CLASSIFIED SHELLFISH GROWING WATERS

In 1995, over 33,000 sq mi of marine and estuarine waters in the contiguous United States were classified as shellfish growing waters under a program to protect human health that is jointly administered by coastal states and the National Shellfish Sanitation Program. This represents a 52% increase since these data were first compiled in 1966. Of the 4,230 growing areas involved, 69% were approved for harvest; 19% were conditionally approved, restricted or conditionally restricted; and only 13% were prohibited–the lowest percentage on record for this category. The 1995 commercial harvest from these waters totaled 77 million pounds of oysters, clams and mussels worth approximately $200 million at dockside.

The following reference format is suggested:

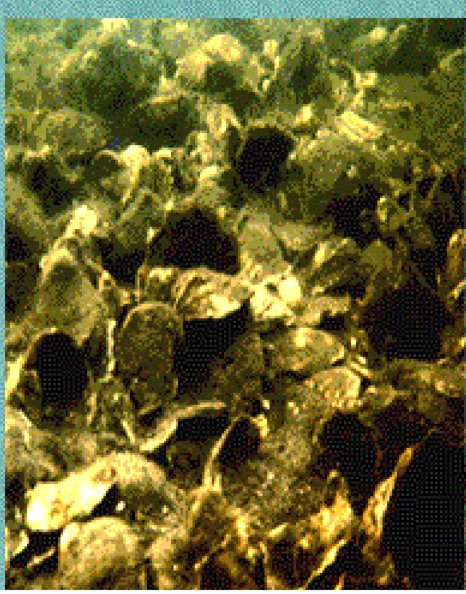
National Oceanic and Atmospheric Administration (NOAA). 1998 (on-line). "Classified Shellfish Growing Waters" by C.E. Alexander. NOAA's State of the Coast Report. Silver Spring, MD: NOAA.

URL: http://state_of_coast.noaa.gov/bulletins/html/sgw_04/sgw.html

INTRODUCTION

The harvest of oysters, clams and mussels along the marine coast of the United States is a tradition that can be traced back many centuries to the native Americans who first inhabited these shores. Hundreds of huge and long-forgotten middens or waste heaps of oyster and clam shells that dot our coast are testimony to the original abundance of these animals and their importance as a source of food (MacKenzie, 1996). Today, most Americans consider shellfish more a delicacy than a staple. Nevertheless, the harvest, processing, distribution and consumption of shellfish, particularly oysters, make up an important industry, supporting thousands of jobs and generating hundreds of millions of dollars for the U.S. economy.

Photo 1. The harvest, processing and consumption of shellfish support thousands of jobs and generate hundreds of millions of dollars for the nation's economy.



Molluscan shellfish also have a long history as vectors of infectious and sometimes dangerous diseases ranging from typhoid fever and hepatitis to diarrhea and minor intestinal disorders (Rippey, 1994). These agents often originate in discharges of human sewage and indigenous marine bacterial pathogens. The unique biology of shellfish and the way we consume them contribute to our vulnerability to shellfish-borne disease. Shellfish are sedentary filter feeders, pumping large amounts of water through their bodies. This process can concentrate microbial pathogens in their tissues, causing little or no harm to the animal, but posing substantial risks for human consumers, particularly because shellfish are often eaten raw or partially cooked.

To protect public health and ensure a safe harvest, the coastal waters of the United States are carefully surveyed and classified for harvest according to guidelines of the National Shellfish Sanitation Program (NSSP) - a cooperative and voluntary alliance among states, the U.S. Food and Drug

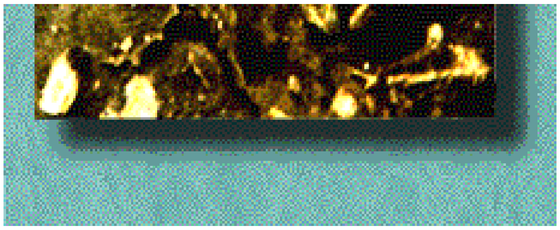


Photo 2. Molluscan shellfish, like these oysters, are sedentary filter feeders, pumping large amounts of water through their bodies to collect food.

Adminstration (FDA) and the shellfish industry. In 1995, 4,230 shellfish growing areas were classified covering more than 33,000 sq mi of coastal and estuarine waters–an area slightly larger than the entire state of Maine (NOAA, 1997). The Federal government publishes a summary of these data as the *National Shellfish Register* approximately every five years.
(top)

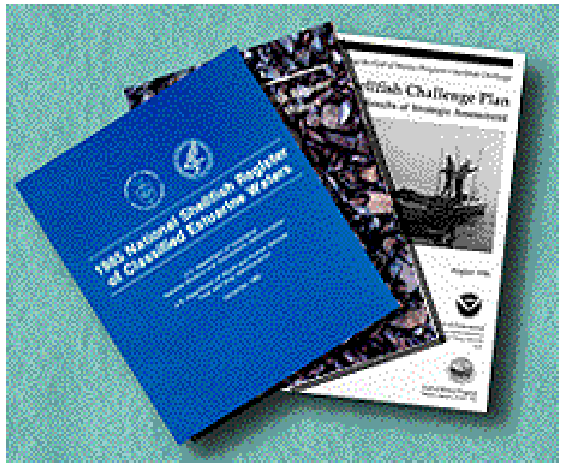


Photo 3. *The National Shellfish Register,* which is published approximately every five years, summarizes the status and trends of classified growing waters.

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NATIONAL PICTURE

The NSSP arose from a series of public health initiatives formulated in the mid-1920s following a widespread outbreak of typhoid fever in which 1,500 cases and 150 deaths were reported (Rippey, 1994). The outbreak was eventually traced to sewage-polluted oysters. The U.S. Public Health Service subsequently recommended sweeping changes in the harvest and distribution of shellfish, including inspection of shellfish growing areas and scientific investigations of disease outbreaks. As these and other recommendations gained acceptance, the incidence of life-threatening outbreaks declined. Of particular importance with respect to typhoid was the initiation of research to find a bacterial indicator of the quality and safety of shellfish growing waters. The last case of shellfish-vectored typhoid fever in the United States was reported in 1954. Today, the NSSP represents a comprehensive program that ensures clean shellfish growing waters and safe handling, processing, packaging and distribution of the shellfish harvest (FDA, 1993a, 1993b).
(top)

Classification of Growing Waters

Coastal states identify, survey and classify shellfish growing waters according to NSSP guidelines (FDA, 1993a). Classification status is based on sanitary surveys of water quality and shoreline surveys of pollution sources. Individual growing areas are classified either as approved for harvest or as one of four harvest-limited categories: (1) conditionally approved, (2) restricted, (3) conditionally restricted, or (4) prohibited. All identified growing waters must be classified as prohibited unless sanitary surveys indicate that water quality meets specific NSSP standards for the other categories. The NSSP standards are rigorous.

Harvesting is permissible in approved areas year-round. Shellfish harvested from restricted areas must be relayed to approved waters or to "depuration" facilities for a designated period of time to reduce their levels of bacteria and viruses before they are processed for human consumption. Conditionally approved and conditionally restricted categories are voluntary; states can use these categories when a predictible pollution event such as seasonal population, heavy rainfall or fluctuating discharges from local sewage plants affect the suitability of an area for harvest. Harvests from waters in these categories typically require substantial state resources for issuing permits, monitoring water quality, creating a management plan, and supervising harvest and transportation. Unfortunately, some potentially productive growing areas remain prohibited for harvest because of inadequate state resources to conduct the requisite sanitary surveys.

