. HABITAT UTILIZATION OF IDENTIFIED EFH SPECIES AND A SUMMARY OF SPECIES WITH EFH DESIGNATION IN THE 10 min. x 10 min. SQUARES OF 31, 38, 39, 48 49, 50, 59, 60, 61, 70, 71, 80, 81, 90, and Mixing Zone (NOAA, 1999)

MANAGED SPECIES	EGGS	LARVAE	JUVENILES	ADULTS
	in upper water column of inner to mid continental shelf	mid-shelf also found in surf zone Prey: zooplankton (copepods, crustacean larvae, chaetognaths)		
Bluefish (<i>Pomatomus saltatrix</i>)			Habitat: Pelagic waters of continental shelf and in Mid Atlantic estuaries from May-Oct.	Habitat: Pelagic waters; found in Mid Atlantic estuaries April – Oct.
Long finned squid (<i>Loligo pealei</i>)	n/a	n/a		
Short finned squid (<i>Illex illecebrosus</i>)	n/a	n/a		
Atlantic butterfish (<i>Peprilus tricanthus</i>)		Habitat: Pelagic waters, greater than 33 ft deep	Habitat: Pelagic waters in 10 – 360 m	Habitat: Pelagic waters
Summer flounder (<i>Paralichthys dentatus</i>)		Habitat: Pelagic waters, nearshore at depths of 10 – 70 m from Nov. – May	Habitat: Demersal waters (mud and sandy substrates)	Habitat: Demersal waters (mud and sandy substrates). Shallow coastal areas in warm months, offshore in cold months
Scup (<i>Stenotomus chrysops</i>)	n/a	n/a	Habitat: Demersal waters	Habitat: Demersal waters offshore from Nov – April
Black sea bass (<i>Centropristus striata</i>)	n/a	Habitat: Pelagic and estuarine.	Habitat: Demersal waters over rough bottom, shellfish and eelgrass beds, man-made structures in sandy-shelly areas, <i>Sabellaria</i> reefs	Habitat: Demersal waters over structured habitats (natural and man-made), and sand and shell areas, <i>Sabellaria</i> reefs.
Ocean quahog (<i>Artica islandica</i>)	n/a	n/a		
Spiny dogfish (<i>Squalus acanthias</i>)	n/a	n/a		

King mackerel (<i>Scomberomorus cavalla</i>)	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone.	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone
Spanish mackerel (<i>Scomberomorus maculatus</i>)	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
Cobia (<i>Rachycentron canadum</i>)	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory	Habitat: Pelagic waters with sandy shoals of capes and offshore bars, high profile rocky bottom and barrier island ocean-side waters from the surf to the shelf break zone. Migratory
	break zone. Migratory	break zone. Migratory		
Sand tiger shark (<i>Odontaspis taurus</i>)		Habitat: Shallow coastal waters, bottom or demersal		Habitat: Shallow coastal waters, bottom or demersal
Atlantic angel shark (<i>Squatina dumerili</i>)		Habitat: Shallow coastal waters,	Habitat: Shallow coastal waters	Habitat: Shallow coastal waters, bottom (sand or mud near reefs)
Dusky shark (<i>Charcharinus obscurus</i>)		Habitat: Shallow coastal waters		
Sandbar shark (<i>Charcharinus plumbeus</i>) Pratt, 1999		Habitat: Shallow coastal waters; submerged flats (1-4 m). Important nursery area off Broadkill and Primehook beaches.	Habitat: Shallow coastal waters; submerged flats (1-4 m) Important nursery area off Broadkill and Primehook beaches.	Habitat: Shallow coastal waters; submerged flats (1-4 m)
Scalloped hammerhead shark (<i>Sphyrna lewini</i>)			Habitat: Shallow coastal waters	
Atl. sharpnose shark (<i>Rhizopriondon terraenovae</i>)		Habitat: Shallow coastal waters	Habitat: Shallow coastal waters	Habitat: Shallow coastal waters
Clear nose skate (<i>Raja eglanteria</i>)		Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters
Little skate (<i>Leucoraja erinacea</i>)		Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters
Winter skate (<i>Leucoraja ocellata</i>)		Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters	Habitat: Shallow Coastal waters

The sharks' main nursery areas on the East Coast are in Delaware and Chesapeake bays. Pup and juvenile sharks use submerged flats for residence and feeding in water depths of from 1 to 4 meters. On the Delaware coast they extend from Roosevelt Inlet at the southern terminus of Broadkill Beach to Port Mahon in the north. The greatest concentrations of young sharks occur off Broadkill and

Primehook beaches, Delaware. They also are found in great numbers on submerged flats off the New Jersey shore (1-4 m) between Villas and Reed's Beach and shoal areas throughout the Bay such as Deadman and Hawksnest Shoal. They are limited by salinity to areas south of the latitude of Fortescue, NJ. Juveniles and pups may be caught almost anywhere in the bay, but the southwest coastal areas have the greatest consistent numbers as reflected in Catch per Unit Effort (CPUE) data (Merson and Pratt, 1998).

EFH is designated for the skate species for juveniles and adults. The Little skate and Winter skate are broadly distributed from Newfoundland to Cape Hatteras. Juveniles and adults mostly prefer sand or gravelly bottoms and mud. During the spring they move into shallow water and during winter head into deeper water. The Clearnose skate is broadly distributed along the eastern United States from Nova Scotia to Northeastern Florida. Juvenile and adult Clearnose skates are most abundant in summer months and less abundant in the cooler months of fall, winter, and spring. They prefer soft bottom habitats but can also be found in rocky or gravelly bottoms. Skate diets consist primarily of polychaetes, amphipods, decapod crustaceans, squid, bivalves, and small fish. Turbidity during the placement or transplant of shell may impact sight feeding but the skates will flee the area to feed in neighboring waters and the elevated turbidity is temporary. Therefore, no more than minimal impact to feeding success should occur.

Effect Analysis. It is anticipated that all fish species, being mobile organisms will vacate the proposed shell planting sites during the time of construction and not be adversely impacted by the proposed work. Elevated turbidity levels due to construction, are anticipated to lower fairly quickly following completion of the shell planting. Improved habitat quality of the oyster beds, due to the proposed shell planting is expected to enhance the habitat quality for fish species which use the oyster beds, particularly during larval or juvenile stages. Many fish species rely on healthy oyster beds for a source of food and are directly dependant on the maintenance of shell surface area to support the food resources important to their needs.

There are a number of Federally-managed fish species where Essential Fish Habitat (EFH) was identified for one or more life stages within the project impact areas. Fish occupation of waters within the project impact areas is highly variable spatially and temporally. Some of the species are strictly offshore, while others may occupy both nearshore and offshore waters. In addition, some species may be suited for the open ocean or pelagic waters, while others may be more oriented to bottom or demersal waters. This can also vary between life stages of Federally-managed species. Also, seasonal abundances are highly variable, as many species are highly migratory. For most of the fish species in Delaware Bay, no adverse effect is anticipated on adults and juveniles because both stages can move away from the project impact area. Minimal adverse effect on eggs and larvae is expected as they are demersal at these life stages. All shell placements will occur on existing natural oyster beds. No impact to soft bottom habitat will occur.

The shortnose sturgeon is a Federally-endangered fish that lives in the Delaware Estuary. Likewise, any sturgeon in the proposed shell planting areas are anticipated to vacate the shell planting area during actual construction and a temporary post-construction period until elevated turbidity levels dissipate.

5.5. Monitoring

From 1997 to the present, through the efforts of the state regulatory agencies, the Shellfish Councils,

and the Haskin Shellfish Research Laboratory (HSRL) of Rutgers University have established a significant assessment infrastructure that has produced a sustainable industry in Delaware Bay. In New Jersey, this process has been formalized through a stock assessment workshop, a rigorous stock survey, and the development of a coupled shellfisheries-disease model to permit projections of yearly harvest. Through these efforts, a consistent fishery has been established and a stable stock structure has been maintained. The resiliency of Delaware Bay oyster populations was reduced with the advent of Dermo in the 1990s.

The proposed shell planting and monitoring project seeks to continue to promote improvements in the oyster resource of Delaware Bay and habitat quality-critical during a period of high infestation of disease. The program is not revolutionary, in the sense that the approach has been used successfully by other states as well as in several previous initiatives within Delaware Bay. Several oyster reef restoration projects are underway on the East and Gulf coasts of the U.S. Monitoring is essential and research vital to our understanding of genetic implications of restoration strategies, larval dispersal patterns, factors affecting early post-settlement survival, disease dynamics, and landscape-level patterns in restoring oyster reef habitat (Coen and Luckenback, 1999). The monitoring program is, however, revolutionary in that it is the first such one developed based on detailed measurements of shell budes and comprehensive stock surveys permitting targeted shell planting to quantify results of the ecological return on investment.

The Monitoring and Assessment Program for 2008, although reduced in size due to funding restraints under the current Section 1135 authority, will acquire the data necessary to evaluate the success of the 2008 shell-planting program. The increment in abundance achieved by the program over the abundance that would have been present in the absence of the program at present will be used to establish the degree of success. Each year the total number of oysters supported by the shell planting is assessed. The addition of shell should augment the production of the Delaware Bay oyster fishery. Each state sets its quota to determine the number of bushels permissible for harvest in the coming year based on a formal stock assessment. The monitoring program will compare the quotas set each year to the quota that would have been established had the shell-planting program not been carried out. A shell plant is expected to substantially increase larval settlement in the year that it occurs. However, the shell added will continue to serve as substrate over future years. The usable life span of a shell plant is likely to exceed 10 years (Powell, pers. comm., 2007). Therefore, it is likely that the benefit of previous years' shell plants may be underestimated. That is, the gain in abundance at any time will underestimate the true gain over the usable life span of the shell plant.

