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Coastal Resources — Tidal Estuaries, Shoreline Waters, and Coral Reefs

The United States' extensive coastal resources include nearly 67,000 miles of ocean shoreline, more than 5,500 miles of Great Lakes shoreline, nearly 90,500 square miles of estuarine waters, and extensive coral reef areas.

The oceans are one of the earth's most significant resources. The global ocean affects the health and safety of the world by providing food, recreation, local weather amelioration, and global climate stabilization. Predictions say that 75% of the U.S. population will live, work, or play along ocean coasts by the year 2015.

The Great Lakes—Superior, Michigan, Huron, Erie, and Ontario— are an important part of the physical and cultural heritage of North America. Spanning more than 750 miles from west to east, these vast inland freshwater seas have provided water for consumption, transportation, power, recreation, and a host of other uses. The Great Lakes basin is home to more than 10% of the U.S. population and some of the world's largest concentrations of industrial capacity. Many consider the Great Lakes the United States' fourth seacoast.

Estuaries are the waters where rivers meet the oceans and include bays and tidal rivers. These waters serve as nursery areas for many commercial fish and most shellfish populations, including shrimp, oysters, crabs, and scallops. Most of our nation's fish and shellfish industry relies on productive estuarine waters to provide healthy habitat for some stage of fish and shellfish development. Recreational anglers also enjoy harvesting fish that reproduce or feed in estuaries, such as striped bass and flounder.

Coral reef systems include a collection of biological communities, representing one of the most diverse ecosystems in the world. Individual coral, which are tiny animals called polyps, secrete a hard calcium carbonate skeleton, which serves as a uniform base for a colony of coral. Coral reefs provide habitats for a large variety of organisms that rely on the coral as a source of food and shelter. Residents of coral reefs include various sponges; molluscs such as sea slugs, oysters, and clams; crustaceans such as crabs and shrimp; many kinds of sea worms; echinoderms such as star fish and sea urchins; other cnidarians such as jellyfish and sea anemones; various types of fungi; sea turtles; and many species of fish.

Water Quality Assessment

States and tribes rate water quality by comparing data to their state and tribal water quality standards. Water quality standards include narrative and numeric criteria that support specific designated uses. Standards also specify goals to prevent degradation of good quality waters.

States and tribes use their numeric and narrative criteria to evaluate whether the designated uses assigned to the waterbodies are supported. Designated uses reflect the goals of the Clean Water Act. They aim to protect human health and the biological integrity of aquatic ecosystems. The most common designated uses are:

- Aquatic life support
- Drinking water supply
- Recreation such as swimming, fishing, and boating
- Fish consumption.

After comparing water quality data to standards, states and tribes classify the waters into the following categories:

- **Good/Fully Supporting:** Good water quality supports a diverse community of fish, plants, and aquatic insects, as well as the array of human activities assigned to an estuary by the state. These waters meet applicable water quality standards, both criteria and designated use.

- **Good/Threatened:** Good water quality currently supports aquatic life and human activities in and on the estuary. These waters are currently meeting water quality standards, but states and tribes are concerned they may degrade in the near future. These concerns are based on a trend of increasing pollution or land use changes that may threaten future water quality.

- **Fair/Partially Supporting:** Fair water quality supports aquatic communities with fewer species of fish, plants, and aquatic insects and/or pollution occasionally interferes with human activities. These waters are meeting water quality standards most of the time, but exhibit occasional exceedances. For example, runoff during severe thunderstorms may temporarily elevate fecal coliform bacteria densities and indicate that shellfish are not safe to harvest and eat immediately after summer storms.

- **Poor/Not Supporting:** Poor water quality does not support a healthy aquatic community and/or prevents some human activities on the estuary. These waters are not meeting water quality standards. For example, estuarine waters may be devoid of fish for short periods each summer because excessive nutrients from runoff initiate algal blooms that deplete oxygen concentrations.

- **Not Attainable:** The state has performed a use-attainability analysis and demonstrated that support of one or more designated beneficial uses is not attainable due to specific biological, chemical, physical, or economic/social conditions (see Chapter 1 for additional information).

Most states rate how well a waterbody supports individual uses (such as swimming and aquatic life) and then consolidate individual use ratings into a summary table. This table divides assessed waters into those that are:

- **Good** – Fully supporting all of their uses or fully supporting all uses but threatened for one or more uses.

- **Impaired** – Partially or not supporting one or more uses.

- **Not attainable** – Not able to support one or more uses.

It is important to note that five states did not include the effects of statewide fish consumption advisories for mercury when calculating their summary use support status in coastal waters. Alabama, Florida, Louisiana, Mississippi, and Texas excluded the impairment associated with statewide mercury advisories in order to convey information that would have been otherwise masked by the fish consumption advisories. If these advisories had been included, all of the states' coastal waters would receive an impaired rating. (See the discussion of mercury in Chapter 4.)

Similarly, six states did not include the effects of statewide fish consumption advisories for other pollutants. Connecticut and Rhode Island excluded the impairment associated with statewide PCB advisories, Maine excluded the impairment associated with a statewide dioxin advisory for lobster tomalley, Massachusetts excluded the impairment associated with a statewide PCB/organics advisory, and New Jersey and New York excluded the impairment associated with statewide PCB/cadmium/dioxin advisories.

ESTUARIES

Twenty-two of the 27 coastal states, the District of Columbia, the Virgin Islands, and the Delaware River Basin Commission (collectively referred to as states in the rest of this chapter) rated general water quality conditions in some of their estuarine waters (Appendix C, Table C-2, contains individual state data).

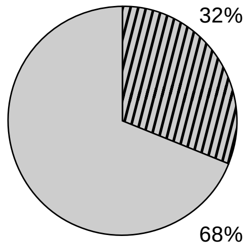
In addition, New Jersey and the Interstate Sanitation Commission reported individual use support status in estuarine waters but did not summarize overall water quality conditions. EPA used shellfishing use support status to represent overall water quality conditions in New Jersey's estuarine waters and fish consumption use support status to represent overall water quality conditions in the Interstate Sanitation Commission's estuarine waters. Puerto Rico also provided information on its estuarine waters based on linear miles rather than square miles. Consequently, the data could not be aggregated with those reported by the states.

Altogether, these states assessed 28,687 square miles of estuarine waters, which equals 32% of the 90,465 square miles of estuarine waters in the nation. The states based 63% of their assessments on monitored data and evaluated 17% of the assessed estuarine waters with qualitative information (see Appendix C, Table C-2, for individual state information). The states did not specify whether 20% of the assessed estuarine waters were monitored or evaluated.

Although the number of assessed estuarine square miles remained fairly constant between 1996 and 1998, the percent of assessed estuarine waters declined significantly. This change is due to the fact that Alaska, Guam, and the Commonwealth of the Northern Mariana Islands provided estimates of their total estuarine waters. These waters represent an increase of over 49,000 square miles of estuarine waters.

Estuaries Assessed by States

1998 28,687 square miles = 32% assessed
Total square miles: 90,465[a,e]



1996 28,819 square miles = 72% assessed
Total square miles: 39,839[b]

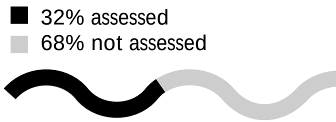
1994 26,847 square miles = 78% assessed
Total square miles: 34,388[c]

1992 27,227 square miles = 74% assessed
Total square miles: 36,890[d]

[a]Source: 1998 state section 305(b) reports.
[b]Source: 1996 state section 305(b) reports.
[c]Source: 1994 state section 305(b) reports.
[d]Source: 1992 state section 305(b) reports.
[e]The total number of estuarine square miles reported by the states increased between 1996 and 1998 because Alaska, Guam, and the Commonwealth of the Northern Mariana Islands provided estimates of their total estuarine waters.

Assessed Waters

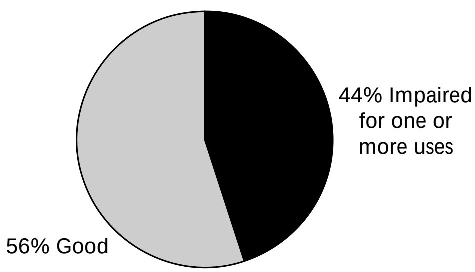
Total estuaries = 90,465 square miles[a]
Total assessed = 28,687 square miles



Of the assessed estuarine waters:

- 63% were monitored
- 17% were evaluated
- 20% were not specified

Assessed Water Quality



[a]Source: 1998 state Section 305(b) reports.

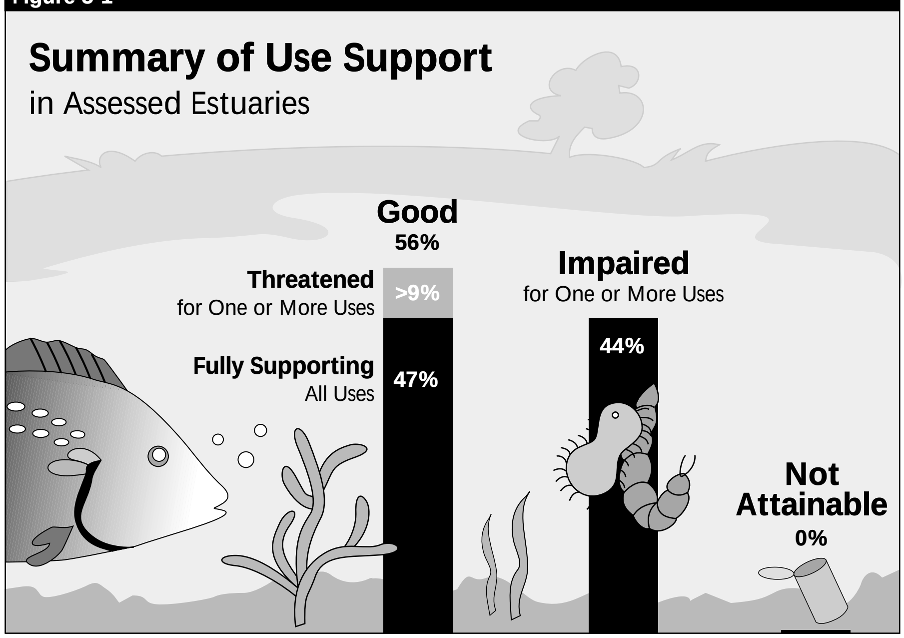
56% of ASSESSED estuaries have good water quality.

The states constantly revise their assessment methods in an effort to improve their accuracy and precision. These changes limit the comparability of data from year to year. Similarly, differences in state assessment methods limit meaningful comparisons of estuarine information submitted by individual states. States devote varying resources to monitoring biological integrity, water chemistry, and toxic pollutants in fish tissues. The wide range in water quality ratings reported by the states reflects both differences in water quality and differences in monitoring and assessment methods.

Summary of Use Support

The states reported that 56% of the assessed estuarine waters have good water quality that fully supports designated uses (Figure 5-1). Of the assessed waters, 47% fully support uses and 9% are threatened for one or more uses. Some form of pollution or habitat degradation impairs the remaining 44% of the assessed estuarine waters.

Figure 5-1



This figure presents the status of the assessed square miles of estuaries. Of 28,687 square miles assessed, 56% fully support their designated uses and 44% are impaired for one or more uses. Nine percent of assessed waters are fully supporting uses but threatened.

Based on data contained in Appendix C, Table C-2.

Individual Use Support

Individual use support assessment provides important detail about the nature of water quality problems in our nation's surface waters. The states establish specific designated uses for waterbodies through their water quality standards. The states consolidate their more detailed uses into five general use categories so that EPA can present a summary of the state and tribal data.

The standard uses are aquatic life support, fish consumption, shellfish harvesting, primary contact recreation (such as swimming and diving), and secondary contact recreation (such as boating). Few states designate saline estuarine waters for drinking water supply use and agricultural use because of high treatment costs.