The primary basis for harvest restrictions is the concentration of fecal coliform bacteria associated with human sewage and with organic wastes from livestock and wildlife. Other classification factors include proximity to known point and nonpoint sources of pollution, weather (e.g., heavy

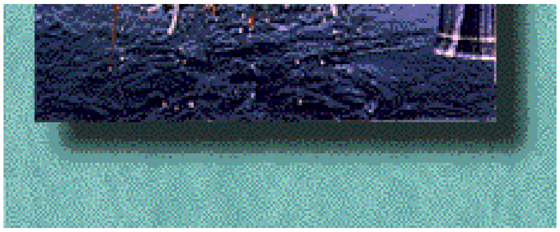

Photo 4. Shellfish growing waters are identified, surveyed and classified by coastal states. Status is based upon sanitary surveys of water quality and shoreline surveys of pollution sources.

rainfall that temporarily introduces pollutants), tides, circulation and prevailing winds. In some cases, monitoring also includes toxic industrial contaminants, such as heavy metals, and marine biotoxins associated with coastal "blooms" of certain planktonic species –the so-called "red tides."

Some scientists and fishermen question the use of fecal coliform concentrations for indexing shellfish growing areas, particularly in waters that receive chlorine-disinfected effluents from wastewater treatment plants (Rippey, 1994). Although chlorine is generally affective in inactivating most bacterial species, including bacterial pathogens, it is less effective against enteric viral pathogens found in sewage, such as the common Norwalk-type virus associated with minor intestinal distress and related problems. The use of alternative indicators of fecal pollution is currently under investigation by the FDA.
(top)

National Status and Trends of Classified Growing Waters

The *National Shellfish Register* provides a record of the acreage of all classified shellfish growing waters in the contiguous United States. The *Register* was first published in 1966 to meet the need for summary information on the status and extent of the nation's commercial shellfish growing areas. Subsequent Registers were published in 1971, 1974, 1980, 1985, and 1997. It includes surveys of 21 states along the Atlantic, Gulf of Mexico and Pacific coasts (Alaska and Hawaii are typically excluded, and Pennsylvania has no suitable harvest waters). Since 1985, the *Register* has been compiled by the Office of Ocean Resources Conservation and Asssessment of the National Oceanic and Atmospheric Administration (NOAA) in association with coastal states, the ISSC, the FDA and others.

Photo 5. Since 1966, the acreage of classified shellfish growing waters has increased from 10 million to over 21 million acres.

Since the publication of the first *Register* , the acreage of classified shellfish growing waters has increased more than twofold from 10 million to over 21 million acres (Figure 1) (Houser and Silva, 1966; FDA, 1971; EPA, 1975; DOC/HHS, 1985; NOAA, 1991; NOAA, 1997). An expanding consumer demand for shellfish has, in part, fueled this increase. For example, from 1970 to 1995, the U.S. population increased 28% from 205 to 263 million people. During the same period, consumption of fresh and frozen shellfish (which includes oysters, clams and mussels) increased 98%, from 246 to 487 thousand tons (NMFS, 1971, 1995). Though these numbers are small compared to consumption of chicken (about 6.5 million tons in 1995) or beef (about 8.5 million tons), this trend has nevertheless brought pressure on coastal states to clean up harvest-limited areas and to classify new growing areas, including an increasing number of coastal ocean areas that are outside the traditionally classified bays and estuaries.

For 1995, Louisiana (3.9 million acres) and North Carolina (2.8 million) led the United States in classified acreage (Table 1). Other important states include Maine (1.8 million acres), Virginia (1.6 million), Texas (1.6 million), Massachusetts (1.5 million), Florida (1.4 million) and Maryland (1.4 million). Chesapeake Bay, the largest estuary in North America, led all estuaries in classified acreage with 2.5 million acres, followed by Albemarle/Pamlico Sounds in North Carolina (1.9 million), and Breton/Chandeleur and Mississippi Sounds in Louisiana (1.1 million) (Table 2).

Table 1. 1995 Classified U.S. Shellfish Growing Waters

State	Classified Acres (x 1,000)	% Harvest Limited

Maine	1,852	16
New Hampshire	61	10
Massachusetts	1,548	27
Rhode Island	284	14
Connecticut	369	66
New York	1,134	14
New Jersey	737	29
Delaware	326	23
Maryland	1,440	9
Virginia	1,650	6
North Carolina	2,803	15
South Carolina	783	10
Georgia	187	63
Florida	1,445	79
Alabama	292	100
Mississippi	431	36
Louisiana	3,964	46
Texas	1,620	49
California	24	96
Oregon	91	89
Washington	308	36
Total	21,349	31

Photo 6. Louisiana led all states in 1995 with 3.9 million classified acres, followed by North Carolina (2.8 million acres), Maine (1.8 million) and Virginia (1.6 million).

Table 2. Classified Shellfish Growing Waters of the Contiguous United States: 1995

Top 10 Estuaries	State(s)	Estuary	Classified Acres (x 1,000)
1.	MD/VA	Chesapeake Bay	2,534
2.	NC	Albemarle/Pamlico Sounds	1,935
3.	LA	Breton/Chandeleur Sounds	1,190
4.	LA	Mississippi Sound	1,089
5.	NY/CT	Long Island Sound	810
6.	DE/MD	Delaware Bay	508
7.	LA	Atchafalaya/Vermillion Bays	500
8.	LA	Terrebone/Timbalier Bays	410
9.	TX	Lower Laguna Madre	399
10.	ME	Penobscot Bay	383

On average, 70% of all classified waters are approved for harvest each year, 10% are conditionally approved, restricted, or conditionally restricted, and 20% are prohibited (Table 3). Since 1966, the percentage of all classified waters approved for harvest has decreased 10%. However, data compiled for the *1995 Register* suggests significant improvements. For example, the overall percent of harvest limited waters decreased from a high of 42% in 1985 to 31% in 1995. The percent of prohibited waters also decreased, from a high of 26% in 1974 to 13% in 1995, the lowest percentage recorded.

When state managers close or otherwise restrict a shellfish growing area, they typically cite one or more sources of fecal coliform bacteria and other potential contaminants as the reason. This information was collected for the 1990 and 1995 *Registers* (Table 4). In 1995, the most common pollution source cited was urban runoff; identified as a principal or contributing factor in 40% of all harvest-limited growing areas. Unidentified sources upstream of coastal watersheds (39%) and wildlife (38%) were close behind, followed by individual wastewater treatment systems (e.g., septic tanks) (32%) and wastewater treatment plants (24%). Other sources reported include agricultural runoff (17%), marinas (17%), boating (13%), industrial facilities (9%), combined sewer overflows (7%), direct discharges (4%), and feedlots (3%). The 1990 *Register* reflects the same

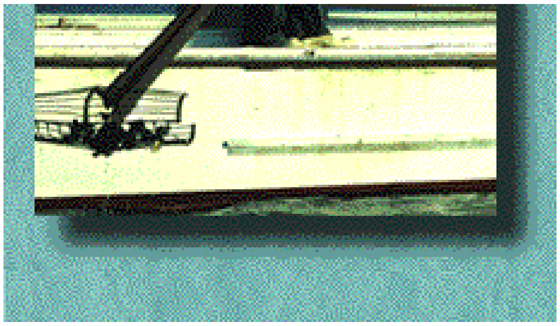

Photo 7. Over 77 million pounds (meat weight) of oysters, clams, mussels and scallops worth $200 million at dockside were harvested from U.S. classified waters in 1995.

top five sources of pollution, although in slightly different order. Marine biotoxins associated with "red tides" and other naturally occuring contaminants such as *Vibrio* spp., a free-living marine and estuarine bacteria associated with stomach and intestinal disorders of varying intensity, can also cause temporary closures, although they are not usually regarded as a pollution source (Rippey, 1994; FDA, 1993a).
(top)

National Harvest from Classified Waters

Commercial fishermen harvested just over 77 million pounds (meat weight) of oysters, clams, mussels and scallops worth $200 million at dockside from U.S. classified shellfish growing waters in 1995 (NMFS, 1997). Half the harvest, by weight and value, was oysters, followed by clams (40% by weight, 46% by value), mussels (9% by weight, 2% by value) and scallops (less than 1% by weight and value). Almost 60% (107 million pounds) of all molluscan shellfish landed in 1995 were harvested more than three miles offshore, and thus, outside of state classified waters. This percentage includes all sea scallops, most bay scallops and significant numbers of clams, particularly surf clams and ocean quahogs. The offshore harvest was worth an additional $137 million.