A secondary aspect of the proposed shell planting and monitoring program is to seek a wider constituency in the revitalization of the oyster population and continued interest in improvements to habitat quality within Delaware Bay. Increasing estuary-wide awareness through a multifaceted education and outreach program is proposed to bring together stakeholders from across the region to build stewardship for this natural resource. A successful resource management program depends upon the support of the general public. In time, this stewardship and public awareness should mobilize additional involvement and resources for the revitalization process.

The shell planting program was designed to specifically address the issue of low recruitment and the inability of recruitment rates on natural oyster beds to sustain population abundance over time. The monitoring program for 2008 consists of four components: (1) monitoring of shell plants in the event that the state of New Jersey, Division of Shellfisheries pursues future transplants; (2) periodic tracking

of trends in growth and disease exposure for the shell plants (in previous years accomplished monthly but reduced to only a few select months this year; (3) a quantitative evaluation in October to determine the overall success of each year's program at season's end; and (4) a survey of targeted oyster beds to improve bed areal estimates, where required. A shell budget has been calculated to evaluate the efficacy of the shell planting program from the 2007 data.

5.5.1. Monitoring Results

New Jersey oyster beds have been losing approximately 250,000 to 500,000 bushels of cultch annually since 1999 (the first year that survey data was available and an estimate calculated). The shell budget shows a substantial reduction in shell loss in the bay in 2005 through 2007 as a result of the shell-planting program that has reduced the yearly deficit by at least two-thirds. The data suggest that 2007 is the first time in an eight-year time series that New Jersey beds are in relative equilibrium. However, it should be noted that the improved shell balance observed in 2007 is due to two factors: 1) the purposeful addition of the planted shell, and 2) the relatively high level of natural input due to the Dermo epizootic that occurred in 2007. Since the onset of Dermo disease in 1990, two periods of epizootic mortality have occurred, each being multi-year (Powell et al, SAW 2008). The first occurred during the 1992-1994 period and the second from 1998-2002, with an intermediate lessening in intensity in 2001. The time series suggests that 2007 may be initiating another period of higher than average Dermo mortality.

The current program has a proven track record. In 2003, as part of a pilot shell planting program, the NJDEP planted shell in the vicinity of Reeds Beach in the lower Delaware Bay. Approximately one month later, 16,000 bushels were transplanted to Bennies Sand, an area which has supported the majority of the 1990s oyster harvest. Preliminary monitoring results indicate that these 16,000 bushels increased bed abundance of market size oysters in 2005 by more than half (58% of the market size oysters on Bennies Sand in 2005 came from this 2003 planting) (E. Powell, pers. comm.).

The yearly mortality rate for yearlings from 2006 to 2007 averaged 55.7%, somewhat lower than the long-term average of 62.9%. Shell planted in 2006 continued to attract spat in 2007 at a rate equivalent to native shell. Nevertheless, the net addition of shell to the beds sustained an increased recruitment rate for a second year. Spat set in 2007 was the highest since 1999 bay-wide, ending a string of seven consecutive years of relatively low recruitment and four consecutive years of very low recruitment. Recruitment on direct shell plants in 2007 averaged 237 spat per bushel (native shell on the same grids averaged 222 spat per bushel). The similarity between direct plants and native shell spat set originates in the timing of the set in 2007. Most of the set occurred in late September to early October and the shell planted in June/July, by that time, had lost most of its "cleanliness" and so performed no differently than native shell (pers. comm.. J. Heron, 2008).

This supports what evidence has shown previously: that the biological potential for oyster production in the Delaware estuary remains high (Haskin et al., 1983; Ford, 1997; and Canzonier, 1992b). Resource management practices are in place and designed to stabilize adult abundance in times of decline and expand adult abundance when needed, using different techniques designed to enhance oyster productivity even in the face of diseases.

2005. Surveys taken for the 8th SAW report (Powell *et al.*, 2006) indicated that oyster abundance declined slightly in 2005 to the lowest level since the onset of Dermo disease circa 1989 and to one of

the lowest levels in the 1953 to 2005 record. Declines were concentrated on medium-mortality beds upbay of Shell Rock. Elsewhere, abundance was increased over 2004 levels. 2005 was the sixth consecutive year of low recruitment. The number of spat per bushel sampled was insufficient (0.340) to sustain the present population. Recruitment enhancement in 2005 was successful. Shell plants raised the ratio of spat to oyster on Shell Rock from 0.471 to 0.991, and on the high mortality beds from 0.808 to 0.905. As of 2005, in the 53-year history of the New Jersey oyster survey, a bay-wide set exceeding 1 spat per oyster had happened only 17 times. Shell planting in New Jersey in 2005 enhanced recruitment bay-wide by 10%, even though the total area planted was a mere 100 acres. On Shell Rock, shell plants accounted for 52.4% of total recruitment. In 2005, comparisons in Delaware could only be made on a per-bushel basis. Nevertheless, data from the Delaware survey indicates that shell planting successfully enhanced recruitment in 2005. The average spat/bushel from 15 samples at Ridge/Jigger Hill was 8.1. The average spat/bushel from 6 samples on Lower Middle was 23.3. The average spat/bushel for all Delaware beds was 14.5. In contrast, the shell plants yielded an average of 43 spat/bu (three times the bay average). The spat monitoring program suggested two recruitment waves occurred in 2005, one early in July and another later, in August/September.

2006. New Jersey conducts a yearly monitoring program to track recruitment potential and in 2006, this program was extended to Delaware portions of the bay. The 2006 program showed greater spat availability downbay but a lower setting potential overall than in 2005. The monitoring program showed two recruitment waves occurring in 2006: one early in July downbay and one in August upbay. Increase in recruitment on directly planted shell was about a factor of 5.9 over native shell.

Recruitment remained low bay-wide in 2006. Evidence suggests that low spat abundance is associated with low adult abundance, and data analyses suggest that the explanation involves the contribution of live oyster shell to the cultch resource preferred for settlement. This implies that high recruitment may be less likely under current conditions of low abundance and emphasizes further the need for continual shell planting to increase oyster abundance. Overall, recruitment enhancement programs were successful in 2006. In New Jersey, shell planting in 2006 enhanced recruitment by a factor of 1.34 bay-wide, providing 26% of total recruitment on New Jersey beds. On Shell Rock, shell plants accounted for 50% of total recruitment. On the high mortality beds, shell plants accounted for 58% of total recruitment (Powell *et al.*, 2007).

Spawning stock biomass rose in 2006. Increases were observed in all bay regions except upbay on the low-mortality beds. Spawning stock biomass has increased steadily on the high-mortality and medium-mortality beds over the last three years and has risen for the last two years on Shell Rock. Spawning stock biomass was above the biomass target in three of 4 bay regions and near the threshold for the low-mortality beds. *Perkinsus marinus* (Dermo) prevalences in the area of the bay used for shell planting are typically above 50%. In 2006, oysters on the 2005 shell plants were monitored for Dermo infection. The bed-average prevalence was 100% and 90% for these two sites, respectively. These compare closely to the values obtained in October 2005 for the previous year's shell plants. The evidence suggests that Dermo infection is lower on oysters obtained from shell plants relative to oysters naturally occurring on the bed.

Although the beds continued to suffer a net loss of shell in 2006, the shell-planting program reduced this net loss to the lowest value during the 1999-2006 time period. The shell budget estimates identify the importance of shell planting in maintaining the integrity of the beds during times of disease when low abundance limits the amount of shell added to the beds through natural mortality. Shell plants

provide substrate to enhance recruitment. The shell budget also permits more effective planning for future shell plants. Most beds that did not receive shell plants in 2006 suffered losses of surficial shell.

In summary for 2006, low-mortality beds were not showing significant improvement but beds in other bay regions appear to have improved since 2004. However, the fact that all bay regions fall below their abundance targets indicates that actions to enhance abundance are needed in all bay regions. A continued need exists to minimize shell loss to reinforce the maintenance of biomass at or above target levels. Abundance has been enhanced on the high-mortality beds and Shell Rock by downbay transplants. The shell planted in 2006 continued to attract spat in 2007 at a rate of attraction approximately equal to native shell. This net addition of shell over multiple years resulted in an increase in the number of recruits for a second year, indicating the long-term biological benefit of shell plants beyond the planting year (9th SAW, Powell *et al.*, 2007).

2007. From surveys taken during the 2007 monitoring program, quantitative estimates using the time-series analysis indicate that oyster abundance summed across all strata and bay regions declined somewhat from 2006, but remained above the 2003-2005 values (i.e. falling from 2006 on some low-mortality beds but rising dramatically on the productive beds of Shell Rock, principally as a result of the shell-planting program). Abundance in 2007 fell 32% on low mortality beds and on high mortality beds (10%) from 2006, but remained consistent with values observed during the 2000s. The proportion of the stock on high mortality beds remained relatively high for the third straight year (14th and 18th percentiles for the 55-year time series) as well as when compared to the post-1988 time series. Spawning stock biomass decreased bay-wide by 8% in 2007. It rose slightly on low mortality beds, declined by 24% on medium mortality beds, though still remaining relatively high for the 1990-2007 time series, declined by 25% on high mortality beds, and rose dramatically on Shell Rock (factor of 2.03). Spawning stock biomass is highest on the medium mortality beds in most years. In 2007, these beds contributed 38.7% to the bay-wide spawning stock biomass. The low mortality beds contributed an additional 27.8% and the high mortality beds contributed an additional 20.9%.

Aside from the decline in adult oyster abundance due to high mortalities resulting from Dermo disease, there are reduced numbers of oyster spat due to relatively poor natural setting that has also contributed significantly to the demise of the Delaware Bay oyster. Spawning stock biomass decreased bay-wide by 8% in 2007 (i.e. rose slightly on low-mortality beds, declined on medium-mortality beds, though still remaining relatively high for the 1990-2007 time series, declined on high-mortality beds, and rose dramatically on beds at Shell Rock).

