THE MARINE TURTLE HATCHERIES OF SRI LANKA

A TURTLE CONSERVATION PROJECT (TCP) REVIEW AND ASSESSMENT OF CURRENT HATCHERY PRACTICES AND RECOMMENDATIONS FOR THEIR IMPROVEMENT.

CENTRE FOR HERPETOLOGY
MADRAS CROCODILES BANK
POST BAG No. 4
MAMALLAPURAM - 603 104
TAMILNADU, S. INDIA

(Fourth Edition)
Peter Richardson, TCP Leader,
4.08.1996
Abstract

Marine turtles have been protected in Sri Lanka since 1972 and yet illegal exploitation of marine turtles and their eggs continues unabated. Egg collecting is the most widely practiced form of exploitation. Almost 100% of turtle nests that occur on the South-West coast are robbed of their eggs. Some of these eggs are sold by collectors to marine turtle hatcheries which were initially established to save some turtle eggs from human consumption. A survey by the TCP revealed that current management practices and conditions in Sri Lanka’s 16 hatcheries are such that they are currently contributing very little to the conservation of marine turtles. This report summarises the survey, identifies the problems and recommends a “Hatchery License Scheme”. This report recommends that such a scheme should be implemented by the Department of Wildlife Conservation in conjunction with the Ceylon Tourist Board in order to ensure that Sri Lanka’s hatcheries are effective in the conservation of marine turtles.
1. Introduction

Of the 8 species of marine turtle that inhabit the world’s oceans, 5 species visit the shores of Sri Lanka to nest. These are the Green turtle (Chelonia mydas), the Leatherback turtle (Dermochelys coriacea), the Olive Ridley turtle (Lepidochelys olivacea), the Hawksbill turtle (Eretmochelys imbricata) and the Loggerhead turtle (Caretta caretta). All these species and their eggs have been legally protected in Sri Lanka since an amendment to the Fauna & Flora Protection Ordinance in June of 1972 (Deraniyagala, 1953, Hewavisenthi, 1980).

All marine turtle species are listed by the International Union for the Conservation of Nature (IUCN) as either “endangered” or “vulnerable” because marine turtle populations are threatened by various human activities throughout the world (IUCN, 1995). One of the most significant threats to marine turtle populations in Sri Lanka is the practice of marine turtle egg collecting, usually carried out by people living close to turtle rookeries. Surveys carried out by the Turtle Conservation Project (TCP) indicate that almost 100% of the marine turtle nests occurring on the South-West coast are robbed of their eggs. Whole clutches of eggs are taken while the female turtle is laying, or else the nest is located and excavated the following morning. The eggs are either immediately consumed raw on the beach, sold to private dealers for distribution and consumption or sold to turtle hatcheries (Richardson, in litt).

2. The marine turtle hatcheries of Sri Lanka.

The rise of the “hatchery industry” has been well documented and coincided with the increase of tourist development on the South-West coast (Hewavisenthi, 1990, Wickramasinghe, 1982, Dattari and Samarajeewa, 1982). Well-intentioned individuals and NGO’s initially established hatcheries to save some turtle eggs from human consumption. However, during the 1980’s, local entrepreneurs began to recognise that there was an interest in turtles and their conservation amongst the affluent tourists who visited Sri Lanka. Some tourists were even prepared to donate money to hatchery managers as a contribution to help run the hatcheries. The hatcheries soon became tourist attractions and several entrepreneurs began establishing hatcheries along the South-West coast. Consequently, the NGO’s and the original concerned individuals were either out-competed by the businessmen or were deterred from continuing an involvement with the hatcheries due to the change in the ambitions of some hatchery managers (Dr. R. Fernando, pers. comm., 1993).

The basic concept of Sri Lanka’s turtle hatcheries is not complicated. Hatchery managers buy eggs from turtle egg collectors and rebury the eggs
in protected areas of beach. The eggs incubate, hatch and the resulting hatchlings emerge from the nest. Sri Lanka’s marine turtle hatcheries definitely reduce the threat of terrestrial predation, both human and animal, to eggs and emerging hatchling turtles.

However, in 1993 Hewavisenthi catalogued a series of management practices occurring in Sri Lanka’s hatcheries that she suggested may be deleterious to the resulting turtle hatchling’s chances of survival and reproductive potential (Hewavisenthi, 1993).

