NJ Department of Environmental Protection
Water Monitoring and Standards

Reappraisal Report of Shellfish Classification for Growing Area DB2

(The Delaware Bay – Cape Shore Area)

December 2014

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

NJ Department of Environmental Protection
Bob Martin, Commissioner

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December 2014

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Cover Photo – Cape May Point Lighthouse, Cape May Point, NJ (photo by Paul Wesighan on April 2, 2015).

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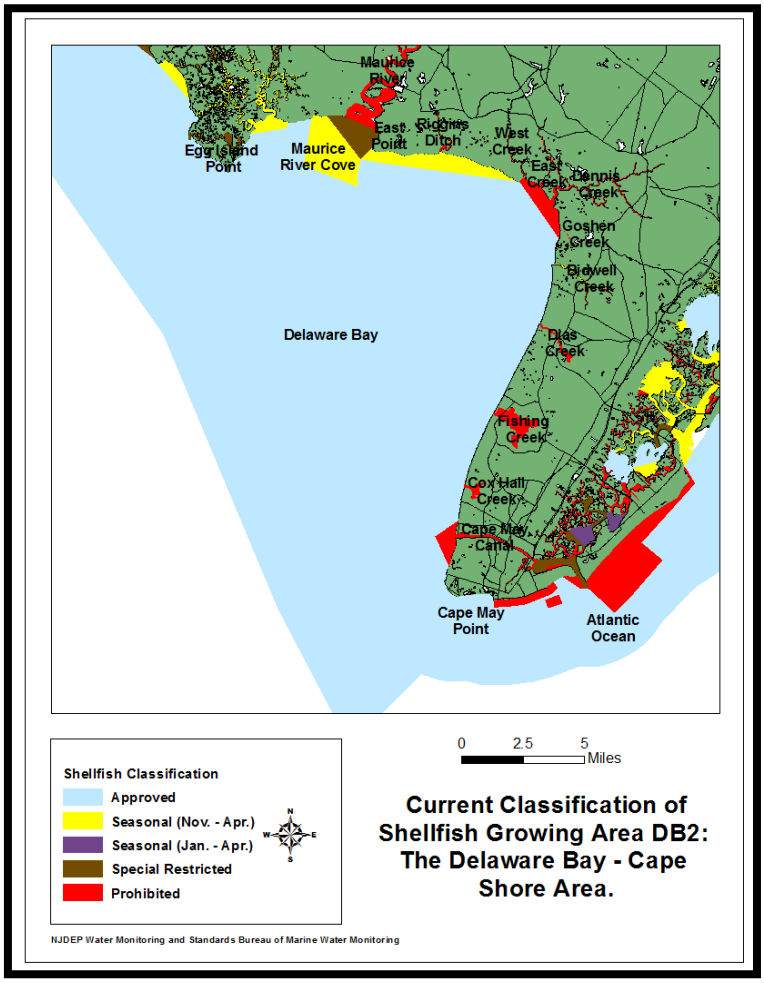
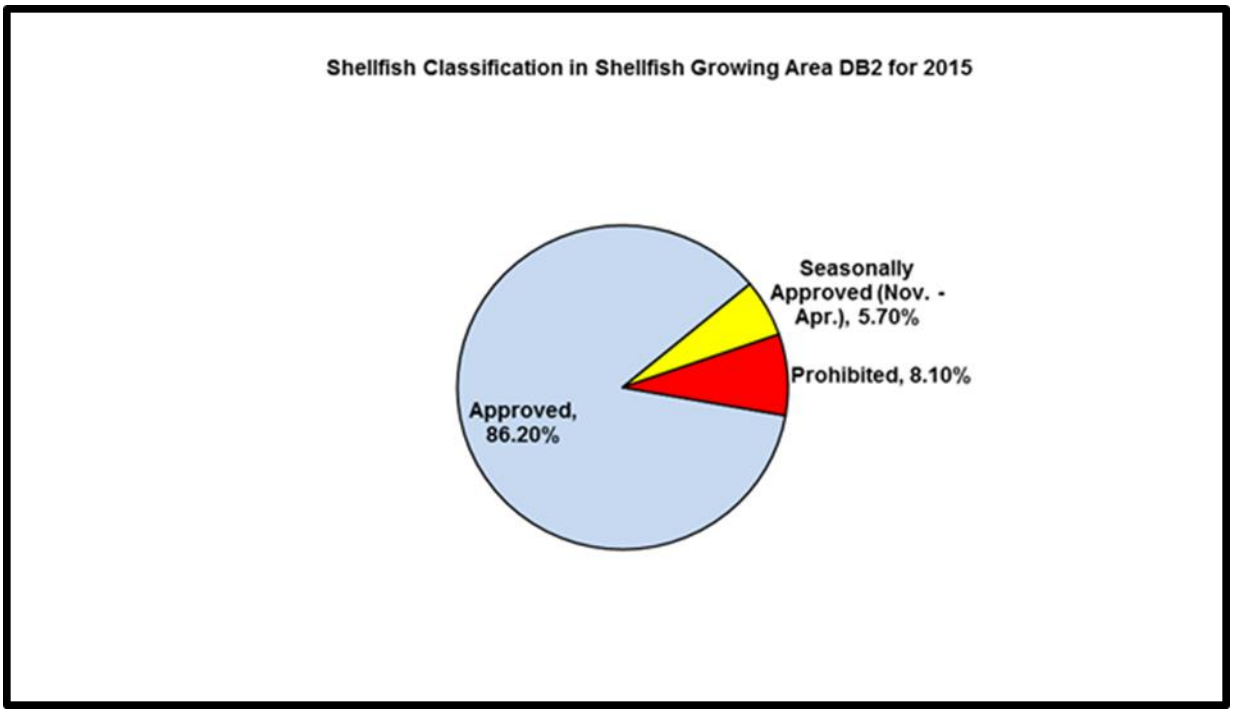
EXECUTIVE SUMMARY

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 (86.2%)*, *Seasonally Approved (November to April) (5.7%)*, and *Prohibited (8.1%)* for shellfish harvesting (as seen in the figure to the right).



This report includes water quality data collected between January 1, 2011 to September 30, 2014 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 960 water samples were analyzed for fecal coliform bacteria from 46 monitoring stations. All but two sampling stations (**3880** and **3895F**) were in compliance with the fecal coliform criteria for the *Approved*, *Seasonally Approved (January to April)*, and *Prohibited* classifications of this shellfish growing area, as specified by the National Shellfish Sanitation Program (NSSP). Sampling Station **3880** is located south of East Point in *Approved* shellfish waters and Sampling Station **3895F** is located southwest of the mouth of Dias Creek in *Approved* shellfish waters and both of these sampling stations exceeded the shellfish classification criteria, year-round and in the summer, for these waters. The overall water quality for this growing area is generally good. There were no significant changes to land use 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. Since it was the second year that Sampling Station **3880** exceeded the existing *Approved* shellfish classification criteria, five new sampling stations were added to the area around this sampling station to determine the size of the area that would need to be downgraded in the future.



