



**NJ Department of Environmental Protection
Water Monitoring and Standards**

**Sanitary Survey Report of Shellfish Classification
for Growing Area DB3
The Delaware Bay Offshore (Cross Ledge, Deadmans &
Brandywine Shoal)**



March 2016

State of New Jersey

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NJ Department of Environmental Protection

Bob Martin, Commissioner

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for Growing Area DB3
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Brandywine Shoal)**

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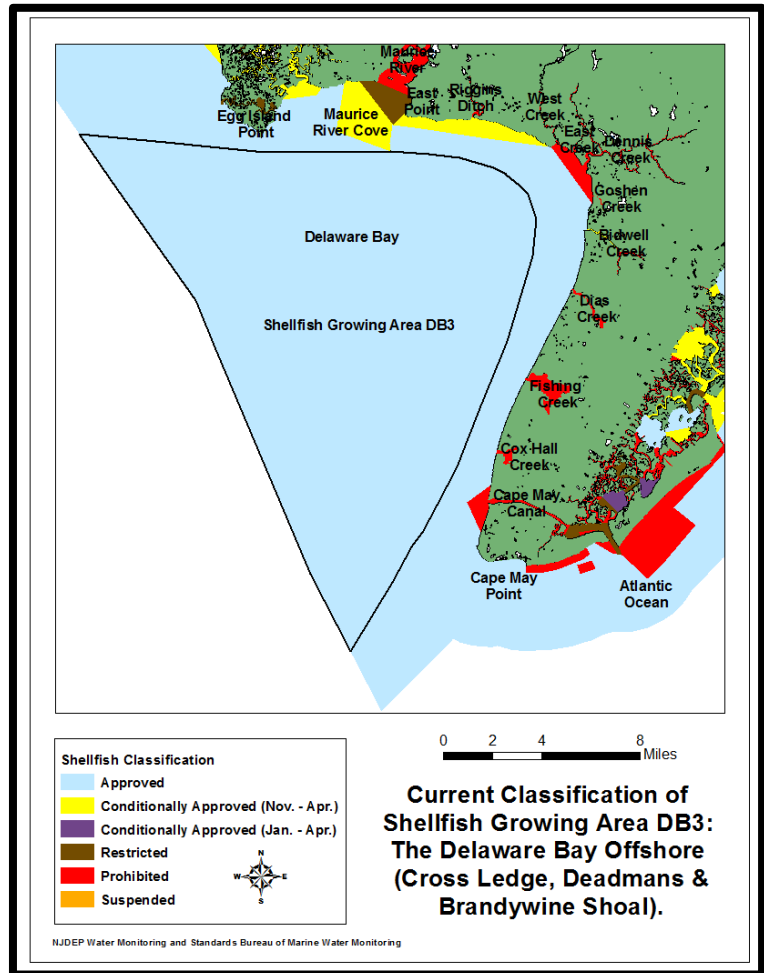
Cover Photo – The Delaware Bay Offshore Remote area, as seen from the airplane during a coastal monitoring flight of NJ waters.

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EXECUTIVE SUMMARY

Shellfish Growing Area DB3, The Delaware Bay Offshore (Cross Ledge, Deadmans & Brandywine Shoal), is a remote shellfish growing area located west of Cape May County and south of the eastern part of Cumberland County in the southwestern part of New Jersey. The water quality data presented in this Sanitary Survey of Shellfish Growing Area DB3 were collected between May 2006 and March 2016. This shellfish growing area is a remote area with no human habitation and no actual or potential pollution sources, and, as such, is sampled using the Remote strategy. According to NSSP sampling criteria, only 2 water samples are needed for each sampling station per year. The approximate size of this shellfish growing area is 135,345 acres, and the shellfish classification for this growing area is *Approved* for shellfish harvesting (as seen in the figure to the right). All sampling stations were in compliance with the fecal coliform criteria for the existing classifications of this shellfish growing area, as specified by the National Shellfish Sanitation Program (NSSP). No classification changes are recommended for this shellfish growing area. There were no observed changes to pollution sources of this area.