2.1, Considering the effects of hatchery practices on the marine turtle reproductive cycle.

2.1.1, Nesting: One must consider the natural lifecycle of marine turtles in order to evaluate the possible effects of hatcheries. After fertilization, the female turtle hauls herself ashore to nest. Recent research indicates that nesting female turtles return to their natal beaches to nest (Meylan et al., 1980). Therefore, there must be some form of imprinting, whereby female hatchling turtles “remember” certain characteristics of their natal beach in order to return years later to lay their eggs. It is unclear precisely when in the lifecycle the imprinting process occurs. However, if the imprinting process occurs during incubation and/or the first few days of the hatchlings lives, then it is probable that the hatchery management practices will affect this process.

Once on the beach, the female turtle carefully selects a nest site using receptive organs in the skin on the underside of her throat. It is believed that these organs can detect and evaluate chemical and moisture content in the sand as well as the surface temperature of the sand (Mrosovsky, 1983). We can assume that the female turtle’s nest site selection criteria are based on some instinctive environmental factor specifications that only she is completely aware of. The nest excavation is also carefully executed and one can assume that the nest dimensions that the female is attempting to achieve are based on instinctive specifications that have evolved over millions of years. If eggs from a natural nest are removed to an artificial nest, they may be subjected to different site specific conditions to those that satisfied the female turtle.

2.1.2, Incubation: The development of turtle embryos within eggs and the subsequent emergence of hatchlings is a complex process and there are large “gaps” in scientific knowledge regarding hatchling turtle biology. For example, sex determination of hatchling turtles is temperature dependent and occurs during the incubation period. The sex determination temperature threshold is species specific (Mrosovsky, 1994). Consistent and significant deviation from natural incubation temperatures of artificially constructed turtle nests will result in the alteration of the natural sex ratio of the clutch. If the sex ratios of several generations of hatchlings from the
hatcheries are being altered, there may be deleterious consequences for the marine turtle populations of Sri Lanka.

2.1.3, Hatchling emergence form the nest: Hatchling turtles emerge from their eggs and remain in the nest for approximately two days. It is thought that the reason why the hatchlings wait within the nest is so that the majority of the eggs hatch in this time and therefore a cooperative effort to emerge from the nest is facilitated. During this period the navels of the first hatchlings partially heal and therefore become less of a liability after emergence from the nest. As soon as the hatchlings emerge from the nest, they make their way down to the sea as quickly as possible. Hatchling emergence typically occurs at night when they are inconspicuous and there are fewer terrestrial predators. If hatchlings are released during the day, as Hewavisenthi reported, they may be more liable to detection by predators than if they are released at night.

Hatchlings find their way to the sea using light cues. Once in the sea the hatchlings swim constantly against the direction of the waves for a period of 24-48 hours without feeding. This instinct is known as “juvenile frenzy”. During this period the hatchlings derive their nutrition from an internal, residual yolk, an energy supply which is exhausted at the end of the frenzy. The juvenile frenzy behaviour takes the hatchlings away from the coastal waters which have the highest concentration of potential predators (e.g. sharks, large fish, sea birds etc.). After the first days of constant swimming the hatchlings’ behaviour changes from the frenzy to foraging for food amongst floating debris. By this time the hatchlings have reached open water and are distributed by epipelagic currents (Mrosovsky 1983, Wynken and Salmon 1992).

2.1.4, Hatchlings in hatcheries: Hewavisenthi stated that the hatcheries would retain hatchling turtles in concrete tanks for at least three days a practice which was first recorded in Sri Lanka’s hatcheries in 1982. In 1986 Perera suggested that the reason for hatchling retention was to allow the navel to heal and thus reduce the hatchlings’ chances of being attacked by predatory fish (Wickremasinghe, 1982, Perera, 1986).

The authors’ observations indicate that when hatchlings are kept in tanks for a given period (e.g. 3-4 days), the hatchlings spend the first one or two days constantly swimming around the tanks without feeding. On the third day the hatchlings’ behaviour changes to feeding behaviour and because they are kept in tanks with many of their siblings, they begin to bite at each other. Some of the hatchlings receive injuries as a result, which often become infected by bacteria and fungi, thus lowering the hatchlings’ chances of survival.

