# Chapter 5 Response Considerations for Sea Turtles

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## *Key Points*

- Spill responders must consider sea turtle-related tradeoffs in several ways, depending on spill location, time of year, and species of turtle.
- Sea turtles are likely to be at greatest risk when they are aggregating, usually peaking around nesting and hatching periods, and when they are foraging in convergence zones.
- Spill response in sea turtle habitat uses standard techniques, but they are modified to accommodate unique features and sensitivities of sea turtle behavior and life history.
- Several aspects of sea turtle biology and behavior place them at particular risk, including lack of avoidance behavior, indiscriminate feeding in convergence zones, and inhalation of large volumes of air before dives.
- While more common as a management technique, intrusive intervention to remove turtles or nests should be considered a response measure of last resort.

The preceding chapters have shown that sea turtles are vulnerable to oil exposure by many different routes—primarily due to the unfortunate overlap of habitat utilization by turtles and the physical behavior of oil. Turtle habitats include fine-grain sand beaches (nesting), seagrass beds and coral reefs (foraging), and open water convergence zones and sargassum mats (developmental). These habitats are often the places where oil strands or aggregates, hence there is an enhanced potential for sea turtles to encounter spilled oil. Since we know that oil harms turtles, reducing exposure should be the focus of response actions. As Lutz (1989) noted, "the potentially harmful effects of an oil spill on sea turtles must clearly be taken seriously, and any strategy to prevent turtles from encountering the oil must be regarded as a preferred frontline defense."

However, while reducing or preventing turtles from encountering oil is the preferred, obvious, and logical strategy, it is not necessarily easy or even possible. No response action is 100 percent effective, but any reduction in oil exposure reduces the potential stress on threatened sea turtle populations. Spill response planners should thus ask the following questions related to sea turtles:

- What are the open water and shoreline response actions we might consider in the event of a spill in an area frequented by sea turtles?

- Given the habitat preferences and unique features of sea turtle life history, do we need to modify standard response practices to accommodate sea turtles and minimize the impact to their populations?
- How would we do this?
- Can we anticipate spill impacts to turtles well enough that contingency plans will operationally reflect what we know?

**USFWS - U.S. Fish and Wildlife Service (U.S. Department of the Interior).**

**Section 7 consultation - requirement under the Endangered Species Act for federal agencies to address potential impacts of their actions on threatened species.**

NOAA and the U.S. Fish and Wildlife Service (USFWS) share trustee resource responsibility under Section 7 of the Endangered Species Act to address any potential impacts of a spill response on sea turtles and their critical habitat. Area contingency planning must consider possible impacts to listed species from response activities and how to avoid or mitigate them. During an actual response, emergency consultations for Section 7 concerns would be held to consider specific response actions and how they might impact sea turtles. Figure 5.1 shows a schematic of how the consultation process works.

Responses to oil spills depend on the product spilled and the environment at risk. The general features of spill response equipment and strategies are described in other publications.[2] In this chapter, we provide some basic information on response activities that might be considered in sea turtle habitat.

## *Open-Water Response Options*

The overlap of oil and habitat also implies that sea turtles may be at increased risk from response activities themselves. Some of these activities and their impacts are discussed below.

### Mechanical Recovery Offshore

Spilled oil on water is contained and collected using equipment such as booms and skimmers.[3] At many spills, mechanical collection is relied upon as the primary on-water cleanup method, but experience has shown that mechanical recovery alone cannot adequately deal with large spills offshore. Prior to the *Exxon Valdez* oil spill, average mechanical recovery effectiveness was typically estimated at around 10 to 20 percent, although it may be up to an average of about 30 percent now (PMG, Inc. 2001). Weather and ocean conditions, the nature of the oil, and other factors can limit the effectiveness of mechanical recovery. For example, containment booms do not perform well in heavy waves, in shallow waters, or in swift currents—an estimated 58 percent of all spills occur in water moving over 1 knot (PMG, Inc. 2001). Even under ideal circumstances, mechanical recovery may not successfully control large spills or oil that has spread over large areas. In such cases, alternative open-water response techniques, such as dispersant application or *in-situ* burning of oil on water, may significantly reduce the time that oil remains on the surface, the formation of tarballs, and the risk that oil will reach shore.

