ancient mariners, ancient fuels

how sea turtles cope with our modern fossil fuel dependency

We crave oil and gas, and we are running out of those fuels. To meet the challenge brought about by increasing demand and dwindling supply, our current effort to extract such energy sources has resulted in some of the boldest technological feats ever undertaken, including hydrocarbon exploration, development, and production in locations as inconvenient as the open sea. This offshore production of oil and gas uses intense industrial activity including shipping, port terminals, pipelines, and offshore platforms. Some of the platforms are among the largest structures ever built, each housing a small city of workers. Many thousands of platforms are now clustered on offshore oil and gas fields around the world.

In a way, sea turtles perform a similar extraction of resources, but without all the high technology: they search for food in the same shelf waters dotted with offshore platforms, and they nest on adjacent beaches. This juxtaposition of sea turtles and industry poses many challenges to conserving these endangered creatures.

The potential risks for turtles living amid offshore platforms are varied. Artificial lighting on platforms and from coastal terminals can disrupt the orientation of hatchlings making their way from nests to the sea. Explosions from rig-removal operations can kill turtles living near decommissioned platforms. Channel dredging can destroy foraging habitat, erode nesting beaches, and kill turtles that come in contact with suction dredge heads. Increased vessel traffic can result in turtle deaths from boat strikes. Discharge of heavy metals and organochlorines can negatively affect sea turtle health. Oil can leak, spill, and gush with adverse effects on sea turtles that include ingestion of tar, as well as both chemical and physical effects from contact.

Major oil spills can also affect sea turtles at all life stages; indeed, it is likely that nearly all turtles coming in contact with an errant oil slick will die or become severely debilitated. Major spills are grim events, but, thankfully, they are uncommon. What was probably the largest oil-spill threat to sea turtles occurred over a period of months beginning in June 1979 in the Gulf of Mexico, just a few hundred miles southeast of Rancho Nuevo, Tamaulipas, Mexico. It is difficult to imagine a more "perfect storm" of bad location and timing for sea turtles. The location was offshore from the only nesting beaches for the Kemp's ridley, the world's most endangered sea turtle. The timing coincided with the peak of the Kemp's ridley nesting season. The spill itself was big, occurring when an exploratory oil well on the Ixtoc platform suffered a "blowout"—an event now recognized as the largest unintentional oil spill in history. Throughout the months of hatchling production at the Rancho Nuevo nesting beach and into the spring of the following year, between 10,000 and 30,000 barrels per day flowed into the Gulf. In total, an estimated 500,000 tons of oil distributed itself along Gulf currents.

Although several dead, oil-covered green turtles and Kemp's ridleys reached land, where their appearance was recorded, most of the evidence of sea turtle mortality probably remained far out to sea. Most of the turtles affected were likely the young pelagic or oceanic "lost-year" turtles that are seldom seen either live or dead. But with our current knowledge about their habitat, it seems clear that the same oceanographic forces transporting and collecting young turtles along with their drift community would also concentrate spilled oil and tar. So, it seems reasonable that mortality in this open-ocean life stage is probably high for large spills.

Including mortality of vulnerable but difficult-to-count oceanic-stage turtles, individual oil spills are probably worse for sea turtles than we can measure. But are spills in general an important worldwide threat? The *Oil Spill Intelligence Report* lists about 4,100 major spills (greater than 34 tons) that occurred in more than 100 countries between 1978 and 1995. Is this number a lot? It is to the unlucky life forms in the path of a spill, but in terms of total oil entering the sea, perhaps not. According to the 1995 National Academy of Sciences report *Oil in the Sea,* about 62 percent of the oil in our oceans comes

AT LEFT: Oil rigs operate 24 hours a day and need a brightly illuminated drilling floor and deck. This artificial lighting can disorient sea turtles. © REBECCA McLEAN

A juvenile green turtle drifts within pelagic *Sargassum* in the open waters of the Gulf of Mexico off the coast of Florida, U.S.A. Green turtles, loggerheads, hawksbills, and Kemp's ridleys all associate with open-ocean *Sargassum* during their early life stages. © BLAIR WITHERINGTON

from natural undersea seeps. And of the remaining oil spilled by us, most leakage comes from everyday use of oil rather than from major spills.

Today, there is a strong case to be made that oil-spill risk has greatly declined. Modern oil companies are now intensely concerned about spill events and have numerous safeguards in place to make such acute hazards rare. Still, chronic effects from oil can be important. In a study of post-hatchling loggerheads in the Atlantic Ocean off Florida, U.S.A., about 40 percent of the young turtles had ingested tar. Of the ingested tar that was analyzed to determine its origin, most came from shipping fuel oil. This threat underscores deficiencies in the practices of oil users rather than producers.

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In Western Australia, one of the most significant threats to sea turtles posed by offshore oil and gas extraction has come from the artificial lighting of platforms and terminals. This lighting has included flares (flames of vented gas) and the glaring high-intensity lighting typical of any 24-hour industrial operation. Where those lights have been visible from green turtle, flatback, and hawksbill nesting beaches, hatchlings emerging from nests are misdirected away from the sea. Some of those hatchlings that are able to reach the surf may eventually become disoriented by additional offshore light sources. Thanks to increased attention to this problem, oil and gas industry operations in northwestern Australia now have light-management plans that include guidelines meant to reduce light usage, to minimize wattage, to direct light away from beaches, and to replace lighting with long-wavelength sources that have reduced effects on sea turtles.

