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*Sea Turtles and Oil—
A Synopsis of the Available Literature*

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SEA TURTLES AND OIL

INTRODUCTION

The recent Arabian Gulf oil spill raised an issue that is frequently encountered when an oil spill occurs in a tropical or temperate climate. What are the direct and indirect effects of oil on sea turtles? Although there have been many oil spills in areas populated by turtles, it is still unclear how oil physiologically affects turtles in open water. Because the range of adult turtles is wide, it is unusual to have large numbers of turtles directly impacted by an oil spill. Even in the Arabian Gulf spill, only three oiled turtles were recovered. Spill-related turtle impacts are mostly anecdotal and poorly documented as to cause of death.

The purpose of this report is to summarize the studies that have discussed oil and sea turtles. Some of these reports are only observations of oiled or dead turtles as a result of an oil spill. Other studies have directly examined the physiological and behavioral effect of oil on various sea turtle life stages. Finally, research has been performed on the impact of pelagic tar on turtles. Pelagic tar primarily comes from the discharge of tanker ballast water, although weathered oil from spills does make up a small portion of the tar. Pelagic tar is outside the realm of emergency response, but it is still important because of its potential for chronic impacts to turtles.

SUMMARIES OF SELECTED OIL SPILL OBSERVATIONS

- RÜTZLER AND STERRER, 1970

This study examined the effect of a spill of 20,000 barrels of diesel oil and Bunker C oil on the natural resources in Panama. The authors reported that dead and dying young sea turtles were observed on oiled mangrove beaches two months after the spill. They did not examine the turtles to determine the exact cause of death.

- DELIKAT, 1980

The IXTOC I well blowout resulted in a discharge of oil into the Gulf of Mexico in 1979 and 1980. The oil eventually impacted portions of the Mexican and Texas coasts. The annual summer nesting ground of the

Kemp's ridley sea turtle is located along the eastern Mexican coast, and in the summer of 1979 this nesting ground was threatened by the IXTOC spill. This paper summarized the efforts of the various state and federal agencies in establishing a second breeding population at Padre Island, Texas. Almost 2000 eggs were transported to Padre Island, and the hatching success of this second population was seventy percent. Preliminary hatching in 1980 was up to ninety percent. The paper tentatively concludes that the turtle hatchlings suffered no apparent harm from the spill, however the author does stress the need for studies to monitor long-term impacts.

- HOOPER, 1981

This report summarized the numerous scientific studies that were conducted during the IXTOC I well blowout. Seven living, oiled sea turtles including six green and one Kemp's ridley were collected during the spill. Only one of the green turtles was thoroughly oiled and had to be cleaned and rehabilitated. The remaining individuals were not severely impacted, and did not warrant cleaning. In addition, two oiled green turtle carcasses and one oiled Kemp's ridley carcass were recovered from the Texas coast. Preliminary autopsies indicated that there was no apparent cause of death other than oil contamination. There was no indication of oil ingestion.

- MARINE TURTLE NEWSLETTER, 1990

This newsletter reports on a heavily oiled green sea turtle discovered in the waters off Kona, Hawaii in July 1989. The turtle, which was still alive when discovered, was encased in approximately five pounds of tar. The entire external body was covered with tar, except for its nose. The turtle was cleaned and rehabilitated, and as of January 1990, was still alive. The oil covering the turtle was believed to be weathered bunker or refined fuel oil. The oil may have come from the Lanai-Molokai oil spill which occurred several months earlier.

- GITSCHLAG, 1991

The *Mega Borg* oil spill, off the coast of Texas, resulted in a discharge of 4.3 million gallons of Palanca Angola crude oil. This paper examined the impact of the oil on the sea turtles. No turtles were observed swimming amidst the oil, and only one turtle (a loggerhead) was captured in the waters near the spill. There was no external oiling of the turtle, and no indication of internal petroleum contamination based on an analysis of the feces. This turtle was tagged, released, and followed for six months. During that period, the turtle survived.