***In-situ* burning - response technique in which spilled oil is burned in place.**

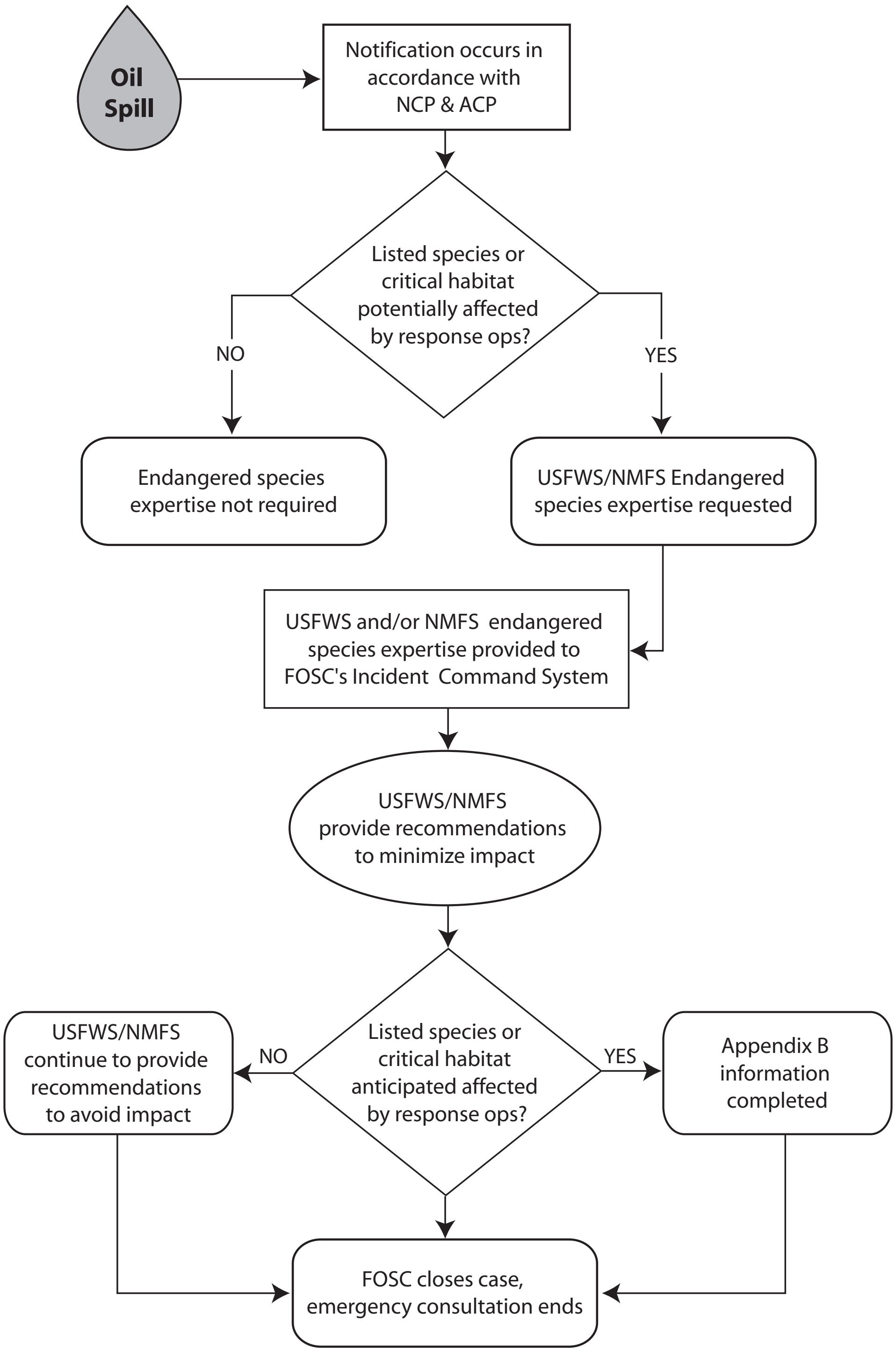



*Figure 5.1 Schematic of Section 7 endangered species consultation process (from U.S. Coast Guard 2002).*

**NCP**- **National Contingency Plan.**

**ACP**- **Area Contingency Plan.**

**FOSC**- **Federal On-Scene Coordinator.**

The timing of a spill would define the threat to turtles imposed by boom deployment at a particular location. A spill at nesting or hatching time could have severe consequences to a turtle population. At other times, impacts might be minimal. In either case, consultation with resource experts and careful monitoring for turtle activity is advisable throughout a spill response in order to consider impacts of proposed response strategies on nesting and hatching events.

**Offshore Dispersant Application**

Chemical dispersants contain surfactants that reduce the surface tension of oil, enabling the oil layer to be broken into fine droplets that mix into the water column and are dispersed by currents. Most oils will, to some degree, physically disperse naturally from agitation created by wave action and ocean turbulence; chemical dispersants are designed to enhance this natural process. Rapidly dispersing oil early in a spill reduces the oil on the water surface and thus the amount of oil available to be driven ashore by winds. In contrast, oil droplets dispersed in the water column are unlikely to strand ashore because they are driven by currents, not winds. An added benefit of dispersing oil is that dispersants inhibit the formation of tarballs, a known hazard for turtles.

Dispersants are typically sprayed directly onto floating oil as fine droplets, either from aircraft or boats, generally within the first several hours after a spill. Under appropriate conditions, lighter fuel to medium crude oils can be easily dispersed; heavier bunker oils much less so. Weathering increases oil viscosity and may cause formation of water-in-oil emulsions, which are less amenable to dispersion. Among the advantages of dispersants are that they can treat large areas of spilled oil quickly and effectively before the slick can spread significantly; can be applied in rougher weather and sea conditions than mechanical recovery methods; and can be used in areas too remote to deploy mechanical protection and cleanup methods.

**ppm** - **parts per million.**

Ideally, chemical dispersants should be applied in well-mixed waters, where the dispersed oil plume can be diluted to low levels before reaching productive nearshore waters. After dispersion into the water column, spreading or diluted oil becomes three-dimensional, and concentrations drop rapidly. The highest concentration of chemically dispersed oil typically occurs in the top meter of water during the first hour after treatment. Concentrations of more than 10 parts per million (ppm) of dispersed oil are unlikely below 10 m; even within 1 m, concentrations rarely exceed 100 ppm. The continuous mixing and dilution of open waters are sufficient to rapidly reduce these concentrations; field studies indicate that they decline to nearly undetectable or background levels within several hours of application. Dispersed oil droplets break down by natural processes such as biodegradation. The chemical dispersants applied, like the oil droplets, are diluted by diffusion and convective mixing, and readily biodegrade. Laboratory studies indicate that dispersed oil biodegrades much more rapidly than undispersed oil (within days to weeks).

Untreated surface oil can recoalesce in surface convergence zones even after it has spread to a very thin layer, and surfactants help to prevent this reoccurrence. Since juvenile turtles aggregate along convergence zones, using dispersants should reduce their exposure to oil. Dispersants also reduce adherence of oil droplets to solid particles and surfaces, and may reduce the tendency of oil to stick to turtle skin.

Unfortunately, little is known about the effects of dispersants on sea turtles, and such impacts are difficult to predict in the absence of direct testing. While inhaling petroleum vapors can irritate turtles' lungs, dispersants can interfere with lung function through their surfactant (detergent) effect. Dispersant components absorbed through the lungs or gut may affect multiple organ systems, interfering with digestion, respiration, excretion, and/or salt-gland function—similar to the empirically demonstrated effects of oil alone.