Photo 8. Aquaculture supplied 72% of the oysters harvested in 1995 according to the National Marine Fisheries Service–up from 43% in 1985.

Harvest trends from classified waters vary. Some species and regions are in decline; others are relatively stable; still others are increasing. Overall, the 1995 harvest was, by weight, 13% below average for the previous 10 years and 10% below the average dollar value (NMFS, 1997; NMFS, 1995). Factors contributing to harvest success include level of effort, the relative health of a particular stock, consumer demand and, of course, the water quality in classified growing areas. Shellfish farming, or aquaculture, which is usually conducted in the same classified waters as the wild harvest, has also become an important harvest factor. For example, NOAA's National Marine Fisheries Service (NMFS) estimates that oysters from aquaculture represented 72% of the national oyster harvest in 1995, up from 43% in 1985 (NMFS, 1995).

Finally, there is the almost entirely undocumented recreational harvest. Figures from the U.S. Fish and Wildlife Service, which reports that over one million persons averaged about five days each of recreational shellfishing (e.g., for clams, oysters, crabs, shrimp) in 1996 (Aikman, 1997 pers. com.), suggest that the recreational fraction of the harvest is potentially significant, particularly for local and accessible (nearshore) species.

Photo 9. Over 77 million pounds of shellfish were commercially harvested in 1995. Recreational harvest is undocumented, but potentially significant.

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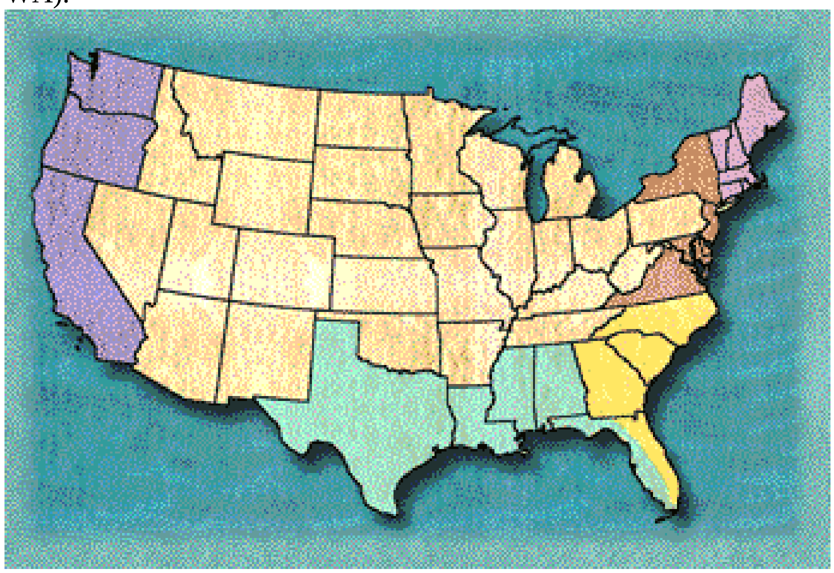
REGIONAL CONTRASTS

The contiguous United States can be divided into five coastal regions for comparison purposes: North Atlantic (ME, NH, MA, CT, RI), Mid-Atlantic (NY, NJ, DE, MD, VA), South Atlantic (NC, SC, GA, FL-part), Gulf of Mexico (FL-part, AL, MS, LA, TX) and the West Coast (CA, OR, WA).



Regional Summary of Classified Waters

According to data collected for the 1995 *Register* , the Gulf of Mexico region contains the largest regional fraction of the nation's classified growing waters, with 36%. Louisiana alone represents nearly one-fifth of the nation's growing areas, with a vast intertidal zone measuring 3.9 million acres. The Mid-Atlantic region, which includes the almost equally vast Chesapeake Bay, is second, with 25% of the total, followed by the North Atlantic region (19%) and the South Atlantic region (18%). The West Coast region contains the smallest fraction, with only 423,000 classified acres, less than 2% of the national total. The patterns are similar for the 14.8 million acres that are approved for harvest and for the 2.8 million acres that are prohibited–highest for the Gulf of Mexico, lowest for the West Coast.

Photo 10. Thirty-six percent of U.S. classified shellfish growing waters are in the Gulf of Mexico region, followed by the Mid-Atlantic region (25%), the North Atlantic region (19%), the South Atlantic region (18%) and the West Coast region (less than 2%).

There are dramatic regional differences in the fractions of acreage approved for harvest. For example, in the three Atlantic regions, 80% or more of all shellfish growing waters are approved for harvest. In the Gulf of Mexico and the West Coast regions, however, less than half are approved. More differences are apparent in the percentages for prohibited waters. For example, 30% of the West Coast region waters are prohibited, compared to 13% in the Gulf of Mexico and 7% in the Mid-Atlantic regions. These results reflect not only differences among regions in the suitability of growing waters for shellfish harvest, but also, and perhaps more significantly, differences among states in shellfish management strategies.

Photo 11. Mussels are harvested primarily on the Atlantic Coast where the commercial harvest comes almost entirely from Maine.

Regional variations in pollution associated with harvest limits reflect differences in population, land use and level of coastal development. For example, although urban runoff and wastewater treatment plants are significant pollution sources in all regions, they are most prominent in the North and Mid-Atlantic regions. However, in the less populated coastal regions of the Gulf of Mexico and West Coast, pollution associated with individual wastewater treatment systems is second only to pollution associated with unidentified sources upstream of coastal watersheds. Agriculture is a major contributor to harvest limits in the South Atlantic and West Coast regions, but it has almost no impact in the more urban North Atlantic region. Contamination associated with local concentrations of wildlife is reported for half the growing waters in the Gulf of Mexico and two-thirds in the South Atlantic. The South Atlantic is also the only region where feedlot runoff appears to be a significant pollution source. Finally, boating is a significant factor in the Gulf of Mexico and North Atlantic regions, while marinas are important contributors in the Gulf of Mexico and Mid-Atlantic.

(top)

Regional Harvest from Classified Waters

The nation's commercial shellfish harvest from classified waters consists primarily of two species of oyster, a dozen species of clams, and blue mussels (NOAA, 1997). The eastern oyster is harvested along the Atlantic and Gulf of Mexico Coasts; the Pacific oyster on the West Coast. Clams are harvested on the Atlantic and West Coasts. Mussels are harvested primarily on the Atlantic Coast where the commercial harvest comes almost entirely from Maine.

In 1995, the Mid-Atlantic led all regions, with 25 million pounds (meat weight) harvested from classified waters, primarily quahog clams and oysters. The Gulf of Mexico was close behind with 21.4 million pounds of oysters, followed by the North Atlantic (13.6 million pounds of mussels and clams), the West Coast (13.5 million pounds of primarily manila clams) and the South Atlantic (3 million pounds of quahog clams and oysters).

The Gulf of Mexico led the nation in oyster landings with 56% of the oyster harvest. The West Coast was second, with 25%, followed by the North Atlantic (13%), Mid-Atlantic (4%) and South Atlantic (2%). Louisiana led all states with 13.8 million pounds, followed by Washington (8 million), Texas (5.4 million) and Connecticut (5 million).

Of the 32.3 million pounds of clams landed in 1995, 47% were from the Mid-Atlantic, followed by the North Atlantic (33%), the West Coast (12%) and the South Atlantic (8%). The Atlantic landings consisted primarily of surf (46% of all Atlantic landings), quahog (38%), and softshell (8%) clams. The West Coast landings consisted almost exclusively of manila clams from Washington. New Jersey leads all states, with 35% of the clams harvested, followed by Massachusetts (11%), Washington (10%) and New York (8%).

