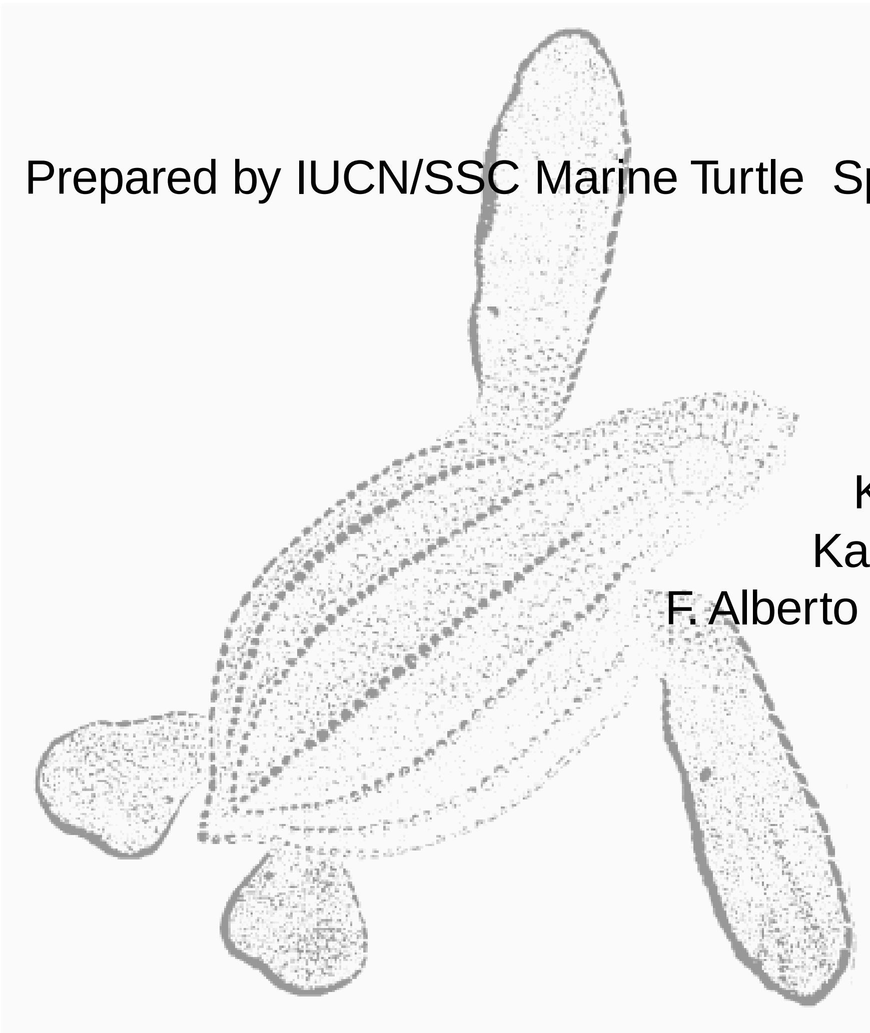
Research and Management Techniques for the Conservation of Sea Turtles



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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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Reducing Threats to Eggs and Hatchlings: Hatcheries

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When to Build a Hatchery

Ideally, sea turtle eggs should incubate in the natural nest. Relocation of eggs to a protected hatchery site should be undertaken only as a last resort and only in cases where *in situ* protection is impossible. At most rookeries, egg relocation programs only benefit clutches deposited in dangerous circumstances—for example, those laid too near the sea, too near artificial sources of light, in armored or erosion-prone areas, or in the path of vehicle or concentrated foot traffic. But even in such cases, *in situ* protection is often sufficient (see Boulon, this volume). In many parts of the world, however, egg depredation by people or by animals associated with people is so intense that mortality approaches 100% in any clutch not relocated to an enclosed hatchery. At sites where the dominant threat is human exploitation, the hatchery must be guarded at all times.

