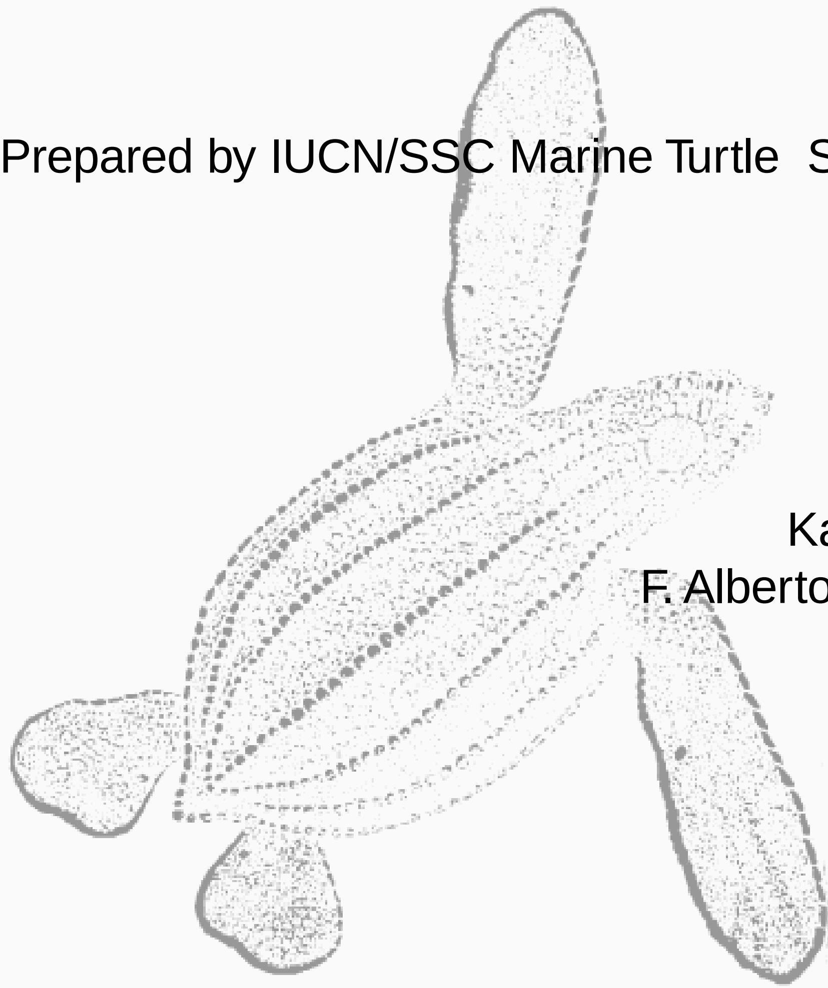
Research and Management Techniques for the Conservation of Sea Turtles



Prepared by IUCN/SSC Marine Turtle Specialist Group

Edited by
Karen L. Eckert
Karen A. Bjorndal
F. Alberto Abreu-Grobois
M. Donnelly

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To order copies of this publication, please contact:

Marydele Donnelly, MTSG Program Officer
IUCN/SSC Marine Turtle Specialist Group
1725 De Sales Street NW #600
Washington, DC 20036 USA
Tel: +1 (202) 857-1684
Fax: +1 (202) 872-0619
email: mdonnelly@dccmc.org

Preface

In 1995 the IUCN/SSC Marine Turtle Specialist Group (MTSG) published *A Global Strategy for the Conservation of Marine Turtles* to provide a blueprint for efforts to conserve and recover declining and depleted sea turtle populations around the world. As unique components of complex ecosystems, sea turtles serve important roles in coastal and marine habitats by contributing to the health and maintenance of coral reefs, seagrass meadows, estuaries, and sandy beaches. The *Strategy* supports integrated and focused programs to prevent the extinction of these species and promotes the restoration and survival of healthy sea turtle populations that fulfill their ecological roles.

Sea turtles and humans have been linked for as long as people have settled the coasts and plied the oceans. Coastal communities have depended upon sea turtles and their eggs for protein and other products for countless generations and, in many areas, continue to do so today. However, increased commercialization of sea turtle products over the course of the 20th century has decimated many populations. Because sea turtles have complex life cycles during which individuals move among many habitats and travel across ocean basins, conservation requires a cooperative, international approach to management planning that recognizes inter-connections among habitats, sea turtle populations, and human populations, while applying the best available scientific knowledge.

