

A HISTORY OF OYSTERING IN RARITAN BAY,
WITH ENVIRONMENTAL OBSERVATIONS

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INTRODUCTION

Oystering in Raritan Bay was practiced by the Indians who colonized its shores hundreds of years ago, and by the European colonists and their descendants who eventually depleted the oyster beds. A commercial oyster industry began in 1825 and lasted until about 1925; this is the main topic of the paper. The oyster industry in the bay was part of a much larger oyster industry which extended along the east coast of North America from the Maritime Provinces of Canada to Texas. During that time, oysters were a more important part of the diet of Americans than in the early 1980s. About 30 million bushels of oysters a year were produced from Rhode Island to Chesapeake Bay in 1890 and about 25 million bushels in 1900 (Lyles 1969). The population of the entire United States was about 75 million and most people worked in farming or fishing in 1900 (Hindley 1959). By the early 1980s, annual oyster production from the same area of Rhode Island to Chesapeake Bay area was about 5 million bushels (MacKenzie 1983) while the population of the United States was slightly above 230 million. Thus, the population is 3.3 times larger but consumes only one-fifth as many oysters; the per capita consumption of oysters is about one-seventeenth of what it was. During the late 1800s and early 1900s, many families had two oyster dinners a week, one nearly always on Sunday. Shucked oysters were peddled from horse-drawn carts on the streets of eastern cities for about 25 cents a quart. In sections of the cities, oyster and clam bars operated on almost every block, much as small restaurants do now, and oysters were commonly eaten in saloons. Oysters were frequently sold by name according to their source: Malpeques, Cotuits, Robbins Islands, Blue Points, Rockaways, Sounds, Prince's Bays, Shrewsburys, Maurice River Coves, Bombay Hooks, Potomacs, Rappahannocks, Chincoteagues, etc. The largest oyster markets were Boston, New York, Philadelphia, Baltimore, Norfolk and New Orleans. Luxury liners on international cruises carried oysters for passengers. The Raritan Bay oyster industry produced roughly 2 percent of the total oyster crop in the northeastern United States.

The colonists of Massachusetts, Rhode Island, New York and New Jersey gathered local oysters as one of their foods. As populations increased the supplies of oysters dwindled, seed oysters from Chesapeake Bay were transplanted to Wellfleet (Massachusetts), Narragansett Bay, Long Island Sound, Raritan Bay and Delaware Bay in the spring and harvested in the fall to meet the demand for oysters. The earliest European settlers of New York City area had gathered local oysters for consumption, but eventually depleted the supply. Afterwards, supplies of market oysters to the city were imported from

various estuaries along the Atlantic coast. The oysters were transported mostly by schooners, which carried a substantial amount of freight-- agricultural produce, coal, lumber, brick, stone and other commodities--, besides oysters, along the eastern seaboard. The schooners and sloops also dredged many of the oysters. The operations of boats were subject to the whims of the weather.

Production of oysters was labor intensive when compared with present standards in crop production. A large amount of labor was involved in building schooners, sloops, skiffs, tongs, rakes, dredges, anchors, baskets, floats and oars, cutting and hauling stakes out of woods and then setting them in place with cement buoy stones to mark the corners of lease boundaries, making ropes, sails and knives, waterproofing the outer clothing of boat crews with linseed oil, shucking and cleaning oysters, and obtaining ice to preserve them. On the beds, tongs were operated by hand, dredges were hauled by hand and oysters were shoveled into baskets and the baskets were hand carried; oyster skiffs were rowed. The reputations of men were based on their strength and the work they could perform; captains had higher status than deck-hands on boats. Oysters were abundant in most estuaries, though, which helped to compensate for the labor expended. One common saying was: "Who is going to eat all these oysters?"

ORIGINAL DISTRIBUTION OF OYSTERS IN RARITAN BAY

The distribution of oysters in Raritan Bay in the precolonial period is incompletely known. A huge bed, later known as the Great Beds (Fig. 1), occurred at the western end of the bay just beyond the mouths of the Raritan River and the Arthur Kill. Oysters grew along the Raritan River from its mouth to five miles upriver (Hall, 1894). Oyster beds also occurred along the entire length of the Arthur Kill and to an extent in the Kill Van Kull. Another natural bed, known as the Chingarora Bed, occurred at Keyport. Mitchell (1961) states that a chain of beds extended from Sandy Hook across New York Harbor, up the Hudson River to Ossining, New York. (The locations of these beds in Raritan Bay are not certain.) Oysters grew along the shores of Jersey City, Manhattan, and Brooklyn and Wards, Ellis, and Bedloe's islands.

OBSERVATIONS ABOUT OYSTERS, 1748-51 (KALM, 1770)

The following observations made about oysters near the present location of New York City probably apply to the Raritan Bay as well. The Indians used oysters and other shellfish (clams and mussels) as one of their chief foods and were active in gathering them. The shellfish were eaten fresh and also preserved for later consumption by being strung dried and then smoked. They sold a portion of their shellfish to other Indians further inland. Large piles of oyster and mussel shells existed where the Indians had their huts. (Note: piles of oyster shells made by Indians existed in the early 1900s at Perth Amboy and Union Beach, New Jersey, and other localities.)

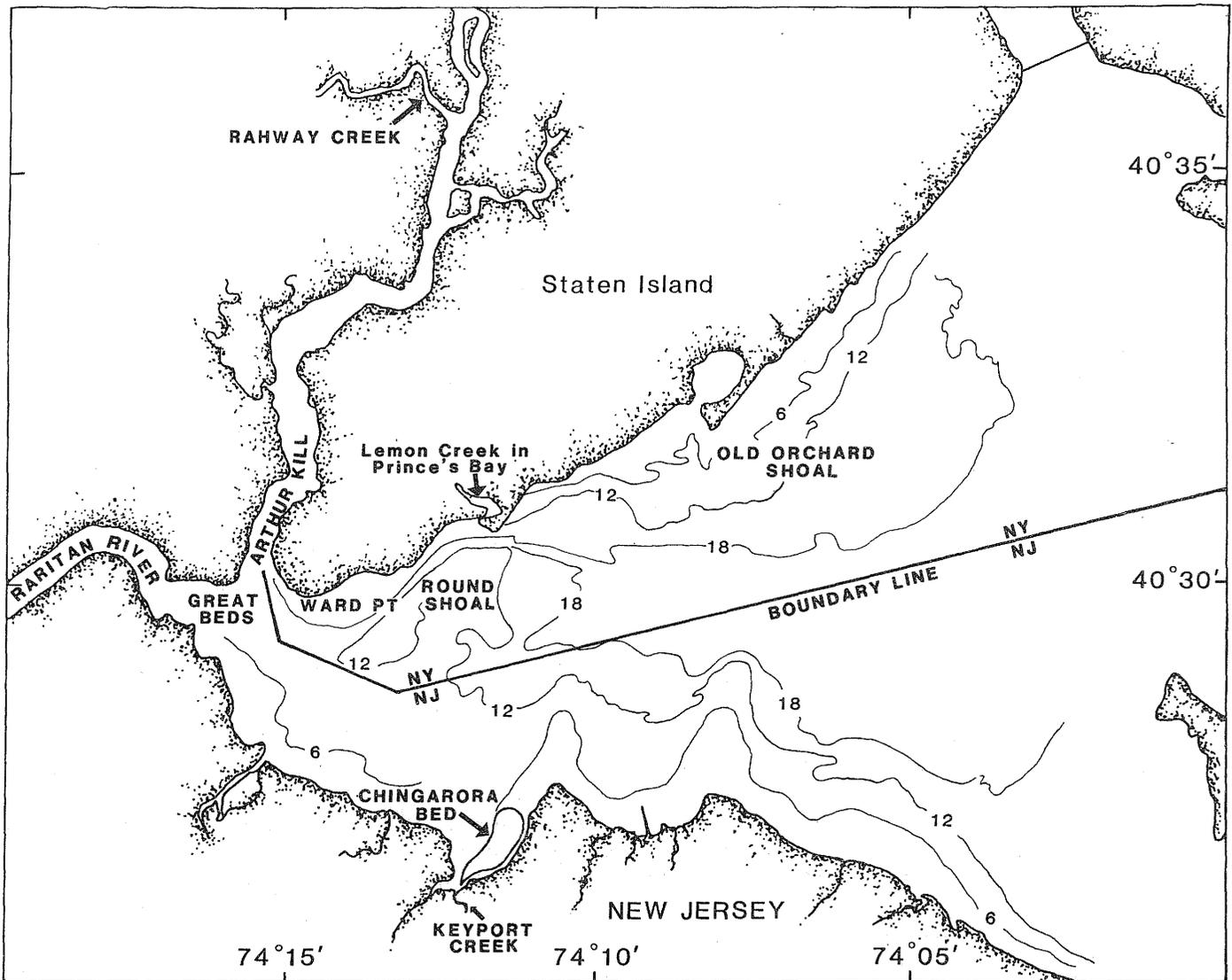


Figure 1. Some of the principal oyster beds, the creeks where oysters were floated, the location of the boundary line between New York and New Jersey and the water depths at various locations in Raritan Bay.

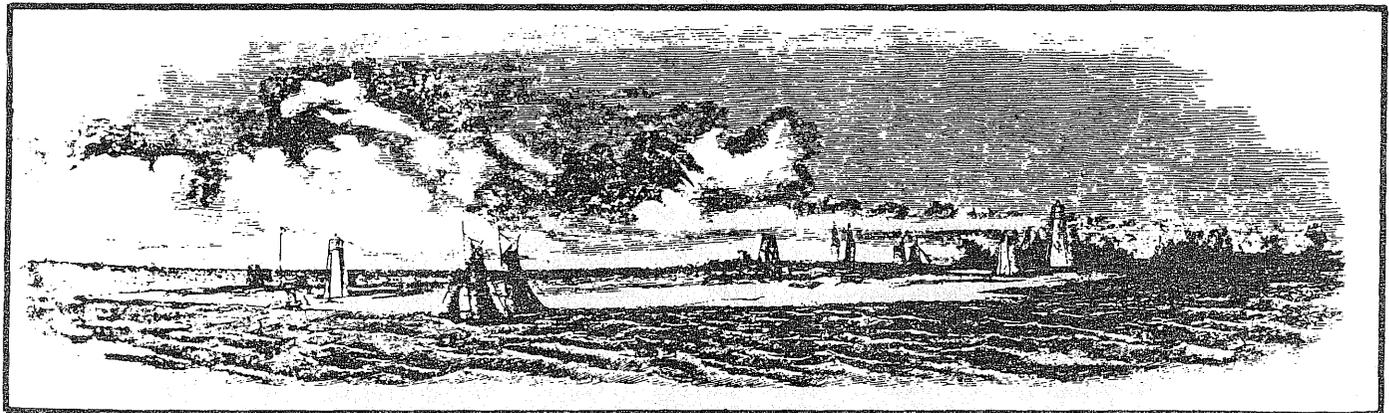


Figure 2. A schooner rounding Sandy Hook, New Jersey, heading to Virginia to buy seed oysters for planting on Raritan Bay oyster beds (from: Frank Leslie's Illustrated Newspaper 1857). The transplanting of seed from Chesapeake Bay to Raritan Bay took place during March and April each year.

