NJ Department of Environmental Protection
Water Monitoring and Standards

Sanitary Survey Report of Shellfish Classification for Growing Area DB2

(The Delaware Bay – Cape Shore Area)

April 2012

State of New Jersey
Chris Christie, Governor
Kim Guadagno, Lt. Governor

NJ Department of Environmental Protection
Bob Martin, Commissioner

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(The Delaware Bay – Cape Shore Area)

New Jersey Department of Environmental Protection
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April 2012

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Cover Photo – Cape May Ferries and Terminal Building, NJ (photo by Paul Wesighan on August 21, 2012).

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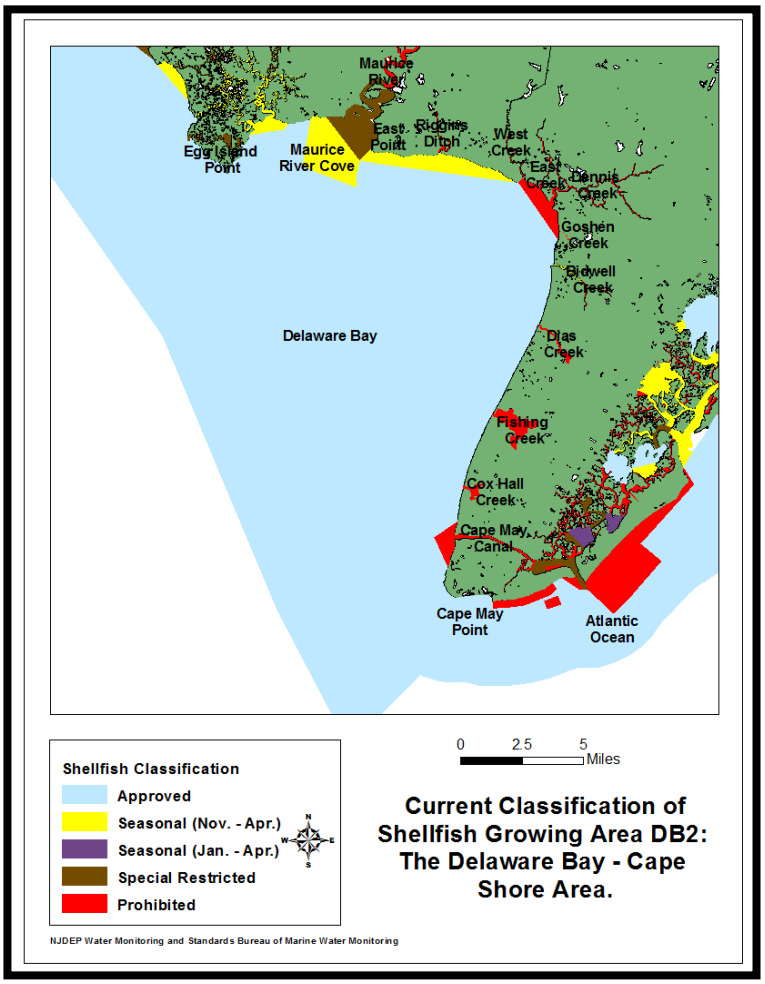
EXECUTIVE SUMMARY

Shellfish Growing Area DB2, The Delaware Bay – Cape Shore Area, is located in the southwestern part of New Jersey. It borders the shoreline of the Delaware Bay from East Point in Maurice River Township, Cumberland County, and extends southeast to Cape May Point in Cape May County. The approximate size of this shellfish growing area is 34,528 acres, and the shellfish classification for this growing area is *Approved*, *Seasonally Approved (November to April)*, and *Prohibited* for shellfish harvesting (as seen in the figure to the right).

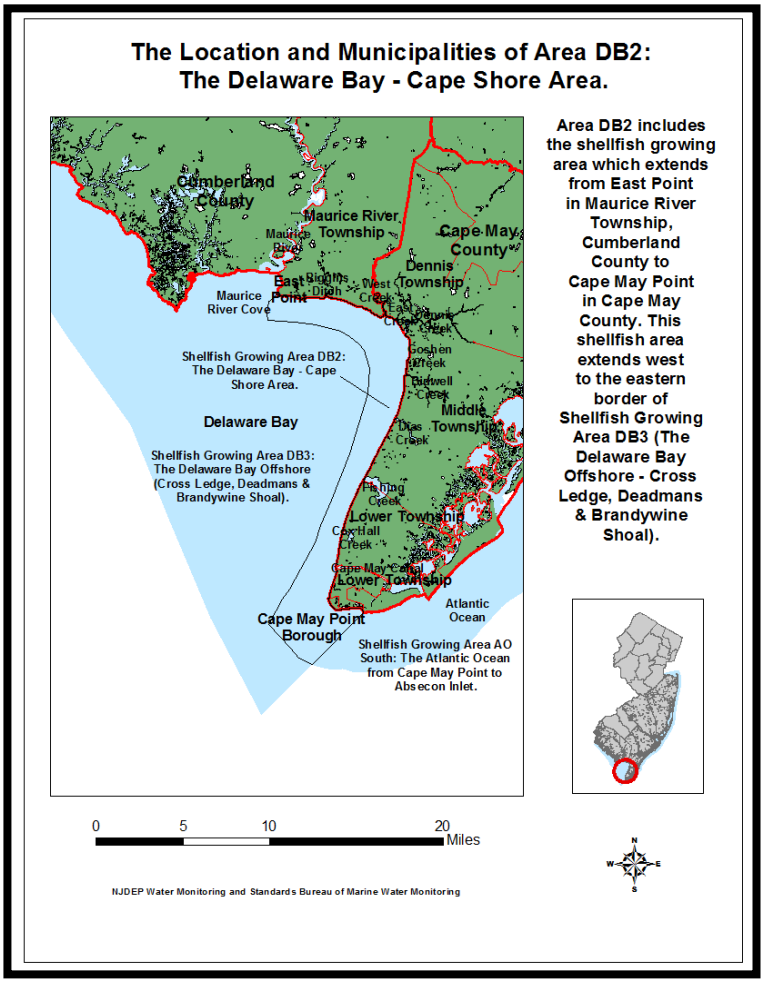


This report includes water quality data collected between May 1, 2007 and April 30, 2012 using the Adverse Pollution Condition (APC) strategy for all of the sampling stations in this growing area because there is one permitted indirect discharge to this shellfish growing area. That is the discharge pipe for the Wastewater Treatment Facility at Bayside State Prison, which discharges into Riggins Ditch. Approximately 705 water samples analyzed for total coliform bacteria from 41 monitoring stations. All sampling stations were in compliance with the total coliform criteria for the *Seasonally Approved (January to April)*, *Special Restricted*, and *Prohibited* classifications of this shellfish growing area, as specified by the National Shellfish Sanitation Program (NSSP). The overall water quality for this growing area is good. There were no significant changes to landuse patterns, hydrography, or pollution discharges to this area that would change the shellfish classification of the shellfish waters in this area, as documented in the shoreline survey included in this report.

DESCRIPTION OF GROWING AREA

Location & Description

Shellfish Growing Area DB2 is located in the southwestern part of New Jersey (see figure below). This shellfish growing area borders the shoreline of the Delaware Bay from East Point in Maurice River Township, Cumberland County, and extends southeast to Cape May Point in Cape May County. The northwestern edge of this shellfish growing area is located south of East Point, which is east of the mouth of the Maurice River at the border between this shellfish growing area and Shellfish Growing Area DB1 (The Delaware Bay from Maurice River Cove to Artificial Island). The western edge of this shellfish growing area is located about 1.4 miles south of the shoreline bordering the coast of Maurice River Township in Cumberland County, about 2.5 miles west of the shoreline bordering the coast of Dennis Township in Cape May County, and about 1.7 miles west of the shoreline bordering the coast of Lower Township in Cape May County at the border between this shellfish growing area and Shellfish Growing Area DB3 (The Delaware Bay Offshore – Cross Ledge, Deadmans & Brandywine Shoal). The southeastern edge of this shellfish growing area is located southeast of Cape May Point at the border between this shellfish growing area and the southwest edge of Shellfish Growing Area AO South (The Atlantic Ocean from Cape May Point to Absecon Inlet).



This shellfish growing area also includes Riggins Ditch, West Creek, East Creek, Dennis Creek, Roaring Ditch, Old Robins Branch, Crow Creek, Sluice Creek, Goshen Creek, Bidwell Creek, Dias Creek, Fishing Creek, Cox Hall Creek, and smaller tidal tributaries.

