



The Deepwater Horizon Oil Spill: Coastal Wetland and Wildlife Impacts and Response

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Summary

The explosion of the Deepwater Horizon drilling rig in the Gulf of Mexico on April 20, 2010, and the resulting oil spill began a cascade of effects on the coastal areas of the Gulf and on the wealth of species that inhabit those areas. These wetlands, like those elsewhere, have value for water quality, flood control, shoreline protection, and recreation. They serve as nurseries for many species, including fish and shellfish of commercial significance, waterfowl, and a host of resident and migratory species. They also have cultural importance to the people of the Gulf. The effects of the spill come on top of historic wetland losses due to subsidence, drainage, and saltwater intrusion, along with rising sea levels, coastal erosion, and global climate change.

Impacts of oil spills on wetland ecosystems depend on multiple factors, including the type of oil, exposure of the oil to weathering factors before it reaches the shore, the season in which the spill occurs, etc. Estimating wildlife impacts is particularly difficult in this case because the spill occurred far offshore, and the initial wildlife mortality came far out in the Gulf, where animals sank without reaching the shore. With the arrival of oil closer to the shore, more animals could be counted. Moreover, because the Gulf wetlands host many species of birds during seasonal migrations, impacts of the spill could be felt in areas well away from the Gulf. Mitigation and cleanup of damage to wetlands is far from an exact science and involves many tradeoffs: there is no single, best solution. This report describes a range of options from mechanical recovery and use of dispersants to doing nothing.

Among other issues is a seemingly simple question: who decides what to do? But the answer is complex. The organizational structure for deciding how to respond to oil spills is specified in the National Contingency Plan (NCP), which was created administratively and has been broadened by the Clean Water Act, the Superfund law, and the Oil Pollution Act. Under the NCP structure, the Coast Guard is the lead federal agency for overseeing response and cleanup. Oil has reached more than 10% of Gulf shoreline, but until oil from the well stops flowing, very little cleanup of wetlands is occurring, because of both the ongoing risk of greater harm from cleanup and the potential for re-oiling. As cleanup proceeds, a number of questions arise. To cite only two, what factors will determine cleanup strategies, and how are needs to improve scientific understanding of the spill's impacts being considered?

Decisions about cleanup of wildlife are no easier. Cleanup of individual animals is labor-intensive, and some scientists argue that the survival of an animal that has been cleaned is so uncertain as to call into question whether treatment is, in fact, humane. Rescue groups are dedicated to salvaging those that can still be saved. The effects on a species as a whole vary markedly from one species to another, depending on that species' abundance and ecological needs; appropriate responses at the species level are unclear.

Additionally, the advent of hurricane season poses new risks to areas that may not otherwise be affected directly by the spill. History, particularly from the relatively well-studied *Exxon Valdez* spill of 1989, offers insight into the future of Gulf resources as well. First, some cleanup efforts might do more harm than good in the long run. Second, it is not possible to predict all of the ramifications for the complex Gulf ecosystem in the decades to come, but history suggests that at least some effects will continue for decades. Finally, litigation could play a major role in disseminating—or not disseminating—scientific information about the spill and its effects.

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Introduction

Since the April 20 explosion on the mobile offshore drilling unit Deepwater Horizon in the Gulf of Mexico, public and private efforts have focused on capping, cutting off, containing, and capturing oil. These collective efforts under water and on the surface of the Gulf are intended in large part to keep the oil from reaching coastal marshes and wetlands—what Coast Guard Admiral Thad Allen, the National Incident Commander for responding to the spill, termed the “worst case scenario for us to deal with.”¹ Nevertheless, within days there were reports that oil had reached coastal areas and had begun to affect land and wildlife: on June 22, more than 10% of Gulf coast shoreline miles were oiled, according to the government.²

This report will address the importance of wetlands in general, the ecology of the coastal wetlands in the Gulf, impacts of oil spills on wetland habitats, response options, the implications of hurricane season for the spill’s impacts, and cleanup and recovery issues.³ The emphasis is on the nearshore environment, though a few species found in deeper waters will be mentioned. In addition, some lessons from past spills such as the *Exxon Valdez* in Alaska will be discussed along with issues that may arise in the years after the leak from the deepwater well is capped.

Why Are Wetlands Important?

Wetlands are sometimes referred to as “in-between” areas that consist of both dry uplands and open water environments—they are transition zones that are neither “land” nor “water.” More commonly, wetlands are known as marshes, bogs, and swamps. Because they have both upland and aquatic characteristics, they often have a richer flora and fauna than other environments. In practice, wetlands may be hard to define, but scientists generally agree that the presence of a wetland can be determined by a combination of certain distinctive soils, plants, and hydrology. In different regions, some wetland areas may be continuously inundated by water, while other areas may not be flooded at all, or only at certain times of the year. In coastal areas, flooding may occur daily as tides rise and fall.

Functional values, both ecological and economic, at each wetland depend on its location, size, and relationship to adjacent land and water areas. Many of these values have been recognized only recently. Historically, many federal programs encouraged wetlands to be drained or altered, because they were seen as having little intrinsic value. Today, scientists and policymakers recognize many valuable functions, including flood control and shoreline protection, as well as nurseries and protection for fish, shellfish, and wildlife, as described in the box below.

¹ Admiral Thad Allen press conference call, May 21, 2010, p. 7, http://www.deepwaterhorizonresponse.com/posted/2931/Teleconference_Allen_May_21.562827.pdf.

² Unified Command for the BP Oil Spill, “The Ongoing Administration-Wide Response to the Deepwater BP Oil Spill,” June 22, 2010, <http://www.deepwaterhorizonresponse.com/go/doc/2931/689139/>.

³ This report will not address questions of liability or compensation. These areas are addressed in other CRS reports, including CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur; also see CRS Report R41308, *The 2010 Oil Spill: Criminal Liability Under Wildlife Laws*, by Kristina Alexander.

Functions and Values of Wetlands

Water Quality. Wetlands are efficient water filters, because wetland plants and soils clean water of contaminants before it moves into surface waters or groundwater. Wetlands filter runoff and remove sediment, nutrients, pesticides, metals, and other pollutants.

Flood Buffers and Erosion Control. Wetlands reduce the severity of floods by acting as natural retention areas; consequently, destruction or loss of wetlands makes downstream flooding worse. Similarly, nearshore wetlands act as buffers to reduce shoreline erosion and stabilize land.

Shoreline Protection. Coastal wetlands are particularly important in the Gulf region, because they can help reduce coastal flooding by absorbing the energy, wind, and water from incoming hurricane storm surges. Many of the coastal areas in the Gulf are in flat or low-lying areas, which are particularly vulnerable to tropical storms and hurricanes. It is estimated that for every 3.4 miles of healthy coastal wetlands that a given storm surge must travel over, the height of the surge is diminished by one foot.

Nurseries for Fish and Shellfish. Coastal wetlands serve as important nurseries for numerous fish and shellfish, as many species depend on wetlands for some or all of their life cycle, where they feed, take refuge, or reproduce. Approximately 75% of the nation's commercial fish and shellfish depend on estuaries at some stage in their life cycle, and estuaries depend on the adjacent wetlands to maintain water quality and provide the basis for food chains. About 97% of the commercial fishery landings from the Gulf are species that depend on estuaries for reproduction, nursery areas, food production, migrations, or shelter. Commercial fishing in the Gulf coastal region contributed more than \$680 million to the nation's economy in 2007.

Wildlife Habitat. Coastal wetlands are home to many different animals and, importantly, are stopover or winter habitat for many migrating birds. In the Gulf region, birds that live in wetlands include many species of egrets, shorebirds, ibises, pelicans, herons, and others. Gulf wetlands also are home to many threatened or endangered species such as piping plovers, and several species of sea turtles and sturgeon. Marine mammals are also found in wetlands and along the Gulf coast; species include manatees, three species of whales, and seals. Some of the marine mammals are also protected as endangered or threatened. (See "Coastal Habitat as Home," below.)

Recreation. Many recreational activities depend on wetlands, including fishing, hunting, bird-watching, boating, and wildlife photography. In 2004, tourism and recreation employment in the five Gulf coast states totaled more than 416,000 jobs.

Cultural Importance. Many cultures have been heavily influenced by or rely upon wetlands, such as the Cajun culture in the Gulf. Some Cajuns who live along bayous and wetlands rely upon those wetlands for fishing, hunting, and trapping. Similarly, wetlands are important to several indigenous tribes in the Gulf region. The Seminole tribe of Florida, for example, depends on healthy natural resources of the South Everglades and Big Cypress regions for fishing, hunting, and economic support (conducting tours).

Sources: Gulf Restoration Network, *Wetland Importance*, <http://www.healthygulf.org/our-work/wetlands/wetland-importance>; National Oceanic and Atmospheric Administration, National Marine Fisheries Service, *Wetlands, Fisheries, & Economics in the Gulf of Mexico*, <http://www.nmfs.noaa.gov/habitat/habitatconservation/publications/habitatconnections/num4.htm>; National Ocean Economics Program. *Coastal and Ocean Economic Summaries of the Coastal States, 2009*. <http://www.oceaneconomics.org/NationalReport>. For information on disaster assistance for commercial fisheries in light of the spill, see CRS Report RL34209, *Commercial Fishery Disaster Assistance*, by Harold F. Upton.