Although early dispersants contained components that were highly toxic to aquatic life, toxicity is significantly reduced in modern formulations. For fish and other species that have been tested, dispersed oil is generally no more toxic than undispersed oil. Lutz created a very general framework for considering toxicity of oil dispersants to sea turtles (Figure 5.2) based on known effects of oil and hypothesized impacts of chemical dispersants, but direct experimental evidence to support the framework has not been generated.

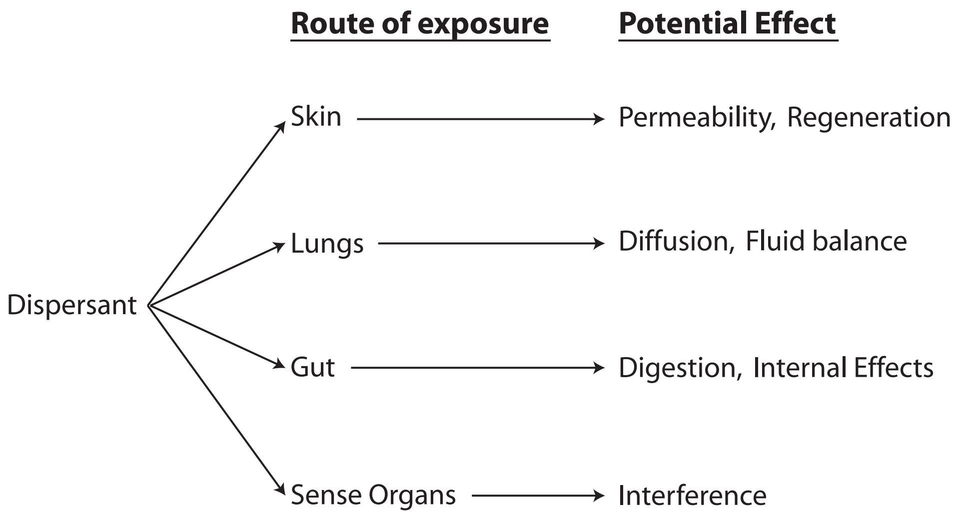



*Figure 5.2 Conceptual framework for considering chemical dispersant effects to sea turtles (adapted from Lutz 1989).*

As a general practice, surveying to ensure that no marine mammals or sea turtles are present can minimize the likelihood of direct contact with dispersant chemicals. Spraying might also be discouraged where turtles congregate, such as sargassum mats and convergence zones. But even with the disadvantages of dispersants, the consequences of sea turtles coming into contact with and ingesting floating oil (see Chapter 4) may argue for using their use to retard the formation of tarballs.

If applied appropriately offshore, chemical dispersants could be an effective tool for protecting turtles and the nearshore habitats they utilize. Possible effects on organisms in the water column and tradeoffs among resources at risk (such as coral reefs and seagrass beds) should be considered in spill response planning and decision-making.

Most regions that are home to turtle nesting sites and foraging areas have dispersant contingency plans in place. These plans have designated, specific pre-approval zones and guidelines for dispersant use, facilitating the decision-making process should a spill occur.[4]

## Offshore *In-situ* Burning

*In-situ* burning is a response technique in which spilled oil is burned in place. Under appropriate conditions, *in-situ* burning can remove large quantities of oil quickly and efficiently. Although this method has been effectively used for certain shoreline habitats (marshes, for example), consideration here is limited to using it on the open ocean.

In a typical *in-situ* burn in open, marine waters, oil is collected within a fire-resistant, U-shaped boom, towed away from the main slick, and ignited. The boom is towed slowly to maintain the oil toward the back end—at the bottom of the U—and at a sufficient thickness to sustain the burn. Most crude and refined oils will burn on water if the oil layer is at least a few millimeters (more than 2 to 3 mm) thick. The technique is less effective if winds are blowing harder than 20 knots and seas are higher than a half to 1 m, impeding the operator's ability to control the boom and maintain the necessary oil thickness. *In-situ* burning can be used simultaneously with other oil spill response techniques or when other techniques are not feasible. The response window can last several days, although burn efficiency is reduced by significant emulsification, evaporation of lighter and more easily burned volatiles, and spreading of spilled oil. Consequently, burning at sea is most effective early in a spill response.

A major potential advantage of *in-situ* burning is that it can remove large quantities (over 90 percent at maximum efficiencies) of contained oil, potentially exceeding the maximum efficiencies of mechanical and chemical response methods. Burning also requires less equipment and fewer personnel and produces less waste for disposal than other cleanup techniques. In remote areas and near sensitive habitats, where minimizing disturbance is desirable, *in-situ* burning can offer significant logistical and environmental advantages.

Potential disadvantages of *in-situ* burning include production of highly visible smoke and other combustion by-products. Using this method in highly populated areas may be restricted due to concerns about the effect of fine particulate material in the smoke on human respiratory health. Special Monitoring of Applied Response Techniques (SMART) protocols were developed by the U.S. Environmental Protection Agency, the U.S. Coast Guard, NOAA, and the Agency for Toxic Substances and Disease Registry (ATSDR) to monitor particulate levels and provide real-time feedback to responders when burning is conducted near population centers. Such feedback helps responders determine levels at which smoke does not pose human health risks.

**ATSDR - Agency for Toxic Substances and Disease Registry, U.S. Department of Health and Human Services.**

A practical limitation of burning is that the specialized boom that is used is expensive and not widely stockpiled around the coasts. Despite its limitations, the general consensus among researchers is that *in-situ* burning has a definite role in certain inshore situations (e.g., oil trapped in marshes), in ice, and where oil is being continuously released from a stationary source such as a well blowout (PMG, Inc. 2001).