The municipalities on the shore of this shellfish growing area include Maurice River Township in Cumberland County, and Dennis Township, Middle Township, Lower Township, and Cape May Point Borough in Cape May County. The locations of these municipalities are shown in the figure to the right. Population statistics for the adjacent municipalities can be found in a reappraisal report of

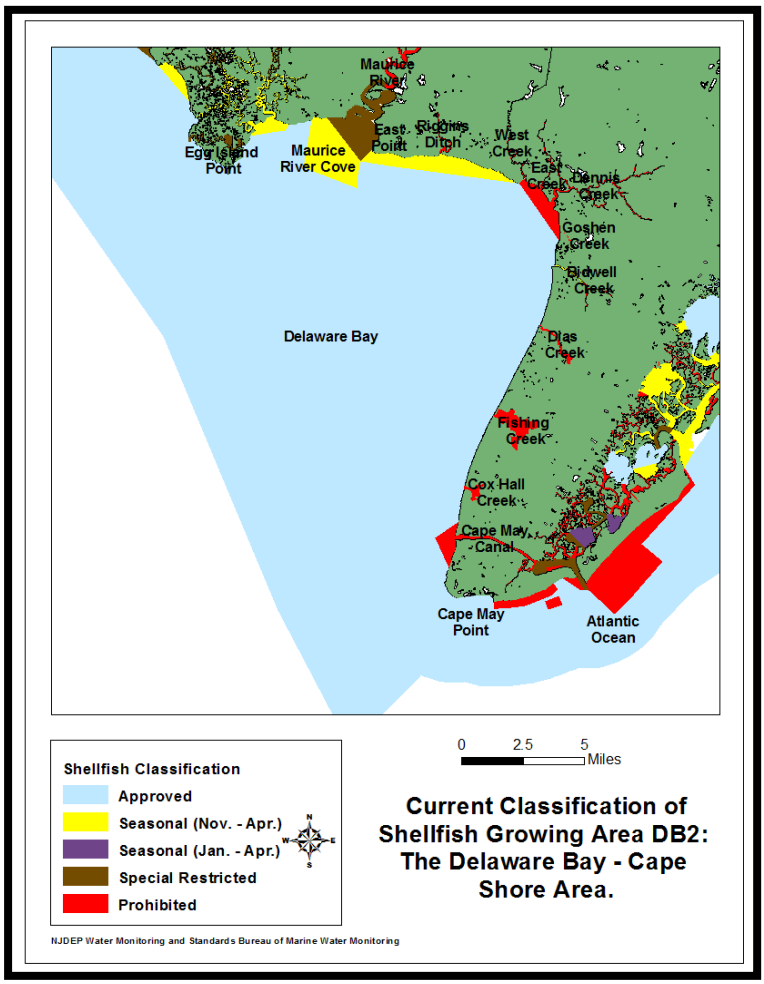
this shellfish growing area, which was written in March 2008 and included the population statistics from the 2000 census of this area.

In Cumberland County, Riggins Ditch and West Creek drain into this shellfish growing area. In Cape May County, West Creek, East Creek, Dennis Creek, Roaring Ditch, Old Robins Branch, Crow Creek, Sluice Creek, Goshen Creek, Bidwell Creek, Dias Creek, Green Creek, Fishing Creek, Cox Hall Creek, Pond Creek, and the Cape May Canal drain into this shellfish growing area. This shellfish growing area drains through the Cape May Channel into the Atlantic Ocean.

The approximate size of this shellfish growing area is about 34,528 acres. The shellfish classification for this growing area is *Approved*, *Seasonally Approved (November to April)*, and *Prohibited* for shellfish harvesting. The *Seasonally Approved (November to April)* waters are located in the north part of this shellfish growing area south of Thompsons Beach and Moores Beach. The *Prohibited* waters are located west of the Cape May Canal, in Cox Hall Creek, in Fishing Creek, in Dias Creek, in Bidwell Creek, in Goshen Creek, in Dennis Creek, in East Creek, in West Creek, and in Riggins Ditch. The *Approved* waters include the rest of the waters in this shellfish growing area.

Growing Area Classification

The primary shellfish classifications of this growing area are *Approved*, *Seasonally Approved (November to April)*, and *Prohibited*, and the approximate size of this shellfish growing area is 34,528 acres. There are approximately 29,766 acres of *Approved* waters, 1,967 acres of *Seasonally Approved (November to April)* waters, and 2,795 acres of *Prohibited* waters in this shellfish growing area. The figure to the right shows the current classification of this shellfish growing area.



The *Seasonally Approved (November to April)* waters are located in the west part of Bidwell Creek and in the inshore part of the Delaware Bay west of West Creek. The *Prohibited* waters are located in Riggins Ditch, West Creek, East Creek, Dennis Creek, Roaring Ditch, Old Robins Branch, Crow Creek, Sluice Creek, Goshen Creek, the east part of Bidwell Creek, Dias Creek, Fishing Creek, Cox Hall

Creek, in the inshore part of the Delaware Bay that extends from West Creek to Goshen Creek, and a small area of the Delaware Bay west of the Cape May Canal. The *Approved* waters are located in the Delaware Bay from East Point to Cape May Point, excluding the areas already mentioned above. The *Prohibited* shellfish classification includes Riggins Ditch, because the NJDOC Bayside State Prison Sewage Treatment Plant directly discharges treated wastewater from the outfall pipe into the waters of Riggins Ditch, which flows into the north part of this shellfish growing area. There are also two marinas in Dennis Creek and the docking facilities for the Cape May – Lewes Ferry in the Cape May Canal that require buffer zones; these determine the shellfish classification for Dennis Creek and the small area in the Delaware Bay to the west of the Cape May Canal in this shellfish growing area.

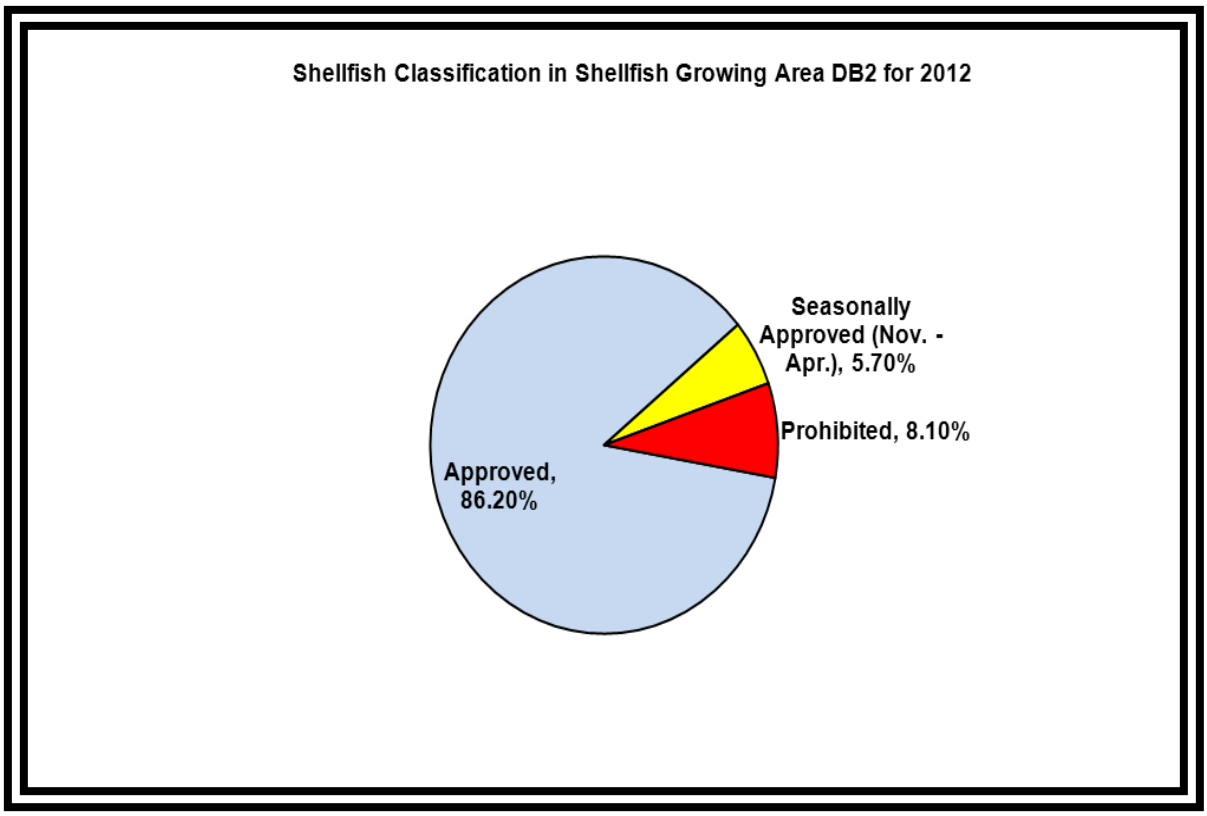
In the reappraisal report written for DB2 in 1997, the areas of Dividing Creek and the Maurice River Cove were included as part of Shellfish Growing Area DB2, which extended from Dividing Creek in Downe Township, Cumberland County to Cape May Point in Cape May County.

In the August 2000 Sanitary Survey of Shellfish Growing Area DB2, this shellfish growing area was restructured to coincide with the State watershed planning and management areas, and Dividing Creek and the Maurice River Cove became part of Shellfish Growing Area DB1 (Watkins, 2000). The boundaries of Shellfish Growing Area DB2 were then changed to extend from East Point in Maurice River Township, Cumberland County to Cape May Point in Cape May County. In the 2000 report, all of the sampling stations in this shellfish growing area were in compliance with the total coliform criteria for the existing water quality shellfish classification criteria, and there were no recommended shellfish classification changes for this area.

In the November 2003 Reappraisal of the Delaware Bay Cape Shore, one sampling station (Sampling Station **3893**) exceeded the total and fecal coliform criteria year-round and in the summer for the *Approved* shellfish classification. Sampling Station **3893** is located northwest of the mouth of Dias Creek in *Approved* shellfish waters. In this report, it was determined that the bacteria counts were higher during the summer months and were most likely impacted by boating activity and increased population pressures from the summer tourism industry. Therefore, due to the location and close proximity of this sampling station to the sampling stations that were in compliance, no classification changes were made at that time (Nguyen, 2003).

In the 2007, 2008, 2009, and 2010 Annual Reviews of Shellfish Growing Area DB2, no classification changes were proposed (NJDEP, 2008, NJDEP, 2009, NJDEP 2010, NJDEP, 2011). No sampling stations in this shellfish growing area exceeded the existing shellfish classification criteria, and the data supported the existing shellfish classifications for this area. The last Sanitary Survey for this growing area was written in 2000.