Twenty-five states reported the individual use support status of their estuarine waters (see Appendix C, Table C-3, for individual state information). Most often, these states examined aquatic life conditions and swimming use in their estuarine waters (Figure 5-2). The states reported that pollutants:

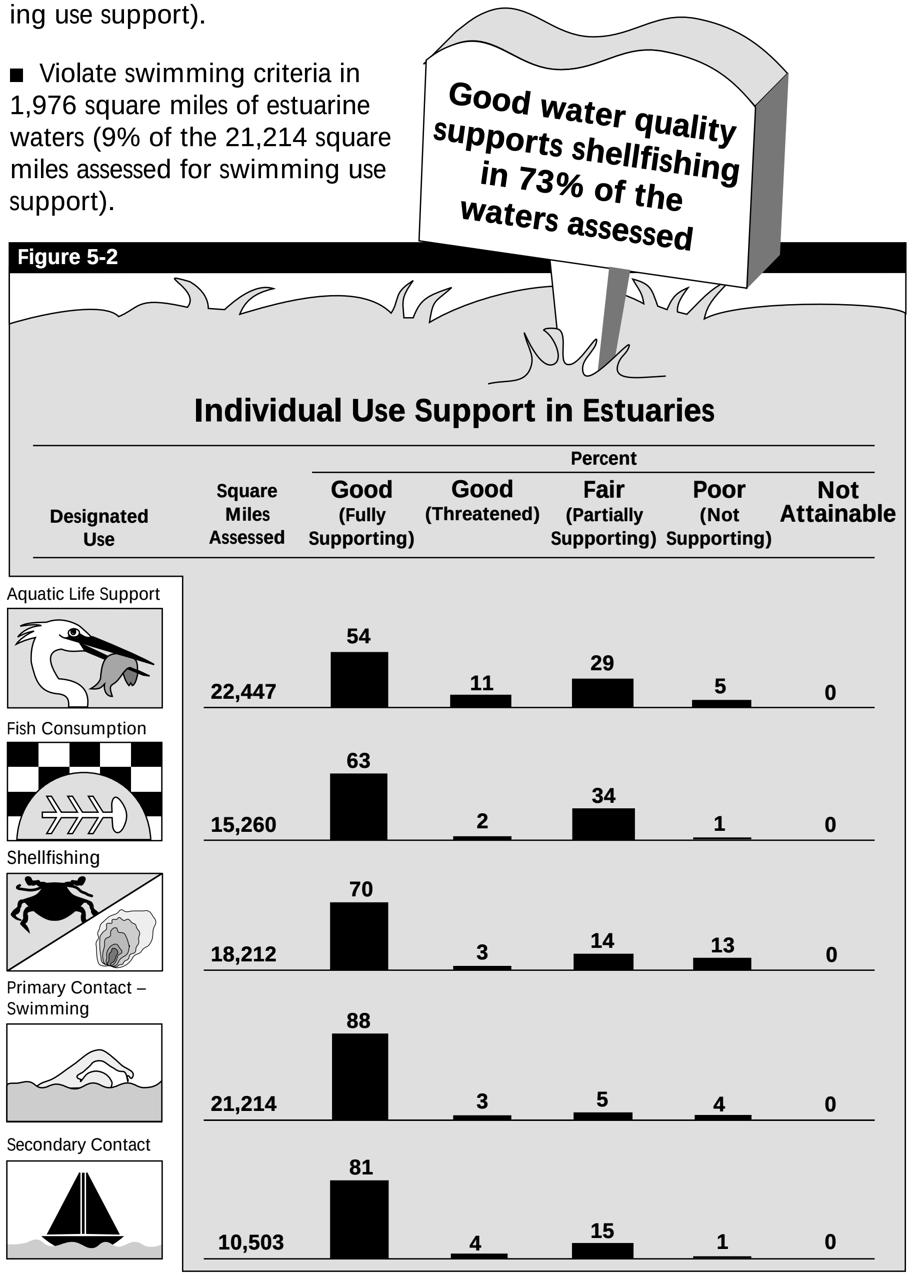
■ Impact aquatic life in 7,779 square miles of estuarine waters (about 34% of the 22,447 square miles assessed for aquatic life support)

■ Restrict fish consumption in 5,432 square miles of estuarine waters (about 35% of the 15,260 square miles assessed for fish consumption)

■ Prevent shellfish harvesting criteria in 4,929 square miles of estuarine waters (27% of the 18,212 square miles assessed for shellfishing use support).

■ Violate swimming criteria in 1,976 square miles of estuarine waters (9% of the 21,214 square miles assessed for swimming use support).

Figure 5-2



This figure presents a tally of the square miles of estuaries assessed by states for each category of designated use. For each category, the figure presents a summary of the proportion of the assessed waters rated according to quality.

Based on data contained in Appendix C, Table C-3.

Water Quality Problems Identified in Estuaries

When states and tribes rate waters as impaired, they also attempt to identify the causes and sources of impairment. Figures 5-3 and 5-4 identify the pollutants and sources of pollutants that impair the most square miles of assessed estuarine waters.

The following sections describe the leading pollutants and sources of impairment identified in estuaries. It is important to note that the information about pollutants and sources is incomplete. The states and tribes do not always report the pollutant or source of pollutants impacting every impaired estuarine waterbody. In some cases, they may recognize that water quality does not fully support a designated use but may not have adequate data to document the specific pollutant or stressor responsible for the impairment. Sources of impairment are even more difficult to identify than pollutants and stressors.

Pollutants and Processes Impacting Estuaries

Twenty-seven states reported pollutants and processes related to human activities that impact some of their estuarine waters (see Appendix C, Table C-4, for individual state information).

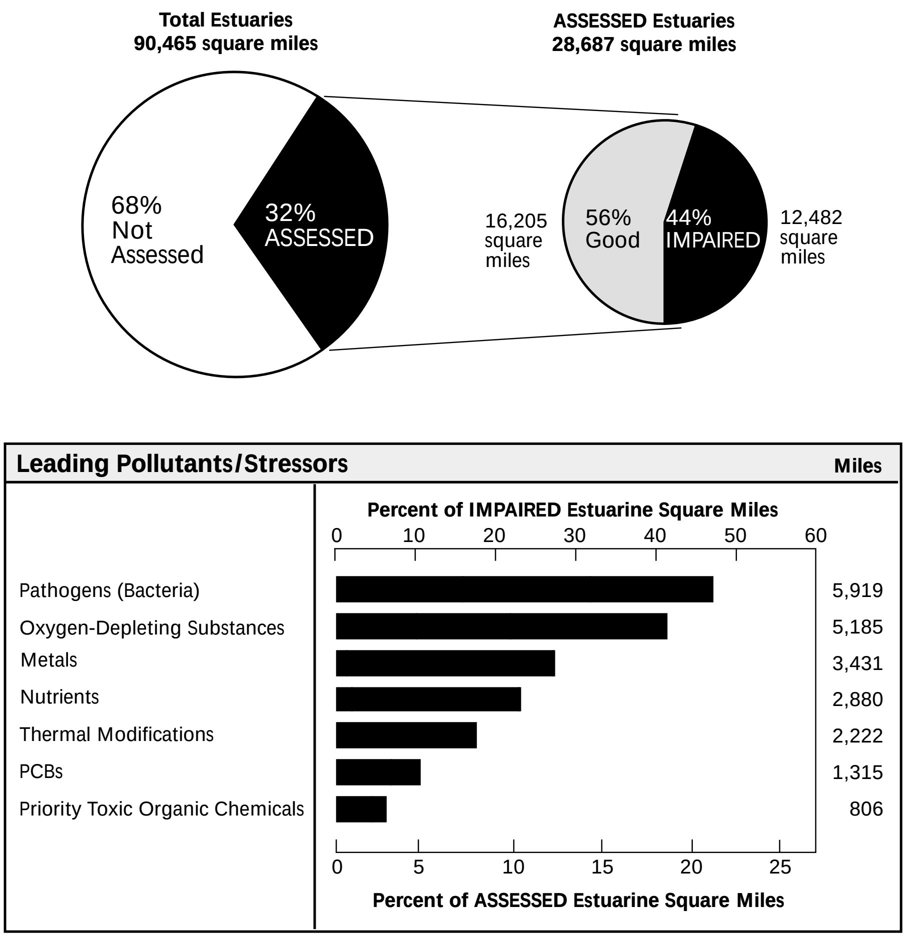
Often, more than one pollutant or stressor impacts a single estuarine waterbody. In such cases, the states and other jurisdictions count a single square mile of estuary under each pollutant or stressor category that impacts the estuary. Therefore, the percentages of estuarine waters impaired by all the pollutant and process categories do not add up to 100% in Figure 5-3.

The states identified more square miles of estuarine waters polluted by bacteria (pathogens) than any other pollutant or stressor (Figure 5-3). Twenty-five states reported that bacteria pollute 5,919 square miles of estuarine waters (21% of the assessed estuarine waters and 47% of the impaired estuarine waters). Most states monitor indicator bacteria, such as *Escherichia coli*, that inhabit the digestive tracts of humans and other warm-blooded animals and populate sewage in high densities. Such bacteria provide evidence that an estuary is contaminated with sewage that may contain numerous viruses and bacteria that cause illness in people. Most states monitor the indicator bacteria rather than run multiple tests to detect the numerous harmful viruses and bacteria in sewage.

Pathogenic viruses and bacteria seldom impact aquatic organisms such as fish and shellfish. However, shellfish can accumulate bacteria and viruses from contaminated water and cause illness when ingested. Therefore, the Food and Drug Administration and the states restrict the harvest and sale of shellfish grown in waters polluted with indicator bacteria. Bacteria also interfere with recreational activities because some pathogens can be

Figure 5-3

Leading POLLUTANTS in Impaired Estuaries



States assessed 32% of the total square miles of estuaries for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 56% are rated as good and 44% as impaired. When states identify waters that are impaired, they describe the pollutants or processes causing or contributing to the impairment. The bar chart presents the leading causes and the number of estuarine square miles impacted. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these pollutants. The lower axis compares the square miles impacted by the pollutant to the total ASSESSED square miles. The upper axis compares the square miles impacted by the pollutant to the total IMPAIRED square miles.

Based on data contained in Appendix C, Table C-4.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair an estuary.

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur because a major pollutant may be released from many minor sources. It also happens when states do not have the information to determine all the sources of a particular pollutant/stressor.

According to the states, **PATHOGENS** (bacteria) are the most common pollutant affecting assessed estuaries. High levels of pathogens prompt health officials to close areas to shellfish harvesting and swimming. Pathogens (bacteria)

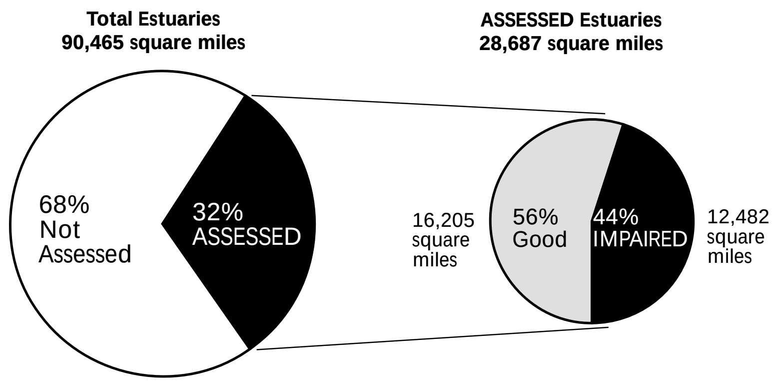
- Are found in 21% of the assessed portions of estuaries (see Figure 5-3)
- Contribute to 47% of reported water quality problems in the impaired portions of estuaries.

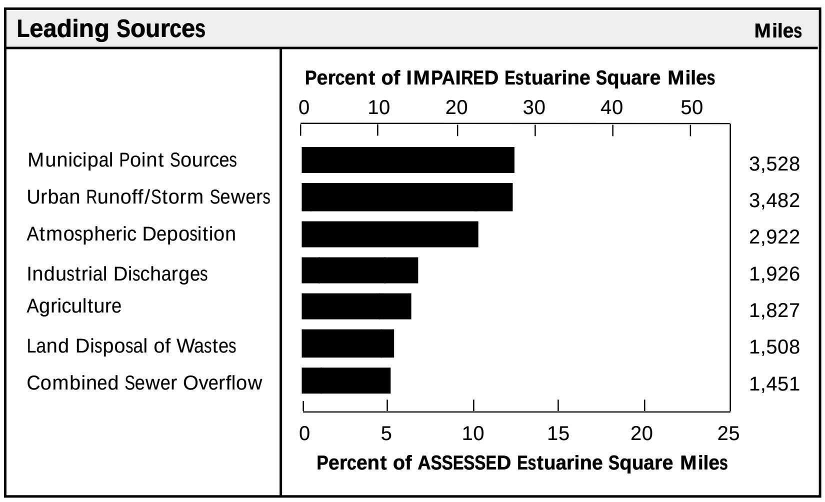
According to the states, **MUNICIPAL POINT SOURCES and URBAN RUNOFF/STORM SEWERS** are the leading sources of pollution in assessed estuaries. These sources each

- Affect 12% of the assessed portions of estuaries
- Contribute to 28% of reported water quality problems in the impaired portions of estuaries (see Figure 5-4).