Presumably, any *in-situ* burning would involve surveying the immediate area for turtles before proceeding. During a 1993 full-scale test of *in-situ* burning off the coast of Newfoundland, wildlife surveillance and hazing teams reportedly spotted a sea turtle in the test area prior to the burn ignition, but there was no indication of adverse effect to it or any other wildlife. Obviously, *in-situ* burning would be an unlikely response choice where sea turtles aggregate—although in such an area, the impacts of prolonged or heavy exposure to untreated surface oil would be evaluated against the risks. The ability of response crews to sufficiently control and steer burning oil away from turtles in the water would be a major factor. Although a burn operation is fairly localized, whether sea turtles would avoid it is not known.

While the effects of smoke on sea turtles in particular have not been studied, at least one physiologist asserts that "lungs are lungs" and the effects should be similar for all air-breathing vertebrates. Evaluating human health risk from smoke plumes has focused on inhalation of very fine particulate material (termed PM10, or particulate material less than 10 microns in diameter) as the greatest risk factor. Fine particles can become lodged deep within the alveoli of the lungs, compromising respiratory capacity. Because turtles must surface regularly to breathe, they are at risk from inhaling gases and particulates present in a plume near the surface. Another hazard is that after a burn, a small percentage of the original oil volume remains as a taffy-like residue, which must be collected and disposed of properly. Since turtles are known to ingest tarballs and other solid materials they encounter, it is important that these residues be removed. In addition, under certain circumstances burned oil can sink, so operational personnel should evaluate the potential for burn residues to be denser than seawater. If this is likely to

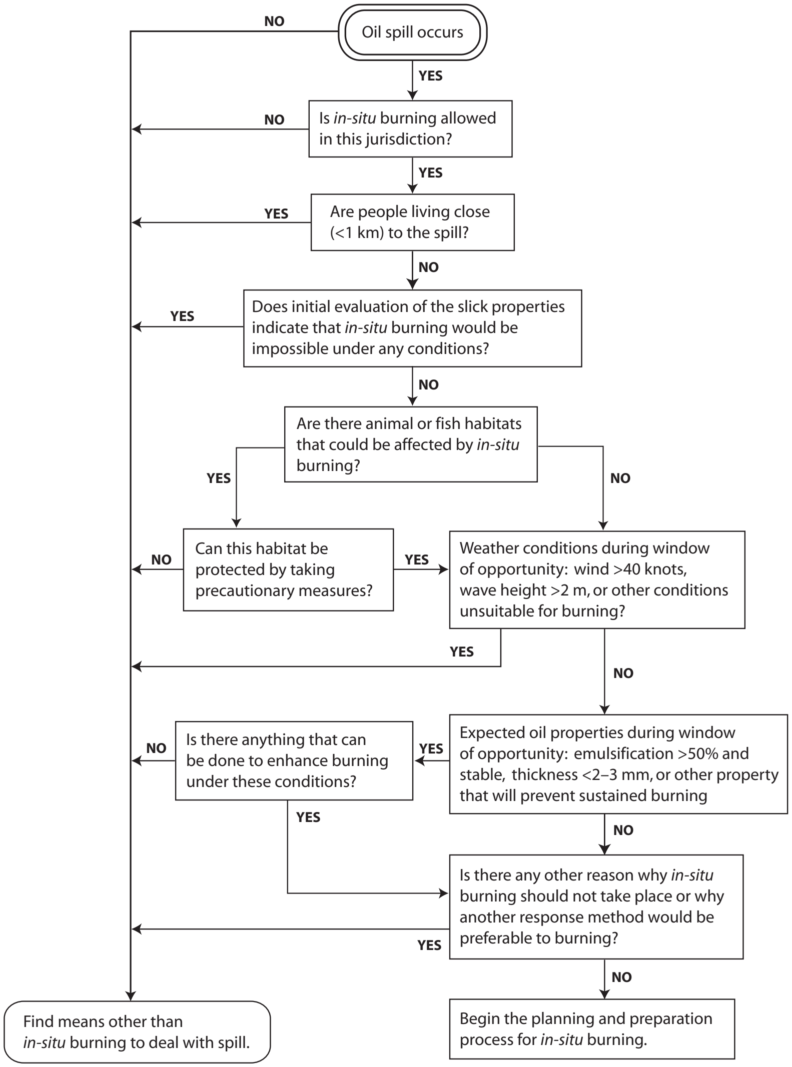
**PM10 - particles with an aerodynamic diameter less than or equal to a nominal 10 micrometers.**

happen near sea turtle habitat, *in-situ* burning would not be appropriate because sea turtles might try to eat the submerged oil residues.

Laboratory and field studies of potential toxicity effects indicate situ burning does not have adverse effects on the underlying water column beyond those associated with unburned oil. Almost all heat is directed upward and outward, so heat absorbed by the underlying water is generally negligible, particularly where currents continuously exchange water beneath the burn.

Figure 5.3 portrays a decision flowchart for *in-situ* burning that illustrates how wildlife considerations are factored into the overall framework for evaluating use of the technique.

*Figure 5.3 Decision flowchart for evaluating in-situ burning as a spill response option (adapted from U.S. Coast Guard and Environment Canada 1998).*



## *Shoreline Cleanup*

Oil stranded on shorelines presents the greatest risk to sea turtles during the nesting season (Lutcavage et al. 1997). When oil comes ashore after nests have been dug and eggs laid, the response priority would be to protect the nests during cleanup and make every effort to remove oil from beaches and nearshore areas before eggs hatch and hatchlings head to sea (incubation is two months).

The general requirements for nesting beaches (Chapter 2) are that they be high enough to prevent tidal inundation, porous enough for gaseous exchange, and have moisture and sand grain characteristics that permit effective excavation. Depending on the specific situation and the time of year relative to nesting, many of the usual and accustomed shoreline cleanup methods appropriate for sand beaches may be employed—but with additional caveats. Manual methods, mechanical cleanup (with some constraints), use of sorbents, sediment reworking, and vacuum techniques have all been successfully used to collect and/or reduce the degree of oiling on sand beaches. Oiled wrack or debris could also be collected and disposed—although this would need to be balanced against the increased foot traffic and potential for disturbance.

