Restoration Database


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Filters (1 selected)

Ecosystem Functional Groups / Biomes

Regions

Countries

Keyword

North Cape Shellfish Restoration, Block Island Sound

Project Filters

Degradations

Restoration activities implemented

STAPER Filters What is STAPER? ()

Assessment of opportunities for ecosystem restoration

Improving the institutional enabling environment for ecosystem restoration

Planning and implementation of ecosystem restoration activities

Monitoring, evaluation, feedback, and disseminating results

Currently selected: Keyword: North Cape Shellfish Restoration, Block Island Sound ×

Projects (1) | Resources (0) | Institutional Members (0) | Academic Programs (0)

Showing 1 to 1 of 1 matching projects

USA: Rhode Island: North Cape Shellfish Restoration, Block Island Sound

In 1996, the tank barge North Cape and the tugboat Sandia grounded off the coast of Rhode Island; Credit: NOAA

Volunteers created hundreds of shell bags for oyster larvae s construction; Credit: NOAA

Overview

In January of 1996 the tank barge, North Cape, struck ground off the coast of Rhode Island spilling approximately 828,000 gallons of No. 2 heating oil into Block Island Sound. The results of over 30 studies of potential resource injuries caused by the spill were reviewed and a variety of experts in relevant scientific and technical disciplines were consulted. Based on this work, it is believed that the spill caused significant injuries to biota in the offshore and salt pond environments and to a variety of birds. Under the natural resource damage assessment provisions of the Oil Pollution Act, a trustee council, made up of representatives of Rhode Island Department of Environmental Management (RIDEM), U.S. Fish and Wildlife Service (FWS), and National Oceanic and Atmospheric Administration (NOAA), was established to review, select, and oversee implementation of restoration actions for natural resources injured by the spill. A comprehensive restoration plan was developed and projects were implemented for American lobster, piping plover, common loon, and sea ducks. Projects were also implemented to restore alewife runs in the salt pond watersheds as compensation for lost recreational fishing opportunities, and open space lands have been protected to compensate for losses to other marine and salt pond organisms. This particular case study focuses on the shellfish restoration project which was an effort to restore quahog, bay scallop and oyster populations in the coastal Rhode Island salt ponds following injuries caused by the North Cape oil spill. Approximately 1.0 million kilograms of bivalve biomass were lost (direct mortality plus production foregone). The majority of the injury was to surf clams, (Spisula solidissma), of which 19.4 million animals were killed, resulting in a loss of 970,400 kilograms biomass. The goal of the restoration was to fully address the impacts to shellfish by returning injured natural resources to their pre-spill (baseline) conditions as well as compensate for interim losses of the shellfish resources. This was attempted by replacing the quantity of biomass (direct mortality plus forgone production) lost due to the spill. This replacement biomass is measured as the wet tissue weight of animals added to the system (stocked) plus weight added by the growth of stocked shellfish. Aspects of the restoration included quahog rescue from the Providence River Federal Navigation Channel dredge area, stock enhancement and restoration of quahogs, bay scallops and oysters through nursery, spat collection, spawning sanctuaries, and reseeding projects. Results from the research studies and monitoring have aided in developing effective methods for restoration and management of shellfish species. Cost effective methods of rearing shellfish have been developed, factors affecting survival (seed size, stocking density, available habitat, disease, etc) have been identified, the importance and value of monitoring has been demonstrated, and community interest and awareness of Rhode Island's premier shellfish industry has been fostered by recruiting citizens to be actively involved in the restoration. The knowledge gained through these restoration activities will aid in the future management of shellfish so that they continue to provide ecological services to the Rhode Island salt ponds and Narragansett Bay.

Project Details

Lead entity types:

- Governmental Body

Adaptive management

Describe adaptive management processes and mid-course corrections taken to address unforeseen challenges and improve outcomes in each of the following categories:

Other:

The importance and value of monitoring was demonstrated in this restoration. Monitoring data was analyzed and the strategies employed were adjusted to keep the restoration heading along the desired ecological trajectory. Broadcast seeding was determined to be an ineffective method of restoration, and nursery, grow-out, spat collection and spawning sanctuary techniques were developed and improved for the three shellfish species being restored or enhanced. Experiments conducted have furthered the knowledge of habitat requirements and environmental conditions that may impact shellfish. Results from the experiments and monitoring have aided in developing effective methods for restoration and management of these species so that they continue to provide ecological services to the Rhode Island salt ponds and Narragansett Bay.