Figure 5-4

Leading SOURCES of Estuary Impairment*





States assessed 32% of the total square miles of estuaries for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 56% are rated as good and 44% as impaired. When states identify waters that are impaired, they also describe the sources of pollutants associated with the impairment. The bar chart presents the leading sources and the number of estuarine square miles they impact. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these sources. The lower axis compares the square miles impacted by the source to the total ASSESSED square miles. The upper axis compares the square miles impacted by the source to the total IMPAIRED square miles.

Based on data contained in Appendix C, Table C-5.

*Excluding unknown, natural, and "other" sources.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair an estuary.

transmitted by contact with contaminated water or ingestion during swimming (Figure 5-5).

Twenty-two states reported that oxygen depletion from organic wastes impacts 5,185 square miles of estuarine waters (18% of the assessed estuarine waters and 42% of the impaired estuarine waters). Oxygen-depletion may trigger fish kills and foul odors and can adversely affect aquatic life.

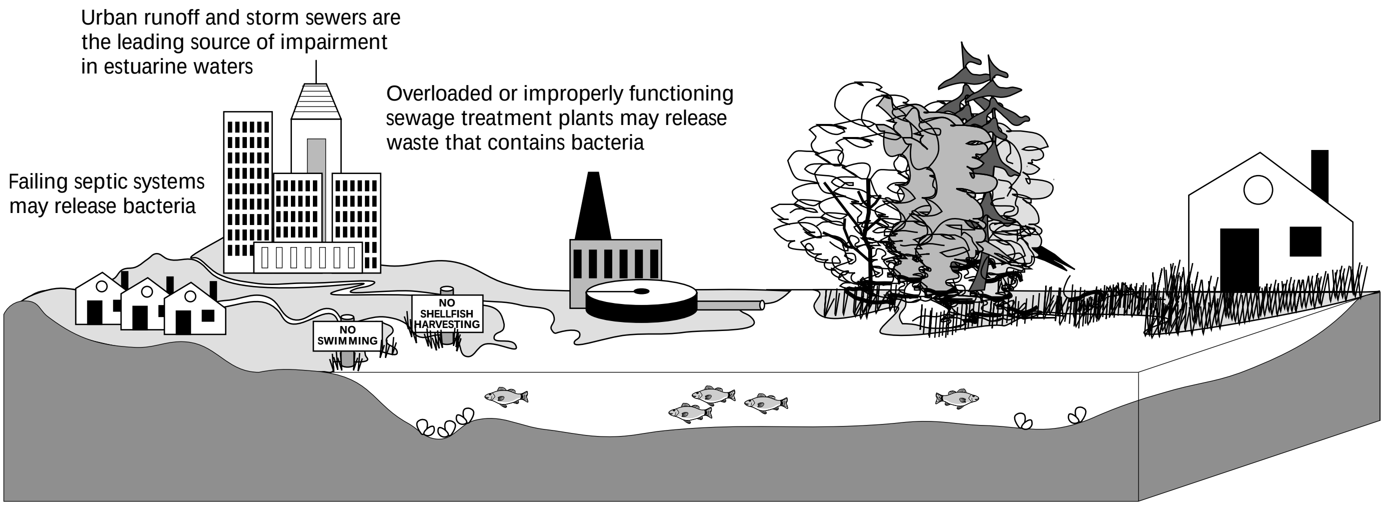
The states report that metals pollute 3,431 square miles of estuaries (12% of the assessed estuarine waters and 27% of the impaired estuarine waters). Similar to lakes, this is mainly due to the widespread detection of mercury in fish tissue samples. See the highlight on page 196 for more information on mercury contamination of fish tissue.

The states also report that excess nutrients impact 2,880 square miles (10% of the assessed estuarine waters and 23% of the impaired estuarine waters). As in lakes, extra inputs of nutrients destabilize estuarine ecosystems. When temperature and light conditions are favorable, excessive nutrients stimulate population explosions of undesirable algae whose decomposition causes oxygen depletion.

The states report that thermal modifications (activities that alter the temperature of estuarine waters) degrade 2,222 square miles (8% of the assessed estuarine waters and 18% of the impaired

Figure 5-5

Sources of Bacteria



Some bacteria, such as fecal coliforms, provide evidence that an estuary is contaminated with fecal material that may contain pathogenic bacteria and viruses harmful to people. Often, the pathogenic viruses and bacteria do not adversely impact aquatic life such as fish and shellfish. However, shellfish may accumulate bacteria and viruses that cause human diseases when ingested. Therefore, officials restrict shellfish harvesting in contaminated waters to protect public health. Bacteria also impair swimming uses because some pathogenic bacteria and viruses can be transmitted by contact with contaminated water.

estuarine waters). Estuaries are often home to large utilities that discharge heated cooling water as they produce electricity. The change in temperature may impact the ability of fish to spawn. In addition, heated water holds less dissolved oxygen, which is needed by many aquatic organisms.

The states determined that PCBs pollute 1,315 square miles (5% of the assessed estuarine waters and 11% of the impaired estuarine waters). Although use of PCBs has been banned, quantities of the chemical persist in the environment. PCBs bioaccumulate in the fatty tissue of organisms. Consumption of contaminated fish and shellfish can pose public health threats.

The states also reported that priority toxic organic chemicals pollute 806 square miles (3% of the assessed estuarine waters and 6% of the impaired estuarine waters). These chemicals, which include pesticides such as DDT and chlordane, pose risks to human health and aquatic life.

Oxygen-depleting substances, metals, nutrients, and priority organic chemicals are widespread problems reported by more than 10 of the 27 coastal states. In contrast, only a few states reported significant impacts from thermal modifications and PCBs.

Sources of Pollutants Impacting Estuaries

Twenty-six states reported sources of pollution related to human activities that impact some of their estuarine waters (see Appendix C, Table C-5, for individual state information). These states reported that municipal sewage treatment plants are the most widespread source of pollution in their assessed estuarine waters. Pollutants in municipal discharges degrade aquatic life or interfere with public use of 3,528 square miles of estuarine waters (12% of the assessed estuarine waters and 28% of the impaired estuarine waters) (Figure 5-4).

The states also reported that pollution from urban runoff and storm sewers impacts 3,482 square miles of estuarine waters (12% of the assessed estuarine waters and 28% of the impaired estuarine waters), atmospheric deposition of pollutants impacts 2,922 square miles of estuarine waters (10% of the assessed estuarine waters and 23% of the impaired estuarine waters), industrial discharges pollute 1,926 square miles of estuarine waters (7% of the assessed estuarine waters and 15% of the impaired estuarine waters), agriculture pollutes 1,827 square miles of estuarine waters (6% of the assessed estuarine waters and 15% of the impaired estuarine waters), land disposal of wastes pollutes 1,508 square miles (5% of the assessed estuarine waters and 12% of the impaired estuarine waters), and pollution from combined sewer overflows impairs 1,451 square miles of estuarine waters (5% of the assessed estuarine waters and 12% of the impaired estuarine waters). Urban sources contribute more to the degradation of estuarine waters than does agriculture because urban centers are located adjacent to most major estuaries.

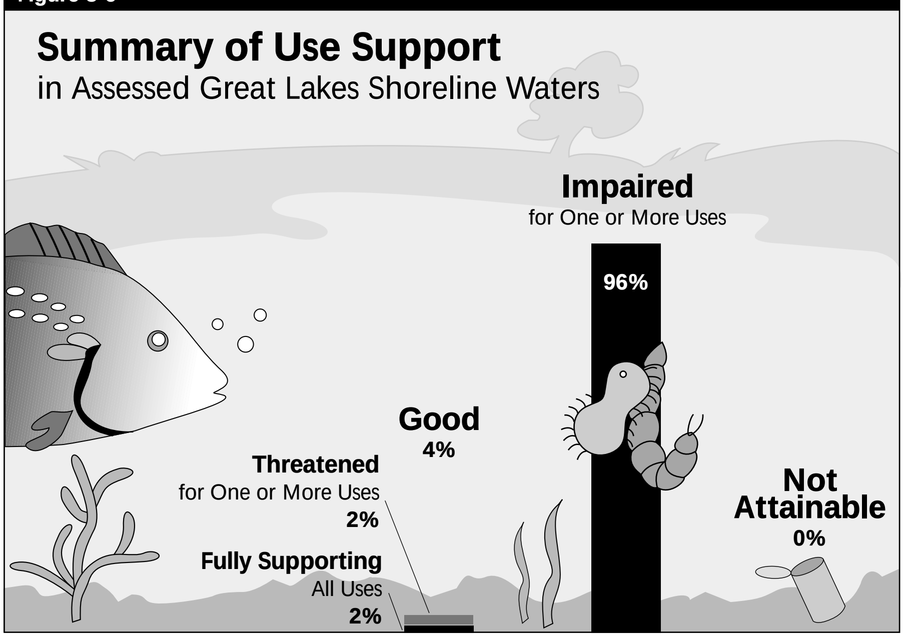
GREAT LAKES SHORELINE

Five of the eight Great Lakes states rated general water quality conditions in 4,950 miles of Great Lakes shoreline in their 1998 Section 305(b) reports (see Appendix F, Tables F-1 and F-2, for individual state information). These states based 74% of their assessments on monitored data and evaluated 14% of the assessed shoreline miles with qualitative information (see Appendix F, Table F-2, for individual state information). The states did not specify whether the remaining 12% of the assessed shoreline miles were monitored or evaluated.

Summary of Use Support

The states reported that only 4% of their assessed Great Lakes shoreline miles have good water quality that fully supports designated uses (Figure 5-6). Of the assessed waters, 2% fully support uses and 2% fully support uses but are threatened for one or more uses. Some form of pollution or habitat degradation impairs the remaining 96% of assessed Great Lakes shoreline. This degradation leads to fish consumption advisories. Nearly all of the Great Lakes shoreline supports recreation and drinking water uses.

Figure 5-6

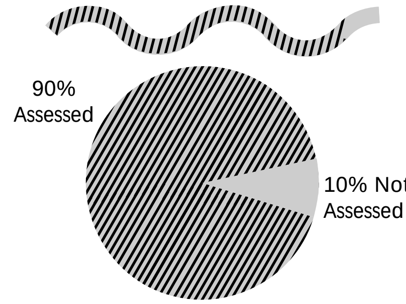


This figure presents the status of the assessed Great Lakes shoreline waters. Of the 4,950 miles of Great Lakes shoreline assessed, 4% fully support their designated uses and 96% are impaired for one or more uses. Two percent of the assessed waters are fully supporting uses but threatened.

Based on data contained in Appendix F, Table F-2.

Great Lakes Shoreline Miles Assessed by States

1998 4,950 miles = 90% assessed
Total shoreline miles: 5,521



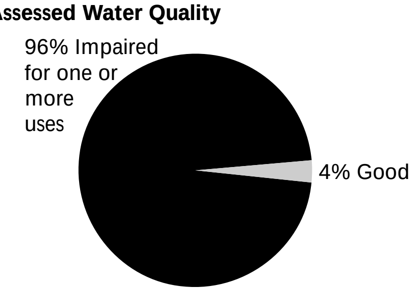
1996 5,186 miles = 94% assessed
Total shoreline miles: 5,521[b]

1994 5,224 miles = 94% assessed
Total shoreline miles: 5,559[c]

1992 5,319 miles = 99% assessed
Total ocean shore miles: 20,121[d]