### Passive Methods

Passive response methods rely on some mechanism to collect and hold oil until workers can remove it for disposal. The most common are absorbents and adsorbent booms and pads, which act as sponges to bind and channel oil. Adsorbent equipment, primarily "pom-poms" or snare booms, bind oil to exterior surfaces of oil-attracting (oleophilic) material (Figure 5.4). Either approach requires tending to ensure proper deployment and replacement when saturated with oil.

*Figure 5.4 A sea turtle nest endangered by the 1993 Bouchard B155 oil spill in Tampa Bay. The trench and adsorbent snare boom (black material on the ocean-facing side of the nest) are intended to reduce the severity of exposure from any oil stranding near the nests. Photo courtesy of Dr. Anne Meylan, Florida Fish and Wildlife Conservation Commission, Florida Marine Research Institute.*

### Manual and Mechanical Oil Removal

Both manual and mechanical removal methods work well on sand beaches, and both have been used at turtle nesting sites. Manual removal is preferred because it requires less heavy equipment and tends to remove less sand. Sand removal should be minimized as much as possible on turtle nesting beaches, and beach profiles should not be altered because female turtles coming ashore to dig nests could become disoriented. However, if oiling is extensive and subsurface oiling is present, mechanical methods can be used with some precautions and careful oversight. A combination of mechanical and manual removal methods were used at spills in Tampa Bay and Puerto Rico (see pages 76 and 78).

**Oleophilic** - **oil-attracting.**

Disposing of oiled sand is an important aspect of manual or mechanical removal, because it involves transporting potentially large quantities of material to treatment or disposal sites. Offsite treatment, and later replenishment, is an alternative that can be considered, especially where sand is not naturally replenished on beaches. At the *Berman* barge spill in Puerto Rico, oiled sand was treated off-site; however, the cleaned sand was not redeposited on the beach. Instead it was used for construction projects.

Turtle nests should not be disturbed during cleanup activities. This guidance is complicated by the fact that, in most cases, when oil is threatening a nesting beach during nesting season, the majority of sea turtle nests will be unmarked. If nesting locations are known, they can be protected by controlling access routes to the beach, marking and fencing sites, and carefully deploying equipment and personnel. It is unlikely that turtle nests would be directly impacted if shorelines were oiled after eggs had been deposited, since females typically dig nests well above the high-tide line. However, survey and response workers could conceivably crush eggs, and sand could be compacted over nests, which would make it difficult for hatchlings to emerge. At the barge *Bouchard B155* spill in Tampa Bay (page 76), the relatively small number of turtle nests on area beaches made it possible for volunteers to clearly mark nest locations and protect them with a fence. Hatchlings were collected, transported south to another county, and released (A. Meylan 2002[5]). Mechanical cleanup methods were used extensively at this spill, largely because of the challenge of removing thick layers of buried oil. However, response vehicles were restricted to the middle and lower intertidal levels, well away from nesting sites.

Generally, fencing and marking nests after a spill, or when a threat exists, works only for the most recent nests, not for those that have been in the ground for a longer time. Figure 5.4 illustrates some important aspects of the approach resource managers used during the *Bouchard B155* spill: the nest is conspicuously marked (not simply a stake), and it encloses a large area that includes a buffer. The buffer area was a critical protective zone when the beach was worked by heavy equipment (A. Meylan 2002[6]).

## Bioremediation

Bioremediation, specifically adding nutrients to a spill area, can speed oil degradation in many habitats, including sandy beaches (Venosa et al. 1996). A major limitation of bioremediation at turtle nesting beaches is that it takes at least several weeks before oil is successfully degraded to background levels. Time is often critical when cleaning oil in turtle habitats. If oiling occurs when no turtles are present or expected within approximately six weeks, then nutrients could be added after the major portion of the oil has been removed by other methods.

One approach considered to be a bioremediation technique on sand beaches is tilling, in which the beach surface is worked with equipment to expose and aerate oil residues. Although tilling is frequently used on recreational beaches (it resembles grooming practices common in such areas), it is not recommended on nesting beaches because it would be disruptive.

**Vacuuming**

Vacuuming can remove pooled oil or thick oil accumulations from the sediment surface, depressions, and channels. Vacuum equipment ranges from small units to large suction devices mounted on dredges or trucks. Vacuuming can be used effectively on heavier and medium oils, provided they are still reasonably fluid. Lighter, more flammable petroleum products, such as jet fuel and diesel, generally should not be vacuumed.

## *Indirect Response Impacts*

Unintended adverse impacts to turtles may be caused by response activities, and should be anticipated and controlled. Examples include:

- Foot and equipment traffic in nesting areas. Compressing sand in the upper intertidal and dune areas should be avoided because compression makes it more difficult for females to dig nests and for hatchlings to dig themselves out. Equipment and personnel also can crush eggs in nests. Vibrations from heavy machinery may result in hatchlings emerging from their nests during the day, timing that would leave them more vulnerable to predators (S. Milton 2002[7]).
- Artificial light. Any artificial lighting associated with the response should be minimized during the nesting season, because females and hatchlings, which are attracted to bright light, are easily disoriented by artificial lighting. Turtle researchers try to minimize even the use of flashlights at night. Witherington and Martin (2000) provide extensive, detailed information and guidance on lighting considerations that affect sea turtle behavior. This would prove to be a practical and relevant reference during a major spill response in which beach activity could take place at night.
- Artificial barriers on the beach, including berms, sorbents, and booms can prevent hatchlings from reaching the water and adult females from reaching potential nesting sites. For hatchlings, temporary entrapment by a boom can increase the risk of predation during their migration to the water, when they are especially vulnerable to predators.
- Small boat traffic and increased collision risk. Boat operators working in offshore shallow areas need to be cognizant of the risk of colliding with swimming turtles and take precautionary measures.

