

Response To Oil Spills

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INTRODUCTION

RESPONSE TO OIL spills requires the combined efforts of the owner or operator of the facility or vessel that spilled the oil, the federal *On-Scene Coordinator* (OSC), and state and local government officials. The specific steps taken to respond to a spill depend on the type of oil discharged, the location of the discharge, the proximity of the spill to sensitive environments, and other environmental factors.

Oil spills do not occur only in coastal areas. Various types of oils are also spilled in inland areas. Many of the same problems associated with cleanup efforts found in conjunction with coastal spills are created when spills occur in inland areas from sources such as storage tank rupturing, pipeline leaks, and oil transport accidents.

Because they usually occur closer to areas where people live and work, inland spills typically have a more direct impact on human populations than marine and coastal spills do. Inland oil spills are more likely to have negative impacts on drinking water sources, metropolitan areas, recreational waterways, and shoreline industry and facilities. Also, species affected by coastal and inland spills are likely to differ because freshwater and marine ecosystems are different.

There are many sources of oil spills. Vessels are major sources for both coastal and inland spills. Offshore facilities such as oil rigs are also large contributors to coastal spills. Fixed facilities such as gas stations and oil tank farms are responsible for a large percentage of inland releases.

The *Exxon Valdez* oil spill is probably the best known and most widely reported of all spills. Another very large spill, the Ashland oil spill, happened the year before the *Exxon Valdez* spill, when a giant inland storage tank ruptured. Although these events were catastrophic, responders learned a great deal from them. The lessons they learned have helped to prevent more oil spills and to make

response more effective when spills do occur. This chapter describes these spills and the responses to them. It also describes three other spills that highlight a variety of types of oil spills and response activities.

EXXON VALDEZ SPILL

AT TWO YEARS OLD, the oil tanker *Exxon Valdez*, with a capacity of 1.46 million barrels (62 million gallons) of oil, was the newest and largest of Exxon's 19-ship fleet. On the evening of March 23, 1989, 1.26 million barrels of oil (54 million gallons) were loaded onto the ship in Valdez, Alaska. The ship left the port at 9:10 p.m., bound for Long Beach, California.

Chunks of ice from the nearby Columbia Glacier were sitting low in the water, so the ship's captain tried to turn into an empty inbound shipping channel to avoid them. The ship was moving at approximately 12 miles per hour when it struck the rocks of Bligh Reef in Prince William Sound. The underwater rocks tore huge holes in 8 of the vessel's 11 giant cargo holds, releasing a flood of oil into the Sound. More than 11 million gallons of oil spilled within 5 hours of the event. Seven hours after the spill was reported, the resulting oil slick was 1,000 feet wide and 4 miles long.

In addition to the spilled oil, there were other immediate dangers. About 80 percent of the ship's oil cargo remained on board; the ship was resting in an unstable position and was in danger of capsizing. Removing the remaining oil from the ship and cleaning the spilled oil were top priorities.

Since the incident occurred in coastal waters, the U.S. Coast Guard's OSC had authority over all activities relating to the cleanup effort. Once the OSC was notified of the spill, he immediately closed the Port of Valdez to all

traffic. A Coast Guard investigator, along with a representative from the Alaska Department of Environmental Conservation, visited the scene of the incident to assess the damage caused by the spill. By noon on Friday, March 25th, the Alaska *Regional Response Team* was brought together by teleconference. The *National Response Team* was activated soon thereafter. The National Response Team is based in Washington, D.C. It is composed of representatives from 14 different federal agencies, with either the U.S. Environmental Protection Agency (EPA) or the U.S. Coast Guard taking primary responsibility for coordinating oil-spill cleanup activities.

The Alyeska Pipeline Service Company first assumed responsibility for the cleanup. Alyeska operates the trans-Alaska pipeline and the shipping terminal at Valdez. Exxon and the other oil companies that operate in Alaska each own part of the pipeline company. Alyeska is responsible for carrying out plans for oil-spill emergencies in the area. The company opened an emergency communications center in Valdez shortly after the spill was reported and set up a second operations center in Anchorage, Alaska.

The OSC, in cooperation with the Exxon Corporation, established several goals for the response. The most important goal was to prevent additional spilling of oil. Because the *Exxon Valdez* was unstable and in danger of capsizing, the 43 million gallons of oil still onboard the tanker threatened the environmentally sensitive Prince William Sound. The first priority was to protect four fish hatcheries that were threatened by the spill. In addition, there were concerns about the safety of response personnel, since highly flammable and toxic fumes made response actions difficult.