The presence of shellfish growing waters suitable for harvest does not necessarily correlate with the quantity of shellfish landings. For example, in 1995, the state of Louisiana had almost 14 times as much classified acreage as did the state of Washington. Yet, through intensive aquaculture, shellfishermen in Washington landed 32 pounds of oysters per acre, while compared to four pounds per acre in Louisiana.
(top)

CASE STUDIES

The following case studies illustrate regional issues affecting the U.S. shellfish industry. The Navesink River improvements represent the type of small-scale restoration going on in many states. Red tides present a unique and typically unpredictable problem in many regions, particularly in the Gulf of Mexico. The dramatic decline of the Chesapeake oyster provides an important lesson in resource management.

Navesink River, New Jersey

In 1996, New Jersey upgraded 624 acres of some of the most productive shellfish growing waters in the state to "conditionally approved" after more than 20 years of harvest restrictions (Zimmer, 1997). Located at the northern tip of New Jersey's Atlantic shoreline, just south of the Sandy Hook peninsula, the lower Navesink River has been the focus of a decade-long effort by Federal, state and county governments to control nonpoint pollution (pollution that cannot be ascribed to a discrete source).

Major improvements to the Navesink River began in the mid-1970s. Following the elimination of 14 small and outdated wastewater treatment plants discharging to the river, the sewage was conveyed to a larger, secondary treatment facility for discharge offshore. The next step was to control runoff from the area's numerous horse farms through the steady implementation of "best management practices," including improved handling of organic wastes and modification of pastures to protect local surface waters.

Today, quahog and softshell clams taken from the lower Navesink River between November and April no longer require relaying to nearby approved areas or depuration facilities, but can go directly to processing for consumption. This milestone represents a significant step toward restoration of New Jersey's shellfish areas, including the 1,600 acres in the upper Navesink River that remain restricted. Future improvements will include strengthening rules for development along the estuarine shoreline; further reducing nonpoint pollution, particularly from marina and boating activity; and designating the Navesink and nearby Shrewsbury Rivers as a "special water area" in the state's coastal management program.
(top)

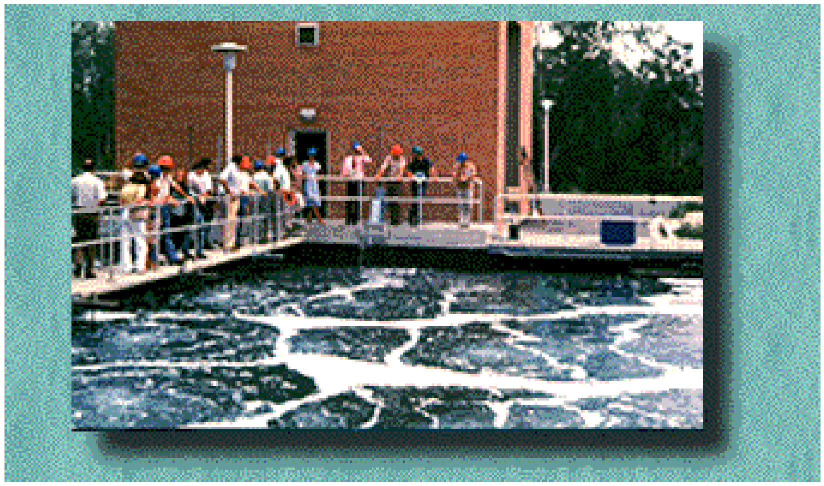


Photo 12. Replacing small and outdated wastewater treatment facilities with a larger, modern facility improved water quality in the Navesink River.

Red Tides in the Gulf of Mexico

In November/December 1996, a rare incursion of red tide along the northern Gulf of Mexico coast resulted in the first ever closure of oyster harvesting in Mississippi and in Mobile Bay, Alabama (National Association of Conservation Districts, 1997). Louisiana, not affected by red tides since 1969, also closed some areas. The closures were particularly devastating to local oystermen because they came in the midst of the usually lucrative holiday season when the demand for oysters peaks.

Red tide is the term used to characterize a natural bloom of toxic marine algae that often colors coastal waters red, brown or even green and is brought ashore via coastal currents (Anderson, 1994). Clams, mussels or oysters ingest the algae from the water column as food and retain the toxins in their tissues. Typically, the effects on the shellfish are only marginal, but, depending on the species of algae, eating a single oyster can cause serious illness and even death in humans.

Photo 13. Shellfish exposed to red tides are often hazardous to humans because they acquire concentrated toxins by ingesting red tide algae.

Red tides occur throughout the world, and numerous species are responsible. In the Gulf of Mexico, the dinoflagellate (a type of single-celled algae) *Gymnodinium breve* is typically responsible.

Although *G. breve* is not associated with human mortality, it can cause serious illness in humans and devastating fish kills (Anderson, 1994). It regularly affects Texas and Florida, but its appearance in the northern Gulf raises concerns that the incidence of red tides is increasing, perhaps in tandem with increasing human coastal population. Investigations to determine these relationships are under way. Meanwhile, many of the most vulnerable states have instituted monitoring programs to protect public health and learn more about these phenomena.
(top)

The Decline of the Chesapeake Oyster

Many years before Captain John Smith first rounded Cape Henry, Virginia in the early 17th century, the Algonquin Indians already called it "Chesepiooc" for "great shellfish bay" (White, 1989). By the late 19th century, during the "golden age" of oysters in the United States, an armada of fishermen were harvesting an estimated 120 million pounds (meat weight) of oysters per year from Chesapeake Bay (MacKenzie, 1996). But, the 20th century has taught us that even seemingly boundless resources can and do have an ending. From a more recent high water mark of 41.6 million pounds harvested in 1954 to a shockingly low harvest of only 571 thousand pounds in 1993, the once booming oyster industry of Chesapeake Bay has all but disappeared (Figure 2) (NMFS, 1997).

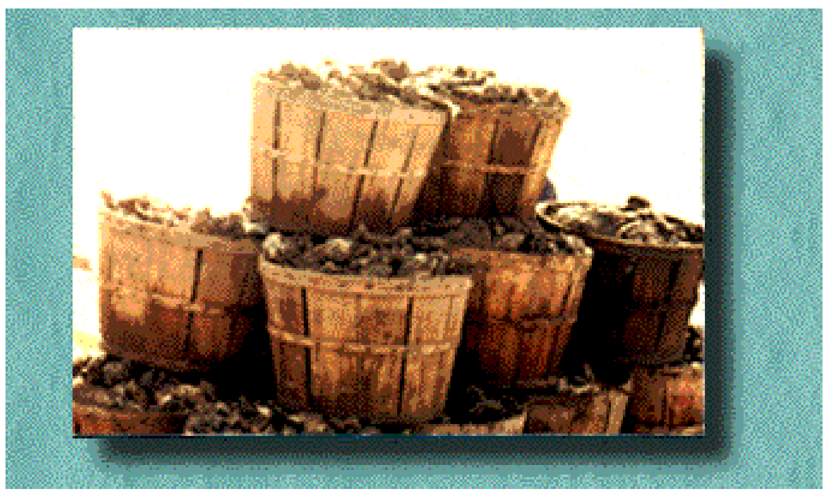


Photo 14. The harvest of Chesapeake Bay oysters decreased from 41.6 million pounds (meat weight) in 1954 to an all-time low of 571 thousand pounds in 1993.

The boom began as railroads opened new markets to a burgeoning population and food preservation improved with the use of artificial ice, which appeared around 1880. Once eaten only by the wealthy (except in local harvest areas), oysters became a hugely popular fresh food, cheaper than beef, poultry or fish (MacKenzie, 1996). According to Parks (1986), "No evening of pleasure was complete without oysters . . . In every town there were oyster parlors, oyster cellars, oyster saloons, and oyster bars, houses, stalls, and lunchrooms." The Chesapeake Bay region prospered as a center of harvest and associated boat-building, shucking, canning and other activities.