To date our success in achieving both of these tasks has been minimal. Sea turtle species are recognized as "Critically Endangered," "Endangered" or "Vulnerable" by the World Conservation Union (IUCN). Most populations are depleted as a result of unsustainable harvest for meat, shell, oil, skins, and eggs. Tens of thousands of turtles die every year after being accidentally captured in active or abandoned fishing gear. Oil spills, chemical waste, persistent plastic and other debris, high density coastal development, and an increase in ocean-based tourism have damaged or eliminated important nesting beaches and feeding areas.

To ensure the survival of sea turtles, it is important that standard and appropriate guidelines and criteria be employed by field workers in all range states. Standardized conservation and management techniques encourage the collection of comparable data and enable the sharing of results among nations and regions. This manual seeks to address the need for standard guidelines and criteria, while at the same time acknowledging a growing constituency of field workers and policy-makers seeking guidance with regard to when and why to invoke one management option over another, how to effectively implement the chosen option, and how to evaluate success.

The IUCN Marine Turtle Specialist Group believes that proper management cannot occur in the absence of supporting and high quality research, and that scientific research should focus, whenever possible, on critical conservation issues. We intend for this manual to serve a global audience involved in the protection and management of sea turtle resources. Recognizing that the most successful sea turtle protection and management programs combine traditional census techniques with computerized databases, genetic analyses and satellite-based telemetry techniques that practitioners a generation ago could only dream about, we dedicate this manual to the resource managers of the 21st century who will be facing increasingly complex resource management challenges, and for whom we hope this manual will provide both training and counsel.

Karen L. Eckert
Karen A. Bjorndal
F. Alberto Abreu Grobois
Marydele Donnelly
Editors

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Reducing Threats To Nesting Habitat

Blair E. Witherington
Florida Department of Environmental Protection, Florida Marine Research Institute, 9700 South A1A, Melbourne Beach, Florida 32951 USA; Tel: +1 (407) 674-1801; Fax: +1 (407) 674-1804; email: spinnaker@ prodigy.net

Overview

Favorable nesting habitat is critical for sea turtle reproduction and is central to the survival of sea turtle populations. Threats to nesting habitat are defined as any action or process that can alter the sand substrate of the nesting beach, injure or kill sea turtles or their eggs, and/or cause the disruption of normal behavior patterns. The purpose of this section is to describe several such threats and to propose responses that promote sea turtle conservation.

There are at least four response categories in mitigating agents that threaten nesting beach habitat. The first and best response is to eliminate the threat. For example, restricting sand mining to inland deposits, prohibiting beach driving, and turning off beachfront lighting that would otherwise misdirect hatchlings. In some cases, it may be sufficient to restrict harmful activities to periods outside the nesting and hatching seasons, which extend from the date of first nesting to approximately two months after the last nest is laid.

A second response is risk reduction, or managed risk. The goal of managed risk is to reduce the probability of a threat occurring and to reduce the negative effects of a threat when is does occur. Managed risk is an important proactive response to oil spills, for example. Other applications of managed risk include the use of "turtle friendly" beachfront lighting in development plans in order to reduce the probability of hatchling misdirection and mortality, and the establishment of setback requirements for beach developments so that the need for coastal armoring is reduced.

A third response is to move eggs from high-risk areas to safer natural beach areas (see Boulon , this volume) or enclosed hatcheries (see Mortimer, this volume). Although moving eggs can sometimes be the only way to save them, this response can have many negative effects. Even careful excavation, movement, and reburial of sea turtle eggs can reduce hatching and emergence success, alter hatchling sex ratios, and reduce hatchling fitness. Moreover, egg translocation does not protect nesting females from the same effects threatening their eggs and can eliminate incentives to remove threats on the nesting beach. For these reasons, the translocation of eggs should be considered *only* as a last resort and only when high egg mortality has been demonstrated and is certain.