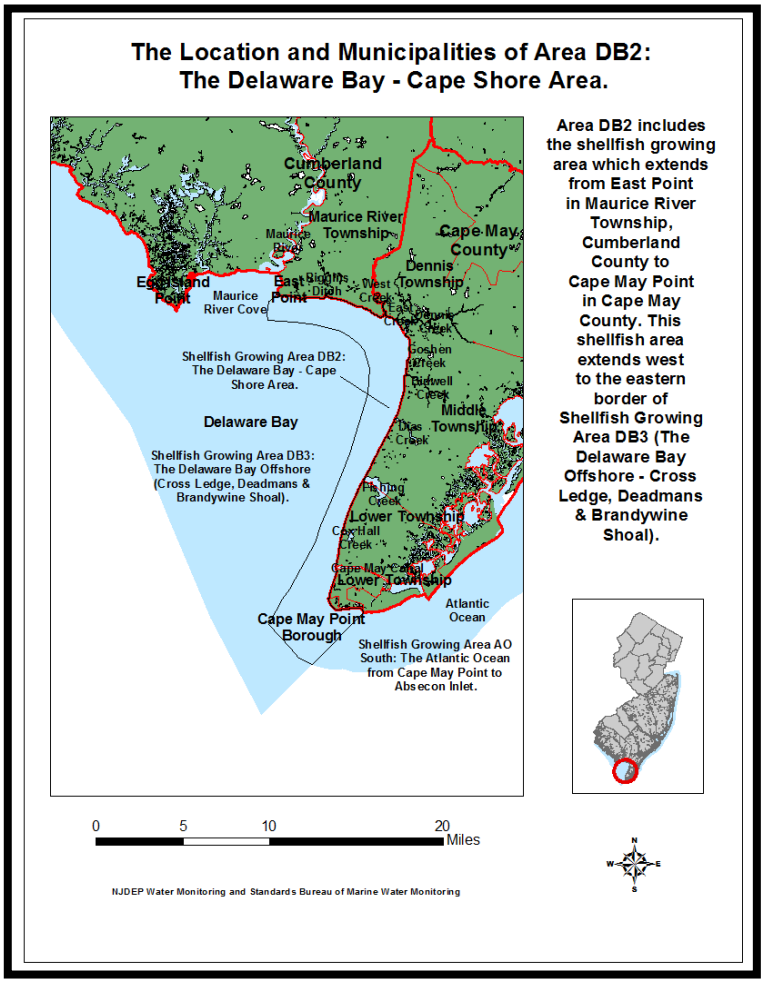
DESCRIPTION OF GROWING AREA

Location & Description

Shellfish Growing Area DB2 is located in the southwestern part of New Jersey (see figure on next page). 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.

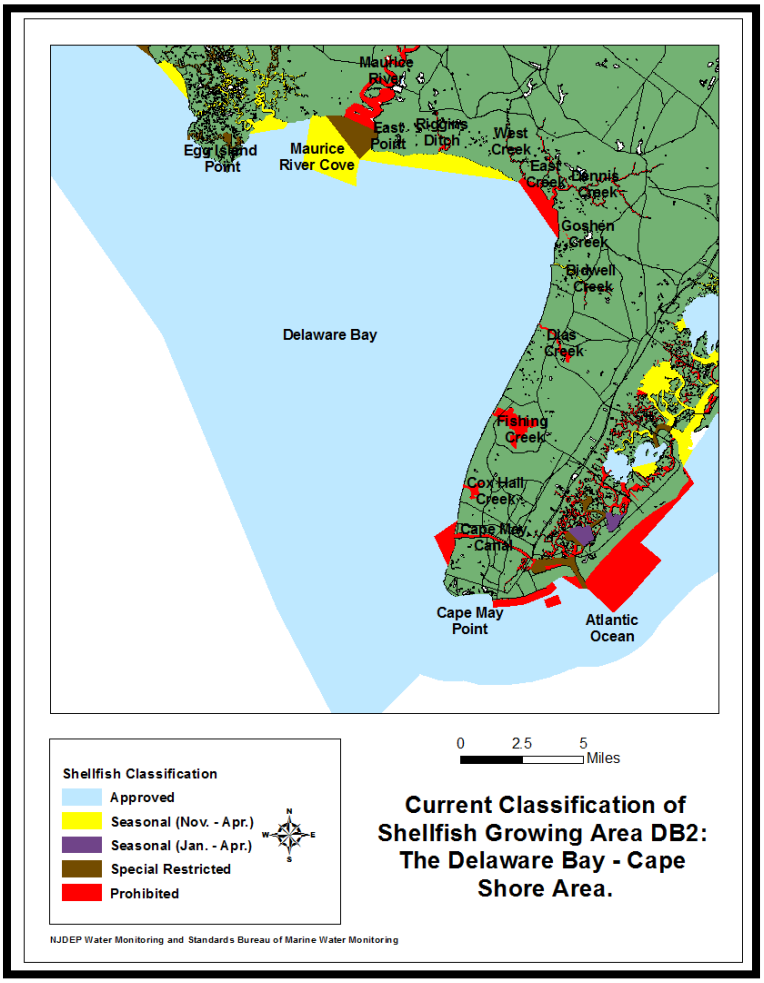


In Cumberland County, Riggins Ditch and West Creek drain into this shellfish growing area. In Cape May County, West Creek, East Creek, Dennis Creek, Roaring Ditch, Old Robins Branch, Crow Creek, Sluice Creek, Goshen Creek, Bidwell Creek, Dias Creek, Green Creek, Fishing Creek, Cox Hall Creek, Pond Creek, 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 on the next page 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 Bidwell 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 Bidwell 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 2011 Annual Reviews of Shellfish Growing Area DB2, no classification changes were proposed (NJDEP, 2011, NJDEP, 2012). 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.

In the 2012 Annual Reviews of Shellfish Growing Area DB2, one sampling station (**3880**) exceeded the *Approved* shellfish classification criteria. This sampling station is located south of East Point in *Approved* shellfish waters. It was recommended that this sampling station be closely monitored during shoreline surveys of this area since it was the only sampling station in the area to exceed its existing shellfish classification.

In the 2013-2014 Annual Review of Shellfish Growing Area DB2, two sampling stations (Sampling Stations **3880** and **3895F**) exceeded the existing *Approved* shellfish classification criteria. Sampling Station **3880** is located south of East Point in *Approved* shellfish waters and Sampling Station **3895F** is located southwest of the mouth of Dias Creek in *Approved* shellfish waters and both of these sampling stations exceeded the shellfish classification criteria, year-round and in the summer, for these waters. In the Annual Review, it was recommended that these sampling stations be closely monitored during shoreline surveys of this area. Since it was the second year that Sampling Station **3880** exceeded the existing *Approved* shellfish classification criteria, five new sampling stations were added to the area around this sampling station to determine the size of the area that would need to be downgraded in the future. 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 2014 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/.

Evaluation of Biological Resources

This growing area has a wide diversity of biological resources. The total shellfish landings for New Jersey from 2011 to 2014 can be seen in the table below (NMFS, 2015). 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 2014 at the time this reappraisal report was written.

New Jersey Shellfish Landings - 2011 to 2014 (NMFS, 2015).