SUMMARIES OF LABORATORY AND FIELD STUDIES

- FRITTS AND MCGEHEE, 1982

This study, performed in 1980, consisted of a field portion which studied the effect of weathered IXTOC oil on the incubation and hatching success of Kemp's ridley turtle eggs, and a laboratory portion which looked at the effect of fresh South Louisiana crude oil on the incubation and hatching success of loggerhead turtle eggs. The study found that, because the toxic volatile components had been greatly reduced in weathered oil, there was little effect of the IXTOC oil on the eggs. Fresh South Louisiana crude oil, however, resulted in increased mortality and also affected hatchling morphology.

- VARGO ET AL., 1986

The purpose of this research, conducted from 1982 to 1985, was to study the possible effects of weathered South Louisiana crude oil on hatchling and juvenile loggerhead and green sea turtles. The turtles were held in pools or tanks and were exposed to either chronic (0.05 cm oil layer for 96 hours) or acute (0.5 cm oil layer for 48 hours) levels of oil. The study found that numerous physiological and behavioral effects were exhibited by sea turtles from their exposure to crude oil. These effects included changes in the breathing rate, white blood cell count, blood glucose levels, salt gland functioning, and skin appearance.

SUMMARIES OF PELAGIC TAR STUDIES: OBSERVATIONS AND LABORATORY STUDIES

- WITHAM, 1978

This paper reports on three small green turtles that were found on Florida east coast beaches in 1976. One was found dead, having eaten a tar ball. Another was found alive but covered with oil. It eventually died. The third turtle was picked up alive, but had tar in its mouth. Subsequent cleaning resulted in the eventual release of the turtle.

- WITHAM, 1983

This paper reported that 27 small sea turtles impacted by oil or tar had been handled by the Florida Department of Natural Resources between 1978 and 1983. Sixteen of the turtles died, the remaining 11 were rehabilitated. Tar was found to have sealed the mouths and nostrils of the turtles.

- VARGO ET AL., 1986

In addition to the work mentioned above, this study also determined if experimental effects of oil exposure were similar to exposure to oil in the natural environment. The authors obtained six stranded living sea turtles that were oiled (probably from pelagic tar) and made clinicopathological measurements identical to those performed in the laboratory experiments. Three of the turtles had depressed red blood cell, hemoglobin, and hematocrit counts. Four were emaciated and had low blood glucose levels. Several experienced inflammation and reddening of the skin. These results correlate in part with the experimental data discussed above. Of the six turtles studied, one died. An autopsy revealed the liver had cellular degeneration and a severe, diffuse hepatocellular change. This condition could not be specifically associated with the oil contamination.

- VAN VLEET AND PAULY, 1987

This study, based on work performed in the report by Vargo *et al.* (1986), examined the chemical composition of pelagic tar found in or on nine

stranded turtles, including three green, two hawksbill, three Kemp's ridley, and one loggerhead. The tar, analyzed to determine its source, was found to have originated from crude oil tanker discharges. No analysis on the nine turtles was conducted to determine how the tar affected the turtles' physiology. Previous studies cited in this report indicate that the highest concentration of pelagic tar is along southeast Florida. Turtles located along this part of the coast may be more subjected to pelagic tar. This assumption is supported by data from the Florida turtle stranding network which indicates that the highest number of turtle strandings are along the southeast coast. The authors conclude that crude oil tanker discharge is having a significant effect upon the turtle population.

- GRAMENTZ, 1988

A study conducted off the coast of Malta examined loggerheads inadvertently caught in fishing nets. Of the 99 turtles examined, 12 were contaminated with crude oil, four with crude oil and plastic litter, and one with crude oil and metal litter. Tar was found on the flippers, necks, and mouths of the impacted turtles and coating plastic pieces the turtles ingested. The author observed that turtles did not avoid crude oil. He also stated that it is not known if small quantities of oil are harmful but large quantities of oil or tar can immobilize small, young turtles and eventually cause death due to exhaustion.

CONCLUSIONS

The results of the above studies, specifically the laboratory and field oiling ones, indicate that crude oil has detrimental affects on sea turtle eggs, hatchlings, and juveniles. The major conclusions from these studies are summarized below.

- The number of unhatched eggs in a nest are much higher when fresh crude oil is on the surface of the sand during the last half or quarter of incubation. This effect could be due to the crude oil aromatics in the nest atmosphere which displace or inhibit the use of available oxygen during the period of

development when the rate of oxygen consumption is reaching its peak (Fritts and McGehee, 1982).