A fourth response is to do nothing. Some threats *(e.g.,* chronic erosion) either cannot be eliminated or threaten too few nests to justify costly mitigation. The cost of mitigation may be a financial loss, the loss of conservation opportunities elsewhere, or a biological loss *(e.g.,* harming when one intends to help). Care should be taken not to overestimate the consequences of natural threats. It is reasonable to assume that the selective pressures of these threats on sea turtles have shaped biological mechanisms to mitigate them and that nesting in locations that seem risk-prone may actually provide a fitness advantage to developing hatchlings. For instance, some nests deposited low on the beach may be successful despite moderate erosion and overwash. On some beaches, the reduction of pathogens by overwash can make these nests among the most productive nests on the beach.

Erosion and Accretion

It is in the nature of beaches to erode and accrete. When these processes become extreme during the nesting-hatching season, females can experience difficulty in nesting and eggs can be uncovered, inundated, or swept away. Extreme erosion and accretion can occur during storm events, during periods of high wind, or when the placement of man-made structures modifies the natural movement of sand along the coastline. Nesting access is reduced by eroded escarpments and by uprooted, woody dune vegetation that may subsequently accumulate on the beach. Severe accretion can deposit sand over existing nests so that developing eggs suffocate and hatchlings are prevented from escaping.

Although the natural events that cause erosion and accretion cannot be stopped, their consequences can sometimes be lessened. Fallen trees and debris can be removed (but should not be excavated) from the beach, escarpments can be leveled, and the profile of the beach can be restored by artificially "nourishing" the beach with sand (see below). No action that requires heavy machinery should be conducted during nesting and hatching seasons. Even a beach that appears devastated by erosion may have surviving nests that would be damaged by work vehicles and the movement of sand. Sometimes doing nothing is the best strategy; beaches that are unaffected by man-made stabilization structures often recover fully over the course of a few months.

Tropical storm forecasting seldom gives accurate predictions of landfall more than 24 hr in advance. Although damage from these storms can be severe, it is often localized in an area that cannot be predicted. Given the negative effects of translocating eggs and the unpredictability of storms, moving large numbers of nests prior to a forecasted storm is not recommended.

Chronic erosion, as opposed to acute storm-generated erosion, may destroy some nests placed low on the beach, but these losses are frequently overestimated. As a general rule, nests should only be translocated if they are low enough on the beach to be washed daily by tides or if they are situated in well documented high-risk areas that routinely experience serious erosion and egg loss *(e.g.,* nests laid near river mouths or beneath eroding sea walls)

Beach Armoring

Beaches are sometimes armored to protect coastal property from erosion. Armoring can include sea walls, rock revetments, sandbag structures, sand fencing, gabions, and other rigid structures. Beach armoring can eliminate nesting habitat, exacerbate erosion, block access by nesting turtles, and fatally entrap turtles. Structures built perpendicular to the coast and intended to control long-shore sand movement *(e.g.,* groins and jetties) present similar threats to nesting habitat. Such structures typically exacerbate erosion on down-current sand beaches.

The best way to reduce the threat of armoring is to eliminate the necessity for it. Any permanent structure built immediately adjacent to the beach or on the primary dune is likely to become threatened by erosion; thus, development near sea turtle nesting beaches should adhere to conservative setback requirements. On relatively stable beaches construction should not take place within approximately 50 m of the zone of mean high water. This setback distance should be greater for shorelines with more dynamic cycles of erosion and accretion. If structures do become threatened by erosion, they should be moved away from the sea if at all possible; armoring (which is expensive and very often ineffective) should be the last resort. Replacement of beach sands by beach nourishment is a preferred alternative to armoring, but presents its own suite of adverse consequences (see below).

Artificial Beach Nourishment

Artificial beach-nourishment (sometimes referred to as beach renourishment or rebuilding) is the artificial replacement of sand that has been lost to erosion. Like beach armoring, artificial nourishment only becomes necessary when valuable man-made structures are threatened by erosion (although there may be ancillary incentives, such as the desirability of a wide beach for tourism). Methods for beach nourishment include mechanically dumping or pumping sand from outside sources onto the beach or scraping sand from the lower beach to deposit it onto the upper beach.

Although beach nourishment is a preferred alternative to armoring, it is not without negative effects. The suitability of a nourished beach as nesting habitat depends on the quality of sand used and the method(s) of deposition. Some nourished beaches have an excessive clay, silt, and shell content, and may have a spatial distribution of sand grains that is poorly sorted. These conditions may leave the nourished beach prone to the formation of escarpments and may produce sand that is too compact for nest excavation by sea turtles. Sand on a nourished beach also may vary greatly in moisture content, solar reflection, and thermal conduction, which can affect nesting, hatching success, and hatchling fitness (reviewed by Crain *et al.*, 1995).