The colonists gathered quantities of oysters as food. They used the shells to make lime for mortar used in construction of stone houses, and also scattered them over their farm fields, presumably to correct soil acidity.

The observations below are summarized from the writings of Ingersoll (1881) and Hall (1894), both employed by the Federal Government to study the oyster industry; Kochis (1975), who summarized reports from a number of newspapers, journals and books from that period; the Staten Island Historian (a quarterly periodical), historical newspaper articles about oystering; and interviews with people familiar with the oyster industry (see ACKNOWLEDGMENTS). Investigative reporters during the 1800s had to make some estimates concerning quantities of oysters planted and harvested and the numbers of oystermen and boats. The statistics relating to these items vary somewhat among the reporters and should be considered as estimates.

OYSTERING ON THE NATURAL BEDS

In the early 1700s, many colonists gathered oysters for consumption from natural beds in western Raritan Bay, Arthur Kill and Raritan River. Because the salinity was relatively low in the Arthur Kill and Raritan River, the oysters there remained small and thus were much less desirable as food than those in Raritan Bay (eventually, oysters in the Kill and river were gathered as seed to be spread on leased beds in Raritan Bay). Some oysters were consumed immediately and some were stored in cellars for eating during winter. It is not recorded how the oysters were taken; probably, some were gathered by hand at low tide, some with tongs (invented by the Indians) and some dredged from sailing boats. The first dredges consisted of a wooden crossbar with iron teeth to which a rope mesh bag was attached. After the Civil War, an improved dredge was developed with the frame and bag made of iron. People from other areas also sailed into the bay to take oysters. After a period of years, the oysters became relatively scarce, and restrictions were imposed in an effort to preserve them: oysters could be taken only between September 1 and May 1, and only by local people; the Indians did not have to abide by the restrictions. Nevertheless, the oysters became depleted. (The Indians along the New Jersey coast ceded their lands to the State and were moved to the Oneida Reservation in New York by 1802.)

THE COMMERCIAL OYSTER INDUSTRY, 1825 TO ABOUT 1925

Importing Seed Oysters

Because oysters represented an important source of protein, the local people began to import seed oysters from other areas by sailboat for planting on Raritan Bay beds, allowing them to grow to market size and then selling them. The first imported oysters came from Chesapeake Bay (Virginia), in the spring of 1825, and were spread on Round Shoal, which had been barren of oysters, off the town of Prince's Bay, Staten Island. Apparently, the oysters did well and the planter recovered a large portion of them the next fall, because in the ensuing years, more planters did the same. Quantities of oysters were imported from Virginia, mostly from the James, York and

Rappahannock rivers. The oysters were transplanted to Raritan Bay during March and April.

Eventually, a large number of schooners (most had two masts but a few had three or four masts) and some sloops were employed for transporting the oysters (Fig. 2). The schooners had a captain (45 to 70 years old) and a crew of four young men. Onboard, they subsisted on salted and smoked meats, and canned and dry foods. It took a schooner 35 to 40 hours to sail from Raritan Bay to Chesapeake Bay, two days to load with from 2,500 to 3,500 bushels of oysters, and another 35 to 40 hours to return to Raritan Bay. Sailing was done by day and night. If the local tongers were unable to work because the weather was bad, the schooners had to remain longer in the rivers. During such delays the crew watered the seed to keep it alive.

In Chesapeake Bay, the seed oysters were gathered by men in boats using tongs. The tonging boats had a crew of two. Usually, the two gathered about 125 bushels of rough culled seed (it was mixed with small quantities of shells) in six to seven hours on days with good weather.

When a schooner from Connecticut, Raritan Bay, Delaware Bay or another northern locality sailed into a river, such as the James, its crew dropped the anchor and, if the schooner was unknown to the tongers, raised an empty basket up the mast as a signal that it wanted to buy seed. As many as 20 boats tied up alongside the schooner to sell seed. The schooners had four loading sites; each was termed a fall. A boom and bushel container was lowered from each fall to the tonging boats for transferring seed to the schooner. The bushels were tallied as they were dumped on deck; the tongers received about 15 cents in the early years and 35 cents in the later years per bushel for the seed oysters, and they were 'paid on the spot'. A schooner which carried 3,000 bushels of oysters bought about 24 loads (assuming each consisted of 125 bushels) from the tonging boats. When the schooner was loaded, the anchor and sails were raised and the captain headed for Raritan Bay. The oysters were known as 'Virginia seed', 'Chesapeakes', 'soft' and 'fresh' oysters.

Some seed from northern estuaries was also imported to Raritan Bay. Most of it was gathered by men in skiffs using tongs.

The principal ports for oyster boats in Raritan Bay were Prince's Bay, and Perth Amboy and Keyport, New Jersey (Fig. 3). In addition, coastal towns on Staten Island, such as Tottenville, Chelsea, Mariners Harbor and Port Richmond had fleets of boats; Mariners Harbor had about 100 boats.

Bedding the oysters

When a schooner arrived in Raritan Bay, the captain headed for a designated bed to plant the oysters. The schooner sailed back and forth over the bed while the oysters were being shoveled overboard to spread the oysters as evenly as possible. Probably, the planters experimented with different planting rates. Taking a typical spreading density used currently of about 750 bushels of seed per acre, a schooner-load of 3,000 bushels of seed would cover four acres of bottom. The Virginia seed was left on the beds for one growing season. On most beds, the entire quantity of oysters was harvested and sold each fall. Thus, the beds were clean for a new crop of seed the following spring. Any plantings of small northern seed were left on the beds for an extra year or two, however, to allow them to grow. Usually, planters



Figure 3. (a) Enclosed boat basin at Perth Amboy, New Jersey. The cluster of boats at upper right, probably represents a group of men tonging oysters from skiffs at Ward Point. (b) The creek at Keyport, New Jersey. The illustrations show sloops, skiffs and oyster floats (from Ingersoll 1881).

spread the small northern seed over the beds with relatively soft bottoms and later transplanted it to beds which had hard bottoms for the final growing season. The Virginia oysters were planted on the hard bottoms. One report stated that a planting of Virginia oysters increased 40 percent in volume from planting to harvesting (average yields were probably at least 1 to 1, i.e., one bushel of seed yielded at least one bushel of market oysters). Another report stated that a company in Keyport bought Virginia seed one spring for \$150,000 and sold the harvested oysters resulting from it during the subsequent fall for \$500,000. During the season of 1879-80, oyster production from Raritan Bay was estimated at 430,000 bushels.

When the bedding of oysters began, no system of leasing bottoms existed. In the beginning, a planter staked the boundaries of a plot with hemlock poles (many poles were later anchored in place with 200-pound cement stones) and claimed that the oysters which he had planted on it were his. Such claims were often disputed, and they were brought to the courts to be settled. The courts ruled that if a person staked a plot and planted oysters on it, his claim would be upheld. The claim system gradually evolved into a formal granting system, under which individuals had the legal right to hold oysters on designated sections of bottom. Leases ranged from a fraction of an acre to about 100 acres (Fig. 4). Planters who held a lease at Ward Point had to pay \$1.00 a year for it, because the bottom there was especially good (hard) for oysters; however, planters holding leases in other locations did not have to pay for them.

Eventually, two Raritan Bay areas were leased to planters; one was in New York and extended about 10 miles long and five miles wide off the Staten Island coast at depths of mostly 8 to 25 feet, and the other was off Keyport (Fig. 5). Oystering became a large commercial industry and many individual planters formed companies. Some companies held a number of leases, and companies which held leases in other states, such as Connecticut, also held leases in Raritan Bay. As many as 1,000,000 bushels of oysters were spread over the beds each spring (more typical quantities may have been closer to 300,000 to 500,000 bushels). Some of the beds with soft, muddy bottoms were not planted. The setting of oyster spat on the imported oysters was sparse, and did not contribute much to the quantity of oysters produced. Probably, the Chesapeake Bay oysters did not spawn in the colder waters. Spat setting may have been denser than believed; much of the spat could have been killed by oyster drills and rock crabs before it was noticed. Starfish (Asterias forbesi) which cause much damage to oysters in Connecticut are scarce in Raritan Bay, and apparently did little damage to the oysters. Temperatures above 73°F have an adverse effect on starfish (MacKenzie 1970), and in Raritan Bay temperatures rise above that in midsummer (see Fig. 6).

Some hazards threatened the oyster plantings. A summer with several major storms and large freshets seemed to produce thinner oysters than a calm summer. Severe easterly storms buried some of the oysters. Old Orchard Shoal was the most exposed to storms and thus the most dangerous ground on which to plant oysters. In the early 1900s, one company planted only four-year-old oysters brought from Milford and New Haven, Connecticut to Raritan Bay; they were planted in the spring and harvested in September before storms could bury them. At times, schools of black drum (Pogonias cromis) entered the bay and ate some oysters. Some poaching of the oysters occurred and public fishermen tried to dig clams on the oyster leases. To protect their oysters, the