The figure on the preceding page illustrates the shellfish classification for this growing area. The shellfish classification of this area can be seen in the 2012 State of New Jersey Shellfish Growing Water Classification Charts booklet on chart number 18, or on WM&S/BMWM's website at http://www.state.nj.us/dep/bmw/.


Shellfish Classification in Shellfish Growing Area DB2 for 2012
Seasonally Approved (Nov. - Apr.), 5.70%
Prohibited, 8.10%
Approved, 86.20%

Evaluation of Biological Resources

This growing area has a wide diversity of biological resources. The total shellfish landings for New Jersey from 2007 to 2012 can be seen in the first table below (NJDEP, 2012, NMFS, 2012). The total shellfish landings includes hard clams, soft clams, blue mussels, bay scallops, eastern oysters, ocean quahogs, surf clams, sea scallops, and blue crabs. Shellfish landing statistics had not been verified and posted for 2011 and 2012 at the time this reappraisal report was written.

Hard clams (*Mercenaria Mercenaria*) exist in high densities and are privately and commercially harvested (Morris, 1975, Gosner, 1978). The shellfish landings for hard clams in New Jersey from 2007 to 2012 can be seen in the second table below (NJDEP, 2012, NMFS, 2012). Hard clam landing statistics had not been verified and posted for 2009, 2010, 2011 and 2012 at the time this reappraisal report was written.

New Jersey Shellfish Landings - 2007 to 2012 (NMFS, 2012).

NEW JERSEY SHELLFISH LANDINGS 2007 to 2012		
YEAR	POUNDS OF MEAT (millions)	$ VALUE (exvessel)
2007	84,766,901	$120,767,607
2008	74,319,008	$144,736,585
2009	87,654,064	$125,735,266
2010	61,976,167	$144,863,008
2011	*	*
2012	*	*

New Jersey Hard Clam Landings - 2007 to 2012 (NJDEP, 2012).

NEW JERSEY HARD CLAM LANDINGS 2007 to 2012		
YEAR	POUNDS OF MEAT (millions)	$ VALUE (exvessel)
2007	239,733	$968,308
2008	1,529,231	$6,306,220
2009	*	*
2010	*	*
2011	*	*
2012	*	*

* No Data

The cities of Port Norris and Bivalve, along the Maurice River in Cumberland County, were once known as the hub of the Delaware Bay oyster industry, and Bivalve was once recognized to be the oyster capital of the world for its oyster production and processing industries. Their oyster industry

processed and delivered thousands of pounds of oysters to markets all over the eastern coast of the United States (Flemlin and Tweed, 2000, Matassino, et al, 2002).

The population of oysters in the Delaware Bay had fluctuated widely. In the early 1900's, annual oyster landings were from one million to two million bushels. However, in the 1950's, the oyster population was reduced dramatically by the disease MSX, which is caused by the parasite *Haplosporidium nelsoni*. Only 49,000 bushels of oysters were harvested in the Delaware Bay in 1960. There was a gradual increase in the numbers of oysters harvested in the late 1960's and early 1970's. Then, in 1990, a new disease named Dermo was found to be spreading among the oyster population on the eastern side of the Delaware Bay and it caused heavy losses of both planted and seeded oysters. Dermo is caused by the parasite *Perkinsus marinus*. In 1988, juvenile oyster disease (JOD) also became a serious problem for oyster nurseries in the northeastern Atlantic region. The causative agent for JOD is unknown (Guo, Dr. Ximing, and Dr. John Kraeuter, 2000). While MSX, Dermo and JOD are diseases of oysters, they do not infect humans and therefore do not have any public health significance.

The Haskin Shellfish Research Laboratory of Rutgers University has attempted to develop disease resistant strains of oysters that show a resistance to MSX. Their long-term oyster-breeding program has genetically produced a disease resistant strain of oysters for MSX, and they have also genetically produced an oyster with some resistance to Dermo. These disease-resistant oysters are the main production line for the Atlantic Cape Fisheries oyster farm in Cape May (Guo and Kraeuter, 2000).

The Delaware Bay also contains the world's largest population of horseshoe crabs (*Linulus polyphemus*). New Jersey reported an increase in horseshoe crab harvests from approximately 250,000 animals in 1993 to over 600,800 in 1996. However, due to an alarming drop in the adult crabs seen spawning on the beaches, a moratorium was placed on their collection for 1998. In New Jersey for 2003, the landings for horseshoe crabs were 367,553 pounds harvested for an exvessel value of $193,605 (NJDEP, 2005). In New Jersey for 2005, the landings for horseshoe crabs were 330,714 pounds harvested for an exvessel value of $120,782 (NMFS, 2008). After 2005, there was a moratorium placed on the harvest of horseshoe crabs in the Delaware Bay, and horseshoe crab landings for 2006 were 9,141 pounds harvested for an exvessel value of $3,474 (NMFS, 2008). A total moratorium was placed on the harvest of horseshoe crabs for 2007 and, from 2007 to 2012; the National Marine Fisheries Service had no values for horseshoe crab landings for those years. Currently, New Jersey allows a minimum harvest and has tight restrictions on the conditions under which a permit for harvest is issued. Since horseshoe crabs are used as bait for catching eels and conch, are vital to medical research and the pharmaceutical products industry, and their natural habitat is gradually being lost to development and shoreline retreat, the population of horseshoe crabs has been declining. Migrating shorebirds also feed on the eggs of nesting horseshoe crabs, which also contributes to their decline in population numbers (Matassino, et al., 2002).

For migrating shorebirds, the Delaware Bay is located along the Atlantic Flyway, which is an important migratory corridor for wildlife populations of shorebirds along the eastern half of the United States. The Delaware Bay area is considered to be one of the largest stopover locations along the Atlantic Flyway, with an estimated 425,000 to 1,000,000 migratory shorebirds converging and feeding in the Delaware Bay Estuary. Red Knot, Dunlin, Ruddy Turnstone, Sanderling, Semi-Palmated Sandpiper, and other species of shorebirds use the Delaware Bay Estuary as an important

resting and feeding area, and they are known to consume large quantities of horseshoe crab eggs (certain species of shorebirds can and will eat thousands of horseshoe crab eggs in a single day) (Matassino, et al., 2002).

Blue crabs (*Callinectes sapidus*) are also found in the waters of the Delaware Bay and they are commercially and recreationally harvested from these waters. In New Jersey for 2007, the landings of blue crabs were 4,821,452 pounds harvested for an exvessel value of $6,004,341 (NJDEP, 2012). In New Jersey for 2010, the landings of blue crabs were 9,267,976 pounds harvested for an exvessel value of $11,858,093 (NJDEP, 2012). Striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) are also an important biological resource in the Delaware Bay and Delaware River (Matassino, et al., 2002). Both of these species of fish are commercially and recreationally harvested in the waters of this shellfish growing area, since this area is also utilized for fishing and boating. In 1991, the striped bass was classified as a gamefish in New Jersey, and this status prevents the commercial harvest or sale of this first coastal saltwater species designated as such in New Jersey (Bochenek, 2000).

The wetlands bordering this shellfish growing area also contain the Corsons Wildlife Management Area, the Heislerville Wildlife Management Area, the Turkey Point Fish & Wildlife Management Area, the Egg Island Berrytown Wildlife Management Area, the Fortescue Wildlife Management Area, the Nantuxent Wildlife Management Area, the New Sweden Wildlife Management Area, the Dix Fish & Wildlife Management Area, the Osborn Fish & Wildlife Management Area, and the Mad Horse Creek Wildlife Management Area.

SHORELINE SURVEY: EVALUATION OF POTENTIAL POLLUTION SOURCES

Shoreline Survey

The shoreline survey that was performed for this area on August 10 and August 21, 2012 determined that there have been minor changes made to the area since the last reappraisal of this area.

There were photographs taken during the shoreline survey of this shellfish growing area on August 10 and August 21, 2012. The photograph on the front cover shows the location of the Cape May Ferries and Terminal Building in Cape May, NJ. Additional photos taken during the shoreline survey of this area are attached at the end of this report in the Supporting Documentation section.

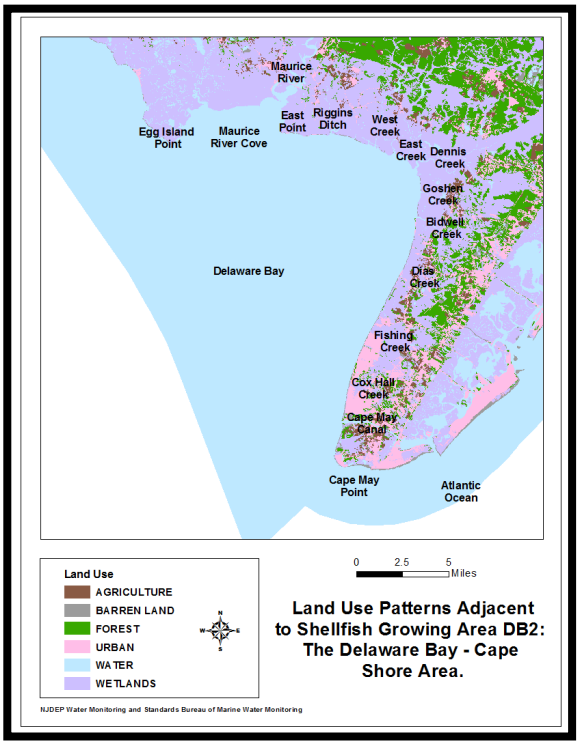
During the shoreline survey on August 10, 2012, the stormwater outfall at the end of Ocean Avenue in the Villas was discharging a heavy volume of brownish water into the Delaware Bay. Water samples were collected on August 21, 2012 at the end of this stormwater outfall to determine the potential impact to these shellfish waters.