## *Preventative Measures*

A potential worst-case scenario was faced during the Ixtoc I well blowout in 1979, when the only nesting site of the Kemp's ridley turtle was threatened by oil during the nesting season. When there seems to be no other option, or if a large percentage of an entire species' population may be at risk from oiling, nests may need to be relocated or hatchlings captured and released at a location free of oil.

### Relocating Nests

Relocating sea turtle eggs should only be undertaken when other alternatives are not available. Nests should be relocated only within 12 hours of egg deposition, after which moving an egg is likely to disturb the newly attached egg membranes and kill the embryo. Eggs may also be moved after 14 days of incubation (Limpus et al. 1979). The eggs should be handled gently and any unnecessary movement (especially rotation) avoided. If relocation is adopted as an option during a spill, only trained, experienced, and authorized personnel may disturb nests or move eggs. In addition, specific permits from state and federal regulators will likely be necessary for specialists handling turtles and turtle nests.

### Capture and Release of Hatchlings

Another mitigation technique is to leave the eggs to hatch naturally from their nests, but to capture the turtle hatchlings before they migrate to the water. Hatchlings are then released at an alternative location, free of oil. This technique was used for Kemp's ridley hatchlings during the Ixtoc I spill (described in greater detail on page 73).

## *Application of Sea Turtle Information for Spill Response and Planning*

Since we already know that it is a good idea to prevent sea turtles from coming into contact with oil, finding operational and practical spill response information is important in any response planning. An initial question asked at any incident is, "What is at risk?" For turtles, a spill response tool developed and supported by NOAA is the Environmental Sensitivity Index (ESI) atlases, which portray geomorphology (shoreline characteristics) and resource information for an area. Turtles are a major feature of Florida's ESI maps, which depict nesting beaches, in-water distribution, shoreline habitats, species composition, seasonality, relative concentration, nesting beach survey boundaries, and source documentation (Zengel et al. 1998). Much of the information was provided by state biologists and resource managers. Figure 5.5 is an example of the resultant product.

**ESI** **- Environmental Sensitivity Index map.**

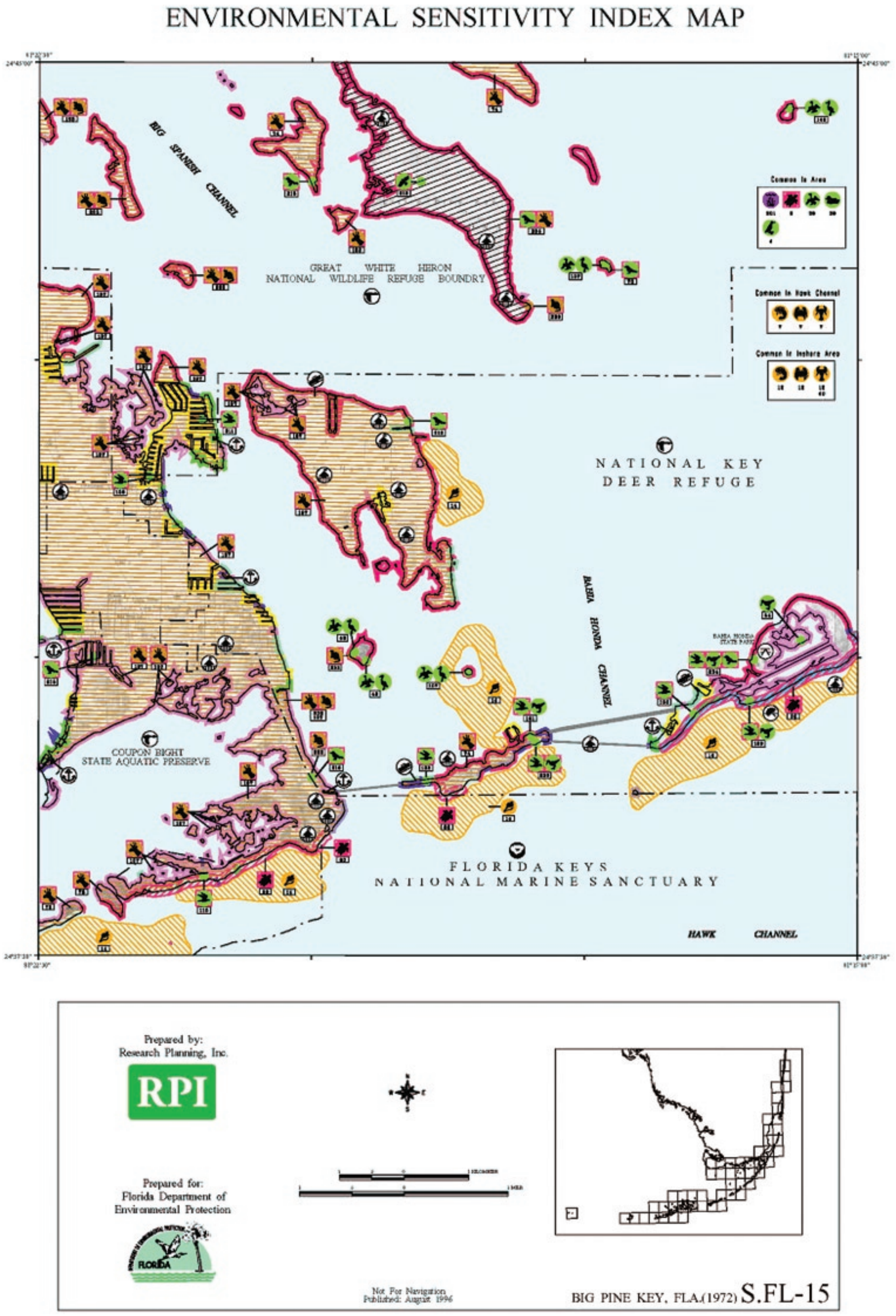
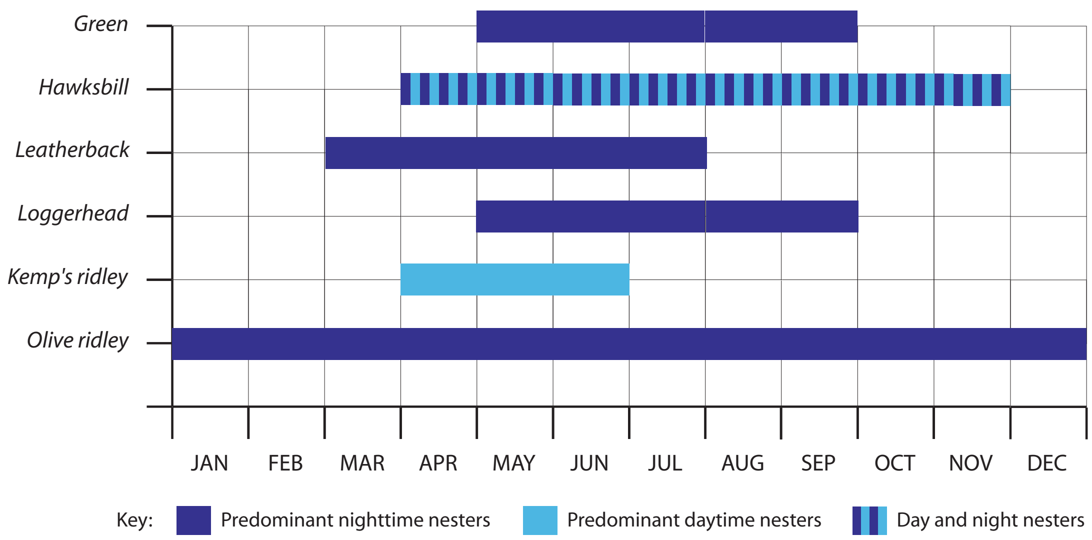