Oyster condition throughout the bay increased in 2007 to one of the highest values in the 1990-2007 time series. Spat set observed in 2007 was the highest since 1999 bay-wide, ending a string of seven consecutive years of relatively low recruitment and four consecutive years of very low recruitment. The number of spat recruiting per oyster was the highest since 1999 at 1.413, and one of the highest on record. Shell planting in 2007 enhanced recruitment by a small factor bay-wide. Recruitment was increased 6% on the medium mortality beds and 1.9% on the high-mortality beds. These increments were relatively low due to the lateness of 2007's largest setting event, which limited the influence of the planted shell's "cleanliness" and because of the overwhelmingly good set generally throughout the bay (Powell *et al.*, 2008).

5.6. Socioeconomic Resources

To date, approximately 659,886 bushels of shell have been planted and an additional 287,000 bushels are proposed to be planted in 2008. The program is a collaborative effort at the local, state, and federal levels involving ten partners. The additional of shell is critical for maintaining the integrity of the oyster reef itself; and essential for the settlement of spat to maintain the population. Shell is not a permanent resource. Gradually it deteriorates and disappears. Previous to the emergence of oyster diseases such as MSA and Dermo, shell was added to the beds through natural mortality while populations were maintained by annual high recruitment. Once adult oysters began to decline at a rate higher than could be renewed, over time, insufficient shell was available for adequate settlement. The shell planting program, in just three years, has essentially stabilized this loss and the ecological benefits of the population retained. The continued disease pressure from Dermo and a number of consecutive years of below average recruitment would have resulted in the closure of the oyster fishery in 2006, had the shell planting program not been put into place in 2005.

The proposed plan is expected to continue to increase oyster habitat, expand oyster abundance, and revitalize the natural resource with concomitant improvements in Bay habitat quality from increased habitat complexity brought about by shell planting as well as increased water clarity brought about by the increased filtration by an abundant shellfish resource. Expansion of oyster abundance provides increased substrate and expanded habitat complexity for a variety of other species, which in turn increases recreational value of the estuary.

Recovery of oyster abundance to the abundance at maximum sustainable yield (msy) would increase stock abundance by about a factor of 4. Currently there is a rebuilding program ongoing for the Delaware Bay oyster fishery. Due to this program and the current msy, only 1-3% of the available stock is fished per year. At msy, 7% of the stock can be harvested. The economic value of the oyster fishery at msy is estimated to be \$165,615,141 yearly. The present value is about \$12,000,000 yearly. The proposed shell-planting project will not achieve msy values, but, as an example, a doubling of oyster abundance is worth more than the simple multiplier of 2 because the allowable fishing rate increases disproportionately. A factor of 4 increase in abundance would allow a factor of about 7 increase in fishing or a factor of 28 increase in total value. 2007 allocations were above the long-term, on average, and estimates of future harvests suggest that the 2005-2006 programs may double harvests in 2008-2009, relative to the long-term average (E. Powell, pers. comm., 2007). Early projections show that the 2005-2007 shell planting programs should generate minimally \$15.6 million dollars of dockside value in the oyster fishery, which would have a total economic value of \$93.4 million (using the typical economic multiplier of six, which is used by the National Marine Fisheries Service). The return on investment (expenditures to date: \$6 million in federal and state dollars) is about \$28 per \$1 invested. This is a minimal estimate as additional oysters in the population also increase the reproductive capacity of the population and add to the long-term value of the shell in stabilizing the oyster bed. In addition, the oyster industry provides \$2 for each harvested bushel, so that the program generates additional funding for reinvestment in the resource (J. Heron, pers. communication, 2008).

5.7. Cultural Resources

The planting of additional oyster shell should have no effect on significant cultural resources. The periodic harvesting of oysters does involve the shallow disturbance of the sea floor at the time of

harvesting. However, oyster harvesting has been carried out in these areas for hundreds of years. This project's indirect effect of promoting the future harvesting of oysters while sustaining the existence of the oyster beds will sustain the cultural significance of the bayshore communities that have been a focal point of this area since the 1700s.

5.8. Unavoidable Adverse Environmental Impacts

The long-term adverse impact of the no action alternative would be decline in both the natural environment and the ecological value of the Delaware Estuary to the regional economic environment. Decimated by disease and low recruitment since 2000, oyster populations of Delaware Bay are not expected to recover without intervention. Oyster spat are not presently recruiting in numbers large enough to replace the number of oysters lost to harvest, predators and disease and shell bed deterioration has reached alarming levels. It is anticipated that unless the decline in oyster populations are reversed, oyster beds may be closed to harvesting and habitat quality will most likely continue to decline. The shell budget shows a substantial reduction in shell loss during 2005-2007 as a result of the shell-planting program (which has reduced the yearly deficit by at least two-thirds).

The impacts anticipated to occur as the result of a shell planting are positive. Shell planting will provide oysters the needed hard substrate of a sufficient elevation above the sediments to settle and grow. Shell planting had been conducted on a smaller, trial-basis initially (2003) and has proven successful both in the small pilot study as well as the subsequent three years. To date, approximately 1,341,000 bushels of shell have been planted in three years in the Delaware Bay under this program. Approximately 287,000 additional bushels will be planted in 2008 to revitalize the oyster population.

5.9. Short-term Uses of the Environment and Long-term Productivity

All shell placements will occur on existing natural oyster beds. No impact to soft bottom habitat will occur. The shell planting operation may entail temporary and localized increases in turbidity in the water column but this is expected to dissipate quickly. Revitalization of the oyster in Delaware Bay will contribute to the overall economy of Delaware Bay shore communities. The ecological benefits associated with a viable oyster resource are far reaching for the general health of the estuary. Oyster beds provide protective habitat for various economically important invertebrates and finfish species; and the filtering capacity of oysters will result in improved water quality. Furthermore, increased abundance is necessary to generate shell to retain bed integrity and maintain habitat complexity.

5.10. Irreversible and Irretrievable Commitments of Resources

The selected plan proposes to use surf clam and ocean quahog processed shell generated from shucking companies. Clean clam shell provides an adequate substitute for oyster shell for oyster larvae settlement. Hence, the proposed project is recycling a waste product as a useful commodity, thereby alleviating present storage and disposal requirements. With the additional pressure on oysters due to harvesting, it is critical that an active replacement program be implemented to ensure adequate shell cultch for successful future settlements.

5.11. Cumulative Effects

Cumulative effects of the proposed shell planting program are all anticipated to be positive. Oysters

provide a sustainable food supply that can be restored under proper augmentation and management conditions. Recovery of oyster abundance to a level at maximum sustainable yield (msy) will achieve an even greater harvesting rate because natural mortality from disease is expected to decline and the natural recruitment rate is expected to increase with positive impacts occurring over many years. Planted oyster shell beds are anticipated to have approximately a 10-year life span. As additional spat survive to reproductive age, successive year broodstock will increase. In addition to the economic value gained, the oyster is a keystone species in the estuary and an increase in the oyster population translates to improved water quality as a result of enhanced filtering capacity and expanded habitat complexity and diversity of estuarine species, as oyster beds provide habitat to a variety of benthic organisms that in turn provide food for recreationally and commercially important invertebrate and finfish species.

6.0. COORDINATION

Coordination for this project was done with Federal, state and local resource agencies. Agencies notified of this proposed project included the U.S. Fish and Wildlife Service, the U.S. Environmental Protection Agency, the National Marine Fisheries Service, the New Jersey Department of Environmental Protection, and the Delaware Department of Natural Resources and Environmental Control.

A public notice was issued describing the selected plan and the availability of the draft Environmental Assessment. All comments received on the draft report during the comment period are included in an Appendix of this final report.

7.0. LITERATURE CITED

- Canzonier, W.J. 1992 (a). *Remote setting of disease resistant oysters in Delaware Bay*. Final Project Report to USEPA, Region III. 45 pp.
- Canzonier, W.J. 1992 (b). *New Jersey oyster production: Thirty-five years of observation from deck and dockside*. Mid-Atlantic States Seafood Association. Seafood Seminars. Pleasantville, New Jersey Oct 27-29, 1992.
- Coen, L.D. and M.W. Luckenback. 1999. *The role of oyster reefs on seagrass meadows*. Transactions of the American Fisheries Society 112: 267-271.
- Delaware River and Bay Authority, 1999. *Oyster Industry Revitalization Task Force: Report to the governor and legislature of the state of New Jersey*.
- Ford, S.E. 1997. *History and present status of molluscan shellfisheries from Barnegat Bay to Delaware Bay*. In: *The History, Present Condition, and Future of the molluscan fisheries of North and Central America and Europe*. Vol. 1: North America (Mackenzie, C.L., Jr., V.G. Burrell, Jr., A. Rosenfield, and W.L. Hobart, Eds.) pp. 119-140. U.S. Department of Commerce, NOAA Technical Report NMFS, Seattle, Washington.
- Ford, S., E. Powell, J. Klincke, and E. Hoffman. 1999. Modeling the MSX parasite in eastern oysters (*Crassostrea virginica*) populations. 1. Model development, implementation, and verification. J. Shellfish Res. 18: 475-500.
- Haskin, H.H., R.A. Lutz, and C.E. Epifanio. 1983. Benthos (Shellfish) Chapter 13. In: *The Delaware Estuary: Research as background for estuarine management and development* (Sharp, J.H., Ed.) pp. 183-207.
- Hofmann, E.E., E.N. Powell, J.M. Klinck, and G. Saunders. 1995. Modeling diseased oyster populations. I. Modeling *Perkinsus marinus* infections in oysters. J. Shellfish Res. 14: 121-151.
- Howe, S. and W. Leathem, 1984. Secondary production of benthic macrofauna at three stations in *Delaware Bay and coastal Delaware*. NOAA Tech Memo. NMFS-NEFC-32.
- Howe, S.D., D. Maurer, and W. Leathem. 1988. *Secondary production of benthic mollusks from the Delaware Bay and coastal area*. Estuarine, Coastal, and Shelf Science, Vol 26: 81-94.
- Kinner, P., D. Maurer, and W. Leathem. 1974. *Benthic invertebrates in Delaware Bay: animal-sediment associations of the dominant species*. Int. Revue ges. Hydrobiol. 59: 685-701.
- Leathem, W. and D.Maurer. 1980. *Decapod crustaceans of the Delaware Bay area*. J. of Nat. Hist. Vol 14.
- Maurer, D. L. Watling, P. Kinner, W. Leathem, and C. Wethe. 1978. *Benthic invertebrate assemblages of Delaware Bay*. Mar. Biol. Vol 45: 65-78.