If artificial nourishment is selected as a management response, it should only be undertaken outside of the nesting-hatching season. Nourishment during the nesting-hatching season will bury nests and destroy eggs. Translocation of nests prior to nourishment projects is an incomplete way to protect nests from burial. Movement-induced mortality (to embryos) is likely and surveyors will be unable to locate some nests. Data from Florida (USA) indicate that approximately 8% of freshly deposited sea turtle nests are incorrectly identified as abandoned attempts even by trained surveyors. Nourishment activities commonly take place continuously, day and night, and require lighting, activity, and equipment that can be disruptive to nesting and fatal to hatchlings.

No nourished beach will perfectly match the sand that has eroded away. It is not clear how well quality-control of sand and choice of spreading methods can limit the differences between nourished and natural sands. A principal criterion by which nourished beaches are judged is the similarity of sand compaction to the original beach sand. Crain *et al.* (1995) offer a range of compaction values and methods by which compaction can be measured. Nourished beaches that are too compact are often tilled, however, it has not been determined whether this will significantly soften beach sands.

Sand Mining

Sand mining operations remove large quantities of sand from beaches to be used as fill, in the making of concrete, and for other construction activities. Sand mining diminishes the profile of the beach and promotes instability. The persistent removal of beach sand disrupts stabilizing vegetation, exacerbates erosion, and can eliminate nesting habitat. Mining should not be allowed to occur on sea turtle nesting beaches.

Commercial sand mining extracts sand at a faster rate than it is replenished by natural coastal processes; thus, it is a serious threat whether conducted during or outside the nesting-hatching season. Translocation of nests away from a beach to be mined is a poor solution to this threat. It is noteworthy that mining sand on beaches up- or down-current from nesting habitat also degrades nesting habitat, since large scale sand extraction disrupts the complex interchange of sediments along the coast. Similarly, mining sediments from the water near beaches should be carefully evaluated for potential effects on beach erosion, since offshore material is essential for natural beach maintenance. It is recommended that sand extraction sites be confined to inland quarries or properly evaluated offshore sites.

Beach Lighting

Artificial lighting near nesting beaches deters sea turtles from nesting and interferes with the ability of hatchlings to move from their nest to the sea. In part, hatchlings reach the sea by orienting toward the brightest horizon (see Witherington and Martin, 1996, for a review). The brightness of artificial lighting can misdirect hatchlings away from the sea and leave them vulnerable to dehydration, exhaustion, and predation. As a consequence, any artificial lighting visible from a nesting beach can cause high hatchling mortality.

Nighttime beach surveys should be conducted so that specific problem light sources can be identified. A surveyor should walk the entire length of the beach at the tide line looking for artificial light sources. Any source visible from the beach should be noted by describing its location, appearance, and methods by which it can be corrected (see methods below). Because artificial lighting problems may develop during the nesting-hatching season, multiple surveys should be conducted. A survey conducted before the nesting season begins will allow managers time to correct potential lighting problems and follow-up surveys during the season will reveal what corrections have yet to be made.

There are many ways to alter light sources so that their effect on sea turtles is reduced (Witherington and Martin, 1996). Although permanent alterations are best, temporary alterations made during the nesting-hatching season can be sufficient to protect sea turtles. The most widely applicable solutions include the following:

1. Turn lights off during the nesting-hatching season. This is the simplest, most effective, and least expensive solution, but it may not be accepted by property owners in cases where lighting is deemed essential for security or other reasons.
2. Lower, shield, recess and/or redirect lights. These actions are effective to the extent that they reduce the amount of light reaching the beach. Dune vegetation, existing buildings, and opaque shields can be used to hide light sources from the beach. Fixtures that are designed to control light well and that are directed down and away from the beach are among the best types of lighting to use near sea turtle nesting beaches (Figure 1).
3. Close curtains or blinds after dark and apply a dark tint or film to windows that face the beach. Light from the interior of buildings can also be