Numerous equipment problems slowed down the response to the spill. Alyeska had booms and other mechanical containment equipment available, but there was not enough equipment to contain an 11 million-gallon spill. Because of the remote location of the spill, equipment had to be moved over great distances to reach the accident scene. The barge that Alyeska's response team normally used had been stripped for repairs and was not immediately available. It took ten hours to prepare and load the barge and another two hours to reach the *Exxon Valdez*.

In addition, the remote location of the incident presented many logistical problems. Because the spill site was located two hours by boat from the port of Valdez, every task was time-consuming. The response had to be staged from mobile platforms, and equipment had to be air-dropped or delivered by boat.

Other problems became apparent as the emergency teams began to arrive to help with the cleanup. Only limited lodging was available in Valdez, a small village of only 4,000 people. The small airstrip at Valdez could not handle large planes carrying the cleanup equipment. These planes

were forced to land in Anchorage, a nine-hour drive from Valdez. The Federal Aviation Administration, the agency responsible for all air traffic control, had to set up a temporary tower to manage increased flights to the area.

At the start of the spill, necessary communications between response personnel were difficult because there was limited phone service in Valdez. The Coast Guard OSC was the only person with a direct telephone line out of the community. The lack of phone lines delayed requests for resources that response teams needed to combat the spill; it took time for the phone company to increase the number of phone lines. Radio communication was also troublesome. The large number of boats working the area led to multiple simultaneous radio transmissions. The mountainous terrain also made radio communication difficult. The Coast Guard established a news office and requested more communications staff because many news reporters and crews were arriving in Valdez every day.

On the second day of the spill, Exxon assumed responsibility for the cleanup and its costs. Exxon activated its emergency center in Houston, Texas, which sent equipment to stabilize the ship. The company directed another ship, the *Exxon Baton Rouge*, to remove the remaining oil from the stricken *Exxon Valdez*. In taking responsibility for the cleanup operations, Exxon set out to address the problems mentioned earlier. The company opened a communications network that allowed information about the spill and the cleanup efforts to be shared with state and federal government officials, private company representatives, and others who were interested in the events surrounding the spill. The company, in cooperation with the Coast Guard, installed four weather stations around Prince William Sound to provide weather forecasts that were critical to planning cleanup efforts. A refueling station for helicopters was set up in Seward, Alaska. More than 274 tons of additional equipment, including *skimmers*, booms, and *dispersants*, arrived at the site by the fourth day.

Maxi-barge hoses down the shoreline.





Wildlife can become heavily oiled.

Hundreds of people were brought to the area to help conduct the cleanup effort within two days of the spill. More than 1,000 Coast Guard personnel, along with employees of the National Oceanic and Atmospheric Administration, the U.S. Fish and Wildlife Service, and EPA helped with the response. Nine additional Coast Guard cutters and eight aircraft were brought to the scene. Specialists from the Hubbs Marine Institute of San Diego, California, set up a facility to clean oil from otters, and the International Bird Research Center of Berkeley, California, established a center to clean and rehabilitate oiled waterfowl.

Three methods were attempted in the effort to clean up the spill: in-situ burning, chemical dispersants, and mechanical cleanup.

A trial burn was conducted during the early stages of the *Exxon Valdez* spill. A fire-resistant boom was placed on tow lines, and the two ends of the boom were each attached to a ship. The two ships, with the boom between them, moved slowly through the main portion of the slick until the boom was full of oil. The ships then towed the boom away from the slick, and the oil was ignited. The fire did not endanger the main slick or the *Exxon Valdez* because of the distance separating them. Because of unfavorable weather conditions, however, no additional burning was attempted in this cleanup effort.

Soon after the spill, dispersants were sprayed from helicopters. Mechanical cleanup was started using booms and skimmers. The use of dispersants proved to be controversial. Alyeska had less than 4,000 gallons of dispersant available at its terminal in Valdez and no application equipment or aircraft. A private company applied dispersants on March 24 with a helicopter and dispersant bucket. Because there was not enough wave action to mix the dispersant with the oil in the water, the Coast Guard representative at the site concluded that the dispersants were not working.

Skimmers, devices that remove oil from the water's surface, were not readily available during the first 24 hours

following the spill. Thick oil and heavy kelp tended to clog the equipment. Repairs to damaged skimmers were time-consuming. Transferring oil from temporary oil storage vessels into more permanent containers was also difficult because of the oil's weight and thickness. Continued bad weather slowed down the recovery efforts.