Since the negative effects of hatcheries (see below) are often greater than the risks posed by non-human predators, managers must quantitatively assess rates of depredation before adopting a hatchery program. At sites where depredation is high enough to warrant a hatchery program, the predators involved are usually species introduced by people *(e.g.,* feral dogs, cats, pigs) or species whose populations are unnaturally high as a result of conditions created by people. Such conditions can occur where human refuse provides a supplementary food source for the predator *(e.g.,* raccoons, rats, vultures) or where people have eliminated a predator's natural enemies. Under these circumstances, predator eradication or aversion methods might be considered as complementary to or as an alternative to a hatchery (but see Boulon, this volume).

The Limitations of Hatcheries

Because hatchery programs have the following serious limitations, *they can produce a net negative impact on turtle populations.* Preliminary assessment must conclude that less manipulative options are impractical or ineffective, that hatchery sites are available, that a sufficient proportion of eggs can be collected and suitably transported to the hatchery, that personnel are available to guard the facility, and that financial resources are sufficient for maintenance. The following caveats should be considered:

1. Hatcheries are very expensive in terms of the financial and human resources required to collect and maintain each clutch;
2. The effective operation of a hatchery depends on well-trained, reliable staff, but budgetary constraints usually provide only minimum wage salaries (or force the operation to rely on volunteers);
3. Hatching success in hatcheries is usually lower than in natural nests even when hatcheries are constructed and supervised by conscientious staff;
4. Hatchling sex ratios are often skewed towards one sex or the other, depending on conditions in the hatchery (see Merchant, this volume; Godfrey and Mrosovsky, this volume, for a discussion of temperature dependent sex determination in sea turtles);
5. Improper methods of hatchling release produce high rates of mortality. When hatchlings are released at the same time and place each day, fish feeding stations are created. Moreover, by the time of their release (usually morning), the hatchlings are exhausted from a night of fruitless struggle in the hatchery, most of them having emerged from

the nest within a few hours of sunset the night before. During the night, many succumb to predators (ranging from ants and crabs to birds and small mammals);

6. The establishment of hatcheries as a compromise measure to mitigate the destruction of nesting habitat (such as that caused by artificial lighting) creates a dangerous dependence on human intervention which may be impossible to maintain over time; and

7. Hatcheries have a harmful psychological effect on people. Because they are so labor intensive, they promote or endorse a belief that participants and supporters are doing more good for turtles than they actually are. As a result, programs that are more effective but politically less attractive may be ignored.

Recommended Hatchery Methodology

Hatchery Siting and Construction

Hatcheries should be located as close as possible to the nesting beach to minimize physical trauma to eggs during transportation, to reduce the time interval between when the eggs are laid and when they are planted in the hatchery, to provide the opportunity for embryos and hatchlings to imprint on the nesting beach, and to facilitate hatchling release. To maximize the diversity of conditions in which eggs are incubated and hatchlings released, several hatcheries should be established if possible. The hatcheries should be positioned to include the range of microhabitats utilized by nesting turtles, keeping in mind the need to include representative temperature regimes. Beach surveys can provide information on nest site selection (see Schroeder and Murphy, this volume).

All sea turtle species nest above the high tide line. The surface of the hatchery site should be located at least 1 m vertical distance above the level of the highest spring tides to prevent underground flooding of the eggs. Avoid placing the hatchery where it might be inundated by tidal streams that form behind the beach during very high tides, or near the mouths of rivers or streams where routine or unpredicted flooding could destroy the hatchery. Chain link fence, wire mesh or barbed wire should enclose the hatchery. To discourage crabs and other small burrowing predators from entering the enclosure, a 1-2 m wide strip of netlon mesh (1 cm mesh) should be buried to a depth of at least 0.5 m along the inside of the fence. To prevent infestation from fungus and bacteria, the same hatchery site should not be used during two consecutive nesting seasons.

At beaches where individual nests are at risk from localized threats such as erosion, inundation, or unintentional human disturbance, threatened egg clutches can be selectively relocated to safer points along the beach (see Boulon, this volume). In such cases, where human or animal predation is not a serious problem, it is best not to construct an enclosed hatchery or to employ cylindrical mesh enclosures (see below). Ideally, hatchlings should not be dependent on people for their release.