When the hatchlings are released on the fourth day, instead of swimming out to sea and therefore out of the dangerous coastal waters, the hatchlings continue feeding behaviour within the coastal waters and are therefore more vulnerable to predation than if they had been released
immediately after hatching. Even if hatchlings released after internment do survive predation, they do not reach the open ocean currents and will therefore not be distributed to natural foraging grounds.

It is believed, therefore, that the retention of hatchling turtles in tanks seriously reduces the probability of their survival after release and serves absolutely no conservation purpose (Hewavisenthhi, 1993, Eckert, pers. comm. 1994). Hewavisenthhi's and Amarasooriya's findings regarding the effects of captivity on hatchling behaviour also support this view (Hewavisenthhi, 1991, Amarasooriya, NARA, 1996 in press).

3, The TCP hatchery survey

TCP staff and volunteers surveyed all hatcheries that have been recorded in literature and other hatcheries that they were either told about or encountered during the survey. All the hatcheries listed in Table 1, except the Aquatic Resort, were visited several times between 3.1993 and the 5.1995. The conditions of the hatchery during each visit were recorded onto data sheets. If present, the hatchery managers were interviewed about local turtle natural history and about their hatchery management practices.

3.1, Survey results

The TCP survey revealed that there are at least 16 hatcheries currently operating in Sri Lanka and all are located on the west coast between Koggala and Chilaw. Eight of these hatcheries are located between Balapitiya and Induruwa, a stretch of coastline which may be considered the most significant turtle rookery on the west coast (Dattari and Samarageewa, 1982). The results of this survey are shown in Table 1.
Table 1: General conditions and practices of the hatcheries in Sri Lanka. The following table summarises the conditions and management practices as recorded by TCP volunteers during a survey of Sri Lanka’s hatcheries. Column 1, refers to the security of both the incubation enclosure and the hatchery tanks. The standard of the hatcheries is polarised such that they are either well maintained or poorly maintained with few intermediate exceptions. Therefore, the tendency is that if the incubation enclosure is secure then the hatchery tanks are usually secure also. Column 2, is self-explanatory. Column 3, refers the species and number of juvenile turtles kept for display to tourists and the abbreviations derive from the Latin names as follows: Cm = Green turtle, Ei = Hawksbill turtle and Lo = Olive Ridley turtle. Column 4, refers to the suitability of the general facilities (e.g. tanks, equipment etc.) and their maintenance as required by the “draft hatchery guidelines” included at the end of this report. Column 5, refers to the last date that TCP volunteers visited the hatchery. The contents of this table are based on the data collected over a series of visits.