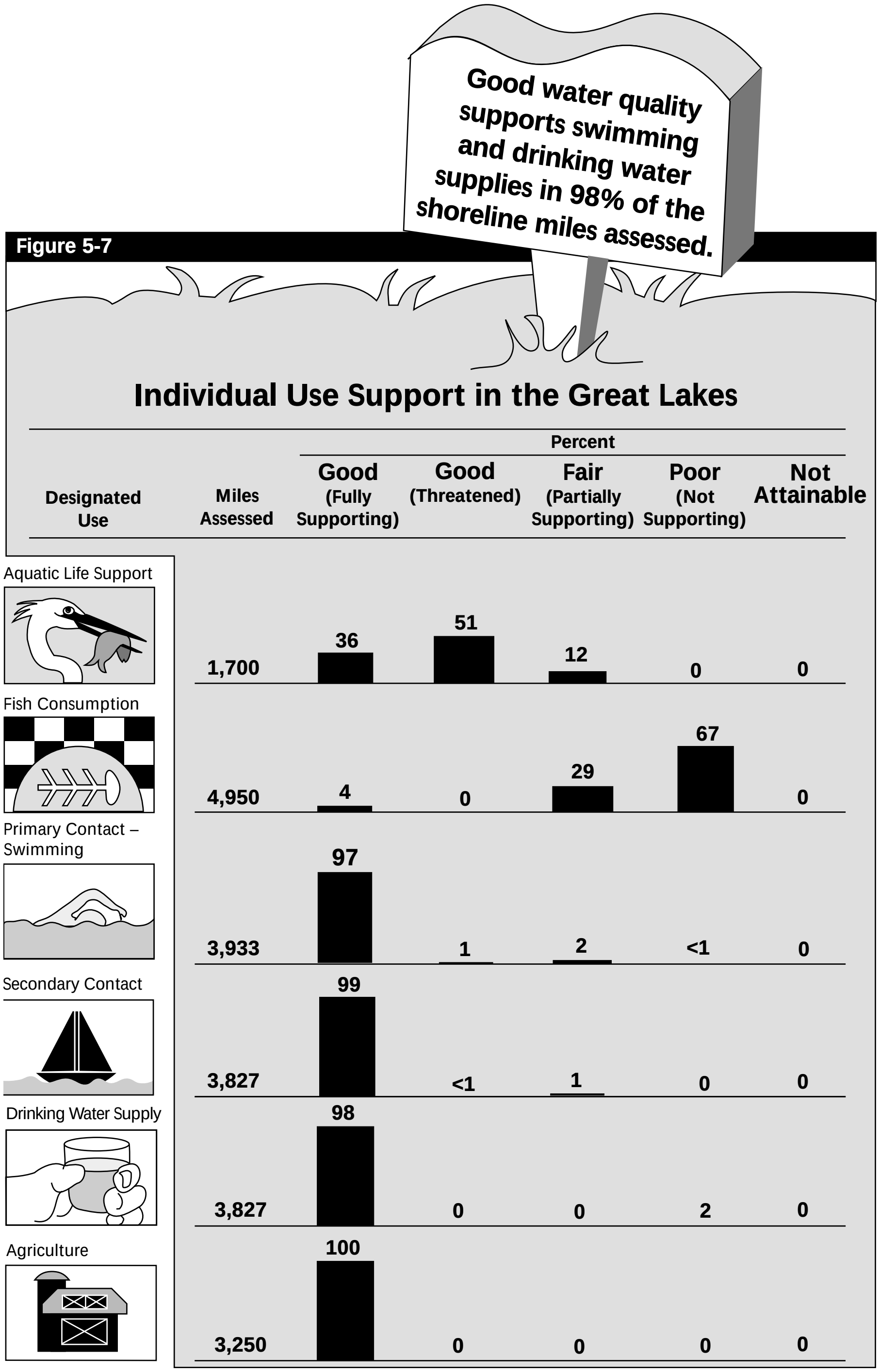
Of the assessed Great Lakes shoreline waters:
- 74% were monitored
- 14% were evaluated
- 12% were not specified

Assessed Water Quality



[a]Source: 1998 state section 305(b) reports.
[b]Source: 1996 state section 305(b) reports.
[c]Source: 1994 state section 305(b) reports.
[d]Source: 1992 state section 305(b) reports.

Figure 5-7



This figure presents a tally of the miles of Great Lakes shoreline assessed by states for each category of designated use. For each category, the figure presents a summary of the proportion of the assessed waters rated according to quality.

Based on data contained in Appendix F, Table F-3.

Individual Use Support

The states establish specific designated uses for waterbodies through their water quality standards. The states consolidate their more detailed uses into six general use categories so that EPA can present a summary of the state and tribal data. The standard uses consist of aquatic life support, fish consumption, primary contact recreation (such as swimming and diving), secondary contact recreation (such as boating), drinking water supply, and agricultural use.

Five of the eight Great Lakes states reported the individual use support status of their Great Lakes shoreline (see Appendix F, Table F-3, for individual state information). These states report that swimming, secondary contact, drinking water supply, and agricultural uses are met in nearly all assessed shoreline miles (Figure 5-7). The reporting states indicated that the greatest impacts to Great Lakes shoreline are on fishing activities.

The states bordering the Great Lakes have issued advisories to restrict consumption of fish caught along their entire shorelines. Depending upon location, mercury, PCBs, pesticides, or dioxins are found in fish tissues at levels that exceed standards set to protect human health. The water concentrations of most organochlorine compounds have declined dramatically since control measures began in the mid-1970s. As a result, concentrations of these contaminants in fish tissue have also declined, although 3,313 shoreline miles (96% of the assessed Great Lakes waters) still fail to fully support fish consumption uses.

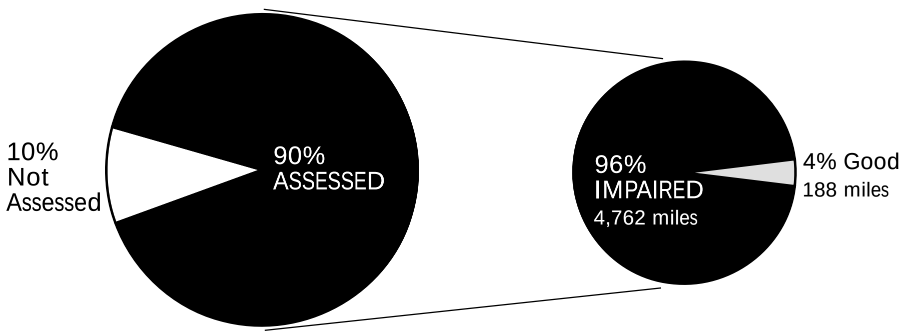
Water Quality Problems Identified in Great Lakes Shoreline Waters

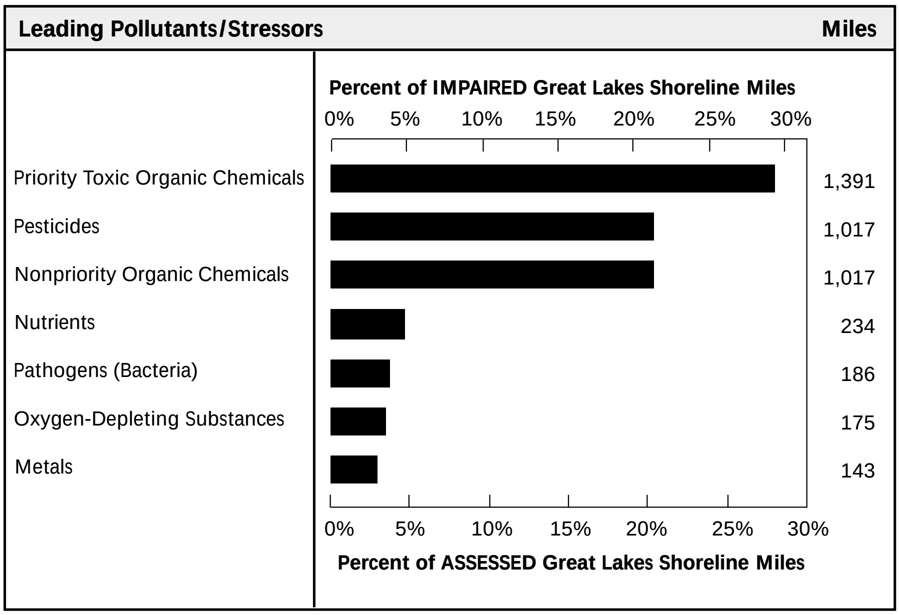
Only three Great Lakes states identified pollutants and sources of pollutants degrading Great Lakes shoreline (Appendix F, Tables F-4 and F-5, contain individual state information). Limited conclusions can be drawn from such a small fraction of the nation's Great Lakes shoreline miles. The top causes of impairment cited by the three states were priority organic chemicals, pesticides, and nonpriority organic chemicals. In addition, excess nutrients, bacteria (pathogens), oxygen-depleting substances, and metals caused water quality impairments in more localized areas (Figure 5-8).

The states reported that atmospheric deposition, discontinued discharges from pipes, contaminated sediments, industrial discharges, urban runoff and storm sewers, agriculture, and municipal sewage treatment plants are the primary sources of pollutants that impair their Great Lakes shoreline waters (Figure 5-9). Discontinued discharges refer to historical discharges that resulted in sediment contamination that remains today.

Figure 5-8

Leading POLLUTANTS in Impaired Great Lakes Shoreline Waters





States assessed 90% of the total miles of Great Lakes shoreline for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 4% are rated as good and 96% as impaired. When states identify waters that are impaired, they describe the pollutants or processes causing or contributing to the impairment. The bar chart presents the leading causes and the number of Great Lakes shoreline miles impacted. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these pollutants. The lower axis compares the miles impacted by the pollutant to the total ASSESSED miles. The upper axis compares the miles impacted by the pollutant to the total IMPAIRED miles.

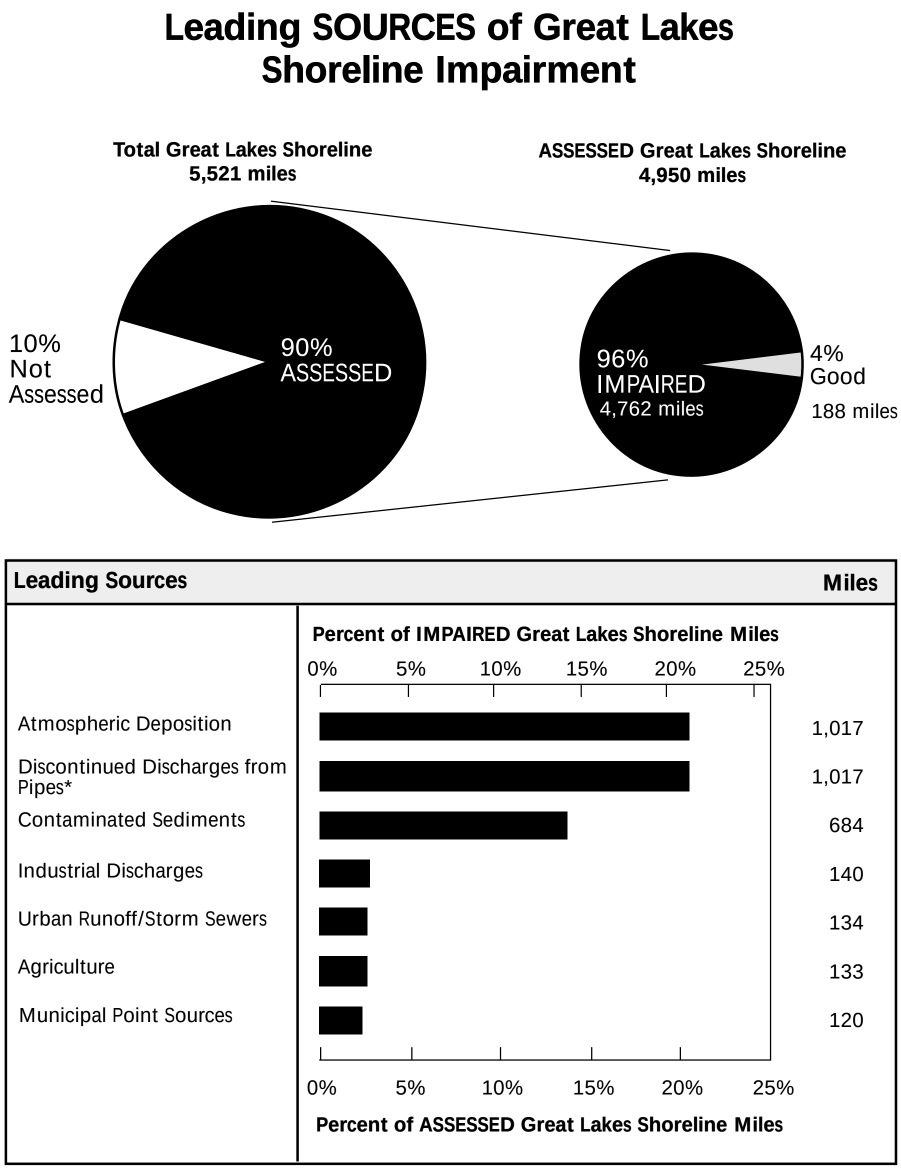
Based on data contained in Appendix F, Table F-4.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline.

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur because a major pollutant may be released from many minor sources. It also happens when states do not have the information to determine all the sources of a particular pollutant/stressor.

* These discharges resulted in sediment contamination that remains today.

Figure 5-9



States assessed 90% of the total miles of Great Lakes shoreline for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 4% are rated as good and 96% as impaired. When states identify waters that are impaired, they also describe the sources of pollutants associated with the impairment. The bar chart presents the leading sources and the number of Great Lakes shoreline miles they impact. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these sources. The lower axis compares the miles impacted by the source to the total ASSESSED miles. The upper axis compares the miles impacted by the source to the total IMPAIRED miles.

Based on data contained in Appendix F, Table F-5.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline.