How Many Eggs?

Many resource managers believe that to maintain a healthy nesting population, at least 70% of the eggs laid should be protected. In cases where the population has already suffered a history of over-exploitation, that figure needs to approach 100%. At some sites, predictable weather patterns produce primarily male offspring during some months and primarily female offspring during other months. To help ensure a natural sex ratio, eggs destined for the hatchery need to be obtained throughout the nesting season in numbers proportional to the amount of nesting that occurs each month for each species.

Collection and Transport

To minimize embryonic mortality due to handling, all eggs should be planted in the hatchery within 2 hr of being laid (no clutch should remain unburied for periods exceeding 5 hr). Where there is an opportunity to collect eggs as they are laid, some workers catch eggs by hand as they drop from the cloaca and place them gently in a bag or bucket. Others position a large clean plastic bag in the nest beneath the cloaca, taking care not to collapse the egg chamber or disturb the turtle (the eggs drop directly into the bag without being handled or coated by sand). The sack of eggs is removed quickly before nest covering commences, or exhumed after the turtle has finished covering her nest. In other circumstances, clutches must be excavated after the nesting turtle has returned to the sea. Eggs should always be handled with care; when transported by vehicle they should be cushioned from vibrations.

Special care is needed when handling eggs that are more than 2 hr old (for example, when translocating eggs the following morning or when salvaging mid-term clutches that become threatened by erosion). The delicate embryonic membranes of older eggs are easily torn if the eggs are rotated or jarred. Dislodgement of the embryo results in death. Precautions should include marking the top of the egg with a soft grease pencil and transfering the eggs to a bucket or other inflexible container (not a sack) to ensure that they are not rotated either during transport or during reburial.

Reburial

Insofar as possible, each egg clutch should be planted within the hatchery enclosure in microhabitat approximating its natural nest. Hatchery nests should be situated at least 1 m apart to minimize their impact upon one another and to allow room for hatchery caretakers to move about. Nests should be constructed in the shape of a flask or urn, with a rounded bottom and a straight narrow opening leading from the egg chamber to the surface. Natural nest depth should be measured and duplicated in the hatchery. If nest excavation is hampered by cave-ins during periods of very dry weather, pour a bucket of fresh water into the unfinished nest, and then continue nest construction. Place eggs into the hatchery nests a few at a time if eggs are less than 2 hr old (one at a time if eggs are holder than 2 hr); under no circumstances should the eggs be "poured" into the nest. The damp sand removed during excavation of the artificial nest should be used to cover the eggs, firmly tamping it in place in layers of 8-12 cm. Dry sand should not contact the eggs, and should be used only during the final stages of covering the nest. Each nest should be numbered and associated with a standard data record form (see also Miller, this volume).

Cylindrical Mesh Enclosures

Most managers recommend placement of a cylindrical mesh enclosure over the top of each nest. These should be constructed from plastic netlon mesh (<1 cm mesh). "Chicken wire" should not be used; the mesh is too large and hatchlings get injured when their heads and flippers protrude through the openings. Netlon mesh should be cut into pieces approximately 40 cm in height and 195 cm in length, to form a cylinder 60 cm in diameter. A metal stake 0.25 cm in diameter can be used to join the ends of the mesh to form the cylinder and to secure it into the substrate. The mesh should be buried about 10 cm into the sand to reduce entry by burrowers, such as crabs. Depending on local rates and sources of depredation, the top of the cylinder can be fitted with a netlon cover, mosquito netting, or other appropriate mesh. By restraining the hatchlings that emerge, data recording *(e.g.*, number, size, weight of hatchlings) is facilitated. The disadvantage is that unless the hatchlings are released within a short time after they emerge from the nest, they are likely to suffer exhaustion, desiccation, loss of vigor, and possibly injury or death from predators.