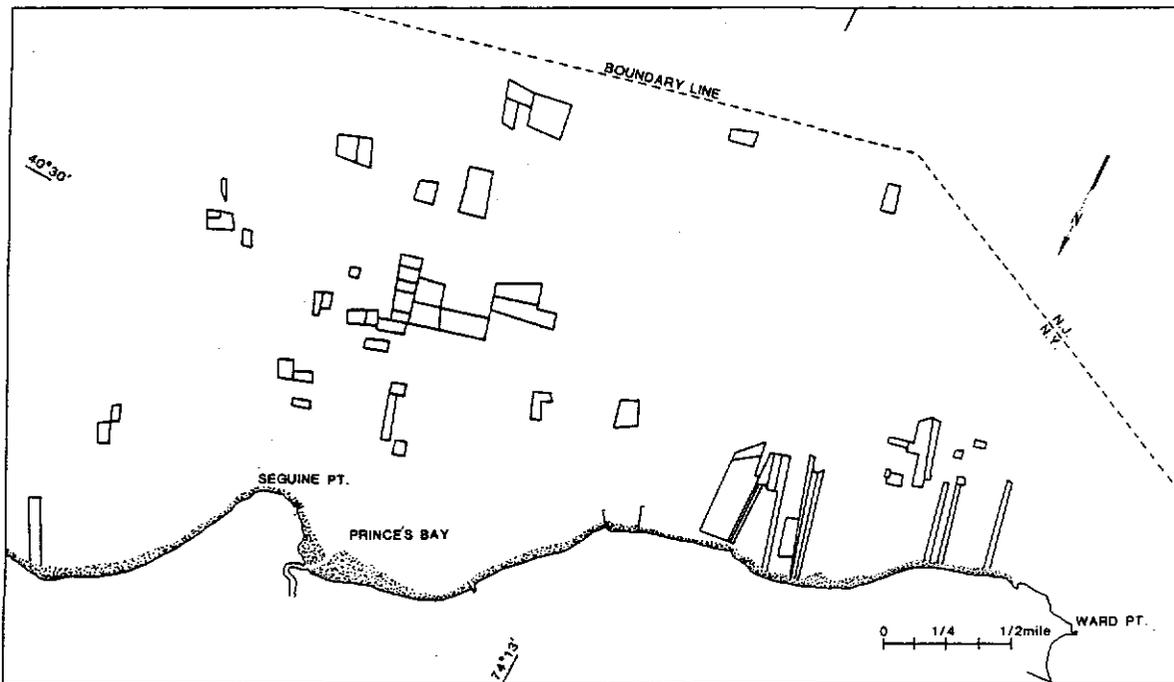
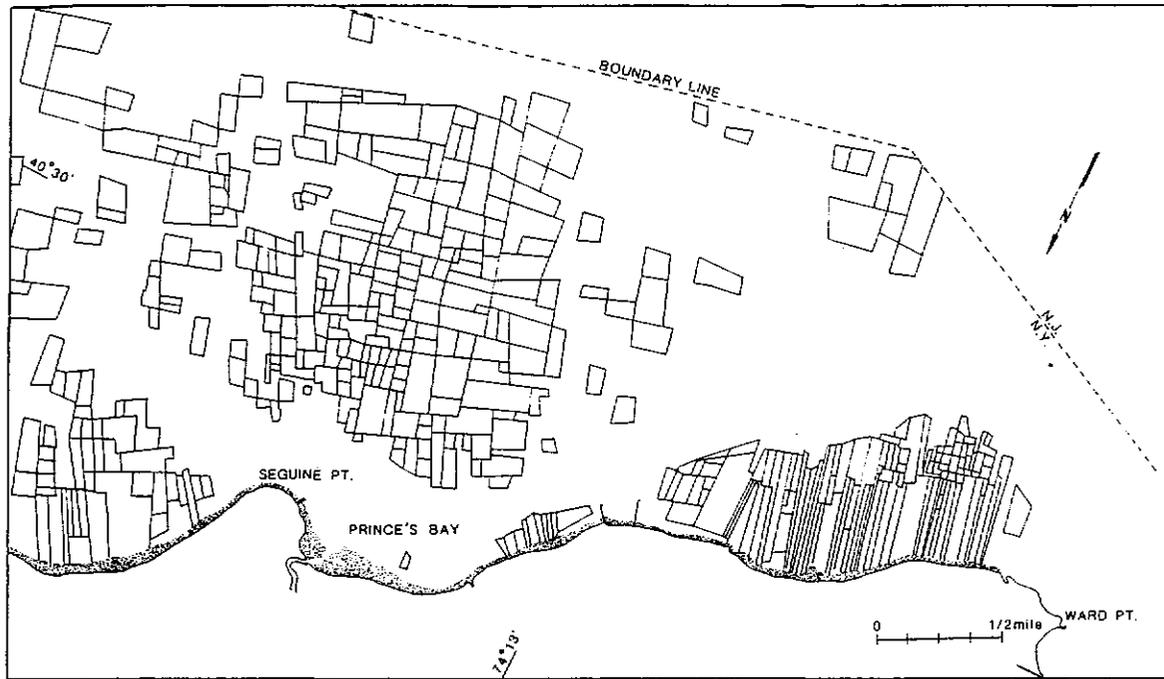


Figure 4. (a) Leased beds off Prince's Bay (Round Shoal) and Ward Point, Staten Island, in Raritan Bay in 1917. (b) Same area as (a) in 1937 after the industry was closed down because the water was polluted.

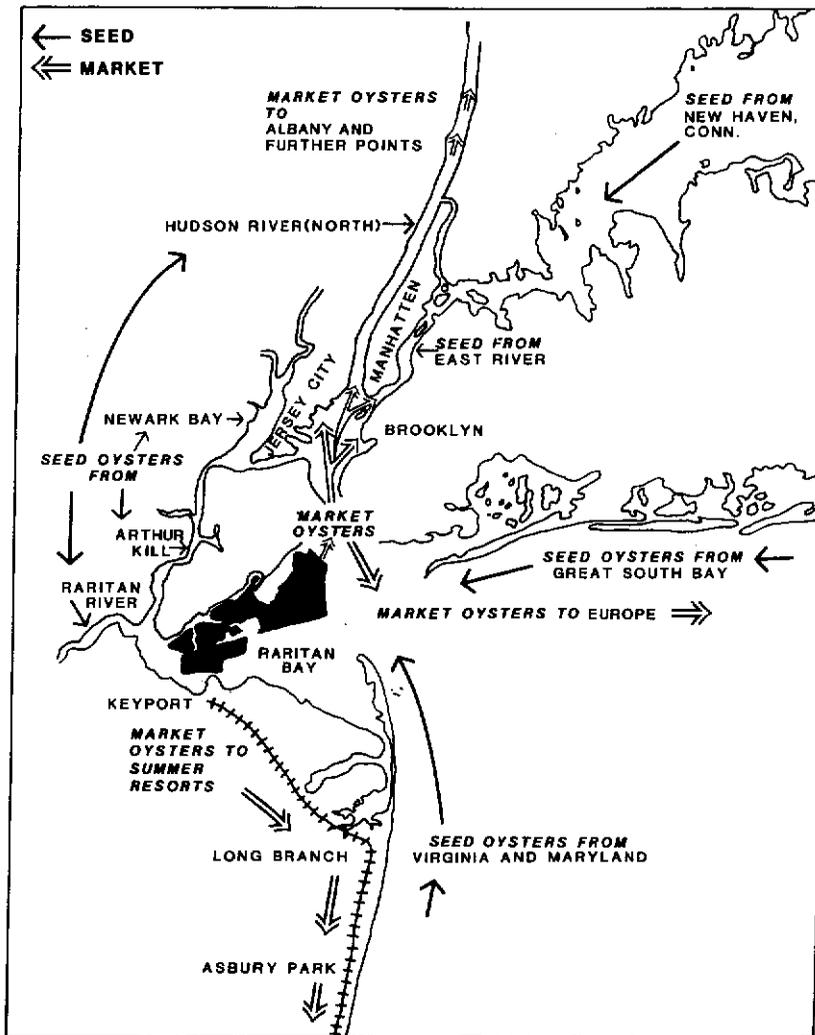


Figure 5. Locations of leased oyster beds (shaded areas) in Raritan Bay. Sources of seed oysters for the leased beds (single arrows) and marketing routes (double arrows) in the late 1800s.

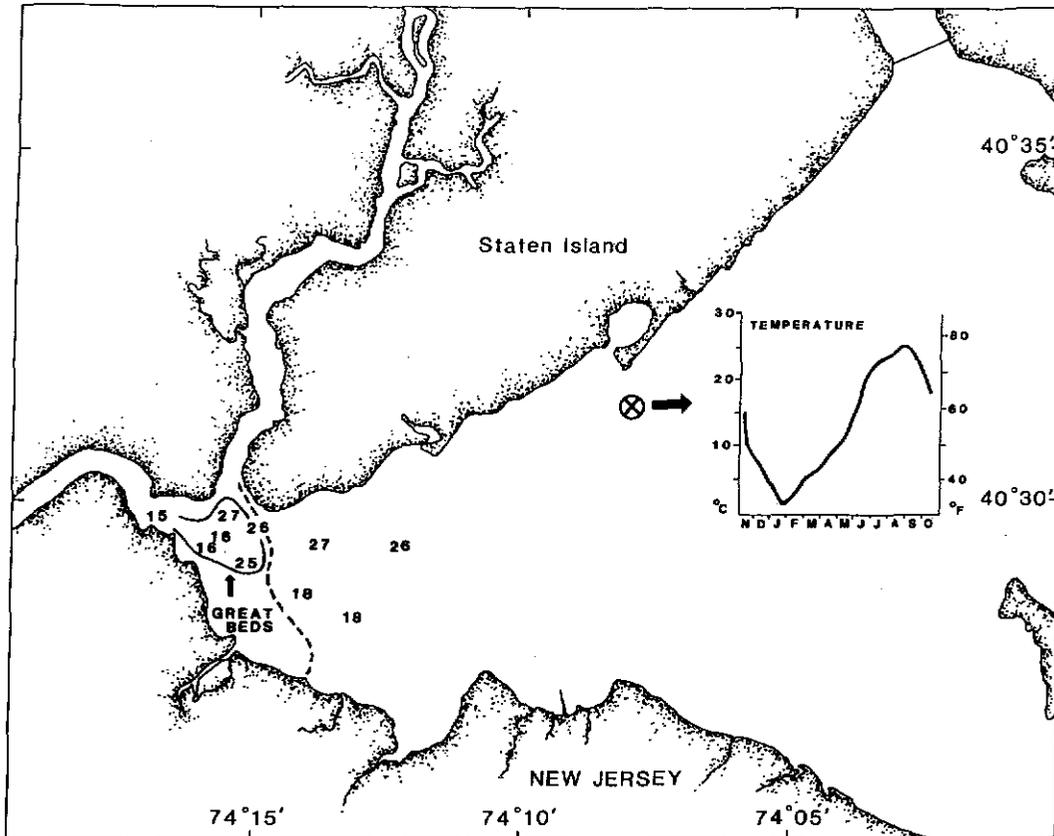


Figure 6. Salinities and temperatures in Raritan Bay. Arrow points to the limits of the Great beds. Dashed line is hypothetical 15 ppt line at the end of the ebb current in late March-early April in the pre-colonial period. The numbers correspond to bottom salinities at the end of the ebb current in late March 1984. The graph shows bottom temperatures, monthly, for a year. (Temperature data provided by A. L. Pacheco).

