OIL SPILL SCIENCE
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SEA TURTLES AND THE DEEPWATER HORIZON OIL SPILL

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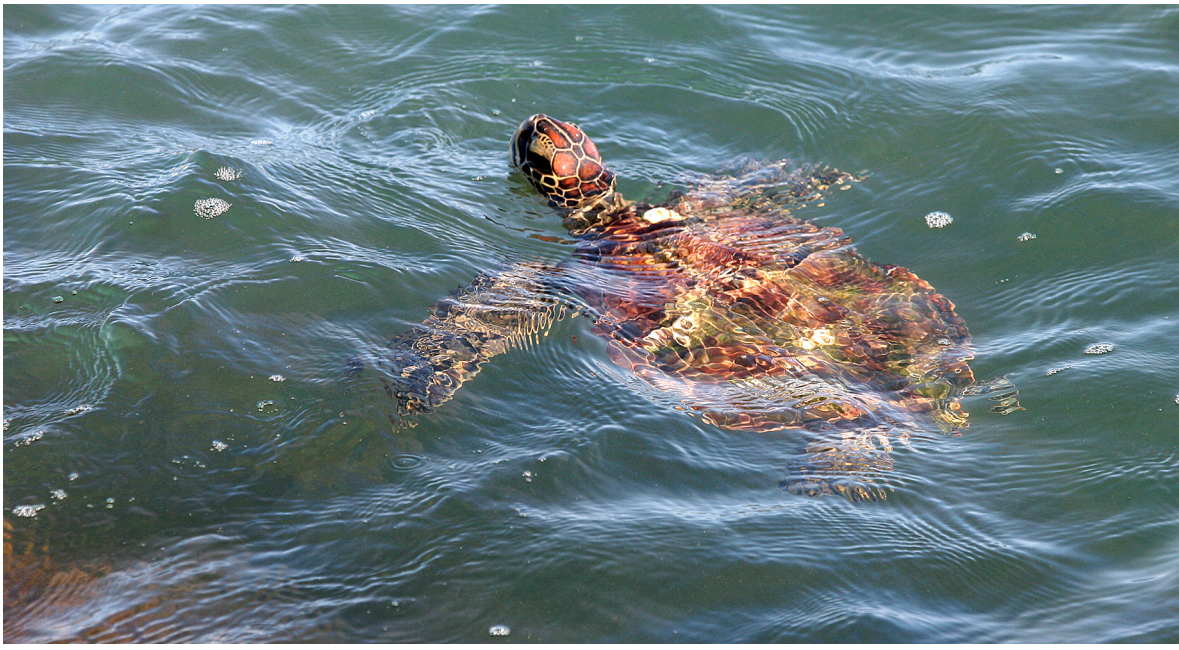
In April 2010, the Deepwater Horizon (DWH) oil spill, the largest offshore spill in U.S. history, occurred in the Gulf of Mexico. Emergency response personnel, natural resource managers, non-profit organization staff, scientists, volunteers, and many others worked together to rescue sea turtles. Sea turtles are some of the world's most well-known endangered and threatened animals. So far, what have we learned about the impact DWH had on sea turtles in the Gulf?



A healthy green sea turtle swims in the Gulf of Mexico. (Texas Sea Grant/Pam Plotkin)

THE BASICS OF THE SEA TURTLE LIFE CYCLE

Sea turtles are long-lived, air-breathing reptiles that spend most of their lives in the sea. They are highly **migratory** and depend on several habitats across large geographic areas throughout their life cycle (Figure 1). As **hatchlings**, sea turtles emerge from eggs located in nests on sandy beaches. Hatchlings crawl from their nests to the nearest coastal waters and swim out into the open ocean. These young turtles spend the next phase of their lives in and around convergence zones, or areas where open ocean currents come together. Here they feed and grow. As **juveniles**, they spend much