OCEAN SHORELINE WATERS

Fourteen of the 27 coastal states and territories rated general water quality conditions in some of their coastal waters (see Appendix C, Table C-6, for individual state information). In addition, New Jersey reported individual use support status in ocean shoreline waters but did not summarize general water quality conditions. EPA used swimming use support status to represent general water quality conditions in New Jersey's ocean shoreline waters. Texas provided information on its ocean shoreline waters based on square miles rather than linear miles. Consequently, the data could not be aggregated with those reported by the other states.

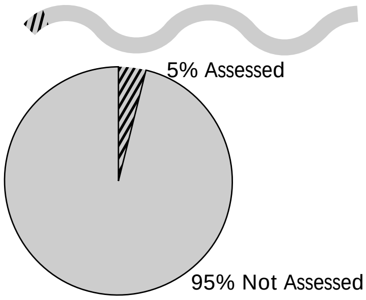
All together, these states assessed 3,130 miles of ocean shoreline, which equals 5% of the nation's coastline (including Alaska's 44,000 miles of coastline) or 14% of the 22,419 miles of national coastline excluding Alaska. The states based 25% of their assessments on monitored data and 66% on qualitative information (see Appendix C, Table C-6, for individual state information). The states did not specify whether 9% of the assessed coastal shoreline waters were monitored or evaluated.

The number of ocean shoreline miles assessed by the states decreased slightly between the two reporting cycles. This decrease is due primarily to the fact that, in 1998, the assessment information provided by Texas could not be aggregated with that reported by the other states. Also during the 1998 reporting cycle, the states' estimates of their total ocean shoreline miles increased by more than 8,000 miles. This change is due to the fact that Alaska refined its estimate of shoreline mileage and Guam and the Commonwealth of the Northern Marina Islands provided estimates of their total ocean shoreline. Excluding Alaska, the other 14 reporting states provided information on 69% of their own 4,536 coastal shoreline miles.

Ocean Shoreline Waters Assessed by States

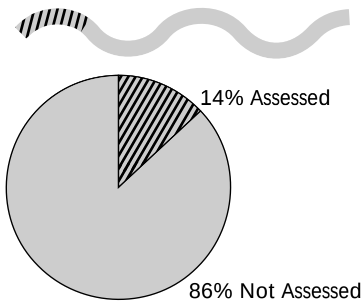
Including Alaska's Ocean Shoreline

1998 3,130 miles = 5% assessed
Total ocean shoreline miles: 66,645[a]



Excluding Alaska's Ocean Shoreline

1998 3,130 miles = 14% assessed
Total ocean shoreline miles: 22,419

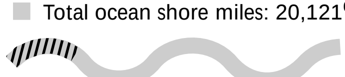


Of the assessed ocean shoreline miles:
- 25% were monitored
- 66% were evaluated
- 9% were not specified

1996 3,651 miles = 6% assessed
Total ocean shoreline miles: 22,585[b]

1994 5,208 miles = 9% assessed
Total ocean shoreline miles: 58,421[c]

1992 3,398 miles = 17% assessed
Total ocean shore miles: 20,121[d]

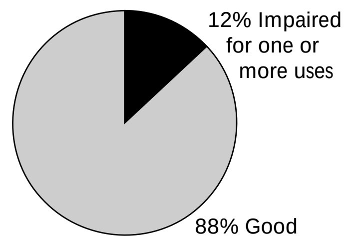


[a]Source: 1998 state section 305(b) reports.
[b]Source: 1996 state section 305(b) reports.
[c]Source: 1994 state section 305(b) reports.
[d]Source: 1992 state section 305(b) reports.

Summary of Use Support

The states reported that 88% (2,753 miles) of their assessed ocean shoreline miles have good quality that supports a healthy aquatic community and public activities (Figure 5-10). Of the assessed waters, 80% fully support designated uses and 8% are threatened for one or more uses. Some form of pollution or habitat degradation impairs the remaining 12% of the assessed shoreline (377 miles).

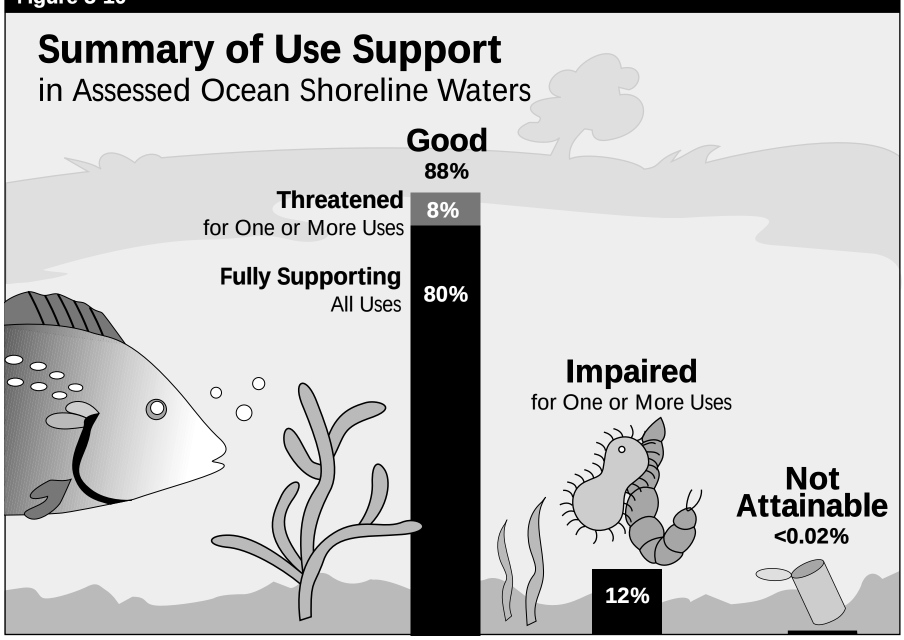
Assessed Water Quality



Individual Use Support

The states establish specific designated uses for waterbodies through their water quality standards. The states consolidate their more detailed uses into five general

Figure 5-10



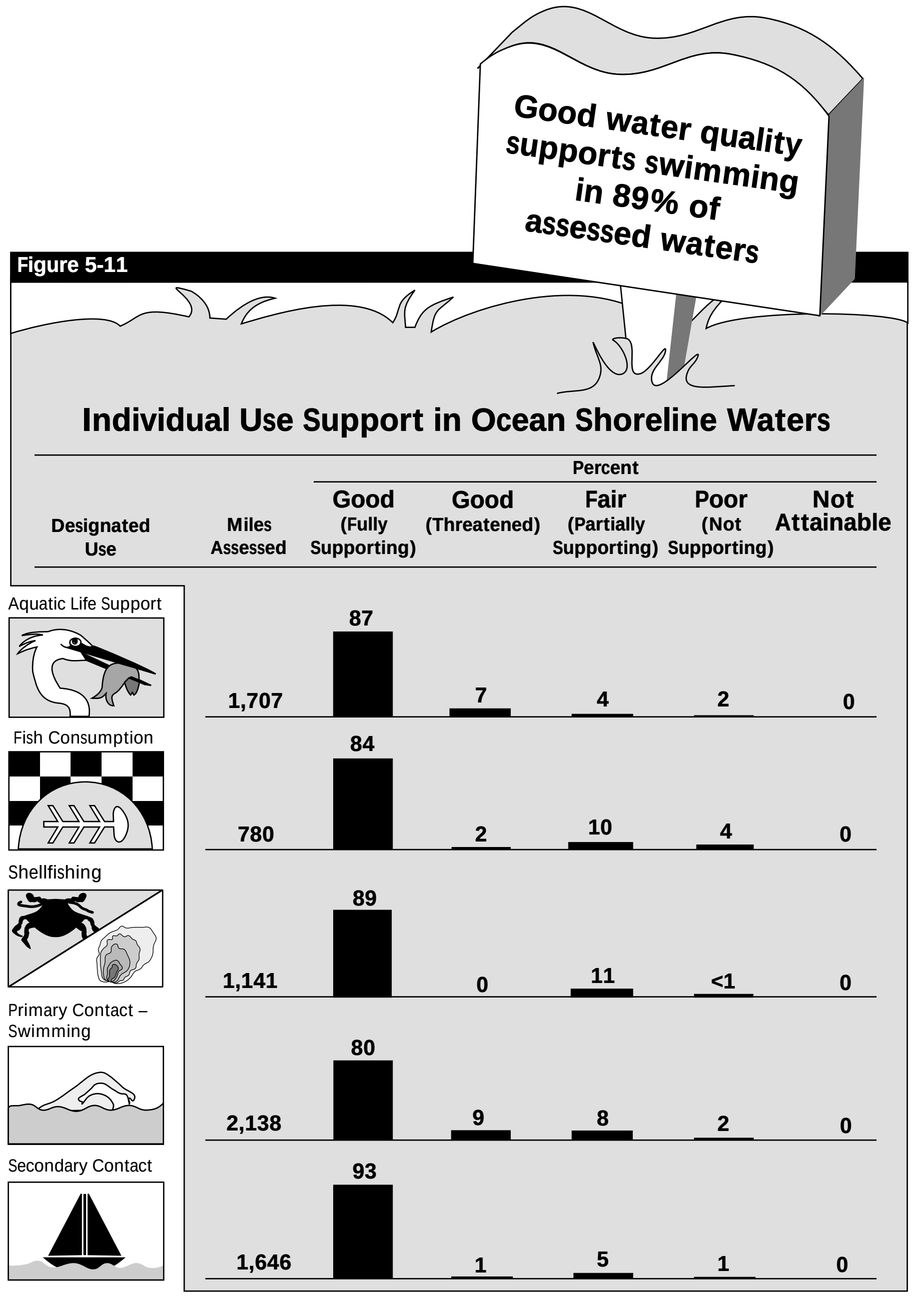
This figure presents the status of the assessed miles of ocean shoreline. Of the 3,130 miles ocean shoreline assessed, 88% fully support their designated uses and 12% are impaired for one or more uses. Eight percent of the assessed waters are fully supporting uses but threatened.

Based on data contained in Appendix C, Table C-6.

use categories so that EPA can present a summary of the state and tribal data. The standard uses consist of aquatic life support, fish consumption, shellfish harvesting, primary contact recreation (such as swimming and diving), and secondary contact recreation (such as boating). Few states designate saline ocean waters for drinking water supply use and agricultural use because of high treatment costs.

The states provided limited information on individual use support in ocean shoreline waters (Appendix C, Table C-7, contains individual state information). Thirteen states rated swimming use in their ocean shoreline waters, but only nine states rated aquatic life support, six rated fish consumption use, eight rated shellfishing support, and nine rated secondary contact recreation use. Limited conclusions can be drawn from such a small fraction of the nation's ocean shoreline miles (Figure 5-11).

It is important to note that eleven states have adopted statewide coastal fish consumption advisories for mercury, PCBs, and other pollutants. The effect of these advisories is not reflected in Figure 5-11.

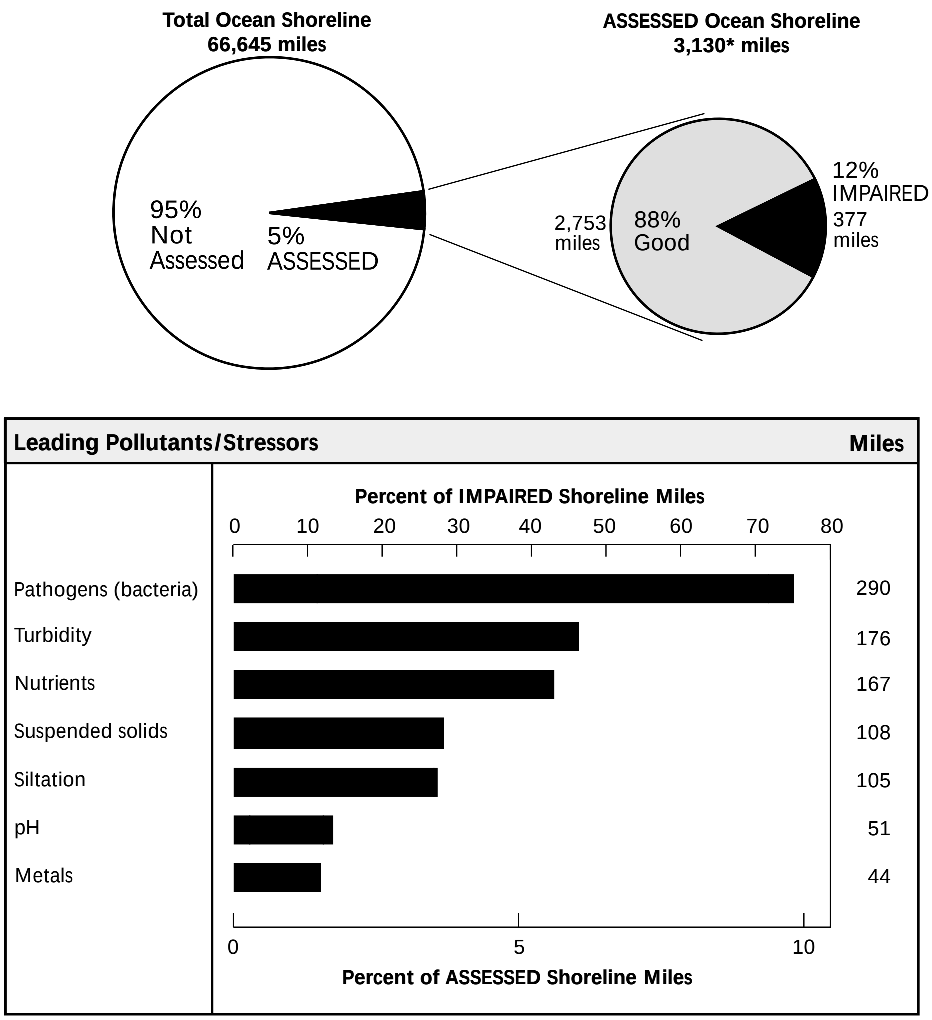


This figure presents a tally of the miles of ocean shoreline assessed by states for each category of designated use. For each category, the figure presents a summary of the proportion of the assessed waters rated according to quality.