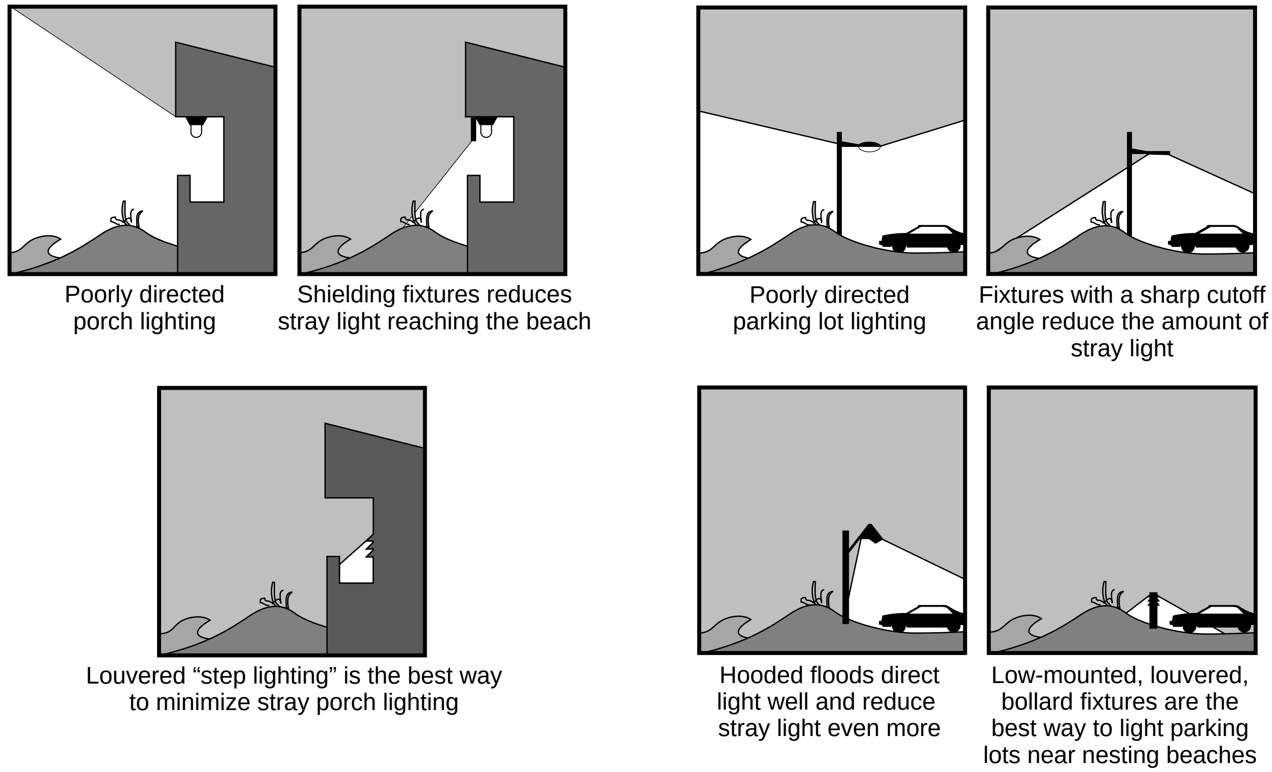

Figure 1. Light management techniques for building and pole-mounted lighting near sea turtle nesting beaches.

reduced by moving lamps away from beach-side windows.

4. Use light sources that sea turtles see poorly. Sources that emit very little short wavelength light *(e.g.,* pure yellow and red sources) are less disruptive to nesting and hatchling sea turtles than are sources that emit a substantial amount of short-wavelength light *(e.g.,* violet, blue, and green sources, or any source that appears whitish or golden). Low-pressure sodium vapor sources (not to be confused with high-pressure sodium vapor sources) are the purest yellow light sources and may be the best commercially available light sources for applications near nesting beaches. Yellow incandescent light bulbs, commonly called “bug lights,” can be acceptable if used sparingly. Neither low-pressure sodium nor bug lights are completely harmless and they can affect some species more than others (Witherington and Martin, 1996); therefore, they should be shielded or directed so that they are minimally visible from the beach.

Light management rather than light prohibition is the most realistic conservation policy for developed sea turtle nesting beaches. To gain cooperation from property owners, they should be reassured that light management will allow them to direct light onto their property where it is needed as long as that light does not “leak” out onto the beach. For a detailed presentation of light management techniques for sea turtle nesting beaches, see Witherington and Martin (1996).