<table>
<thead>
<tr>
<th>Address</th>
<th>Secure (yes, no)</th>
<th>Hatching retention (days)</th>
<th>Captive juveniles (No. &amp; sp.)</th>
<th>Facilities (suitable, unsuitable)</th>
<th>Date of last visit</th>
</tr>
</thead>
<tbody>
<tr>
<td>Koggala Beach Hotel, Koggala</td>
<td>no</td>
<td>0</td>
<td>0</td>
<td>unsuitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Sea Turtle Hatchery and Research Centre, Dodanduwa</td>
<td>no</td>
<td>30+</td>
<td>2 Cm, 1 Ei</td>
<td>unsuitable</td>
<td>3.1995</td>
</tr>
<tr>
<td>Triton Hotel, Ahangama</td>
<td>yes</td>
<td>0</td>
<td>0</td>
<td>suitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Sunset Restaurant, Ahangama beach (North of Triton Hotel)</td>
<td>no</td>
<td>?</td>
<td>2 Cm, 1 Lo</td>
<td>unsuitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Hibiscus Restaurant, Ahangama beach (North of the Triton Hotel)</td>
<td>no</td>
<td>10+</td>
<td>0</td>
<td>unsuitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Unnamed hatchery, approximately 1 km south of the Victor Hasselblad Hatchery, Koggala</td>
<td>yes</td>
<td>?</td>
<td>0</td>
<td>suitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Victor Hasselblad Hatchery, Koggala</td>
<td>yes</td>
<td>4+</td>
<td>3 Cm, 11 Ei, 3 Lo</td>
<td>suitable</td>
<td>2.1995</td>
</tr>
<tr>
<td>Sea Turtle Sanctuary, Farm and Hatchery, Galle Rd., Mahalapana, Koggala</td>
<td>no</td>
<td>14+</td>
<td>2 Cm, 1 Ei</td>
<td>unsuitable</td>
<td>5.1994</td>
</tr>
<tr>
<td>Sea Turtle Hatchery and Research Centre, Galle Rd., Induruwa</td>
<td>no</td>
<td>?</td>
<td>1 Cm</td>
<td>unsuitable</td>
<td>2.1995</td>
</tr>
<tr>
<td>Sea Turtle Protection Association, Galle Road, Bentota South</td>
<td>yes</td>
<td>7+</td>
<td>4 Cm, 1 Ei, 1 Lo</td>
<td>suitable</td>
<td>2.1995</td>
</tr>
<tr>
<td>Neptune Hotel, Galle Rd., Beruwela</td>
<td>no</td>
<td>14</td>
<td>0</td>
<td>unsuitable</td>
<td>3.1995</td>
</tr>
<tr>
<td>Mount Lavinia Hotel, Mount Lavinia</td>
<td>yes</td>
<td>14+</td>
<td>0</td>
<td>unsuitable</td>
<td>5.1995</td>
</tr>
<tr>
<td>St. Thomas’s College Hatchery, Mount Lavinia</td>
<td>yes</td>
<td>30+</td>
<td>0</td>
<td>unsuitable</td>
<td>3.1993</td>
</tr>
<tr>
<td>Aquatic Resort, Pamballa, Chilaw (Loris, 1995)</td>
<td>?</td>
<td>?</td>
<td>0</td>
<td>?</td>
<td></td>
</tr>
</tbody>
</table>
3.1, cont: Table 1 summarises a large quantity of data for convenience. Therefore, to give a more detailed picture, some general and reoccurring aspects of hatchery management recorded in this survey are described below. Although there is some variance, most of the hatcheries have, or claim to have, similar management practices as follows.

3.1.1, Purchase of eggs: The eggs are bought from collectors usually operating on local beaches. The exceptions to this practice are Mount Lavinia Hotel, who buy eggs from a “Moratuwa turtle farm” (not recorded in this survey); St. Thomas’s College, who buy eggs from either the Hasselblad hatchery or the Sea Turtle Protection Association; Aquatic Resort who buy eggs from the Hasselblad hatchery; Unnamed hatchery who buy eggs from the Hasselblad hatchery.

3.1.2, Burial of eggs and incubation: The eggs are reburied in hand dug nests in protected areas of sand. Nest depths are usually determined by estimated measurements based on the depth of the nest excavators arm in the sand. The incubation enclosures vary in conditions and quality. Ideally they should be secure so that predators cannot enter and should be free of vegetation as growing roots can penetrate nests and ruin whole clutches of eggs. Many of the poorer hatcheries had insufficient fencing around open-topped enclosures and/or vegetation encroaching into the enclosure area.

3.1.3, Hatchling emergence: When the eggs hatch, the hatchlings are usually allowed to emerge from the nest themselves although some hatcheries excavate the hatchlings from the nest after the first few hatchlings have emerged. As emergence usually occurs at night, the hatchlings are left to wander around the incubation enclosure until the following morning. They are then collected and placed in concrete tanks containing sea water where they remain for a varying number of days until they are released to the sea (see Table 1, Column 2). No reliable data could be obtained regarding hatching success rates but it is believed to vary between hatcheries.

3.1.4, Hatchling and juvenile retention: The periods of hatchling captivity and the reasons for keeping them in tanks vary according to different hatchery managers. Most of the reasons are totally unfounded and not based on scientific evidence. Many hatchery owners claim that keeping hatchlings in tanks for a number of days allows them to grow big enough to avoid predators. As the hatchlings’ main predators include large fish and sea birds, this reasoning is illogical as the rate of growth of a hatchling in the first two weeks of its life is insufficient for it to no longer be attractive as a prey item for these predators.
Another alleged reason for hatchling internment is that the hatchlings' navels, which are fleshy and exposed on hatching, completely heal in captivity and are therefore no longer a liability to the young turtles when they are released several days after hatching. Although the navel does heal after several days internment, this is not a valid reason for maintaining hatchlings in tanks due to the disruption to the lifecycle caused by this practice as described in section 2.1.4. Indeed, the author is unaware of any literature or records outside of Sri Lanka regarding the issue of navel healing and it's importance to hatchery management. It is possible that the navel healing issue appears to have arisen only in Sri Lanka's hatcheries (George Hughes, Director, Natal Parks Board, pers. comm. 1994).