Coastal Wetlands and Assets in the Gulf of Mexico

The U.S. portion of the Gulf of Mexico has 1,631 miles of coastline.⁴ There are an estimated 15.6 million acres of wetlands in both saltwater and freshwater habitats in the coastal watersheds of the five U.S. states around the Gulf. (See **Figure 1**, which identifies wetlands in Louisiana, Mississippi, Alabama, and Florida and the federal government's analysis of the oil spill's trajectory forecast as of June 24.) Saltwater habitat wetlands, which occur in tidal areas where saltwater and freshwater mix, total 3.5 million acres and are of three types: estuarine intertidal emergent wetlands (salt and brackish water marshes), estuarine shrub wetlands (mangrove swamps and other salt-tolerant woody species), and estuarine and marine intertidal non-vegetated wetlands (such as sand bars, shoals, and sand spits). Freshwater habitat wetlands total 12.1 million acres and include forested and shrub wetlands, and emergent wetlands.⁵ These types of wetlands generally contain shallow water and are dominated by herbaceous plants. Areas directly adjacent to the Gulf shoreline that are potentially exposed to oil from the Deepwater Horizon spill contain both saline and brackish tidal wetlands and tidal freshwater wetlands.

Environmental Sensitivity Index (ESI) maps prepared by the National Oceanic and Atmospheric Administration (NOAA) provide a concise summary of coastal resources that are at risk if an oil spill occurs nearby. In these maps, areas are scored from 1 to 10, and under this system most Gulf coast wetlands are ranked at 10, the most sensitive or at risk.⁶

Gulf Coast Protected Lands

The Gulf coast is the site of a number of national wildlife refuges, national parks, and national seashores that are home to numerous birds and other wildlife; many of these assets are identified in **Figure 2**. Many are within the current or possible trajectory of the oil spill, according to the Department of the Interior. These at-risk assets include 20 coastal national wildlife refuges (as of late June, four were in the immediate path of oil as it spread to shore: Breton and Delta, both in Louisiana, and Grand Bay and Bon Secour, in Alabama). Also at risk are Gulf Islands National Seashore (Florida and Mississippi) and Padre Islands National Seashore (Texas), Jean Lafitte National Historical Park and Preserve (Louisiana), and at least eight other national park units in all five Gulf coast states.⁷ In addition to federally protected lands, many state parks and public beaches are located along the coasts, as well as a few military bases that offer wildlife habitat. **Figure 2** shows some of the federal and other protected lands that provide important habitat for birds.

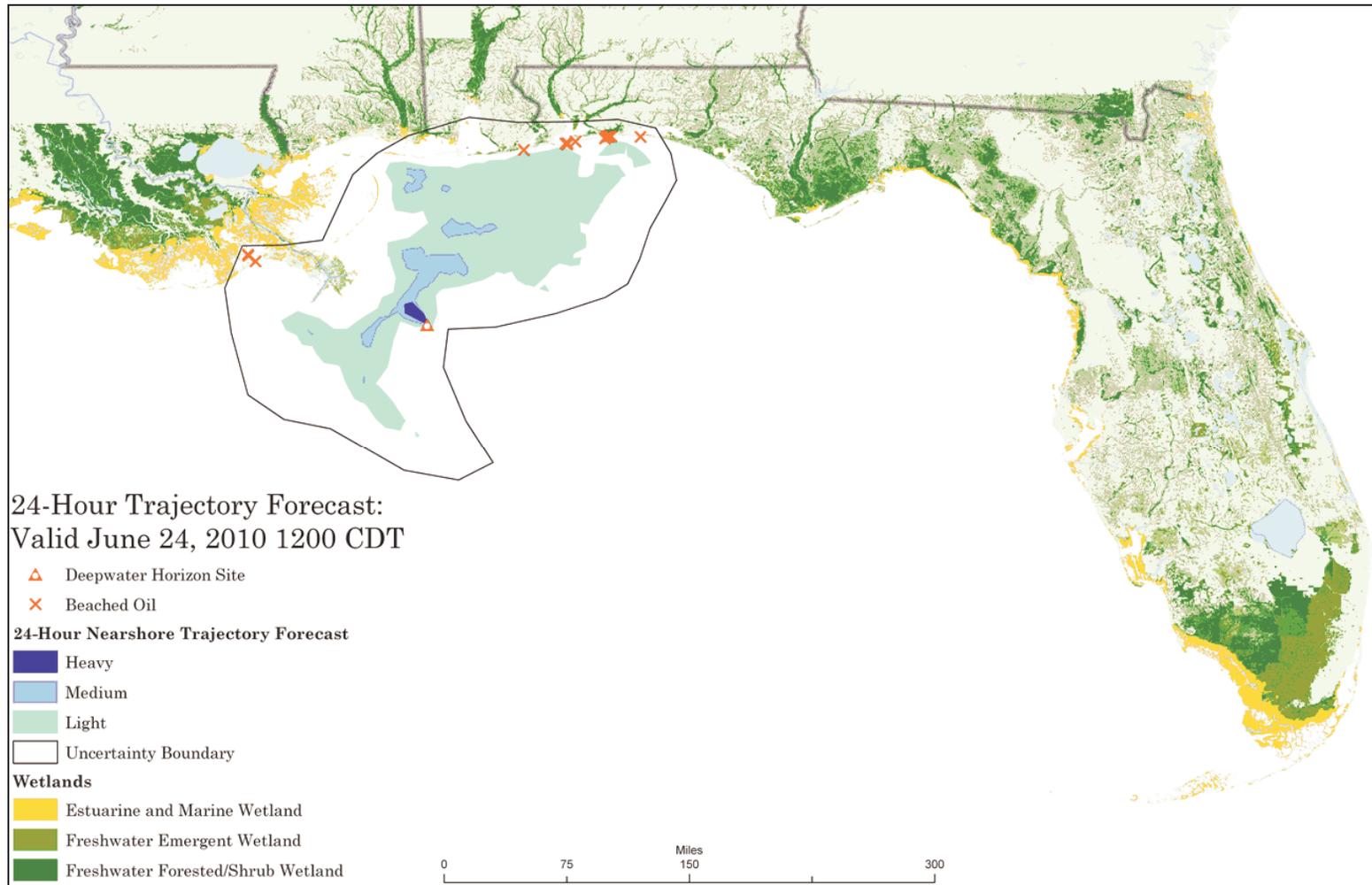
⁴ The Gulf coastline consists of the following: Florida (Gulf portion), 770 miles; Alabama, 53 miles; Mississippi, 44 miles; Louisiana, 397 miles; and Texas, 367 miles. See "Coastline of the United States," <http://www.infoplease.com/ipa/A0001801.html>.

⁵ An emergent wetland is one that has plants, such as cattails and bullrushes, whose roots and part of the stem are below water level with the rest of the plant above water.

⁶ See http://response.restoration.noaa.gov/book_shelf/827_ERD_ESI.pdf.

⁷ U.S. Department of the Interior, "Interior Fact Sheet—BP Deepwater Horizon Response, DOI Gulf Coast Assets," undated, <http://www.doi.gov/deepwaterhorizon/Interior-Fact-Sheet-BP-Deepwater-Horizon-Response.cfm>.

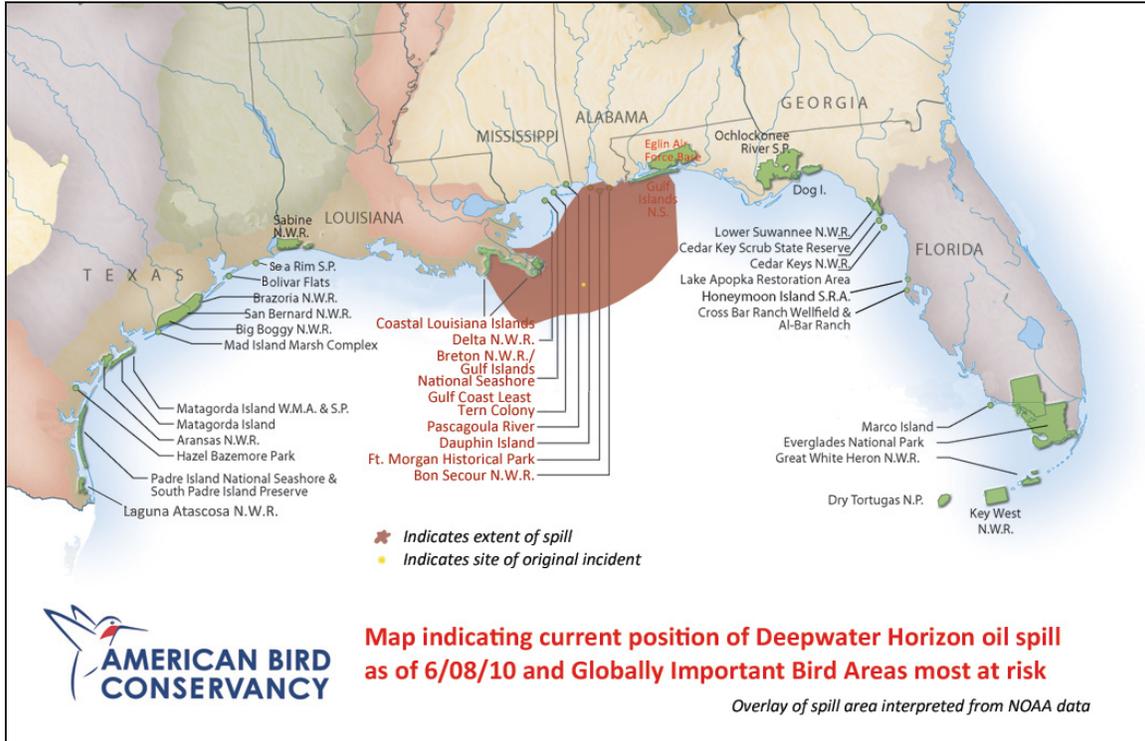
Figure 1. Gulf of Mexico Coastal Wetlands and Gulf Coast 24-Hour Oil Spill Trajectory Forecast



Source: Prepared by CRS based on NOAA Office of Response and Restoration 24-Hour Trajectory Forecast; U.S. Fish and Wildlife Service National Wetlands Inventory; ESRI Data and Maps 9.3.1.

