

# MANUAL OF SEA TURTLE RESEARCH AND CONSERVATION TECHNIQUES

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GEORGE H. BALAZS

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#### C.4.2.6 Weight

The weight range of the scale used should depend upon the weight of the turtle. Triple beam balances or spring scales can be used. A weighing device is available for shipboard use. Mount a large single beam balance (200 pounds, modified with supplemental weights for up to 500 pounds) to a block and tackle suspended from the ship's rigging. Place the turtle in a circular net (5-foot diameter) with a rope margin. Attach the rope to the beam's lower hook and hoist the turtle and net off the deck for weighing.

Nesting females can be weighed after nesting with a spring dial scale mounted to a horizontal pole. Tie or net the turtle to the scale and use the pole supported on the shoulders of two people to lift her off the beach for weighing.

Again, the weight data collected for nesting females may not be worth the effort expended, and the trauma to the turtles.

#### C.4.3 Tagging Sea Turtles

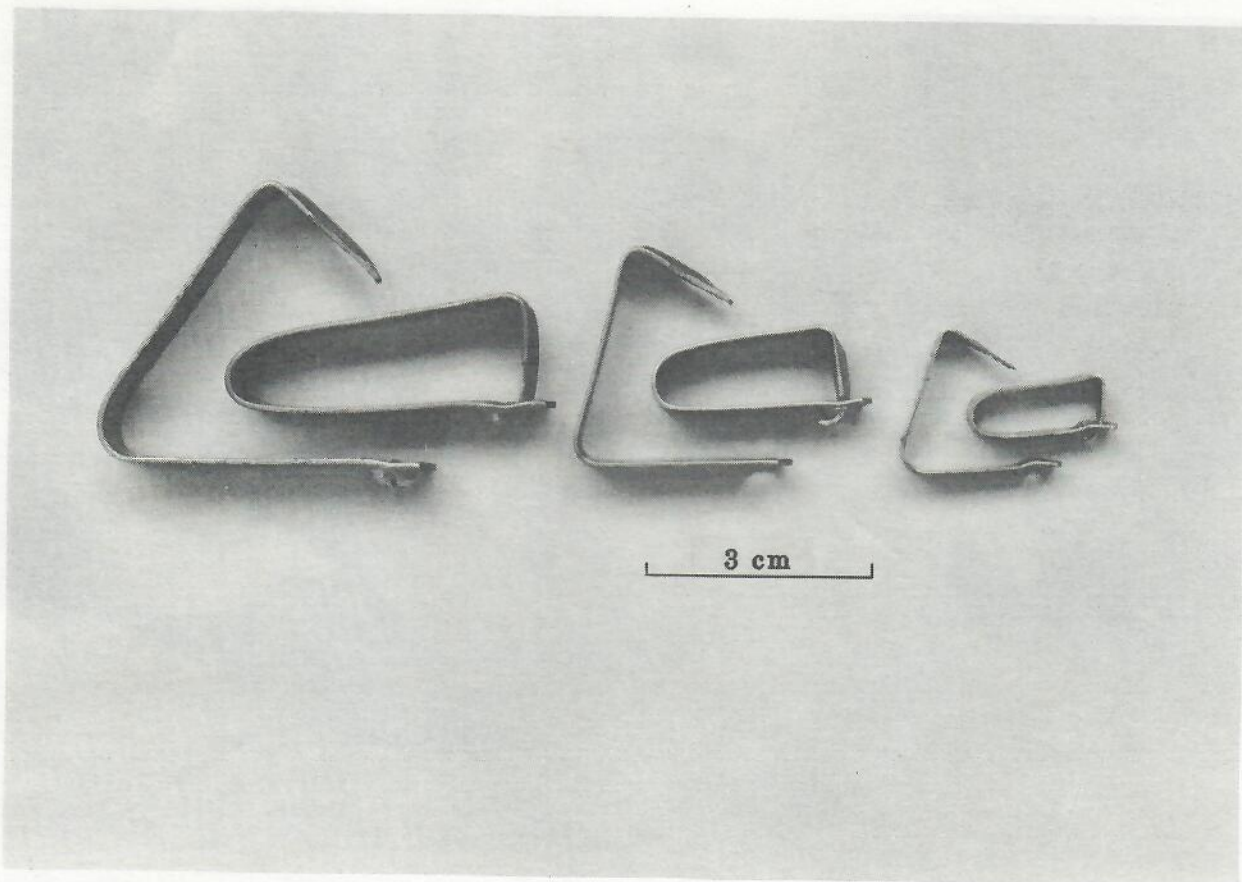
##### C.4.3.1 Preferred Tag Type

Turtles are usually tagged with Monel-alloy tags generally used for marking livestock. Several companies manufacture these tags; the authors will supply trade information upon request.

Tags come in sizes suitable for both adult and juvenile turtles. The largest are made from a metal strip 0.9 cm wide and about 8.5 cm long, which gives a folded length of 4.2 cm. The smallest tag shown in Figure 17 can be used on turtles about 2 kg in weight. Tag manufacturers supply special applicators; some resemble a simple pair of pliers with the working surfaces molded to fit and enclose a tag, while others have levers arranged to allow the tag to be clinched with less hand pressure. Figure 17 illustrates commonly used tags.