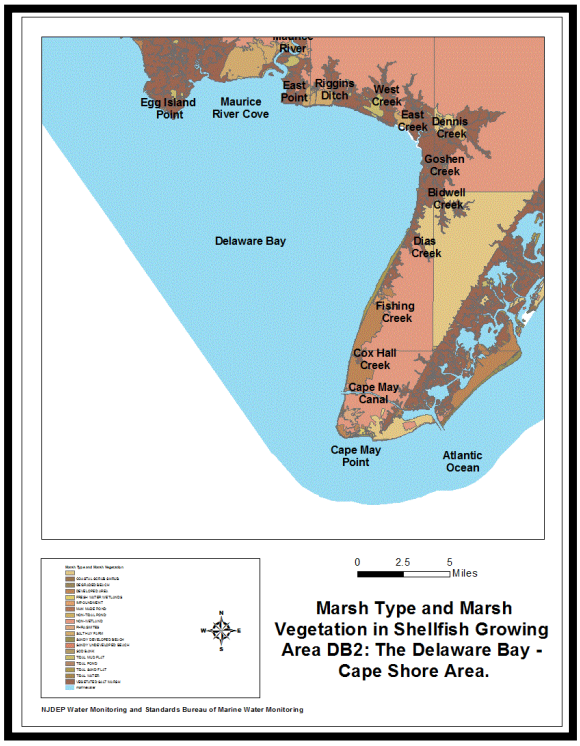
Land Use

The major land use patterns for the municipalities to the north and east of this shellfish growing area are mainly wetland areas, agricultural areas, and forest areas, with some urban areas interspersed between them (see left figure on next page). The urban areas are mainly located in clusters to the

east and northeast of this shellfish growing area and some of these municipalities (Cape May Point, North Cape May, and the Villas) are connected to public sewer systems where there is a minimal potential for pollutant inputs into these shellfish growing waters from sewage contamination. Based on a review of water quality and bathing beach data, there is no current evidence that the direct and indirect discharges from these surrounding urban areas affect the water quality of this shellfish growing area.

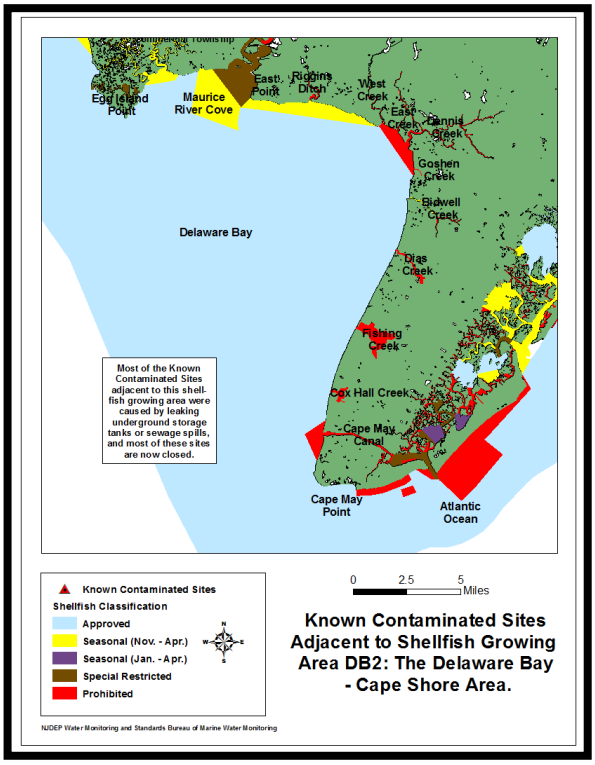
The wetlands surrounding this shellfish growing area also contain the Cape May National Wildlife Refuge to the east, the Dennis Creek Wildlife Management Area to the northeast, and Corsons Wildlife Management Area, Heislerville Wildlife Management Area, Egg Island Berrytown Wildlife Management Area, and Fortescue Wildlife Management Area to the north. The figures on the next page show the land use, vegetation, and municipalities that surround this shellfish growing area.





Known Contaminated Sites

NJDEP, Site Remediation Program (SRP) has established a list of the Known Contaminated Sites (KCSNJ), Classification Exception Area (CEA) and Currently Known Extent (CKE) of groundwater pollution. KCSNJ are those non-residential sites and properties within the state where contamination of soil or groundwater has been confirmed at levels equal to or greater than applicable standards. This list of Known Contaminated Sites may include sites where remediation is either currently under way, required but not yet initiated or has been completed. CEA and CKE areas are geographically defined areas within which the local groundwater resources are known to be compromised because the water quality exceeds drinking water and groundwater quality standards for specific contaminants (NJDEP).

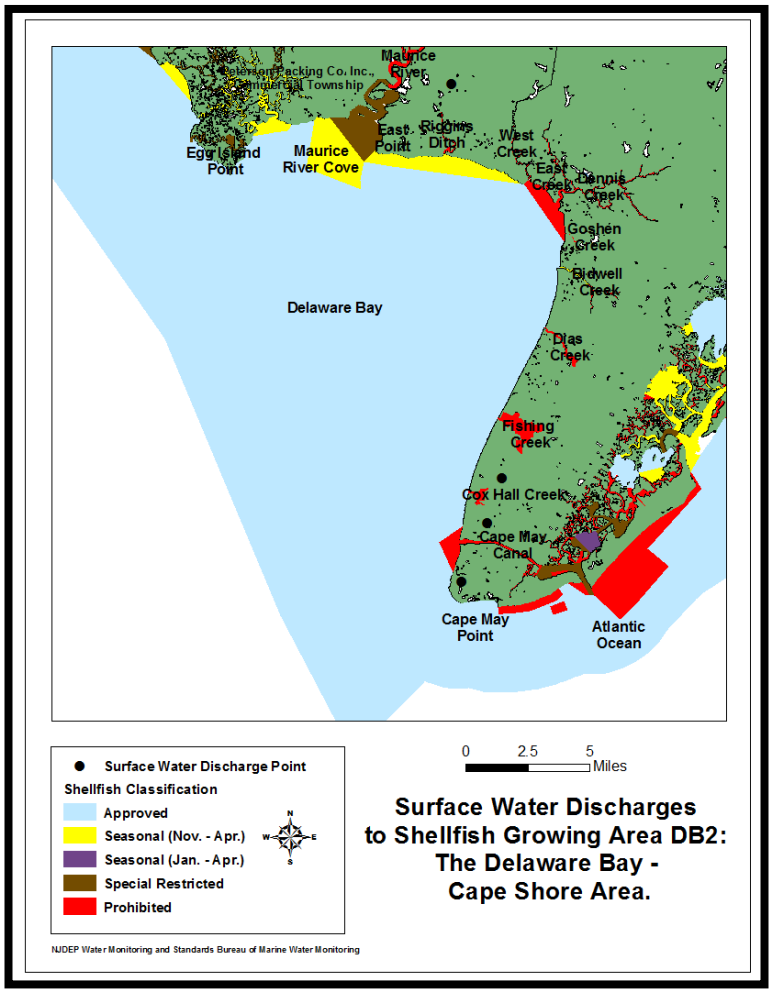


This shellfish growing area, which extends from East Point to Cape May Point, has several known contaminated sites located in the adjacent areas (see preceding figure). The major concentrations of these known contaminated sites are located to the east in Lower Township, Middle Township, and to the northeast in Commercial Township. The primary causes of these known contaminated sites are from leaking underground storage tanks. Most of these known contaminated sites are now closed.

Surface Water Discharges

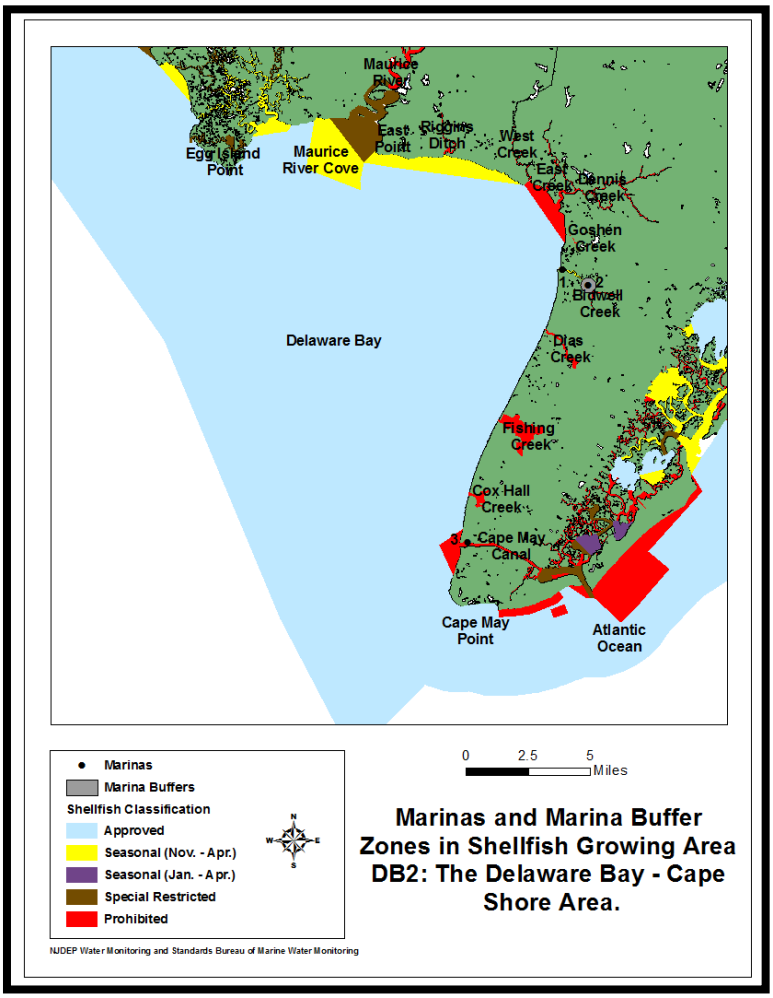
The discharge of pollutant from a point source is authorized under New Jersey Pollutant Elimination System (NJPDES), and the regulations are found at N.J.A.C. 7:14A. The main purpose of the NJPDES program is to ensure proper treatment and discharges of wastewater. By doing so, the permit limits the amount or concentration of pollutants that can be discharged into ground water, streams, rivers, and the ocean. Facilities regulated under this program include mines, schools, hospitals, large corporate office buildings, industrial manufacturing facilities, campgrounds, mobile home parks, food processor, potable water treatment plants, sewage treatment plants, or any dischargers that may have the potential to impact water quality. As of December 2010, there were 6,752 active permits. The number of active permits includes permits for all NJPDES permit classes, including Discharge to Surface Water (DSW), Discharge to Groundwater (DGW), Significant Indirect User (SIU), Discharge of Stormwater (DST), and Residuals (RES), (NJDEP, Division of Water Quality).