The demand for oysters declined rapidly in the early 1900s when increased concerns over sanitation and diseases like typhoid drove consumers away. The result was a sharp reduction in harvest that caused widespread hardships and failures among the oyster businesses. In Chesapeake Bay and other regions, the systematic loss of habitat through siltation and overfishing also contributed to decreasing supplies (Rothschild et al., 1994).

In the late 1950s, harvest dropped significantly again when a new disease named MSX began to kill huge numbers of oysters in the Bay. Dermo, another fatal oyster disease, gained strength in the Bay in the early 1980s, further crippling the industry (MacKenzie, 1996; Kennedy et al., 1996). Although these diseases do not make the consumption of oysters unsafe, they continue to have a devastating effect in the Bay and other regions, typically killing oysters before they reach harvestable size. MSX and Dermo are caused by naturally occurring parasitic organisms that are not directly associated with human activities. Their ecology and control are not yet well understood. Millions of dollars are spent each year investigating restoration options. Some scientists and managers believe that at least a partial recovery is possible.

In contrast to harvest declines, the quality of Chesapeake Bay's classified shellfish growing waters has been consistently above national averages since this information was first recorded in 1966. For example, on average, 90% of the Chesapeake's classified waters are approved for harvest, compared to 68% for the rest of the nation. Similarly, on average, less than 6% of the Chesapeake's classified waters are prohibited, compared to over 24% for all other areas. This suggests that at least during the past 30 years, Chesapeake Bay has been less affected by pollution associated with harvest limitations than many other estuaries.

(top)

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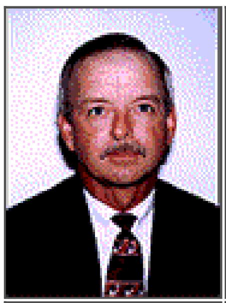
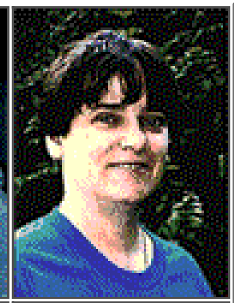
EXPERT INTERPRETATION

The four individuals below are experts in the topic of Classified Shellfish Growing Waters. Here they voice their opinions on two questions relevant to that topic.

Question 1 – Given the statistics on the area of shellfish growing waters with some type of harvest limitation, are shellfish safe to eat?

Question 2 – What needs to be done to reduce the area of harvest limited shellfish growing waters and how hard will this be to do?

Experts

			
Ken Moore	**Chris Nelson**	**Scott Rippey**	**Bonnie Zimmer**

Ken B. Moore

Executive Director, Interstate Shellfish Sanitation Conference

Since 1993, Mr. Moore has served as Executive Director to the Interstate Shellfish Sanitation Conference (ISSC), a partnership of shellfish-producing states, the shellfish industry, and the U.S. Food and Drug Administration. For four years prior to that, he was Chairman of the ISSC executive board. Mr. Moore has also worked extensively for over 10 years as the manager of South Carolina's shellfish sanitation program in its Department of Health and Environmental Control.

Response to Question 1

Response to Question 2

(top)

Question 1. Given the statistics on the area of shellfish growing waters with some type of harvest limitation, are shellfish safe to eat?

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Molluscan shellfish are animal-derived protein foods that are often consumed raw or partially cooked. Consumption of raw shellfish, as with consumption of other types of raw animal-derived protein foods, increases the risk of illness. Cooking can reduce the number of potentially pathogenic organisms and the risk of illness. To reduce the potential risk associated with consumption of raw molluscan shellfish, the Food and Drug Administration (FDA), in cooperation with the States, administers the National Shellfish Sanitation Program (NSSP). The FDA, the States and the ISSC recognize the harvesting classification system of the NSSP as the best approach for minimizing illness associated with shellfish consumption. States monitor shellfish growing waters to determine that they are safe before harvesting is permitted. The FDA routinely audits the States' classification of shellfish harvesting areas to verify that none pose a threat to public health. The program does not attempt to achieve maximum utilization of all harvest areas.

(top)

Question 2. What needs to be done to reduce the area of harvest limited shellfish growing waters and how hard will this be to do?

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Improving water quality in shellfish growing waters is the most direct way to reduce the acreage of harvest-limited shellfish growing areas; however, present land uses in coastal areas makes this very difficult. The present bacteriological indicator, fecal coliform, does not distinguish sources. The premise of the National Shellfish Sanitation Program classification criteria is that all fecal coliform has public health significance. This conservative approach is often reflected in harvest-limiting classification. Continuation of effective coastal zone management programs and, where possible, the elimination of existing sources of bacteriological and chemical contaminants, are steps that can be taken to reduce harvest limitations. These approaches are expensive and require extensive planning and, as a result, often encounter social and political opposition.

(top)

Christopher Lee Nelson

Vice President for Research and Development, Bon Secour Fisheries, Inc., Bon Secour, Alabama

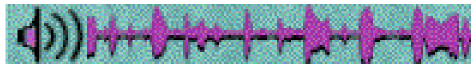
Mr. Nelson has been active since 1989 in all aspects of the Bon Secour Fisheries oyster operation, from developing innovative oyster aquaculture techniques to working with regulatory authorities on guidelines for the National Shellfish Sanitation Program. He also participates in the Gulf Oyster Industry Council, Interstate Shellfish Sanitation Conference, and Gulf and South Atlantic Fisheries Development Foundation.

Response to Question 1

Response to Question 2

(top)

Question 1. Given the statistics on the area of shellfish growing waters with some type of harvest limitation, are shellfish safe to eat?

Click here for audio response

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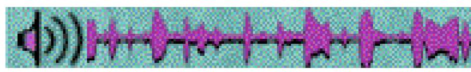
Yes, shellfish (oysters, clams, and mussels) harvested from State-certified sanitary growing areas are safe to eat. Healthy persons may even safely eat them raw. The fact that there are extensive areas of shellfish growing waters that are permanently or temporarily closed to harvesting is actually a testament to the sanitary quality of the growing areas that are open for harvesting. The National Shellfish Sanitation Program (NSSP) administered by the U.S. Food and Drug Administration, in cooperation with the States, provides stringent guidelines for monitoring the water quality and conducting sanitary surveys around shellfish growing areas. This program, which was started in 1924, has tremendously reduced the incidence of shellfish-borne disease related to polluted growing areas. Thoroughly cooked shellfish are among the safest foods since the NSSP is designed to provide shellfish which are safe for raw consumption. However, persons with liver, stomach or blood disorders, or who have a compromised immune system, should not eat raw foods, including raw shellfish.
(top)

Question 2. What needs to be done to reduce the area of harvest limited shellfish growing waters and how hard will this be to do?

Click here for audio response

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Continued vigilance with respect to existing water quality standards in our estuaries will provide the greatest chance for reducing harvest-limited areas. Control of stormwater runoff through best management practices and through protection of coastal wetlands may begin to reduce the levels of sewage- related bacteria in potential harvesting areas. Finding and reducing the sources of nonpoint source pollution (such as stormwater runoff) and reducing their impact on water quality certainly remains as one of the great hopes for increasing the areas available for safe harvest. Agencies involved with closing harvesting areas to protect public health must also openly communicate and cooperate with agencies charged with controlling water pollution. However, interagency cooperation is difficult at all levels of government. The shellfish industry must also become more involved in the process of monitoring and protecting water quality. Unfortunately, the obvious sources of water pollution have largely been addressed. Therefore, what remains may present a much greater challenge.
(top)

Scott R. Rippey

Microbiologist, U.S. Public Health Service, U.S. Food and Drug Administration

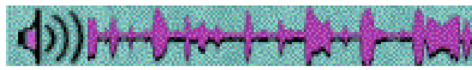
For the past 20 years, Dr. Rippey has conducted microbiological research to assist in the development of policy on public health issues related to seafood consumption and the contamination of marine waters; the development of microbiological indicators for assessing marine recreational water quality; and the application of biological indicators for evaluating eutrophication in fresh and coastal waters.