The code numbers (from National Band and Tag Company, Newport, Kentucky, USA) and base lengths for the three sizes of tags illustrated in Fig. 17 are: Small, No. 4, 2 cm; Medium, No. 681, 2.8 cm; Large, No. 49 or 19, 4.2 cm.

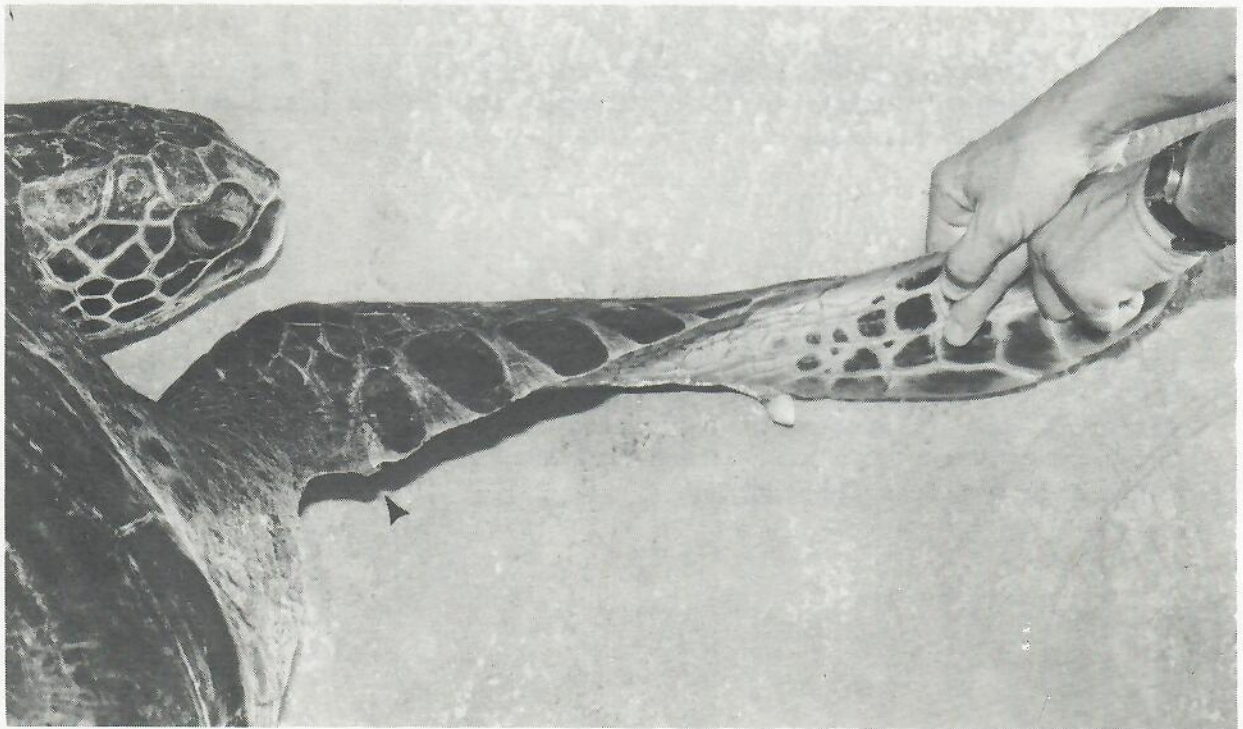
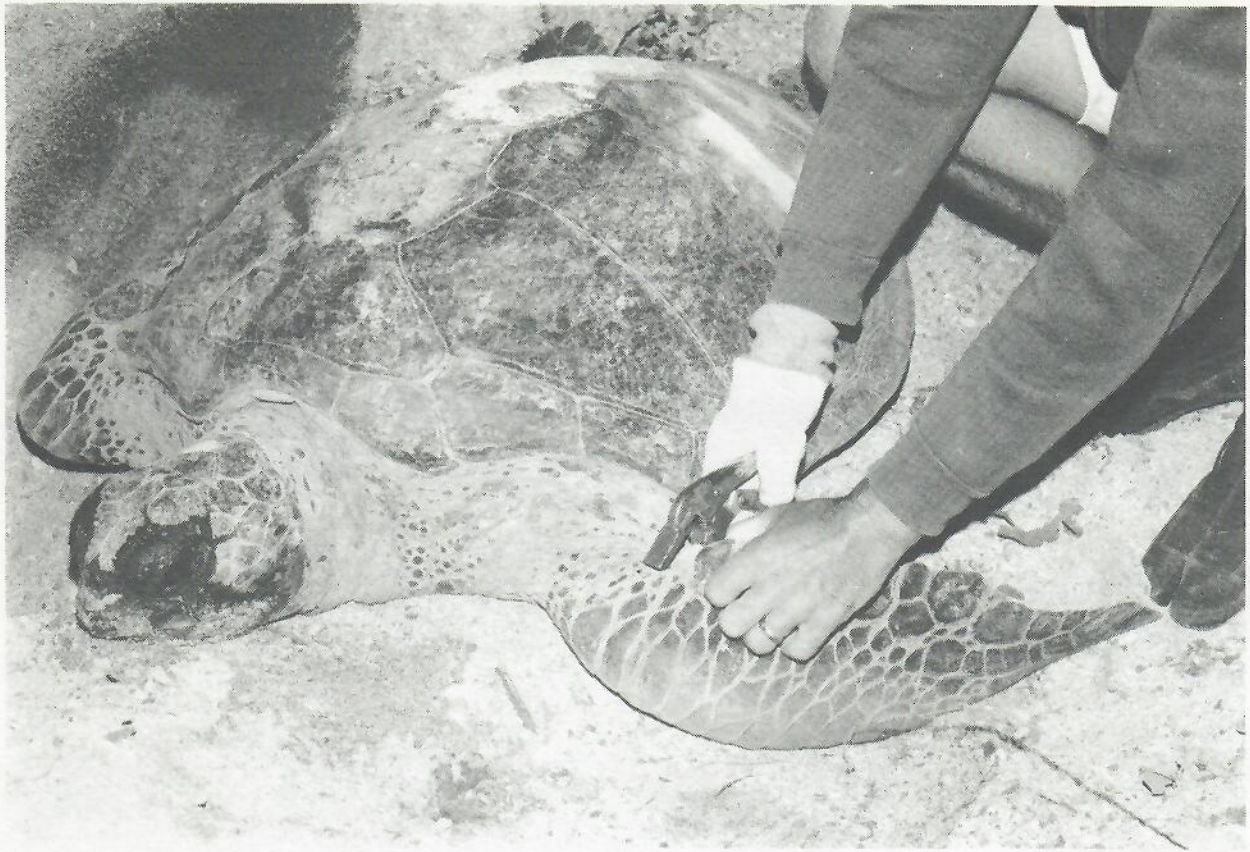
Tag manufacturers imprint, to the buyer's specifications, a serial number on one face, with or without one or more letter prefixes. Although not always done in the past, surveyors should co-ordinate with each other to avoid using the same numbers, since the different return address may not be noticed. The reverse side bears the tagger's or institution's name (usually abbreviated) and the permanent institutional address since tags may be returned many years after application. In some cases, the tag offers a reward to the finder of a tagged turtle.