Shellfish Classification in Shellfish Growing Area DB3 for 2016



DESCRIPTION OF GROWING AREA

Location & Description

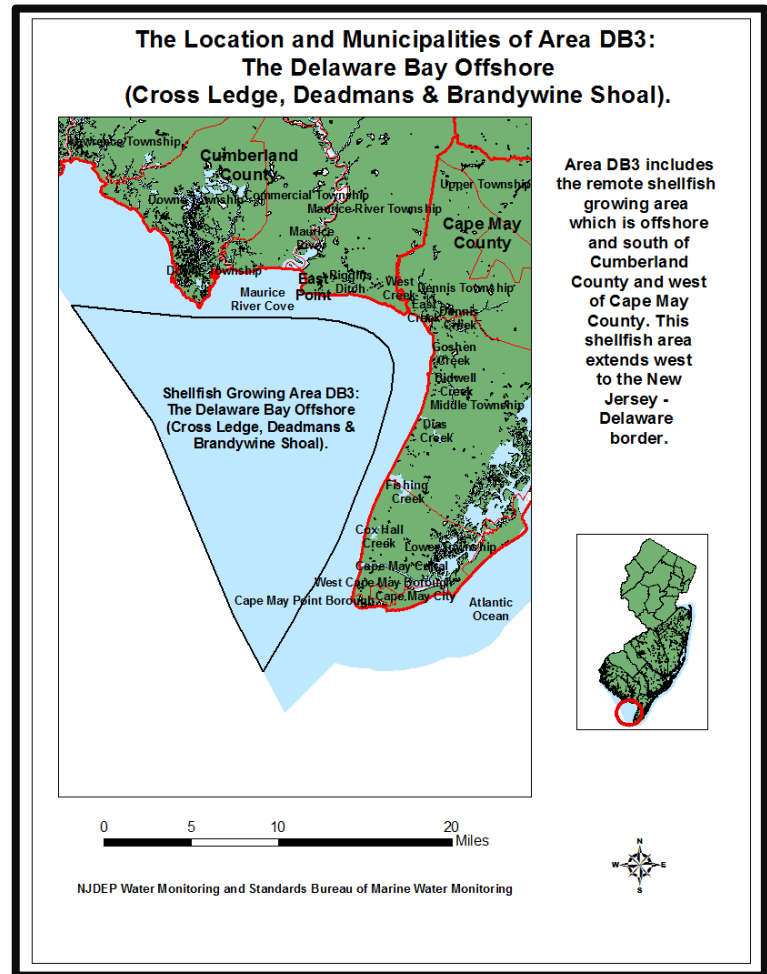
Shellfish Growing Area DB3: The Delaware Bay Offshore (Cross Ledge, Deadmans & Brandywine Shoal) is a remote shellfish growing area located in the southwestern part of New Jersey (see figure on next page). The eastern edge of this shellfish growing area is about 1.2 miles west of the shoreline bordering the coast of Lower Township, about 1.7 miles west of the shoreline bordering the coast of Middle Township in Cape May County, and about 2.5 miles west of the shoreline bordering the coast of Dennis Township in Cape May County. The northwestern edge of this shellfish growing area is located about 223 yards north of channel buoy Flashing Green 2.5 second "29" (Fl G 2.5 sec "29") in the Delaware Bay and the northern edge of this shellfish growing area is located at channel buoy Flashing 4 second 27 feet 7M (Fl 4 sec 27ft 7M) in the Delaware Bay, which is about 1,088 yards southeast of the tip of Egg Island Point in Downe Township, Cumberland County. The western edge of this shellfish growing area is located at the border between New Jersey and Delaware, which is a line extending southeast from a point about 7.4 miles west of Egg Island Point to a point about 7.3 miles west of Cape May Point.

This remote shellfish growing area does not border any shorelines. The shellfish classification of this growing area is *Approved* and the approximate size of this shellfish growing area is 135,345 acres.

The municipalities onshore of this remote shellfish growing area include Cape May Point Borough, Lower Township, Middle Township, and Dennis Township to the east in Cape May County, and

Maurice River Township, Commercial Township, Downe Township, and Lawrence Township to the north in Cumberland County. The locations of these municipalities are shown in the figure to the right.

In Salem and Cumberland Counties, the Delaware River drains into this shellfish growing area to the northwest. This area can be found on Chart 18 of the “2015 State of New Jersey – Shellfish Growing Water Classification Charts” (NJDEP, 2015). The figure on page 4 shows the current classification of this shellfish growing area.



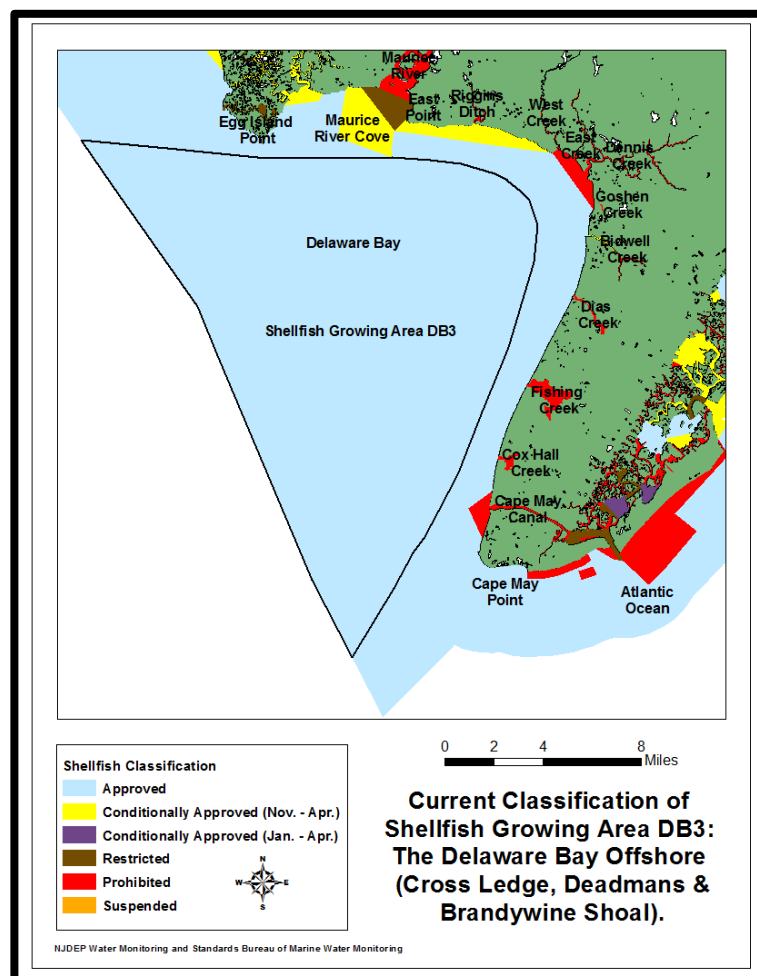
Growing Area Classification

The shellfish classification for this growing area is *Approved* for shellfish harvesting (NJDEP, 2015). Since 1992, this shellfish growing area has been classified and sampled as a remote area. According to the NSSP *Guide for the Control of Molluscan Shellfish*, a growing area may be placed in the remote status if: 1) a sanitary survey determines that the area has no human habitation, and is not impacted by any actual or potential pollution sources, and 2) the area is in water that is classified as *Approved* (USPHS, 2013 Revision). Shellfish Growing Area DB3 meets both of these criteria.