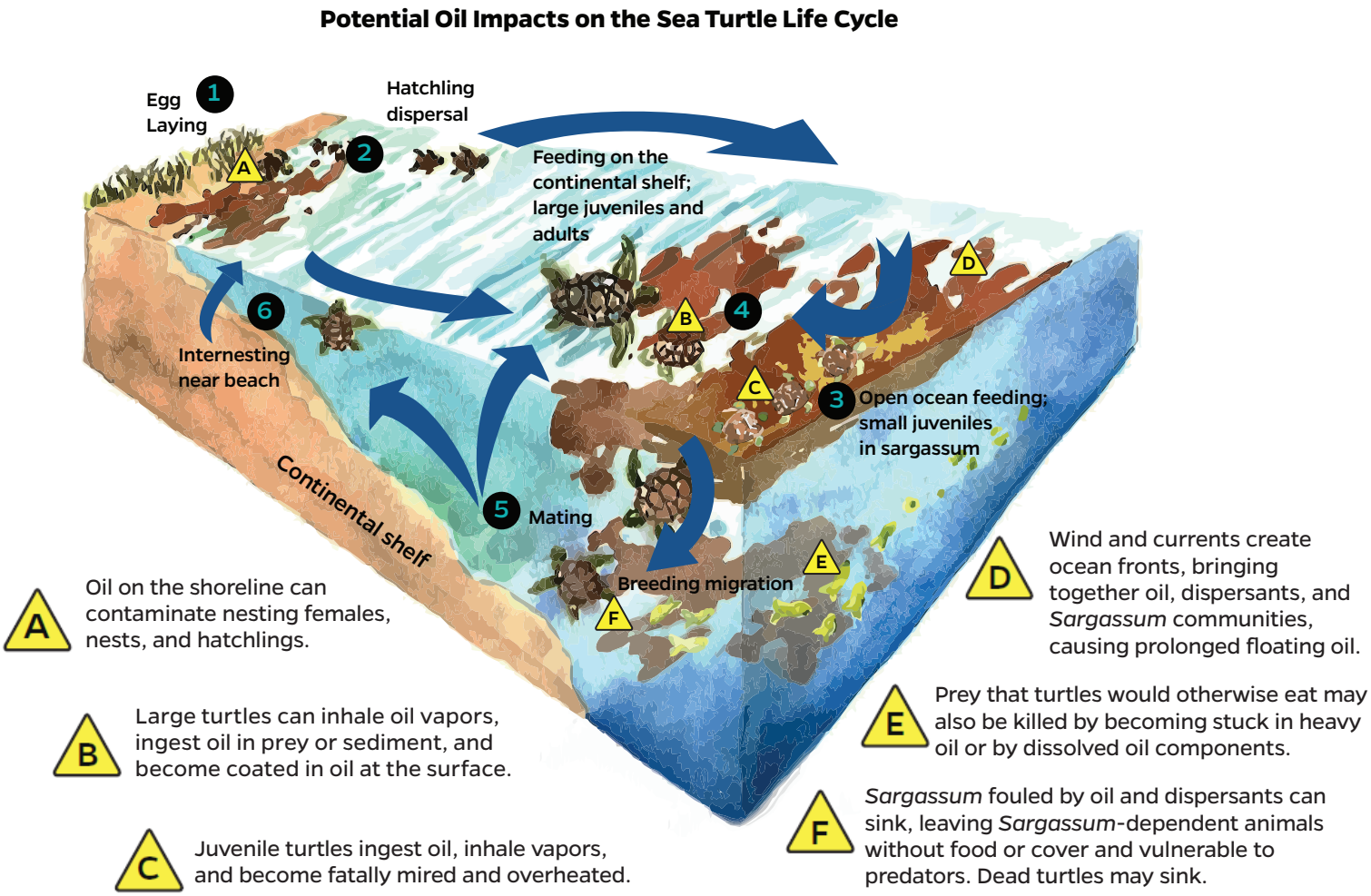


FIGURE 1. *Sea turtles in the Gulf of Mexico require many different types of habitat throughout their long lives, putting them at risk during oil spills. (Florida Sea Grant/Anna Hinkeldey, adapted from NOAA)*

of their time at or near the ocean surface. Sea turtles have a long life span and, depending on the species and environmental conditions, can survive more than 50 and even up to 100 years old. They grow slowly and mature later in life. They swim back toward the **continental shelf** to mate when grown to sexual maturity. Most sea turtles in the Gulf of Mexico spend the majority of their lives in the waters of the continental shelf area, though leatherbacks spend their lives in open ocean waters. During the nesting season, mature females of all species return to the same coastal area from which they emerged as hatchlings to dig their own nests and lay eggs.[1,2]