Note: NOAA has temporarily stopped the offshore forecast due to small amounts of oil offshore, the absence of recent observations confirming significant amounts of oil in offshore areas, and the large separation between the loop current complex and the oil slick.

Figure 2. Globally Important Bird Areas in the Gulf of Mexico
(oil spill areas as of date shown)



Source: American Bird Conservancy. Map is updated at irregular intervals. See http://www.abcbirds.org/gulf_spill_map.html.

Historic Loss of Gulf Coast Wetlands

Coastal wetlands are subjected to stressors from land-based activities, including dredging and filling, and from seaward events, such as coastal storms, tidal surges that cause erosion, saltwater intrusion, and inundation. In recent years, Gulf coast wetlands have experienced acreage losses from these multiple stressors. Between 1998 and 2004, coastal wetlands in the five Gulf states declined by an estimated 371,000 acres (2.3% total); although there were small wetlands gains in portions of the region, losses far outweighed the gains. Saltwater wetlands declined overall by nearly 45,000 acres (about 1.2%) during that period, while freshwater wetlands declined by 329,000 acres (2.7%). The changes in wetland acreage were much greater for Gulf coastal wetlands than for coastal wetlands in other regions, such as the Atlantic coast, which experienced a 0.1% overall decline, or the Great Lakes, which had a 0.3% increase between 1998 and 2004. The losses of wetland acreage in the Gulf coast are attributed to a number of factors. Most saltwater wetland losses in the Gulf resulted from inundation or flooding from storms or sea level rise, while losses of freshwater wetlands have resulted from development in rural and urban areas, timber harvesting activities, drainage, and filling for extensive residential and commercial development activities.⁸

⁸ Susan-Marie Stedman and Thomas E. Dahl, *Status and Trends of Wetlands in the Coastal Watersheds of the Eastern United States, 1998 to 2004*, National Oceanic and Atmospheric Administration, National Marine Fisheries Service and U.S. Department of the Interior, Fish and Wildlife Service, 2008.

Wetland Loss in Louisiana

In Louisiana specifically, wetland change and loss have been especially severe for decades, even before the Deepwater Horizon oil spill. Wetlands are vital to many parts of the state's economy, yet they have been converting from land to water more rapidly than elsewhere. Louisiana's wetlands today represent about 40% of the wetlands of the contiguous United States, but about 80% of historic losses. Louisiana lost about 1,900 square miles of coastal lands, primarily marshes, from 1932 to 2000, plus 200 square miles or more from hurricanes in 2005.⁹ While the rate of wetlands loss has decreased, it is estimated that Louisiana loses about 25 square miles (16,000 acres) of wetlands annually, and the state experiences about 90% of the total coastal marsh loss in the continental United States each year.¹⁰

Changes to the state's coastal area result from a combination of natural environmental processes (erosion, saltwater intrusion into fresh systems, sea level rise) and human-related activities, according to the U.S. Geological Survey. Wetland loss has occurred naturally for centuries, but until recently, land losses have been counterbalanced by various natural wetland-building processes.

The seasonal flooding that previously provided sediments critical to the healthy growth of wetlands has been virtually eliminated by construction of massive levees that channel the river for nearly 2,000 kilometers; sediment carried by the river is now discharged far from the coast, thereby depriving wetlands of vital sediment. In addition, throughout the wetlands, an extensive system of dredged canals and flood-control structures, constructed to facilitate hydrocarbon exploration and production as well as commercial and recreational boat traffic, has enabled salt water from the Gulf of Mexico to intrude brackish and freshwater wetlands. Moreover, forced drainage of the wetlands to accommodate development and agriculture also contribute to wetlands deterioration and loss.¹¹

Also important to the entire coastal ecosystem of the Gulf are barrier islands that are a first line of defense acting as a buffer to reduce the effects of ocean waves and currents on estuaries and wetlands. Barrier islands result from the accumulation of sediments deposited at the mouths of rivers such as the Mississippi in Louisiana and the Apalachicola in Florida. Over thousands of years, sediments accumulate as unconsolidated sands and muds and gradually become compact. At the same time, marine coastal processes of erosion and degradation work at the margins of the land, eventually resulting in formation of low-relief islands that are separated from the mainland by shallow bays and lagoons. Plants often get established on barrier islands, especially on the leeward side, and help to provide stability.

But in these low-lying areas, even a moderate wind can raise water levels at the shoreline. Today, barrier islands are eroding as a result of storms, sea level rise, and human development. As they

⁹ Hurricanes Katrina and Rita produced both gains and losses of wetland acreage. As of October 2006, it was estimated that the net effect of the 2005 hurricanes was loss of nearly 217 square miles (139,000 acres) of land just in Louisiana. This estimate was considered preliminary, because some transformations of land to water are permanent, and others are transitory or temporary. Confirmation of permanent losses from the hurricanes' storm surges is unlikely before several growing seasons have passed. John A. Barras, *Land Area Changes in Coastal Louisiana After the 2005 Hurricanes: A Series of Three Maps*, U.S. Geological Survey, Open-File Report 2006-1274, October 2006.

¹⁰ U.S. Geological Survey, National Wetlands Research Center, U.S. Department of the Interior, "Without Restoration, Coastal Land Loss to Continue," May 21, 2003, http://www.nwrc.usgs.gov/releases/pr03_004.htm.

¹¹ U.S. Geological Survey, Marine and Coastal Geology Program, "Louisiana Coastal Wetlands: A Resource At Risk," November 3, 1995, <http://marine.usgs.gov/fact-sheets/LAwetlands/lawetlands.html>.

disintegrate, they expose the system of sheltered onshore wetlands to wave action, saltwater intrusion, storm surge, sediment transport, and contamination by oil that is now circulating in the waters of the Gulf. According to the USGS, the potential exists for water to move across the full width of the islands in locations that are both low and narrow, possibly transporting oil inland into back bays and marshes.¹²

Coastal Habitat as Home

The coastal estuaries, marshes, and beaches of the Gulf also serve as habitat for a wealth of plants and animals.¹³ (Many of the most valuable areas are shown in **Figure 2**.) They are among the most productive of all ecological communities. The plant life consists of plankton, algae, and larger plants, including grasses and some salt-tolerant trees such as bald cypress and tupelo gum trees. Water in such habitats is full of silt, and easily stirred by minor wave action. The turbid waters are full of invisible single-celled algae, and other small photosynthetic microorganisms. These plants in turn feed zooplankton—microscopic animals that are food for fish larvae, juvenile crabs and shrimp, and on up the food chain. The high productivity of coastal wetlands leads to enormous species diversity, with species adapted to their own niches varying in salinity, turbidity, light penetration, wave action, and other factors that may or may not be well understood. Not surprisingly, the rich marshes and, to a lesser extent, beaches of the Gulf provide breeding grounds, nurseries, stopover points, and homes for many species, including many that are threatened, endangered, or economically important.

Breeding Grounds and Nurseries

While many commercial species are caught in deeper water, a tremendous array of fish and shellfish depend on marshes and estuaries of the Gulf for some part of their life cycle: blue crab, shrimp, oyster, menhaden, black and red drum, flounder, striped mullet, and others. Adults of these species generally move into the marshes and estuaries, spawn (after which the spawning adults of some species die, but those of other species return to spawn again in later years), and leave eggs to hatch and develop. These eggs and juveniles serve as food for higher-level predators such as crabs, minnows, gobies, and other small species. In turn, small alligators, herons, egrets, shorebirds, turtles, and other species feed on these animals, particularly in tidal areas where a low tide may concentrate available food resources. The insects of the marshes and estuaries feed—and many feed on—a host of young birds. The smaller birds build nests in the grasses or on floating vegetation or nearby beaches. Other larger species nest in trees, often in huge colonies. The highest levels of biodiversity are typically found in marsh areas, whether freshwater, brackish, or saline. Somewhat lower diversity occurs in open bays of fresh or saltwater, and in mudflats or marginal beaches.

The key feature of coastal ecology is that damage to the coast, and particularly to biologically rich marshes, will have effects on many species that spend the bulk of their life cycles many miles distant on land, and in oceans, lakes, and rivers. Among the most transitory of species are the

¹² U.S. Geological Survey, “Barrier-Island Inundation and Overwash: Application to the Deepwater Horizon Oil Spill,” June 15, 2010, http://www.usgs.gov/deepwater_horizon/scenario/.

¹³ An overview of coastal ecology, particularly in the upper Gulf of Mexico and coastal Louisiana, can be found in Michael J. Mac, Paul A. Opler, and Catherine D. Pucket, et al., *Status and Trends of the Nation’s Biological Resources, Vol. 1*, U.S. Geological Survey, Reston, VA, 1998, pp. 384-430.

migrants that use the coast as a stopover for resting and feeding during their spring or fall migrations.

Stopover Areas for Migrants

Gulf coast refuges are hot spots for bird watchers at all seasons, and especially in the spring migration. Of the Delta and Breton National Wildlife Refuges, which lie at the mouth of the Mississippi River, one author writes:

Some of the most impressive sights are in the spring migration, when great numbers of small birds come in from across the Gulf, sometimes to their first landfall in hundreds of miles, weary and highly visible—rose-breasted and blue grosbeaks, indigo and painted buntings, scarlet and summer tanagers. There are as many as twenty-five warbler species, along with tremendous flights of tree swallows—sometimes sixty thousand, skimming over the inland ponds or just stopping to rest a little while before moving on north.¹⁴

Shorebirds (plovers, gulls, terns) and wading birds (egrets, herons, ibises, bitterns), pelicans, and various species of hawks and other birds are present in the spring and fall in coast marshes. In the winter, waterfowl such as Canada, snow, and blue geese are abundant, along with dozens of species of ducks.

