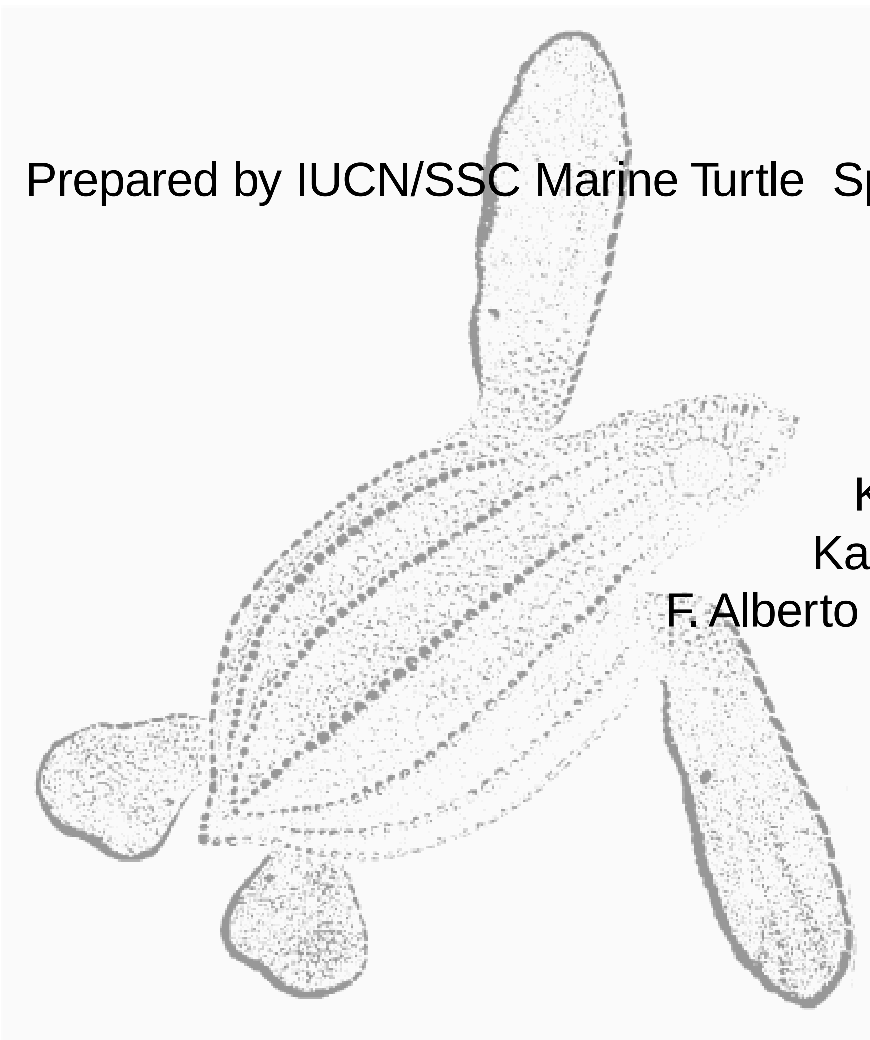
# Research and Management Techniques for the Conservation of Sea Turtles



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## 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.

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***Research and Management Techniques for the Conservation of Sea Turtles***
*K. L. Eckert, K. A. Bjorndal, F. A. Abreu-Grobois, M. Donnelly (Editors)*
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# Reducing Threats to Foraging Habitat

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It is intuitive that protecting sea turtles, eggs and hatchlings from harm is only the first step to ensuring the survival of threatened and endangered populations. Strategies to reduce or eliminate threats to foraging and nesting habitats must be an important part of any management plan (see also Witherington, this volume). Foraging habitat is, to a large extent, species specific; collectively, however, most species rely heavily on coastal marine ecosystems for food. There are some life-stage exceptions, including epipelagic post-hatchling dispersal *(e.g.,* see Carr, 1987).