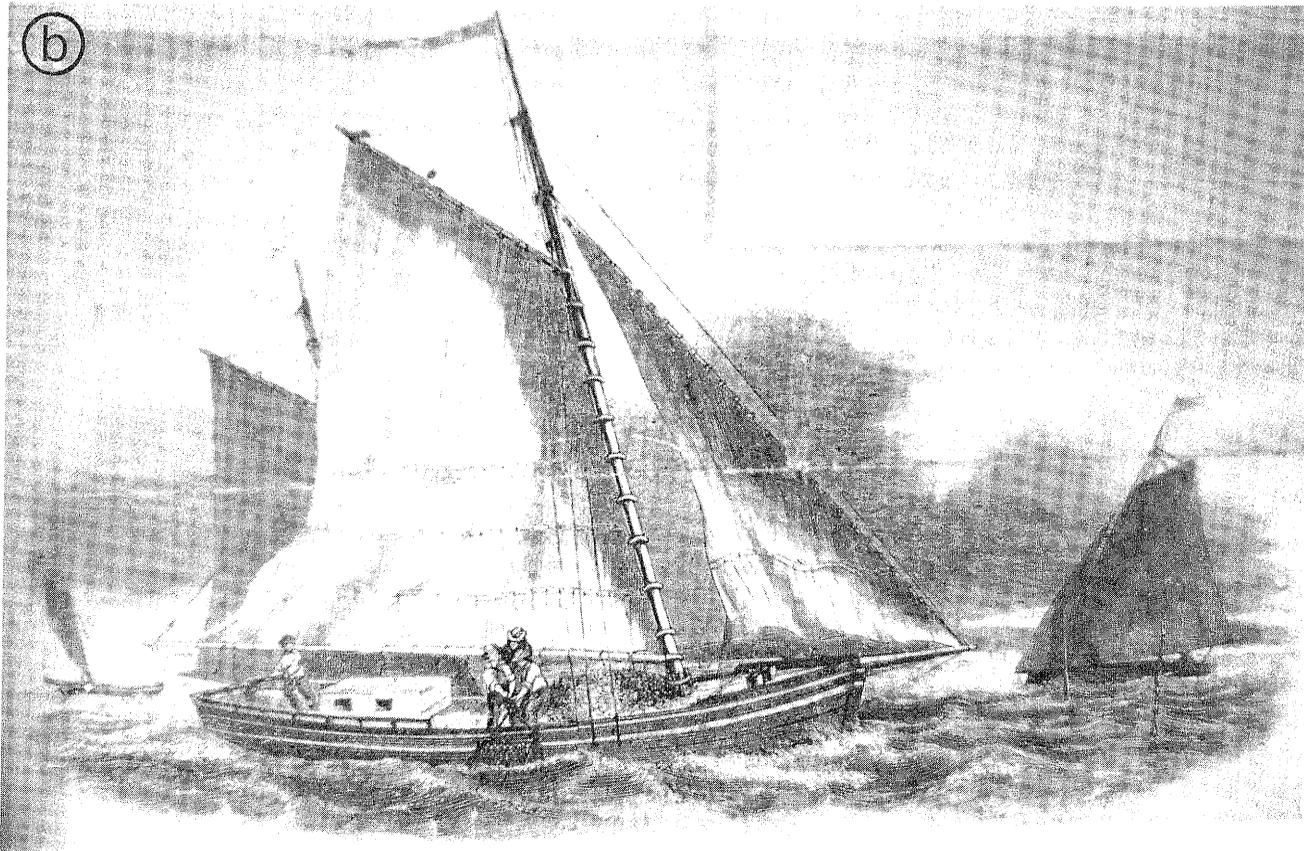
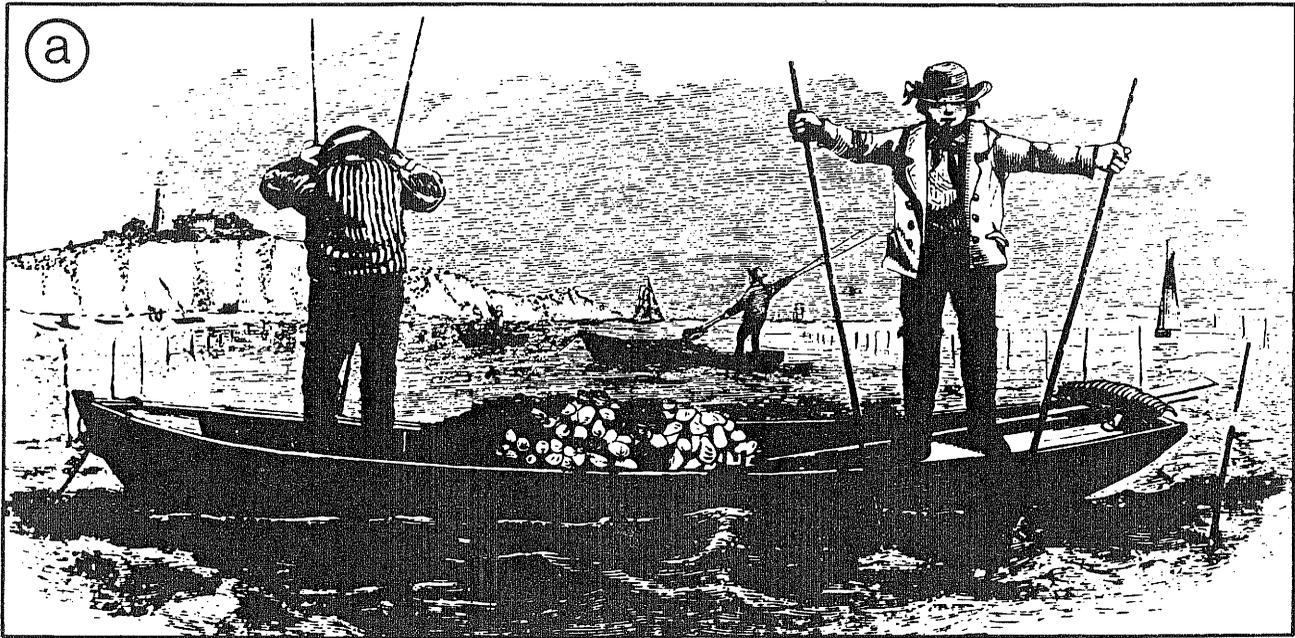
leaseholders founded oyster planting associations on Staten Island and Keyport in the 1870s and 1880s. The associations hired watch boats to patrol the beds at night.

Use of Chesapeake Bay and Northern Seed

During the Civil War, schooners were restricted from sailing to Chesapeake Bay because it was feared they might carry messages or otherwise aid the southern military forces. Thus, the oyster planters had to obtain seed oysters in the North. Following the war, the importation of Chesapeake Bay seed was resumed and thereafter about three-fourths of the seed came from Virginia and Maryland. Sources included Hampton Roads, the James, York, Rappahannock, and Choptank rivers, Tangier Sound, and Chincoteague Bay, etc., and came from public and private beds. The seed varied in price from 15 to 60 cents per bushel. In addition, the planter paid about \$300 for each boat load, of perhaps 3,000 bushels, for transportation, and about \$48 more for spreading the oysters on the beds. The remaining fourth of the seed, which sometimes totalled about 250,000 bushels, was from northern areas: the Raritan River, Arthur Kill, Newark Bay, the Hudson River (then known as the North River) and the East River and sold for about 50 cents a bushel. Northern seed was also imported from Great South Bay on Long Island and Connecticut (Fig. 5). The Connecticut seed was transplanted with engine-powered boats after 1900. Connecticut had imported most of its seed from Chesapeake Bay but became a seed producing area when it was discovered that spat would set in quantity on beds after the shells of Chesapeake Bay oysters were spread over the bottom. Seed was also imported from Delaware Bay in small amounts. In March and April, hundreds of men in skiffs tonged or raked up seed oysters in the Arthur Kill and Newark Bay for planting in Prince's Bay and other parts of Raritan Bay. The boats employed in transporting oysters from the Hudson River and Newark Bay to Raritan Bay were captained by the proprietors of leased beds and usually had three deckhands. The northern seed grew into superior shipping oysters and these were the oysters selected for shipments to the Midwest and Europe.

Marketing the Oysters

The principal oyster marketing season began on September 1 and ended around Christmas. Most oysters were harvested by tonging from skiffs (Fig. 7a), near a sloop anchored on the beds. The tonging skiffs were 21-26 feet long and 5-6 feet wide. Rakes with long slender handles, similar to the bull rakes used now for clamming, were also used to harvest the oysters in relatively deep water. The tongers culled the oysters from shells and refuse and transferred them to the sloops. The sloop carried the men to and from the bed and along with the oyster catch (a sloop-load consisted of 200 to 800 bushels of oysters). When oysters became scarce, sloops dredged most of the remaining oysters off the beds. For a long time, the sloop's dredges were hauled arduously by hand; one-bushel dredges were hauled by one man, three-bushel dredges by three men (Fig. 7b). Eventually, some sloops were fitted with hand winders for pulling in the dredges, but winding was slower than hand hauling, and some vessels retained the hand hauling method. One practice was to allow men, called gleaners, to tong and dredge up any oysters that remained on the beds on 50:50 shares. Usually, gleaners had two to three weeks of work, earning \$4 to \$5 a day. Later, the gasoline engine substantially improved the efficiency of boats. The first engine-powered oyster boat was built in 1896 and by 1910 every oyster company on Raritan Bay had at least one



DREDGING FOR OYSTERS, STATEN ISLAND

Gleason's Ill. News, 1853

Figure 7. Harvesting oysters in the 1850s. (a) Tonging for oysters in Prince's Bay. The rake in the skiff was used for harvesting oysters in deep water (from: Ballou's Pictorial Drawing-Room Companion 1855). (b) Hauling in a dredge full of oysters on a sloop (from: Gleason's Illustrated News, 1853).

engine-powered oyster boat equipped with dredges hauled in by power. Probably, most oysters were harvested by power boats after 1910.

When the harvested oysters were brought ashore, they were put in floats in brackish water creeks and held there for a single change of high tide or overnight, 'to give the oysters a drink'. The floats were about 25 to 35 feet long, 20 feet wide and 16 inches deep (Fig. 8). In the floats, the oysters opened and flushed out any mud and sand; 'drinking' oysters made their flesh whiter, freshened their flavor and when shucked increased the volume of a gallon of oyster meats by about a pint. Oysters were 'given a drink' in Lemon Creek in Prince's Bay and on the flats off Mariners Harbor on Staten Island, in Keyport Creek and the Rahway River in New Jersey and probably other localities (Fig. 1). Oysters were held in the floats for a longer period if they did not whiten or the landing port had a temporary oversupply. (The practice of 'drinking' oysters in floats around Raritan Bay and New York was abolished during the period of the typhoid fever scares. Since then, oysters along the Atlantic coast have been washed in sterile stainless steel tanks containing fresh water. The tanks are called 'blowers' because air is forced into the bottom of the tanks to agitate the oyster meats.)

In Keyport, many of the oysters were shucked in three large oyster houses (Fig. 9), and each had a huge pile of oyster shells beside it. Some of the shells were spread on the beds in July to collect a set of spat. Shells were also used to make roads in Keyport and nearby towns, sold to the poultry industry, which crushed and fed them to chickens for hardening egg shells, and to make lime for farms (apparently, the inshore beds in Keyport collected some natural sets of spat, but the beds on the Staten Island side of the bay may not have collected much set because no reports mention the spreading of shells there to collect spat).