Birds using the coast during migration may summer and breed in any part of the continental United States and Canada. Those that departed the coast before the spill on April 20 will be unaffected for this breeding season, at least until they return. Upon their fall return, they will encounter the spill and its effects just before they begin their journeys across the Gulf to winter homes in the Caribbean or Latin America. In both directions, there are tremendous strains on the energy and stored fats of the migrants; for some, a meal immediately before or after their flight across the Gulf may be critical to reaching their destinations. Consequently, depending on their migration patterns, bird populations as far away as Alaska and northern Canada or central and South America or the Caribbean may be affected by the Gulf spill.

Threatened and Endangered Species

The Gulf coast is home to a wealth of species listed under the Endangered Species Act (ESA).¹⁵ **Table 1** shows the total number of listed animal species in each of the five Gulf coast states, as well as the number of animal species living in that state's coastal or marine environment that could be affected by oil contamination. As the table shows, the bulk of the listed species in each state are not likely to be affected by the spill because their habitats do not occur along the coast. In a few cases, the threat to a species is conjectural, because its habitat may be fairly near the coast, but not likely to become oiled unless storms blow contamination inland. (Note that where species are at risk primarily in the event of major storms, the entry in the table adds them in by showing a range of potentially affected species.)

The list of species that are likely to have direct mortality or indirect effects from loss of food, nesting habitat, and the like includes many fairly well-known species: piping plovers, least terns,

¹⁴ Laura Riley and William Riley, *Guide to the National Wildlife Refuges: How to Get There and What to See and Do* (Garden City, NY: Anchor Press, 1981), p. 238.

¹⁵ 16 U.S.C.A. § 1531.

five species of sea turtles, the American crocodile, three species of whales, manatees, and three species of sturgeon. The list also includes a number of lesser-known species: four species of beach mice, the Stock Island tree snail, the smalltooth sawfish, and others.

In addition to the species currently listed, two species that were once listed but have recovered are also experiencing effects of the spill: the American alligator, as well as the brown pelican, which has become iconic in the current case because it is designated as the Louisiana state bird. The American alligator is found fairly commonly farther inland now, but it may occur in brackish water; risk to the species would be greatest in the event of storms that push oil inland. Even so, many alligators are so far inland that a severe hurricane would likely push oil products into only a portion of their current range.

Pelicans, on the other hand, are found almost exclusively in marine and coastal environments. Because pelicans nest in great rookeries, returning birds can contaminate their own nests as well as those of other birds. Eggs of any species that have been fouled are nearly certain to die, even with minor contamination. Chicks may be abandoned when parent birds die or become too debilitated to feed their young. Fish fed to the young may be contaminated and have uncertain effects on the birds' development.

Table 1. Endangered and Threatened Animal Species in the Gulf of Mexico
(coastal species in habitats that may become oiled)

State	Total Endangered Animal Species	Endangered Animals: Possibly Oiled Habitat	Total Threatened Animal Species	Threatened Animals: Possibly Oiled Habitat
Texas	49	8	9	3
Louisiana	10	8	8	4-5
Mississippi	20	10	11	4
Alabama	58	10-11	21	4
Florida	35	23-24	19	9-10

Source: Compiled by CRS from FWS Endangered Species Program Data, Species Profiles. Available at <http://www.fws.gov/Endangered/>.

Notes: All listed coastal and marine species in a state are considered as being in potentially oiled habitat, except certain species occurring only on the east coast of Florida. A range of figures indicates that the exact location of the some coastal species is not known, or that effects on the listed species might depend on the occurrence of severe storms washing contaminated oil well into coastal marshlands. Columns cannot be added, since many coastal species occur in multiple states. An FWS website list shows fewer animals, but omits species under the jurisdiction of NMFS; see <http://www.fws.gov/home/dhoilspill/pdfs/FedListedBirdsGulf.pdf>.

Oil Spills: Impacts on Wetland Habitats and Animals

Habitats such as salt marshes and mangrove forests and the biota that reside in them are subject to destruction or alteration by oiling events.¹⁶ The degrees of impacts of oil on wetland vegetation

¹⁶ National Research Council of the National Academies, *Oil in the Sea III, Inputs, Fates, and Effects* (Washington, (continued...))

are variable and complex and can be both acute and chronic, ranging from short-term disruption of plant functioning to mortality. The primary acute damage to the marshes is that plants, which hold the soil in place and stabilize shoreline, will suffocate and die, especially if multiple coatings of oil occur. Once vegetation dies, the soil collapses. Then the soil becomes flooded, and plants cannot re-grow. If plants cannot re-establish, soil erosion is accelerated, giving rise to even more flooding and further wetland loss. If oil penetrates into the sediments, roots are continuously exposed to oil, with chronic toxicity making production of new shoots problematic. Consequently, plant recovery is diminished, and eventually land loss occurs. In addition to direct impacts on plants, oil that reaches wetlands also affects animals that utilize wetlands during their life cycle, especially benthic organisms that reside in the sediments and are a foundation of the food chain.¹⁷

In the Gulf, coastal saltwater wetlands and tidal freshwater wetlands are sensitive to oil, both immediately and in the long term. The severity of immediate and longer-term impacts and damages depend on a number of factors, including—

- the type and quantity of oil spilled (low-sulfur light crude such as that associated with the Deepwater Horizon is considered less toxic than denser heavy crude or refined fuel oils involved in other spills, and the quantity of oil from the current spill is believed to be the largest that has ever occurred in U.S. waters);
- the condition of the oil on and below the surface, including the length of time it is in the water before it hits land (oil weathers over time, through the natural actions of evaporation, photodegradation, and microbial degradation, which all reduce acute toxicity);
- season and prevailing weather (both the natural degradation processes and ecosystem recovery occur more rapidly in warmer climates than colder regions, but a spill that occurs during the growing season of plants will have more severe impact than one in the fall or winter when plants are dormant);
- type of shoreline and composition of vegetation (wetlands and similar fragile environments are more at risk and more difficult to clean than harder surfaces such as sandy beaches);
- type of waves and tidal energy in the area of the spill (wave energy is necessary to help move oil away from land and to enhance the effects of chemical dispersants); and
- presence of dispersants (chemical dispersants are used to enhance breakdown of the oil, but the long-term ecosystem effects of chemically dispersed oil and the dispersants themselves are uncertain).¹⁸

(...continued)

D.C.: The National Academies Press, 2005), p. 157.

¹⁷ Dennis F. Whigham, Stephen W. Broome, and Curtis J. Richardson, et al., Statement of the Environmental Concerns Committee, Society of Wetland Scientists, “The Deepwater Horizon Disaster and Wetlands,” http://www.sws.org/docs/SWS_OilEffectsOnWetlands.pdf.

¹⁸ Testimony of Jane Lyder, Deputy Assistant Secretary for Fish and Wildlife and Parks, Department of the Interior, before the House Natural Resources Subcommittee on Insular Affairs, Oceans and Wildlife, June 10, 2010.

Estimating Mortality

The effects on wetland habitats lead directly to effects on the animals and plants in those habitats. The federal government has the lead in managing some categories of species, while states take the lead in the rest. Comprehensive data are more readily available for the former, which are called federal “trust species.” The trust species consist of birds, marine mammals, and threatened and endangered species. The principal federal agencies involved in managing these species are the Fish and Wildlife Service (FWS, Department of the Interior) and the National Marine Fisheries Service (NMFS, Department of Commerce).

Birds

Oil contamination of birds can have acute effects. If contamination of its feathers is severe, the bird loses the feathers’ insulation properties and dies of hypothermia even in seemingly warm weather.

Birds are primarily affected through thermoregulatory challenges caused by oiling of plumage and through ingestion. Oil reduces the ability of bird feathers to provide insulation, which increases their risk of hypothermia. Rate of heat loss is much higher in the water than in air, so oiled plumage is particularly problematic for birds that must find food in the water, such as seabirds, cormorants, and grebes. Oil is most commonly ingested by birds while preening their contaminated feathers or while feeding on contaminated prey.¹⁹

The President of the American Bird Conservancy stated that “rescue groups are prepared to do everything humanly possible to capture and save as many oiled birds as they can find, but there are problems well beyond our abilities to mitigate or even count. In addition to the potential catastrophic losses to shorebirds that we know to be at risk on their breeding grounds and in the wetlands around the Gulf, the oil spill poses a serious threat to seabirds.”²⁰

The coating of feathers also results in loss of buoyancy, and, if severe, can cause the bird to drown and then sink. It is this phenomenon that makes an accurate estimate of bird deaths extremely difficult, and tends to make recovery counts of carcasses or of surviving but oiled birds a marked undercount of actual deaths, particularly for species that forage farther offshore. According to the Exxon Valdez Oil Spill Trustee Council, after the 1989 Alaska spill, the number of recovered carcasses of birds was only a fraction of the estimated deaths:

The carcasses of more than 35,000 birds and 1,000 sea otters were found after the spill, but since most carcasses sink, this is considered to be a small fraction of the actual death toll. The best estimates are: 250,000 seabirds, 2,800 sea otters, 300 harbor seals, 250 bald eagles, up to 22 killer whales, and billions of salmon and herring eggs.²¹

The number of live but contaminated birds found in the Gulf as of June 18, 2010, was 665, along with 885 carcasses, for a total of 1,550.²² The carcasses are stored, and will be used as evidence in

¹⁹ Holly K. Ober, *Effects of Oil Spills on Marine and Coastal Wildlife*, Dept. of Wildlife Ecology and Conservation, Univ. of Florida, 2010, <http://www.wec.ufl.edu/Effects%20of%20oil%20spills%20on%20wildlife.pdf>.