THREATS AND PROTECTIONS

The federal **Endangered Species Act (ESA)** classifies all sea turtle species found in U.S. waters as **endangered** or **threatened**. Five species of sea turtles live in the Gulf of Mexico: loggerhead, leatherback, green, Kemp's ridley, and hawksbill. Loggerheads are listed as threatened, while the other four are listed as endangered. Additionally, many international organizations require protections for sea turtles. For example, the **Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)** prohibits international trade of some endangered wildlife, including sea turtles.

Even though sea turtles are under international and domestic protection, they are vulnerable to death from both natural and human causes (Table 1). Sea turtle eggs are eaten by animals like ants, raccoons, foxes, coyotes, and crabs.[1] If the hatchlings survive their race across the beach from nest to ocean, they are then at risk of being eaten by seabirds, sharks, dolphins, tarpon, snapper, and other fish.[1] Scientists estimate that only 1 in 1,000 hatchlings survive to adulthood, though this rate varies depending on the species and other factors.[3,4] Additionally, drastic drops in water temperature cause "cold-stunning"

in sea turtles. Cold-stunned turtles become sluggish and unable to avoid predators, and many are eaten or wash ashore.[1] Sea turtles also die from a variety of diseases.[1] They are faced with a multitude of threats from humans, including

- destruction and alteration of nesting and feeding habitat,
- incidental capture in commercial and recreational fishing gear,
- becoming entangled in or ingesting trash in the ocean,
- exposure to harmful chemicals,
- vessel strikes, and
- hunting and gathering of turtles and their eggs, drinking turtle blood, or trading turtle shells.[1]

THE RISE AND FALL OF THE KEMP'S RIDLEY

Scientists are studying the role the DWH spill played in the decline in Kemp's ridley sea turtles in 2010. The status of the Kemp's ridley population is of particular importance because they are the most endangered sea turtle in the world.[4,5] They live primarily in the Gulf of Mexico, nesting on beaches in Mexico and Texas.[5] The Kemp's ridley population severely declined in the 1960s, almost to the point of extinction.[5,6] This was due to over-harvest of eggs from beaches in Mexico

TABLE 1. *Sea turtles die from both natural and man-made causes.[1] Understanding the impacts from the many sources of mortality throughout their life cycle can help resource managers protect sea turtles.[17] (adapted from NOAA)*

Source of mortality	Primarily caused by humans	Main life stage affected	Level of Impact
Shrimp trawling	Yes	Juveniles to adults	High
Natural predation	No	Eggs, hatchlings	High
Artificial lighting	Yes	Nesting females, hatchlings	High
Disease	No	Juveniles to adults	High for green sea turtles
Beach Use	Yes	Nesting females, eggs	High on some beaches
Other fisheries	Yes	Juveniles to adults	Medium
Vessel-related injuries, including propellers	Yes	Juveniles to adults	Medium
Poaching	Yes	Eggs, juveniles, adults	Low to medium
Beach development	Yes	Nesting females, eggs	Low to medium
Cold-stunning	No	Juveniles to adults	Low
Entanglement	Yes	Juveniles to adults	Low
Power plant-related injuries	Yes	Juveniles to adults	Low
Oil platform removal	Yes	Adults	Low
Beach renourishment	Yes	Eggs	Low with monitoring
Eating debris & trash	Yes	Juveniles to adults	Unknown
Toxins	Yes	Unknown	Unknown
Habitat damage	Yes	Hatchlings to adults	Unknown

SHRIMP FISHERS PROTECT TURTLES USING TURTLE EXCLUDER DEVICES (TEDS)