In the Reappraisal of the Delaware Bay Offshore for 2013, data were evaluated from May 2002 to April 2012 and all of the sampling stations met the *Approved* criteria for water quality. No changes were proposed for the shellfish classification or sampling strategy for this shellfish growing area (Wesighan, 2013).

In the 2006 to 2015 Annual Reviews of Shellfish Growing Area DB3, no classification changes were proposed (NJDEP, 2006, NJDEP, 2007, NJDEP, 2008, NJDEP, 2009, NJDEP, 2010, NJDEP, 2011, NJDEP, 2012, NJDEP, 2013, NJDEP, 2014, NJDEP, 2015). 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 area was written in 2004.

The figure below illustrates the shellfish classification for this growing area. The shellfish classification of this area can be seen in the 2015 State of New Jersey Shellfish Growing Water Classification Charts on chart number 18, or on WM&S/BMWM's website at: <http://www.state.nj.us/dep/bmw/waterclass.htm>.



Evaluation of Biological Resources

This growing area has a wide variety of biological resources. The eastern oyster (*Crassostrea virginica*) exists in medium abundance in the Delaware Bay, and has a long history of its

commercial and economic importance in the Delaware Estuary (Morris, 1975, Gosner, 1978, Matassino, et al, 2002). The table below shows the New Jersey eastern oyster direct market landings totals for the Delaware Bay from 2006 to 2015 (NJDEP, NJ Division of Fish and Wildlife, Bureau of Shellfisheries, 2016).

The table on page 6 shows the total New Jersey shellfish landings data from 2006 to 2015 (NMFS, 2016). Shellfish landing statistics had not been verified and posted for 2015 at the time this sanitary survey report was written. These shellfish species include blue crabs (*Callinectes sapidus*), blue crabs – peelers, hard clams (*Mercenaria mercenaria*), blue mussels (*Mytilus edulis*), bay scallops (*Aequipecten irradians*), oysters (*Crassostrea virginica*), ocean quahogs (*Arctica islandica*), surf clams (*Spisula solidissima*), and sea scallops (*Placopecten magellanicus*) (Morris, 1975, Gosner, 1978). However, this report primarily focuses on bivalve mollusks, such as clams, quahogs, oysters, and mussels, and does not include crustaceans, such as blue crabs.

New Jersey Eastern Oyster Direct Market Landing Totals for Delaware Bay - 2006 to 2015 (NJDEP, NJ Division of Fish and Wildlife, Bureau of Shellfisheries, 2016).

NEW JERSEY EASTERN OYSTER DIRECT MARKET LANDING TOTALS for DELAWARE BAY 2006 to 2015		
YEAR	BUSHELS	\$ VALUE
2006	60,450	\$2,418,000
2007	81,235	\$3,249,400
2008	89,882	\$3,595,280
2009	80,690	\$3,227,600
2010	74,375	\$2,975,000
2011	94,470	\$3,306,450
2012	78,140	\$2,344,200
2013	84,276	\$3,371,040
2014	76,910	\$3,076,400
2015	87,430	\$3,934,350

New Jersey Shellfish Landings - 2006 to 2015 (NMFS, 2016).

NEW JERSEY SHELLFISH LANDINGS 2006 to 2015		
YEAR	POUNDS OF MEAT (millions)	\$ VALUE (exvessel)
2006	82,590,256	\$107,698,150
2007	84,773,015	\$120,806,986
2008	72,774,385	\$138,292,883
2009	84,304,018	\$122,286,222
2010	62,169,293	\$145,037,263
2011	65,434,503	\$177,412,023
2012	57,693,336	\$146,022,490
2013	45,992,234	\$96,264,744
2014	55,569,046	\$120,369,860
2015	*	*

*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 (*Limulus polyphemus*). In New Jersey for 2005, the landings for horseshoe crabs were 330,714 pounds harvested for an exvessel value of \$120,782 (NMFS, 2016). 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, 2016). A total moratorium was placed on the harvest of horseshoe crabs in New Jersey for 2007 and, from 2007 to 2015; the National Marine Fisheries Service has no values for horseshoe crab landings in New Jersey for those year. Since horseshoe crabs are used as bait for catching eels and conch, 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 2006, the landings of blue crabs were 5,769,631 pounds harvested for an exvessel value of \$5,973,932 (NMFS, 2016). In New Jersey for 2014, the landings of blue crabs were 3,136,732 pounds harvested for an exvessel value of \$6,191,634 (NMFS, 2016). The National Marine Fisheries Service has no values for blue crab landings in New Jersey for 2015 when this report was written. 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