The oysters were taken from the floats, put in oak baskets, which the industry used by the thousands, loaded onto sloops or passenger steamers (Fig. 10) and taken to New York City and other markets (Fig. 5). (Usually, large schooners were used to transport seed oysters from Chesapeake Bay to Raritan Bay, while sloops were used to carry market oysters from the bay to New York.) The sloops heading for New York had to wait for the flood current in the Hudson River because they could not sail against the ebb. Any oversupplies of oysters brought to New York were also held in floats. Apparently, most Raritan Bay oysters were sold in Manhattan, where the sloops unloaded them onto oyster barges, scows and other oyster vessels at Broome Street in the East River, and Tenth Street and Charles Street in the Hudson River (Fig. 11). Oysters from other areas were received there also. On the barges, most oysters were packed whole for sale to the half-shell trade, but some were shucked. Oysters destined for the half-shell trade were graded into four sizes and sold to wholesalers. Landed prices received for oysters varied according to their sizes and to some extent their sources. In 1840, average prices received for Raritan Bay oysters of various sizes were:

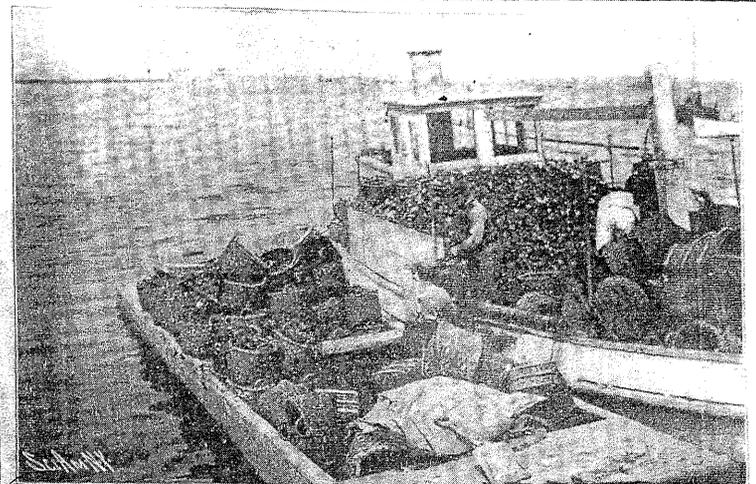
-Extras	\$15 to \$25 per 1,000
-Box oysters	\$7 to \$10 per 1,000
-Cullens	\$3.50 to \$5 per 1,000
-The poorest	50 cents per bushel



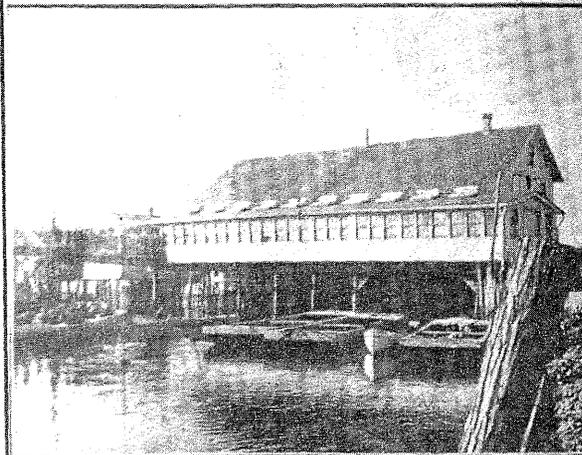
Figure 8. Floats of the type used to clean, fatten and whiten Raritan Bay oysters after they were harvested. Photos taken in Bivalve (Delaware Bay), New Jersey (from: Undersail - the Dredge Boats of Delaware Bay [used with permission of Wheaton Village, Millville, New Jersey]).



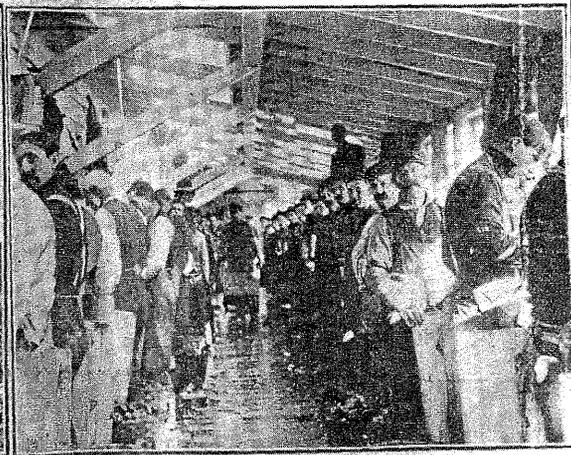
DRINKING OYSTERS



UNLOADING OYSTERS FROM DREDGE BOAT INTO SCOW



J. A. W. FLSWORTH'S OYSTER HOUSE



OYSTER HOUSE, OPENERS AT STALLS

Figure 9. View of the oyster industry at Keyport, New Jersey around 1910. Photo at upper right shows dredge boat with load of oysters being transferred to a scow for transport into Keyport creek. The dredge boat operated with an engine and the dredges (8 bushel capacity) were pulled in over rollers by engine. Note the post which replaced the mast. Photo at upper left shows the 'drinking' of oysters; apparently, the oysters were left in baskets for 'drinking'. Photo at lower left shows an oyster house; the oysters were lifted into the house through holes in the floor. Photo at lower right shows some of the shuckers in the oyster house; they opened 50-100 thousand gallons of oysters a year. The oyster house, which opened in 1900, discontinued operations in 1926. (Photo composite courtesy of Keyport Historical Society).

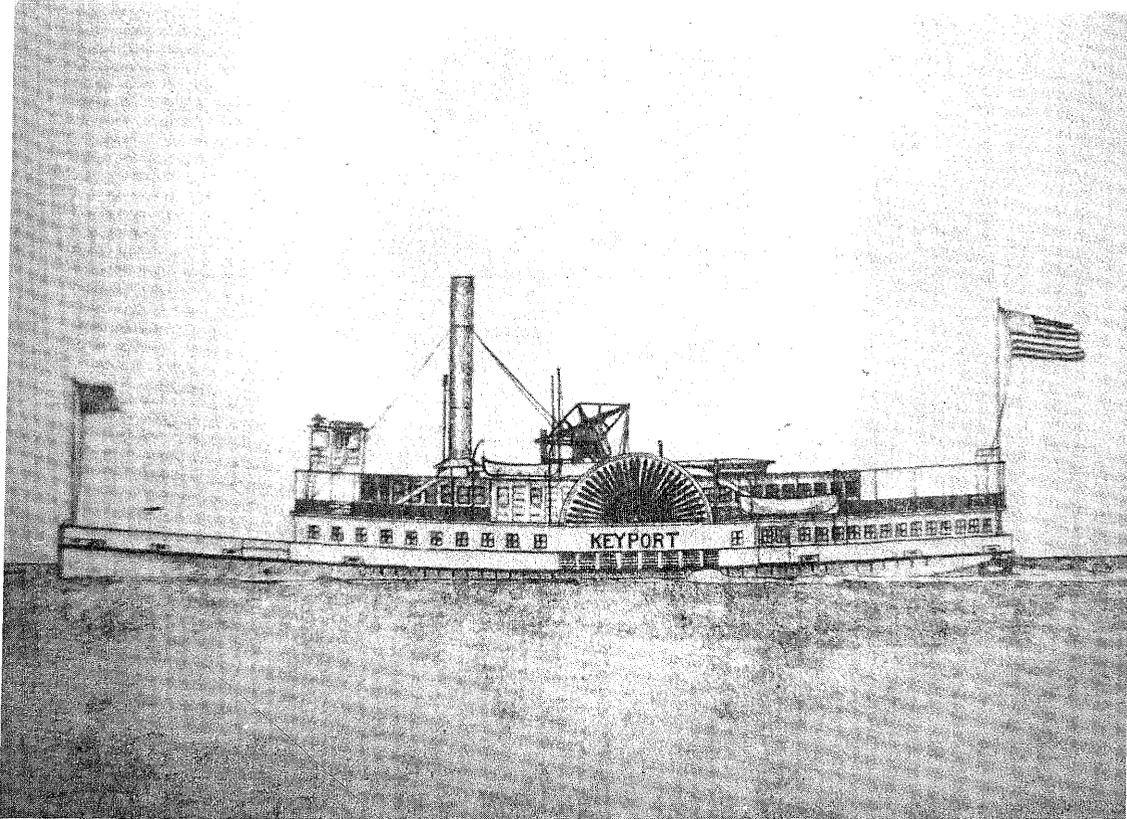


Figure 10. A steamer which transported passengers between Keyport, New Jersey and New York City also carried oysters to the city.

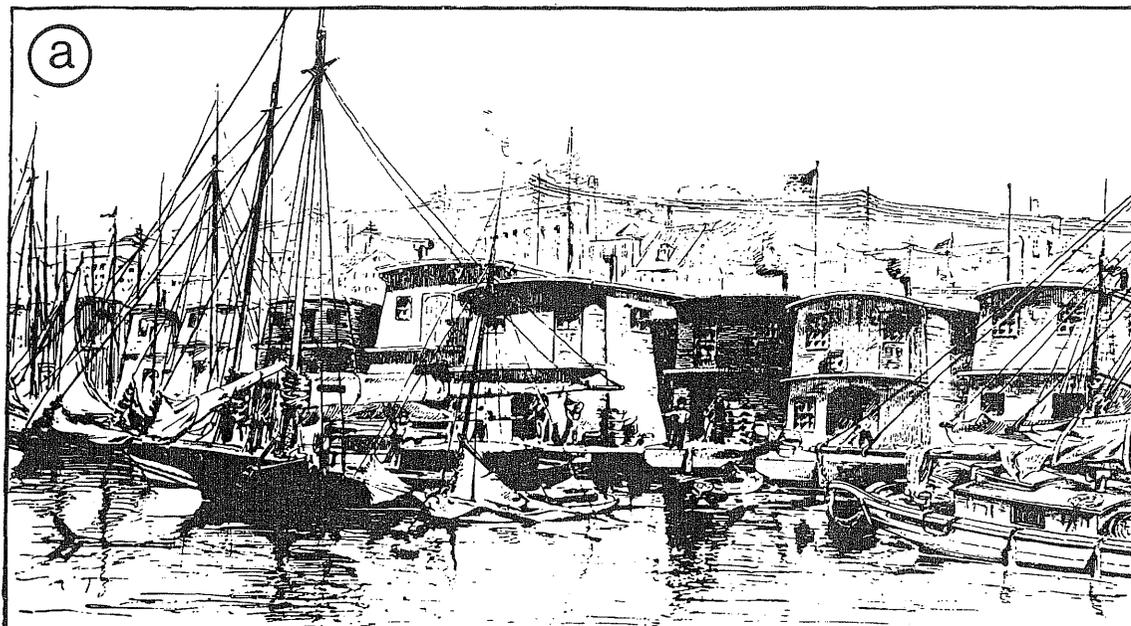


Figure 11. Oyster barges in Manhattan, New York City, where oysters were received from sloops, packed in barrels (some were shucked), and then put on horse-drawn wagons for delivery to points in the city. A barge could handle about 700 bushels of oysters a day. (a) The barges as seen from the river, showing the sloops which delivered the oysters (drawing from Ingersoll 1881). (b) The barges from land, showing a horse-drawn wagon and barrels of oysters (photograph from the Oysterman and the Fisherman 1912).

Oysters were also marketed at other locations along the Hudson River, including Jersey City, Brooklyn and towns above New York and Albany. Sometimes, as many as 40 sloops were tied up unloading oysters in Albany. Some oysters landed in Albany were taken by wagons and boats via the Erie Canal to Buffalo. Before the railroads came into being, oyster growers visited towns on the Hudson River early in the fall for orders which were filled before ice formed in the river. Quantities of Raritan Bay oysters were also shipped overland to the Midwest and West Coast and also Europe, mostly England.

During summer, some oysters were harvested to supply New Jersey tourists at sea coast resorts south of Sandy Hook, such as Long Branch and Ocean Grove. For this market, the oysters were landed at Keyport and delivered by rail. The oysters shipped by rail were packed in barrels (three-bushel capacity). Raritan Bay oysters were known as 'Sounds' (in the 1800s, the Arthur Kill was known as Staten Island Sound), 'Prince's Bays', 'Keyports' and 'Amboys'. They were relatively fat, and had excellent keeping qualities when stored out of water.

Most activity on the oyster beds occurred during the fall harvesting season, less during the spring planting season, and little in summer and mid-winter. In the fall, the western end of Raritan Bay was said to have an 'uncountable number of skiffs and sloops harvesting oysters from the beds amidst a forest of oyster stakes that were so numerous they were difficult to sail through'.