Fishing gear is one of many threats sea turtles face. In particular, shrimp trawl nets unintentionally capture sea turtles. Often, sea turtles can't escape these nets and they drown. However, shrimpers and natural resource managers have worked together to come up with a solution that promotes turtle-safe, wild-caught shrimp. They created Turtle Excluder Devices (TEDs), a metal grid that attaches to one end of a shrimp trawl net; its design allows sea turtles to escape the net. When properly installed, TEDs have been shown to be 97 percent effective in excluding turtles from shrimp trawls. Federal law now requires TEDs on most shrimp trawlers in the Gulf of Mexico and South Atlantic.[17]

Texas Sea Grant extension agent Tony Reisinger works with shrimpers in Brownsville to correctly install Turtle Excluder Devices in shrimp trawls. (Texas Sea Grant/Chris Hale)

FLOATING SAFE HARBORS

The National Oceanic and Atmospheric Administration (NOAA) considers *Sargassum* or Gulf weed to be an **Essential Fish Habitat (EFH)** because many species use it for spawning, feeding, and growth. *Sargassum* offers juvenile turtles protection from predators and is a food source. It floats and drifts with currents in the ocean, accumulating in convergence zones, as do surface oil slicks.[1,8] Oil from the Deepwater Horizon spill caused the loss of nearly 25 percent of the *Sargassum* habitat in the northern Gulf.[8] Losing such an important habitat created challenges for small and juvenile sea turtles.[8]

(Gulf Coast Research Lab/Jim Franks)

and loss of turtles from commercial shrimp trawling in the Gulf of Mexico.[4-6] The Kemp's ridley population numbers began to rebound only after two decades of successful binational conservation and management efforts.[5,6] Kemp's ridleys continued to thrive so much that the National Marine Fisheries Service predicted that by 2011, Kemp's ridleys would be down-listed on the Endangered Species list and eventually delisted by 2024.[7] This means the ridleys would have been moved from the category of endangered to threatened, and potentially removed from the list by 2024.[7] However, the Kemp's ridley population drastically decreased again in 2010, the year of the DWH spill, changing the outlook for the species.[4,6] The prediction for a 2011 down-listing did not come true, and the Kemp's ridley remains on the Endangered Species list as endangered.

WHAT HAPPENED TO SEA TURTLES DURING AND AFTER THE DEEPWATER HORIZON OIL SPILL?

Risk

DWH oil spilled for 87 days throughout the northern Gulf of Mexico, spreading from the open ocean to the continental shelf, coastal wetlands, and beaches.[2,8] Sea turtles use all of these habitats, so they were at high risk of oil exposure (Figure 1).[2,8] Sea turtles do not always swim away from oil spills, and they must take large breaths of air above the water before they dive.[1,9] This behavior can lead to inhaling or ingesting surface oil. Additionally, sea turtles feed in convergence zones where oil tends to accumulate, potentially causing them to eat oil with their food.[1,2,8]

Rescue

Representatives from many organizations worked together to rescue oiled sea turtles during the spill. These included fishermen, marine mammal and sea turtle stranding networks, federal and state agency personnel, scientists from various institutions, and volunteers. Rescue crews headed offshore in charter fishing boats to search for oiled turtles. Teams cleaned and examined the sea turtles, obtained oil samples, and transported turtles to rehabilitation facilities in Louisiana, Mississippi, and Florida to receive veterinary care. Sea turtle experts rehabilitated more than 450 oiled sea turtles and later released them into oil-free waters.[10]

Turtle nests were also rescued. Experts relocated nearly 275 loggerhead turtle nests from oiled beaches from the northern Gulf to the Atlantic coast of Florida. To do so, they dug up the eggs and placed them in special foam boxes for transport. They transported approximately 28,000 sea turtle eggs to an incubation facility at the Kennedy Space Center in Cape Canaveral, Fla. Authorities there monitored the eggs in a climate-controlled environment until the hatchlings emerged and could be released on unoiled Atlantic coast beaches.