**Figure 17.** Commonly used flipper tags for sea turtles. Each of the three tags is shown in both the open and locked position. Photo by G. H. Balazs.

#### C.4.3.2 Where to Tag

Most workers tag turtles through the trailing edge of one fore-flipper, either proximal to, between or through the large scales edging the center part of the flipper (Figure 18). Some workers prefer to perforate the flipper with a pointed chisel before applying the tag. This can prevent the non-clinching that can occur when the turtle's tough skin deflects the tag tip.



**Figure 18.** Method of tagging the trailing edge of foreflipper. Photo by G. H. Balazs

Double-tagging is recommended whenever possible. Separate (and usually consecutively numbered) tags are fixed to each front flipper. This procedure will partially offset the erratic loss of flipper tags.

#### C.4.3.3 When to Tag

Deciding when to tag a turtle depends on the conditions of each survey. If turtles are very numerous and if a large area must be patrolled or manpower is short, turtles may be tagged at any time. Ideally, however, the nesting females should be tagged only when the nesting process is completed, i.e., when the female has nested and started to return to the water. Some surveyors have tagged sea turtles successfully during oviposition, but others have found that some populations of sea turtles (especially green turtles), will stop laying eggs and start covering the nest if tagging is attempted. This Manual recommends that turtles be tagged as late as possible in the nesting process.

Some workers routinely turn turtles on their backs for tagging after nesting. This Manual, however, recommends tagging turtles while they are upright, if this is safe and convenient. The upright turtle should be restrained while one person holds the flipper and a second applies the tag.

#### C.4.3.4 Alternative Tagging Methods

Sometimes, a Monel-alloy tag applied as described stays on a turtle for more than a decade. However, a significant number of tags are lost quickly - often within a few weeks. Losses may occur when the tag tears through the flesh of the turtle's flipper, when the tag is clinched improperly, or when either the narrow bar that holds the tag tip corrodes or the entire tag corrodes.

Tags made with the more corrosion-resistant alloy, "Inconel 625," are better than Monel. Unfortunately, "Inconel" tags are not yet readily available, and the cost is relatively high. Titanium tags are now being used in Australia; evaluation is not yet available.

Some workers double-tag turtles and/or apply the tags closer to the tip of the foreflipper so that the clinched tag actually encloses the distal phalanges. This must be done carefully so that the tag does not wobble and interfere with the swimming stroke. If clinched firmly, the tags won't be torn out. Some turtle biologists report they can fix tags more firmly to leatherbacks' hindflippers than to their foreflippers.

The enterprising researcher may design and use tags completely different than those described. Early attempts at carapace tags (discs wired through the rear part of the carapace) were largely unsuccessful because the tags damaged the animal or were dislodged during copulation. A new type of carapace tag attached by a stainless steel bolt is being tested. Similarly, some researchers have had success with plastic tags; others have not. "Spaghetti tags" (long, thin, cylindrical pieces

of flexible plastic strung through a hole in the flipper and imprinted with a number and address) have been tried but do not appear to be satisfactory. Various other types of experimental tags have been described, and some have been tested.