Vehicles, Foot Traffic, and Livestock

Vehicular activity (including beach cleaning equipment), foot traffic, and livestock on the beach all have the potential to expose or crush eggs, and to interfere with the ability of hatchlings to reach the sea. Hatchlings awaiting emergence within nests are particularly vulnerable to crushing and to entrapment resulting from a collapse of the airspace within the nest.

Heavy vehicles such as automobiles, trucks, earth-moving equipment, and beach-cleaning tractors can cause much greater disturbances than foot traffic. Wheeled and tracked vehicles that deeply penetrate soft sand leave ruts that can entrap hatchlings. Although hatchlings can escape from most footprints, they often choose to crawl for great distances within tire ruts, thereby decreasing the chances that they will enter the sea. Hatchlings may stay crawling within ruts due to their tendency for orientation toward open areas.

Mechanized beach cleaning involves the raking of flotsam and litter from the beach. Mechanical raking can penetrate nests, expose eggs, and destroy them.

Other effects of beach cleaning include effects that are common to other vehicular activities.

During the nesting-hatching season, vehicular traffic and livestock should be kept off nesting beaches and the dune, especially at night when most hatchlings emerge from nests and when females of most species attempt nesting. Due to the effects of tide on beach width, it is seldom practicable to simply restrict vehicles or livestock to the lower beach where nesting is infrequent. Because it is not yet known how extensive mortality from these sources can be, translocating nests to mitigate the damage may not be justifiable; efforts to remove the threat(s) should take precedence.

Where vehicular use is required for emergency access, law enforcement, research, or management activities, only vehicles with low-pressure tires (< 35 kPa or 5.0 psi, as with most "balloon-wheeled" all-terrain motorcycles) should be used. Vehicular activity should be restricted to below the high tide mark. Where human foot traffic is extensive, as is the case for urban bathing beaches, or where mechanized beach cleaning is conducted, nests can be cordoned off to protect them from disturbance. Raking by hand is preferred over the use of beach-cleaning machines.

Obstacles

Debris *(e.g.,* rope, fishing line, glass, metal, plastic, and Styrofoam), recreational and work equipment *(e.g.,* chairs, chaise lounges, watercraft, umbrellas, parked vehicles, pipes, refuse cans, tarpaulins), structures *(e.g.,* cabanas, shanties, animal pens, boardwalks, fencing), and other obstacles have the potential to entrap, entangle, and impede nesting turtles and their hatchlings. Potentially harmful debris should be removed from the beach at regular intervals. Complete cleaning of the beach (from the extraction of large stumps to the removal of low density accumulations of beached seaweed) is seldom necessary and may be detrimental. Seaweed and other debris should never be buried on the beach during the nesting-hatching season.

Most of the threat from recreational equipment can be eliminated by pulling equipment and watercraft off the beach at the end of the day. Cabanas and shanties should be positioned away from areas where turtles nest. Structures on the beach should be supported by a single pole rather than multiple poles which can entrap turtles. Ideally, specific areas with no nesting should be designated for watercraft launching.

Oil Spills

Oil spills frequently occur in catastrophic proportions and can pose grave threats to marine and coastal ecosystems. Sea turtles are one group among many groups of organisms affected by spills. Spills that take place during the nesting-hatching season can be lethal to all life stages on or near the beach: mating pairs, nesting females, eggs, hatchlings, and young post-hatchlings at sea. Oil cleanup activities can also be harmful. Earth-moving equipment can dissuade females from nesting and destroy nests, containment booms can entrap hatchlings, and lighting from nighttime activities can misdirect them.

The difficulty of mitigating the effects of oil spills on sea turtle nesting beaches should provide an incentive to locate oil transport activities away from important nesting areas. Nonetheless, oil spills have some potential to occur on almost any beach. Because of this threat, many areas have government or contract teams prepared to respond to spills with extensive equipment and personnel.

The best strategy for lessening threats to sea turtles is for local sea turtle conservation biologists to coordinate with these spill response teams before spills occur. Response teams or the government entities that oversee them should be given summary information on nesting and hatching seasons, density of nesting, species occurrence, and whom to contact about specific nest information. Where possible, sea turtle workers should keep in summary form, specific information on where nests are and when they were deposited. Sea turtle workers can assist in reducing the harm from oil cleanup activities by clearly marking nest areas (if known) and examining containment booms for trapped hatchlings.

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