A surface water discharge involves the release of treated effluent from various municipal and industrial facilities directly into a river, stream, or the ocean. According to the NJPDES program, there was four surface water discharges found in this shellfish growing area.



Marinas

The discharge of sewage from vessels into the waterways can contribute to the degradation of the marine environment by introducing disease-causing microorganisms (pathogens), such as bacteria, protozoan, and viruses, into the marine environment. Chemical compounds, such as oil and gasoline resulting from spills, leaks, and pressure washing from vessels can poison fish and other marine organisms. Research has shown that by-products from the biological breakdown of petroleum products can harm fish and wildlife, and pose threats to human health if ingested. (NOAA) For this reason, waters within the marina basin are restricted to shellfish harvesting. Depending on the size of the marina, the water quality, flushing rates, and the depth of the water, shellfish waters immediately adjacent to each marina may be classified as *Prohibited*, *Special Restricted*, or *Seasonally Approved* (no harvest during summer months when the marina is normally active). There are three marinas situated within this shellfish growing area.

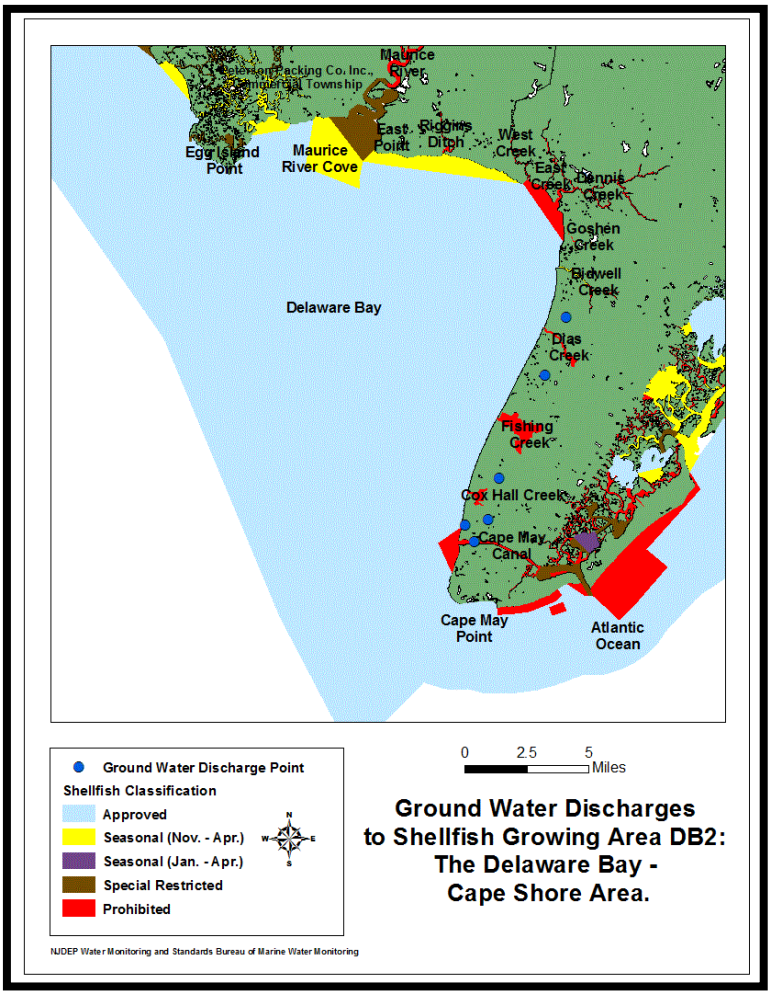


To protect waters from the pollution generated by marina related activities, NJDEP implemented the New Jersey Clean Marina Program. This is a volunteer based program for marinas. The program provides assistance and guidance to marinas as well as boaters on ways to reduce pollution, including sewage facility management, fueling operations, fish and solid waste management and boat cleaning. Currently, there are only a small percentage of marinas in the state that do participate in this program. The lists of marinas that are certified and/or pledged under this program are on http://www.njcleanmarina.org/.

Map Key	Marina Name	Location	# of Wet Slips Total/Boats > 24ft.	*Size of Buffer Area* (radius; feet)	*Average Water Depth (ft)*	*Pumpout Facility*
1	Smokey's Marina	Middle Township	100/0	590	6	No
2	Bayway Marina	Middle Township	66/66	1628	2	Yes
3	Cape May – Lewes Ferry Terminal	Lower Township	4/4	157	13	Yes

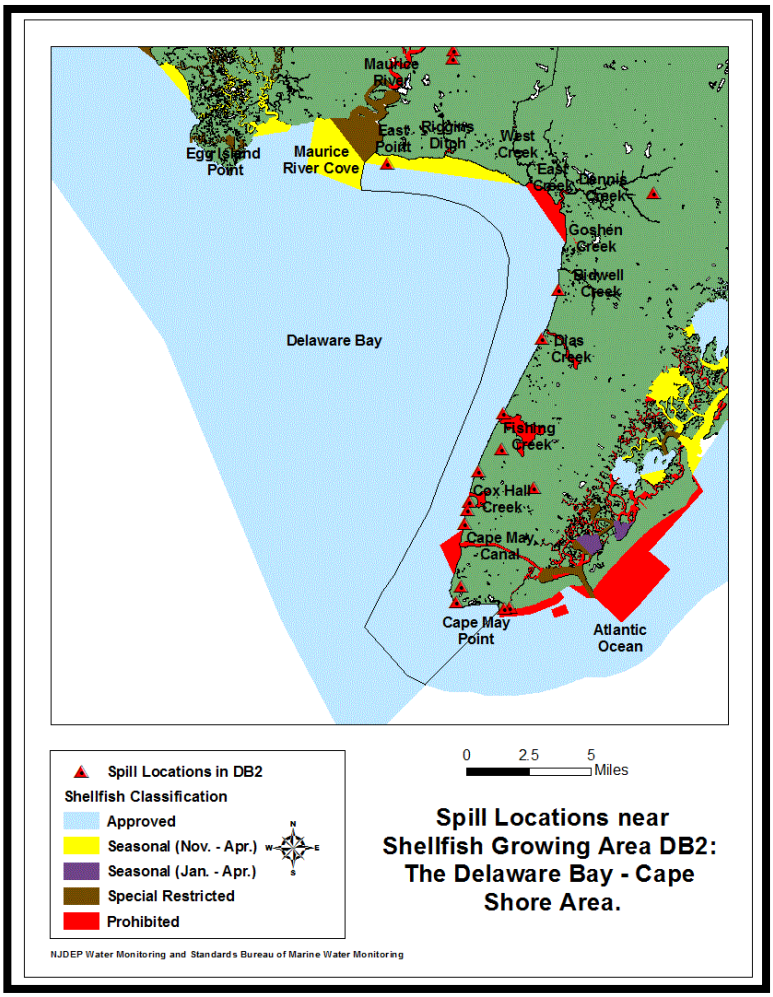
Groundwater Discharges

According to NJPDES, there are several facilities with active Discharge to Groundwater (DGW) permit in this area. Besides groundwater discharger, septic systems are widely used in remote area where public sewer lines are inaccessible. When septic systems fail to function properly, it could lead to groundwater contamination. The location of groundwater injection, surface water discharge (stormwater), and septic areas are shown in the figure to the right.



Spills, Unpermitted Discharges, and Closures

On June 16, 2007, a sewage spill was reported for the area of Main Avenue and Riverside Avenue near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring on this date, approximately 30,000 gallons of sewage spilled into the Maurice River at this location when a malfunction at a pump station caused the sewage to overflow into the storm drain. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. However, the edge of this shellfish growing area is located near the mouth of the Maurice River. This sewage spill was reported as terminated on this date and the cleanup of the area was completed at the time this report was received.



On July 6, 2007, an algae spill was reported for the area of the end of Hollywood Road, in Lower Township, Cape May County. According to the report sent to WM&S' Bureau of Marine Water Monitoring on this date, approximately 1,000 gallons of algae spilled into the Delaware Bay at this location when township personnel unclogged a pipe that was clogged by a recent storm and drained the wetlands south of Tolz Beach. This spill was reported as terminated on this date.