Effect of the Industry on Local Economies

The local economies of Raritan Bay were substantially fostered by the development of the oyster industry. Human populations on the northern and western sides of the bay grew along with the oyster industry. The population of Staten Island, which had been relatively small, grew considerably as a result of the work generated by the oyster industry. Nearly all families in the southern half of the island were involved in some phase of oystering, mostly handling oysters on the beds and ashore. But other phases existed. For example, Tottenville had a shipyard in which sloops and schooners were built. (Some engine-powered oyster boats also built there remain active in Long Island Sound in the 1980s.) Keyport had 23 planters and 89 men worked for them on the water. The workers tonged oysters on the beds and then handled oysters in floats and baskets in Keyport Creek. In addition, scores of men shucked oysters. Keyport had a factory which made baskets for the industry and two kilns for making lime from oyster shells for farms. Communities had blacksmiths who made gear for the oystermen and farmers. Grocery and hardware stores were supported in part by the trade of people in the oyster industry.

In the 1850s an estimated 1,000 to 3,000 people were supported by the industry and 400 ships and sloops worked on the beds. Investment capital was in the millions of dollars, and the richest Staten Islanders were oystermen. The Raritan Bay oyster industry did well economically because the bay had excellent hard bottom for raising oysters, large supplies of seed oysters were available for planting, oysters grew fast, yields were good, oysters became fatter than those in most other estuaries and large markets were nearby.

Pollution and the Demise of the Industry

The oyster industry in Raritan Bay prospered until about 1910, when the water in New York Harbor started to become polluted. Newspaper reporters traced cases of typhoid to Raritan Bay oysters and in 1918, a typhoid fever outbreak made more than 15,000 people sick and resulted in 150 deaths. The outbreak was traced to the consumption of shellfish, much of it from Raritan Bay. The bay was temporarily closed to oyster and clam harvesting. (Much of the contamination of oysters may have occurred while they were held in floats in Lemon, Keyport and Rahway Creeks, Mariners Harbor and alongside the oyster barges in New York.) The negative publicity caused the oyster wholesalers to abandon the Raritan Bay oyster industry since they were reluctant to assume the financial risk for building boats and buying Chesapeake Bay seed oysters. The industry limped along, threatened by pollution scares, until about 1925 when it more or less closed down.

Effect of the Closure on the Oystermen

The closure of the oyster industry plunged the oystermen into a depression. It was especially hard because the men had investments in their boats and gear which could not be used to any substantial extent for other purposes. Attempts were made to lift the closure (the oystermen who were having difficulty finding acceptable alternative employment got politicians to lend their help) and some were temporarily successful, but closures followed each time because more illnesses were traced to Raritan Bay oysters. Most men had to turn to other local jobs, or move elsewhere. Thus, the closures displaced many oystermen and their families, eliminated small family leaseholds and shore-based enterprises which had supported the oystermen, and diminished the quality of rural coastal life.

The larger oyster companies which had beds in other states were allowed to transplant their oysters from Raritan Bay to the other beds for cleansing. Most oysters were transplanted to Gardiners Bay in eastern Long Island and Narragansett Bay, Rhode Island. By that time a railroad ran from Greenport to New York City which transported market oysters to the city.

Effect of the Closure on Consumers

Since the Raritan Bay oyster industry produced only a small percentage of the total oysters at the time, the closure had only small effect on the oyster market. New York, its chief market, was already obtaining most of its oysters from other sources, i.e., Connecticut, Long Island, Delaware Bay and Chesapeake Bay. Probably, some people missed the locality names and the taste of Raritan Bay oysters.

During the 1880s and 1890s, the railroad industry developed refrigerated railroad cars, which made it possible to ship huge quantities of chilled beef and pork from the Midwest to eastern cities (Walsh 1982). The meats competed with oysters as a source of protein. Since about 1900, the decline in oyster production has been caused, in part, by a reduced demand. How much of the reduced demand resulted from a fear of disease is not known. In recent years, shellfish, including oysters, and fish have been shown to be more healthful than meats; they contain unsaturated fats and smaller amounts of cholesterol. Thus, the demand for seafood has risen in relation to meats.

ENVIRONMENTAL OBSERVATIONS

Effects of Oyster Plantings Upon the Environment

The plantings of oysters across the western and northern portion of Raritan Bay must have had an enormous effect upon the biota of the bay. The almost continuous populations of oysters resulted in a huge increase in the surface area of the bottom. Oyster clusters project as much as 6 inches above the bottom, each with a much larger surface area than the bottom below it. Moreover, the new substrate was shell rather than sand or mud. It provided a larger environment for such shell encrusting species as filamentous diatoms, sponges, bay anemones (Diadumene leucolena) (Fig. 12), bryozoans, slipper shells (Crepidula sp.), mussels (Mytilus edulis), barnacles (Balanus sp.), polychaetes and others. Beds of oysters also provided cover for mud crabs, hard clams (clams are most abundant under oysters which protect the seed from predation) and hake (Urophycis sp.). All of the associated species could occur in greater abundance after the oysters were present than they had on the sand bottom without oysters. Since many species are fish prey, more fish probably inhabited Raritan Bay. It has been shown in other areas that oyster beds contain a larger mass of invertebrates and fish, such as cunner (Tautoglabrus adspersus) and summer flounder (Paralichthys dentatus) than exists on sand bottoms nearby (Arve 1960; MacKenzie 1981). Probably, the invertebrates which require open, sandy bottoms declined in numbers where the oysters were planted. Most biota associated with the oysters were tonged or dredged up with the oysters and died during the fall, but new generations settled on the new crop of seed oysters during the following spring and summer.

The feeding by oysters and encrusted animals must have also had a substantial effect on other biota of the bay. They would have removed quantities of phytoplankton from the water; a large oyster, 4 to 5 inches long, for example, can transport from 9 to 48 quarts of water across its gills daily for feeding and respiration (Galtsoff 1964). Moreover, the quantities of feces and pseudofeces which they produced would have provided a rich environment for benthic bacteria, protozoans and other invertebrates.

The presence of oyster stakes attached to the cement stones which marked the corners of oyster beds provided a habitat of their own. A variety of encrusting organisms attach in a continuous layer to these substrates, and certain fish, such as the cunner, remain around such objects.

One can only speculate about other effects. Did the importation of oysters from Chesapeake Bay, Long Island Sound and other areas introduce any new species into Raritan Bay, and did the presence of oysters act to slow water currents in the bay?

Various Impacts upon the Oyster's Environment

The adverse impacts of man's activities upon the oyster environment can be considered in four categories. In the order of occurrence, the impacts were: 1) increased silt inflow, 2) dredging of channels, 3) increase in salinity and 4) water pollution. Some conclusions about impacts are speculative because until recently no quantitative records were available.

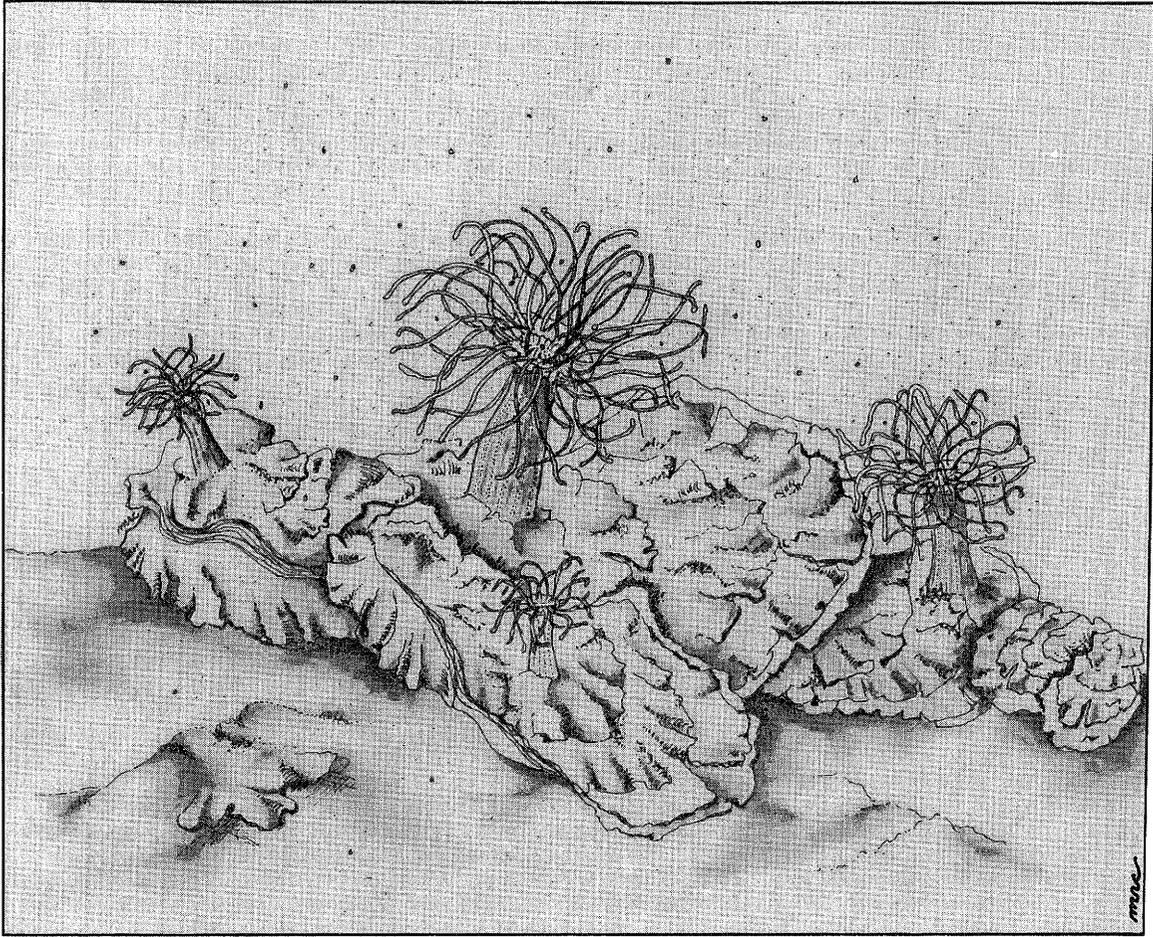


Figure 12. Bay anemones, which prey on the larvae of oysters and other invertebrates, are abundant in the western third of Raritan Bay.

1. Increased silt inflow

When colonists populated the drainage area of the Raritan River, they cut down trees and plowed land to establish farms. Thereafter, a great deal of erosion of sediment occurred. As sediments were carried into streams, the larger particles settled out early, but much of the silt and clay remained in suspension until it reached the mouth of the river and entered Raritan Bay. Here, the current flow was considerably reduced and much of the sediment settled to the bottom. The presence of oysters on the bottom tends to accumulate silt because the oysters act as baffles which interrupt and reduce the flow. As mentioned earlier, a natural chain of oyster beds extended from a point about five miles upriver from the mouth of the river to about a mile eastward from its mouth (the Great Beds). Undoubtedly, the entire stretch of oysters accumulated quantities of silt beginning during the colonial period and continuing afterwards. In addition, a channel was dug in the Raritan River from its mouth to New Brunswick in 1837, and one was dug in the Arthur Kill in the early 1890s. The digging, which was done with clamshell buckets, removed quantities of oysters, destroyed part of the oyster's environment (oysters cannot grow in a channel bottom overlaid with mud), and released quantities of silt into the water which would have settled on the remaining oyster beds along the river and the Great Beds (Fig. 13a).