It seems clear to the author that the main reason for keeping hatchling turtles in tanks is that the sight of several hundred "cute" hatchling turtles swimming is an attractive spectacle paying tourists. Tourists are usually required to pay an entrance fee to the hatcheries (between Rs. 50 to Rs. 100). If an entrance fee is not required then the guide will usually appeal for donations. The visitors to the hatchery, in their understandable ignorance, see many baby turtles and believe that the hatcheries are conserving many turtles.

Some hatcheries charge tourists to release hatchlings during the day. This results in the hatchlings being taken by diurnal fish or eaten by birds such as crows and kites once the tourists have moved away from the beach. The release of hatchlings during the day is of no benefit to the conservation of sea turtles.

Another practice encountered in Sri Lanka's hatcheries is that of rearing (or catching) and keeping sub-adult turtles for display to tourists. Again, the behavioural effects of rearing and keeping turtles in captivity until sub-adult are unknown. Because of hatchery managers' lack of knowledge regarding turtle husbandry, sub-adult turtles are often kept in dirty and unsuitable conditions.

4, Conclusions & Recommendations

The reproductive biology of marine turtles has evolved over millions of years. Given the significant gaps in scientific knowledge regarding marine turtle biology, conservationists would be wise to minimise interference of the natural incubation and hatchling emergence in nests that are not threatened by the immediate natural environment in order to facilitate the recruitment of individuals capable of successful reproduction into wild populations. Thus, the best method of conserving marine turtle nests and hatchlings is "in situ" nest protection, whereby eggs are left to incubate where they were laid by female turtles and the nesting habitat is protected.
However, where there is extensive egg collecting activity and "in situ" nest protection (i.e. continuous manual and/or mechanical protection of nests) is impossible or economically unfeasible, then hatcheries can play a useful role in the conservation of marine turtles. The human population along the west coast is large and concentrated and the protection of nests "in situ" along the entire coast would be a difficult, costly and probably an ineffective operation.

Most of Sri Lanka's existing hatcheries are tourist "traps" and have little potential conservation value. But some hatcheries, particularly those with good facilities could have a potential conservation and educational role along the South-West coast if the managers could be persuaded to follow scientific management guidelines. Included at the end of this report is a copy of the draft guidelines compiled by the TCP. These guidelines could be the subject of the initial discussion seminar and if necessary, could be altered before finalisation of the logistics of the scheme. For these hatcheries to maintain a sustainable conservation role, the guidelines should take into account the necessity of the hatcheries to maintain their viability as tourist attractions.

4.1, Recommended action for the establishment of a hatchery license scheme: The licensing scheme should be established by the Department of Wildlife Conservation (DWLC) and could be implemented as follows:

i. All hatcheries currently operating in Sri Lanka should be inspected by DWLC officers. During the initial visit, the officers should record hatchery management practices and conditions. It would also be useful for the officers to note the likelihood of the hatchery owners ever being able to follow the draft hatchery management guidelines with resources available.

ii. All hatcheries should be informed of the intentions of the DWLC to establish a license scheme. Managers of all the hatcheries should be sent an information pack. The pack should contain details of the current laws regarding the protection of marine turtles in Sri Lanka and how the hatcheries are presently infringing those laws. The pack should also include current information concerning the biology and behaviour of marine turtles and a summary of hatchery management practices based on international and expert opinion, including a draft set of guidelines. In an accompanying letter, the hatchery owners should be invited to attend a two day seminar, hosted by the DWLC and the Ceylon Tourist Board (CTB) two months after the initial mailing and located within the Galle district. Other attendees should include academics, environmental NGO representatives and relevant governmental department representatives.
III. During this seminar, the guidelines should be discussed with all the hatchery managers present and the license conditions should be explained by the DWLC. Hatchery managers should be made aware that if they are successful in obtaining a license they will be allowed to display it and advertise that they are approved by the DWLC and the CTB. If they are not granted a license and continue with their business, then they will be subject to prosecution.