²⁰ See <http://www.abcbirds.org/newsandreports/releases/100504.html>.

²¹ See <http://www.evostc.state.ak.us/facts/qanda.cfm>.

²² See FWS Consolidated Fish and Wildlife Collection Report at http://www.fws.gov/home/dhoilspill/pdfs/collection_06182010.pdf.

litigation concerning damage to natural resources. If no more carcasses were found, and if the same ratio were to apply to the BP spill as in the *Exxon Valdez* spill, then about 6,300 bird deaths would be expected.²³ However, not only does this calculation assume (improbably) that no more carcasses will be found, but also that the diligence and thoroughness in collecting carcasses in the Gulf is similar to the diligence and thoroughness in Prince William Sound.

Marine Mammals

Marine mammals inhabiting the Gulf include manatees, several species of whales, dolphins, and seals. These species do not have significant hair that can become oiled, but rely on a layer of fatty tissue for warmth. However, contact with oil can cause skin irritations, perhaps leading to infections. A more significant threat is inhalation of fumes when they surface to breathe. Moreover, their prey may be contaminated with hydrocarbons, or the prey populations may be reduced or absent. Some of the Gulf's whales feed by sifting large amounts of water through plates called baleen. These plates may become clogged with oil.²⁴ As of June 18, 2010, there were 3 marine mammals collected alive, and 44 dead; of the carcasses collected, 35 did not have visible oil, and a necropsy will be needed to determine the cause of death.²⁵ While marine mammals may be physically capable of avoiding oil slicks, according to the National Oceanic and Atmospheric Agency, "[r]esearch on dolphins in human care has shown that the animals avoid oil on the surface of the water, however observations of wild dolphins have documented the animals swimming in, feeding in and socializing in oiled water during previous oil spills in the Gulf of Mexico."²⁶ Where a spill covers a very large area and volume of water as it does in the Gulf, the animal may have to avoid much of its previous range.

Endangered Species

Threatened and endangered species living in the wetlands and coastal areas face varying degrees of risk. Moreover, the threats to a given individual may be different from those to a species: a breeding bird that is unable to find sufficient food to feed its young may abandon its attempt to breed for the year, but can survive itself. The young will die without the care of the parent bird. Or the eggs may become oiled, fail to hatch, and be abandoned. In either case, if abandonment is widespread, the damage to the species could be severe even if all adult birds were to survive.

Weather and Storms

The effectiveness of offshore measures in capturing or breaking up oil in open waters of the Gulf in part determines whether oil reaches coastal areas. One factor that can influence the success of

²³ Data on bird deaths from oil spills are scarce. The ratio of carcasses to actual deaths could be higher or lower than those in Prince William Sound.

²⁴ Holly K. Ober, *Effects of Oil Spills on Marine and Coastal Wildlife*, Dept. of Wildlife Ecology and Conservation, Univ. of Florida, 2010, <http://www.wec.ufl.edu/Effects%20of%20oil%20spills%20on%20wildlife.pdf>.

²⁵ Katy Reckdahl, "When Animal Rescues Fall Short, Evidence of Oil Spill's Toll on Wildlife Is Collected," *New Orleans Times-Picayune*, June 12, 2010, http://www.nola.com/news/gulf-oil-spill/index.ssf/2010/06/when_animal_rescues_fall_short.html.

²⁶ See http://gulfseagrant.tamu.edu/oilspill/facts_impacts.htm.

such measures is storms and weather events, since high winds and strong tides can push oil further inland from shoreline areas.

On May 27, the National Hurricane Center (NHC) issued its outlook for 2010 hurricanes in the Atlantic Ocean and Gulf of Mexico, beginning on June 1, predicting an “active to extremely active” season.²⁷ If hurricanes occur while large amounts of oil are present in Gulf waters and at shorelines, several concerns emerge. First, barrier islands that normally protect coastal wetlands from oil may be overtopped or destroyed by winds and water. Second, heavy winds and storm surges could push oil further inland into areas that would not normally become oiled. Third, even after oil stops flowing from the Deepwater Horizon site, hurricane-strength winds could stir up oil that has penetrated sediments, thus releasing oil and causing renewed impacts on plants and wildlife.

According to the NHC, the presence of oil is not expected to affect either the intensity or the track of a fully developed tropical storm or hurricane appreciably, and an oil slick would have little effect on a hurricane, a storm surge, or nearshore wave heights. In addition, high winds and seas are expected to mix and weather the oil, which can help accelerate biodegradation processes and disperse the oil further. Movement of oil would depend greatly on the track, wind speed, and size of a hurricane, and other factors in the evolution of the storm.²⁸

Mitigation and Cleanup of Wetlands

Much of the ongoing response effort in the Gulf is focused on capturing, or otherwise addressing, oil in open waters or setting barriers to deflect it from reaching land. Protective booms placed offshore are intended to prevent oil from reaching shore. Another defense measure, a project to build sand berms to provide additional physical protection for Louisiana’s barrier islands, is being constructed, despite controversies about the effectiveness of the approach.²⁹ But, inevitably, some oil escapes capture and is pushed by wind and tides toward land. Wetland plants can be affected both by oil that floats over the surface of the marsh and by oil that has been incorporated into sediment. There are several possible approaches to cleaning up oil that reaches coastal wetlands and competing theories of different approaches in different places. Moreover, experts acknowledge tradeoffs for each approach. Each has limitations—some of which are serious—and none is effective in all cases. As Coast Guard Admiral Thad Allen said, “The problem is, the hardest place to pick up oil is in a marsh or a wetland.”³⁰ There is no silver bullet and no single best solution, and often the response can be more destructive than the spill itself. Some studies even suggest that a certain level of oil in the soil of wetlands may stimulate plant growth, although the mechanisms by which this occurs are not clearly understood.³¹

²⁷ See http://www.noaa.gov/stories2010/20100527_hurricaneoutlook.html.

²⁸ National Oceanic and Atmospheric Administration, U.S. Department of Commerce, “NOAA’s Oil Spill Response, Hurricanes and the Oil Spill,” May 27, 2010, http://www.nhc.noaa.gov/pdf/hurricanes_oil_factsheet.pdf.

²⁹ For discussion of the Louisiana protective berm project, see CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur.

³⁰ Admiral Thad Allen Press Conference, June 5, 2010, <http://www.deepwaterhorizonresponse.com/go/doc/2931/620563/>.

³¹ Qianxin Lin, Irving A. Mendelssohn, and Charles B. Henry, Jr., et al., “Effect of Oil Cleanup Methods on Ecological Recovery and Oil Degradation of *Phragmites* Marshes,” 1999 *International Oil Spill Conference, Paper ID #250*, 1999, <http://www.iosc.org/papers/00598.pdf>.

Mechanical Recovery

Mechanical removal techniques are often used first, once oil reaches land. It is possible in some cases to physically remove oil by hand, with shovels or rakes, vacuums, or other equipment, or to skim and mop it with absorbent materials. However, these methods are difficult, and their effectiveness is highly variable. This technique works best on sandy beaches or rocky shores but is difficult in marshy areas, because damage from heavy equipment and human trampling of sensitive plants and soils can equal or exceed damage from the oil. Recovery of wetland vegetation from the mechanical cleanup can take considerable time. Further, oil sitting on the surface of shallow waters can get pushed into soft ground where, in the absence of oxygen, it contaminates sediments or biodegrades very slowly.

Flushing

In some cases low-pressure flushing can be used to push oil into areas where it can be vacuumed up or absorbed. Seawater is pumped through the marsh to dilute the oil that sticks to grasses, thus enhancing tidal movement to promote natural recovery. High-pressure spraying can be effective (it was used to clean the rocky shore of Prince William Sound in Alaska, though with some negative effects on shoreline invertebrates), but the Gulf coastal wetland environment is very different from that in Alaska, and high-pressure spraying likely would erode soils and destroy wetland vegetation. Even low-pressure spraying only works when oil is floating on the surface.

Applying Chemical Dispersants

A related technique is to spray dispersants—a mixture of surfactants, solvents, and other chemicals—onto the oil. Like dish soap, dispersants break the oil into smaller droplets that fall from the surface into the water column, where microbes degrade them or currents move them away. This technique is primarily used in open waters: chemical dispersants are being used in the Gulf spill to break up oil before it reaches shorelines. However, there is some evidence that when dispersants are added to water during flushing of marsh vegetation, oil removal is slightly enhanced.³²

But there are many questions about environmental effects of chemically dispersed oil and the dispersants themselves in wetlands. Many scientists contend that adding dispersants enhances removal and that on balance the use of dispersants is less harmful than letting oil get into marshes. However, other scientists are concerned about harmful effects of dispersants on aquatic plant and animal life in both open waters and coastal areas. If dispersants are used, there are environmental tradeoffs: (1) greater concentrations of chemically dispersed oil in the water column, (2) a potential reduction in persistent stranded oil, and (3) unknowns in terms of long-term toxicity.³³ Long-term effects of applying dispersants to oil in coastal wetlands are not well known, because research has focused more on acute toxicity than chronic effects. If dispersant chemicals penetrate sediments, the toxic effects might be long-lasting, some say.

³² National Research Council of the National Academies, *Oil in the Sea III, Inputs, Fates, and Effects* (Washington, D.C.: The National Academies Press, 2005), p. 144.

³³ Testimony of Aaron Viles, Gulf Restoration Network, before the House Natural Resources Subcommittee on Insular Affairs, Oceans and Wildlife, June 10, 2010.