State of Progress:

- Implementation

Project Start:

2002-08-25

Project End:

2011-08-25

Total budgeted expenses:

- USD 1-2 million

Project motivation:

- Economic or social crisis (e.g., agricultural failure, overfishing, land abandonment, COVID-19)

Global Regions:

- Americas
- Northern America
- World

Countries:

- United States of America

Ecosystem Functional Groups / Biomes:

- Marine shelf biome

Extent of project:

- Other

Extent of restoration:

- Other

Degradations:

- Contamination (biological, chemical, physical or radiological)

Description:

On January 19, 1996, during a severe winter storm, the tank barge North Cape, carrying 94,000 barrels (3.9 million gallons) of two blends of No. 2 home heating oil, struck ground off Moonstone Beach in South Kingstown, Rhode Island and began to leak oil into the surrounding water. Winds reaching 50 knots formed large, breaking waves that dispersed the oil throughout the water column and into contact with bottom sediments resulting in high concentrations of toxic components (i.e. polycyclic aromatic hydrocarbons, PAHs) in the shallow waters near shore (French McCay 2003). A second winter storm five days later brought the oil, which had been dissipating, back into the sensitive intertidal zone, resulting in substantial mortality of marine organisms (Gibson et al. 1997). In total, an estimated 828,000 gallons of the fuel oil were released into the coastal and offshore environments before the North Cape was refloated and moved to Newport, Rhode Island on Friday, January 26, one week after grounding. The trustees reviewed the results of over 30 studies of potential resource injuries cause by the spill and consulted with a variety of experts in relevant scientific and technical disciplines. Based on this work, the trustees believed that the spill caused significant injuries to biota in the offshore and salt pond environments and to a variety of birds. While the effect of the oil spill was extensive, this case study is focused on the bivalve mortality and subsequent shellfish population restoration. The trustees used a combination of field data and modeling to quantify injury to offshore community natural resources. Field data was used to document the abundance of biota in impact and reference areas and concentrations of total petroleum hydrocarbons (TPH) and PAH in sediment, water, and biota. These data were combined with information about oil fate and toxicity, and species abundances, to estimate the magnitude of injury through the use of a fate and effects model (SIMAP). SIMAP estimates the distribution of spilled oil (as mass and concentrations) on the water surface, on shorelines, in the water column, and in the sediments. The model is three-dimensional, using a latitude-longitude grid to map environmental data. Algorithms based on state-of-the-art published research account for spreading, evaporation, transport, dispersion, emulsification, entrainment, dissolution, volatilization, partitioning, sedimentation, and degradation of the oil. Acute mortality of water column and benthic resources is estimated as a function of temperature, concentration of dissolved aromatics, and the length of exposure. Acute mortality of other wildlife is estimated as a function of area swept by oil, dosage, and vulnerability. Chronic effects of long-term exposure to sediment concentration of oil or via ingestion are not considered by this model. The model was modified to more closely simulate the conditions of the North Cape spill by adding a surf entrainment algorithm. The results and output of the fates portion of the model were validated by comparison with overflight maps made during the response to the spill and with the measured concentrations of TPH and PAH in samples taken during the week following the spill. A complete description of the modeling is available in French (1998a). Pre-spill abundance of bivalves was estimated using data from non-impacted sites as well as abundance data from previous studies in the literature. Areal extent of the injury was estimated by modeling. Bivalve injury was quantified with the SIMAP computer model. Bivalve exposure modeling accounted for all bivalves injured in the spill, not just those that washed up on shore. The modeling was based upon exposure to dissolved aromatic compounds in water at the bottom. Effects considered were acute toxicity as a result of this exposure. Chronic effects of long-term exposure to sediment concentrations of oil or via ingestion were not assessed in this analysis (French 1998a). The analysis indicates that approximately 1.0 million kilograms of bivalve biomass were lost as a result of the spill (direct mortality plus production foregone). The majority of the injury was to surf clams, of which 19.4 million animals were killed, resulting in a loss of 970,400 kilograms biomass. Limited amounts of blue mussels (Mytilus edulis), quahogs/hard clams (Mercenaria merenaria), soft shell clams (Mya arenaria), oysters (Crossostrea virginica) and bay scallops (Argopecten irradians) were also killed by the oil spill. The area of impact was both within and outside the salt ponds, although injury to surf clams and other bivalves was primarily in the offshore environment, in the Nebraska Shoal area from Point Judith to Charlestown beach (French 1998a and b). The trustees estimated that the injured bivalve populations would return to baseline levels through natural recovery within three to five years after the spill. This period of time encompasses the expected lifespan of the bivalves killed by the spill. Thus, based on information currently available there was no indication that bivalve larval abundance (and therefore future generations of bivalves) would be affected significantly in future years.