IV. The hatchery managers should then be invited to apply for a DWLC hatchery license, valid for one year, with a deadline for applications of six weeks after the seminar. After the DWLC receive the application, the hatchery will be subject to inspection by DWLC officers. During the inspection, the hatchery manager must prove that they are able to follow the licensed guidelines. Subject to the results of this inspection a license may or may not be granted.

V. All hatcheries will then be subject to frequent and random inspections by DWLC officers. During these inspections the licensed hatchery managers must be able to prove that they are following the license guidelines. If the hatchery fails to convince the DWLC officers that they are following the guidelines, then the license should be revoked. If any hatchery continues to operate without a license, then the hatchery managers should be prosecuted.

VI. Information leaflets should be produced by the DWLC and the CTB for distribution to tourists and Sri Lankans. The leaflets should describe the licensing scheme and promote those hatcheries that have been granted a license. Tourists should also be invited to report any irregularities that they experience during a visit to a hatchery.

VII. Sri Lankan environmental NGO members should be encouraged to visit the licensed hatcheries and report to the DWLC whether or not the hatcheries are following the license guidelines.

VIII. One condition of the license other than adherence to the guidelines should be that the DWLC has the authority to permit research in the hatcheries at any time. Research projects should then be established to evaluate the effects of the hatcheries on biological factors (e.g. incubation temperature and sex-ratios, hatching success rates etc.). University students reading biological subjects should be encouraged and employed in this research, along with DWLC officers and NGO volunteers.

IX. Hatchery managers would have to reapply for the license each year for as long as they are operating. Random DWLC inspections should continue and failure of hatchery managers to meet license conditions should result in the denial of the license renewal. Any person found to be operating a hatchery without a license should be prosecuted.
In parallel to these measures the DWLC and concerned NGO’s should carry out turtle conservation educational programmes to educate coastal communities and schools as to why they should not eat turtle eggs.

This scheme of licensing, inspection and research outlined above should eradicate the poor hatcheries whilst improving the better ones. Serious hatchery managers should be enthusiastic about joining the scheme due to the obvious promotional benefits. Thus, hatcheries would begin to play a more useful and sustainable role in the conservation of turtles on the South-West coast. In preparation for a situation whereby the turtle nesting populations are no longer under threat from the practice of turtle egg collecting, a plan of future "phasing out" of hatcheries may be useful.

5. References


Address of the Marine Turtle Newsletter;

Scott & Karen Eckert, Editors
Marine Turtle Newsletter
Hubbs-Sea World Research Inst.
1700 South Shores Rd.
San Diego
California 92109, USA

Address of the Turtle Conservation Project (TCP),
NGO reg. no. 6/6/17/3/24:

Turtle Conservation Project(TCP),
14 A, De Saram Rd
Mount Lavinia
Sri Lanka
Tel/Fax: 94 1 732371.
Draft of the hatchery management guidelines

These are the hatchery management guidelines as compiled by the TCP. They are not intended as an absolute management plan but rather a starting point for discussion in order to finalise hatchery management guidelines to be used in a hatchery license scheme. It is important to note that hatchery managers must be persuaded to keep records of all aspects of their hatchery operation to aid future hatchery improvement schemes.

1. Hatchery enclosure: The hatchery enclosure should be as similar to the conditions in which nests are naturally found as possible. It should be positioned at the back of the beach so that high or storm tides do not flood the nests.

The hatchery enclosure must be secure against predators such as mongoose, crows, kites, monitor lizards and crabs. It should be constructed from fine mesh wire or, failing that, from bamboo canes buried vertically in the sand. The wire or canes must extend downwards below the sand at least 50cm to prevent predators, particularly crabs, from burrowing into the enclosure. In the enclosure, pots can be buried in the sand at the enclosure perimeter, so that crabs walking around the enclosure will fall into the pots and therefore facilitate easy removal. The top of the hatchery enclosure must be covered with a net to prevent crows and kites from stealing hatched hatchlings.

No plants must be allowed to grow in the hatchery enclosure or close enough to it for their roots to penetrate the enclosure as roots can ruin clutches.

2. Collection of eggs: When nesting females are found by hatchery staff, it must be stressed that on no account should they be approached closely or disturbed by lights until they have started egg-laying. Prior to egg-laying, the females are very sensitive to disturbance and may abandon nesting. A female turtle that is consistently deterred from nesting may not attempt to nest again and may dump her eggs at sea. After egg-laying has started, it is possible to examine the female with a minimum use of light.