On August 6, 2007, a crude oil spill was reported for the area of Village Road, in Lower Township, Cape May County. According to the report sent to WM&S' Bureau of Marine Water Monitoring on this date, an unknown amount of crude oil spilled onto the beach of the Delaware Bay at this location from an unknown source and the spill was a block long. This crude oil spill was reported as terminated on this date and the cleanup of the area was completed at the time this report was received.

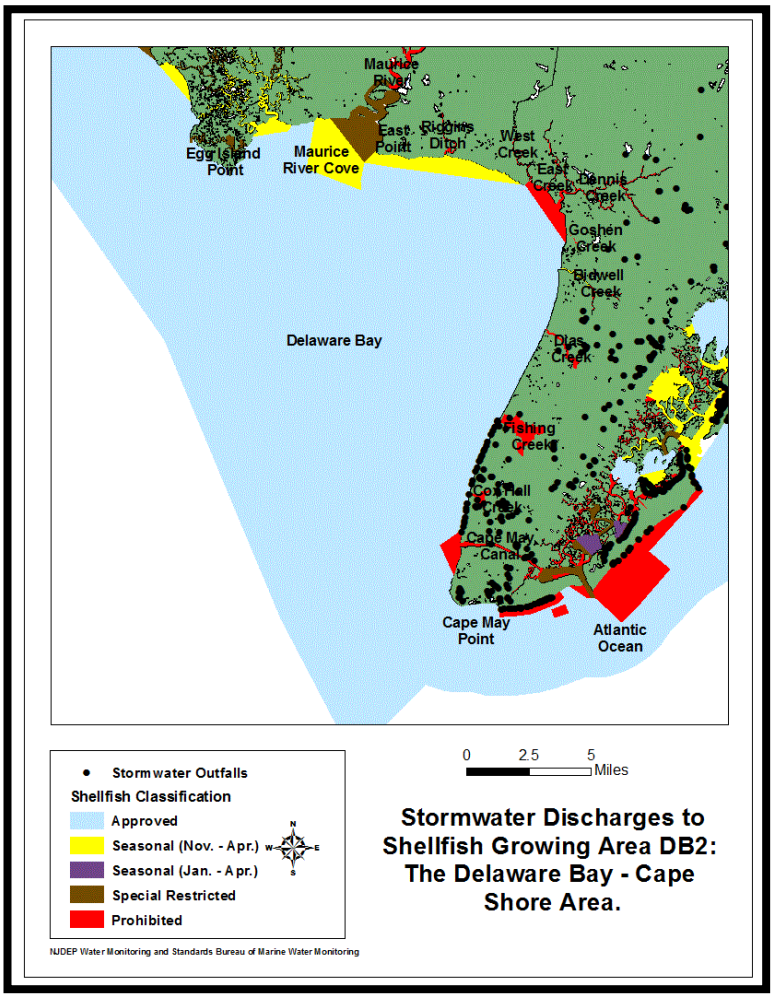
There were no records of spills or unpermitted discharges in the spills database from 2008 to 2012. There were also no emergency closures of shellfish waters in shellfish growing area DB2 due to spills or unpermitted discharges for the time period from May 2007 to April 2012.

Dredging

The process of dredging can impair water quality and contaminate shellfish beds that are living near dredging and disposal sites. WM&S/BMWM is given the opportunity to review such project through CAFRA submission and will deny a project if the proposed dredging or disposal site can potentially contaminate shellfish beds or impair water quality. The bureau's comments are taken into consideration by the NJDEP, Division of Land Use Regulations (DLUR) when approving or denying a permit. There were four dredging projects submitted to DLUR between 2007 and 2012 for this area. A dredging project was submitted for Bidwell's Creek in May 2007 and denied by the WM&S/BMWM because the project and disposal site were located in *Approved* shellfish waters and contamination to shellfish beds were determined to be possible.

Stormwater Discharges

Stormwater runoff is generated when precipitation from rain and snowmelt flows over land or impervious surfaces and does not percolate into the ground. As the runoff flows over the land or impervious surfaces (paved streets, parking lots, and building rooftops), it accumulates debris, chemicals, sediment or other pollutants that could adversely affect water quality if the discharge is untreated run-off. The typical pollutants that are associated with stormwater run-off are bacterial, heavy metals, pesticides, herbicides, chlorides, petroleum, and nutrients. (NJStormwater.Org) Most of the stormwater outfalls within this growing area are near residential and urbanized districts. About 70 outfalls in this area have the potential to impact water quality. The bulk of these outfalls are in Lower Township, Middle Township, and Dennis Township.



These outfalls usually discharge to nearby creeks and lagoon systems. For this reason, shellfish harvesting is condemned in all lagoon system.

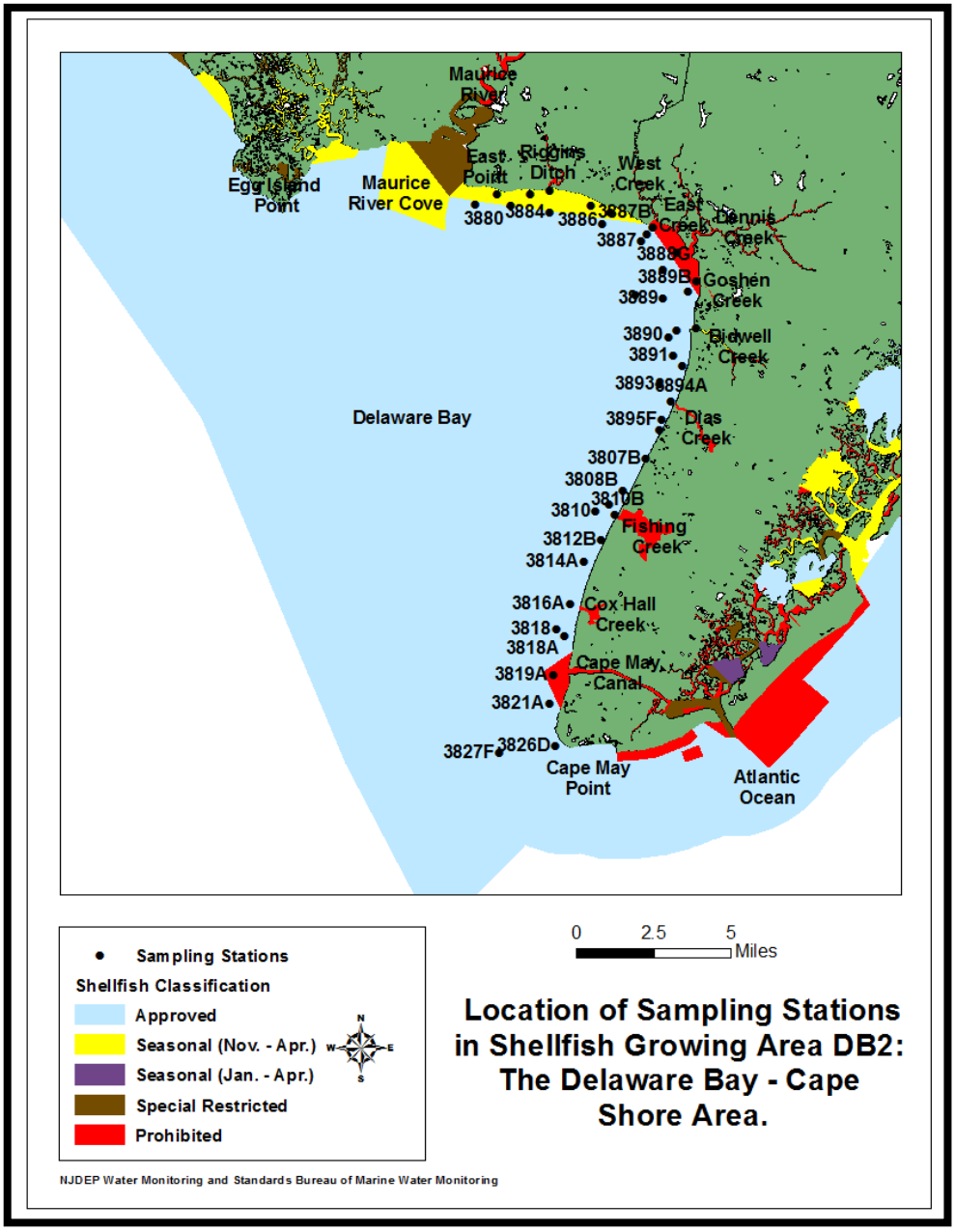
WATER QUALITIES STUDIES

Sampling Strategy

The State Shellfish Control Authority has the option of choosing one of two water monitoring sampling strategies for each growing area. For additional information on the types of sampling strategies, see the *Shellfish Growing Area Report Guidance Document, 2007.* This shellfish growing area could possibly be impacted by the discharges from the sewage treatment facility in this area or combined sewer overflows; therefore, it was sampled under the Adverse Pollution Condition (APC) Strategy.

Methods

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 1992). From 2007 through 2012, approximately 705 water samples were collected for total coliform bacteria from 41 monitoring stations. The locations of these stations are shown in the map below. These samples were analyzed by the standard three-tube MPN method and/or standard three-tube four-dilution method (APHA, 1970). Water quality sampling, shoreline and watershed surveys were conducted in accordance with the NSSP *Guide for the Control of Molluscan Shellfish,* Revision 2009. Data management and analysis was accomplished using database applications developed for the Bureau. Mapping of pollution data was performed with the Geographic Information System (GIS: ARC map).