NEW JERSEY SHELLFISH LANDINGS 2011 to 2014		
YEAR	POUNDS OF MEAT (millions)	$ VALUE (exvessel)
2011	65,425,598	$177,229,339
2012	57,692,498	$146,048,687
2013	46,002,626	$96,407,954
2014	*	*

* 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 2014; 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 2011, the landings of blue crabs were 9,599,249 pounds harvested for an exvessel value of $9,418,538 (NMFS, 2015). In New Jersey for 2013, the landings of blue crabs were 4,390,692 pounds harvested for an exvessel value of $8,114,944 (NMFS, 2015). 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, and the Egg Island Berrytown Wildlife Management Area.

SHORELINE SURVEY: EVALUATION OF POTENTIAL POLLUTION SOURCES

Shoreline Survey

The shoreline survey that was performed for this area on April 2, 2015 and June 30, 2015 determined that there have been minor changes made to the area since the last reappraisal of this area.

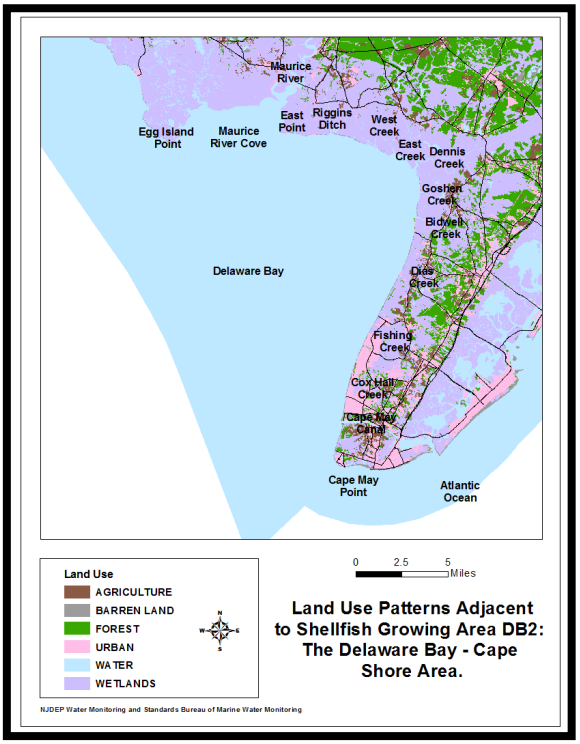
There were photographs taken during the shoreline survey of this shellfish growing area on April 2, 2015 and June 30, 2015. The photograph on the front cover shows the location of the Cape May Point Lighthouse in Cape May Point, NJ, taken on April 2, 2015. Additional photos taken during the shoreline surveys of this area are attached at the end of this report in the Supporting Documentation section, including photographs of the septic tanks for the homes in the Reeds Beach area taken on June 30, 2015.

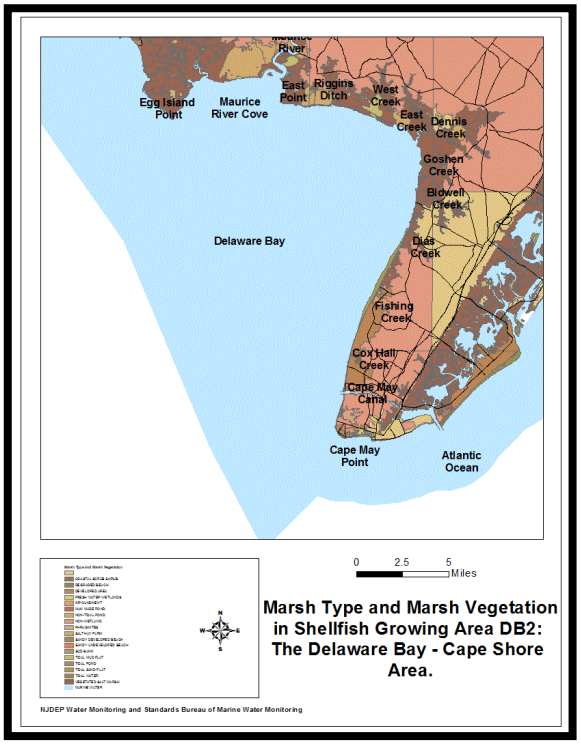
During the shoreline survey of this area on June 30, 2015 at the Cape May – Lewes Ferry Terminal, there are three active vessels and one decommissioned vessel. There are pump stations on the three active docks that pump the sewage from the vessels to emacerators that grind up any solids and the sewage is then pumped to the sewer main in the street. At Smokey's Marina, there are a number of floating docks that make up the 100 total wet slips for this marina.

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.

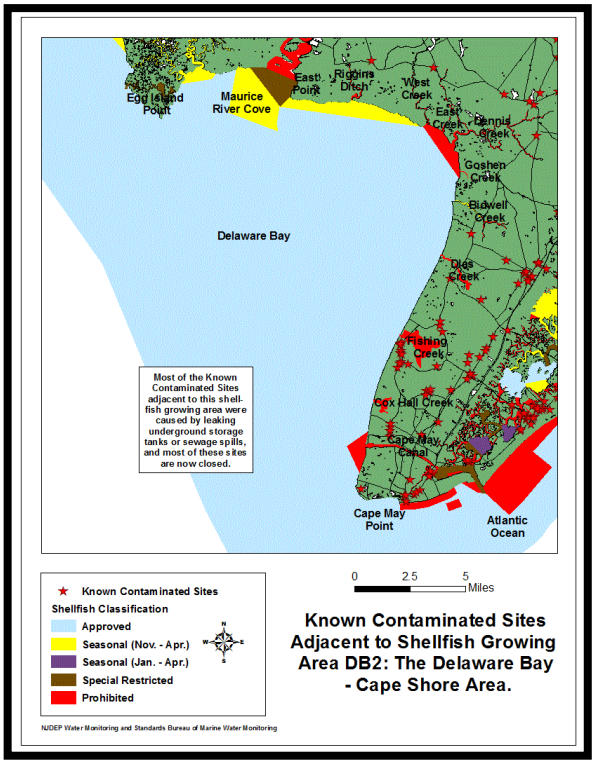
The wetlands surrounding this shellfish growing area also contain the Cape May National Wildlife Refuge to the east, the Dennis Creek Wildlife Management Area to the northeast, and Corsons Wildlife Management Area, Heislerville Wildlife Management Area, and the Egg Island Berrytown Wildlife Management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


Maurice River
Egg Island Point
Maurice River Cove
East Point
Riggins Ditch
West Creek
East Creek
Dennis Creek
Goshen Creek
Bidwell Creek
Delaware Bay
Dias Creek
Fishing Creek
Cox Hall Creek
Cape May Canal
Cape May Point
Atlantic Ocean
Land Use
AGRICULTURE
BARREN LAND
FOREST
URBAN
WATER
WETLANDS
0 2.5 5
Miles
Land Use Patterns Adjacent to Shellfish Growing Area DB2: The Delaware Bay - Cape Shore Area.
NJDEP Water Monitoring and Standards Bureau of Marine Water Monitoring


Egg Island Point
Maurice River Cove
East Point
Riggins Ditch
West Creek
East Creek
Dennis Creek
Goshen Creek
Bidwell Creek
Delaware Bay
Dias Creek
Fishing Creek
Cox Hall Creek
Cape May Canal
Cape May Point
Atlantic Ocean
0 2.5 5
Miles
Marsh Type and Marsh Vegetation in Shellfish Growing Area DB2: The Delaware Bay - Cape Shore Area.
NJDEP Water Monitoring and Standards Bureau of Marine Water Monitoring

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).