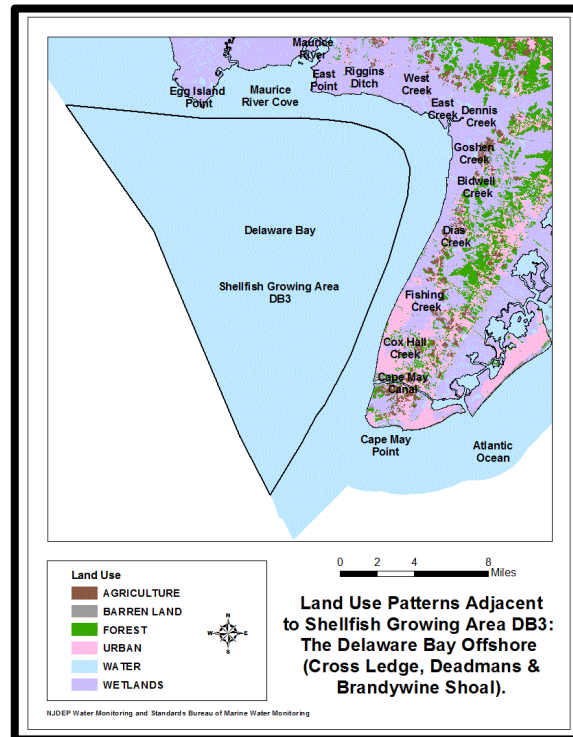
Shoreline Survey

Shellfish Growing Area DB3 is a remote area, which is completely surrounded by water and borders Shellfish Growing Area DB2 (The Delaware Bay - Cape Shore) to the east and Shellfish Growing Area DB1 (The Delaware Bay from Maurice River Cove to Artificial Island) to the north. During the shoreline surveys conducted in and around the Delaware Bay, no evidence could be seen that direct and indirect discharges from potential sources of pollution draining into Shellfish Growing Areas DB1 and DB2 are having an impact on the water quality of this remote growing area.

Land Use

The major land use patterns for the municipalities to the north and east of this remote offshore shellfish growing area are mainly wetland areas, agricultural areas, and forest areas, with some urban and rural areas interspersed between them (see figure on the next page). The urban and rural areas are mainly located in clusters to the southeast, east, and north of this remote shellfish growing area, but this growing area does not border on any of these urban and rural areas. The urban areas are primarily connected to sewage treatment facilities; the rural areas, however, are connected to private septic systems and failing septic systems could be a potential indirect source of pollution to Shellfish Growing Areas DB1 and DB2. There is no current evidence that the direct and indirect discharges from these potential sources are affecting the water quality of this remote offshore shellfish growing area.

The wetlands onshore and surrounding this remote 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 figure to the right shows the land use patterns for the surrounding shoreline of this area. There are no storm water outfalls or marinas draining into this remote offshore shellfish growing area.



Spills, Unpermitted Discharges, and Closures

On August 1, 2006, it was reported that 50,000 gallons of sewage spilled into the Delaware River near Camden when a sewage main ruptured during drilling operations by the Camden County Municipal Utilities Authority near their wastewater treatment plant. The shutdown of the pump station for these repairs caused an additional 3,000,000 gallons of sewage to overflow and spill into the Delaware River on August 2, 2006. There is no shellfish classification for the Delaware River near Camden because shellfish is not harvested in these waters. In the Delaware River, the shellfish waters nearest to this area are the *Special Restricted* shellfish waters that begin immediately to the south of Artificial Island. Repairs to the sewage main and the clean up to the area were in progress when this report was received.

On December 28, 2006, a sewage spill was reported for the area of Shell Road and Bianca Avenue, in Carneys Point, Salem County. According to the report sent to WM&S' Bureau of Marine Water Monitoring on this date, approximately 1,000 gallons of sewage spilled into the Delaware River at this location when a sewer main collapsed. There is no shellfish classification for the Delaware River near Carneys Point because shellfish is not harvested in these waters. In the Delaware River, the shellfish waters nearest to this area are the *Special Restricted* shellfish waters that begin immediately to the south of Artificial Island. When this report was received, repair crews were on the scene setting up bypass pumps and repairs to the sewer main were underway.

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. The upper edge of this shellfish growing area is located south of the mouth of the Maurice River in *Approved* shellfish waters. 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 2010.

On April 19, 2011, a sewage spill was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 307,000 gallons of partially treated sewage was discharged into the Maurice River at this location because one of the clarifiers was down due to construction and the other clarifier couldn't handle the overflow from the discharge that comes from the Delmonica Foods plant. The flow of the sewage treatment facility was diverted to their south plant. When I spoke to Jim Grob of the Millville Sewage Authority Wastewater Treatment Facility on April 20, 2011 at 11:23 AM, I was told that both clarifiers would be up and running in two days but the current flow would continue to be diverted to their south plant. 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 south of the mouth of the Maurice River. On April 21, 2011, water samples were collected at eight sampling stations in the Maurice River from the Maurice River Cove to the Mauricetown Bridge and analyzed for mTec levels. The mTec levels were highest in the Maurice River Cove and off of Bivalve and lowest at the Mauricetown Bridge. These results were consistent with the water quality results found in the Maurice River and Maurice River Cove during the special study of this area of

July 2004 to October 2005 and did not show any impacts to the water quality of this area from the sewage spill.

On August 26, 2011, the State of New Jersey Department of Environmental Protection put into effect a precautionary closure for all shellfish waters in New Jersey due to the approach of Hurricane Irene ‘to assure that the public health is not imperiled by the consumption of shellfish that may be subject to pollution or to any other conditions which may render shellfish dangerous.’ All shellfish waters in the Delaware Bay were closed to shellfish harvesting. Water samples were collected on 9 sampling dates (8/29, 8/30, 8/31, 9/1, 9/2, 9/3, 9/4, and 9/8). On September 8, 2011, water quality showed an improvement in a portion of the Delaware Bay south of a line from Beadon Point to the Cross Ledge abandoned lighthouse and the shellfish waters south of this line were reopened. On September 10, 2011, six monitoring stations were added to the sampling collection in the main channel and in the oyster areas from Ship John Shoal to Benny Sands. Additional water samples were collected on 9/10, 9/12, 9/14, and 9/15. On September 15, 2011, the salinity readings at 14 monitoring stations showed unusually low levels and many readings were outside the tolerance range for oysters (5-30psu). The low salinity was due to the tremendous flow of fresh water from the Delaware River as a result of record precipitation. Additional water samples were collected on 9/17, 9/19, and 9/21. The samples collected on September 21, 2011 showed an improvement in water quality with the samples collected slightly north of Nantuxent Cove and southbound meeting the *Approved* criteria. Additional samples were collected on 9/23 and 9/26. Coliphage and fecal coliform samples on shellfish tissue were collected on September 28, 2011 and the tissue samples were within acceptable levels. Therefore, on September 29, 2011, the Department reopened shellfish harvesting to that portion of the Delaware Bay south of a line from Ben Davis Point, through sampling station s3800F and 3800, and to a point at the state boundary line at Latitude 39 degrees 15 minutes 10.158 seconds N, Longitude -75 degrees 20 minutes 17.038 seconds W. Additional water samples were collected on 9/23 and 9/26. The samples collected on September 26, 2011 showed an improvement in water quality in the Upper Delaware Bay, with samples meeting the *Approved* criteria. Coliphage and fecal coliform samples on shellfish tissue were collected on October 3, 2011 and the tissue samples were within acceptable levels. Therefore, on October 4, 2011, the Department reopened shellfish harvesting to the entire Delaware Bay. Having determined through sample monitoring that all the waters of the Delaware Bay were now safe for the harvesting of shellfish, all of these shellfish waters were returned to their prior classification.