Efforts to save delicate areas began early in the cleanup. Sensitive environments were identified, defined according to degree of damage, and then ranked for their priority for cleanup. Seal pupping locations and fish hatcheries were given highest priority; special cleaning techniques were approved for these areas. Despite the identification of sensitive areas and the rapid start-up of shoreline cleaning, wildlife rescue was slow. Adequate resources for this task did not reach the accident scene quickly enough. Through direct contact with oil or because of a loss of their food resources, many birds and mammals died.

On June 12, 1992, more than three years after the spill, the Coast Guard announced that the cleanup activities should end. Although the cleanup activities ceased, there were still pools of oil left in some areas. The harm caused to the ecosystem by the oil left in these areas was considered too small to justify the cost of further cleanup.

During the years after the *Exxon Valdez* oil spill, cleanup and environmental restoration of the affected shorelines and islands continues. The cost of the cleanup has amounted to billions of dollars, and the cost of legal settlements has resulted in millions more.

The *Exxon Valdez* incident and the environmental impact caused by the spill attracted the attention of political, scientific, and environmental groups from around the world. The scientific groups include those from Exxon



Workers use pressure hoses to clean the shoreline.

Corporation and EPA that were involved in efforts to use experimental technologies, such as bioremediation, to clean up the spill. The National Oceanic and Atmospheric Administration provided weather forecasts for Prince William Sound. This allowed the cleanup team to know what type of cleanup technology would be compatible with the changing weather conditions in the sound. Some of the groups formed a trustee council. This council is made up of representatives from numerous federal and Alaskan state agencies that deal with environmental issues. This trustee council has been successful in promoting more scientific research on the *Exxon Valdez* incident.

The *Exxon Valdez* incident also prompted the U.S. Congress to pass the *Oil Pollution Act of 1990*. This law required EPA and the Coast Guard to strengthen regulations on oil tank vessels and oil tank owners and operators. As of July 17, 1992, all tank vessels of 20,000 tons or greater are required to carry special equipment that will enable the vessel captain and the vessel traffic center in Valdez to communicate better for safer sailing through that area.

Projects to restore affected areas to their original conditions have been ongoing. A legal settlement has helped to fund restoration efforts. On September 30, 1991, Exxon agreed to pay \$900 million to the U.S. and Alaska governments in 10 annual payments. The agreement requires that the funds be used first to reimburse the federal and state governments for the costs of cleanup, damage assessment, and litigation. The remaining funds are to be used for restoration. The settlement also has a provision allowing the governments to claim up to an additional \$100 million to restore resources that suffered a substantial loss.

The *Exxon Valdez* oil spill caused injury to the environment at virtually all levels. However, the extent and degree of injury was uneven across the oiled landscape. Some species were only slightly affected, for example, the brown bear and Sitka blacktail deer. Other species, like the common murre and the sea otter, suffered population-level injuries, with possible long-term consequences.

The complex issue of determining injury from the *Exxon Valdez* spill is highly controversial and is still being argued in the courts, at scientific meetings, and in scholarly and professional journals. Both the oil that reached the shore and the efforts to clean it up severely impacted intertidal habitats and biota. Seabirds and marine mammals, which are especially vulnerable to floating oil, suffered heavy mortalities. Some of the studies done to determine the damage estimated that between 100,000 and 300,000 birds were killed. Studies also reported that populations of some common murre colonies in the affected area were reduced by one-half. One study estimated a loss of 2,650 sea otters in Prince William Sound. The spill severely impaired south-central Alaska's fisheries, which are the foundation for most of the region's small communities. The spill also had severe social and psychological consequences for the area's human population.

The *Exxon Valdez* Oil Spill Trustee Council concluded that natural resource injuries from exposure to the spill or from the cleanup included the following:

- *Mortality*: Death caused immediately or after a period of time by contact with oil, cleanup activities, reductions in critical food sources caused by the spill, or other causes
- *Sub-lethal effects*: Injuries that affect the health and physical condition of organisms (including eggs and larvae), but do not result in the death of juvenile or adult organisms
- *Degradation of habitat*: Alteration or contamination of flora, fauna, and the physical components of the habitat

The Trustee Council also acknowledged that some environmental damage might persist for generations. Other resources that the Trustee Council listed as injured included archeological sites that may have been oiled or affected by cleanup activities on sensitive sites. Areas designated by the state or federal governments as Wilderness Areas were considered to be injured because the spill damaged the public's perception that these areas were pristine. The Trustee Council also found that services (human uses) were injured by the spill.