#### **C.4.3.5 Tagging Hatchlings**

There is a pressing need for a method of marking hatchlings in a way that will remain distinctive when the turtle matures. The formidable obstacles to developing such a tag include the tremendous increase in biomass as the turtle grows from about 30 g to 100 kg or more, and the huge number of hatchlings that must be tagged to ensure reasonable odds of one or more surviving to maturity and being found. The methods proposed include grafting a piece of the light plastron onto the dark carapace and vice versa; inserting a magnet in the body cavity; causing the turtle to have a permanent immunological response to a certain antigen; excising particular marginal scutes, together with the underlying part of the bony shell, and for the leatherback turtles, clipping off the extreme posterior end of the carapace. A disadvantage of all these methods is that only someone familiar with the project and the tagging method could detect a tagged turtle. Also, the mutilation/excision marks may either heal completely and disappear or heal in a way that mimics a natural injury.

#### **C.4.3.6 What to Record When Tagging**

When a turtle is tagged, relevant biological data should be recorded. A tagging log should include the serial number of tag or tags, whether the turtle already had a tag, or a scar from a lost tag, the position of the tag, the date, time and location of tagging, whether or not the turtle nested, tidal and meteorological data, carapace length (ideally in a straight-line, but acceptable with a flexible tape if so stated), and possible other parameters (e.g., carapace width, weight). Tag data should be placed in a permanent depository, such as the files of a museum or government agency. No central turtle tag data clearing house now exists, though establishing one is under discussion.

Two Beach Survey data sheets presented in Section C.4.4 indicate the types of data that should be recorded. Data collection can be modified to suit the specific conditions of a given beach survey project.

#### **C.4.3.7 What to Do When a Tag is Recovered**

Many turtle tags are recovered by fishermen who have caught and killed the turtle. Tags are also recovered from turtles that were accidentally caught, and often killed, by shrimp trawlers and other trawlers. In these cases, the tag should be removed, opened up, flattened to fit into an envelope, and mailed to the address on the tag. An accompanying letter should give full details about the date, time, place and circumstances of the capture, the carapace length, weight, and the turtle species.

If a tagged turtle is observed nesting, or if a tagged turtle is caught alive and can be released alive, the tag should not be removed without good reasons. These reasons include: a) A tag that is badly corroded, about to drop off or is nearly illegible and has little further useful life. Sometimes the tag face is so damaged that the researcher should ensure that the number has been read correctly; b) Recapture of a turtle that the recoverer recognizes as an exceedingly unusual or noteworthy record; c) When the recoverer has tags and applicators on hand, an exceptionally old, worn tag or a poorly attached one can be replaced before the turtle is released.

#### **C.4.3.8 Permits for Tagging Programs**

Those interested in starting a sea turtle tagging project should consult with their own natural resources or wildlife agencies and obtain any required permits.

#### **C.4.4 Data Form for Sea Turtle Beach Surveys**

A standard data form for Sea Turtle Beach Surveys includes information on measuring, tagging, nesting and hatching. Form 7 is designed for use in a tagging program, but it may be used without tagging.

Form 7. Sea Turtle Tagging and Nesting Data Form - Beach Survey.

SPECIES: \_\_\_\_\_ NEST or FALSE CRAWL (circle which)

INVESTIGATOR: \_\_\_\_\_ DATE \_\_\_\_\_ TIME: \_\_\_\_\_

LOCATION: \_\_\_\_\_ TIDE: \_\_\_\_\_

EVIDENCE OF PREVIOUS TAG (Circle) YES - NO

OLD TAG NUMBER 1: \_\_\_\_\_ OLD TAG NUMBER 2: \_\_\_\_\_

NEW TAG NUMBER 1: \_\_\_\_\_ NEW TAG NUMBER 2: \_\_\_\_\_

SURFWATER CONDITION (circle) CALM, MOD. (2-3 feet) ROUGH (3-6 feet) \_\_\_\_\_

CARAPACE LENGTH: \_\_\_\_\_ cm inches (circle) WEIGHT: \_\_\_\_\_ kg lb (circle which)  
straight/curved (circle which)

COMMENTS: VEGETATION \_\_\_\_\_

STRUCTURES: \_\_\_\_\_

OTHER: \_\_\_\_\_

DISTANCE NEST CONSTRUCTED FROM MEAN HIGH WATER LINE: \_\_\_\_\_ M FT (circle which)

TOTAL NUMBER OF EGGS: \_\_\_\_\_

FATE OF NEST: \_\_\_\_\_ INCUBATION DAYS: \_\_\_\_\_ NUMBER OF HATCHLINGS: \_\_\_\_\_

PERCENT HATCH: \_\_\_\_\_

COMMENTS: \_\_\_\_\_

TOTAL INVESTIGATING TIME: \_\_\_\_\_ Hours/ \_\_\_\_\_ Minutes/

CRAWL DIAGRAM (Sketch here)



In a low density nesting situation, a separate page should be used for each turtle encountered. Sheets for multiple nesting by the same turtle should be collated. For *arribadas* or high-density nesting situations, fewer data may be recorded for each turtle, and data for several turtles may be included on one page of lined paper.