Since most marine resource managers are concerned with waters under national or provincial jurisdiction, coastal waters receive the most management attention. This is befitting, since most threats to the marine environment emanate from land and thus the coastal zone is disproportionately affected. This section reviews major threats to sea turtle foraging habitats in coastal waters, especially coral reefs and seagrass. Integrated Coastal Zone Management (ICZM) is proposed as the most effective long term response. Specific remedies to persistent threats *(e.g.,* anchoring) are also described. To maximize the effectiveness of specific remedies, they should be imposed as part of a holistic coastal zone protection strategy.

## Threats to Foraging Habitat

### *Declining Water Quality*

An overall general decline in water quality, particularly in relation to activities which increase turbidity, is perhaps the most important factor affecting coastal habitats. Seagrasses require a greater percentage of incident light than most other marine aquatic plants. Their distribution is restricted by depth, temperature and salinity, but depth as a function of light availability is the main limiting factor. Hence, the first areas to be affected by a decline in water clarity are the deeper seagrass beds where light attenuation is more severe (Kenworthy *et al.,* 1988, 1991).

Turbidity can be increased by sediment runoff from land-based sources as a result of poor land clearing practices for agriculture, forest products, road construction and other development. Similarly, dredging for navigational purposes or shoreline reclamation can significantly increase nearshore turbidity in localized areas, thus affecting proximal seagrasses. Physical alteration of the sea bed, such as occurs during dredging, blasting and anchoring, can also be an important contributing factor in reducing the area of seagrass cover.

Increased levels of nutrients *(e.g.,* sewage, agrochemicals) discharged from land-based sources can also lead to higher turbidity because the nutrients result in higher levels of phytoplankton in the water column. In addition, increased nutrient levels generally enhance the growth of epiphytes on the blades of seagrasses, causing a shading effect which can lead to grass mortality. If water quality is improved, seagrass productivity increases and with deeper light penetration, seagrass distribution also increases. As a direct result, fish and other wildlife dependent on seagrasses also benefit, including both herbivorous and omnivorous sea turtles (the latter preying upon crustaceans and other invertebrates inhabiting seagrass ecosystems).

As in the case of seagrass, water quality is a limiting factor for coral reefs. Sedimentation and eutrophication are major factors in the worldwide decline of coral reefs (Ginsburg, 1994). Increased levels of sediment smother reef organisms and reduce the light available for photosynthesis. Heavy sedimentation is also associated with lower coral growth and diversity, less live coral cover, reduced coral recruitment, and decreased calcification and coral productivity (Rogers, 1990). Consequently, sedimentation of the coastal zone from dredging and land-based runoff is one of the biggest potential sources of reef degradation from human activities. The effects can be long-lasting, with resuspension and transport of dredged sediment occurring years after dredging has stopped.

Similarly, increased levels of nutrients, such as from under-treated sewage, can cause significant changes in reef communities. Studies in Kaneohe Bay, Hawaii (U.S.) demonstrate that sewage effluent enhances benthic algal biomass and phytoplankton in the water column. The latter led to an increase in benthic filter feeding invertebrates which, together with the benthic algae, competitively excluded corals (Pastorak and Bilyard, 1985).

The many inter-linkages between these dominant tropical marine ecosystems (coral reefs and seagrasses) amplify the negative effects of anthropomorphic threats acting on either one of them. Seagrasses trap and stabilize sediments, preventing sediment from settling on the reef (Ogden, 1983); simultaneously, coral reefs provide a natural breakwater, reducing wave energy and thus creating ideal conditions for the growth of seagrass. A change in one ecosystem as a result of man's activities often has repercussions in an adjacent ecosystem, illustrating their ecological interdependence and emphasizing the need for a holistic approach to their management and conservation.