Other effects from oil and gas operations are even more difficult to measure than are those from spills and lighting. Habitat loss is one of the more difficult effects to understand. However, it is likely that each new development of offshore platforms, undersea pipelines, shipping channels, and port terminals has some associated environmental perturbation and loss of sea turtle habitat. Similar to managing artificial lighting, reducing effects on sea turtle habitat has also become a goal that influences hydrocarbon development.

Even direct effects can be difficult to measure. Dredges are well known to kill turtles, and in some areas with hard sea bottom, explosives are used to facilitate dredging and pipeline installation. However, the actual number of sea turtle deaths is unclear in all but the most intensely scrutinized of those activities. Explosives are also used to remove offshore platforms that have been decommissioned. In the Gulf of Mexico, the United States has closely examined the threats to sea turtles caused by explosive rig removal. During almost two decades of observing rig explosions, the National Marine Fisheries Service reports that four loggerheads were injured and only one was killed. Of course, the eventual removal of each of the 7,000 or so offshore platforms worldwide will have a substantially larger effect. But a greater effect could result from allowing the platforms to collapse on their own.

Additional uncertainty concerns threats from vessel strikes. Like other perturbations arriving with oil and gas operations, additional boat traffic is certain to have some effect. However, aside from the understanding that vessels do strike and kill sea turtles in high numbers where traffic is frequent, there is currently no way to estimate risk brought about by additional traffic. Nor is it clear what types of vessels pose the greatest risk to sea turtles. Nonetheless, minimizing intersections between boats and turtles makes sense. Thus, researchers

are using satellite-tracking data to identify home ranges and pathways for the industry to steer around.

In addition to uncertainty about individual threats, however, threats posed by oil and gas operations remain unclear for entire regions. In western Africa's hydrocarbon-rich Gulf of Guinea, three developing countries (Angola, Equatorial Guinea, and Nigeria) have seen economic explosions from the proceeds of recent offshore petroleum activity. The result has been an unprecedented expansion of exploration and development in what is likely one of the most important nesting and foraging areas for sea turtles in the world. The island of Bioko, deep within the Gulf of Guinea, provides nesting beaches for large numbers of leatherbacks and green turtles, in addition to scattered hawksbills and olive ridleys. The island also happens to be at the center of Equatorial Guinea's offshore oil industry, which has recently propelled this small country into the world's fastest-growing economy.

The nesting beaches on Bioko Island have been largely protected from human activity by steep mountains immediately to the north. Further, because few people live near the nesting beaches, there is little artificial lighting that would threaten nesting turtles and hatchlings. Presently, most oil industry activities take place beyond the north end of the island, in the waters between Bioko Island and mainland Africa. As a result, offshore oil and gas extraction, a coastal petroleum refinery, and a large methanol plant remain opposite the principal nesting beaches on the island. In the past decade of oil and gas operations near Bioko Island, there have been no major oil spills, and regional oil companies have taken an active role in the area's sea turtle conservation programs. Keeping this apparent harmony between industry and sea turtles will be a challenge and, with continued diligence, a developing success story.

Although it seems as if the age of fossil fuels has been tough on sea turtles, one could argue that they have survived more tumultuous times. This view might be difficult to fathom for modern observers of sea turtles and the seaborne hydrocarbon industry in a place such as the Gulf of Mexico. Today, in addition to being habitat for five species of sea turtles, the Gulf of Mexico happens to have more than half of the world's offshore platforms, together with tens of thousands of miles of pipeline and an intense level of shipping—all commensurate with the oil hunger of the United States, Earth's largest consumer of petroleum.

Mexico's Cantarell oil field is the second-largest oil-producing complex in the world. The field was formed roughly 65 million years ago when the monstrous Chicxulub asteroid struck Earth. In addition to making an enormous basin of petroleum deposits, the asteroid's impact also shocked the planet to the point that all the dinosaurs died. Yet, somehow the Cretaceous ancestors of our modern sea turtles survived. Today, the oil from Cantarell contributes little by little to the recent, chronic, planetary change with which we—and sea turtles—will struggle to cope. By comparison, managing a softer offshore energy industry would seem simple.

Threats to sea turtles are not likely to halt multi-billion-dollar operations. Nor will sea turtles play any more than a minor role in our weaning from fossil fuels. Although we have set upon the path of realization that burning carbon results in a hot planet with rising seas, fully realizing those consequences apparently requires a soaking-in period (unlike the consequences themselves, which are, literally, soaking in as we ponder them). Yet, in the short term, sea turtles are playing—and will continue to play—a role in shaping how we extract and use hydrocarbons.

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For a massive oil tanker that is difficult to stop, minor steering adjustment can avoid catastrophic collisions. Similarly, effects on sea turtles from offshore industry can be vastly reduced with some research-guided planning and small operational changes. With adequate information on site-specific sea turtle life history, some effective spill contingency plans could guide sea turtle protection following accidents; light-management plans could guide protection of nearby nesting beaches; and a host of other *best practices* could be made into industry standards to reduce effects from vessel traffic, dredging, and other activities.

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Female green turtles rest in the intertidal zone around Barrow Island in western Australia during mating season. Barrow Island is home to a major oil and gas development. © KELLIE PENDOLEY