- Hatchling morphology is affected by the amount of oil and time of oiling. The hatchling weight is lower and the size is smaller when the eggs are exposed to a light dosage of oil mixed in the sand, or when the oil is applied to the surface of the sand half way through the incubation process. The reason for this effect may be due to oxygen displacement, as mentioned above (Fritts and McGehee, 1982).

- Weathered oil is less toxic to turtle eggs than fresh crude oil. Therefore the effects on turtles of a one-time spill on a nesting beach are relatively short-lived, and may only affect one reproductive cycle. Another point to consider is how fresh oil can get to a turtle nest. The nests are normally located above the high tide level and therefore only susceptible at very high tides. If the oil did not affect the eggs, the salt water may, as it has been shown that salt water inundation negatively affects hatchling survival and morphology (Fritts and McGehee, 1982).

- Young turtles exposed to oil in water respond by increasing their dive time and by diving deeper (Vargo *et al.*, 1986).

- Crude oil causes reddening and sloughing off of the skin of juveniles, which can reduce the viability and increase the chance of infection (Vargo *et al.*, 1986).

- The oil increases respiratory rate, and decreases the blood glucose level (Vargo *et al.*, 1986).

- The oil causes an immune system response as indicated by an increase in the white blood cells (Vargo *et al.*, 1986).

- The oil also interferes with the functioning of the salt gland, thereby upsetting the water balance and internal ion regulation (Vargo *et al.*, 1986).

- In the Vargo *et al.* study, the turtles recovered from all the oil effects they experienced. Because the oil was in the water where they were held, the turtles had no means of avoiding the oil, thus the conditions outlined in the Vargo *et al.* study may be more severe than those encountered in the natural environment. However, the pelagic tar research did indicate that there was some correlation between the laboratory results and the natural

environment. One possible reason why the turtles recovered from their exposure was that after removal from the oil, all turtles were cleaned, held in filtered sea water, given high quality food, and treated with antibiotics. The research did not take into account that in the natural environment disease and predators may kill the already weakened animals (Vargo *et al.*, 1986).

- The turtles feed on objects floating at the water surface, therefore they are susceptible to tar balls. Oil ingested by the turtles does not pass rapidly through the digestive track, but is instead retained for several days. During this time toxic components of the oil can be passed on to other organs or tissues (Van Vleet and Pauly, 1987).
- Turtles are exposed to the tar which accumulates in the windrows of Sargasum. When their flippers become coated with the tar, they may clean their flippers, thereby contaminating their mouths. The tar may then impede feeding, which could lead to starvation (Vargo *et al.*, 1986).

Certainly more research needs to be conducted in this area as there are still unanswered questions. However it appears that oil does affect the behavior and physiology of juvenile sea turtles, the hatching success of the eggs, and morphology of the hatchlings. Although the oil may not directly kill the turtles, it may weaken them to the point that they are more susceptible to predation or disease.

A review paper published in 1980 discusses the potential problems relating to coastal management of sea turtles. The author notes that one possible way turtles are exposed to petroleum products is by ingesting contaminated food. He states that many filter feeder and detrital feeders concentrate pollutants, and these animals are food items for turtles. Some species of sea turtles eat pelagic jellyfish, which concentrate contaminants (due to their place in the food web). Because these turtles specialize in this one prey item, they may be ingesting high levels of pollutants (Frazier, 1980).

A 1990 publication by the National Research Council titled "Decline of the sea turtles: causes and prevention" evaluated the population decline and causes of mortality in sea turtles. The report mentions very little about the effect of oil pollution on the turtle. The executive summary states: "Deaths resulting from ingestion of plastics and debris and from accumulation of toxic substances, especially from ingested petroleum residues, could be important, but the committee was

unable to quantify them". The study cites lack of data on physiological effects of pollutants in sea turtles as the reason the effect of the pollutants on the turtles' survival could not be estimated. The report goes on to say that additional information is needed on the reaction of sea turtles to petroleum ingestion, fouling, and toxicity (NRC, 1990).

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