- Merson, R. R., and H. L. Pratt. 1998. *Nursery and pupping grounds of the sandbar shark, Carcharhinus plumbeus, in Delaware Bay*. 1998 Shark Evaluation Workshop Document SB-IV-24. U.S. Dep. Commer., NOAA, Natl. Mar. Fish. Serv., Southeast Fish. Sci. Cent
- Powell, E.N., S.E. Ford, M. Cummings, R.D. Barber, and B.M. Brewster, 2001. *Army Corps of Engineers Delaware River Main Channel Deepening project monitoring study-oyster component*. In: Pre-construction oyster, water quality and sediment monitoring study for the Delaware River Main Channel Deepening project.
- Powell, E.N., K.A. Ashton-Alcox, S. Banta, and A.J. Bonner. 2001. *Impact of repeated dredging on a Delaware Bay Oyster Reef*. J. of Shellfish Res. Vol. 20: No. 3 961-975.
- Powell, E.N. and K. Ashton-Alcox. 2004. *A comparison between a suction dredge and a traditional oyster dredge in the transplantation of oysters in Delaware Bay*. J. of Shellfish Res. Vol. 23: No. 3 803-823.
- Powell, E.N. Kraeuter, J. and Ashton-Alcox, K. 2006. Haskin Shellfish Research Laboratory, Report of the 2005 (8th) Stock Assessment Workshop for the New Jersey Delaware Bay Oyster Beds.
- Powell, E.N., J.N. Kraeuter and K.A. Ashton-Alcox. 2006. *How long does an oyster shell last on an oyster bed?* Estuar. Coast. Shelf Sci. 69: 531-541.
- Powell, E.N. Kraeuter, J. and Ashton-Alcox, K. 2007. Haskin Shellfish Research Laboratory, Report of the 2006 (9th) Stock Assessment Workshop for the New Jersey Delaware Bay Oyster Beds.
- Powell, E.N. Kraeuter, J. and Ashton-Alcox, K. 2008. Haskin Shellfish Research Laboratory, Report of the 2007 (10th) Stock Assessment Workshop for the New Jersey Delaware Bay Oyster Beds.
- USACE, 2005. *Delaware Bay Oyster Restoration Project, Delaware and New Jersey, Final Environmental Assessment*.
- USACE, 2006. *Delaware Bay Oyster Restoration Project, Delaware and New Jersey, Final Environmental Assessment*.
- Versar, Inc. 2001. Powell, E.N., F. Kelley, and R. Diaz. *Pre-construction oyster, water quality, and sediment monitoring study for the Delaware River Main Channel Deepening project*. Prepared for the U.S. Army Corps of Engineers, Philadelphia District.

8.0. EVALUATION OF 404(b)(1) GUIDELINES

I. Project Description

A. Location:

The project site is the Delaware Bay between Bombay Hook on the western side (Delaware), and to just below Artificial Island on the eastern side (New Jersey) to the mouth, a distance of about 50 miles. The proposed shell planting would take place on portions of the natural oyster beds of Delaware Bay in both the states of Delaware and New Jersey. The exact locations will be selected by the New Jersey Department of Environmental Protection (NJDEP) and the Delaware Department of Natural Resources and Environmental Control (DNREC) based on bottom surveys to be carried out at the inception of the project.

B. General Description:

The approach taken in the two states will differ somewhat to maximize use of local conditions. The objective is to plant approximately 287,000 bushels of clean surf clam and ocean quahog in areas approximately 25 acres in size, which is the recommended size because it encompasses a 0.2" latitude x 0.2" longitude rectangle, so the design facilitates navigation. This is the minimum size rectangle needed for vessel maneuverability during planting. It is also equivalent to the size of the sampling unit used in the New Jersey stock survey, thereby facilitating evaluation of project success in comparison to bay-wide oyster production.

C. Purpose

The proposed work is a continuation of the shell-planting project initiated in 2005. For the fourth consecutive year, shell planting will take place in portions of the natural oyster beds of Delaware Bay in the states of Delaware and New Jersey, as selected by the New Jersey Department of Environmental Protection (NJDEP) and Delaware's Department of Natural Resources and Environmental Control (DNREC) based on bottom surveys that occur annually. Approximately 286,000 bushels of shell were planted on several existing oyster bed locations within Delaware Bay in July 2005. In 2006, approximately 500,193 bushels of shell were planted. In addition to direct shell planting, previously planted shell with spat were transplanted upbay. In 2007, approximately 554,790 bushels of shell were planted. Post construction monitoring results from the 2007 program indicated extraordinary bay-wide recruitment rates (spat set in 2007 was the highest since 1999 bay-wide). As in previous years, new shell plants equaled or far exceeded the recruitment rates of native shell. Over the course of the three years of shell budget assessments in the bay, shell plantings have resulted in substantial reductions in shell losses (2005-2007) and has reduced the yearly deficit by at least two-thirds. The 2007 plant was the first time in eight years (since 1999) that New Jersey oyster beds were relatively in equilibrium. Older shell plants continue to attract recruitment, thus demonstrating the long-term biological benefit of the addition of shell beyond each one-year increment. The 2007 shell planting program contributed incalculably to maintaining the ecological services provided by the bay's oyster beds.

D. General Description of Dredged or Fill Material:

The proposed placement material is clean (processed) surf clam, ocean quahog and oyster shell. Oyster harvesters themselves were once required to replace a portion of the shell from oysters they harvested, but this practice was eliminated in 1979. Recently, very little clean shell has been replaced on the seed beds because the only source of funds has been the Oyster Resource Development Account. This account receives fees from oyster growers, but due to low harvests, rarely has sufficient funds for a significant planting. Local clam companies generate large quantities of ocean quahog and surf clam shells and these shells provide an adequate substitute for oyster shell, with surf clam being the preferred of the two. Hence, this project will also recycle a waste product into a useful commodity, thereby alleviating present storage and disposal issues.

E. Description of Placement Method:

Clean shell will be brought on site by barge or oyster boat and washed overboard with a high pressure hose. Suction vessels for possible upbay transplant.

II. Factual Determination

A. Physical Substrate Determinations:

1. Clean oyster shell and clean clam shell. Shell is “cured” by storing on land for a sufficient amount of time to insure that any associated shellfish meat or other biotic growth has decomposed prior to shell planting.
2. Other effects would include a temporary increase in suspended sediment load during the construction period. The substrate in the project area is large-grained (>20mm) nontoxic sand and projected turbidity increases are not anticipated to be high or of long duration.
3. Actions taken to minimize impacts include selection of clean, inert clam and oyster shell.

B. Water Circulation, Fluctuation and Salinity Determinations

1. Water. Consider effects on:

- a. Salinity - No effect.
- b. Water Chemistry - No significant effect.
- c. Clarity -Minor short-term increase in turbidity during construction.
- d. Color - No effect.
- e. Odor - No effect.
- f. Taste - No effect.
- g. Dissolved gas levels - No significant effect.
- h. Nutrients - Minor short-term effect
- i. Eutrophication - No effect.
- j. Others as appropriate - None
-

2. Current patterns and circulation

- a. Current patterns and flow - Circulation would not be significantly impacted by the proposed work as placement of shell will not significantly alter the existing bathymetry of the area.

- b. Velocity - No effect on tidal velocity and longshore current velocity regimes.
- c. Stratification – N/A. Thermal stratification typically does not occur within relatively shallow, well-mixed, high tidal energy areas of Delaware Bay. Some minor stratification in deeper areas during summer months.
- d. Hydrologic regime - The regime is estuarine. This would remain the case following construction of the proposed project.

3. Normal water level fluctuations – N/A

- 1 Salinity gradients - There would be no effect on the existing salinity gradients.
- 2 Actions that would be taken to minimize impacts - Utilization of clean, inert oyster and clam shell will minimize water chemistry impacts.

C. Suspended Particulate/Turbidity Determinations

1 Expected changes in suspended particulate and turbidity levels in the vicinity of the placement site - There would be a short-term, minimal elevation of suspended particulate concentrations during construction phases in the immediate vicinity of the work area.

2 Effects (degree and duration) on chemical and physical properties of the water column:

- a. Light penetration - Short-term, limited reductions would be expected at the shell placement sites due to construction activities in the water.
- b. Dissolved oxygen - There is a potential for a slight decrease in dissolved oxygen levels but the anticipated low levels of organics in the turbidity generated during construction should not generate a high, if any, oxygen demand.
- c. Toxic metals and organics - Because the fill material is essentially all clean, inert shell, no toxic metals or organics are anticipated.
- d. Pathogens - Pathogenic organisms are not present on clean, inert shell.
- e. Aesthetics - Construction activities associated with the fill site would result in a minor, short-term degradation of aesthetics.

3. Effects on Biota

- a. Primary production, photosynthesis - Minor, short-term effects related to turbidity.
- b. Suspension/filter feeders - Minor, short-term effects related to suspended particulates outside the immediate deposition zone. Sessile organisms typically present on existing oyster beds have evolved to withstand a limited level of suspended particulate matter. The project will result in an increased elevation of the existing oyster beds, thereby reducing siltation and/or suffocation of inhabitants.
- c. Sight feeders - Minor, short-term effects related to turbidity.