Based on data contained in Appendix C, Table C-7.

Figure 5-12

Leading POLLUTANTS in Impaired Ocean Shoreline Waters



States assessed 5% of the total miles of ocean shoreline for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 88% are rated as good and 12% as impaired. When states identify waters that are impaired, they describe the pollutants or processes causing or contributing to the impairment. The bar chart presents the leading causes and the number of ocean shoreline miles impacted. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these pollutants. The lower axis compares the miles impacted by the pollutant to the total ASSESSED miles. The upper axis compares the miles impacted by the pollutant to the total IMPAIRED miles.

Based on data contained in Appendix C, Table C-8.

*Includes miles assessed as not attainable.

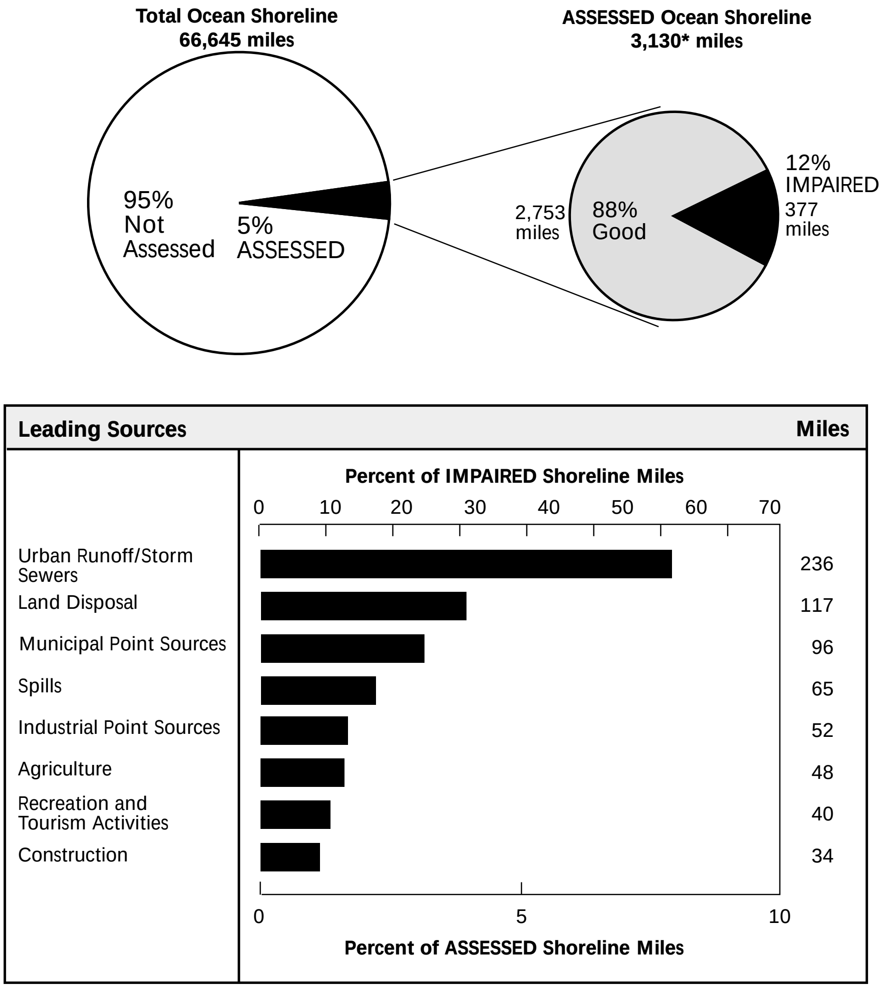
Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline.

Water Quality Problems Identified in Ocean Shoreline Waters

Of the 15 states that reported on coastal waters, 10 identified pollutants and sources of pollutants degrading ocean shoreline waters (Appendix C, Tables C-8 and C-9, contain individual state information). The primary pollutants and stressors reported by the 10 states include bacteria (pathogens), turbidity, excess nutrients, suspended solids, siltation, acidity (pH), and metals (Figure 5-12). The primary sources reported include urban runoff and storm sewers, land disposal of wastes, municipal sewage treatment plants, accidental spills, industrial discharges, agriculture, recreation and tourism activities, and construction (Figure 5-13).

Figure 5-13

Leading SOURCES of Ocean Shoreline Impairment†



States assessed 5% of the total miles of ocean shoreline for the 1998 report. The larger pie chart on the left illustrates this proportion. The smaller pie chart on the right shows that, for the subset of assessed waters, 88% are rated as good and 12% as impaired. When states identify waters that are impaired, they also describe the sources of pollutants associated with the impairment. The bar chart presents the leading sources and the number of ocean shoreline miles they impact. The percent scales on the upper and lower x-axis of the bar chart provide different perspectives on the magnitude of the impact of these sources. The lower axis compares the miles impacted by the source to the total ASSESSED miles. The upper axis compares the miles impacted by the source to the total IMPAIRED miles.

Based on data contained in Appendix C, Table C-9.

†Excluding natural sources.

*Includes miles assessed as not attainable.

Note: Percentages do not add up to 100% because more than one pollutant or source may impair a segment of ocean shoreline.

The pollutants/processes and sources shown here may not correspond directly to one another (i.e., the leading pollutant may not originate from the leading source). This may occur because a major pollutant may be released from many minor sources. It also happens when states do not have the information to determine all the sources of a particular pollutant/stressor.

CORAL REEFS

Among the most productive ecosystems in the ocean, coral reefs are inhabited by a wide variety of fish, invertebrate, and plant species. These reefs are the living jewels that encircle the shoreline in many tropical areas, providing important assets to local and national economies, including fisheries for food, materials for new medicines, and income from tourism and recreation. Coral reefs also provide coastal communities with protection from storms.

Coral reef areas are found in only three states—Florida, primarily in the Florida Keys; Hawaii, throughout the Hawaiian archipelago; and Texas, in the offshore Flower Gardens (Figure 5-14). Lush reef areas are also found in five U.S. territories in both the Atlantic and Pacific regions, including American Samoa, Guam, the Northern Mariana Islands, Puerto Rico, and the U.S. Virgin Islands.

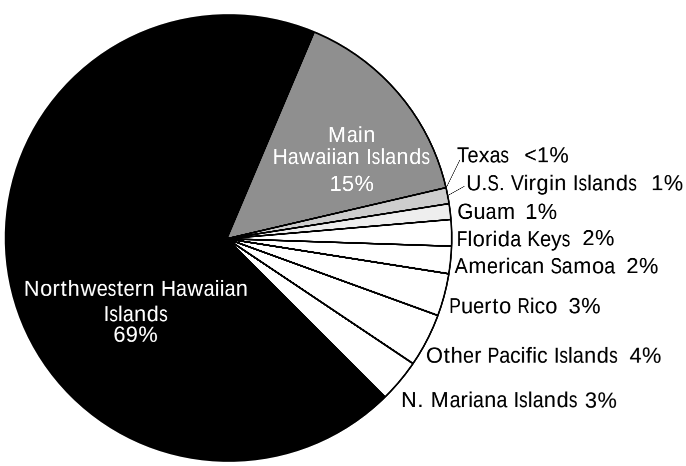
The proximity of coral reefs to land makes them particularly sensitive to impacts from human activities. Because they depend on light, coral reefs require clear water for growth and can be severely damaged by sediment or other factors that reduce water clarity or quality. Recent evidence indicates that coral reefs are deteriorating worldwide, and many are in crisis. Symptoms include loss of hard corals, increased abundance of algae, and a dramatic increase in bleaching episodes and disease outbreaks. In an effort to prevent further loss of coral reef ecosystems, on June 11, 1998, President Clinton signed Executive Order 13089 on Coral Reef Protection, which created the U.S. Coral Reef Task Force. The task force is charged with the following duties:

- Mapping and monitoring reefs
- Researching coral reef degradation
- Working to implement measures to protect reefs
- Promoting reef conservation worldwide.

Efforts are under way in Hawaii, Florida, and American Samoa to assess the status of coral reefs and identify pollutants and stressors to coral reef ecosystems. The findings will be used to develop management actions to protect coral reefs in these states.

Figure 5-14

U.S. Coral Reef Areas



Hawaii's Coral Reefs

The islands of the Hawaiian archipelago are isolated by over 2,000 miles of ocean from any major land mass. These remote islands consist of 8 major islands and 124 smaller islands, coral atolls, and shoals. Because of its great distance from all other major land forms, Hawaii has an extremely high level of endemic species—species that are found nowhere else on earth.

Coral reefs are important to the Hawaiian Islands for several reasons. The existence of coral reefs protects and stabilizes the shoreline from dangerous waves and storm surge. The reefs are also the underwater structures that create Hawaii's famous surf beaches. Most of the sand on Hawaii's beaches comes from the breakdown of coral from both physical and biological activity as the polyps and small portions of the coral skeleton are consumed by coral-grazing fish such as parrotfish. Because they provide shelter for a wide variety of fish and invertebrate species, coral reefs are a vital habitat. They provide nursery areas for many types of juvenile fish and shellfish species. Reefs are also valuable sources of medicine such as anticancer agents for the pharmaceutical industry; coral is now also being used for human bone replacement.

Coral Reef Degradation in Hawaii

Natural impacts to Hawaiian coral reefs occur as a result of hurricanes and severe storms. Outbreaks of Crown-of-Thorn starfish populations that feed voraciously on coral polyps kill large parts of the reef. Coral bleaching and other coral diseases are also natural stressors on coral reefs.

Human activities also can cause significant impacts to coral populations. These activities include

- Introduction of alien species from ballast water of international cargo ships
- Removal of selected tropical fish and invertebrate species for the aquarium trade
- Commercial and recreational fishing pressures
- Marine debris, petroleum, and other toxic chemical spills
- Nutrient pollution from nonpoint source agricultural runoff or from point source discharges from sewage treatment facilities
- Sediment runoff
- Offshore dredging activities
- Marine tourism
- Urbanization of coastal areas.

See the accompanying highlight for more information on the effects of tropical fish collection.

Status of Hawaii's Coral Reefs

In *Hawaii's State of the Reefs Report* (1998), the state reported on the status of a number of environmental characteristics of Hawaii's reefs, including:

■ **Water Quality** – While the status of water quality for human health effects is fairly well known, little is known about the environmental effects of water quality in coral reef areas. Increased nutrient inputs and sediment loadings are a concern. The state plans to improve monitoring in coral reef ecosystems.

■ **Stony Corals** – Overall, there is no evidence of major declines due to human disturbances, although there have been some specific site effects. With impacts from activities such as illegal fish collection, coastal development, habitat disturbance, and introduction of alien species, the state plans to increase monitoring efforts and implement a number of management actions to prevent coral decline.

■ **Other Corals** – Although the status of other types of coral is poorly known, there is anecdotal evidence of decline. These coral are subject to overharvesting, increased nutrient input, habitat disturbance, and coastal development. The state is considering limiting or prohibiting their collection.

■ **Reef Fish** – There is anecdotal evidence that the population of reef fish are on the decline. The state plans to investigate recreational take data and revise regulations to take into account ecosystem effects of reef fishing.

■ **Marine Turtles** – One species of marine turtle is in significant decline. These turtles are subject to poaching, by-catch in gill nets, and harassment. The state plans to investigate gill net rules and strengthen protection and harassment regulations.

■ **Hawaiian Monk Seals** – This species is in significant decline because of harassment and death by marine debris and discarded nets. The state is working to protect the critical habitat of the monk seal.