*Figure 5.5 An Environmental Sensitivity Index map for South Florida's turtle habitat areas.*

In other U.S. waters, there is enough basic information about nesting patterns that can be consolidated into a quick graphic reference that shows which turtles might be at risk at a given time of day and year from an oil or hazardous chemical release and subsequent response to it. Figure 5.6 shows that the middle of the year—from around March through September—is when oil spilled on or near nesting beaches would likely result in the greatest exposure to turtles. Conversely, December through February is a period of low activity near the beaches themselves. The figure also shows the generally observed day and night timing patterns for nesting across species; that is, which species typically come ashore at night and which ones come ashore during the day. As might be expected, this graphic comes with a qualifier; it should be used as a general reference only, and local biological experts should always be consulted as the primary source of information.

*Figure 5.6 Times when oil near or on nesting beaches will have the most and least effect on turtles, by species. From Miller (1997) and U.S. Fish and Wildlife Service (2003).*




In the United States, the state of Florida has been most active in attempting to provide a standardized approach to interactions with sea turtles and sea turtle nests. Florida has developed comprehensive guidelines for dealing with sea turtles on state beaches. Excerpts from a single section of Florida's "Marine Turtle Guidelines" are included as Appendix B. The full document is available online at http://floridaconservation.org/psm/turtles/Guidelines/MarineTurtleGuidelines.htm.

Appendix B includes only the material that might be instructive for spill response and shoreline survey activities, nesting surveys, and identification of nesting sites. The guidelines describe appropriate ways to identify and mark nesting sites, which might be adapted for use during oil spill responses. While a spill responder needs to have a complete understanding of how various spill containment and cleanup operations may affect sea turtles in the water and on the nesting beach, he or she does not need to have the sort of training that permit holders possess to handle marine turtles, hatchlings, and nests. Florida permit holders have this information already, and other states may have different requirements. As previously noted, anyone engaging in these direct activities with sea turtles would need to be properly permitted and possess this expertise and training.

Readers are encouraged to view the complete Florida guidelines to more fully understand the complexities of managing turtles in close proximity to human populations. While they are specific to Florida (other jurisdictions will have different or perhaps conflicting policies for dealing with turtle issues), they are nevertheless relevant and usable for spill responders in the field.

During a Fort Lauderdale oil spill of undetermined origin in 2000 (see page 79), both the U.S. Fish and Wildlife Service (USFWS) and the Florida Fish and Wildlife Conservation Commission sea turtle staff were asked to provide general guidance on how to minimize impacts to sea turtles. The following simple guidelines were provided (S. MacPherson 2002[8]):

- Daily early morning nesting surveys should be completed prior to any heavy equipment being allowed on the beach.
- Nests should be marked for avoidance by heavy equipment.
- Hatchlings emerging from nests in an area where oil is present on the beach and/or in the adjacent offshore area should be collected and released on a non-impacted beach.
- If oiled turtles start washing ashore, stranding surveys may need to be increased to more than once per day.

## Handling and Rehabilitation

Beyond the observation that turtles are seriously harmed by oil contact, we know very little about actual cause-and-effect relationships related to sea turtle oil exposure. Not knowing what physiological systems are most vulnerable, it is not possible to recommend precise rehabilitation measures, except those related to salt gland function (detailed below). Otherwise, little firm information is available on which to base rehabilitation best management practices during an oil spill. As a result, well-intentioned but questionable ad hoc rehabilitation efforts have been documented: for example, in 1990, a young hawksbill turtle covered with crude oil was found off Kralendijk, Bonaire, and taken to a mariculture facility, where it was cleaned with kerosene and detergent (Sybesma 1992).