4. Actions taken to minimize impacts include selection of clean, inert oyster and clam shell. Standard construction practices would also be employed to minimize turbidity and erosion.

D. Contaminant Determinations

The discharge material (shell) is not expected to introduce, relocate, or increase contaminant levels at the placement site. This is assumed based on the characteristics of the materials, the

proximity of the placement site to sources of contamination, the area's hydrodynamic regime, and existing water quality.

E. Aquatic Ecosystem and Organism Determinations

1. Effects on plankton -The effects on plankton should be minor and mostly related to light level reduction due to turbidity. Significant dissolved oxygen level reductions are not anticipated.

Effects on benthos - There would be a minor disruption of the benthic community in the immediate placement area due to the addition of more shell to the existing shell bottom. The loss is offset by the expected rapid opportunistic recolonization from adjacent areas that would occur in the improved (elevated) shell bed habitat following cessation of construction activities and the importance of added shell in sustaining the habitat for the shell bed benthos. The new benthic community will be the same in composition due to the nature of the project (i.e. bottom habitat type will not change).

2. Effects on Nekton - Only a temporary displacement is expected as nekton would probably avoid the active work areas. Many fish species use oyster beds as a source of food and are directly dependent on the maintenance of shell surface area to support the food resources important to their needs. The proposed project will enhance habitat quality of the oyster beds by providing more available substrate.

3. Effects on Aquatic Food Web - Only a minor, short-term impact on the food web is anticipated. This impact would extend beyond the construction period until recolonization of the filled area has occurred. A positive impact on the food web is anticipated following the placement of additional shell on the shell beds to increase surface area of available substrate.

4. Effects on Special Aquatic Sites - No wetlands would be impacted by the project.

5. Threatened and Endangered Species - Several species of threatened and endangered sea turtles might be in the project area during the period of construction. Sea turtles may be present in the project area but it is unlikely that construction activities will have an adverse effect. Shortnose sturgeon, an endangered fish species within the purview of the National Marine Fisheries Service, migrates through the project area in the spring from the sea to spawn in the upper estuary. However, most fish are observed in the upper tidal freshwater areas of the estuary and are not expected to be impacted by the proposed project.

6. Other wildlife - The proposed plan would not adversely affect other wildlife. The proposed project is anticipated to provide a positive impact to habitat availability within existing natural oyster beds.

7. Actions to minimize impacts - Impacts to benthic resources will be minimal at the placement site considering the anticipated recolonization. No impacts to Federal and state threatened and endangered species are anticipated due to the short-term nature and location of the proposed project. The project area is not considered spawning habitat for winter flounder due to high velocity currents.

F. Proposed Placement Site Determinations

1. Mixing zone determination

- a. Depth of water - < 20 feet
- b. Current velocity – current velocities can exceed 100 cm/sec.
- c. Degree of turbulence – Moderate to high due to high velocity currents
- d. Stratification - None
- e. Discharge vessel speed and direction - Not applicable
- f. Rate of discharge – Not applicable
- g. Dredged material characteristics – Not applicable
- h. Number of discharge actions per unit time – Not applicable

2. Determination of compliance with applicable water quality standards - Prior to construction a Section 401 Water Quality Certificate and Federal consistency concurrence with the State of New Jersey's Coastal Zone Management Program will be obtained. Under a current agreement with the State of Delaware, a Section 401 Water Quality Certification is issued under General Permit #27 (Aquatic Habitat Restoration, Establishment, and Enhancement Activities). However, at the request of DNREC, a water quality certification application has been submitted. A Federal consistency determination with the Delaware Coastal Zone Management Program will be obtained.

3. Potential effects on human use characteristics

- a. Municipal and private water supply - No effect
- b. Recreational and commercial fisheries – Positive effect after construction as the project will directly increase habitat quality of the oyster beds and indirectly result in improved water quality in Delaware Bay.
- c. Water related recreation – No effect.
- d. Aesthetics - Short-term effect during construction.
- e. Parks, national and historic monuments, national seashores, wilderness areas, etc. – No effect.

G. Determination of Cumulative Effects on the Aquatic Ecosystem – Positive impacts are anticipated to oyster populations, benthic habitat quality, and water quality within the Delaware Bay.

H. Determination of Secondary Effects on the Aquatic Ecosystem – the proposed project offers positive impacts to the aquatic ecosystem present within Delaware Bay.

III. Finding of Compliance or Non-Compliance with the Restrictions on Discharge

- A. No significant adaptation of the Section 404(b)(1) Guidelines was made relative to this evaluation.
- B. The alternative measures considered for accomplishing the project are detailed in Section 3.0 of the document of which this 404(b)(1) analysis is part.
- C. A water quality certificate will be obtained from the New Jersey Department of Environmental Protection. A Nationwide General Permit applies to this project according to an agreement with the state of Delaware.
- D. The proposed project will not violate the Toxic Effluent Standards of Section 307 of the Clean Water Act.
- E. The proposed project is in compliance with the Endangered Species Act of 1973. Informal coordination procedures have been completed.
- F. The proposed project will not violate the protective measures for any Marine Sanctuaries designated by the Marine Protection, Research, and Sanctuaries Act of 1972.

- G. The proposed project will not result in significant adverse effects on human health and welfare, including municipal and private water supplies, recreation and commercial fishing, plankton, fish, shellfish, wildlife, and special aquatic sites. Significant adverse effects on life stages of aquatic life and other wildlife dependent on the aquatic ecosystem; aquatic ecosystem diversity, productivity, and stability; and recreational, aesthetic, and economic values will not occur.
- H. Appropriate steps to minimize potential adverse impacts of the project on aquatic systems include selection of clean, inert shell fill material.
- I. On the basis of the guidelines, the placement sites for the fill material is specified as complying with the requirements of these guidelines, with the inclusion of appropriate and practical conditions to minimize pollution or adverse effects on the aquatic ecosystem.

APPENDIX



REPLY TO
ATTENTION OF

DEPARTMENT OF THE ARMY
PHILADELPHIA DISTRICT, CORPS OF ENGINEERS
WANAMAKER BUILDING-100 PENN SQUARE EAST
PHILADELPHIA, PENNSYLVANIA 19107-3390

RECEIVED
APR 15 2008

HISTORIC PRESERVATION OFFICE

Environmental Resources Branch

New Jersey Historic Preservation Office
ATTN: Ms. Dorothy Guzzo, Administrator
New Jersey Department of Environmental Protection
CN 404
Trenton, New Jersey 08625

APR 10 2008
08-1173-1 DE
HP-D2008-170 Prod
ATTN B21622 CONLIN
please see 2nd page

Dear Ms. Guzzo:

Pursuant to Section 106 of the National Historic Preservation Act of 1966, as amended, we are requesting your review comments on the proposed "Delaware Bay Oyster Restoration Project, Delaware and New Jersey - draft Environmental Assessment", dated April 2008. This Environmental Assessment evaluates the potential environmental impacts of a proposal to continue a multi-year effort to provide habitat restoration to existing oyster beds within Delaware Bay in both the states of New Jersey and Delaware.

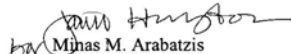
For the fourth consecutive year, shell planting is proposed to take place in portions of the natural oyster beds of Delaware Bay. Approximately 286,000 bushels of shell were planted on several existing oyster bed locations within Delaware Bay in 2005. Approximately 500,193 bushels were planted in 2006, and in 2007, approximately 554,790 bushels were planted. Post construction monitoring in 2007 indicated extraordinary bay-wide recruitment rates (spat set in 2007 was the highest since 1999 bay-wide). Over the course of the last three years of shell budget assessments in the bay, shell plantings have resulted in substantial reductions in shell losses and has reduced the yearly deficit by at least two-thirds. Last year's plant was the first time in eight years that New Jersey oyster beds were relatively in equilibrium. Older shell plants continue to attract recruitment of oysters and demonstrate the long-term biological benefit of the addition of shell beyond each one-year increment.

The USACE, Philadelphia District proposes to plant approximately 287,000 bushels of shell on existing oyster beds in the waters of Delaware and New Jersey in Delaware Bay in the summer of 2008 under the remaining available funds provided under the current authority of Section 1135 of the Water Resources Development Act of 1986. Both the states of Delaware and New Jersey are co-sponsors.

No response required.

The report is available to download from the Philadelphia District's webpage at: <http://www.nap.usace.army.mil/cenap-pa/news.htm>. There are no known shipwrecks or deeply buried prehistoric or historic archaeological deposits in the project area. Shallow archaeological deposits, if they ever existed, would likely have been removed by past oyster harvesting. Pursuant to 36 CFR 800.4 (d)(1) we request your concurrence by 2 June 2008 that there will be no adverse effects to significant cultural resources. If you have any questions regarding the Environmental Assessment, please contact Ms. Barbara Conlin of the Environmental Resources Branch at (215) 656-6557.

Sincerely,


Minas M. Arabatzis
Chief, Planning Division

As proposed, the project will not adversely affect historic properties. Pursuant to 800.5(c), if no consulting parties object to this finding within the 30 day review period, the project may proceed, as proposed, unless resources are discovered during project implementation, pursuant to 800.139 NP


Date 4-24-2008

Deputy State Historic Preservation Officer

TERRY KARSCHNER

No response required.



STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES & ENVIRONMENTAL CONTROL
DIVISION OF SOIL AND WATER CONSERVATION
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

DELAWARE COASTAL
MANAGEMENT PROGRAM

TELEPHONE: (302) 739-9283
FAX: (302) 739-2048

April 25, 2008

Minas M. Arabatzis
Philadelphia District, Corps of Engineers
Wanamaker Building, 100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

**RE: Delaware Coastal Zone Federal Consistency Modification Request
Delaware Bay Oyster Restoration Project (FC 07.078)**

Dear Mr. Arabatzis:

The Delaware Coastal Management Program (DCMP) concurred with your consistency determination request for the above referenced project in a letter dated May 30, 2007. The approval was granted for the multi-year project as described in the "Delaware Bay Oyster Restoration Project, Delaware and New Jersey- Draft Environmental Assessment 2007." As the project proposed for summer 2008 is consistent with the multi-year proposal which has already been approved, additional review from this office is not necessary.