Burning

Burning is considered one of the most effective techniques for responding to spilled oil. It was used successfully to clean up several oil spills following Hurricane Katrina, and, when wind conditions permit, it is being used now *in situ* in the Gulf to prevent oil from reaching shore. But there are limits to how and when burning can be used. For example, marshes with low water levels cannot be burned without killing the plant roots (research has shown that the presence of even just a few inches of water above the roots can protect plants, when burning is used). Burning plants at the coastline may kill plants and result in further coastal erosion. It can be difficult to control the burn and confine it to small areas, thus threatening other plant material not affected by oil. Burning removes oil's more toxic components, such as volatile aromatic compounds, but it does not destroy stickier, heavier (high molecular weight) compounds that can sink into wetland soil. There is evidence that the concentration of oil in sediments is greater in areas that have been burned than in unburned areas.³⁴

Also, oil that is weathered, or degraded (that is, petroleum that has been on the surface and exposed to air for several days), does not burn well, because flammable hydrocarbons have volatilized. That is likely to be the case with oil reaching the coast from the Deepwater Horizon spill, as it may take more than a week for tides and winds to move oil from the rig site to shore.

Cutting Back Vegetation

In small heavily oiled areas, vegetation can be cut back to leave plants intact and prevent oiling of birds that come in contact with the vegetation. This technique is moderately effective at cleaning up oil, but it does not work well in large areas, such as those likely to be affected by the Deepwater Horizon spill. One of the risks is physical damage from human contact and trampling. Some experts believe that areas where grasses are cut take much longer to recover than oiled areas that are not cut.

Bioremediation

Biodegradation is the process in which oil molecules are broken down by bacteria, which occurs naturally. However, to make oil biodegrade faster, bioremediation agents or techniques are sometimes applied. Bioremediation involves either introducing nutrients in the form of fertilizer into the marsh (i.e., biostimulation) or adding bacterial microbes designed to be especially effective at degrading oil (i.e., bioaugmentation). EPA has made information available about dispersants and bioremediation agents that are authorized for use on oil discharges in the United States.³⁵

This technique can be effective in some places, but where it has been used on spills in wetland areas, results have been mixed. Experts believe that it probably has limited potential in coastal marshes such as those in Louisiana, because oxygen levels in wetland soils often are so low that microbe activity is limited, whether nourishment is added or not. That is, oxygen is the factor

³⁴ National Research Council of the National Academies, *Oil in the Sea III, Inputs, Fates, and Effects* (Washington, D.C.: The National Academies Press, 2005), p. 144.

³⁵ U.S. Environmental Protection Agency, "National Contingency Plan Product Schedule," http://www.epa.gov/emergencies/content/ncp/product_schedule.htm.

limiting degradation of oil, not nutrients, and there are no proven methods of adding oxygen to muddy, water-saturated marsh soils. It is likely to be more effective in wetlands on a higher elevation than coastal Louisiana, or areas that are infrequently flooded, because more oxygen is present. Bioremediation is not usually considered as a first response but is more often a secondary treatment after removal of bulk oil.

Nutrient addition may enhance the growth and productivity of dominant plant species within an oiled area, but it also may reduce species diversity or composition among remaining wetland plants. It may even be toxic to some organisms. Bioremediation in combination with detergents was used during cleanup of the *Exxon Valdez* spill. In that instance, treated areas were significantly cleaner after the first year, but scientists later determined that the addition of large amounts of fertilizer or nutrients disturbed the ecological balance of the overall system, thus altering the course of long-term recovery.³⁶

Doing Nothing

It may seem counterintuitive, but many scientists believe that doing nothing is sometimes the best option, contending that aggressive cleanup or remediation can have serious harmful effects and may delay the eventual recovery that might naturally occur. According to the National Research Council, there is no consensus on whether it is better to immediately clean up an oiled area that may then take many years to re-establish, or leave it alone to weather naturally and risk uncertain effects over long periods. In many instances, cleanup techniques delay recovery time, due to physical disruption of roots, flushing of soils, lowering the soil surface below levels where aquatic vegetation can re-establish, and activities that mix oil deeper into wetland and marsh soils.³⁷

On the other hand, if oil is allowed to persist around plants, it kills the existing vegetation and can prevent new shoots from growing when they contact floating oil, which could lead to more wetland erosion. By deciding to do nothing, there are essentially no direct environmental side effects, and it may still be possible to explore alternatives later. But several considerations do apply: when the oil is especially heavy (although that is not the case in the Gulf spill), or if tides are insufficient to move the oil, unassisted or natural recovery may not be completely effective. Also, doing nothing may be more appropriate for a one-time event (such as the *Exxon Valdez* incident) than for a spill in which oil continues to flow and vegetation is re-oiled over many months, as is likely to be the case with the Deepwater Horizon spill. Further, because effectiveness may not be known for months or years, it can be difficult to persuade the public that doing nothing is best.

³⁶ *ScienceDaily*, "Caution Required for Gulf Oil Spill Clean-Up, Bioremediation Expert Says," May 4, 2010, <http://www.sciencedaily.com/releases/2010/05/100504142110.htm>.

³⁷ National Research Council of the National Academies, *Oil in the Sea III, Inputs, Fates, and Effects* (Washington, D.C.: The National Academies Press, 2005), pp. 142, 145.

Oil Spill Response: Who Decides What to Do?³⁸

Several options, including technologies, exist for responding to oil that reaches coastal wetlands, but all have apparent advantages and disadvantages, as previously described. Now that oil has moved from the open Gulf waters to shoreline areas, decisions about how to actually respond will be made within the overall complex organizational structure that exists in the United States for responding to oil spills.

The federal government's oil spill response framework is found in the National Contingency Plan, which contains the government's procedures for responding to oil spills and hazardous substance releases. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) was established administratively in 1968, after U.S. policymakers observed the response to a 37-million-gallon oil tanker spill (Torrey Canyon) off the coast of England and saw the need for a coordinated approach to cope with potential spills in U.S. waters.³⁹ Subsequent laws have broadened the NCP, including the Clean Water Act in 1972 (33 U.S.C. 1251 et seq.); the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA or Superfund, 42 U.S.C. 9601 et seq.) in 1980; and the Oil Pollution Act (OPA, 33 U.S.C. 2701 note) in 1990.

The NCP establishes the National Response System (NRS), which is intended to be a multitiered and coordinated national response strategy. Key components of the NRS include:

- a National Response Team (NRT), composed of representatives from the 15 federal departments and agencies assigned roles in responding to oil spills.⁴⁰ The U.S. Coast Guard chairs the NRT when a response is being mounted to a spill in a coastal region.
- Regional Response Teams (RRTs), composed of regional representatives of each NRT member agency, state governments, and local governments. The Coast Guard leads the relevant RRT during responses to oil spills in coastal waters.
- Area Committees (ACs), composed of qualified personnel from federal, state, and local agencies. The primary function of each AC is to prepare an Area Contingency Plan (ACP) for its designated area.
- an On-Scene Coordinator (OSC), who directs the response efforts and coordinates all other efforts at the scene. In general, in coastal areas Coast Guard Captains of the Port serve as OSCs for their particular area.⁴¹

The NCP provisions specific to oil spill response are found in 40 CFR Part 300, Subpart D. As the primary response authority in coastal waters, the Coast Guard OSC has the ultimate authority to ensure that an oil spill is effectively removed and actions are taken to prevent further discharge from the source. The OSC is broadly empowered to direct and coordinate all response and

³⁸ The following section of this report is based in part on CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur.

³⁹ See EPA "National Contingency Plan Overview" at <http://www.epa.gov/emergencies/content/lawsregs/ncpover.htm>.

⁴⁰ For a list of member agencies, see <http://www.nrt.org/production/NRT/NRTWeb.nsf/MADispForm?Openform>.

⁴¹ The corresponding role for spills in EPA's jurisdiction is the Remedial Project Manager.

recovery activities of federal, state, local, and private entities (including the responsible party), and will draw on resources available through the appropriate ACPs and RRTs.

To manage response operations for the Deepwater Horizon spill, the federal government has established a Unified Command structure, led by a National Incident Commander (Coast Guard Admiral Thad Allen in the current case), to link the organizations responding to the incident and provide a forum for those organizations to make consensus decisions.

Although the OSC must consult with designated trustees of natural resources⁴² and the governor(s) of the state(s) affected by the spill, the OSC has the authority and responsibility to determine when removal (i.e., cleanup) is complete.

As oil from the Deepwater Horizon spill has begun to reach the shores of several Gulf coast states, the entities charged with responding to the spill have recently begun to focus on cleanup of coastal marshes and wetlands, particularly on considerations related to the several possible cleanup techniques discussed in this report. In early June, representatives of several federal agencies that are part of the NRT, plus emergency response and local technical experts, held a workshop to develop a response plan for marshes and other nearshore and shoreline areas affected by the oil spill. The resulting plan identifies current cleanup methods and strategies along with their advantages and disadvantages, depending on the level of oiling of marshes, and includes a table showing potential activities that can be considered by the Incident Commander (Admiral Allen).