Planning and Review

Goals and Objectives

Was a baseline assessment conducted:

unsure

Was a reference model used:

RM5

were_goals_identified:

YES

Goals and objectives:

- Other

Goals Description::

The overall goal of the shellfish restoration is to replace the lost shellfish biomass through a variety of multi-species enhancement and restoration techniques. The restoration fully addressed the impacts to shellfish from the North Cape oil spill by attempting to return natural resources to their pre-spill (baseline) conditions, as well as compensate for interim losses of the shellfish resources. The trustees determined that restoration actions would be required to return the ecosystem to baseline conditions as the resources were not expected to recover in a reasonable amount of time without human intervention.

Stakeholder Engagement

Were Stakeholders engaged?:

unsure

Description of Stakeholder Involvement:

Under the authority of the Oil Pollution Act (OPA), Rhode Island Department of Environmental Management (RIDEM), the National Oceanic and Atmospheric Administration (NOAA), and the U.S. Department of the Interior (DOI) represented by the U.S. Fish and Wildlife Service (FWS) were designated as natural resource trustees and had the responsibility to restore, rehabilitate, replace, or acquire the equivalent of natural resources injured as a result of the North Cape oil spill. The trustees, on behalf of the public, assessed the natural resource injuries, planned for appropriate restoration projects, prepared the draft and final restoration plans, and implemented and oversaw restoration activities. Restoration plans were reviewed by experts from industry, restoration scientists, and interested members of the public. Decisions guiding restoration implementation and monitoring were developed as a part of a settlement agreement between the natural resource trustees and responsible parties. Final authority to make determinations regarding injury and restoration rested solely with the trustees. The trustees have considered and evaluated a full suite of restoration alternatives for compensating shellfish injuries from the North Cape oil spill. Quahog, bay scallop, and oyster provide ecological services (e.g., water filtration, benthicpelagic coupling from feeding activity, food for fish and invertebrates that prey upon molluscan larvae and seed, benthic biomass, and habitat value) similar to those functions lost due to the North Cape shellfish injuries. Since these shellfish species have declined relative to their historic populations due to heavy fishing pressure and habitat loss and degradation, it is reasonably certain that their restoration would result in enhanced ecological services in the area of spill impact. Thus a net ecological benefit to compensate for the oil spill injuries to natural resources is expected. Finally, shellfish restoration in the salt ponds and adjacent waters of Narragansett Bay is a feasible and proven technique, since restoration of shellfish has a long history in Northeast estuaries, with well-developed grow-out methods and reasonably well documented results.