#### C.4.5 Determination of Hatching Success

Sea turtle population estimates depend, in part, on accurate assessment of number of eggs laid and number of healthy hatchlings that emerge.

The Sea Turtle Egg and Hatching Data Form (Form 8) defines the most important information needed for this assessment.

Form 8. Sea Turtle Egg and Hatchling Data Form.

Date Nest Laid \_\_\_\_\_ If Not Fresh, Estimate Age (Days) \_\_\_\_\_ Species \_\_\_\_\_

Date Nest Hatched \_\_\_\_\_ Days \_\_\_\_\_ Nest Excavated by \_\_\_\_\_

Location of Nest \_\_\_\_\_

Tag No. of Turtle (If Applies) \_\_\_\_\_ Incubation Method \_\_\_\_\_

Hatchling Data

Hatched eggs (H), from which hatchlings escaped from eggs \_\_\_\_\_

Hatchlings escaped from nest (HN) \_\_\_\_\_

Hatchlings dead in nest (DN) \_\_\_\_\_

Unhatched eggs (UH) \_\_\_\_\_

Turtles dead in pipped eggs (DPE) \_\_\_\_\_

Turtles alive in pipped eggs (LPE) \_\_\_\_\_

Infertile eggs with no obvious embryos (INF) \_\_\_\_\_

Unhatched eggs with discernible embryos (DE) \_\_\_\_\_

Deformed hatchlings alive in nest (DA) \_\_\_\_\_

Deformed hatchlings dead in nest (DD) \_\_\_\_\_

Survival Percentage of Hatchlings from Nest (SP) =  $\frac{HN}{H + UH}$  \_\_\_\_\_

Comments: \_\_\_\_\_

Weight of 20 Hatchlings Selected at Random from Nest (Living Turtles Only) (Grams).

1. \_\_\_\_\_ 6. \_\_\_\_\_ 11. \_\_\_\_\_ 16. \_\_\_\_\_ Average Weight \_\_\_\_\_

2. \_\_\_\_\_ 7. \_\_\_\_\_ 12. \_\_\_\_\_ 17. \_\_\_\_\_

3. \_\_\_\_\_ 8. \_\_\_\_\_ 13. \_\_\_\_\_ 18. \_\_\_\_\_

4. \_\_\_\_\_ 9. \_\_\_\_\_ 14. \_\_\_\_\_ 19. \_\_\_\_\_

5. \_\_\_\_\_ 10. \_\_\_\_\_ 15. \_\_\_\_\_ 20. \_\_\_\_\_

Disposition of Hatchlings (Released, Pen-reared, Other) \_\_\_\_\_

## C.5 Market Surveys

Market Surveys can be used to assess the level and type of exploitation of sea turtles in an area.

### C.5.1 Types of Data to Collect on Market Surveys

1. Name and location of market.
2. Date visited.
3. Number of vendors offering sea turtles or parts thereof.
4. Tabulation (in words) on numbers and species of live turtles each vendor offered.
5. Tabulation (in words) of turtle parts each vendor offered for sale. Products may include cut meat, tortoiseshell jewelry, souvenir shells, etc.
6. State whether market survey was complete (i.e., all vendors visited and their products examined) or was based on a sample. If a sample, estimate proportion of total market surveyed.
7. Prices asked for turtles and turtle products (state typical price and currency; highest and lowest prices; also state whether price is fixed or determined by barter).
8. Sources of turtles and season when available, according to vendors or other sources (interested or highly informed vendors should be asked the questions on the draft turtle survey questionnaire of Section C.6).
9. Measurements and weights of turtles or turtle shells seen:

Species:

Sex:

Carapace length (straight):

(curved):

Carapace width (straight):

(curved):

Abnormalities and injuries:

Notes on color and encrusting organisms:

Weight:

Date, location and method of capture:

## C.6 Suggestions for Conducting Interviews

The following notes and draft questionnaire are suggested for use by scientists and fisheries officials when interviewing fishermen or residents of coastal districts.

Field procedures in sea turtle censuses and surveys should be a combination of direct observation and interviews. Repeated visits to one locale are difficult during most short-term surveys, but carefully planned interviews with knowledgeable local residents can yield data of great value. Interviews should be carried out systematically and with patience. The present outline aims to standardize interviews and ensure coverage of the key topics. The questioner ought to be prepared to conduct the interviews according to a mental checklist of the survey's objectives as originally conceived and as modified from time to time. The objectives are much the same in any interview, but the techniques will have to be flexible. Some informants may be willing and able to fill out a written questionnaire. Some may not. Asking a humbly educated informant to fill out a form can alienate him. He is likely to be even more offended when his answers are recorded verbatim. Taped interviews are useful, but some informants react negatively to requests to record the interviews, and even worse if recording is attempted secretly.