On February 21, 2012, a sewage spill was reported for the area in front of a residence at 1137 Roberts Boulevard in Vineland City, Cumberland County. According to the report sent to WM&S’ Bureau of Marine Water Monitoring, this spill started at 8:00 PM on this date and approximately 25 gallons/minute of sewage spilled into the storm drain at this location when a break in the 18” main caused the sewage to overflow into the storm drain and flow into the Maurice River. The shellfish classification of the Maurice River in this area is *Prohibited* to shellfish harvesting. The repairs and cleanup of this sewage spill were reported as pending on this date and time (2/21/2012, 9:48 AM)

this report was received by the WM&S' Bureau of Marine Water Monitoring. When I telephoned and spoke to a representative of the Landis Sewage Authority on February 21, 2012, I was told that the 18" main would be repaired by the next morning. When I telephoned back on February 22, 2012, I was told that the 18" main was repaired at 10:00 AM and the cleanup of the area was underway. In this period of time (14 hours) and a spill rate of 25 gallons/minute, a total of 21,000 gallons of sewage spilled into the storm drain and the Maurice River at this location. The edge of this shellfish growing area is located south of the mouth of the Maurice River in *Approved* shellfish waters and there was no evidence of an impact to the water quality of this remote shellfish growing area.

On March 15, 2012, a sewage spill was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, approximately 19,000 gallons of sewage was discharged into the Maurice River at this location. 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 south of the mouth of the Maurice River. On this date, this sewage discharge was reported as terminated at 10:00 AM and some of the sewage was cleaned up. However, most of the sewage went into the Maurice River at this location.

On June 25, 2012, a raw sewage spill was reported for the area of 1502 Lamberton Road at the Trenton Sewer Utility Sewage Treatment Facility near the Delaware River in Trenton, Mercer County. According to the report sent to WM&S' Bureau of Marine Water Monitoring, this spill started at 8:30 AM on this date when approximately 45,000 gallons of raw sewage was discharged into the Delaware River near Trenton. There is no shellfish classification for the Delaware River near Trenton because shellfish is not harvested in these waters. In the Delaware River, the shellfish waters closest to this area are the *Special Restricted* shellfish waters that begin immediately to the south of Artificial Island. This sewage spill was reported as terminated at 10:52 AM on this date.

On October 16, 2012, a sewage spill was reported for the area of 6 Westwood Drive near Mantua Creek in Mantua Township. According to the report sent to WM&S' Bureau of Marine Water Monitoring, this spill started at 6:50 AM on this date when approximately 45,000 gallons of sewage spilled due to a pump failure and line blockage which caused the sewage to overflow from a manhole and flow into Mantua Creek, which eventually flows into the Delaware River near Paulsboro. There is no shellfish classification for Mantua Creek or the Delaware River near Paulsboro because shellfish is not harvested in these waters. In the Delaware River, the shellfish waters closest to this area are the *Special Restricted* shellfish waters that begin immediately to the south of Artificial Island. This sewage spill was reported as terminated at 8:30 AM on this date and the cleanup of the area was in progress at the time this report was received.

On March 31, 2015, a discharge of sewage (secondary effluent) was reported for the area of 355 Fowser Road at the Millville Sewage Authority Wastewater Treatment Facility near the Maurice

River in Millville, Cumberland County. According to the report sent to WM&S' Bureau of Marine Water Monitoring,, approximately 187,500 gallons of sewage (secondary effluent) was discharged into the Maurice River at this location at 2:00 AM due to a failure of the UV gate. 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 south of the mouth of the Maurice River. This sewage (secondary effluent) discharge was reported as terminated at 5:00 AM on this date when the UV gate was reset.

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.

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 adjacent to this shellfish growing area in DB2 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 Vp sampling 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 stations at the Delaware Bay Cape Shore Atlantic Capes Fisheries shellfish beds in the adjacent growing area of DB2. 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 Remote area or the Delaware Bay - Cape Shore area in 2013.

Also in 2013, oyster tissue samples were collected at the subtidal *Vibrio parahaemolyticus* (Vp) sampling stations in the Shell Rock and Nantuxent sampling beds. On seven (7) dates in 2013 (6/24, 7/15, 7/22, 7/29, 8/5, 8/12, and 8/26), *Vibrio parahaemolyticus* oyster tissue results were very high (ranging from 1,200 on 6/24 and 8/26 to 4,900 on 7/22).

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 harvested 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 the WM&S' Bureau of Marine Water Monitoring, Leeds Point Laboratory added the capability to analyze for both trh and tdh virulent strains as well as for total Vp by both PCR and the direct plating methods. The study also collected samples from Great Bay to study *Vibrio parahaemolyticus* samples from different salinity waters.