Ecosystem Activities and Approaches

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General Activities: RESEARCH AND PLANNING The existing shellfish resources of the coastal ponds were of particular importance to this shellfish restoration. In summer 2001, Ninigret, Quonochontaug, and Winnapaug Ponds were surveyed by RIDEM with assistance from the University of Rhode Island's Graduate School of Oceanography (URI-GSO) to collect baseline information on the shellfish populations. This survey was the initial phase of the North Cape Shellfish Restoration project and was funded by both settlement monies and a private grant to URI-GSO. To complete the study, RIDEM first established a 100-square meter (m2) grid overlay for each pond. For each grid selected for surveying, three 1 m2 substrate plots were sampled to a depth of one foot to determine sediment characteristics and shellfish species and their abundance and size. This survey involved sampling 176 stations covering 1,711 acres in Ninigret Pond, 125 stations covering 632 acres in Quonochontaug Pond, and 118 stations covering 446 acres in Winnapaug Pond (Ganz, pers. comm.). Preliminary results indicated that these salt ponds were dominated by quahogs. Soft-shell clams were locally very abundant and very few oysters or bay scallops were observed in the ponds. The survey established quahog densities of 0.058/m2 in Winnapaug, 2.26/m2 in Ninigret, and 2.43/m2 in Quonochontaug, averaging 25.4 millimeters (mm) in width, and soft-shell clam densities of 0.023/m2 in Winnapaug, 1.04/m2 in Ninigret, and 1.25/m2 in Quonochontaug. Survey results are similar to previous shellfish surveys conducted by RIDEM (Ganz, pers. comm.). The trustees thoroughly evaluated the survey results as part of selecting shellfish restoration sites in these coastal salt ponds. Additional baseline surveys were conducted for Point Judith Pond and other coastal salt ponds during the summer of 2002. METHODS The North Cape Shellfish Restoration Project was accomplished through a variety of shellfish enhancement techniques; including shellfish grow-out and nurseries, direct seeding, and caged spawner sanctuaries. Each restoration component included comprehensive monitoring that was conducted annually while restoration activities were being implemented. The results of this monitoring have led to many adaptive management activities, and as a result, the methods outlined in the original restoration plan (File #1 attached) have changed to ensure the restoration is moving along an ecological trajectory that would most likely reach the goals stated in the restoration plan. Quahog Enhancement The quahog enhancement project was established in 2002 and was based on the release of hatchery-produced seed, grown out to a suitable size to enhance the breeding population, and ultimately, recruitment of subsequent generations. The grow-out of quahog seed typically requires a two-year period in southern New England (Appleyard and DeAtleris 2001). This necessitates "over-wintering"� the juvenile quahogs for at least one winter prior to seeding. At the end of 2005 both the 2004 and 2005 cohorts were over-wintered, as the 2004 cohort were the subjects of a grow-out experiment in Quonochontaug Pond. During the over-wintering of 2005-06, remaining quahogs from the North Cape upweller were housed in troughs in the shallow sub-tidal waters of Point Judith Pond adjacent to the RIDEM Coastal Fisheries Laboratory. Quahogs in the bottom grow-out treatments established in 2005 were left in those treatments after sampling in November 2005. In 2006 the over-wintered seed from 2005 was retrieved, sampled, and the grow-out continued in the North Cape upweller at Camp Fuller. The quahog bottom grow-out treatments were sampled at retrieval to determine annual performance, and added to the North Cape upweller for further grow-out prior to seeding. All over-wintered quahogs were maintained in the upweller to the beginning of August 2006, when a portion of the seed was used to establish growth and mortality experimental plots in both Quonochontaug and Ninigret ponds. The experimental plots were repeats of the design used in Quonochontaug Pond in 2004-05, and were designed to provide spatial information on mortality and growth within the seeding areas and between ponds, as well as temporal variation between years. All remaining quahog were seeded into the protected spawner sanctuary in Ninigret Pond. The final monitoring of experimental plots was completed in August 2007, and was the culmination of the North Cape quahog enhancement program. See the individual North Cape Shellfish annual reports for the complete methodologies for each year of the quahog enhancement work: http://www.darrp.noaa.gov/northeast/north_cape/shellfishRestoration.html. Bay Scallop Restoration In 2002 and 2003, the North Cape Shellfish Restoration Program seeded approximately 1.5 million scallops directly into four coastal ponds (Ninigret, Potter, Quonochontaug, and Green Hill Ponds), in an attempt to re-establish an effective breeding population for the 2004 season (Hancock et al. 2005). In spring 2004, the ponds were surveyed to estimate the total abundance of the surviving scallops. The number of scallops in all ponds was