Response to Question 1

Response to Question 2

(top)

Question 1. Given the statistics on the area of shellfish growing waters with some type of harvest limitation, are shellfish safe to eat?

Click here for audio response

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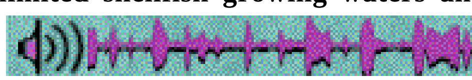
We have yet to document an outbreak of infectious illness (bacterial or viral) associated with the consumption of raw shellfish from growing areas that meet or exceed the current bacterial standard for water, based on fecal or total coliform levels. These standards indicate a certain level of fecal contamination in harvest waters. Therefore, when shellfishing areas are properly classified according to the National Shellfish Sanitation Program–a program that has been evolving since the 1920s when typhoid was a significant public health problem in the U.S.–there appears to be a minimal and acceptable level of risk associated with the consumption of raw shellfish harvested from approved growing waters.

There is an exception to this that involves the *Vibrio* genus, a naturally occurring, marine bacterial group that is not associated with fecal wastes, but is found normally in many saline environments. In health-compromised individuals, particularly those with chronic liver disease, the consumption of raw shellfish can lead to serious illness and death. While the annual number of cases of illness from this organism are very low, at-risk people should avoid the consumption of raw molluscan shellfish, particularly those harvested from Gulf Coast waters.
(top)

Question 2. What needs to be done to reduce the area of harvest limited shellfish growing waters and how hard will this be to do?

Click here for audio response

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Shellfish area closures are based, in part, on the level of fecal contamination occurring in a harvest area. This level is indexed by the fecal or total coliform bacterial indicator groups. Since molluscan shellfish are filter-feeding organisms, they accumulate particulate materials (including pathogenic bacteria and viruses) from overlying waters. In some cases, this accumulation can exceed one hundredfold (level in shellfish/level in water) depending on environmental conditions.

The contaminants of concern to public health are associated with sewage and wastewater. Therefore, the recovery of harvest areas requires mechanisms to control and reduce the level of fecal contamination entering shellfish growing areas. This involves, for the most part, the effective treatment of sewage that will impact estuarine and marine waters, and the control of nonpoint source pollution that is delivered to aquatic environments from a variety of sources. While quite simple in principle, these strategies can be very expensive for coastal communities.

Closures of shellfish waters are also based on the level of marine biotoxins that

occur when a growing area or region is experiencing a "bloom" of toxin-producing phytoplankton. This problem is not subject to control because the organisms of concern occur naturally in the marine environment. However, closures due to unacceptably high biotoxin levels in shellfish are, generally, short-term as phytoplankton blooms come and go with changes in physical or chemical factors that trigger and support bloom conditions. The factors responsible for these events are not well understood.
(top)

Bonnie Zimmer

Environmental Scientist, Bureau of Marine Water Monitoring, Division of Science and Research, New Jersey Department of Environmental Protection

Dr. Zimmer has graduate degrees in community ecology and aquatic ecology. She is a staff scientist with the New Jersey Department of Environmental Protection. Her experience includes analysis of marine community dynamics, water quality modeling, interpretation of complex information using tools such as geographic information systems, and university teaching. She is also an accomplished fine arts photographer, specializing in images depicting ecological interactions.

Response to Question 1

Response to Question 2

(top)

Question 1. Given the statistics on the area of shellfish growing waters with some type of harvest limitation, are shellfish safe to eat?

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Emphatically, yes. Shellfish harvested from approved waters and shellfish cleansed through programs such as the depuration / relay program in New Jersey, where shellfish harvested from marginal waters are held in clean water until the tissue meets FDA standards, are safe to eat. Consumers who purchase the product from a reliable dealer, where they can be assured that the shellfish have been harvested from approved waters and handled appropriately after harvest, should not worry about becoming ill from consuming a contaminated product. Historically, illness related to shellfish consumption has been traced to contamination by either disease-causing bacteria or marine biotoxins associated with algal blooms. Control of these factors has limited the threat of disease associated with eating shellfish. However, control of other factors, such as viral contamination, incorporation of toxic substances into shellfish tissue, and contamination with parasites, is still in its infancy.
(top)

Question 2. What needs to be done to reduce the area of harvest limited shellfish growing waters and how hard will this be to do?

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Shellfish growing areas may be closed for many reasons, including actual bacterial contamination of the water; the likelihood of potential contamination due to spills, stormwater runoff, or treatment plant discharges; or the presence of marine biotoxins associated with algal blooms. The success of attempts to reduce the acreage closed to harvest depends on the specific reasons for the closure. Waters surrounding treatment plant outfalls, within marinas, or in other areas where the likelihood of contamination is high, may never be opened for harvest. Likewise, areas where the sediment is heavily contaminated by toxins and/or bacteria are unlikely to be opened in the near future. However, where the closure is due solely to a malfunctioning treatment facility, the remedy is often relatively easy to identify and implement. Where the closure is due to a combination of multiple sources and/or to nonpoint sources of contamination, it can be more difficult to identify and implement effective

control mechanisms. As the proportion of closed waters is reduced, implementing specific controls to improve water quality becomes more challenging.
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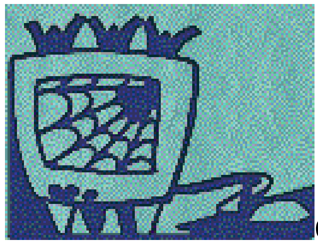

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This web site provides an overview of the *1995 National Shellfish Register*. Users can view and download customized data sets and digital geographic files.

U.S. Food and Drug Administration, Center for Food Safety and Applied Nutrition. *National Shellfish Sanitation Program manual of operations.*

http://vm.cfsan.fda.gov/~ear/nsspman.html

Explains the National Shellfish Sanitation Program and its responsibilities. The downloadable, two-volume manual of operations is a guide for establishing state shellfish laws and regulations, including general administrative procedures, laboratory procedures, guidelines for surveying and classifying growing areas, controlled relaying, patrol of shellfish harvesting areas, control of harvesting, and aquaculture.

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Navesink River

Navesink River Environmental League. Navesink River Water Monitoring Project.

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Abstract of a paper titled *Water monitoring project, shellfish growing area 3: An assessment of shellfish water quality and nonpoint source pollution, 1993.*

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The National Office for Marine Biotoxins and Harmful Algal Blooms. The Harmful Algae Home Page.

http://habserv1.whoi.edu/hab/

Provides a thorough overview of harmful algal blooms including photos, specific algal species, adverse impacts on higher trophic levels, associated human illnesses, regions where harmful blooms occur, frequently asked questions and links to related web sites.

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Describes dinoflagellates, red tides and resulting diseases. Includes fossil records, life history and ecology, systematics and morphology. Also contains links to other pages and data bases on dinoflagellates and shellfish poisoning.
(top)

Shellfish

U.S. Environmental Protection Agency, Office of Wetlands, Oceans and Watersheds. *Indicator 6: Shellfish growing water classification.*

http://www.epa.gov/OWOW/indic/fs6.html

This fact sheet is part of a larger EPA document titled *Environmental indicators of water quality in the United States, June 1996.* It describes the use of shellfish growing water classification as a national "indicator" of environmental health, how the EPA will track progress, and what is being done to improve the conditions measured by the indicator.

The Gulf of Mexico Information Network. Shellfish Restoration.

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Provides an overview of shellfish including definitions, details on the Gulf of Mexico's shellfish economy and tips on avoiding shellfish-related health risks. Links to sites concerned with shellfish regulations, restoration and safety.

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Contains the conference proceedings of the Chesapeake Research Conference Toward a Sustainable Coastal Watershed: The Chesapeake Experience. The site summarizes six papers on the Chesapeake Bay oyster, with overviews on population trends, technical information, economic impacts and management techniques.

Maryland Marine Notes . "The new oyster wars: Battling disease in the lab and bay" by M. Leffler (1995).