Impact

In total and across all Gulf sea turtle species, the **Natural Resources Damage Assessment (NRDA)** estimated that the DWH oil spill and related response activities killed approximately 35,000 hatchling sea turtles, between 55,000 and 160,000 small juvenile sea turtles, and between 4,900 and 7,600 large juvenile and adult sea turtles.[8] NRDA also estimated that the DWH spill impacted the reproductive potential of sea turtles in the Gulf, meaning that thousands of baby turtles will not be born.[8] The magnitude of sea turtle loss due to the DWH spill will make recovery of these populations challenging.[8]

During DWH, sea turtles came into contact with oil in every type of habitat they use throughout their life cycle. Adult females, eggs, and hatchlings encountered oil on beaches and coastal areas. They swam through oil at the

surface of the water, including within floating *Sargassum* habitat. Responders retrieved many sea turtles from the water completely covered, or **mired**, in oil.[8] Miring in oil decreases a sea turtle's ability to move and dive and causes exhaustion, dehydration, overheating, and death. Responders also found turtles with DWH oil coating their eyes, nasal openings, and mouths, resulting in vision loss and causing them to inhale and ingest oil (Figure 2).[8] Without intervention from rescuers, sea turtles mired in oil most likely died.[8]

Despite extensive rescue efforts, many turtles died as an unfortunate consequence of the emergency response to the DWH spill. For example, onshore activities such as moving turtle eggs from Gulf beaches to the Atlantic coast of Florida caused the loss of some sea turtle hatchlings.[8] Oil spill response boats collided with turtles, killing them.[8] Response activities such as oil skimming and burning led to additional turtle injury and death.[8] The emergency response community must often weigh the benefits and risks of available tools and approaches when making oil spill response decisions.[11]

FIGURE 2. *a. Rescuers attempt to locate and pull oiled turtles out of a thick surface oil slick. b. This juvenile sea turtle, like many others found during the DWH spill, is entirely coated in oil, making it virtually impossible for it to not inhale or ingest oil. c. Sea turtles encounter lethally hot sea surface temperatures caused by oil slicks. d. Emergency responders sometimes find stranded turtles with clumps of oil trapped in their windpipes.[8] (NRDA)*

DECISION POINT

The emergency response community is tasked with deciding how to respond to a spill while protecting what is at risk. While preventing spills is the priority, planning for them is necessary. Several processes are available to help guide communities in planning and preparing for oil spills. One process, Environmental Tradeoff Analysis, is an approach used by the response community alongside stakeholders during oil spill planning. Environmental Tradeoff Analysis compares the benefits and risks of potential response options to develop a response strategy that will reduce impacts of a spill on the environment.[11]

Scientists have not yet pinpointed what caused the 2010 Kemp's ridley population decline and slow rate of recovery, but they suggest that a combination of factors could be at play. Cold seawater temperatures around nesting grounds, reduced food sources, and oiled habitat are some of the factors being considered.[4,6] Although computer models suggest that the 2010 Kemp's ridley hatchlings did not encounter the DWH oil directly, the majority of sea turtles found dead since the spill were Kemp's ridleys.[12,8] The NRDA suggested that in 2010, young (older than hatchlings) Kemp's ridleys could have been exposed to oil. Any turtle deaths from oil exposure would have removed them from the breeding population of turtles.[8] This is one example of a potential indirect impact to one sea turtle species. Scientists consider many factors as they continue to evaluate the long term and indirect impacts to ridleys and other sea turtle species from the spill.[8]