This concurrence remains conditioned upon the issuance of a 401 Water Quality Certification from the Division of Water Resources and adherence to the restrictions and/or conditions placed on any and all permits issued to you for this project.

If you have any questions please do not hesitate to contact me or Tricia Arndt at (302) 739-9283.

Sincerely,


Sarah W. Cooksey, Administrator
Delaware Coastal Management Program

SWC/ika
cc: File 07.078
Barbara Conlin-USACE
Roy Miller-DFW

No response required.

State of Delaware
Historical and Cultural Affairs

21 The Green
Dover, DE 19901-3611

Phone: (302) 736.7400

Fax: (302) 739.5660

Review Code: 2008.04.14.01

May 1, 2008

Mr. Minas M. Arabatzis
Chief, Planning Division
US Army Corps of Engineers
Philadelphia District
100 Penn Square East
Philadelphia, PA 19107-3390

Project: Delaware Bay Oyster Restoration, 2008

Dear Mr. Arabatzis:

The staff of the State Historic Preservation Office has reviewed the materials submitted regarding the above cited project. Based on this review, we have made the determination that no historic properties, eligible for or listed in the National Register of Historic Places, will be affected by this project.

Sincerely,



Craig Lukaczic

Archaeologist, Division of Historical and Cultural Affairs

cc: Stephen Marz, Deputy Director, Division of Historical and Cultural Affairs



No response required.



In Reply Refer To:
08-FA0165a

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Jersey Field Office
Ecological Services
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609/646 9310
Fax: 609/646 0352
<http://www.fws.gov/northeast/njfieldoffice>



MAY 08 2008

Mr. Minas M. Arabatzis
Chief, Planning Division
U.S. Army Corps of Engineers, Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Subject: Review of Final Environmental Assessment, Delaware Bay Oyster Restoration Project, Delaware and New Jersey

Dear Mr. Arabatzis:

The U.S. Fish and Wildlife Service, (Service) New Jersey Field Office (NJFO), has reviewed the U.S. Army Corps of Engineers, Philadelphia District (Corps), *Final Environmental Assessment, Delaware Bay Oyster Restoration Project, Delaware and New Jersey* (Final EA) as requested in your April 10, 2008, letter. The following comments are provided pursuant to the National Environmental Policy Act (83 Stat. 852; 46 U.S.C. 4321 *et seq.*). The Service provided comments dated May 3, 2007 on the Corps' Draft EA [our control number 07-FA0165 (enclosed)]. The Service is supportive of the overall project; however, we provided several recommendations for the project in our comment letter. This letter was not included in the Final EA that was made available online.

The following Service recommendations do not appear to have been addressed in the Corps' administrative record and are not addressed in the Final EA:

1. Collect baseline data prior to and after any shell placement to determine the effect, if any, on horseshoe crabs (*Limulus polyphemus*).
2. Consider developing a reliable amount of local oyster hatchery seed for improving oyster (*Crassostrea virginica*) recruitment in Delaware Bay.

In July 2008 we will initiate our fourth year of the Delaware Bay Oyster Restoration project. As construction practices varied yearly, a draft and final EA were released annually. Due to differences in shell quantities, type, placement locations, techniques, and monitoring efforts proposed each year, draft and final EAs addressing each year's efforts were released for review and comment annually. The Service's 8 May 2008 comment letter references review of a "Final EA", however, the EA released for review and comment on 30 March 2008 was a *Draft EA* for the oyster restoration work proposed for the upcoming July 2008 season. Procedurally, we release our National Environmental Policy Act (NEPA) documents as drafts for review and comment by the natural resource agencies and the public, and post the Final EA on our website. The Final report includes all comment letters received during the comment period and our accompanying responses. Comments received typically result in some modifications to the draft report and are documented in the Final report.

The Service's 8 May 2008 comment letter references comments made in a previous comment letter for the preceding year (dated 3 May 2007) and states that the Service's recommendations "*do not appear to have been addressed in the Corps' administrative record and are not addressed in the Final EA*". The Service's 3 May 2007 comment letter was published in Appendix C of the June 2007 Final EA, with all other agency comment letters received, along with our responses, and can be viewed on our website <http://www.nap.usace.army.mil/cenap-pa/news.htm>. This link was provided in our 30 March 2008 letter to your office requesting review and comment on this year's proposed work. The Final EA (June 2007) from the preceding year, as well as the Draft EA for the current proposed effort (April 2008) are both posted on this website. Attached is a copy of your review comment letter dated 3 May 2007 and our responses to your comment from the previous year.

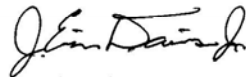
3. Consider a short-term restriction on commercial fishing in the restoration areas until the results of the proposed project are known.
4. Consider the risk of spreading diseases by transplanting seed from leased grounds and marginal areas into high-survival upbay natural oyster beds.

The Service encourages the Corps to incorporate the aforementioned recommendations into the project plan. Moreover, we encourage the Corps to include a discussion of the following issues in any future EA to continue or expand the project:

1. Discuss potential adverse effects on horseshoe crabs and red knots (*Calidris canutus rufa*) in the cumulative effects section of any future EA.
2. Discuss the role contaminants, particularly dioxin and related compounds, play on the recruitment of the eastern oyster in Delaware Bay.

Thank you for the opportunity to further comment on the subject Final EA. Please contact Mr. Carlo Popolizio of my staff at (609) 383-3938, extension 32, if you have any question or require further assistance.

Sincerely,



J. Eric Davis Jr.
Supervisor

Enclosure

See Attached letter dated 3 May 2007 and responses.



In Reply Refer To:
07-FA0165

United States Department of the Interior

FISH AND WILDLIFE SERVICE

New Jersey Field Office
Ecological Services
927 North Main Street, Building D
Pleasantville, New Jersey 08232
Tel: 609/646 9310
Fax: 609/646 0352
<http://www.fws.gov/northeast/njfieldoffice>



MAY 03 2007

Mr. Minas M. Arabatzis
Chief, Planning Division
U.S. Army Corps of Engineers, Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3390

Subject: Review of Draft Environmental Assessment, Delaware Bay Oyster Restoration Project, Delaware and New Jersey

Dear Mr. Arabatzis:

The U.S. Fish and Wildlife Service, (Service) New Jersey Field Office (NJFO), has reviewed the U.S. Army Corps of Engineers, Philadelphia District (Corps), *Draft Environmental Assessment, Delaware Bay Oyster Restoration Project, Delaware and New Jersey* (Draft EA) to: (1) determine if a federally listed endangered and threatened species would be adversely affected by the proposed action; and (2) provide comments on the proposed action as requested in your March 30, 2007, letter. The Service provided comments dated June 22, 2005 for the Corps' bed shell planting (our control number FP-05/15) and appreciates the opportunity to provide further comments on this worthwhile project.

AUTHORITY

The following comments on the proposed activity have been prepared under the authority of the Fish and Wildlife Coordination Act (FWCA) (48 Stat. 401; 16 U.S.C. 661 *et seq.*) the Endangered Species Act of 1973 (87 Stat. 884, as amended; 16 U.S.C. 1531 *et seq.*) (ESA), the Migratory Bird Treaty Act (MBTA) (40 Stat. 755 as amended; 16 U.S.C. 703-712), the National Environmental Policy Act (83 Stat. 852; 42 U.S.C. 4321 *et seq.*) (NEPA), and are consistent with the intent of the Service's Mitigation Policy (Federal Register, Vol. 46, No. 15, Jan. 23, 1981). These comments do not preclude further comment pursuant to NEPA on any future documents.

No response required.

FEDERALLY LISTED SPECIES

The Service concurs with the Corps' determination that the proposed project is not likely to adversely affect federally listed threatened or endangered species under Service jurisdiction.

Except for an occasional transient bald eagle (*Haliaeetus leucocephalus*), no other federally listed or proposed threatened or endangered species under Service jurisdiction are known to occur within the project area. The Service requires no further consultation pursuant to Section 7 (a)(2) of the ESA. If project plans change or new information on federally listed threatened or endangered species becomes available, this determination may be reconsidered.

This determination relates to federally listed or proposed threatened or endangered flora and fauna under Service jurisdiction only. The proposed project is located in the Delaware Bay/River and may affect the federally listed (endangered) shortnose sturgeon (*Acipenser brevirostrum*), Atlantic Ridley turtle (*Lepidochelys kempii*), and leatherback turtle (*Dermochelys coriacea*), and the federally listed (threatened) loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*) within the project area. Principal responsibility for threatened and endangered marine species is vested with the National Marine Fisheries Service (NMFS). We recommend that the Corps initiate Section 7 consultation with the NMFS to ensure that this project does not affect a listed species under the purview of the NMFS.

SERVICE COMMENTS

Horseshoe Crabs

The Delaware Bay sustains the largest concentration of horseshoe crabs (*Limulus polyphemus*) in the world. The Delaware Bay horseshoe crab (*Limulus polyphemus*) population is in decline, due in part to habitat loss. Horseshoe crabs spawn from April to July within the intertidal zone of sandy beaches. Horseshoe crab eggs are a favorite food for many migratory birds, including the red knot (*Calidris canutus rufa*), which the Service has designated as a candidate species for listing pursuant to the ESA. The declining population of the horseshoe crab in the Delaware Bay may be contributing to the declining population of the red knot. Therefore, the Service recommends collecting baseline data prior to and after any shell placement to determine the effect, if any, on horseshoe crabs that may utilize the project area to avoid any additional cumulative impacts on the aforementioned species. The Final EA section on cumulative effects should include a discussion on potential adverse impacts to the horseshoe crab and the red knot.