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Explains the causes and effects of diseases such as dermo and MSX on the Chesapeake Bay oyster population, and documents two ongoing research investigations that focus on disease prevention.

Gladstone Home Page. *Impacts of Disease and Disease-resistant Oysters.*

http://gladstone.uoregon.edu/~sphilip/oyster.html

Describes the threats to the Chesapeake's native oysters, the causes of disease, oyster interaction with disease, and the benefits and dangers from introduced species in the Chesapeake Bay.

NOAA Chesapeake Bay Office. *1995 oyster disease research report.*

http://155.206.19.100/fisheries/odr.html

This report includes information on diagnosis/monitoring, pathology virulence/host defense, pathogen life cycle/host defense, host/pathogen genetics/breeding and management/restoration strategies.
(top)

GLOSSARY

biotoxin: a poisonous substance that is a specific product of the metabolic activities of a living organism.

classified shellfish growing waters: waters that have been classified for commercial harvest of shellfish.

> **approved:** waters from which shellfish may be harvested for direct marketing. Fecal coliform median or geometric mean MPN does not exceed 14 per 100 ml, and not more than 10 percent of the samples exceed an MPN of 43 per 100 ml for a 5-tube decimal dilution test.
>
> **conditionally approved:** waters meeting approved classification standards under predictable conditions. These waters are open to harvest when water quality standards are met, and are closed at other times. Fecal coliform standards are the same as for approved.
>
> **conditionally restricted:** growing waters that sometimes meet the criteria to be restricted; may be harvested if shellfish are subjected to a suitable purification process. Fecal coliform standards same as for restricted.
>
> **harvest-limited:** the sum of shellfish-growing waters classified as conditionally approved, restricted, conditionally restricted and prohibited.
>
> **prohibited:** waters from which shellfish may not be harvested for marketing under any conditions.
>
> **restricted:** waters from which shellfish may be harvested only if they are relayed or depurated before direct marketing. Fecal coliform median or geometric mean MPN does not exceed 88 per 100 ml, and not more than 10 percent of the samples exceed an MPN of 260 per 100 ml for a 5-tube decimal dilution test.
> (top)

coliform bacteria: bacteria, present in sewage, that indicate the possible presence of enteric pathogens of sewage origin. Fecal coliform bacteria are a subset of the total coliform group and are generally considered to be a more reliable indicator of human or animal fecal pollution than the total coliform group, although there are certain limitations to their utility as an indicator.

depuration: the process of placing shellfish harvested from contaminated waters into a controlled aquatic environment designed to flush out and reduce the levels of bacteria and viruses.

effluent: waste material (e.g., sewage, industrial refuse) discharged into the environment.

enteric pathogens: bacteria or viruses that live in the intestines of humans and cause gastroenteritis, hepatitis and other diseases.

estuary: a semi-enclosed coastal water body where fresh and saltwater mix.

Interstate Shellfish Sanitation Conference (ISSC): this organization, founded in 1982 and comprised of interested States, members of the shellfish industry, and the U.S. Food and Drug Administration, provides a formal structure wherein state regulatory authorities can establish uniform and regularly updated guidelines for improving shellfish sanitation and safety.

intertidal zone: the area between the low and high tide marks.

National Shellfish Sanitation Program (NSSP): a cooperative program of the U.S. Food and Drug Administration, shellfish-producing states, and the shellfish industry, designed to control the harvest and distribution of molluscan shellfish for human consumption. The NSSP is administered through the ISSC (see previous entry).

planktonic: having to do with plankton, minute plants and animals (e.g., algae) that passively drift or weakly swim in a water body.
(top)

relay: the supervised transfer of shellfish from restricted waters to approved waters for natural biological cleansing using the ambient environment as a treatment system, usually for a minimum of 14 days before harvest.

sanitary survey: an intensive assessment required by the NSSP for all growing waters that summarizes such factors as actual and potential pollution sources, hydrographic and meteorologic conditions, and coliform bacteria sampling results. The sanitary survey is the administrative document upon which the growing water classification is based.

shellfish: an aquatic animal, such as a mollusk or crustacean, having a shell or shell-like exoskeleton. The *1995 Shellfish Register* includes 22 edible species of oysters, clams, scallops and mussels.

upstream sources of pollution impacting shellfish growing waters: stream-borne contaminants from unspecified sources upstream of shellfish growing waters.

U.S. Food and Drug Administration (FDA): the federal agency with the lead responsibility for ensuring safe shellfish harvest and processing. It is also a member agency of the ISSC. The ISSC entered into a Memorandum of Understanding (MOU) that was published in the *Federal Register* of March 30, 1984 (49 FR12751), agreeing, among other things, that the FDA would provide technical assistance to the ISSC and participate in a cooperative program to develop or revise program criteria and guidelines. In addition, the FDA conducts an annual review of each State Shellfish Control Program to determine its degree of conformity to the NSSP.

watershed: the entire region that drains into a river, river system or water body.
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CREDITS

Acknowledgments

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Scott Rippey, Food and Drug Administration, U.S. Public Health Service, provided information on infectious diseases associated with shellfish consumption. David Sutherland, Fisheries Statistics Division, National Marine Fisheries Service, offered useful insights and summary shellfish harvest data for selected species and states. Judy Jones Putnam, Food and Consumer Economics Division, Economic Research Service, U.S. Department of Agriculture, provided data on the annual consumption of chicken and beef. Richard Aikman, U.S. Fish and Wildlife Service, provided data on recreational shellfishing. Bonnie Zimmer, Division of Science and Research, New Jersey Department of Environmental Protection, provided background information on the Navesink River case study. Ken Moore, Executive Director, Interstate Shellfish Sanitation Conference, Chris Nelson, Vice President for Research and Development, Bon Secour Fisheries, Scott Rippey and Bonnie Zimmer provided technical reviews of this report.
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Others were contributed from outside of NOAA, and we gratefully thank the following institutions and individuals:

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Photo 5. Marc Glatzer, Food and Drug Administration
Photo 7. Chesapeake Bay Foundation
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Photo 10. Marc Glatzer, Food and Drug Administration
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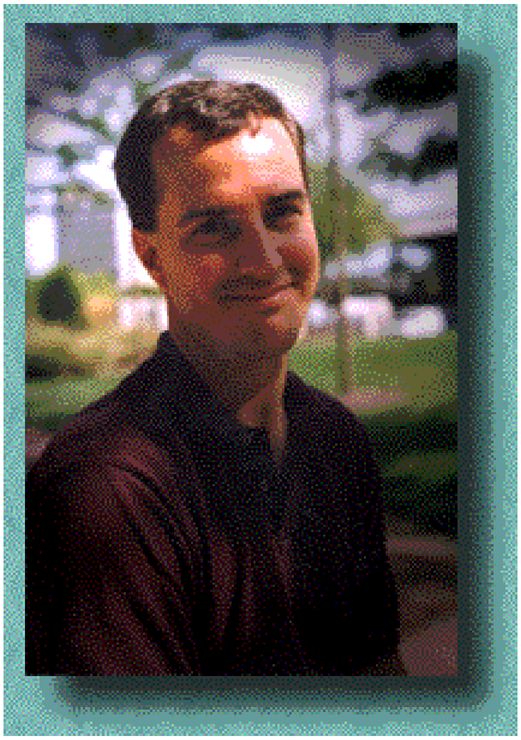
About the Authors



Charles Alexander is an environmental analyst with NOAA's Strategic Environmental Assessments Division where he has worked for the past 12 years. He has a BA in Biology/Geology from Whitman College and Masters degrees in Marine Science and Public Administration from Louisiana State University. Mr. Alexander has conducted a number of unique assessment activities since joining NOAA in 1985. Topics range from coastal wetlands and estuarine eutrophication to integrated desktop information systems and satellite remote sensing.