Little is known about the status of other characteristics, such as mangroves, seagrasses, and large transient fish.

The state has documented impacts to coral reefs from coastal and urban development. For example, "hardening" of shoreline to protect private property has resulted in the loss of approximately 25 miles of beaches on O'ahu, nearly 9 miles of beaches on Maui, and an estimated 3 to 5 miles of beaches on Kaua'i. Beach loss can lead to increased turbidity and wave agitation in the shallowest waters of the back-reef habitat and depletes sand habitat for animals that live on top, in, or around the substrate.

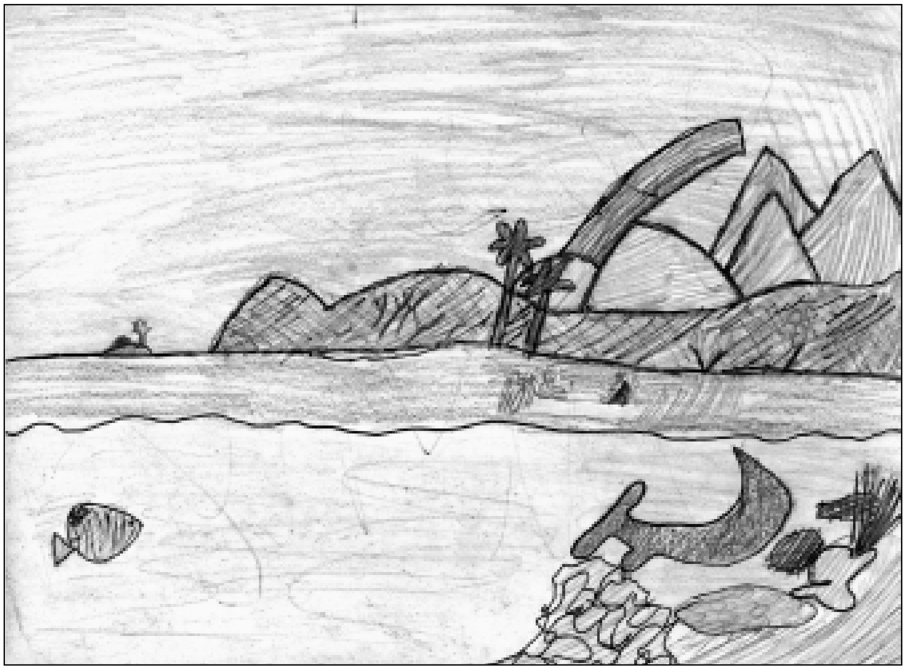
Coral Reef Management in Hawaii

One of the greatest obstacles to marine resource managers in Hawaii has been a lack of an integrated coral reef research and monitoring programs to assess changes in the health and diversity of the reefs. In response to these needs, the state developed the

Coral Reef Assessment and Monitoring Program (CRAMP) in 1998 with input from leading reef scientists and resource managers. The goal of CRAMP is to detect changes in coral reefs and increase understanding of the factors, both human and natural, that influence coral reef stability, decline, and recovery. Collaboration between the University of Hawaii Sea Grant Program, the Hawaii Department of Land and Natural Resources, the U.S. Fish and Wildlife Service Marine Ecosystem Global Partnership Program, the National Oceanic and Atmospheric Administration (NOAA), and other federal agencies helped overcome geographic barriers to conducting a statewide monitoring program in widely dispersed areas of the archipelago. CRAMP has instituted monitoring at 31 CRAMP sites throughout the islands including 21 open access area sites, six marine life conservation area sites, one natural area reserve site, and three fisheries management area sites. This integrated research and monitoring program hopefully will provide answers to help decision makers modify state laws governing activities that harm the health of coral reef communities.

Florida's Coral Reefs

About 5,000 miles east of Hawaii in the green-blue waters of the Atlantic Ocean lies a very different coral reef area—the Florida Keys. The Florida Keys extend approximately 220 miles southwest from the tip of the Florida Peninsula. Adjacent to the Florida Keys islands are spectacular, unique, and nationally significant marine environments, including seagrass meadows, mangrove islands, and



Jesse Xiang, Grade 3, NC

extensive living coral reefs. These reefs suffer from slightly different stresses than those in the Hawaii Islands.

Developing a Water Quality Protection Program

The Florida Keys National Marine Sanctuary and Protection Act of 1990 designated over 2,800 square nautical miles of nearshore coastal waters from Miami to the Dry Tortugas as the Florida Keys National Marine Sanctuary. Recognizing the critical role of water quality in maintaining Sanctuary resources, Congress directed EPA and the state of Florida to develop and implement a Water Quality Protection Program for the Sanctuary in cooperation with NOAA. Programs to monitor seagrass habitats, coral reefs and hardbottom communities, and water quality were instituted with the intent of integrating biological information with water quality.

The Water Quality Protection Program was developed in two distinct phases. Phase 1 efforts included assessments of the Sanctuary's water quality, coral community, submerged and emergent aquatic vegetation, nearshore and confined waters, and spills and hazardous materials. Phase 2 focused on developing options for corrective action, developing a water quality monitoring program and associated research/special studies programs, and developing a public education and outreach program.

Florida's Coral Reef Monitoring Program

The primary goal of the monitoring project, which measures the status and trends of Florida's coral reef communities, is to assist managers in understanding, protecting, and restoring the living marine resources of the Florida Keys National Marine Sanctuary.

A Sanctuary-wide, rather than a single-location monitoring program, is necessary to detect ecosystem change in this diverse and species-rich ecosystem.

This 5-year monitoring project is documenting the status of reef habitats at 40 randomly located reef sites located within five of the nine EPA Water Quality Segments in the Florida Keys National Marine Sanctuary. Data for each successive sampling year will be compared with the prior year's data to obtain a broader understanding of the coral reef system in the Sanctuary. As coral reef monitoring is integrated with the seagrass and water quality programs, the results can be used to focus research on determining causality and can be used to inform and evaluate management decisions. This monitoring project provides the first real opportunity in the Florida Keys to address these questions at the spatial scales required to detect large-scale patterns and discriminate between hypotheses.

Ecological Problems Affecting the Sanctuary

The Sanctuary is part of a complex hydrologic/ecological system that includes the Everglades, Florida Bay, and other adjacent areas. The variety and magnitude of recent ecological problems in the Sanctuary and adjacent areas of Florida Bay indicate that existing management actions are not adequate to prevent continuing environmental degradation. The Phase 1 report outlined the following water quality concerns:

■ Major environmental problems are occurring in Florida Bay including seagrass die-off, sponge die-off, mangrove decline, and algal blooms. The Bay is now in a crisis situation. Historic alterations in the quality and timing of freshwater flow from the Everglades are believed to be the major cause.

■ Water quality in confined waters (e.g., dead-end canals and marinas) is deteriorating and this may be affecting biota in nearshore areas.

■ Septic field leachate from onsite sewage disposal systems is degrading water quality in confined waters.

■ Sewage discharge from live-aboard vessels is degrading water quality in nearshore and confined waters.

■ Discharges from sewage treatment plants may be degrading nearshore water quality.

■ Decomposition of weed wrack and other windblown organic debris is probably degrading water quality in some canals.

■ Stormwater runoff is degrading water quality and may be degrading nearshore water quality.

■ Water-temperature fluctuations, increased nutrient levels, reduced transparency, sedimentation, and contamination from oil spills, pesticides, and heavy metals may be affecting Sanctuary coral reef communities.

■ Degraded water quality is probably adversely affecting submerged and emergent aquatic vegetation in the Sanctuary.

Future Monitoring and Research Activities

The Phase 2 report recommended that monitoring and research studies be conducted to collect additional data in key areas. The highest priority monitoring and research needs include

■ Conducting a long-term comprehensive water quality monitoring study

■ Developing models to predict the outcome of in-place and proposed water quality management strategies

■ Determining what quantities of ground water nutrients are reaching Sanctuary waters

- Assessing leachate transport into nearshore waters

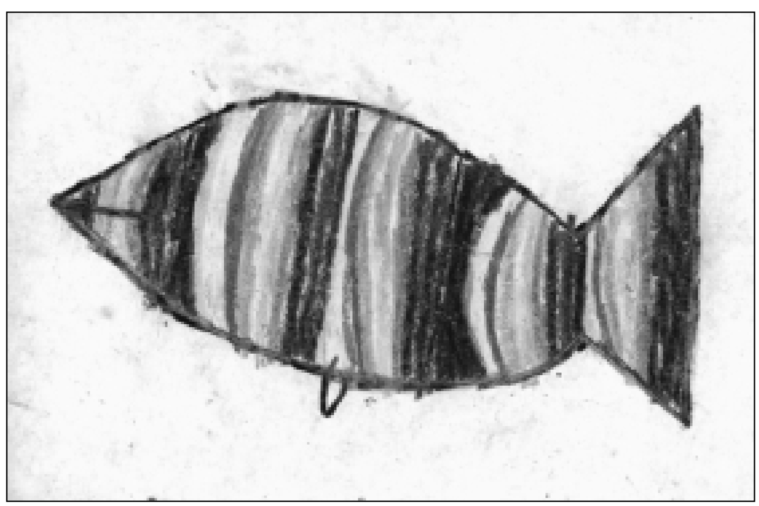
- Conducting research to identify the causal linkages between water quality (e.g., levels of pollutants, nutrients, salinity, temperature) and ecological problems.

American Samoa's Coral Reefs

A study of the coral reefs in the National Park of American Samoa was completed in 1998. The study encompassed reefs on the northern side of Tutuila Island between Fagasa and east of Vatia at Amalua and included reefs situated along exposed coastlines and within sheltered embayments. These reefs represent a moderately diverse, healthy, and resilient assemblage of corals, invertebrates, and fishes. The coral reef and aquatic areas of the National Park of American Samoa offer many opportunities for snorkeling, diving, and aesthetic enjoyment. Humpback whales can be viewed when they visit the island during summer months.

Status of American Samoa's Coral Reefs

In general, the reefs in the National Park of American Samoa appear to be in good condition, probably because of their isolation from most human activities. Recovery from hurricane damage in 1991 was well under way at most sites in the survey, except for Fagasa, which may have experienced increased sedimentation from the construction of a major road in the watershed. There was no evidence of outbreaks of coral-eating seastars or gastropod snails in the reefs. The reef below the old Vatia dump (closed in 1995) shows no obvious signs of degradation from the former dump site with the exception of an unusual yellow film on coral reef rubble under the waterfall below the dump. Additional water quality testing is planned for this site.



Kurt Dalton, Grade 3, NC

A crystal
snowflake
falls down
on the
freezing
white
floor
of
January.

River of Words 1999 Grand Prize Winner (Poetry, Grades K-2)
Martha Bregin, Age 7, MI

River of Words 1999 Grand Prize Winner (Art, Grades 10-12)
Angela Giles, *As it Flows*, Age 18, GA

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One Stressor of Hawaii's Reefs– Tropical Fish Collection

Hawaii is the major supplier of wild-caught marine aquarium fish for the international market. Reported value of all marine animals collected for the aquarium trade is $800,000 to $900,000 annually. The number of commercial permits increased by 39% between 1995 and 1998. Commercial collection conflicts with other uses of reef fish in two ways. First, some of the fish species collected when small for the aquarium trade are also caught when larger by subsistence fishers for food. Second, collectors have depleted territorial species from favored dive sites. Although the direct sale of tropical fish represents a significant economic contribution, dive and snorkel operations gross nearly five times as much in revenue annually just from the sale of dive and snorkel tours. In the past 5 years, the disputes among tropical fish collectors, subsistence fishers, and dive tour operators have intensified.

A study conducted on the Kona Coast of the Big Island of Hawaii found a significant decline in the populations of several species of target aquarium fish. Abundance of yellow tang, kole, longnosed butterflyfish, Potter's angelfish, Achille's tang, and Moorish idols declined 43%, 17%, 54%, 48%, 63%, and 56%, respectively, at the monitored locations.

Rare or solitary species that bring the highest prices in the aquarium trade are also more vulnerable to depletion because these species often have slower recruitment (replacement) rates. Many coral reef fish and invertebrates have complicated relationships to the overall ecology of the reef and their removal often affects the long-term stability of the reef. Tropical fish collection can damage coral reefs in other ways as well:

- Barrier nets used for collecting can entangle on reefs and break off portions of branching corals.
- Collectors often chase agile fish with hand or dip nets and can inadvertently damage fragile coral polyps by kicking the reef with their fins or hitting it with other diving gear.
- Many attractive tropical fish hide in branching corals when chased and some collectors break up the coral colonies to get at the fish.