As to which methods will actually be utilized, the response plan states, “The selection of any cleanup strategy will be determined on a case-by-case basis in consultation with appropriate natural resource experts and trustees. Clean up operations will be conducted by the responsible party and overseen by the Federal, State and Tribal Agencies with authority.”⁴³

However, while the oil is still flowing, very little cleanup actually is occurring, at least near or on the shore, since recontamination could occur readily. Rather, under the National Incident Command structure, Shoreline Cleanup Assessment Teams (SCATs) undertake comprehensive surveys and collect information on oil once it reaches shore.⁴⁴ In the current case, information that the assessment teams report daily is processed by the Incident Command Center as part of broader planning and priority-setting to guide operations. What that means in reality is that shoreline cleanup is limited to triage—removing bulk amounts of oil from beaches and, in some

⁴² Natural resource damages refer to the environmental impacts caused by an oil spill that result in an actual adverse effect on the resource (e.g., animals, plants, and their habitats) or on the services provided by that resource to the public (e.g., drinking water, recreation). When a spill occurs, natural resource trustees conduct a natural resource damage assessment to determine the extent of injury, and the party responsible for the spill is liable for the damages. In the Deepwater Horizon case, the natural resource trustees include NOAA, FWS, the National Park Service, state trustees from Louisiana, Mississippi, Alabama and Florida, tribal trustees, and BP. See http://www.response.restoration.noaa.gov/book_shelf/1959_deepwater-Horizon-NRDA-ORR-web-5-7-10.pdf.

⁴³ U.S. National Response Team, “Oil Spill Response Strategies for Coastal Marshes during the Deepwater Horizon MC252 Spill,” June 15, 2010, [http://www.nrt.org/Production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/SA-1061NRT_Marsh_Cleanup_Options_DWH.06032010.pdf/\\$File/NRT_marsh_cleanup_overview_6-15.pdf?OpenElement](http://www.nrt.org/Production/NRT/NRTWeb.nsf/AllAttachmentsByTitle/SA-1061NRT_Marsh_Cleanup_Options_DWH.06032010.pdf/$File/NRT_marsh_cleanup_overview_6-15.pdf?OpenElement).

⁴⁴ The teams generally consist of four persons, representing the federal government (usually NOAA, sometimes FWS), the affected state, and the responsible party. They often are accompanied by a contract archaeologist who identifies historic sites or structures to be avoided during cleanup, such as civil war artifacts or Indian mounds. The responsible party provides logistics, e.g., helicopters and boats.

cases, heavily oiled marshes—but even these areas are not being thoroughly cleaned now. Methods being used in the marshes are primarily flushing and sorbents. Given the high environmental sensitivity of marshes and wetlands and the potential for re-oiling until the leaking undersea well is capped, the choice for the moment is to do as little as possible that could be more harmful to the ecosystem. Shorelines will be re-surveyed multiple times, as oiling conditions change, which could lead to different recommendations for cleanup.⁴⁵

When the oil does stop flowing, more comprehensive cleanup can begin, and the biology of an area or type of use will determine the desired cleanup endpoint. That could mean, for example, zero tolerance for oil on a high-amenity recreational beach and nearly the same for a marsh. A number of questions can be anticipated to arise during this process.

- What is meant by “case-by-case” determination of cleanup strategy, in the NRT response plan? That is, what factors (physical, biological, legal), would result in different methods being used at some sites? Would this decision include scientific controls to decide what methods are most effective?
- What kind of training is being provided to persons who are actually involved in cleanup? While many persons are reportedly being trained and used for cleanup of less complex areas, such as beaches, different preparation may be required for those who will perform cleanup work in sensitive marshes and wetlands.
- The NRT response plan necessarily is focused on removal of oil, which likely will continue for some time once cleanup is possible. But even at this early stage, there are opportunities for scientific evaluation arising from these events. How are the needs to improve scientific understanding of the impacts of the oil spill and response activities being considered during cleanup?

Who Decides About Wildlife?

The process of cleaning an individual animal may take a week or more: collecting and transporting the animal; rest and/or feeding to allow the animal to withstand the stress of the cleaning or rehabilitation process; cleaning and treatment; drying; further feeding and blood tests, and rest; transport to a release site; and release, often at a very distant location.⁴⁶ As with many wildlife questions, data are better for birds than for many other species.

Cleanup of wildlife is controversial, in terms of both the benefits to individual animals and the question of the cleanup’s relevance to the status of the species. The issue is, if only a small fraction can be saved, and if the food sources, breeding sites, and resting places are damaged or destroyed, how useful is it to clean a small fraction and release the animals to an environment where they may become recontaminated? Even if one focuses on the individual birds rather than the species, some scientists argue that the life expectancy of a bird that has been cleaned and released remains low, and its chances of breeding are poor, although some groups, such as gulls, fare better than other groups.⁴⁷

⁴⁵ Douglas Helton, Incident Operations Coordinator, Office of Response and Restoration, National Oceanic and Atmospheric Administration, U.S. Department of Commerce, personal communication, June 24, 2010.

⁴⁶ For a graphic description of this process, see <http://www.washingtonpost.com/wp-srv/special/nation/one-birds-odyssey/?sid=ST2010061502171>.

⁴⁷ “Should Oiled Birds Be Cleaned?” by Nell Greenfieldboyce, National Public Radio, June 14, 2010. Available at (continued...)

There may be no definitive answer to such questions, other than the human need to do something that might help, plus the expectation that at least some fraction of the cleaned animals will survive at least somewhat longer. It may be no coincidence that so much labor in the rescue of oiled animals is done by dedicated corps of volunteers.

Cleanup and Recovery Issues: The Long Term

Once the oil is removed or cleaned up to the extent possible, recovery of the ecosystem can begin. Recovery can occur within a growing season or require years to decades, based on factors such as those listed previously that influence the severity of impacts (e.g., the type and quantity of oil, and season and prevailing weather). Documented recovery of oiled marshes is more rapid in the warmer environment of the Gulf than in colder climates, but it still ranges from weeks to decades.⁴⁸ Lessons from the *Exxon Valdez* spill may be useful in the BP oil spill for both the biological response and for management of scientific information.

Lessons from the *Exxon Valdez*

The *Exxon Valdez* spill in 1989 had well-known short-term effects, but its long-term effects are less well known. While the markedly different conditions (a single event with short-term oil release; much colder climate; preponderance of rocky shores over marshes, beaches, and mudflats; lower human population; less disturbed baseline ecosystem, etc.) mean that many lessons do not transfer well, two lessons are particularly worth noting as Gulf onshore cleanup plans develop.

First, some short-term remediation actually delayed recovery in some habitats. For example, while rocky shores cleaned with high-pressure hoses or hot water became suitable for the hauling out of seals or sea otters, other aspects of recovery were negatively affected: microbial populations that might have digested oil were destroyed.⁴⁹ At these sites, the recovery process for intertidal species (barnacles, crabs, limpets, etc.) proceeded more slowly than in untreated areas in which some oil weathered and some sank into the rocks, sand, or gravel.⁵⁰

Second, before the spill in Prince William Sound (PWS), the paradigm for oil spills had been that a spill's effects were primarily acute, rather than long-term. But in the intervening 21 years, studies have shown that some effects can endure for decades, and that some species recover much more slowly than others. Research did not continue indefinitely after the spill, and some responses were studied for longer than others. The following list gives a sample of the conclusions of a scientific review of the published information on ecosystem responses in the years after the spill:

(...continued)

<http://www.npr.org/templates/story/story.php?storyId=127749940>.

⁴⁸ National Research Council of the National Academies, *Oil in the Sea III, Inputs, Fates, and Effects* (Washington, D.C.: The National Academies Press, 2005), pp. 145-146.

⁴⁹ Katherine Unger, "Comparing Deepwater Horizon to Exxon Valdez," The Wildlife Society. Available at http://joomla.wildlife.org/index.php?option=com_content&task=view&id=689&Itemid=321.

⁵⁰ For example, see effects of such cleaning at Kenai Fjords National Park, available at http://www.nps.gov/kefj/naturescience/upload/KEFJ_EVOS_1989-2009_qa.pdf.

- While about 2% of the oil mass remained on PWS intertidal beaches after 3.5 years, the rate of decay of this oil dropped markedly in subsequent years because it became sequestered from wave action, sunlight, and oxygen—all of which tend to promote degradation of the oil, as previously described. About 14% of the oil that contaminated PWS tidal areas in 1992 was still present in 2001.
- Where mussels anchored themselves to these rocky shorelines, the subsurface oil contaminated the mussels and provided a route into the food chain.
- In the mouths of rivers, oil in the substrate killed pink salmon embryos at least as late as 1993 (the most recent year available to the reviewers).
- Sea otter populations recovered at the rate of 4% per year, short of the expected 10% per year. By 2000, sea otter populations remained at about half the estimated pre-spill population in one heavily contaminated area. Effects included an abnormally high mortality in animals born after the spill.
- Some birds, such as harlequin ducks, showed higher mortality rates than normal for more than a decade. This species feeds heavily on invertebrates in lower tidal areas. Another sea duck, Barrow's goldeneye, also showed chronic exposure for at least a decade. This species also forages in the nearshore environment.
- Sublethal effects occurred in other species. For example, black oystercatchers (a bird that forages on rocky shores) had less breeding and smaller eggs for at least three years.
- Among social species, such as killer whales, loss of key individuals can affect large numbers of animals: when adult females in this matriarchal species died after the *Exxon Valdez* spill, the social disruption apparently led to suppressed reproduction, and likely to the later disintegration of a pod of whales.⁵¹

While most of the species mentioned above are not found in the Gulf, in both the Gulf and PWS, there exists the opportunity for hydrocarbons to become lodged in various substrates, to be absorbed by various species that are eaten by other species, and to inhibit the growth or reproduction of still others. It remains to be seen how different the biological response in the Gulf will be, but the *Exxon Valdez* spill suggests that long-term impacts are highly likely, even if their specific nature will be difficult to predict.