There are ways to surmount these problems. Keep in mind the procedural outline described below, and memorize the checklist. Write as little as possible during the interview but as soon as it is over, make notes and fill out the questionnaire in private. If there are gaps in the required information, and if the informant was good, return for additional questioning.

### 1. Data on the Informant

You should record the informant's name, address, approximate age and occupation. Try to judge his reliability; what opportunities he has had to get first-hand information; where he acquired his familiarity with turtles; and over what period of time. This assessment is one basis for grading each completed interview.

### 2. Species of Sea Turtles that Occur in the Area

Find out which species of turtles the informant believes are found in the area. Establish this by easy cross-questioning; avoid prompting or leading him into more elaborate answers than his knowledge justifies. Use the color plates of this Manual to aid in obtaining species identifications, but the informant should describe the species he is familiar with before being shown the illustrations.

After confirming the occurrence of a species, ask for all its local (vernacular) names (be they English, Spanish, Dutch, French, Miskito, Papiamento, Carib, or any other language or dialect in local use). When confident that the informant can distinguish one kind of sea turtle from another, record the names used and proceed with the interview.

### **3. Seasonality and Ecology of Foraging Adults**

For each species, determine whether mature turtles occur in the region and how the informant knows they are mature. Ask if the turtles are present during the whole year or only during part of the year. Get information on both seasonal residents and seasonal migrants (see below). Be careful that the informant doesn't confuse the two; they are different. Try to determine the abundance of mature resident turtles of each species and in what habitats they live. Expect only a relative assessment, because there is no known way to count turtles in most foraging habitats. Nevertheless, for each species of resident adults, try to get a valid impression of population abundance and the extent of any local foraging habitat.

### **4. Developmental Colonies**

Once the above data on resident adult turtles of each species are obtained, solicit the same information on the developmental stages, from yearling to submature sizes. Closely question anyone who seems to have a reliable understanding of the habitat distribution and seasonality of the various size classes.

### **5. Nesting**

The most reliable quantitative population information that can be expected from this survey will come from nesting census data, especially in areas where tagging programs have been in progress. When asking questions about nesting, use charts and maps to identify likely sites of concentrated nesting. Also, get density-per-kilometer estimates for separate nestings by each species represented. Wherever warranted, supplement interviews with beach inspection and, in special cases, with aerial survey counts.

### **6. Changes in Population Levels**

Another aim of the interviews is to determine if local opinion suggests whether the local population is stable or, if unstable, the way and degree that the population is changing. Although it is hard or impossible to determine the reliability of population stability estimates in most cases, estimates of fishing effort expended per turtle caught is one useful approach.

### **7. Migratory Routes**

Migration, an important feature of sea turtle biology, has strong bearing on management. As suggested earlier, informants may not clearly distinguish migratory passage from the periodic occupation of developmental or foraging environments. During interviews, solicit local information about regular routes of migration. Ask the informant whether he has ever seen many turtles together at sea. If so, ask where, when, how many, what their average size was, etc. Ask what he believed the turtles were doing. Try to keep the idea of migratory movement separate from seasonal occurrence in a place or habitat.

## **8. Exploitation**

In addition to gathering information on the kinds, abundance, seasonality, and habitat distribution of sea turtles, collect data on exploitation. Are turtles and turtle eggs used locally, exported, or both? What techniques do turtle fishermen use? During which seasons or months do they operate?

## **9. Turtle Laws and Regulations**

To judge public awareness of restrictions and regulations, ask the informant what he can tell you about local turtle laws. Determine if he knows if it is legal to catch turtles; if there are closed seasons, quotas, or size limits; if it is legal to take eggs. This information will not only help to evaluate public awareness of, and attitudes toward, sea turtle regulation, but also will pave the way for the next line of inquiry.

## **10. Incidental Catch**

Tag returns clearly show that, as shrimping fleets have grown, the frequency of turtles caught accidentally in trawls has risen strongly. Obtain estimates or records, if they exist, of numbers of turtles captured this way. Try to determine which species and size groups are caught, whether they are eaten by the boat crews and their families, are sold or are released, and whether there are regulations to control such incidental catches.

### C.6.1 DRAFT QUESTIONNAIRE

#### 1. Data on the Informant

Name: \_\_\_\_\_ Sex: \_\_\_\_\_ Age: \_\_\_\_\_

Address: \_\_\_\_\_

Occupation: \_\_\_\_\_

#### 2. Species of Sea Turtles in the Area

a. How many kinds of sea turtles are known here? Describe them.

b. What local name is used for each of them?

CC = *Caretta caretta* loggerhead

CA = *Chelonia agassizi* black turtle

CD = *Chelonia depressa* flatback

CM = *Chelonia mydas* green turtle

DC = *Dermochelys coriacea* leatherback

EI = *Eretmochelys imbricata* hawksbill

LK = *Lepidochelys kemp* Kemp's ridley

LO = *Lepidochelys olivacea* olive ridley

UK = Unknown

c. How do the various species rank in abundance?

d. Beside the turtles shown in Color Plates 1 - 40 (Annex I), do people ever speak of other kinds here? If so, what are their names, and what do they look like?