Silt, if present in quantity, can have a substantial adverse effect on oyster abundance. It fills any oyster shells positioned cup-side-up, covers the outer surface of shells lying cup-side-down on the bottom and accumulates around oyster clusters, sometimes leaving only a small portion of the oysters exposed to water (Fig. 14). Thus, the presence of silt substantially reduces the available shell area of the bed on which oyster spat can set and grow, and consequently reduces the recruitment of oysters. Wherever silt accumulates more than about 3 inches over the bottom, the habitat cannot support oysters. Siltation is not mentioned in the literature as a factor in the decline of oyster production from the Great Beds, but it probably played a major role. Surveys made in the late 1970s showed that the bottom where the Great Beds were and the channel bottoms in Raritan Bay are now covered by at least several inches of soft mud. Moreover, following a spring rain, the water is completely dark from a meter or so below the surface to the bottom in the area of the Great Beds (Fig. 13b). Silt has probably accumulated in other sections of Raritan Bay. The areas shown on present charts that have mud or soft bottoms may have been somewhat smaller in extent, and the mud layer thinner, during pre-colonial times.

2. Dredging of channels

Figure 15 shows the dates during which the various shipping channels were dug in Raritan Bay, Raritan River and Arthur Kill. Most channelling occurred from 1890 to 1910 and was done with clamshell buckets. The dredging in the western end of the Bay, the river and the Kill must have destroyed quantities of oysters and eliminated much good oyster bottom. As mentioned earlier, quantities of silt were released during the dredging. Any effects of the channels on salinities and currents are unknown.

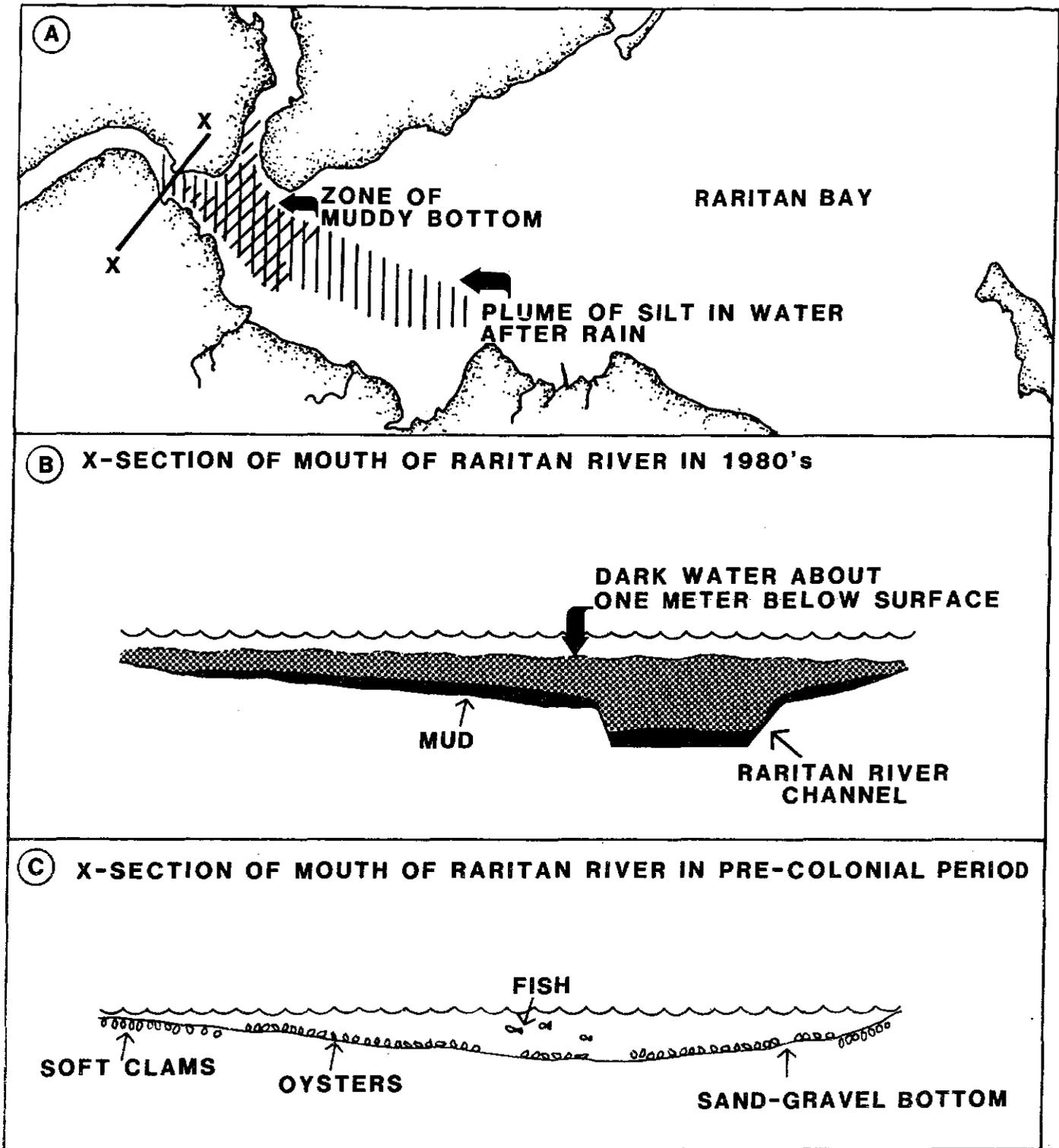


Figure 13. (a) Raritan Bay and surrounding area showing the present extent of muddy bottom just beyond the mouths of the Raritan River and Arthur Kill, and a plume of silt visible from the air following a rainstorm. (Note: such a plume varies in size and often covers most of the bay.) (b) view of the cross-section of the mouth of the Raritan River; a channel has been dredged, mud lies on the bottom, the water is dark, the salinity is higher, and the water and mud contain industrial wastes. The adverse environmental modifications in the Raritan River and Arthur Kill should be considered as a factor which reduced fish abundances in Raritan Bay. (c) probable view of the cross-section of the mouth of the Raritan River during pre-colonial times; oysters grew on the bottom in relatively clear water.

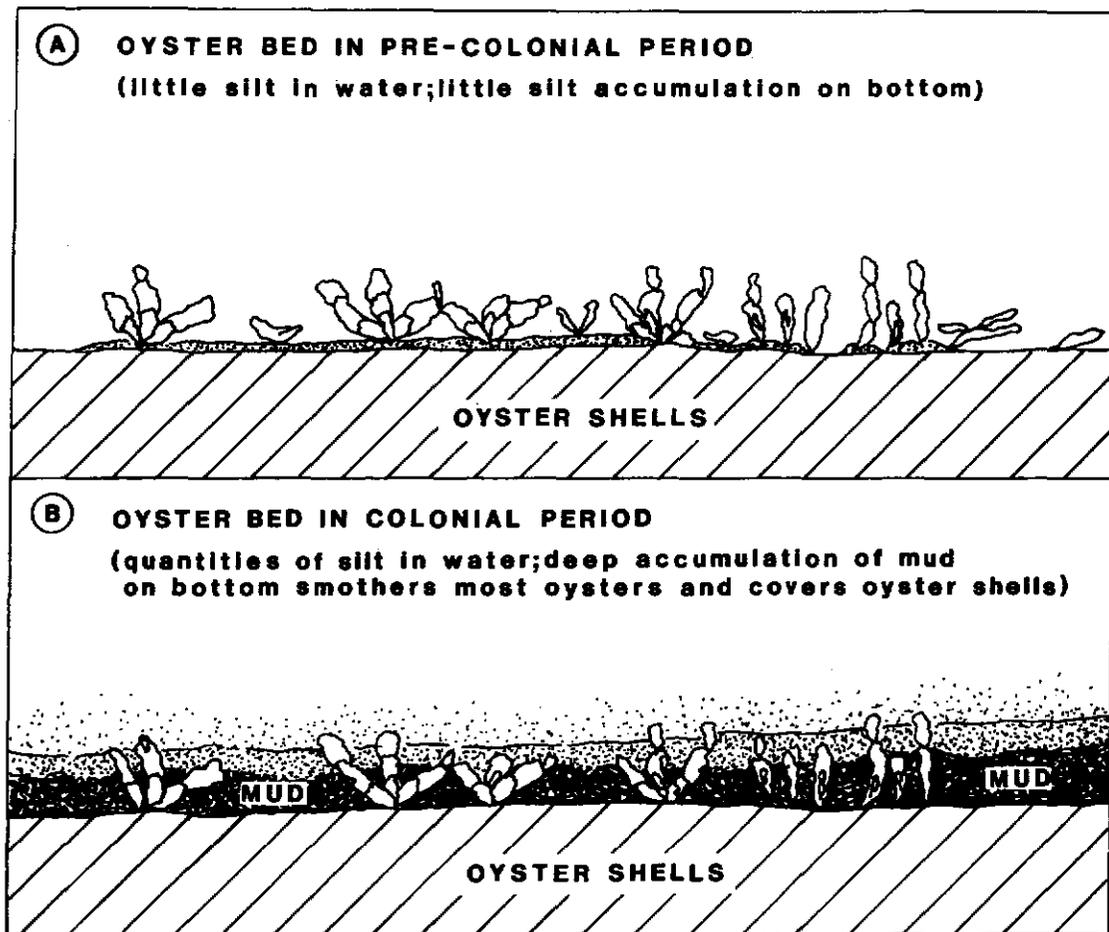


Figure 14. Probable appearance of a section of oyster bottom in the Great Beds, located immediately beyond the mouths of the Raritan River and Arthur Kill in the (a) pre-colonial period and (b) colonial period.