Science and Litigation

Free and open access to scientific information concerning oil spills is not a given. In the Gulf, many lawsuits have been filed already and more can be expected. In the past, litigation strategies have driven parties to these suits to direct government or corporate scientists to withhold data in order to prevent opponents in court from having an advantage as litigation progressed. After the *Exxon Valdez* spill, the Alaska attorney general:

issued a series of memos to state scientists ordering them to keep their data on the spill under wraps. His motivation, [he] said, was to prevent Exxon from gaining the upper hand in the litigation that was shaping up from the moment the *Valdez* ran aground.... The gag has been

⁵¹ Charles H. Peterson, Stanley D. Rice, and Jeffrey W. Short, et al., "Long-term Ecosystem Response to the Exxon Valdez Oil Spill," *Science*, vol. 302 (December 19, 2003), pp. 2082-2086.

particularly effective in muzzling the most contentious data—that relating to environmental damage....

Indeed, far too little data has been made public for the response experts to come to a unanimous opinion of the best strategies for cleanup. In some cases, the response specialists have not been allowed to see the state's damage assessment results....⁵²

In the wake of that spill, contractors working for Exxon were allowed to release results of studies that concluded that the spill had not, and would not, have adverse effects on plants and animals in PWS. Alaska's scientists could not provide timely contrary information.⁵³ At the same time, other Exxon researchers were not allowed to present their research on the spill's effects, due to the possibility of harming Exxon's defense.⁵⁴

The tension between disclosure of scientific research and litigation strategy has already begun in the Gulf, with suggestions that carcasses of dead birds and other animals are being destroyed, rather than kept for scientific investigation or later litigation.⁵⁵

Conclusion

While oil continues to flow and immediate responses are underway, the long-term impacts from the Deepwater Horizon release on the environment cannot be determined. There are unanswered questions about the amount of oil already released and still remaining in the Gulf, how the oil will degrade in the environment, what mitigation actions will be taken, and what immediate and long-term damaging effects might result from those actions.

Oil has the potential to endure in the environment long after a spill. In coastal marshes, oil may be pushed or may seep into bottom sediments and may persist for a long period of time, having potential to be re-suspended by waves or storm events, and remaining a threat to wetlands and wildlife.

The costs of the oil spill in damages to wildlife and wetland resources—killed or injured animals, contaminated or destroyed vegetation and habitat—cannot be measured at this point. Likewise, the financial costs of response and recovery will be unknown for years. Those financial costs will include public and private response activities, fines and penalties, and third party claims. They also will include natural resource damage settlements. In the current case, natural resource damages and assessment costs—including those for determining the extent of impacts, restoring

⁵² Lisa Busch, "Science Under Wraps in Prince William Sound," *Science*, vol. 252 (May 10, 1991), pp. 272-273.

⁵³ *Ibid.*

⁵⁴ Stephanie Pain, "Exxon Gags Sound Researchers," *New Scientist*, no. 1860 (February 13, 1993).

⁵⁵ See <http://rawstory.com/rs/2010/0615/expert-suggests-bp-hiding-oiled-animal-carcasses/>. The ESA, the Marine Mammal Protection Act, could provide for civil and criminal penalties for prohibited taking of wildlife, except that both statutes require that the violation be done knowingly. However, the strict liability provisions of the Migratory Bird Treaty Act (MBTA) make it a more attractive vehicle for prosecutors in the case of the Gulf spill. While it is not clear whether fines under the MBTA would be assessed on the basis of a single spill event or on the basis of each dead or wounded bird, the latter possibility would make an accurate count of bird deaths particularly important. For more information, see CRS Report R41308, *The 2010 Oil Spill: Criminal Liability Under Wildlife Laws*, by Kristina Alexander.

injured resources to baseline, and compensating for interim losses—are likely to be substantial in absolute terms, but still could be small compared with response costs and third party claims.⁵⁶

Although events are still at a relatively early stage, a number of questions arise. When will recovery be complete, and how do we define success, or completion? What is an acceptable level of habitat recovery? NOAA regulations (15 C.F.R. § 990.30) state that recovery “means the return of injured natural resources and services to baseline”—in other words, a return to conditions as they would have been had the spill not occurred. But what this means in actual terms is open to considerable debate. A conventional definition of recovery is probably “return to the way things were before the spill.” Unfortunately, this benchmark is vague and hard to quantify. Change is particularly characteristic of coastal areas, which are already subject to significant annual losses in area. In the case of Prince William Sound, for example, it is difficult to apply this standard of recovery because there is little information about “the way things were” before that spill. Multiple variables affect local species and ecosystem services. Similarly, one species at a spill site could have been on the decline at the time of an incident, because of changing water temperatures or other factors. Even in the absence of a major disturbance like an oil spill and cleanup, ecosystems are constantly in transition, and the physical and biological conditions that once characterized any given site are likely to shift considerably over time.⁵⁷

With so many unknowns, predicting the long-term future of the wealth of natural resources in the Gulf could be foolhardy. Even so, observations from the *Exxon Valdez* spill and other spills offer some insight. First, there will likely be significant long-term effects, and the impacts will not be evenly distributed. Some areas and species will require more time than others. Moreover, the stress of these effects are an add-on to wetlands that are already disappearing due to subsidence, global sea level rise, and other factors. If a wetland area simply disappears as a result of some combination of these factors, no recovery can occur, regardless of remediation. The Gulf’s wildlife was already under stress from these same factors. The spill seems likely to exacerbate existing trends, though in ways that are hard to predict.

Second, litigation has been a driver of post-spill action in past spills, and the BP spill has already sprouted multiple lawsuits. If the *Exxon Valdez* experience is an indicator, the timely sharing of data among scientists appears likely to suffer. Some information could be temporarily or indefinitely concealed, possibly to the detriment of recovery of various resources. Since much is unknown about coastal wetlands and their inhabitants, the withholding of data could be a handicap to recovery.

⁵⁶ Douglas Helton and Tony Penn, “Putting Response and Natural Resource Damage Costs in Perspective,” 1999 *International Oil Spill Conference*, no. #114, <http://www.iosc.org/papers/01767.pdf>. The authors examined cost data on 48 U.S. spill incidents between 1984 and 1997 and found that, overall, response costs were the largest category. However, in the case of the *Exxon Valdez* spill, approximately 30% of the total known costs (which exceed \$9 billion, according to the authors) were response costs, and 60% were third party claims. Natural resource damage and assessment costs comprised 10% of the known costs. For an overview of natural resource damage assessment laws and policies, see CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur.

⁵⁷ U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of Response and Restoration, “Has Prince William Sound Recovered From the Spill?,” June 2, 2005, http://response.restoration.noaa.gov/topic_subtopic_entry.php?RECORD_KEY%28entry_subtopic_topic%29=entry_id,subtopic_id,topic_id&entry_id%28entry_subtopic_topic%29=258&subtopic_id%28entry_subtopic_topic%29=13&topic_id%28entry_subtopic_topic%29=1.

Once oil stops flowing and recovery (however it is defined) is complete, attention will likely turn to restoration. At that point, another question that will arise is, what does restoration mean? In June, President Obama committed the federal government to a long-term plan of Gulf coast environmental restoration. The White House said that a federal interagency task force, led by Navy Secretary Ray Mabus, will develop a plan with the goal of making the Gulf better than it was before April 20 (or, better than the baseline condition called for in NOAA's regulations that define recovery). When that plan emerges, it will represent the most recent such proposal, adding to numerous other plans and projects that have been proposed to rebuild coastal areas that have experienced decades of adverse effects from erosion, storms, and development, especially in Louisiana's wetlands. Some of those earlier plans were endorsed by Congress,⁵⁸ and some of them are underway now, but critics observe that there has been little action to date for reasons that include costs, complexity, and ecological and institutional challenges. Of great interest will be how existing and new plans and proposals will be coordinated, how current short-term responses to the oil spill may affect long-term restoration,⁵⁹ and how barriers that have stalled previous efforts can be overcome. On top of these concerns, hurricane season imposes additional threats.

During the immediate response to the spill, Congress is providing substantial oversight of efforts to contain and mitigate the oil and its impacts. Congress also is considering policy and legislative changes to prevent such events in the future. In the longer term, Congress is likely to be influential in guiding the environmental restoration plan for the Gulf coast that the President has pledged to pursue. During the immediate response to the oil spill, two key questions are, who is responsible for cleanup, and who pays.⁶⁰ Similar questions will arise in relation to longer-term restoration, especially questions of who will pay for restoration and what the federal role will be.

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⁵⁸ For example, the Coastal Wetlands Planning, Protection and Restoration Act of 1990, also known as the Breaux Act, provided funding to carry out coastal wetland restoration projects in Louisiana and other states. Similarly, the 2006 Gulf of Mexico Energy Security Act provided revenues from offshore oil and gas activities for wetland restoration and other activities in states bordering the Gulf.

⁵⁹ For example, in May the federal government granted a portion of Louisiana's request to dredge sand and other material to build berm structures offshore of existing barrier islands in order to reduce inland movement of oil. The state had sought permission to build 128 miles of barrier berms; the government authorized 45 miles of structures. As described in CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur, this proposal has been controversial. For example, in commenting on the state's request, NOAA, EPA and other federal agencies raised a number of concerns, including that the project could deplete finite Louisiana sand resources, thus affecting future high-priority barrier island restoration projects and largely negating two decades' of planning efforts. See "NOAA Considerations on Louisiana Proposal for Barrier Island Restoration Plan" in U.S. Army Corps of Engineers, "Corps decision on state's emergency permit request," May 27, 2010, <http://155.76.147.200/news/Emergency%20Permit%20Documents%20Compressed%20FINAL.pdf>, p. 11.

⁶⁰ For general discussion of these questions, see CRS Report R41262, *Deepwater Horizon Oil Spill: Selected Issues for Congress*, coordinated by Curry L. Hagerty and Jonathan L. Ramseur.