#### 3. Seasonality and Ecological Distribution of Foraging Adults

a. Do fully grown turtles occur here? Which species?

b. Which species live in local waters year round?

c. During what seasons do other species occur?

CC = *Caretta caretta* loggerhead

CA = *Chelonia agassizi* black turtle

CD = *Chelonia depressa* flatback

CM = <i>Chelonia mydas</i>	green turtle
DC = <i>Dermochelys coriacea</i>	leatherback
EI = <i>Eretmochelys imbricata</i>	hawksbill
LK = <i>Lepidochelys kempfi</i>	Kemp's ridley
LO = <i>Lepidochelys olivacea</i>	olive ridley
UK = Unknown	

- d. If turtles are seasonal here, do you have any idea where they come from?
  - e. How do you know this?
  - f. Do turtles arrive and depart on a predictable schedule, or a variable schedule?
  - g. In what kinds of habitats does each turtle species occur: channels, reefs, turtle grass beds, *Gorgonia* beds, mangrove creeks, others?
  - h. How many of each kind of turtle do you catch in a year?
  - i. On a good day, how many (total) do you catch: by netting, harpooning, diving, or by other methods?
  - j. How many days per month or per year do you fish for turtles?
  - k. Are there seagrass beds around here? Do you see adult turtles feeding on these grass beds?
  - l. Are there reefs around here? Are turtles common around these reefs?
  - m. Are there places where turtles are especially numerous?
  - n. Do you ever see turtles offshore? How far out? Which species? What size? Are they in groups? What did they seem to be doing? Are they associated with driftwood, seaweed, or just in the open sea?
  - o. Do you ever see any turtles mating?
- 4. Seasonality and Ecology of Developmental Stages**
- a. What sizes of each species do you find?
  - b. Which species of small turtles live here year round?
  - c. Do you find different types of small turtles in the same habitat? If not, what is the best type of place to find each kind?



- d. Do the different sizes of the same species appear at different times of year?

## 5. Nesting

- a. Do sea turtles nest locally? If so, which species? What seasons? Which beaches? How many in an average year?

CC = <i>Caretta caretta</i>	loggerhead
CA = <i>Chelonia agassizi</i>	black turtle
CD = <i>Chelonia depressa</i>	flatback
CM = <i>Chelonia mydas</i>	green turtle
DC = <i>Dermochelys coriacea</i>	leatherback
EI = <i>Eretmochelys imbricata</i>	hawksbill
LK = <i>Lepidochelys kemp</i>	Kemp's ridley
LO = <i>Lepidochelys olivacea</i>	olive ridley
UK = Unknown	

- b. Are there any places where many turtles gather to nest together? If so, where? What species are involved? Does this happen occasionally or regularly? When?

## 6. Changes in Population Levels

- a. Are sea turtles generally rarer, more numerous, or about the same today in comparison to years past?
- b. How would you rate their abundance today as compared with 10 years ago, or 25 years ago?
- c. To what do you attribute these changes? To annual catch? To changes in effort that has to be spent catching a turtle? To changes in nesting density on local beaches? To information you have seen in print? If so, where?

## 7. Migratory Routes

- a. At certain times of the year, do you see turtles pass by that seem to be going to a particular locality?
- b. If so, which species? What sizes? In groups, or singly? How big are the groups?
- c. Describe the route they seem to be following.

- d. Which way does the main current flow in this area? Does it affect the turtles' movements?

## 8. Exploitation

- a. Is turtle meat sold locally? Is there demand for the meat throughout the country or only among the coastal inhabitants?
- b. What is the current price of turtle meat per pound or per kilo?
- c. Is meat exported to other countries? To which countries? Where is it processed?
- d. How important is turtle meat in the diet of local people?
- e. Which kinds of turtles other than green turtles are eaten, or sold for food?
- f. Are turtle eggs sent to market? If so, what is the order of preference, if any, for eggs of the different species? Does the sale of eggs extend throughout the country or just along the coast?
- g. Is there a market for turtle skins? What kinds of turtles are used? Who buys them? What prices are paid?
- h. Is there a market for tortoiseshell? Is the market local or foreign? How much does the shell sell for (either by weight or per turtle)?
- i. Are small turtles preserved or stuffed for sale to tourists and local residents? Which kinds? How much do they sell for?
- j. Are turtles caught with spear guns, or by swimming, netting, or on the beach? By local people or by visitors?
- k. How many people here hunt turtles for their main source of income? Are turtles captured by other fishermen as well?
- l. How much subsistence capture is done by people who use their catch only themselves or among their family and friends?
- m. Have the recent restrictions on international trade in sea turtle products had any effect on turtle hunting here?
- n. If all export of turtle products were to stop, what would be the effects on local employment and local economies?

## 9. Turtle Laws, Poaching, and Smuggling

- a. Do you consider the laws that prohibit or restrict taking and selling turtles fair or unfair?