After the female has started egg-laying, the eggs can be removed from behind her as she lays or the nest can be carefully excavated after she has departed. The eggs should be removed individually into a suitable container (e.g. styrofoam/wooden box, but not a flexible container such as a plastic bag) for removal to the hatchery. On her path back to the sea, her path must not be blocked by people as she must be allowed to return as quickly as possible.
3. **Purchase of eggs**: Within 12-24 hours of being laid, the embryo becomes attached to the wall of the egg by a delicate membrane. This stage of development is indicated by the appearance of a white disc on the surface of the egg. After this time any movement of the egg must be avoided as it may cause the membrane to break, in which case the embryo will die. Eggs showing this white disc, or older than 24 hours should not be bought.

The egg collector should be asked if he would be prepared to donate the eggs to the hatchery with the possibility of being paid later for the eggs that hatch successfully. These older clutches must be handled with great care so as to avoid any rotation of individual eggs, but otherwise should be placed in the sand as normal.

4. **Digging the nest**: The nest should be dug within the protected hatchery area. The average nest depths of marine turtles differs from species to species. Therefore the nests' depths should be dug to species specific depths as follows:

<table>
<thead>
<tr>
<th>Species</th>
<th>Nest depth (cms)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Green turtle (<em>Chelonia mydas</em>)</td>
<td>65</td>
</tr>
<tr>
<td>Leatherback turtle (<em>Dermochelys coriacea</em>)</td>
<td>70</td>
</tr>
<tr>
<td>Olive Ridley turtle (<em>Lepidochelys olivacea</em>)</td>
<td>40</td>
</tr>
<tr>
<td>Hawksbill turtle (<em>Eretmochelys imbricata</em>)</td>
<td>40</td>
</tr>
<tr>
<td>Loggerhead turtle (<em>Caretta caretta</em>)</td>
<td>40</td>
</tr>
</tbody>
</table>

**N.B:** Temperatures inside a sample of nests located throughout the incubation enclosure should be measured at all times. The pivotal sex-determination temperatures of most of Sri Lanka’s species of turtle are around 29 degrees Centigrade (Mrosovsky, 1994). Eggs incubated at too low a temperature will take longer to develop and will produce mostly male turtles as well as a large number of deformed hatchlings. Likewise eggs incubated at too high a temperature will also produce a large number of deformed hatchlings but will also produce an excess of female turtles. If the nest temperatures are consistently 2 degrees Centigrade more or less than 29 degrees Centigrade then the nest depths given above may need modifying until nest temperatures of approximately 29 degrees centigrade are achieved.
5. Placing the eggs in the nest: The eggs should be handled carefully and placed individually in the egg chamber. They must not be dropped into the nest from the surface. The eggs may be heaped up on each other. Individual nests should be placed at least 75 cms apart.

6. Closing the nest: The sand must be replaced firmly (not too tightly) at continuous stages during the filling process. On completion, the opening should be heaped up a few inches above the surface in order to prevent waterlogging. A small wooden post and “nest sign” should be placed next to the nest to indicate the species, number of eggs buried and the date of laying. Eggs brought from a single nest should be buried in a single nest. Mixing of eggs from different nests should never occur. These instructions should be emphasised to individuals collecting the eggs.

7. Incubation period: The incubation period is also species specific but is normally 48–52 days. Long incubation times may reflect excessive shade of the hatchery or that eggs are being buried too deep. Shortened incubation length may indicate that eggs are being buried not deep enough. Most of the hatchlings should come out of the nest together but sometimes it may take approximately 5 days for all the hatchlings to emerge. The number of eggs (having been written on the “nest sign”) will give an indication as to when most of the hatchlings have emerged. Two days after the emergence of the last hatchling, the nest should be excavated and any hatchlings too weak to dig themselves out should be removed and placed in tanks. At this point the sand around the nest must also be replaced with new beach sand to prevent disease within the hatchery enclosure.

8. Hatchlings: The hatchlings will usually emerge during the night. Ideally, hatchlings should be released immediately after emergence from the nest. If the hatchery cannot be staffed throughout the night, the hatchlings should be collected in the morning and placed in the hatchling tanks until release the following evening. Hatchlings should be allowed to emerge by themselves and should not be “helped” by premature excavation.