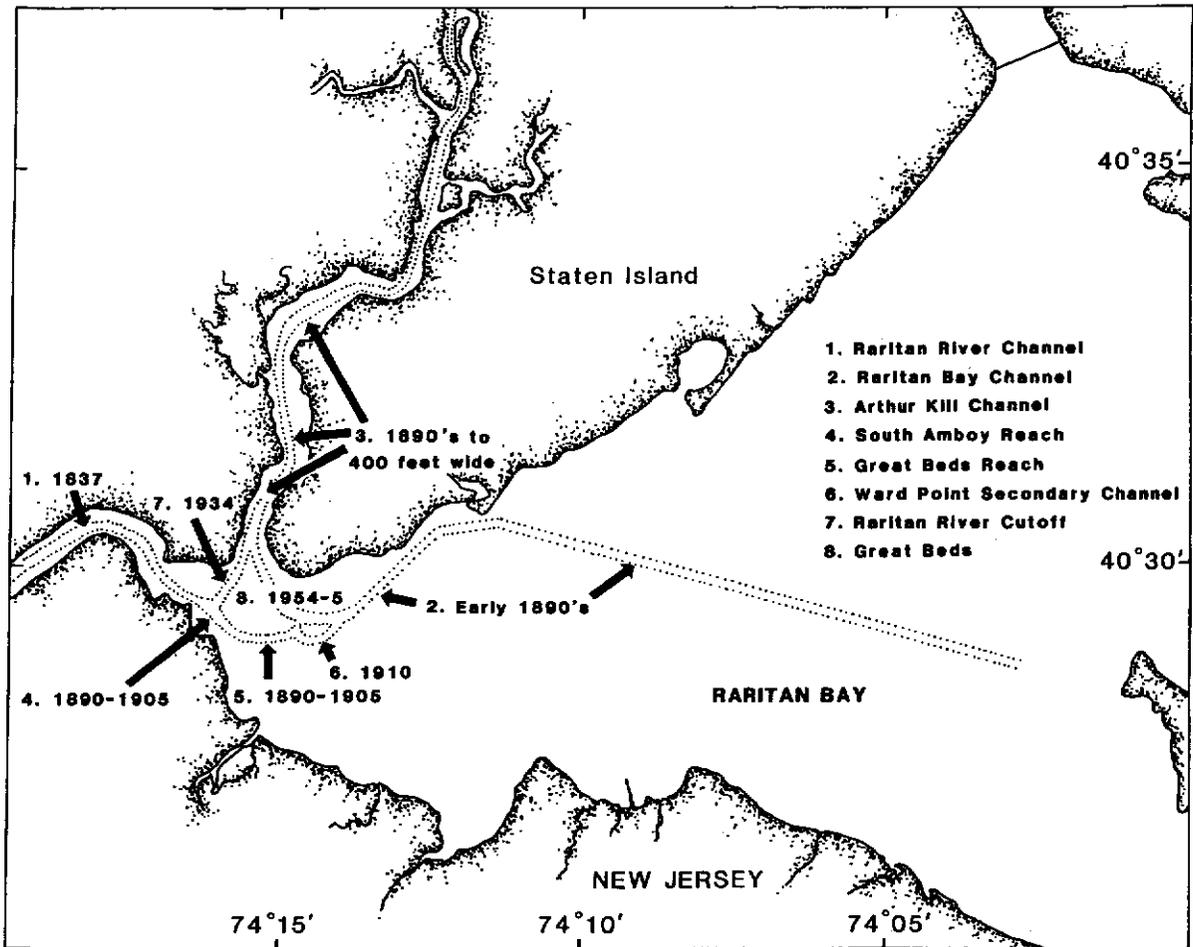


Figure 15. Maps of Raritan Bay, Raritan River and Arthur Kill listing the dates when the channels were dredged.

3. Increased salinity

Usually, natural oyster beds occur within a zone where the bottom salinity ranges from about 7 to 15 ppt at low tide. In such habitats, oyster shells remain nearly free of fouling organisms and predators of seed oysters are relatively scarce. The oyster cannot live at lower salinities. Larval and sedentary stages can live at higher salinities; oysters do not normally occur there, however, because a relatively dense array of organisms occurs which makes the environment much less suitable for survival. Normally, any shells or stones on which the larvae could set are covered with fouling organisms (diatoms, bryozoans, slipper shells [*Crepidula* sp.] and others). Since oyster larvae cannot set on them, settlement of oyster spat is sparse. Moreover, oyster drills and crabs, which destroy quantities of small oysters, are usually abundant. Thus, few of the spat which do set survive beyond a few months.

No record exists of the salinities in Raritan Bay before the early 1800s, when oysters grew on the Great Beds. I measured bottom salinities in the western end of the bay on March 28, 1984 at the end of the ebb current. Salinities on Great Beds ranged from 16 to 27 ppt. A reading of 15 ppt was recorded at a site about one-half mile west of the western extremity of Great Beds (see Fig. 6). A historical record exists of the flow of the Raritan River at Bound Brook, New Jersey, about 20 miles from the mouth of the river. The record extends from 1904 to 1908, with a break to 1945, and is continuous through 1982. The annual river flow at that site was 14.1 percent less (14,267 cubic feet per second) during 1945-72 period than during the 1904-08 period (16,606 cubic feet per second) (Table 1). Data for the recent period are highly variable, however; short periods within it are comparable with the 1904-08 period and thus it is not certain how much the river flow actually diminished. Presumably, river discharges during the pre-colonial period may have been even larger than during the 1904-08 period. Reduced river flows in the Raritan River produce higher salinities over the Great Beds.

What would reduce river flow in the Raritan River? According to the New Jersey Geological Survey, water is now removed from the drainage area of the Raritan River by municipalities. For example, the city of New Brunswick and the Duhernal Water Company at Old Bridge off South River remove more than 33 percent of the river's water during August when the river is low. Though nearly all is returned to the river as processed sewage water, some loss occurs, in part from leaky pipes and in part from water loss to the ground. Elizabethtown removes about 11 percent of the water from the Raritan River of which 30 to 50 percent returns as processed sewage water. The Delaware-Raritan Canal once emptied into the Raritan River. Towns take some water from the canal; estimated at 75 cfs in 1980. Probably, some of the water enters the Raritan River as processed sewage water. Although the diversions are believed to reduce total river flow, the diversions mentioned have taken place largely since the Great Beds were depleted of oysters; however, during the colonial period, farmers in the Raritan River drainage basin dammed a number of the creeks which led into the river. The dams would have reduced river flow and raised salinities over the Great Beds by a small amount.

4. Pollution

Raritan Bay lies 'downstream' from the largest population center in the United States: Greater New York City. Four rivers, the Raritan, Hackensack, Passaic and Hudson, which pass through this center, ultimately drain into Raritan Bay. In addition, the creeks where oysters were held in floats were not sanitary. It is not surprising that the oysters eventually became polluted and the oyster industry was forced to close.

Effects of the Impacts Upon Associated Species

The environmental changes described must have had an enormous effect on the indigenous invertebrates and fish which had populated those areas (Fig. 13b, c). An animal community had evolved to grow on and around oysters or on sandy bottom, and in water carrying less silt, with having a lower salinity and with no industrial wastes. Probably, few of the indigenous invertebrates are now abundant in the area; most numerous today are some mud-dwelling, pollution-tolerant species. The total number of individuals and species of invertebrates is reduced from the pre-colonial period.

Raritan Bay is a nursery area for the larvae of several fish species. Undoubtedly, the environmental modifications in the western end of the bay have reduced fish abundances. Muncy et al. (1979) state that entire aquatic communities including plankton and macroinvertebrates, as well as fish, are substantially modified by high turbidity; large concentrations of silt disrupt activity and respiratory patterns; reduce sight-feeding distances and change orientation patterns of some larval and juvenile fish species. Miller (1974) found that in Hawaiian waters, the number of fish larvae was about 75 percent lower in turbid water than in clear water; the number of fish species present was about 55 percent lower in the turbid water. The reason may be that in highly turbid water, fish larvae are unable to see their prey and cannot orient themselves to the current flow. The environmental modifications should be included as a factor which reduced fish abundances in Raritan Bay.

Pearce (1979) has reviewed quantitative studies, conducted mostly in the 1970s, of the contamination of biota and their environments and some effects of contaminants on invertebrates and fish in Raritan Bay. A feature of the bay which increases its pollution is that the water has a relatively long residence time. The flushing time of the bay is about 32 to 42 tidal cycles or 16 to 21 days (Jeffries 1962). Thus, any contaminant discharged into the bay will remain there for that time and will likely be picked up by the biota and sediments. The concentrations of six heavy metals in bay sediments were highest in the central muddy portions of the bay, but concentrations were also elevated in other portions of the bay. The concentration of copper in the water was 65 ppm (Waldhauer et al. 1978), the highest ever reported for any estuary. The concentration of hydrocarbons in the sediments of the bay was also elevated, especially in its central portion (Stainken 1979; Koons and Thomas 1979). Fish in the bay have body burdens of PCBs. Spot (Leiostomus xanthurus) had 0.53 ppm; small winter flounder (Pseudopleuronectes americanus), 0.37 ppm; larger winter flounder, 0.14 ppm; small bluefish (Pomatomus saltatrix), 3.09 ppm; medium size weakfish (Cynoscion regalis), 0.6 ppm, and eels (Anguilla rostrata), 1.4 to 3.32 ppm. The numbers and species diversity of invertebrates in Raritan Bay were much lower than in other temperate estuaries, and amphipods were absent from the western third of

the bay, suggesting a large amount of pollution (McGrath 1974). The fish in Raritan Bay commonly have fin erosion disease; in a 1967 survey, 70 percent of individuals comprising 22 species of fish caught in Raritan, Lower New York and Sandy Hook bays and the New York Bight apex were diseased and the epizootic was centered in the estuaries (Mahoney et al. 1973). A subsequent study in Raritan Bay and nearby waters showed that 15 percent of winter flounder had fin erosion disease (Ziskowski and Murchelano 1975). A study of the oxygen consumption of the biota, sediment and water immediately above the sediment in Raritan Bay had values ranging from 0.11 to 0.89 ounces/yd²/hr (3.9 to 31.4 ml O₂/m²/hr); the rate is much elevated over pristine environments and undoubtedly results from the loading of sediments with organic material (Thomas et al. 1976). Raritan Bay has extremely high primary productivity--the annual value of 24 ounces C/yd²/yr (817 g C/m²/yr) is considered among the highest anywhere in the world (O'Reilly et al. 1976) (note: it is believed that much of the heavy metal loading of Raritan Bay began during World War II when industrial plants along the Raritan River and other coastal areas had to produce large quantities of goods for the war effort. During that war, people had little concern about water pollution and thus much of the industrial waste was emptied into the rivers. Many plants maintained this means of waste disposal after the war.)

OYSTER RESOURCES IN THE 1980S

The bottoms of most oyster beds, such as Ward Point, Round Shoal, Old Orchard Shoal and the Chingarora Bed, remain in good physical condition and have oyster shells on them. Ward Point and Round Shoal contain small numbers of oysters; oyster setting occurs on the two beds in some years but it is sparse. The bottom of the Great Beds has been destroyed as an oyster habitat because it has been partially dredged and is covered with soft mud; the bottoms of the Raritan River and Arthur Kill have been channelled and probably are covered with mud.

COULD THE OYSTER INDUSTRY OPERATE AGAIN?

In the early 1980s, according to officials in the New York State Department of Conservation and New Jersey Department of Marine Fisheries, fecal coliform and heavy metal quantities in Raritan Bay are far above the maximum allowable for safe shellfish harvesting directly to the market. However, even if they were brought down to safe quantities, the potential for problems is large; a sewage plant breakdown or excessive rainfall could recontaminate the shellfish. Much of the contamination comes from non-point urban areas, such as city streets during rainfalls. To clean up the waters of the bay enough to allow direct consumption of shellfish would at least require that the old cities near Raritan Bay, such as New York, Jersey City and Brooklyn install separate systems for sewage and rainwater runoff. This is an enormous and unlikely undertaking. In addition, manufacturing plants would have to reduce their discharges of pollution into the rivers.

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