Hatchling Release

Under natural conditions, groups of hatchlings enter the sea at random points along the nesting beach and at unpredictable times. Ideally, hatchery turtles should be released in groups as soon as possible after emerging from their nests, but early emergents should not be held back in order to create a larger group. To randomize release sites (reducing the prospect of creating fish "feeding stations"), each release should occur at a point hundreds of meters from previous release points. Hatchery personnel should anticipate hatchling emergence (noting that hatchlings usually emerge about 45-55 days after eggs are laid) and check mesh enclosures at frequent intervals (at least every 30-60 min) during periods of anticipated emergence. To promote natural imprinting, hatchlings should be allowed to crawl across the beach and enter the sea unassisted. When immediate release is impossible, hatchlings should be placed in a soft, damp cloth sack and kept in a cool, dark, quiet place. They should not be kept in water prior to release. Hatchlings kept in a container of water will engage in "swim frenzy" behavior and are likely to exhaust energy reserves stored in the yolk sac; they may even imprint to conditions in the container rather than to those at sea.

Special Techniques

Special incubating techniques have been used with varying degrees of success depending on local conditions. In the Philippines, the Sabah Turtle Islands, the Pacific coast of Guatemala and elsewhere, excessively warm hatcheries suspected of producing only female offspring have been cooled by placing coconut thatch as shade over a portion of the nests. In Malaysia, splitting egg clutches into complements of 40-60 eggs, each buried in a separate nest, has improved rates of hatching success (Mortimer *et al.*, 1994). In Natal, South Africa, hatch success improved in clutches placed inside cylindrical mesh baskets constructed of plastic netlon, and then planted in the hatchery inside the basket (G. Hughes, Natal Parks Board, *in litt* 14 September 1988). However, the same technique when employed in Malaysia produced nearly 100% mortality among late stage embryos and hatchlings (Mortimer and Aikanathan, unpubl. data). In Australia, cooling of newly laid egg clutches to a temperature of 7-10°C within a few hours of oviposition was found to delay formation of embryonic membranes long enough to allow long distance (>1000 km) translocation of egg clutches without reducing viability (Harry and Limpus, 1989).

Egg clutches incubated in Styrofoam boxes enjoy particularly high rates of hatching success, but require careful manipulation of temperature and moisture conditions. Cool temperatures characterize the boxes and favor male offspring. Because warming the boxes in the sun or with artificial heat sources causes moisture loss, careful application of fresh water is needed to keep conditions humid, but not water-logged. To prepare a Styrofoam box nest, pierce the entire bottom of the box with 0.5 cm diameter holes spaced at intervals of about 5 cm to facilitate drainage. Cut three pieces of nylon fabric, each to a size slightly larger than the surface area of the bottom of the box. Place the following materials into the pierced box, in order, starting on the bottom: one piece of nylon fabric, one 10 cm layer of moist beach sand, one piece of nylon fabric, 3-4 layers of freshly laid turtle eggs, one piece of nylon fabric, one 10 cm layer of moist beach sand. When the eggs begin to hatch, the top layer of sand and fabric need to be removed and only then should the Styrofoam lid be put in place to maintain high humidity.

Newly emerged hatchlings should be left inside the closed Styrofoam box for several days prior to their release until they have absorbed their external yolk sac and their plastron has flattened. No one knows with certainty whether Styrofoam box hatcheries interfere with the yet poorly understood mechanisms by which hatchlings imprint to their natal nesting beaches. What is known is that, without careful monitoring and intervention, hatchling sex ratios are strongly skewed and this point can invalidate nearly all other conservation measures. In Malaysia, decades of production of 100% female offspring in hatcheries has been implicated in high rates of infertility among nesting leatherback sea turtles (Chan and Liew, 1996).

Monitoring and Evaluation

Ideally, a statistically viable sample of nests should be monitored for incubation temperature in every hatchery, and certainly this is true in programs which rely on Styrofoam boxes, to ensure that both male and female offspring are produced in approximately equal proportions (see Godfrey and Mrosovsky, 1994, for a review of methodology). To determine hatch success within the hatchery, excavate a sample of clutches at the end of their incubation period (see Miller, this volume).

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