Bacteriological Quality

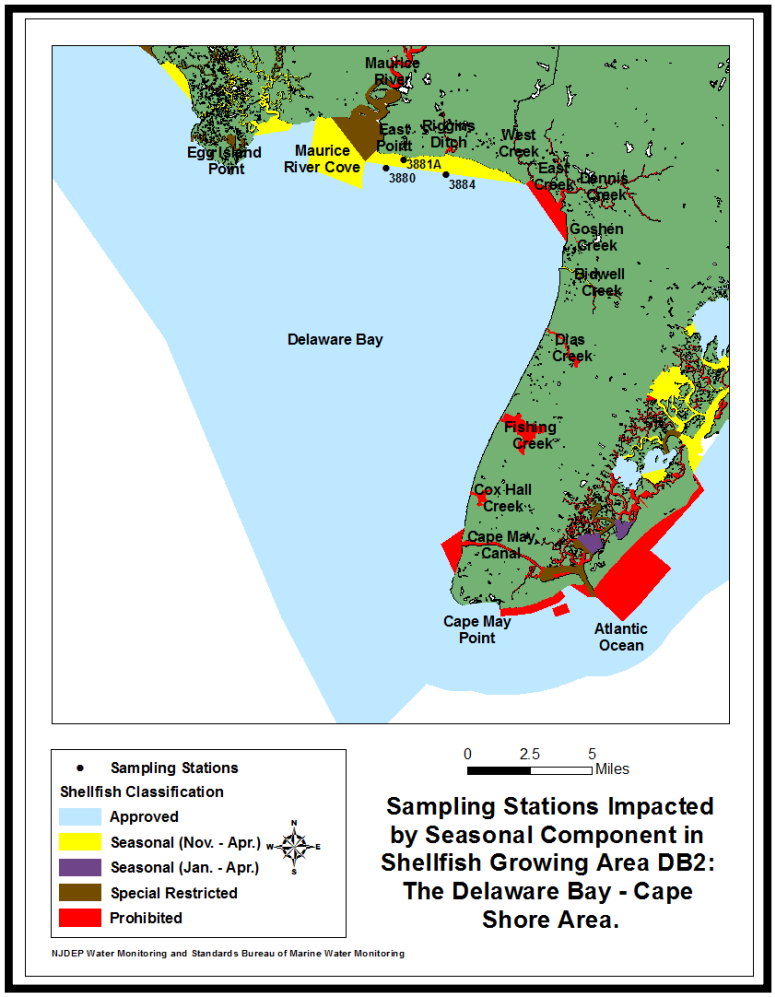
This report includes data analyzed from May 2007 to April 2012. This shellfish growing area is composed of two assignment areas, Assignment 347 (The Delaware Bay - Cape Shore Area) and Assignment 332 (Dividing Creek and Maurice River Cove) are sampled using the APC sampling strategy year-round. Assignment 332 is also sampled with a winter preference during the ebb tide. The preceding figure shows all of the sampling stations for this area. The raw data listings for each sampling station, in accordance with the National Shellfish Sanitation Program (NSSP), are at the end of this report in the Appendix.

Compliance with NSSP SRS Criteria

All of the sampling stations in this shellfish growing area met the *Approved* shellfish classification criteria, year-round, in the summer, and in the winter. Therefore, all of the sampling stations in this area were in compliance with their existing shellfish classification criteria. Some of the other sampling stations in this growing area are also located in shellfish waters that could possibly be impacted by potential sources of pollution, such as the activities in and around the marinas, and the stormwater released from the stormwater outfall pipes into the waters of this area and these shellfish waters are classified accordingly. There were no stations that exceeded the NSSP shellfish classification criteria for water quality in the *Approved*, *Seasonally Approved (November-April)*, and *Prohibited* waters of this shellfish growing area.

Seasonal Effects

As the earth experiences variations in the tilt of its axis and its revolution around the sun, it goes through seasonal phases of summer, spring, autumn, and winter. These seasonal phases cause much variation in the atmosphere of the earth, resulting in changes in weather patterns. Temperature, precipitation, wind, and the general circulation of the atmosphere have seasonal variations that also affect the marine environment (Ingmanson and Wallace, 1989). Seasonal variation may also be the result of a variety of conditions, including specific agricultural land-use practices, biological activity, stream flow and/or sediment.

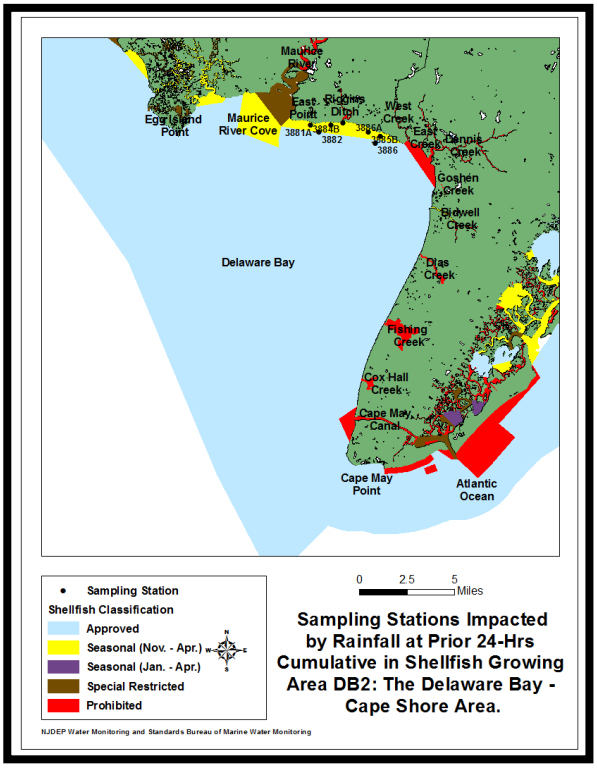


To determine whether seasonal variation can influence bacteria counts, WM&S/BMWM uses a t-test to compare the total coliform MPN values from samples collected during the summer season versus samples collected during the winter months Based on the t-test results, three (3) monitoring stations had a t-statistical probability of less than 0.05. All of these monitoring stations show a higher geometric mean during the summer than during the winter. This shellfish growing area was sampled with no seasonal preference.

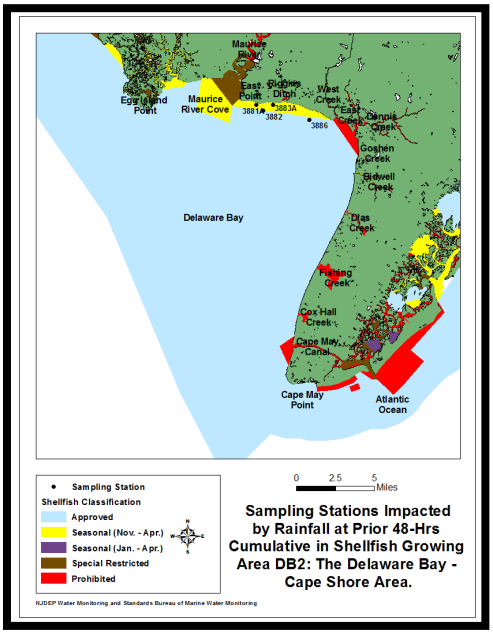
Rainfall Effects

Non-point source pressures on shellfish beds in New Jersey originate in materials that enter the water via stormwater. These materials include bacteria, as well as other waste, that enters the stormwater collection system. To assess rainfall effects, WM&S, BMWM uses the t-test method. This method compares the total coliform MPN values from samples collected during dry weather to samples collected during wet weather. The Wet/Dry Cutoff determines whether a sample was collected under wet or dry condition. Rainfall amounts were from NOAA Station RA035 and RA036. For this growing area, the Wet/Dry Cutoff criterion was set at 0.1 inches, which is the typical standard used for assessing rainfall effects. The t-test calculated the statistical probability for each station based on 24, 48, and 72 hours of rainfall cumulative.

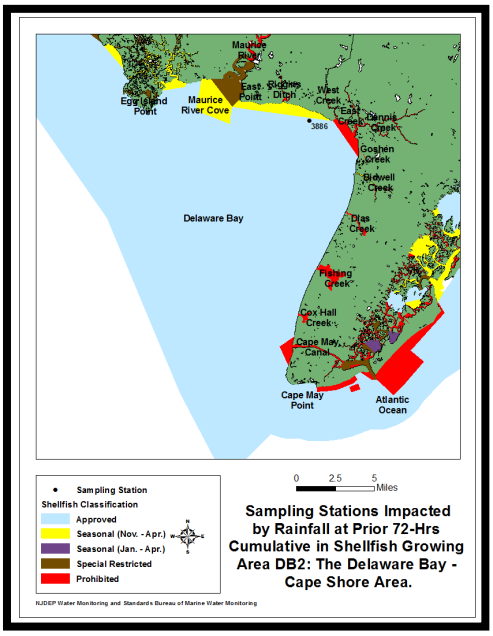
At 24 hours cumulative, seven (7) monitoring stations show a correlation to rainfall. Most of the impacted stations were along the northern shoreline. It was predicted that these stations would respond rapidly to rain due to it close proximity to Riggins Ditch, and the direct discharge flowing from Riggins Ditch into the Delaware Bay. The greatest differences between wet and dry weather geometric mean were in the Delaware Bay south and southwest of Thompsons Beach, and southwest of Moore's Beach.



At 48 hours cumulative, four (4) monitoring stations had a t-statistical probability of less than 0.05. These stations were scattered along the Delaware Bay's northern shoreline. The landscapes surrounding the Delaware Bay are mostly wetland and marshes. These wetlands/marshes can acts as buffer and/or filter against pollutant; thus, delaying the time it takes contaminant to reach open waters.