Project Purpose and Need

In accordance with 40 CFR Part 1502.13, we recommend that the Corps clearly specify in the Final EA the stated purpose and need of the proposed project.

Horseshoe crab habitat consists of sandy or muddy substrate and horseshoe crabs are infrequently caught on oyster reefs. Adding shell to pre-existing natural oyster beds will not impact horseshoe crab habitat. Additionally, shell planting does not occur during the horseshoe crab spawning season (nor the migratory season of the red knots) or the horseshoe crab offshore overwintering season.

The stated purpose and need of the protect is presented in the FONSI, Section 1.0 Introduction and Authority, Section 2.0 Needs and Objectives, and Section 5.0 Environmental Effects.

Parasitism and Health

The Draft EA does not include a discussion of the potential effects of contaminants and their relationship to oyster recruitment in the Delaware Bay area. Wintermyer and Cooper (2003) documented adverse effects from very low parts per trillion of dioxin and related compounds to gonadal and embryonic development and egg fertilization for the eastern oyster in Newark Bay and the Raritan Complex in New Jersey. The Service recommends expanding the Final EA to discuss any role contaminants may play on the recruitment of the eastern oyster in Delaware Bay.

This discussion should include the increased susceptibility of the oyster to MSX/Dermo pathogens when exposed to low levels of dioxin and related compounds.

Alternatives

The Corps' proposed alternatives for the subject project are:

- (a) No action;
- (b) Hatchery Seed; and
- (c) Selected Plan (preferred alternative).

The Service has reviewed the alternatives and provides the following comments:

Alternative a: The Service concurs that the No-Action alternative would fail to address the goals of the project.

Alternative b: The Service agrees that the use of hatchery seed is insufficient to meet the goals of the project. However, the use of available hatchery seed should still be encouraged to supplement existing natural sets that occur in the bay. We recommend a multifaceted approach in the recovery of the oyster rather than the pursuit of a single alternative. By implementing a combination of alternatives b and c, the Corps could increase the potential for improving oyster recruitment in the Delaware Bay and developing reliable amounts of local hatchery seed. We recommend that the Corps consider the combination of alternatives b and c as a fourth alternative to the project.

Alternative c: The Service recommends including additional project features in the preferred alternative.

First, we recommend that the Final EA include description of a proposed multifaceted education and outreach program in conjunction with the proposed restoration project. The Final EA should include the use of milestones to ensure success of this important project feature.

Second, the Draft EA does not include a discussion regarding the use of the shell planting or recruitment areas by commercial fishing. Should commercial fishing be allowed in the project area, underwater disturbances by mechanical fishing gear

Numerous chemical contaminant analyses have been conducted in Delaware Bay. Contaminant levels are low in Delaware Bay (refer to NOAA Status and Trends database-Delaware Bay sites).

Oyster diseases are a function of temperature and salinity and not a function of contamination. Dermo disease has increased due to warming water temperatures. MSX no longer poses a significant influence on Delaware Bay oyster population dynamics (E. Powell, pers. comm. May 2007).

Use of hatchery seed as an alternative plan was considered and discussed in Section 3.0 Alternatives. Reasons for the elimination of this alternative are discussed in Section 3.2. Cost is prohibitive in comparison to consistency of spat capture on shell. Downbay planting and upbay transplanting places more seed into the bay than could be added by hatchery input. As mentioned in Section 3.2: present NJ and DE hatchery capacity is fully used.

The public outreach component of the project is described in Section 1.0. Introduction; subsection 1.1. An additional statement has been added to Section 3.3 (Selected Plan) to reiterate.

The milestones accomplished are fully presented in the annual monitoring program report (a separate document released in March) .

will likely occur and possibly skew future post-monitoring efforts. We recommend that the Final EA include an evaluation of a short-term restriction on commercial fishing in the planting and recruitment areas until the results of the proposed project are known. Allowing the project area to be mechanically harvested would diminish the potential restoration values associated with this project.

Finally, we recommend that the Corps consider the risk of spreading diseases by transplanting seed from leased grounds and marginal areas into high-survival upbay natural oyster beds.

CONCLUSIONS AND SUMMARY OF SERVICE RECOMMENDATIONS

The Service appreciates the opportunity to comment on the Draft EA. The following recommendations are provided for incorporation into the Corps' administrative record and Final EA.

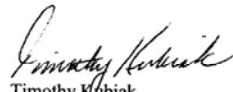
1. Initiate Section 7 consultation with the NMFS to ensure that this project does not affect a listed species under the NMFS purview.
2. Collect baseline data prior to and after any shell placement to determine the effect, if any, on horseshoe crabs.
3. Discuss potential adverse effects on horseshoe crabs and red knots in the cumulative effects section of the Final EA.
4. Confirm in the Final EA a stated project purpose and need in accordance with 40 CFR Part 1502.13.
5. Discuss the role contaminants, particularly dioxin and related compounds, play on the recruitment of the eastern oyster in Delaware Bay.
6. Consider developing a reliable amount of local oyster hatchery seed for improving oyster recruitment in Delaware Bay.
7. Consider the combination of alternatives b and c as a fourth alternative to the project.
8. Incorporate a multi-faceted education and outreach program in conjunction with the proposed restoration project.
9. Consider a short-term restriction on commercial fishing in the restoration areas until the results of the proposed project are known.
10. Consider the risk of spreading diseases by transplanting seed from leased grounds and marginal areas into high-survival upbay natural oyster beds.

The oyster industry is a carefully managed fishery and incorporates a significant assessment infrastructure with an annual stock assessment, stock survey, and shellfisheries-disease models to predict yearly harvest of adults (refer to Section 2.0). The management program in place includes a total allowable catch based on biological reference points that assure expansion of the population in 75% of all years, unless increased harvest demand is deemed desirable to improve population dynamics. Fishing activities do not pose a substantive influence on spat or juvenile oyster survival. Fishing mortality rate on these beds is <10% of the natural mortality rate.

Oyster diseases are spread by water-borne transport. Movement of oysters by man is inconsequential in the spread of MSX or Dermo (E. Powell, Haskin Shellfish Research Lab, pers. comm.).

Thank you for the opportunity to comment on the subject draft report. Please contact Mr. Carlo Popolizio of my staff at (609) 383-3938, extension 32, if you have any question or require further assistance.

Sincerely,



Timothy Kubiak
Acting Supervisor

REFERENCE

Wintermyer, M.L. and K.R. Cooper. 2003. Dioxin/furan and polychlorinated biphenyl concentration in eastern oyster (*Crassostrea virginica* Gmelin) tissues and the effects on egg fertilization and development. 22(3) 737-746.

No Response Required.



UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION 2
290 BROADWAY
NEW YORK, NY 10007-1866

MAY 14 2008

Minas M. Arabatzis, Chief
Planning Division
U.S. Army Corps of Engineers
Philadelphia District
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

Dear Mr. Arabatzis:

The Environmental Protection Agency (EPA) has reviewed the draft environmental assessment and finding of no significant impact (EA/FONSI) for the Delaware Bay Oyster Restoration Project, Delaware and New Jersey.

The proposed project would continue the planting of approximately 287,000 bushels of shell on existing oyster beds in the waters of Delaware and New Jersey in the Delaware Bay for a fourth consecutive year. The specific locations will be selected by the New Jersey Department of Environmental Protection and Delaware's Department of Natural Resources and Environmental Control based on bottom surveys that are carried out annually. The planted shell has enhanced the recruitment of juvenile oysters, and increased oyster habitat. The project is also supported by the Delaware National Estuary Program, of which the Environmental Protection Agency is a stakeholder.

Based on the information in the draft EA/FONSI, we believe that implementation of the selected plan will result in beneficial environmental impacts.

Thank you for the opportunity to review this document. Should you have any questions concerning our comments, please contact Lingard Knutson, of my staff, at (212) 637-3747.

Sincerely yours,

A handwritten signature in black ink, appearing to read "Grace Musumeci".

Grace Musumeci, Chief
Environmental Review Section
Strategic Planning and Multi-Media Programs Branch

cc: I. Purdy, DEPP-CEPB

No response required.



UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE

Habitat Conservation Division
James J. Howard Marine
Sciences Laboratory
74 Magruder Road
Highlands, NJ 07732

May 21, 2008

Minas M. Arabatzis, Chief
Planning Division
Philadelphia District
U.S. Army Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, PA 19107-3390

ATTN: Barbara Conlin, Project Biologist
RE: Delaware Bay Oyster Restoration Project, Delaware and New Jersey – draft environmental assessment

Dear Mr. Arabatzis:

NOAA's National Marine Fisheries Service (NMFS), Northeast Region, Habitat Conservation Division has received the draft environmental assessment (DEA) for the Delaware Bay Oyster Restoration Project dated April, 2008. The DEA evaluates the potential environmental impacts of a proposal to continue a shell planting program initiated in 2005. For the fourth consecutive year, shell planting is proposed to take place in portions of natural oyster beds in Delaware Bay. This year, the Philadelphia District proposes to plant approximately 287,000 bushels of surf clam and ocean quahog shell on existing oyster beds in Delaware and New Jersey waters during the summer of 2008. Both the states of Delaware and New Jersey are co-sponsors of the project.

We have reviewed the DEA and the EFH assessment provided to us for this project. We agree that negative impacts to resources of concern to us including essential fish habitat will be minor and temporary. We have no EFH conservation recommendations to offer. The oyster restoration project will have an overall positive effect on the fishery resources of Delaware Bay. Native oysters (*Crassostrea virginica*) are ecologically important species. We support the District and the states' efforts to restore them in Delaware Bay, as well as continued funding for this important task. We commend the District and the Oyster Revitalization Task Force's for their efforts.

If you have any questions regarding this matter, please contact Karen Greene at 732 872-3023.