9. Retention of hatchlings in tanks: All hatchlings should be released immediately after emergence from the nest. If hatchling retention is deemed necessary for commercial purposes by the management, a minimum of 90% of emerging hatchlings must be released immediately and/or during the hours of darkness. These hatchlings must only be retained in tanks for an absolute maximum of 15 hours after emergence. Ideally, a tank should have a minimum depth of at least 60cm. The water in each tank should be changed every day to prevent infection and disease of any retained.
IMPORTANT: The retention of hatchlings in tanks for more than 15 hours has absolutely no conservation value. Hatchlings retained for longer than 15 hours have a lower chance of survival. In nature, hatchlings emerge from the nest and immediately make their way down the beach, enter the sea and spend the first 2-3 days of their lives swimming constantly out to sea. Then their behaviour instinctively changes and they start looking for food. If hatchlings are kept in tanks for a period of time in which they begin to feed, then on release they will begin looking for food in the offshore waters. The offshore waters have extremely high concentrations of seabird and marine predators such as sharks and large fish. Therefore these feeding hatchlings will be subjected to abnormally high predation.

If such a “sacrifice” is deemed necessary by the hatchery management, a maximum of 10% of each batch of emerging hatchlings may be retained for display to hatchery visitors. These may be retained for an absolute maximum of 72 hours after emergence.

However, Leatherback turtles are extremely rare and have evolved for life in the open ocean, they are therefore poorly adapted to life in a tank, as they collide with the sides, damaging themselves. Hawksbill turtles are globally endangered, and Loggerheads are locally rare and therefore these species along with Leatherbacks should not be retained in tanks. If retention is necessary with these species (e.g. the hatchlings emerge after dawn) then it should not be for a period longer than 15 hours.

If the retained display hatchlings show feeding behaviour (e.g. nipping each other), they should be fed either pelleted fish food (preferred) or chopped fish and should be released on the following evening. Any feeding of hatchlings should take place early in the morning. The tanks should be placed in the shade to prevent the water overheating. Hatchlings are less active in low light conditions and so will use less of their energy reserves if kept in the shade. The tanks must be covered with a net to prevent predators from getting to the hatchlings.

10. Hatchling release: The release of hatchling turtles should always occur in the hours of darkness. It is possible that hatchlings use chemical cues in the sand of their home beach to relocate the beach in later life for nesting. They should therefore be placed at the back of the beach, or where female turtles naturally nest, and allowed to make their own way into the water. Hatchling release should take place in the darkest possible conditions and lights should not be used if unnecessary. If hatchlings are disoriented by strong lights, they should be either switched off (preferable) or placed on the beach and led to the waters edge by torchlight. In the latter case, their movement should be closely watched to ensure that they do not return to the beach, attracted by lights. If hatchlings return to the beach after release because of light disorientation, they must be collected and released in a darker location.
The movement of hatchlings down the beach and then for the first few kilometres offshore are the most hazardous in a turtle's life as they are vulnerable to attack from land predators (e.g. crows and kites) and marine predators (mostly reef fish and sharks). It is therefore vital that hatchlings be released after dark to give them the best chance of avoiding these predators. To give them the longest time to get away in the darkness, hatchlings should be released two hours after sunset. To avoid predators concentrating on areas where hatchlings are released, the point of release should not be the same on consecutive releases and should be varied by at least two hundred yards.

11. Juvenile and sub-adult turtles in hatcheries: The retention of juvenile and sub-adult turtles in hatcheries serves absolutely no role in turtle conservation and should not be encouraged. However, if this practice is deemed necessary by hatchery management for display to hatchery visitors, then it is acceptable to keep one juvenile or sub-adult (up to 50 cms in length) of the Green turtle (Chelonia mydas) and Olive Ridley turtle (Lepidochelys olivacea) only.

The responsible husbandry of single, sub-adult specimens of these species (i.e. Green turtle and Olive Ridley turtle) and albino turtles for display could have a useful role in public education without posing a threat to the populations of those species.

The Leatherback turtle (Dermochelys coriacea) is totally unsuited to captivity. The Loggerhead turtle (Caretta caretta) and the Hawksbill turtle (Eretmochelys imbricata) are too rare in Sri Lankan waters to be recommended for retention.