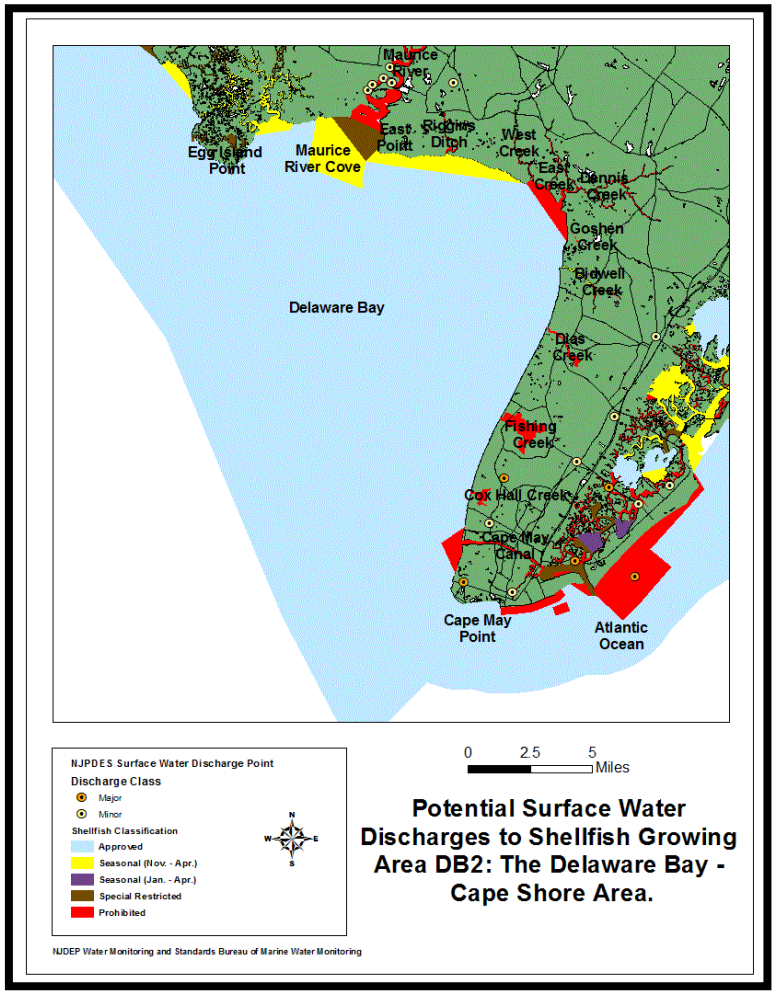


This shellfish growing area, which extends from East Point to Cape May Point, has several known contaminated sites located in the adjacent areas (see figure to the right). The major concentrations of these known contaminated sites are located to the east in Lower Township, Middle Township, and to the 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

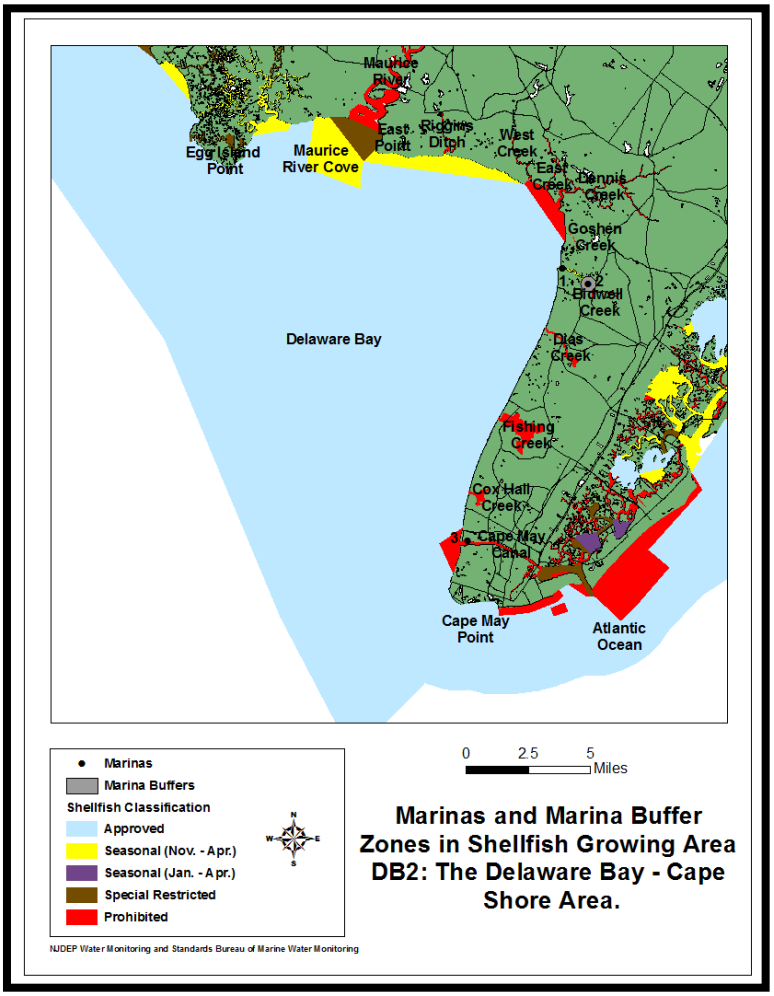
The discharge of pollutant from a point source is authorized under New Jersey Pollutant Elimination System (NJPDES), and the regulations are found at N.J.A.C. 7:14A. The main purpose of the NJPDES program is to ensure proper treatment and discharges of wastewater. By doing so, the permit limits the amount 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 are 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 (3) 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/.