Services were considered reduced or lost if the spill caused any of the following:

- Reduced the physical or biological functions performed by natural resources that support services
- Reduced aesthetic and intrinsic values, or other indirect uses provided by natural resources
- Reduced the desire of people to use a natural resource or area

Each year after the incident, the *Exxon Valdez* Oil Spill Trustee Council has funded research and monitoring projects. Information from these projects helps to define the status and condition of resources and services—whether they are recovering, whether restoration activities are successful, and what factors may be constraining recovery. Recovery monitoring projects have tracked the rate and degree of recovery of resources and services injured by the spill. They may also determine when recovery has occurred or detect reversals or problems with recovery. Research projects have provided information needed to restore an injured resource or service or information about *ecosystem* relationships. Results of restoration monitoring studies suggest that affected ecosystems and populations may regain normal species composition, diversity, and functional organization through natural processes.

Exxon's annual payments to the restoration fund end in September 2001. To ensure funding for continued restoration activities, the Trustee Council places a portion of the annual payments into a restoration reserve fund.

ASHLAND OIL SPILL

ON THE AFTERNOON of January 2, 1988, a four million-gallon oil storage tank owned by Ashland Oil Company, Inc., split apart and collapsed at an oil storage facility located in Floreffe, Pennsylvania, near the Monongahela River. The tank split while being filled to capacity for the first time after it had been dismantled and moved from an Ohio location and reassembled at the Floreffe facility. The split released diesel oil over the tank's containment dikes, across a parking lot on an adjacent property, and into an uncapped storm drain that emptied directly into the river. Within minutes, the oil slick moved several miles down river, washing over two dam locks and dispersing throughout the width and depth of the river. The oil was carried by the Monongahela River into the Ohio River, temporarily contaminating drinking water sources for an estimated one million people in Pennsylvania, West Virginia, and Ohio. The Ashland oil spill is the largest inland oil spill in U.S. history. Although it was less than half the size of the *Exxon Valdez* spill, the Ashland spill highlights the direct impact inland spills can have on large populations—in this case, one million people were affected.

The fuel contaminated river ecosystems, killing thousands of animals, such as waterfowl and fish. Two oil impact studies designed by aquatic toxicologists from the Pennsylvania Department of Natural Resources took mussel samples and a census before and after the spill. Pennsylvania and West Virginia authorities conducted shoreline counts to determine the number of fish killed. In the week following the spill, several counts of dead and stressed fish were taken in dam pools along the river. Fish collection surveys conducted by a local contractor in conjunction with state agencies yielded further information regarding ecological effects. Several groups, including the Pennsylvania Game Commission, the Audubon Society, and dozens of volunteers, were involved in capturing oiled waterfowl. This effort had only limited success due to weather conditions; ice and very low temperatures kept rescue workers on shore, hampering the recovery effort. Although many birds were saved, waterfowl mortality estimates ranged from 2,000 to 4,000 ducks, loons, cormorants, and Canada geese, among others.

After local authorities executed the initial on-scene response during the night, EPA took control of cleanup operations. Response personnel from EPA were dispatched to the site immediately following the incident, and an EPA OSC assumed the lead role in the spill response. The OSC was responsible for delegating tasks and responsibilities to the agency best qualified to perform them.

The Incident-Specific Regional Response Team (RRT) was formally activated two days after the incident. The RRT consisted of many environment- and health-related agencies from the federal level, as well as from the states of



Photo courtesy of US EPA Region III

The Ashland storage tank split when filled to capacity.

Pennsylvania, Ohio, and West Virginia. These agencies worked cooperatively to provide advice and guidance to the OSC regarding environmental and response matters as well as political and legal issues.

Contractors employed by Ashland performed the actual cleanup duties. The contractors used booms, vacuum trucks, and other equipment to retrieve the spilled oil, recovering about 20 percent of the oil that flowed into the river.

EPA, in cooperation with other agencies, monitored the cleanup process and river conditions. State personnel set up a river monitoring system to track the spill, as well as a sampling and analysis process to protect water supplies. EPA also performed follow-up activities, such as compliance inspections and a spill prevention control and countermeasures (SPCC) plan inspection of the facility.