**STSSN - Sea Turtle Stranding and Salvage Network.**

While not necessarily oil-specific, there are, however, well-established procedures in many areas of the United States for dealing with stranded sea turtles , defined as those that wash ashore either dead or alive. A national Sea Turtle Stranding and Salvage Network (STSSN), established in 1980, provides protocols for documenting and handling stranded animals (Shaver and Teas 1999). In the event of an oil spill where sea turtles could be affected, state coordinators for the STSSN (where designated) should be contacted, and shoreline assessment activities should be coordinated with these trained and permitted experts. Appendix C is a list of current STSSN coordinators for the Atlantic and Gulf coasts.

Some guidance for handling sea turtles during spills does exist and is included below as reference material and to serve as a possible basis for action. Appendix A, the at-sea handling protocol prepared by Dr. Anne Meylan of the Florida Marine Research Institute, is one example. The protocol was created during the 1993 *Bouchard B155* barge spill in case large numbers of turtles were encountered during the response and cleanup. Although they are simple, common sense guidelines, they provide a consistent and standardized framework for dealing with sea turtles and are a useful addition to spill response guidance in a specific setting.

Another example, which would be applied under the auspices of trained wildlife veterinarians and resource managers, is more narrowly focused on treatment and monitoring of oiled sea turtles in a rehabilitation center. Walsh (1999) provides an excellent overview of general rehabilitation practices for sea turtles, and other experienced wildlife veterinarians and physiologists (e.g., Bossart 1994[9]; Mignucci-Giannoni 1999) have provided insights that might be incorporated into standard operating procedures during cleaning and rehabilitation activities for a given spill. Some procedures are shared with bird-cleaning protocols; others have been found to work well with turtles in particular. The guidelines are:

- Remove surface oiling

  . . . dishwashing detergent (e.g., Dawn®) or other mild surfactants have been used, along with copious amounts of warm water (Walsh 1999).

  . . . food oils, such as olive, sunflower, or soy, have been found to be effective in breaking up and removing external oiling (Mignucci-Giannoni 1999; Levy 2002[10])
- Rinse and dry
- Repeat cleaning

  . . . 24 to 48 hours later dependent on health status (cleaning cycle repeated until all physical oiling removed (Mignucci-Giannoni 1999)
- Clean head and oral cavities

  . . . (cloths dampened with food oil)
- Administer organic fats (mayonnaise)

…via force-feeding tube (Walsh 1999; Levy 2002; Schaf 2002[11]) to facilitate clearance of oil or tar fouling in the esophagus and gastrointestinal tract.

- Orally administer material to coat gastrointestinal lining

  …and provide relief from irritation (olive oil or Pepto-Bismol®) (Mignucci-Giannoni 1999; Bossart 1994[12])

  …if ingestion is suspected, charcoal-containing compounds may decrease absorption of hydrocarbons that can cause organ damage (Walsh 1999)

- Support with fluids

  …(interperitoneal if necessary)

- Monitor output of tears

  …(secretions) from salt glands (see discussion below)

- Reassess health status daily

  …serial blood samples can help to direct therapy (Walsh 1999)

  …consider euthanasia for very poor condition animals (USFWS permits required)

*Figure 5.7 An oiled green turtle recovered by the Israeli Sea Turtle Rescue Center in August 1999. This and another individual were cleaned, rehabilitated, and released about two months later. The source of oiling was not identified. Photo courtesy of Yaniv Levy, Israeli Sea Turtle Rescue Center, Hofit, Israel.*

Observations in the sea turtle oiling experiments conducted by Lutcavage et al. (1995) (Chapter 4) and at the 1993 Tampa Bay spill suggest that oil exposure can cause turtle salt glands to effectively shut down, at least temporarily. In the Tampa Bay incident, this phenomenon was observed in sea turtles that were cleaned prior to release. Because the salt gland function appears to return to normal slowly, Lutcavage (1994[13]) and Lutz (2002[14]) recommend holding rehabilitated animals for at least 10 to 14 days in isosmotic, one-third seawater and monitoring the osmolarity of salt gland output by collecting and measuring tear salinity with an osmometer.

**Osmolarity - the concentration of an osmotic solution, especially when measured in osmols or milliosmols per liter of solution.**

As noted in Chapter 2, the sea turtle salt gland is not always turned "on;" that is, it must be stimulated by exposure to a salt load. Differences in osmolarity of secretions are substantial between inactive and active salt glands. Lutz (1996) summarized results from several studies to show that the scant secretions from inactive salt glands measure around 300 to 400 milliosmol/kg (about equal to turtle plasma), while stimulated salt gland secretions average around 1,900 milliosmol/kg, about twice the salinity of seawater. Lutz noted that the osmolarity for salt gland secretions from two species, greens and loggerheads, were nearly equal: 1,900 and 1,854 milliosmol/kg. In a spill rehabilitation setting, veterinary staff should, at a minimum, ensure proper function of salt glands before releasing individuals back to the wild, because animals may be imperiled if released prematurely (M. Lutcavage[15]).

Finally, for veterinary professionals dealing with the basics of sea turtle care and rehabilitation, a recently published NOAA technical memorandum, "The Anatomy of Sea Turtles" (Wyneken 2001) is a key reference document. This profusely illustrated, in-depth technical document should be considered as a remarkable and necessary resource for those involved in veterinary medicine related to sea turtles. It is currently available in three forms: print, CD-ROM, and online in pdf format at http://courses.science.fau.edu/~jwyneken/sta/).

## *For Further Reading*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## Chapter Notes

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[2] See, for example, *Characteristics of Response Strategies: A Guide for Spill Response Planning in Marine Environments* (American Petroleum Institute et al., 2001) for an overview of typical response options for several habitats.

[3] Detailed descriptions of the various containment and collection techniques and equipment can be found in the comprehensive *Field Guide for Oil Spill Response in Tropical Waters*, available from the International Maritime Organization (IMO).

[4] See, for example, the Caribbean Regional Response Team Dispersant Usage Plan (CRRT 1995). See p. 66.

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