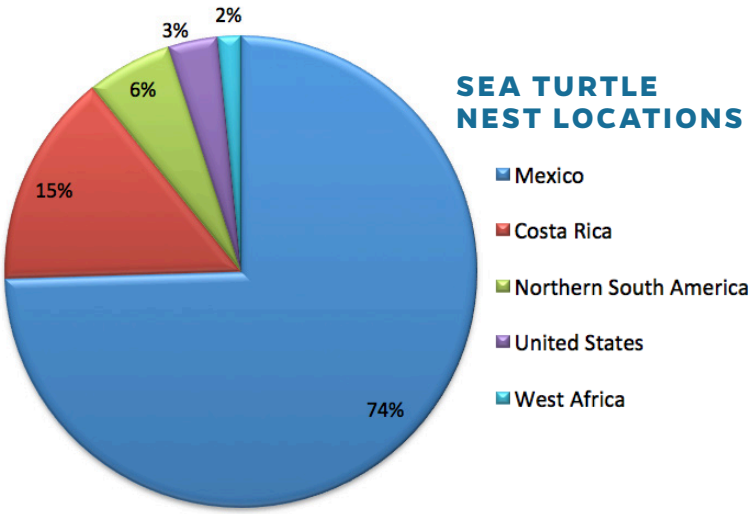


FIGURE 3. *Scientists used computers models to find connections between major turtle nesting beaches and the Deepwater Horizon spill area. More than 95% of sea turtles estimated to be in the spill area hatched from beaches outside of the United States, emphasizing the need to work with international partners.*[13]

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Multi-national collaboration is necessary to understand oil spill impacts and improve the protection of sea turtles.[13] Scientists used ocean circulation models to find connections between major turtle nesting beaches and the DWH oil's path.[13]

These computer simulations estimated that more than 95 percent of the sea turtles likely to have been located near the spill were from non-U.S. nesting populations (Figure 3).[13] These results emphasize how a relatively local disturbance such as an oil spill can have far-reaching impacts.

CONTINUED RESEARCH AND MONITORING

Scientists and natural resource managers do not fully understand oil's impacts on sea turtles' health and reproduction.[8] They continue to monitor Gulf sea turtle populations by counting numbers of nests, hatchlings, and adult females on beaches. However, turtles are far more difficult to track once they reach the open ocean.[13] Scientists have coined a specific term for this period of a sea turtle's life – the "lost years."[14] In the past, scientists thought juvenile sea turtles drifted along with strong ocean currents during this time.[14] More recently, scientists have used computer models and satellite tracking tags to study turtle migration. They found that juvenile green, loggerhead, and Kemp's ridley turtles actively swim in the open ocean and do not behave only as passive drifters.[14,15]

Scientists continue to fill in knowledge gaps about sea turtles so that they can better understand how threats like