Sincerely,


Stanley W. Gorski
Field Offices Supervisor



No response required.



STATE OF DELAWARE
DEPARTMENT OF NATURAL RESOURCES &
ENVIRONMENTAL CONTROL
DIVISION OF WATER RESOURCES
89 KINGS HIGHWAY
DOVER, DELAWARE 19901

WETLANDS & SUBAQUEOUS
LANDS SECTION

TELEPHONE (302) 739-9943
FACSIMILE (302) 739-6304

Ms. Barbara Conlin
U.S. Army Corps of Engineers
100 Penn Square East
Philadelphia, PA 19107

MAY 23 2008

Dear Ms. Conlin:

Enclosed is the Subaqueous Lands Permit granted by the State of Delaware. Please read carefully all the Special and General Conditions contained within this Permit. The permittee and contractor are responsible to ensure that all conditions of the Permit are strictly observed.

Also enclosed are copies of the **Contractor's Post-Construction Completion Report**. This report must be completed and returned within ten days of the completion of the project. Please review all instructions and forms.

If you have any questions, please feel free to contact this office.

Sincerely,

A handwritten signature in cursive script, appearing to read "Laura M. Herr".

Laura M. Herr
Section Manager
Wetlands & Subaqueous
Lands Section

Enclosures

The Post-Construction Report will be submitted.



STATE OF DELAWARE
 DEPARTMENT OF NATURAL RESOURCES &
 ENVIRONMENTAL CONTROL
 DIVISION OF WATER RESOURCES
 89 KINGS HIGHWAY
 DOVER, DELAWARE 19901

WETLANDS & SUBAQUEOUS
 LAND SECTION

TELEPHONE (302) 739-6943
 FACSIMILE (302) 739-6304

Subaqueous Lands Permit: SP-156/08
 Date of Issuance: 5/23/2008
 Construction Expiration Date: 5/23/2011

**SUBAQUEOUS LANDS PERMIT
 GRANTED TO THE U.S. ARMY CORPS OF ENGINEERS
 TO PLACE A TOTAL OF 287,000 BUSHELS OF SHELLS
 ON EXISTING NATURAL OYSTER BEDS
 IN THE DELAWARE BAY ADJACENT TO
 NEW CASTLE AND KENT COUNTIES, DELAWARE**

Ms. Barbara Conlin
 U.S. Army Corps of Engineers
 100 Penn Square East
 Philadelphia, PA 19107

Pursuant to the provisions of 7 Del. C. 7203, and the Department's Regulations Governing the Use of Subaqueous Lands, permission is hereby granted on this 23rd day of May A.D. 2008, to construct the above-referenced project in accordance with the approved plans for the Permit (1 Sheet), as approved on May 22, 2008, and the application dated April 9, 2008 and received by this Division on April 10, 2008.

WHEREAS, pursuant to the provisions of 7 Del. C. 7203, the Secretary of the Department of Natural Resources and Environmental Control through his duly authorized representative finds that it is not contrary to the public interest if this project is approved subject to the terms and conditions herein set forth.

This Permit is issued subject to the following conditions:

No response required.

Delaware's good nature depends on you!

SPECIAL CONDITIONS

1. The conditions contained herein shall be incorporated into any and all construction contracts and other ancillary documents associated with earth disturbance and any other activities directly or indirectly associated with construction which may impact subaqueous lands associated with this project. The permittee and contractor are responsible to ensure that the workers executing the activities authorized by this Permit have full knowledge of, and abide by, the terms and conditions of this Permit.
2. Construction shall be conducted so as not to violate the State of Delaware Department of Natural Resources and Environmental Control's "Surface Water Quality Standards," as amended July 2004.
3. All planted shell shall be clean and disease free.
4. The shells placed in Delaware shall be in locations identified by Delaware shellfish managers.
5. No wetland impacts or impacts to submerged aquatic vegetation are authorized by this Permit.
6. There shall be no stockpiling of materials or equipment in wetlands.
7. This work shall be completed for the purpose of improving oyster habitat in the Delaware Bay.
8. A copy of this Permit must be available on-site during all phases of construction activity.

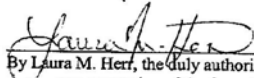
GENERAL CONDITIONS

1. The project is to be undertaken in accordance with the plans submitted and attached hereto. Any activities not specifically authorized herein may require a supplemental approval from this office prior to the initiation of construction. A determination on the need for a supplemental approval will be made by this office pursuant to the permittee submitting written notification and revised plans indicating project changes to this office.
2. Representatives of the Department of Natural Resources and Environmental Control may inspect such work during any phase of the construction and may collect any samples or conduct any tests that are deemed necessary.
3. This Permit does not cover the structural stability of the project units.
4. Any actions, operations or installations which are considered by the Department to be contrary to the best interests of the public shall constitute reason for the discontinuance and/or removal of said action, operation or installation.

All conditions will be met.

5. The issuance of this Permit does not imply approval of any other part, phase, or portion of any overall project the permittee may be contemplating.
6. This Permit is subject to the terms and conditions contained in any easement, license or lease that may have been granted by the State or any political subdivision, board, commission or agency of the State in the vicinity of the project.
7. This Permit is granted for the purposes stated herein. Any other use without prior approval shall constitute reason for this Permit being revoked.
8. This Permit shall expire if the project has not been completed within three (3) years from the date of issuance.
9. If the permittee considers three (3) years insufficient for completion of the project, the permittee may submit a project time schedule for consideration by the Department. If the time schedule is approved it shall be attached hereto and made a part hereof.
10. The permittee shall notify the Department of Natural Resources and Environmental Control within ten (10) days of the date work will be commenced.
11. This Permit is personal and may not be transferred without the prior written consent of the Department. Prior to the transfer of the adjacent upland property, the permittee shall obtain the written consent of the Department to transfer this Permit to the new upland property owner. Failure to obtain such written consent may result in the revocation of this Permit and the removal of all structures authorized by this Permit at the expense of the permittee.
12. The permittee shall at all times comply with all applicable laws and regulations of the Department of Natural Resources and Environmental Control.
13. The issuance of this Permit does not constitute approval for any of the activities as may be required by any other local, state or federal governmental agency.
14. This Permit may be revoked upon violation of any of the above conditions.

IN WITNESS WHEREOF, I, Laura M. Herr, the duly authorized representative of John A. Hughes, Secretary, Department of Natural Resources and Environmental Control, have hereunto set my hand this 23rd day of May, 2008.


By Laura M. Herr, the duly authorized
representative of the Secretary of the
Department of Natural Resources and
Environmental Control

All conditions will be met.

U.S.L.S.
APPROVED PLANS

REPORT # 9-1561d
DATE 5/22/07
(SEE PERMIT # 0000100)

Figure 2.1. Map of Delaware Bay showing the locations of oyster beds.



No response required.

initiative based on the OIRTF. The primary goal was to enhance recruitment by enhancing natural seed supply through the planting of shell (cultch) to provide habitat for recruitment of juvenile oysters (spat). This will increase oyster habitat, expand oyster abundance, and revitalize the natural resource with concomitant improvements in Bay habitat quality from increased habitat complexity brought about by shell planting as well as increased water clarity brought about by the increased filtration by an abundant shellfish resource.

No response required.



**DEPARTMENT OF NATURAL RESOURCES
AND
ENVIRONMENTAL CONTROL**

NOTICE OF AUTHORIZATION

Permit/License No. and Description: SP-156/08 To place a total of 287,000 bushels of shells on existing natural oyster beds in The Delaware Bay adjacent to New Castle and Kent Counties, Delaware

Issued to: U.S. Army Corps of Engineers

Location of Work: Same as above

Date of Expiration: 05/23/2011

**DISPLAY THIS CERTIFICATE IN A
HIGHLY VISIBLE LOCATION ON THE JOB SITE.**

Laura M. Herr, Program Manager
Wetlands & Subaqueous Lands Section



State of New Jersey

DEPARTMENT OF ENVIRONMENTAL PROTECTION
Division of Land Use Regulation
P.O. Box 439, Trenton, NJ 08625-0439
Fax # (609) 292-8115
Fax # (609) 777-3656
www.state.nj.us/landuse

JON S. CORZINE
Governor

LISA P. JACKSON
Commissioner

JUN 02 2008

Minas M. Arabatzis
Chief, Planning Division
Department of the Army
Philadelphia District, Corps of Engineers
Wanamaker Building
100 Penn Square East
Philadelphia, Pennsylvania 19107-3391

RE: Federal Consistency Determination and Section 401 Water Quality Certification for
Delaware Bay Oyster Restoration Project, Delaware And New Jersey
Division File No. 0000-05-0017.1 CDT 080001

Dear Mr. Arabatzis:

The New Jersey Department of Environmental Protection, Division of Land Use Regulation, acting under Section 307 of the Federal Coastal Zone Management Act (P.L. 92-583) as amended, has determined that the proposed project is consistent with New Jersey's Coastal Zone Management Rules at N.J.A.C. 7:7E-1.1 et. seq., and the applicable Rules guiding issuance of a Section 401 Water Quality Certificate.

The proposed project is continuation of a project to implement a resource revitalization program within the Delaware Bay and will take place in portions of the natural oyster beds of Delaware Bay in the states of Delaware and New Jersey. The objective is to plant approximately 287,000 bushels of shell on existing oyster beds in the waters of Delaware and New Jersey in Delaware Bay in the summer of 2008 under the remaining available funds provided under the current authority of Section 1135 of the Water Resources Development Act of 1986. Both the states of Delaware and New Jersey are co-sponsors.

Should you have any questions or wish to discuss this matter further, please do not hesitate to contact Eric M. Virostek at the above address or at 609-984-0288.

Sincerely,

Richard Langbein, Manager
Bureau of Coastal Regulation

c. Paul Scarlett, DFW
Kim Springer, Planning

No response required.