Several important lessons were learned from this spill response. The quick notification by Ashland to the local response authorities and the *National Response Center* (NRC) was fundamental to the establishment of the command post on the evening of the spill.



Photo courtesy of US EPA Region III

The Monongahela and Ohio Rivers converge.

Although there was prompt notification, responders concluded that establishment of a central command post sooner would have improved the response coordination. However, communication was enhanced by the positive presence of the media throughout the incident. This was instrumental in keeping the public informed of the cleanup operations. Evaluators of the response recommended that inventories of locally available equipment be prepared so that emergency responders might locate needed equipment quickly. It was also recommended that, to protect public water sources in future emergencies, water suppliers should plan for the availability of contingency water supplies and equipment.

COLONIAL PIPELINE SPILL

ON MARCH 28, 1993, a rupture occurred in an oil pipeline in Fairfax County, Virginia, sending a 100-foot plume of fuel oil into the air. The high-pressure pipeline, owned by the Colonial Pipeline Company, released an estimated 477,436 gallons of No. 2 heating oil into the environment before it could be shut down and fully drained. One of the largest inland oil spills in recent history, the oil affected nine miles of the nearby Sugarland Run Creek as well as the Potomac River.

The Fairfax County Fire Department conducted the initial response to the release, quickly notifying the NRC. The federal response was initiated by the OSC from EPA. Because many organizations were involved in the response, a unified command was established to coordinate the efforts of federal, state, and local authorities, as well as Colonial Pipeline representatives.

The OSC received support in the form of personnel and equipment from other federal agencies, primarily the Coast Guard Atlantic Strike Team. State officials provided technical support and information. The RRT, a group of representatives from a variety of federal agencies, provided valuable advice and guidance regarding recovery actions and policy questions which arose during the incident.

Colonial Pipeline carried out its duties as the responsible party, hiring contractors to perform containment and recovery actions. Under the direction of the OSC, contractors secured the source of the release by shutting down the pipeline. They then attempted to contain the oil flow along the creek through the use of booms, but a sheen had already developed on the Potomac River. As a precaution to protect public health, water intakes along the Potomac River were closed. Recovery of the oil involved use of skimmers, vacuum trucks, sorbents, and a temporary pipeline to direct recovered oil into tanker trucks. Through these actions, response personnel recovered 372,498 gallons of spilled oil.

Throughout the incident, authorities evaluated the oil's actual and potential impact on human health and the environment. The public water intakes along the rivers presented the greatest concern and were promptly shut down. Local drinking water wells were also feared to be contaminated, but sampling proved that they were not affected. The greatest problem for area residents turned out to be fuel odor. EPA received many complaints from citizens about strong odors. These concerns led the National Park Service to the close nearby Great Falls National Park. Forty-one residents were evacuated from their homes as a precautionary measure. EPA monitored air quality to identify and mitigate health risks associated with the oil fumes.

The U.S. Fish and Wildlife Service, the National Oceanic and Atmospheric Administration, and natural resource trustee agencies provided reports on the effects of the spill on fish, wildlife, and other environmental resources; shoreline evaluations; and rehabilitation of affected wildlife. County animal control set up shelters and recovery activities to restore any affected animals. Fish kills did occur in Sugarland Run, although no other serious impacts on area wildlife were reported.

Establishing a unified command was a key to the successful and timely response at the spill. It made the following critical contributions:

- Early and continued support of the Coast Guard Marine Safety Office and National Strike Force
- Coordination with the RRT, leading to rapid assembly of a large support team to assist the OSC
- Provision of a means of input from all levels of government in spill response
- Allowed EPA enforcement of efforts by the responsible party, along with elimination of duplicate efforts in assessment of the affected areas

The response to the Colonial Pipeline spill demonstrates the smooth operation of the National Response System. Federal, state, and local authorities were able to coordinate personnel and equipment in an efficient manner to recover the spilled oil.

Participants identified several areas for improvement. One suggestion was to develop a directory of water intakes in the area in order to better ensure that drinking water sources are not contaminated in the event of an oil release. A second recommendation addressed the need for better communication with personnel downstream from a release. Other technical issues concerned improvements in skimming and dam systems to increase the speed and ease of recovery.

WISCONSIN FIRE AND BUTTER SPILL

NOT ALL OIL spills involve petroleum oil. Animal fats and vegetable oils can also cause great harm to the environment when spilled. The butter spill described below demonstrates that oil spills can come from many different sources and that fires and other accidents can lead to spills.