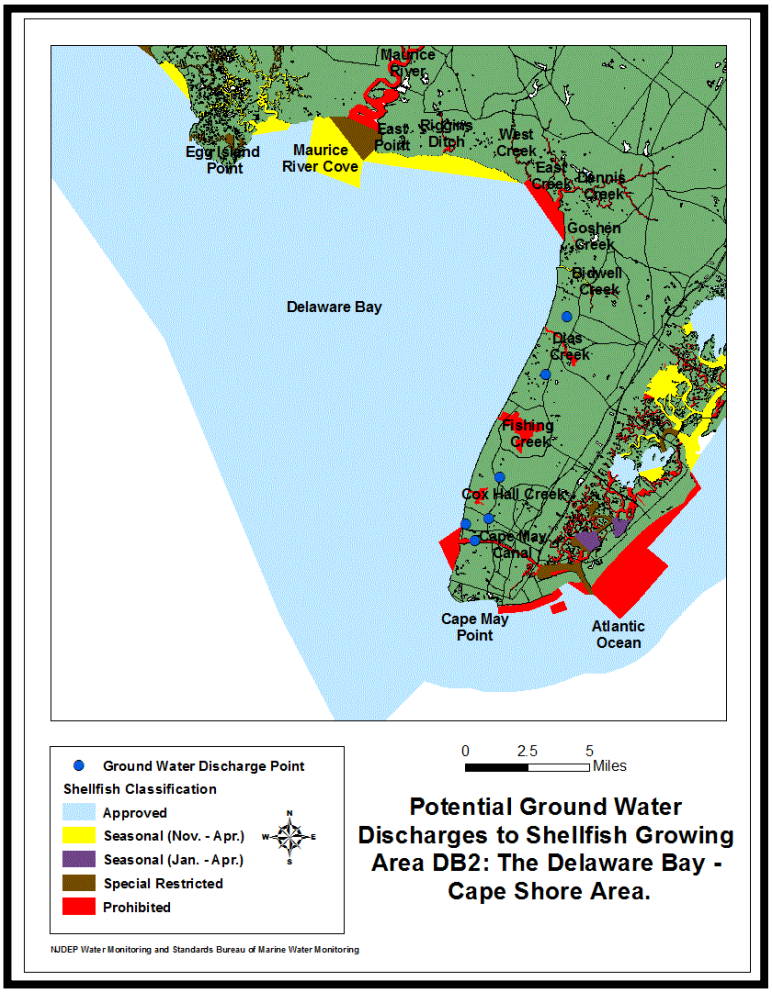
At the Cape May – Lewes Ferry Terminal, there are three active vessels and one decommissioned vessel. There are pump stations on the three active docks that pump the sewage from the vessels to emacerators that grind up any solids and the sewage is then pumped to the sewer main in the street.

At Smokey's Marina, there are a number of floating docks that make up the 100 total wet slips.

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 discharges are shown in the figure to the right.



Spills, Unpermitted Discharges, and Closures

There were no records of spills or unpermitted discharges for this area in the spills database from 2011 to 2014. 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 January 2011 to September 2014.

Naturally Occurring Pathogens

The bacteria *Vibrio parahaemolyticus* (*Vp*) is a naturally occurring bacterium found in coastal waters that causes illness from eating infected raw oysters, clams, and mussels. It is not related to pollution, which means that traditional controls for shellfish sanitation related to growing water classification are marginally effective. Instead, the occurrence of this pathogen in elevated levels appears to be related to the interaction of environmental variables such as temperature, salinity, fresh water inflow to the bay and tidal flushing. The *Vp* bacteria thrives under warm temperatures and is linked to raw oysters harvested and consumed during the summer months. Symptoms of *Vp* illness include diarrhea, nausea, vomiting, abdominal cramps, and in some cases, fever and chills.

In 2002, an investigation by the New Jersey Department of Health and Senior Services (DHSS) reported that two cases of *Vibrio parahaemolyticus* (*Vp*) illness were traced to oysters that were harvested in the Delaware Bay in June of 2001, and portions of the Delaware Bay northwest of a line from Egg Island Point through the Miah Maull Shoal Light (part of Shellfish Growing Area DB1) were closed for shellfish harvesting on July 29, 2002, as required by the National Shellfish Sanitation Program.

The 2002 *Vibrio parahaemolyticus (Vp)* monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, from May 28 through September 24, 2002. A total of 42 oyster samples (sample consists of the homogenate of 12 animals) from eight harvest areas (New Beds, Benny Sands, Hog Shoal, Site #1, Site #8, Site #9, Site R-1, and Site R-2) in the Delaware Bay were collected and analyzed during the 2002 season.

Overall, *Vp* levels detected during the 2002 season were low (the highest total *Vp* was 820 CFU/gram at the New Beds site on July 29, 2002). All sample results for total Vp and the pathogenic strain (tdh) were significantly below the National Shellfish Sanitation Program's guidelines. The revocation of this suspension of the shellfish harvest was put into effect on August 9, 2002, and these shellfish growing waters were returned to their *Approved, Seasonally Approved (November to April),* and *Special Restricted* shellfish classification.

The overall conclusion of the 2002 *Vibrio parahaemolyticus* (*Vp*) monitoring in the Delaware Bay suggested that the *Vp* illnesses were the result of temperature abuses of the oysters after being harvested. Control measures were then suggested and implemented for the harvest of oysters in the Delaware Bay, and the time of harvest was set from 6 A.M to noon for the months of August and September, and enhanced supervision from DEP and DHSS staff to assure compliance with DHSS regulations to minimize the post-harvest growth of *Vp* in the oysters harvested.

In May 2003, the Delaware Bay Shellfish Council agreed to suspend direct market harvesting of oysters from the Delaware Bay from mid to late June, which would coincide with the time frame when oysters are harvested that have been linked to *Vp* illnesses. The New Jersey Department of Health and Senior Services (DHSS) also recommended further measures to insure post-harvest temperature control of oysters for the summer harvesting season, which included the use of light colored tarps to shade the harvested oysters from heating by the sun while on the deck of the boats, the use of open mesh bags or cages to allow air circulation, and a process to maintain oysters wet from harvest through unloading of the oysters from the boats, unless an onboard refrigeration system is provided to chill the product. These recommendations were implemented and are still in effect as of the date of this report.

The 2004 *Vibrio parahaemolyticus* (*Vp*) monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, from June 1 through September 21, 2004. Since there were no reported illnesses attributed to Delaware Bay oysters in 2004, sampling was reduced to a monthly regime instead of the weekly sampling performed during the three previous years. A total of 8 oyster samples from two harvest areas (New Beds and Benny Sands) in the Delaware Bay were collected and analyzed during the 2004 season.
Overall *Vp* levels detected during the 2004 season were very low (highest total *Vp* was 270 CFU/gram on July 20, 2004). All sample results for total *Vp* and the pathogenic strain (tdh) were significantly below the National Shellfish Sanitation Program's guidelines. Additionally, three time/temperature studies were performed on June 30, July 21, and September 22, 2004. This project was funded by a FDA grant and was designed to evaluate the effects of post-harvest handling of oysters on *Vp* levels. Data for this study was presented at the October 2004 Interstate Seafood Conference in Virginia Beach, Va.
The 2005 *Vibrio parahaemolyticus* (*Vp*) monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, from June 24 through September 20, 2005. A total of 10 oyster samples from two harvest areas (New Beds and Benny Sands) in the Delaware Bay were collected and analyzed. Overall, *Vp* levels detected during the 2005 season were low, with the exception of the 7600 CFU/gram detected on July 24, 2005.

The pathogenic strain of *Vp* was detected at the action level from the New Beds site on June 24, 2005, and approximately 93 square miles of the shellfish waters in the north part of the Delaware Bay northwest of a line from the mouth of Straight Creek to Cross Ledge Lighthouse (part of Shellfish Growing Area DB1) were closed to shellfish harvesting due to the presence of the pathogen *Vibrio parahaemolyticus (Vp)* in levels that exceeded the acceptable criteria. The revocation of this suspension of the shellfish harvest was put into effect on July 9, 2005, and these shellfish growing waters were returned to their *Approved* and *Seasonally Approved (November to April)* shellfish classification.