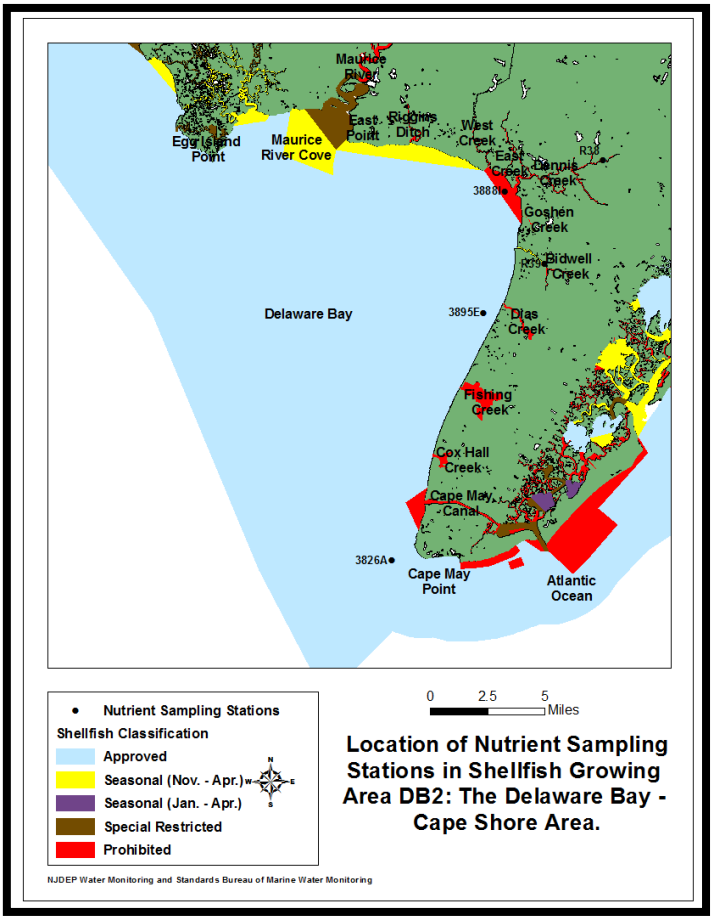
At 72 hours cumulative, there was only one (1) monitoring station affected by rainfall. This monitoring station is located southwest of the shoreline of Moore's Beach in the Delaware Bay. Rainfall did not affect any stations located in the south part of the Delaware Bay. This is perhaps due to the Delaware Bay's water circulation patterns.



RELATED STUDIES

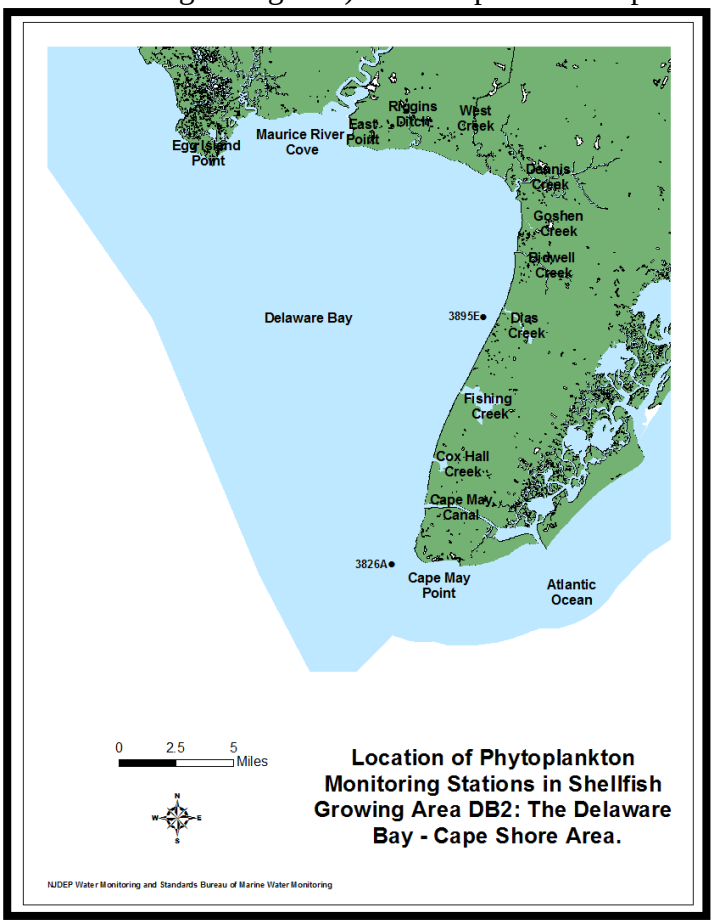
Nutrients

In this growing area, five nutrient monitoring sites were sampled under the estuarine monitoring program. At these nutrient monitoring sites, various parameters were measured including water temperature, salinity levels, secchi depth, total suspended solids, dissolved oxygen levels, ammonia levels, nitrate and nitrite levels, orthophosphate levels, total nitrogen levels, and the inorganic nitrogen to phosphorus ratios. Between 2007 and 2012, 494 water samples were analyzed for these nutrient parameters in this growing area. The table below lists the averages for each of the parameters tested. For full nutrient assessment, see the Estuarine Monitoring Reports, available electronically at: http://www.state.nj.us/dep/bmw/



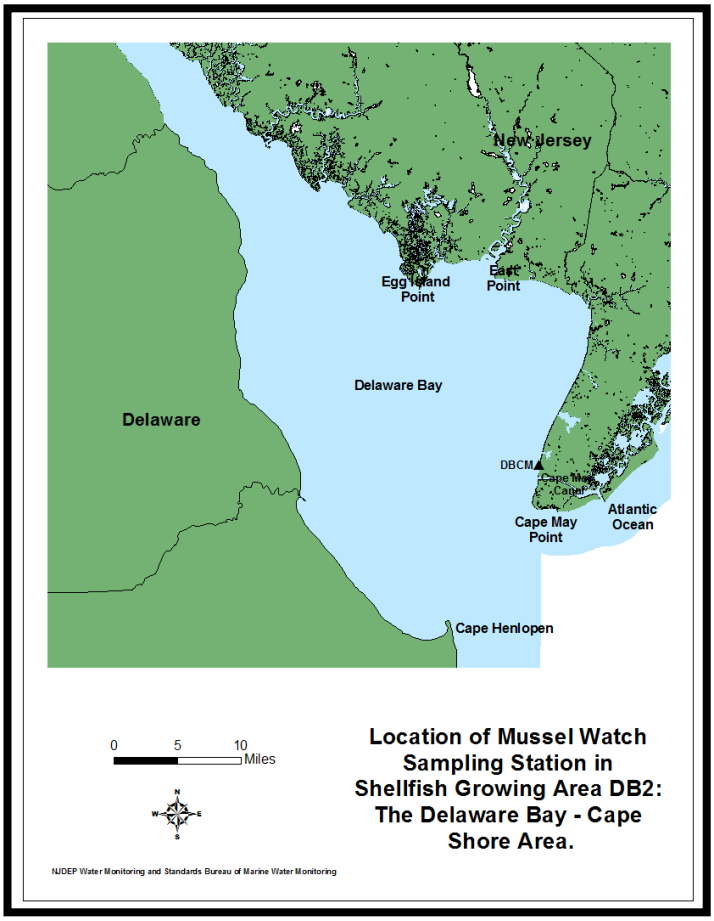
Toxic Monitoring

The Department collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins (see figure for the location of the two phytoplankton sampling stations in this shellfish growing area). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water. Algal blooms were reported each year for the period 2001 to 2005. The areas most severely impacted include the Raritan/ Sandy Hook Bay, the Barnegat Bay, and sporadic offshore areas (NJDEP, 2005). No algal blooms capable of producing biotoxins were identified for the Delaware Bay – Cape Shore area from 2007 to 2012 (NJDEP, 2012). The phytoplankton monitoring of sampling stations in New Jersey waters is available electronically at: www.nj.gov/dep/bmw/.



Mussel Watch Sampling Stations

The NOAA Mussel Watch Program is a program that monitors the levels of toxins and metals in coastal waters (National Oceanic and Atmospheric Administration, 1998). The blue mussel, *Mytilus edulis*, occurs worldwide, effectively takes up toxins and metals from seawater and sediment, and concentrates them in their living tissues. Assays from the living tissues of this shellfish can be made easily and cheaply. The Mussel Watch Program monitors metals such as mercury, lead, zinc, nickel, cadmium, copper, chromium, aluminum, silicon, manganese, iron, arsenic, selenium, tin, antimony, thallium, and silver. The program also monitors toxins such as the synthetic organic compounds that are widely used in pesticides, solvents, flame-retardants, and other products. There is one NOAA Mussel Watch Sampling Station located in this shellfish growing area, and it is DBCM (Delaware Bay, Cape May) (see the figure on this page).



From 2007 to 2012, a review of the Mussel Watch data for Mussel Watch Sampling Station DBCM showed that the levels of the contaminants and pesticides in the assays of the living tissues of the mussels sampled did not exceed the FDA criteria (Conversation of dry weight to wet weight units with Robert Schuster, NJDEP, 2005, NOAA, 1998).
Additional information about this station and the NOAA Mussel Watch Program is available at: http://nsandt.noaa.gov.

CONCLUSIONS

Based on the bacteriological data assessed, all of the sampling stations within this growing area meet their current shellfish classifications. The overall water quality for this growing area is good. No significant changes to landuse pattern, hydrography, or discharges that would change the shellfish waters classification in this area.

RECOMMENDATIONS

Continue sampling using the existing Systematic Random Sampling (SRS) Strategy for Assignments 332 and 347.

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