A fire broke out at the Central Storage and Warehouse Company facility in Madison County, Wisconsin, around 3:30 p.m., May 3, 1991. The facility provided refrigerated storage space for the perishable goods of several food companies. Seventy firefighters responded to the four-alarm blaze, which burned for nearly three days and became the most costly fire in Madison County history. The fire was believed to have been started by the explosion of a forklift battery. Approximately 3,000 nearby residents were evacuated due to the threat of toxic fumes that might have escaped from tanks of anhydrous ammonia and sulfuric acid if the fire had reached them.

The fire destroyed roughly 50 million pounds of food, including nearly 16 million pounds butter. When the fire reached the butter and animal tallow in the warehouse storage facility, it became a hard-to-control grease fire. Melted butter spilled into roadways and ditches, increasing difficulty in fighting the fire and threatening the environment.

Six truckloads of sand were applied to the butter spill in an attempt to absorb it and prevent it from reaching Starkweather Creek. Engineers from the Wisconsin Department of Natural Resources dug a channel from the warehouse to a low-lying area beneath a highway overpass and built hundreds of feet of redirecting dikes to allow the melted butter to flow into the depression and other lagoons. Water that collected in these areas along with the butter was pumped to the city's sewer treatment plant, while congealed material was skimmed from the surface.

Instead of incurring additional costs for disposal, a contractor was hired to attempt to salvage the butter and lard for use in animal feed. Collected material was dumped in a railcar fitted with steam tubes, melted, filtered, processed, and sold.

Very few contaminants were reported to have reached the creek. The area residences are connected to the municipal system's wells, which are deep and securely encased, so the spill did not present a threat to drinking water.

Quick and persistent response action performed by the local fire authorities and the Wisconsin Department of Natural Resources prevented severe environmental damage. It was hypothesized that, had the butter been able to reach the creek, the resulting loss of oxygen in the water would have affected the resident fish species and reversed the effects of a recent \$1 million cleanup effort in the area's watershed.



Photo courtesy of WI DNR

Workers contain spilled butter with booms.



Photo courtesy of WI DNR

Warehouse scene two hours after start of fire.

LAKE LANIER SOYBEAN OIL SPILL

ON SEPTEMBER 26, 1994, north of Atlanta, Georgia, a tanker truck wrecked, releasing approximately 5,000 gallons of low-grade soybean oil. The oil entered a small stream, which allowed it to flow into a man-made impoundment on the Chattahoochee River called Lake Lanier.

Within two hours of the spill, the U.S. Army Corps of Engineers had contained the oil within a one-acre area by deploying a boom across a cove. The federal OSC began removal activities because the responsible party had failed to initiate a response. The oil was corralled to a collection point by boats towing a sorbent boom. Skimmers and vacuum trucks then extracted the oil from the surface of the water. The remaining oil was recovered using sorbent pads and sweeps, bringing the total response time to six days at a cost of nearly \$43,000.

No environmental damage was recorded during response activities. Fish may have been forced to swim from the localized spill area, but no other effects on wildlife were apparent. Effects on the water body itself are unknown.

because no measurements of water quality criteria were made during the cleanup. The OSC decided not to use dispersants because they might have caused the oil to biodegrade very quickly, severely reducing dissolved oxygen levels in the water and damaging the local ecosystem. The primary effects of the spill were realized by property owners who dealt with unpleasant odors and oil coated boats and docks. Several thousand dollars worth of claims for cleaning were incurred; however, the damage would have been much more costly if reaction to the spill had not been as timely.

SUMMARY

OIL SPILLS, especially the *Exxon Valdez* spill, have increased public awareness about the risks involved in the storage and transport of oil. The location of a spill and a lack of necessary equipment often add to response problems. Prevention of spills is the first line of defense, and the oil industry, together with federal agencies, has taken steps to reduce the risks of oil spills. Once a spill occurs, however, improved response coordination between federal, state, and local authorities should produce more rapid and effective cleanup actions and decrease the environmental impact of the discharge. A program to provide better training of emergency response personnel is being prepared, and safety issues are being addressed. Cleaning techniques that are more effective and less labor-intensive are being developed. Studies of the long-term environmental effects of oil spills and their influence on food chains in oceans, freshwater, and on land are now underway. The costs of cleanup activities, ecosystem restoration, and legal settlements of oil spills are so high that the best strategy is to work to prevent discharges.