The 2006 *Vibrio parahaemolyticus* (*Vp*) monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, on June 19, 2006. On this date, a total of two oyster samples from two harvest areas (New Beds and Benny Sands) in the Delaware Bay were collected and analyzed during the 2006 season. Overall *Vp* levels detected during the 2006 season were very low (highest total *Vp* was 140 CFU/gram). All sample results for total *Vp* and the pathogenic strain (tdh) were significantly below the National Shellfish Sanitation Program's

guidelines. There were no reported illnesses attributed to Delaware Bay oysters in New Jersey for 2006.

The 2007 *Vibrio parahaemolyticus* (*Vp*) monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, on June 19, 2007. On this date, a total of two oyster samples from two harvest areas (New Beds and Benny Sands) in the Delaware Bay were collected and analyzed during the 2007 season. Overall *Vp* levels detected during the 2007 season were very low (highest total *Vp* was 170 CFU/gram). All sample results for total *Vp* were significantly below the National Shellfish Sanitation Program's guidelines. The sample results for the pathogenic strain (tdh) were unknown because there was no color reaction with the tdh control filter. There were no reported illnesses attributed to Delaware Bay oysters in New Jersey for 2007.

The 2008 *Vibrio parahaemolyticus* (*Vp*) monitoring of oysters from the Delaware Bay was performed by WM&S' Bureau of Marine Water Monitoring, on June 17, 2008. On this date, a total of two oyster samples from two harvest areas (New Beds and Benny Sands) in the Delaware Bay were collected and analyzed. The *Vp* levels detected on this date were very low (highest total *Vp* was 210 CFU/gram). All sample results for total *Vp* were significantly below the National Shellfish Sanitation Program's guidelines. The sample results for the pathogenic strain (tdh) were unknown because there was no color reaction with the tdh control filter.

On August 19 2008, two reported cases of *Vibrio parahaemolyticus* (*Vp*) illnesses in Maryland were attributed to oysters harvested in New Jersey waters of the Delaware Bay and the shellfish harvest of oysters, clams, and mussels was suspended for approximately 130 square miles of shellfish growing waters in area DB1 northwest of a line from the East Point Lighthouse to Flashing Green 2.5 second "5" in the Maurice River Approach Channel to Flashing 4 second "3" to a point at Latitude 39 degrees 10 minutes 23.3 seconds N., Longitude 75 degrees 2 minutes 19.99 seconds W. to Flashing 4 second 27 feet 7M southeast of Egg Island Point to Elbow of Cross Ledge at Iso 6 second 61 feet 11 M Horn. The revocation of this suspension of the shellfish harvest was ended on August 28, 2008, and these shellfish growing waters were returned to their *Approved, Seasonally Approved (November to April), Special Restricted,* and *Prohibited* shellfish classification.

Every State from which shellfish are harvested is required to conduct a *Vibrio parahaemolyticus* risk evaluation annually. This evaluation considers the interaction of environmental variables such as temperature, salinity, fresh water inflow to the bay and tidal flushing, including seasonal variations in these factors to determine whether the risk of *Vibrio parahaemolyticus* infection from the consumption of oysters harvested from an area is reasonably likely to occur. Based on this assessment, a *Vibrio parahaemolyticus* Management Plan for control measures was developed for New Jersey in January 2010, and put into effect in June 2010.

The *Vibrio parahaemolyticus* Management Plan serves as a document by which the Department establishes shellfish harvest control measures, which can include restrictions on the hours of the harvest of shellfish as per the National Shellfish Sanitation Program (NSSP), requirements to minimize the growth of the pathogen and consequently reduce the risk of illness for the protection of public health. The requirements implemented through the *Vibrio parahaemolyticus* Management Plan were developed through consultation and cooperation with the New Jersey Department of Health and Senior Services, (DHSS), the NJDEP Bureaus of Marine Water Monitoring, Division of

Fish & Wildlife, Shellfisheries, and Marine Law Enforcement; and the U.S. Food and Drug Administration, (FDA), along with New Jerseys' shellfish industry.

In 2012, an intensive study of *Vibrio parahaemolyticus (Vp)* in the oysters harvested in the Delaware Bay was undertaken. Two sampling stations (Delaware Bay – Cape Shore and Delaware Bay - Rutgers Laboratory) were located along the coast of the Delaware Bay in Middle Township, Cape May County. In 2013, the station at Rutgers Laboratory was dropped, and the focus shifted to the Delaware Bay – Cape Shore station for intertidal sampling and the stations from Cohansey to New Beds for subtidal sampling.

In 2013, oyster tissue samples were collected at the intertidal *Vibrio parahaemolyticus (Vp)* sampling beds (Delaware Bay Cape Shore Atlantic Capes Fisheries) in this shellfish growing area. On 15 dates in 2013 (6/17, 6/18, 6/19, 6/20, 7/16, 7/17, 7/18, 7/29, 7/30, 7/31, 8/1, 8/12, 8/13, 8/14, and 8/15), *Vibrio parahaemolyticus* oyster tissue results were very high (ranging from 1,000 on 8/13 to 23,000 on 6/19). There were no closures of shellfish waters for the Delaware Bay – Cape Shore area in 2013.

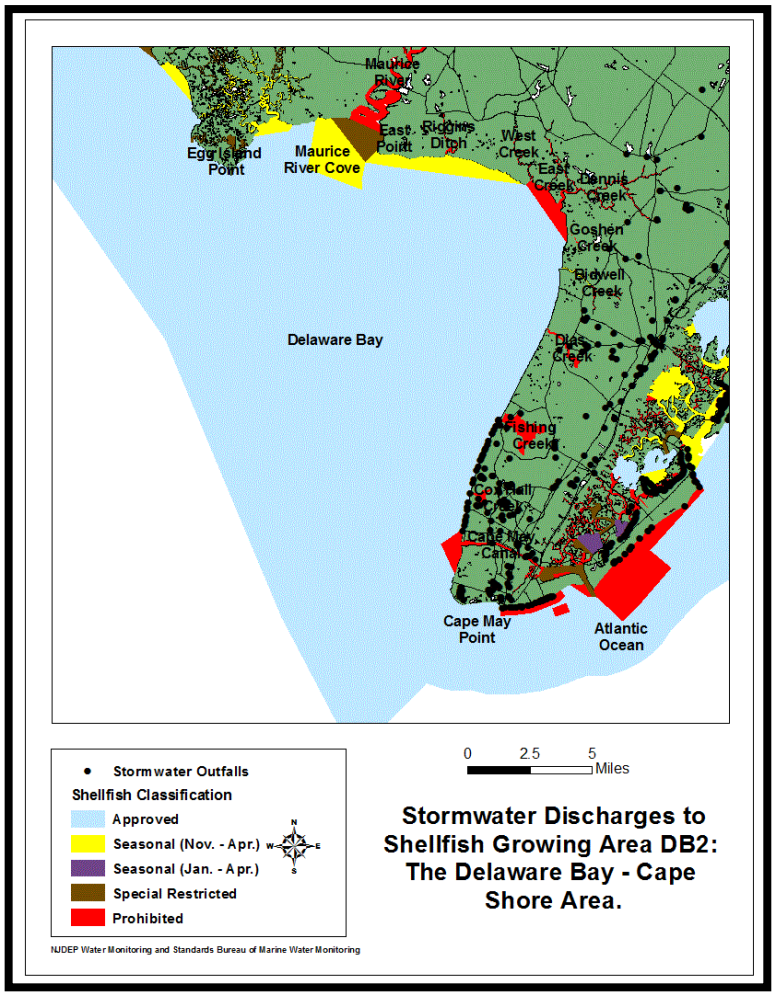
On July 19, 2013, the DEP issued a suspension of the oyster harvest from the Shell Rock oyster bed in Shellfish Growing Area DB1 for the Delaware Bay. This suspension was the result of two reported cases of the naturally occurring pathogen Vibrio parahaemolyticus (Vp) in Ocean City, Maryland. These Vp illnesses were attributed to the consumption of raw oysters from the Shell Rock oyster bed in the Delaware Bay, New Jersey. Based on the results from the analysis of shellfish tissue samples, no additional reported illnesses, and changes in environmental factors, this closure was lifted on August 15, 2013.