low (Hancock et al. 2005). Ninigret Pond had the highest number of surviving scallops, estimated to be 9,300 and these were primarily in the western area of the pond. Diver observations of post release scallops suggested high mortality due to crab predation (Holly et al. 2005). As a result of the low survival of the seeded scallops, the focus of the scallop project was shifted to establishing "˜caged spawner sanctuaries' where broodstock could be protected from predation within mesh cages to minimize mortality and maximize their reproductive output. The caged spawner sanctuary technique was applied in Ningret Pond in 2004 and 2005, Quonochontaug Pond in 2006 and 2007, and Point Judith Pond in 2008. In general, bay scallop spawning sanctuaries consisted of multiple floating wire mesh cages containing 10,000 to 20,000 adult scallops within mesh pouches. The scallop cages were deployed in early June and retrieved in November. Spatial and temporal spat settlement was monitored by the use of spat collectors deployed throughout the pond, and retrieved every 30 days from July to November. Diver surveys were conducted early the following summer season to obtain estimates of free living scallop populations. Monitoring was continued in each pond, even after the spawner cages were moved to a different location, to monitor the continued population changes and fluctuations. The bay scallop nursery, spat collection, spawning sanctuary, and reseeding projects allowed opportunity for community volunteer and educational institution involvement. There were also opportunities to assist in monitoring growth, survival, and recruitment. This community-based restoration effort promoted a stewardship interest in the bay scallop resource and fostered greater regard for following and enforcing fishery regulations and improving salt pond water quality. See the individual North Cape Shellfish annual reports for the complete methodologies for each year of the scallop restoration work: http://www.darrp.noaa.gov/northeast/north_cape/shellfishRestoration.html Oyster Restoration Remote Setting and Oyster Nursery This project restored oyster populations in Rhode Island waters by using the remote setting technique. Rhode Island oysters were collected and held in tanks as adult broodstock for the production of oyster larvae. The larvae were introduced to large setting tanks filled with shell known as cultch. Weathered cultch material was purchased from local suppliers. The shell material was screened to retain large shell fragments. Shells were placed into tubular extrusion netting and sealed at both ends. Within 24 hours, eyed larvae settled onto the cultch, and the shell bags were transported to designated nursery sites at Jenny's Creek on Prudence Island, Point Judith Pond near the RIDEM Coastal Fisheries Laboratory, and Trustom Pond, situated on the Trustom Pond National Wildlife Refuge. Each nursery site required a small area, approximately 1,000 square feet. Shell bags were placed on racks and/or wooden pallets within the intertidal zone region. The oyster spat grew to planting size (~20 mm) in these nurseries within three months. Once the oysters reached this size, the spatted cultch material was transported to designated areas, 3/4 to 1 acre in area, with the material spread in a thin layer (~1-inch thick) on top of the bed cultch material. In 2008, a different approach to raising broodstock was taken to maximize growth and reduce labor costs of remote setting. Post settled oysters individually set on micro cultch were purchased from a commercial hatchery and raised in a floating upweller system (FLUPSY). This approach proved to be an effective and efficient way to maximize growth in a given season. The oysters in the FLUPSY are provided greater access to food due to high water flow-through, maintained with flow pumps. Better nutrition results in larger oysters than those found in the nursery trays at the Coastal Fisheries Laboratory with natural flow. The increased growth will optimally translate into increased survival, as the oysters enter their first winter with a higher energy reserve (Beal et al. 1995; Taborsky 2003). Planted sites were monitored to determine long-term survival, growth, and recruitment in evaluating the performance of the project. These sites were also monitored for the effects of predation and presence of any disease. Bed cultch will continue to be monitored to assess long-term stability, effects of sedimentation, and ecological characteristics. Habitat Enhancement Natural oysters commonly grow on large clusters attaching to hard substrates and other shells, forming large oyster beds and reef structures providing a suitable substrate for oyster larvae settlement (Bahr and Lanier 1981). This program stabilized designated oyster planting sites by utilizing shell material to harden the bottom substrate prior to planting. Free-planting locations were designated under the guidance of RIDEM. These locations were in close proximity to the oyster nurseries in the coastal salt ponds and Narragansett Bay. Shell fragments remaining from shell bag production were used for the bed cultch. Bed cultch material provided a firm foundation for the spatted cultch to minimize sedimentation and