## *Anchoring*

Indiscriminate anchoring can result in significant scarring to both coral reefs and seagrass, and this problem is increasing as tourism and pleasure boating intensifies around the world. Anchors uproot seagrasses and break the rhizome system; once the roots are disturbed, recovery is slow. Repetitive anchoring in many coastal bays of the U.S. Virgin Islands has so reduced seagrass cover that pastures once extending to 18.5 m now rarely persist below 4 m. With disturbance rates higher than recovery rates in many areas, the ecosystems' capacity to support foraging green turtles is declining (Williams, 1988).

Anchors and anchor chains cause significant localized destruction to corals and other reef organisms, including in protected areas; this and other consequences of multiple use present formidable challenges to coastal zone management *(e.g.,* Rogers *et al.*, 1988). In addition to coral breakage and direct mortality, holes and channels in the reef structure created by repetitive anchoring can alter current patterns and result in the erosion of sediments, thus causing further damage. In his review of the impacts of recreational activities on coral reefs, Tilmant (1987) noted three major concerns for reefs experiencing intensive recreational use: boating, diver and fishing impacts. He noted that physical damage to corals by anchors can be extensive; for example, an estimated 20% of staghorn coral *(Acropora cervicornis)* was destroyed at a popular anchorage area in Florida.

## *Oil Pollution and Marine Debris*

Oil pollution and tar fouling are potential (or actual) hazards in many coastal areas. The Wider Caribbean hosts several large refineries and is characterized by active shipping lanes; more than 700,000 tons of oil are transported through the region each day. Following a spill in Caribbean Panama in 1986, seagrasses declined in biomass and infauna was severely affected, intertidal reefs declined, and sub-tidal reefs suffered significant mortality and sublethal effects (Keller and Jackson, 1993). In addition to damage effected by high profile spills, bilge washing by tankers results in chronic pollution which can stress seagrasses and coral reefs (such as by reducing rates of reproduction).

Garbage disposed at sea, or finding its way to the sea from land-based sources, is a serious global threat to the coastal zone. Death to marine organisms as a result of ingestion or entanglement in marine debris is widespread and well publicized *(e.g.,* Balazs, 1985; Laist, 1987), but perhaps less widely known is the threat that debris poses to the environment. For example, plastic bags can wrap around corals and suffocate underlying tissues (Rogers *et. al.,* 1988). Debris also smothers seagrass, and can leak noxious elements and pose other threats to important foraging habitats.

## *Dynamite and Chemical Fishing*

The use of dynamite, chemicals and coral smashing techniques to capture fish cause irreparable harm to the sea bed, and especially to coral reefs. In the case of dynamite, many non-target fish are killed; others do not float to the surface and therefore are not collected. The physical damage effected by methods such as these destroys the very foundation of the reef, reducing or eliminating its capacity to support commercial fishes and invertebrates, as well as sea turtles. Chlorine and a wide variety of other chemicals are extremely toxic to corals. The application of chlorine bleach or other noxious substances to a reef for the purpose of snaring lobster or obtaining fish (including tropical specimens for the pet trade) kills corals, poisons important nursery areas for commercial fishes, and degrades sea turtle foraging habitat.

### *Other Threats*

Other threats to turtle foraging areas include vessel groundings, certain fishing techniques *(e.g.,* bottom trawling, dropping traps or anchoring blocks indiscriminately on living reef), near shore construction *(e.g.,* piers, marinas), shoreline armoring *(e.g.,* jetties, seawalls), careless snorkeling and diving *(e.g.,* touching, collecting, trampling), reef walking (subsistence gleaning of shallow reef organisms, common throughout the insular Pacific), and other activities which directly or indirectly affect the health or physical integrity of seagrasses, coral reefs, mangroves, estuaries and related coastal ecosystems.

## Integrated Coastal Zone Management (ICZM)

A holistic approach to the sustainable management of coastal resources is requisite to the survival of sea turtles and the foraging habitats upon which they depend. The diversity of threats acting upon these habitats requires an integrated management strategy which can coordinate the activities of many sectors, and involve their input in planning exercises. ICZM meets this need by offering a framework within which concerned agencies can work together toward their common objective of sustainable use of coastal resources (Clark, 1992). The components of a national strategy might include planning and zoning for multiple use of coastal areas, developing a marine protected areas network, conducting research and monitoring programs, identifying and fulfilling needs for legislation, policies and special guidelines, and promoting environmental education. The following components are important for sea turtle habitat.