In 2014, oyster tissue samples were collected at the stations from Cohansey to New Beds for subtidal *Vibrio parahaemolyticus* sampling. The intertidal *(Vp)* sampling beds (Delaware Bay Cape Shore Atlantic Capes Fisheries) in this shellfish growing area were dropped from the sampling schedule.

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 systems.



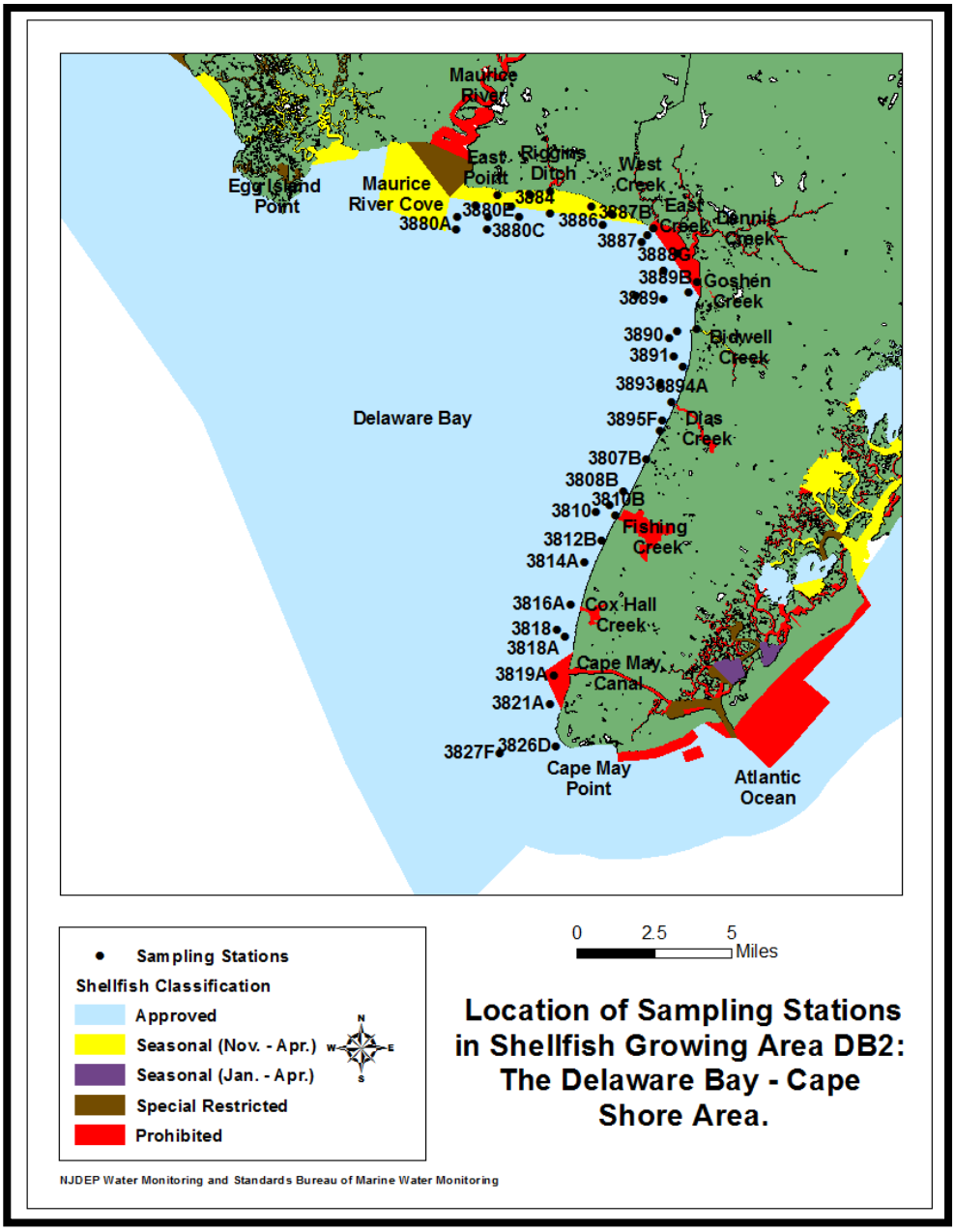
WATER QUALITIES STUDIES

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 2011 through 2014, approximately 960 water samples were collected for fecal coliform bacteria from 46 monitoring stations. The locations of these stations are shown in the figure below. These samples were analyzed by using the fecal coliform mTEC 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 January 2011 to September 2014. 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.