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Return to National Picture

Table 3. Classified U.S. Shellfish Growing Waters: 1966-1995[1,2,3] (acres x 1,000)

	publication years of National Shellfish Register						
	1966	1971	1974	1980	1985	1990	1995
TOTAL	**10,190**	**14,100**	**14,792**	**14,218**	**16,499**	**18,697**	**21,387**
Approved for Harvest	**8,100** (79)	**10,362** (73)	**10,560** (71)	**10,685** (75)	**11,402** (69)	**12,304** (66)	**14,853** (69)
Total Harvest Limited	**2,090** (21)	**3,738** (27)	**4,232** (29)	**3,533** (25)	**6,970** (42)	**6,394** (34)	**6,720** (31)
Conditionally Approved	88 (1)	410 (3)	387 (3)	587 (4)	1,463 (9)	1,571 (8)	1,695 (8)
Restricted	na	30 (<1)	34 (<1)	55 (1)	637 (4)	463 (2)	2,106 (10)
Conditionally Restricted	na	na	na	na	na	na	119 (1)
Prohibited	2,002 (20)	3,298 (23)	3,811 (26)	2,891 (20)	3,335 (20)	4,364 (23)	2,801 (13)

1. Based on National Shellfish Registers (published only in years indicated)
2. Does not include AK, HI
3. Numbers in parantheses are percent of total annual classified acres

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Table 4. Pollution Sources Reported for Harvest Limitations on U.S. Classified Shellfish Growing Waters and Percent of All Harvest Limited Waters Affected

		% affected[1] 1990	1995
POINT			
1	**Industrial facilities** Routine and accidental discharges from production/ manufacturing processes and on-site sewage treatment.	**17**	**9**
2	**Wastewater treatment plants** Routine and accidental sewage discharge from public and private WWTPs with varying treatment	**37**	**24**
3	**Combined sewer overflows** Discharge of untreated sewage/stormwater when sewage system capacity is exceeded in heavy rainfall	**7**	**7**
4	**Direct discharges** Untreated sewage discharged directly to receiving waters by residences, seasonal camps, etc.	**16**	**4**
5	**Marinas** Periodic discharge of untreated or partially treated sewage from berthed vessels	na	**17**
6	**Boating** Periodic discharge of untreated or partially treated sewage from vessels under way or anchored offshore	**18**	**13**
NONPOINT			
1	**Individual wastewater treatment system** Discharge of partially treated sewage from malfunctioning on-site septic systems	**37**	**32**
2	**Urban runoff** Precipitation-related discharges (e.g., septic leachate, animal wastes), from impervious surfaces, lawns, and other urban land uses	**38**	**40**
3	**Feedlot runoff** Primarily precipitation-related discharges of animal wastes from concentrated livestock feeding areas	na	**3**
4	**Agricultural runoff** Precipitation-and irrigation-related runoff of animal wastes and pesticides from crop and pasturelands	**11**	**17**
5	**Wildlife** Precipitation-related runoff of animal wastes from high wildlife concentration areas (e.g., waterfowl)	**25**	**38**
UPSTREAM			
	Stream-borne contaminants from unspecified sources upstream of shellfish growing waters	**46**	**39**
Total Harvest Limited Acres (x1,000)		**6,394**	**6,720**

[1]Harvest limited areas can be affected by multiple pollution sources; therefore, annual values will not total 100.

[Return to National Picture]

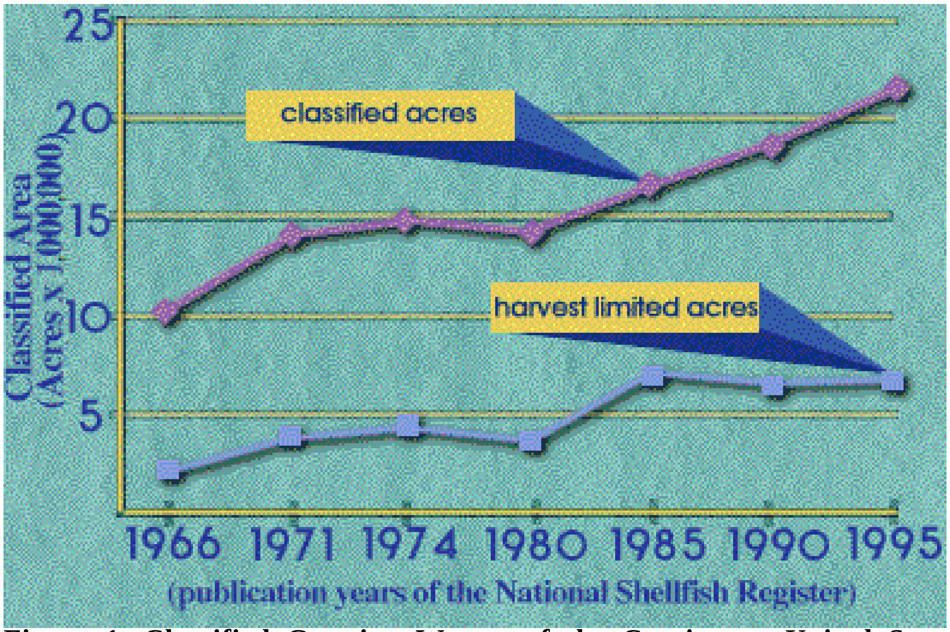

Figure 1. Classified Growing Waters of the Contiguous United States 1966-1995

[Return to Case Studies]

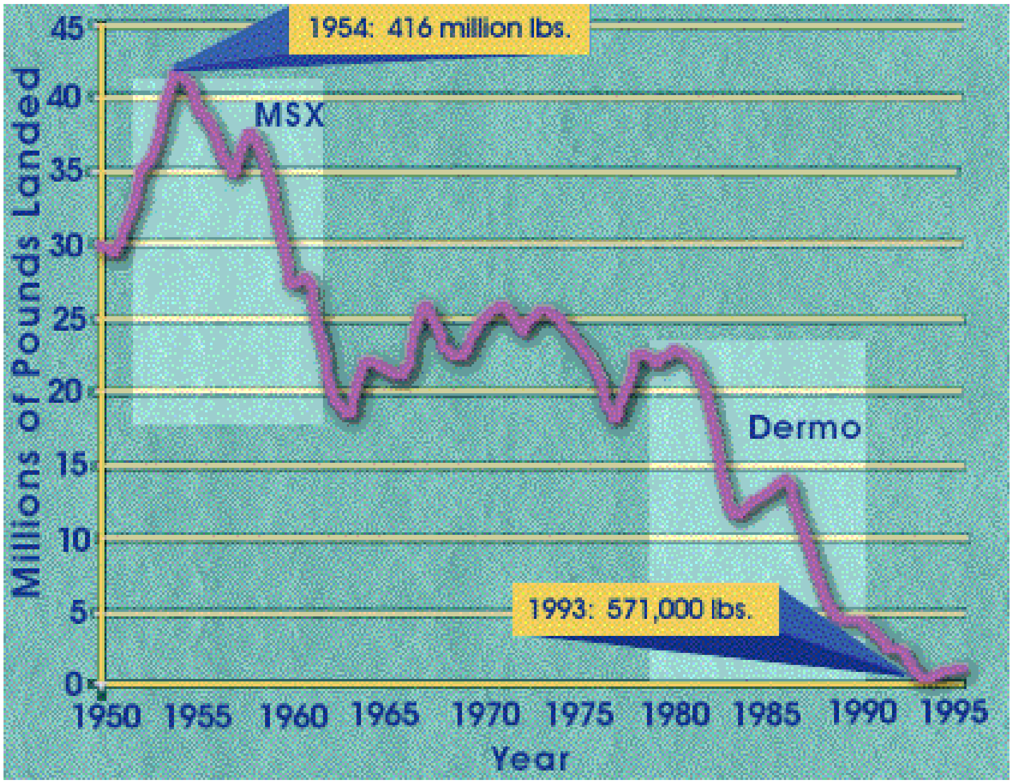

Figure 2. The Decline of the Chesapeake Bay Oyster Harvest