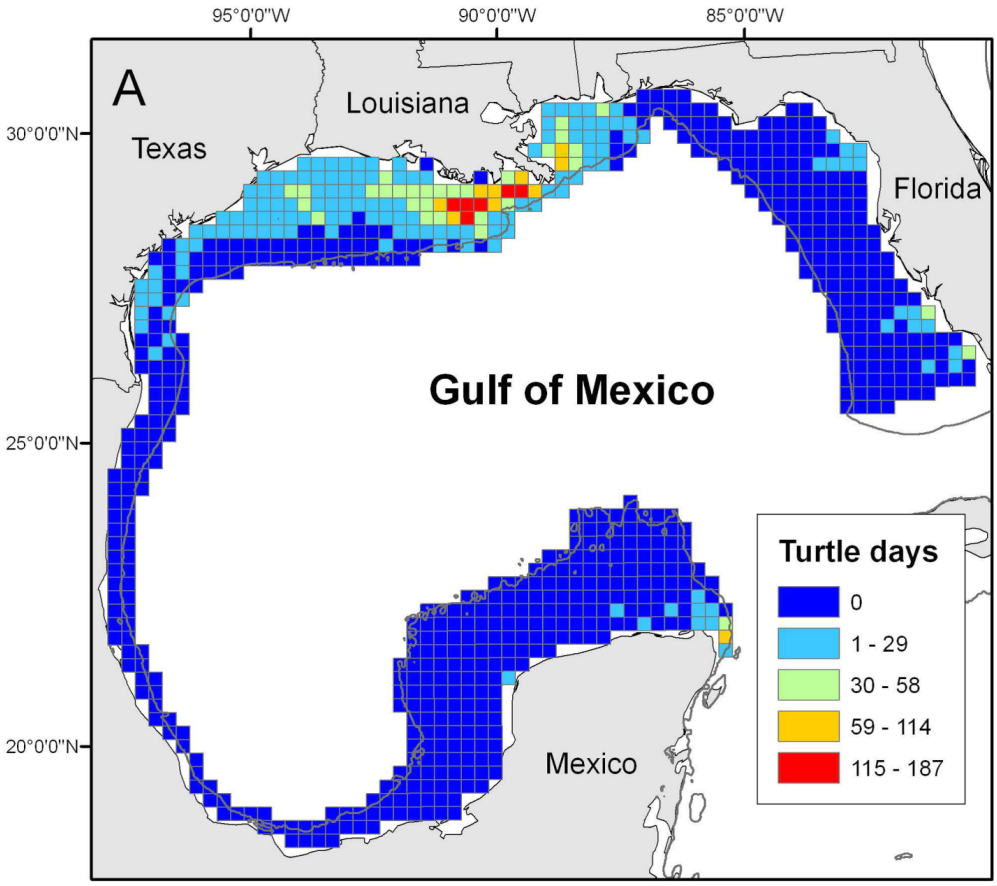

FIGURE 4. *Scientists identified the major foraging "hot spots" for 31 female Kemp's ridley sea turtles from 1998 to 2011. They estimated how much time the turtles spent in these areas feeding as they migrated after nesting. The Deepwater Horizon oil spill impacted major foraging areas off the coasts of Louisiana, Mississippi, and Alabama.*[16] *(adapted from D. Shaver)*

A SEA TURTLE NEEDS YOUR HELP – WHO DO YOU CALL?

If you encounter a sick or injured sea turtle, contact the Sea Turtle Stranding and Salvage Network Coordinator in your area. The following are contacts for the Gulf of Mexico region, but Coordinators operate in other locations as well.

- Texas: 1-866-TURTLE5 (1-866-887-8535)
- Alabama: 1-866-SEA-TURT (1-866-732-8878)
- Florida: 1-888-404-FWCC (1-888-404-3922)
- Louisiana: 1-225-765-2377
- Mississippi: 1-888-806-1674

oil spills impact populations, with the aim of ultimately improving management.[13-16] For example, scientists are learning more about where turtles feed. From 1998 to 2011, they tagged and tracked female Kemp's ridleys to identify "hot spots" or preferred foraging areas. They discovered a critical foraging corridor in the northern Gulf, including coastal Louisiana, Alabama, and Mississippi (Figure 4).[16] Knowing the location of important sea turtle habitats and migration routes helps managers zero in on areas for protection.[16]

For more information about the Deepwater Horizon oil spill's impact to wildlife and other oil spill science topics, visit ***gulfseagrant.org/oilspilloutreach.***

Biologists in Louisiana working with the United States Coast Guard Strike Team care for an oiled Kemp's Ridley sea turtle they named "Lucky." (Louisiana Department of Wildlife and Fisheries)

GLOSSARY

Continental shelf — A shallow undersea plain of varying widths forming a border to a continent and typically ending in a comparatively steep slope to the deep ocean floor.

Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) — An international agreement between governments to ensure that international trade in wild animals and plants does not threaten their survival.

Endangered — Under the U.S. Endangered Species Act, a species is listed as endangered if it is in danger of becoming extinct throughout all or a significant portion of its range.

Endangered Species Act (ESA) — U.S. legislation that provides a framework for conservation and protection of endangered and threatened species and their habitats.

Essential Fish Habitat (EFH) — Under the U.S. Magnuson-Stevens Fishery Management and Conservation Act, NOAA identifies EFH as waters and submerged lands that fish need for spawning, breeding, feeding, and growth.

Hatchling — A young animal that has recently emerged from an egg.

Juvenile — An early phase of growth associated with youth.

Migratory — Having to do with the periodic travel of an animal from one area to another, often over long distances.

Mired — To be covered in, stuck or entrapped within, or be hindered by, a sticky, heavy, or muddy substance.

Natural Resource Damage Assessment (NRDA) — The legal process used to determine the impacts of oil spills, hazardous waste sites, and ship groundings on natural resources and humans.

Threatened — Under the U.S. Endangered Species Act, a species is listed as threatened if it is likely to become endangered in the foreseeable future throughout all or a significant portion of its range.

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