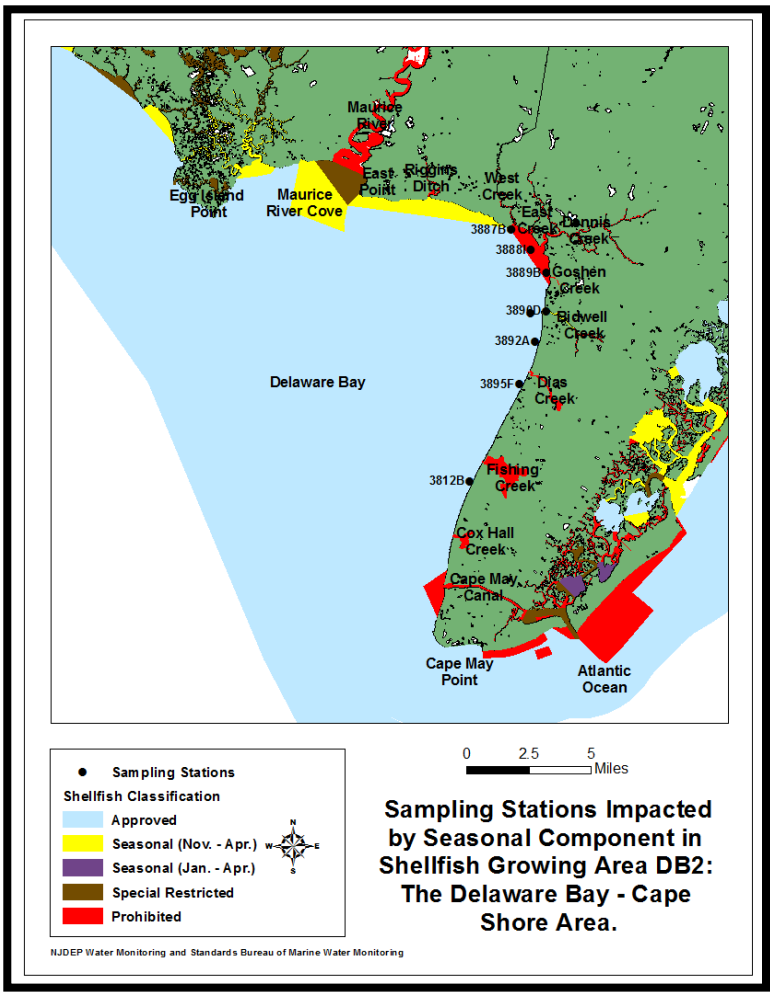
Compliance with NSSP APC Criteria

Most 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, most of the sampling stations in this area were in compliance with their existing shellfish classification criteria. However, there were two sampling stations (**3880** and **3895F**) that exceeded the NSSP shellfish classification criteria for water quality in the *Approved* waters of this shellfish growing area. Five new sampling stations (**3880A**, **3880B**, **3880C**, **3880D**, and **3880E**) were created and placed around sampling station **3880** to determine the size of the area that will need to be downgraded in the future. Sampling station **3895F** will be closely monitored during shoreline surveys of this 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.

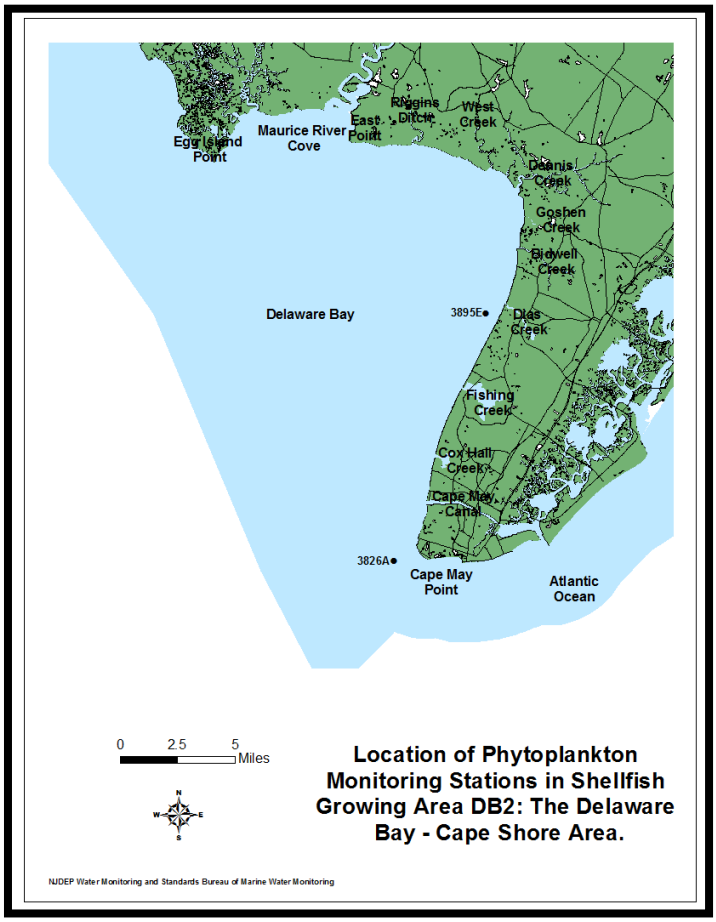
To determine whether seasonal variation can influence bacteria counts, WM&S/BMWM uses a t-test to compare the total coliform MPN values from samples collected during the summer season versus samples collected during the winter months Based on the t-test results, eight (8) monitoring stations had a t-statistical 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.



RELATED STUDIES

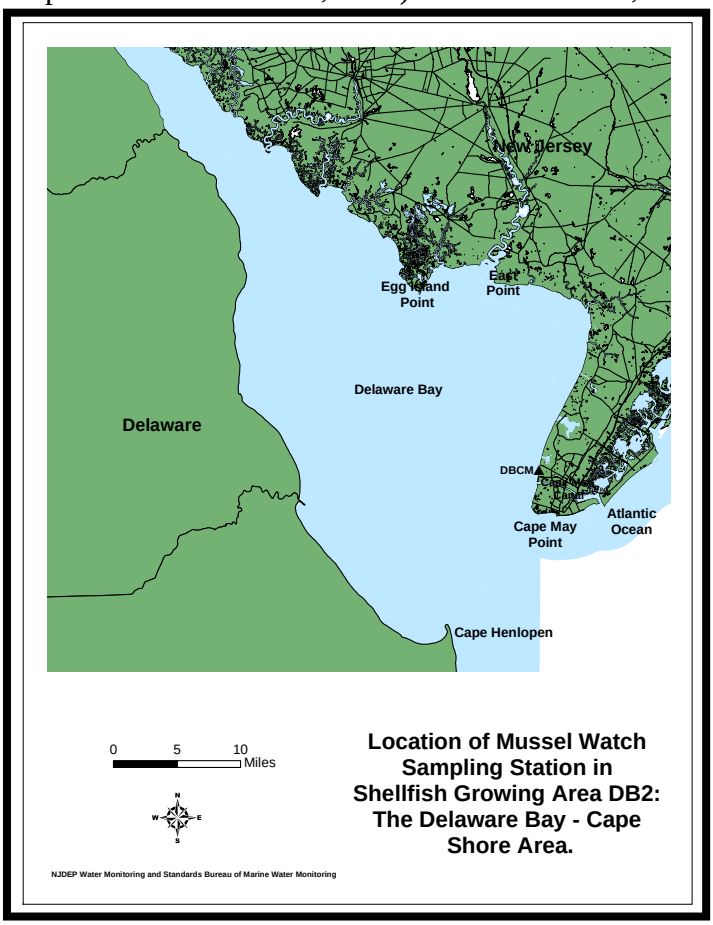
Toxic Monitoring

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 2011 to 2012 (NJDEP, 2015). On July 10, 2013, low levels of the toxin *Dinophysis acuta* were reported for sampling station 3826A off of Cape May Point. 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).



Location of Mussel Watch Sampling Station in Shellfish Growing Area DB2: The Delaware Bay - Cape Shore Area.

From 2011 to 2014, 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 (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, most 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, most of the sampling stations in this area were in compliance with their existing shellfish classification criteria. However, there were two sampling stations (**3880** and **3895F**) that exceeded the NSSP shellfish classification criteria for water quality in the *Approved* waters of this shellfish growing area. Five new sampling stations (**3880A**, **3880B**, **3880C**, **3880D**, and **3880E**) were created and placed around sampling station **3880** to determine the size of the area that will need to be downgraded in the future. Sampling station **3895F** will be closely monitored during shoreline surveys of this area.

RECOMMENDATIONS

Continue sampling using the existing Adverse Pollution Condition (APC) Strategy for Assignments 332 and 347. After adding five new sampling stations around sampling station **3880,** these stations will be used to determine the size of the area that will need to be downgraded in the future. Sampling station **3895F** will be closely monitored during shoreline surveys of this area.

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