In 2014, oyster tissue samples were collected at the subtidal *Vibrio parahaemolyticus* sampling stations in the Cohansey to New Beds *Vibrio* sampling beds on a weekly basis from May through August. Some oysters were immediately iced, some were kept unrefrigerated with shading for 6 hours and other oysters were kept unrefrigerated with shading for 7 hours. Data showed that levels for all strains of *Vibrio parahaemolyticus* (tlh,tdh,trh) were consistently low when removed from the water, and climbed, as expected, when subjected to time without refrigeration. Monitoring data indicated that the levels for all strains of *Vibrio parahaemolyticus* in oyster tissue were within expected ranges. Shell temperatures and shaded air temperatures were measured for all post-harvest handling. The data showed that the shell temperature was much greater than the air temperature from mid-June to mid-July, which also matched with the time frame of historic illness reports. The data from the 2014 *Vibrio parahaemolyticus* study was used to shift the harvest hours for 2015, by changing the month of 6 hours from harvest to refrigeration from mid-June to mid-July. The data also showed that the rest of the *Vibrio parahaemolyticus* oyster harvest can continue with 7 hours from harvest to refrigeration, so overall hours of harvest for the season were not changed. The intertidal (Vp) sampling beds (Delaware Bay Cape Shore Atlantic Capes Fisheries) in this shellfish growing area were dropped from the sampling schedule.

In 2014, there were two confirmed illnesses of *Vibrio parahaemolyticus* attributed to oysters harvested in the Delaware Bay. The first case of *Vibrioparahaemolyticus* illness was from oysters harvested from the Shell Rock oyster beds and confirmed on June 14, 2014, and the second case of

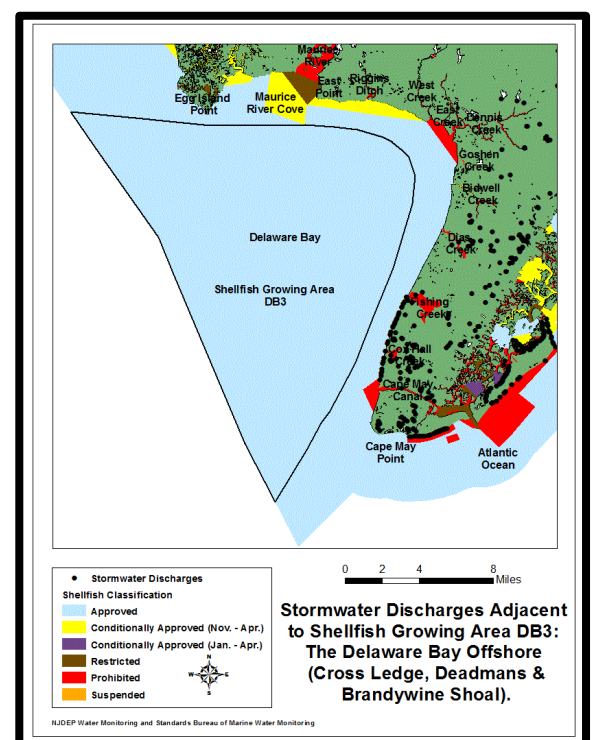
Vibrio parahaemolyticus illness was from oysters harvested from the Cohansey oyster beds on July 18, 2014 and confirmed on July 25, 2014. There was also an unconfirmed illness of *Vibrio fluvialis* attributed to oysters harvested in the Benny Sands, Cohansey, or Shell Rock oyster beds in the Delaware Bay on July 23, 2014. These confirmed illnesses did not result in a *Vibrio* outbreak or shellfish closure.

In 2015, an intensive study of *Vibrio parahaemolyticus* (*Vp*) in the oysters harvested in the Delaware Bay was undertaken. Oyster tissue samples were collected at the subtidal *Vibrio parahaemolyticus* (*Vp*) sampling beds in the adjacent waters of Shellfish Growing Area DB1. On 18 dates in 2015 (once per week between May 5 to August 31), *Vibrio parahaemolyticus* oyster tissue results were analyzed using the PCR and direct plating method for *Vp* (tlh, trh, and Tdh) and PCR for *Vibrio vulnificus*. *Vibrio* was studied in out-of-water initial levels immediately onto ice (once a month), after ice slurry for 10 minutes after 1, 3, and 5 hours of shading on deck, and 5 hours with overnight refrigeration. Meat and shell temperatures were recorded for each step. Temperature buttons were placed in oysters to study cooling effectiveness and time to below temperature of 50 degrees F of slurry and refrigeration. Water quality readings (temperature, salinity, pH, and dissolved oxygen) were taken with each sample collected. The total of results of all parameters was 1,110.

On June 23-24, 2015, there was one confirmed illness of *Vibrio parahaemolyticus* attributed to oysters harvested in the Delaware Bay. This illness was from oysters harvested in the Shell Rock oyster bed and was attributed to temperature abuse during post-harvest handling. This confirmed illness did not result in a *Vibrio* outbreak or shellfish closure.

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 (www.njstormwater.org). Most of the stormwater outfalls adjacent to this growing area are near residential and urbanized districts. There are about 70 outfalls which discharge into the adjacent shellfish growing area of DB2 in the Delaware Bay and



these stormwater outfalls have a minimal potential to impact the water quality of this growing area. The bulk of these outfalls in DB2 are located in Lower Township, Middle Township, and Dennis Township.