suffocation. Approximately 20 to 30 cubic yards were dispersed to a depth of no more than several inches over designated planting grounds approximately 1 acre in size. Bed cultch was loaded from the staging areas onto trucks, boats, or barges for dispersal. Components of this project involved community groups, volunteers, local universities and colleges, agencies, and non-governmental organizations. As part of this habitat enhancement component, monitoring evaluated the rates of spat settlement and growth, as well as sedimentation and other adverse effects. RESULTS Annual reports that present in depth information regarding monitoring methods and results additional research (University of Rhode Island Coastal Fellows research projects), as well as the types of adaptive management that has occurred for each species-specific restoration have been produced since 2003. The reports are available electronically at http://www.darrp.noaa.gov/northeast/north_cape/shellfishRestoration.html. Details of the annual reports are beyond the scope of what can be presented in this case study format. Therefore the following is an overview of the information found in the reports for each species. Quahog Enhancement The quahog enhancement project conducted in Ninigret and Quonochontaug ponds was based on the release of hatchery-produced seed, grown out to a suitable size to enhance the breeding population, and ultimately, recruitment of subsequent generations (Hancock et al. 2005; Hancock et al. 2006; Hancock et al. 2007). The project was completed in 2007, and included the evaluation of various rearing and grow out methods, habitat assessments to determine the most suitable sites for shellfish release, baseline monitoring for assessment of growth and survival, and discrete experiments to assess the growth and mortality of quahogs released at different densities and size classes. Bottom grow out and overwintering in a protected nursery environment was determined to be the most cost effective and successful rearing method. Quahog seed produced utilizing this method had two seasons of growth and reached sufficient size to avoid the very high mortality associated with the release of seed less than about 20 mm length. Quahog seed reared in floating upwellers had higher survival and slightly better growth, but demanded a higher investment of staff time. The annual survival data collected support the conclusion that survival is significantly increased at lower seeding densities (Hancock et al. 2007). Current thought is that predator search efforts are less concentrated in low prey density areas compared to areas where prey have been introduced at higher densities (Peterson et al. 1995; Hancock et al. 2007). The annual survey results also support the conclusion that survival significantly increases with increasing seed size. However, this may not persist beyond a size of about 22.5 mm, indicating a "size refuge"� exists (Peterson et al. 1995; Hancock et al. 2007). Variation in quahog survival was also dependent on the location of test plots which were positioned no further than 100 meters from one another (Hancock et al. 2006). These significant differences in survival of quahog within a few hundred meters may be due to fine scale habitat variations such as changes in sediment type and density, hydrology, or predator concentrations. Bay Scallop Restoration The bay scallop restoration project was based on the release of hatchery produced seed to re-establish effective breeding populations in coastal Rhode Island ponds (Hancock et al. 2005; Hancock et al. 2006; Hancock et al. 2007). The project is on-going and includes monitoring scallop abundance and recruitment of juvenile bay scallops, baseline population estimates to determine efficacy of spawner sanctuaries, as well as discrete experiments to test the tolerance of juvenile scallops to low oxygen levels and examine habitat utilization. The sanctuaries have proven to be a cost effective method for enhancing recruitment to the coastal ponds. Spawner sanctuaries have been deployed in Ninigret (2004 and 2005), Quonochontaug (2006 and 2007) and most recently Point Judith (2008) ponds. The sanctuaries are typically placed in a pond for two years to provide spat fall and eventual broodstock. Broodstock surveys and scallop recruitment monitoring have revealed the success of this method in providing increased numbers of scallops in both Ninigret and Quonochontaug ponds. Scallop abundance is consistently greater in the sandy/rubble habitats of these ponds. Data indicates that location of spat settlement and subsequent recruitment into favorable habitat is an important factor to a successful population. Eutrophication of the coastal salt ponds has caused dissolved oxygen levels to vary widely within a 24-hour period. In order to determine if these variations were having an impact on bay scallop survival a laboratory experiment to test the tolerance of juvenile scallops to low oxygen was conducted. The results indicated that the scallops are tolerant of the diurnal oxygen levels observed and that low dissolved oxygen is not significantly impacting survival. The decline of sea grass beds and other vegetation in the salt ponds was also of concern. To determine if this loss