### *Planning and Zoning*

Effective planning must be closely coordinated at (or between) the appropriate government level(s). ICZM components with direct consequences to sea turtle foraging habitat should focus on improving water quality. For instance, replacing septic tanks and primary/secondary waste water discharges with tertiary waste water treatment; improving watershed management to reduce erosion, thus lowering the sediment load in coastal waters; reducing the use of agrochemicals, thus lowering the runoff of fertilizers and pesticides; developing guidelines with respect to dredging, blasting, and construction in nearshore waters; etc.

Through the process of zoning for multiple use or the designation of Special Management Areas, particular regulations can be introduced which afford protection to, or require mitigating measures for the conservation of, sea turtle foraging areas. For example, prohibiting shrimp trawling in certain areas (such as offshore Playa Rancho Nuevo, Mexico; National Research Council, 1990) or introducing no anchoring zones (Rogers *et. al.,* 1988). One of the simplest methods for preventing damage to seagrasses and coral reefs by anchors is to install mooring buoys at popular anchorage sites; benign and inexpensive technology is readily available *(e.g.,* Halas, 1985).

### *Network of Marine Protected Areas*

As part of the process for planning a system of marine protected areas, sea turtle foraging areas should be identified and mapped. The most important areas should be included within the boundaries of marine parks, thus providing a measure of regulatory protection.

### *Oil Spill Contingency Plans*

In areas subject to oil spill risk, an Oil Spill Contingency Plan should be prepared to ensure that an effective emergency strategy is readily implemented in the event of a spill. An Ecosystem Vulnerability Index should be developed; maps should highlight ecosystems and natural resources most vulnerable to oil pollution (Price and Heinanen, 1992). Emergency response workers should be fully appraised of appropriate protocol in the event that oiled turtles are rescued.

### *Monitoring*

Coral reef and water quality monitoring programs are an essential component of ICZM. Routine monitoring of reefs will indicate changes (positive or negative) over time. The following parameters should be included in the monitoring protocol: species diversity, percentage live coral cover, sedimentation rates, and fish censuses. Several methodologies have been described *(e.g.* UNEP, 1984; Rogers *et al.*, 1994). Appropriate management measures, including zoning for multiple use or closing areas to promote recovery, can be introduced if significant harmful changes are demonstrated.

Water quality management should include establishing criteria or standards which not only avoid further deterioration but also promote improvement. In the case of seagrasses, distribution is tightly controlled by the depth of light penetration. Therefore, the following parameters should be included in the monitoring protocol: total suspended solids, chlorophyll a, dissolved inorganic nitrogen and phosphorus, secchi depth and water color. The light attenuation coefficient can be measured by irradiance meters which detect the wavelengths of light utilized by seagrasses (Kenworthy *et al.*, 1991).

Monitoring programs often require coordination between agencies. When this is the case, data collection techniques should ensure compatibility for the purposes of data analysis.

### *Education*

To ensure that the value of coastal resources and the survival of endangered species, including sea turtles, is appreciated, that the process of integrated coastal management is accepted, and that a participatory approach to management is encouraged, an education program should be introduced at all levels, ranging from policy-makers to school children. Special programs should be prepared to target specific groups such as fishermen and recreational boaters, coastal landowners, and tourists.

## Concluding Remarks

The goal of the ICZM process is "to ensure optimum sustainable use of coastal natural resources, maintenance of biodiversity, and conservation of critical habitats, thus providing the basis for long-term economic development" (Clark, 1992). To conserve migratory species, such as sea turtles, the national planning process should complement a broader international perspective. Issues such as pollution, watershed management, and the designation of protected areas often require a multinational approach (see Trono and Salm, this volume).

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