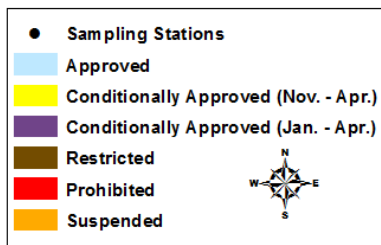
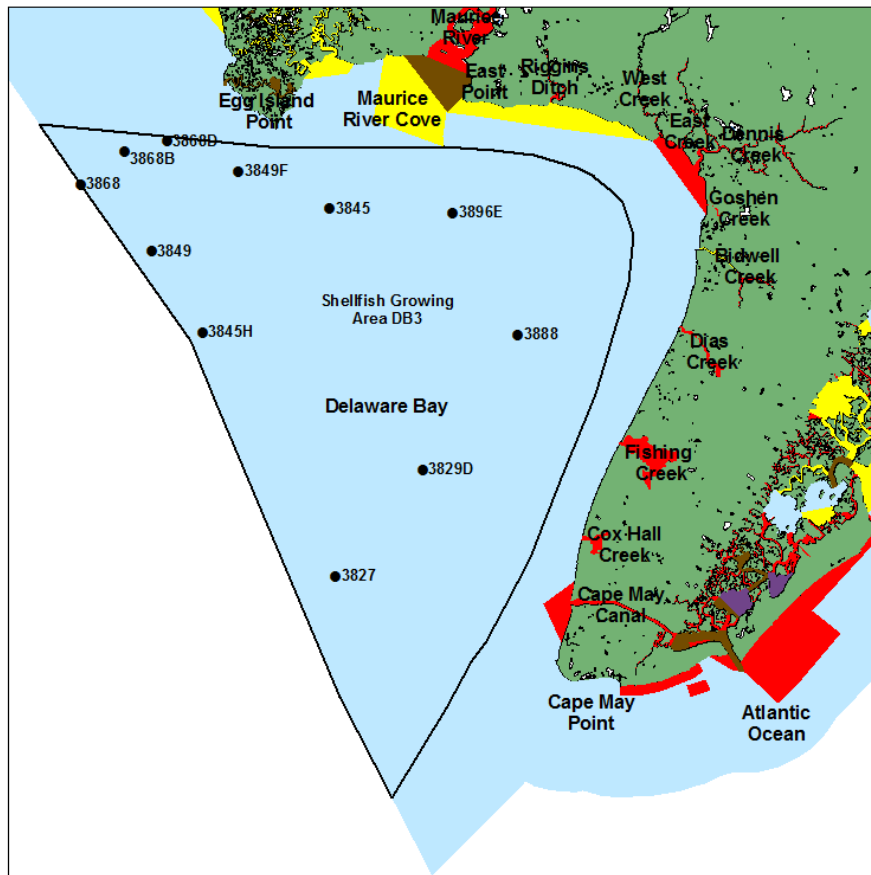
These outfalls usually discharge to nearby creeks and lagoon systems. For this reason, shellfish harvesting is condemned in all lagoon systems.

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.

Water sampling was performed in accordance with the Field Procedures Manual (NJDEP, 2005). From May 2006 through March 2016, approximately 176 water samples were collected for fecal coliform bacteria from 11 monitoring stations. The locations of these stations are shown in the map on the next page. 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 2013. 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).



0 2 4 8 Miles

**Location of Sampling Stations
in Shellfish Growing Area DB3:
The Delaware Bay Offshore
(Cross Ledge, Deadmans &
Brandywine Shoal).**

NJDEP Water Monitoring and Standards Bureau of Marine Water Monitoring

Bacteriological Quality

This report includes data analyzed from May 2006 to March 2016. This shellfish growing area is composed of one assignment area, Assignment 376 (The Delaware Bay Offshore – Cross Ledge, Deadmans, and Brandywine Shoal) and is sampled using the Remote sampling strategy year-round. 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.

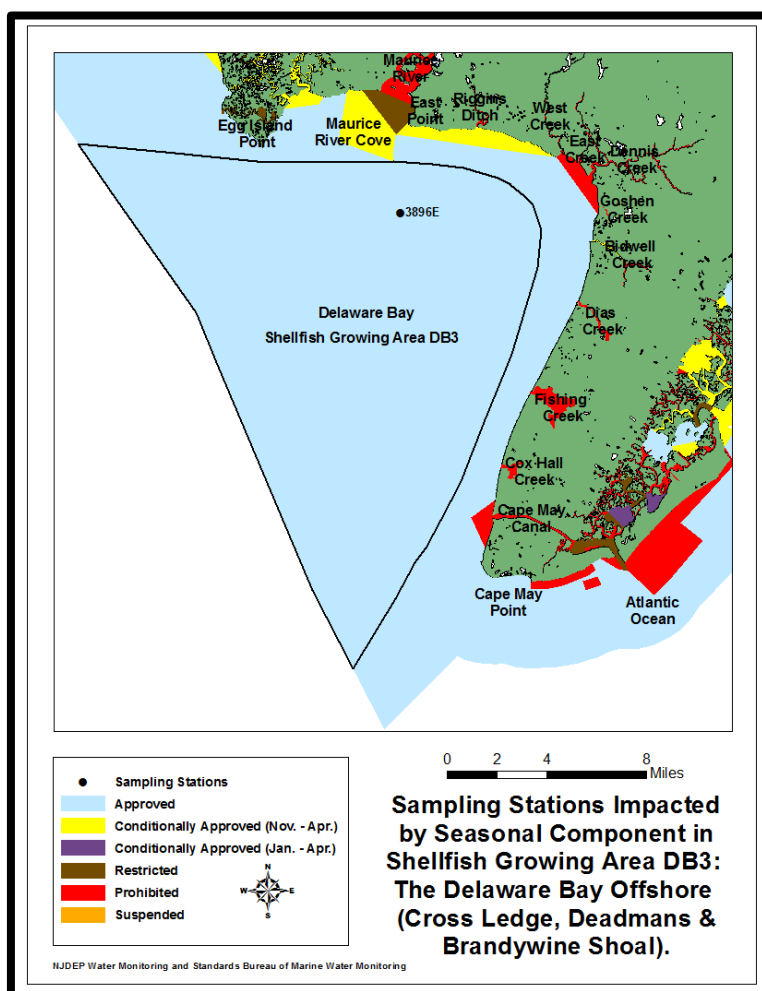
Compliance with NSSP Remote Criteria

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. There were no stations that exceeded the NSSP shellfish classification criteria for water quality in the *Approved* 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 fecal coliform MPN