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While tropical fish collection causes stress to Hawaii's coral reefs, it is by no means the only environmental stress. Other stresses to coral reefs include

- Degradation of water quality by coastal and urban development
- Point and nonpoint sources of pollution from both industry and agriculture, including sedimentation, chemical pollution, and marine debris
- Marine tourism, including snorkeling/scuba diving, reef walking, recreational fishing, recreational boating, and multi-use tour boat activities
- International shipping and oil spills, including ship groundings and sinkings
- Introduction of alien species, including algae and other marine emergent vegetation (mangroves), invertebrates, and fish.

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Harmful Algal Blooms

Harmful algal blooms (HABs) are best known for the problems they cause in coastal ecosystems. Large numbers of marine mammals and seabirds may suddenly die, certain fish species may become hazardous to eat, or people may develop health problems from being near some toxic blooms. Some harmful algae can discolor the water, while other blooms, which may not produce toxins, can cause a loss of oxygen, such as in the "dead zone" of the Gulf of Mexico. Still others may threaten fisheries and human health at very low concentrations that do not discolor the water at all. These microscopic organisms, so small that thousands would fit in a single drop of water, pose an increasingly frequent recurring problem for U.S. coastal communities.

The algae responsible for HABs are a very diverse group of organisms. Many of the organisms are plant-like, both single-celled varieties and large, leafy macroalgae (seaweeds). The most widely known group of algae responsible for many HABs around the world are the dinoflagellates; less common groups include diatoms (*Pseudonitzschia*), some very small flagellates (*Heterosigma*), the brown tide organisms (*Aureococcus and Aureoumbra*), and the bacteria-like blue-green algae (cyanobacteria). While most algae species are not destructive, those species that can cause harm are increasing in bloom frequency, geographic range, and bloom duration.

What Are the Impacts of Harmful Algal Blooms?

If HABs reproduce or accumulate to very high numbers, and then cells begin to die in high numbers, oxygen-poor areas develop as algal cells die and decompose. Low-oxygen waters are poor habitats for coastal fish and shellfish. Additionally, dense accumulations of these algae may cloud the water to such an extent that sunlight is blocked, inhibiting the growth of submerged aquatic grasses. Other harmful algae produce toxins that can kill fish, shellfish, marine mammals, and birds. Severe human health problems are also linked to these toxins such as tumors, nervous system effects, amnesia, and the irritation of respiratory tissues and skin. Some severe cases have resulted in death.

Red tides, caused by the dinoflagellate *Gymnodinium breve*, have caused problems on the Gulf Coast of Florida and on the East Coast since the 1500s. This alga is common in offshore waters and, following transport by ocean currents, has caused blooms from North Carolina to Mexico. The

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toxins produced by these red tides affect the nervous system and blood and can cause mass death in marine animals and respiratory irritation in humans. Blooms in the Gulf Coast of Florida have been blamed for economic losses of about $20 million per event.

Fish kills and human illness in the middle Atlantic states have recently been linked to the dinoflagellate *Pfiesteria piscicida* (Figure 1). Exposure to *Pfiesteria* toxins in the air or water at the site of an outbreak can cause skin irritation as well as short-term memory loss, confusion, and other cognitive impairments in people. However, there is no evidence that illnesses related to *Pfiesteria* are associated with eating fish or shellfish. To date, toxic *Pfiesteria* outbreaks have been associated with brackish, quiet, poorly flushed, warm water; the presence of schooling fish; and nutrient-rich waters that are thought to provide food for nontoxic populations that may transform into toxic blooms.

What Causes Harmful Algal Blooms?

Algae, harmful or otherwise, are natural components of coastal ecosystems. However, the frequency, range, and duration of HABs appears to be increasing. Some experts have attributed the global spread of HABs to introductions by ballast water from ocean-going vessels. When these vessels exchange or off-load their cargo, they frequently empty the ballast water taken on in a foreign port. If the ballast contains living cells or their dormant cysts, the receiving waters are essentially innoculated with harmful algae.

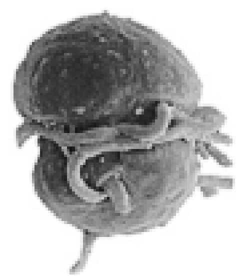

Figure 1. *Pfiesteria* piscicida.

Others have attributed the apparent increase in HAB frequency and duration to land-based sources of nutrient pollution, but nutrients act differently on the various species of harmful algae. For a few HAB species in U.S. inshore waters, such as the fish-killing species *Pfiesteria piscicida* and the amnesia-producing diatom *Pseudo-nitzschia*, there may be a direct link between nutrient loads and the expression of blooms.

Many HAB species are oceanic, such as the red tide species *Gymnodinium breve*. They grow in nutrient impoverished waters in the open ocean and can be transported to the coasts by ocean currents; thus nutrients cannot be implicated as a "cause." However, there is evidence that the growth of the blooms may

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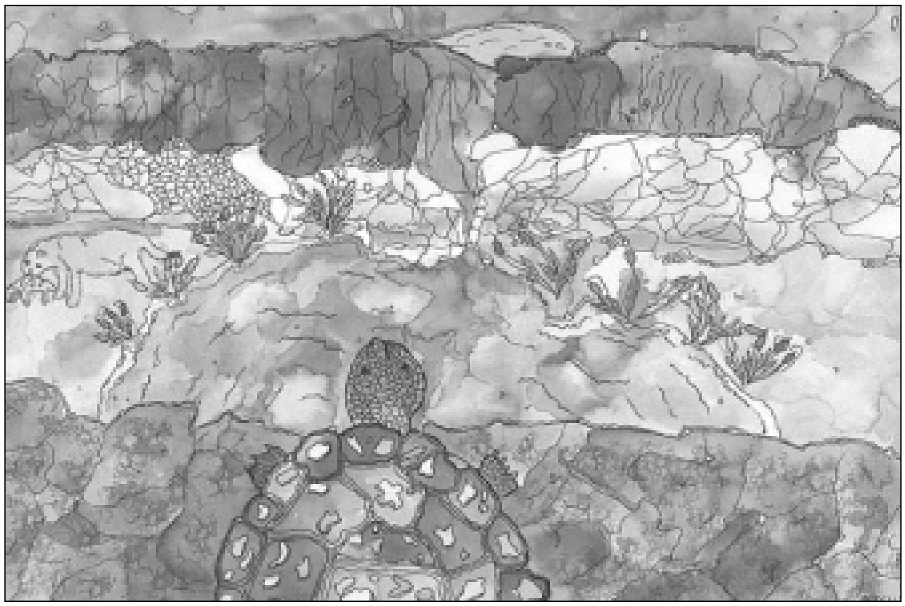
be augmented or perpetuated as a result of encountering coastal waters that have been polluted by nutrients. In other words, when the red tide organisms come into contact with nutrient-rich waters, they become "fertilized," causing rapid growth. Scientists are hypothesizing that the reduction of nutrient pollution should result in less algal growth (including HABs). While this approach will not prevent blooms completely, nutrient reduction strategies should affect the duration and spread of many harmful algal blooms.



River of Words 1999 Finalist, Arielle White, *Untitled*, Age 9, CA

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1998 – The Year of the Ocean

Over half of the world's human population lives within 50 miles of a coastline. We depend on the ocean for many resources, including food, recreation, energy, and climate regulation. Because the ocean is a boundless resource for people the world over, any effective conservation efforts must be multinational in nature.

Realizing that the ocean plays a decisive role in shaping the life of this planet, the United Nations General Assembly passed a resolution declaring 1998 the Year of the Ocean.

The United States kicked off efforts with a Presidential Proclamation declaring 1998 the Year of the Ocean. Subsequently there were two federal workgroups established that identified three main goals:

- Promote awareness and understanding of the value of the sea and its resources
- Ensure the government does all it can to promote exploration, sustainable use, and conservation of the sea
- Cherish our national heritage associated with the sea.

As a result of these workgroups, federal agencies published a series of discussion papers on issues affecting ocean conservation, including transportation; tourism; national security; environmental quality and protection; and marine weather, climate, and hazards. Other activities included hosting workshops (on marine research and education, sustainable coasts, and fisheries and marine living resources management), and encouraging dialogue between industry, academics, government officials, and environmental groups.

These activities set the stage for the National Ocean Conference, which took place June 11-12, 1998, in Monterey, California. At the conference, President Clinton and Vice President Gore launched a series of initiatives to explore, protect, and restore the nation's ocean resources. The President also charged his cabinet to develop recommendations for a coordinated, disciplined, long-term federal oceans policy in a year.
The Oceans: An Agenda for Action

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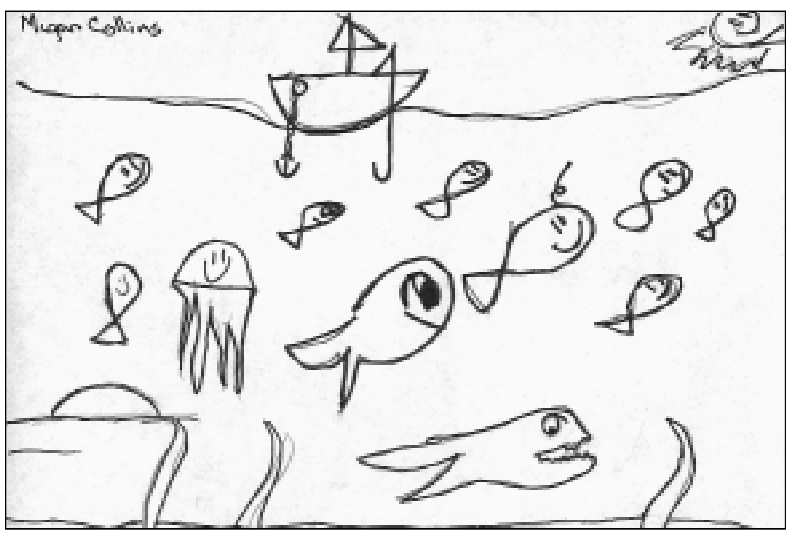
outlines 10 ocean initiatives that the United States shall engage in to protect and enhance the use of ocean resources:

- **Protecting our Oceans from Offshore Oil Drilling** – A 10-year extension of the offshore leasing moratorium; a permanent ban on leasing in national marine sanctuaries.
- **Building Sustainable Fisheries** – A ban on the sale or import of undersized Atlantic swordfish.
- **Ports for the 21st Century** – Funds for dredging shipping channels.
- **Law of the Sea Convention** – The President called on the Senate to ratify U.S. accession to the convention.
- **Protecting Coral Reefs** – Executive order directing federal agencies to expand research, preservation, and restoration activities for the protection of natural corals in the United States.
- **Exploring the Last U.S. Frontier** – Initiatives to increase research and monitoring efforts.
- **Protecting our Beaches and Coastal Waters** – Clean Water Action Plan.
- **Monitoring Climate and Global Warming**.
- **Public Access to Military Data and Technology**.

To learn more about the U.S. involvement in the Year of the Ocean, visit EPA's website at *http://www.epa.gov/OWOW/oceans/yoto/*.



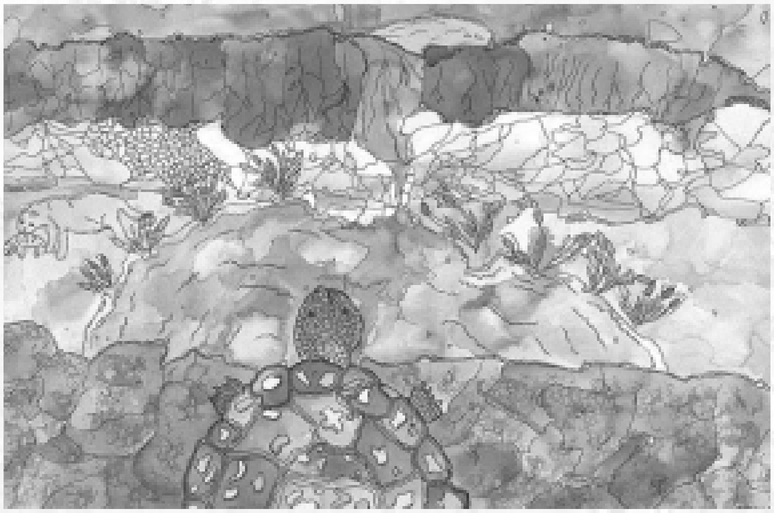
Megan Collins, Grade 3, NC

Obstruction

Winds blowing, rivers flowing,
Birds chirping, animal slurping
From the river, big gulps
Quench their thirst.
The water glistens in the sun.

Twigs breaking, people raking
Leaves falling, dams stalling.
A wall is there, stopping
And holding
The river from flowing and going to its home.

River of Words 1998 Dam Fighter Award
Rachel Prieto, Age 16, MI



Arielle White, Age 9, *Untitled*, CA