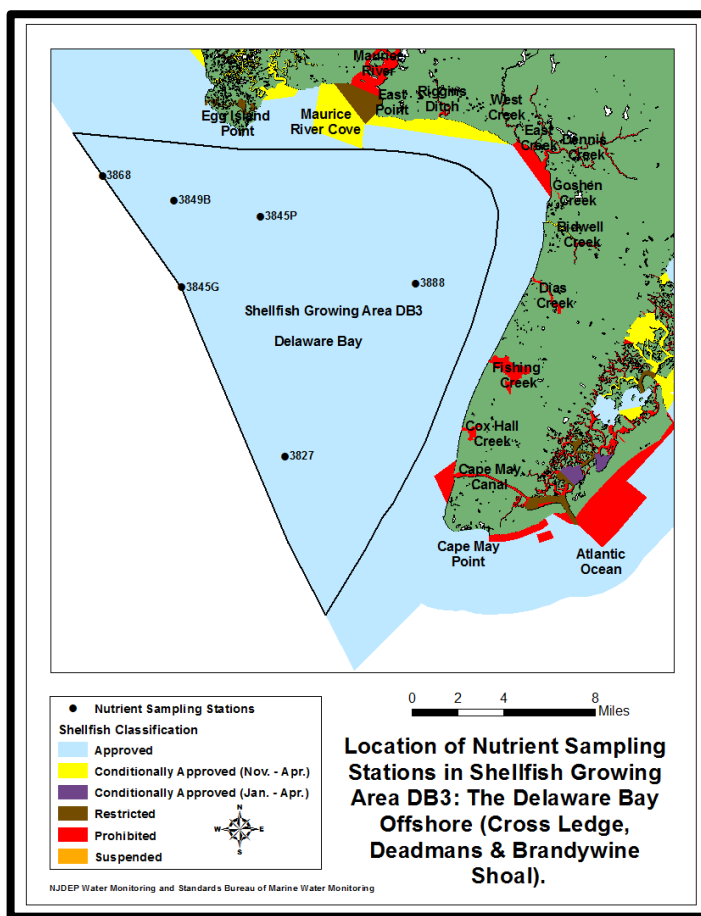
values from samples collected during the summer season versus samples collected during the winter months. Based on the t-test results, one (1) monitoring station (Sampling Station 3896E) had a t-statistical probability of less than 0.05. This monitoring station showed a higher fecal coliform geometric mean during the winter than during the summer, with a geometric mean of 5.0 during the winter and a 2.1 geometric mean during the summer. This shellfish growing area was sampled with no seasonal preference.

RELATED STUDIES

Nutrients

In this growing area, six 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 2006 and 2016, 336 water samples were analyzed for these nutrient parameters in this growing area. For full nutrient assessment, see the Estuarine & Coastal Water Quality Reports, available electronically at:

<http://www.state.nj.us/dep/bmw/reports.htm>



Toxic Monitoring

The DWM&S/BMWM collects samples at regular intervals throughout the summer to determine the occurrence of marine algae that produce biotoxins (see figure to the right for the location of the 48 phytoplankton sampling stations in New Jersey). Certain planktonic species have the potential to adversely affect the suitability of shellfish for human consumption and can adversely affect the respiratory function of people. These planktonic species cause algal blooms that deplete the dissolved oxygen levels in the water.

Since 2007, algal blooms are also identified by the DWM&S/BMWM with the aid of a remote chlorophyll flight sensor. Coastal monitoring flights with remote aircraft sensing have taken place from Coyle Field in Burlington County, north to the Raritan Bay, south to the Little Egg Harbor Inlet, and back to Coyle Field (short flights), and from Coyle Field, north to the Raritan Bay, south to Cape May Point, west into the Delaware Bay, and north through the back bays of New Jersey back to Coyle Field (long flights).

In a partnership between the DWM&S/BMWM, the New Jersey Forest Fire Service (aviation operations and maintenance), Rutgers University (data management), and USEPA Region 2 (funding), these flights (4 short flights and 2 long flights a week) are scheduled for six days a week from May to September of each year. Flight observers are also on these flights to observe conditions that could adversely affect bathing beach and water quality, such as the presence of algal foam from algal blooms, floating trash or debris, broken sewer lines, and the presence or absence of marine life and fish kills. The sensor data from these remote aircraft sensing flights provide estimates of coastal chlorophyll 'a' levels and a perspective on bloom conditions/trends. If estimates of coastal chlorophyll 'a' levels come up high in specific areas during a coastal monitoring flight, this enables the Bureau to target boat sampling to locations where algal blooms might be occurring. The NJDEP and Rutgers University Chlorophyll Remote Sensing flights in the waters of New Jersey are available electronically at: <http://njdep.marine.rutgers.edu/aircraft/>.



Generally, no toxic species associated with large algal blooms over long periods have been recorded for the Delaware Bay Remote Area. The phytoplankton monitoring of sampling stations in New Jersey waters is available electronically at: <http://www.nj.gov/dep/bmw/phytoplankton.htm>.

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. There were no significant changes to landuse pattern, hydrography, or discharges that would change the shellfish water classification in this area.

RECOMMENDATIONS

Continue sampling using the existing Adverse Pollution Condition (APC) Remote strategy for Assignments 376.

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