- b. Are the turtle laws generally respected, or do a lot of people poach?
- c. Does the government make a strong effort to enforce turtle laws? How many officers does the government employ to enforce turtle laws locally?
- d. Do the enforcement officers carry out their job, or are they half-hearted, or timid?
- e. Have you ever heard of anyone getting caught for violating the turtle laws? Have you ever heard of any getting caught for violating the turtle laws? Have you ever heard of anyone being punished?
- f. What kind of penalty usually is imposed?
- g. How do poachers avoid the enforcement officers?
- h. How many people would you say regularly take eggs or turtles illegally?
- i. How important do you consider poaching's effect to be on the survival of local species?

#### 10. Incidental Catch

- a. Do trawlers work in local waters? Are they here all year or just in certain seasons?
- b. Do trawlers or other fishing activities catch sea turtles? How do you know this?
- c. Has this incidental catching of turtles increased lately?
- d. Which kinds of turtles are taken, what sizes, and with what relative frequency?
- e. Do the turtles usually drown in the net, or do most survive?
- f. Are turtles caught by trawlers eaten, sold, or released?

#### D. Management and Conservation

The World Conference on Sea Turtle Conservation, held in Washington, D.C., USA, in November 1979, developed a "Sea Turtle Conservation Strategy" of world-wide scope which is published in Bjorndal (1982; see Reference section). This may be used as a reference document to establish priorities for national sea turtle conservation programs.

International cooperation, exchange of personnel, and consultation between turtle researchers and conservationists play an extremely important role in effective sea turtle conservation and management. For example, when many developing countries first established sea turtle programs, they arranged for national personnel to gain vital experience by participating in established turtle programs in other countries. Such exchange programs have many admirable results and invariably both veteran and novice researchers learn much that is new to them.

Recently, several national and international conferences on marine turtle biology and conservation have been held. Anyone contemplating a major commitment of time and energy to sea turtle work should try to attend such meetings. Regional meetings such as those of IOCARIBE can be especially valuable. New information that is exchanged at such meetings may not actually be published for several years, if ever.

#### **D.1 Beach and Nest Protection**

The procedures recommended for nesting beach protection depend on the kind of predation and other conditions at any particular site. Most turtle conservationists agree that protecting nesting turtles is essential to maintain a viable population. Collection of eggs for human use must be carefully controlled, and in most cases, totally forbidden until turtle populations again reach acceptable levels.

Turtle eggs may be lost to:

- a) Nest predation by man.
- b) Nest predation by domestic animals.
- c) Nest predation by wild or feral animals.
- d) Erosion of the beach, flood tides, and other abiotic factors.
- e) Nest destruction by later-arriving turtles digging up existing nests.

The investigator or turtle conservationist must monitor nesting and hatching to estimate the overall percentage of eggs that are lost for one or another of the above reasons. If losses are not great, manipulation or management of nests may not be necessary. If losses are great, protective measures should be instituted as soon as possible and continued as long as necessary.

##### **D.1.1 Control of Predation by Man**

The first conservation priority is to keep egg collectors and turtle poachers away, and to bring natural predators under control. Beach patrols are usually necessary for this. Several nations have found that a good course of action is to hire the most active poachers to work on these patrols, if it can be ensured that they will not draw

their pay while continuing to poach for profit. Such an approach curbs exploitation while drawing on the poachers' experience and expertise to benefit the turtles.

Effective patrols can be organized with assistance from military organizations, conservation officials and interested amateurs. Where sea turtles are under the auspices of fishery departments, local legislation might need amendment to enable enforcement officials and other wildlife specialists to assist in turtle patrols. If properly trained and organized, local amateur groups and naturalist societies greatly assist beach patrol and turtle protection efforts. Turtle hunters may be armed, and some turtle beaches can be dangerous. So care must be taken in recruiting amateur aides and they should carry some conspicuous form of identification.

#### **D.1.2 Control of Domestic Predators**

Domestic animals such as dogs and pigs destroy sea turtle nests and eggs on many beaches and must be controlled. When predator restraint or elimination is not possible, the nests should be moved to a suitable protected area.

#### **D.1.3 Control of Wild Predators**

Under normal circumstances, wild predators such as raccons and coyotes should not be exterminated. They should be controlled, however, when they are extremely populous and are destroying a large number of turtle nests, or where the turtle nesting population is already endangered. No entirely satisfactory control mechanism for such predation has been found. Experiments to reduce raccoon predation on loggerhead nests in the United States have had variable results. Experiments in which eggs are moved from the original nest to a facimile only a few yards away show some promise; both human and animal predators may be foiled by this strategy. But in some cases, a hatchery may be the only means of controlling predators.

#### **D.1.4 Protection from Beach Erosion**

Turtles may nest too close to the sea or in areas where high tides or storms are likely to erode the beach during incubation. The conservationist has several options discussed in Section D.1.6

#### **D.1.5 Protection from Later Nesting Turtles**

There are a few places in the world where turtles nest in such density that numerous nests are destroyed when other turtles subsequently arrive and dig in the same spot on the beach. Such nesting sites are unique natural laboratories for studies of what may be one of the few natural limits on turtle populations. But these beaches also provide an opportunity to enhance hatchling survival by moving some of the early-season nests to protected locations.

#### D.1.6 Egg Handling and Relocation

Sea turtle eggs should be allowed to incubate in their natural beach setting whenever they are likely to survive. Practical conservation management, however, sometimes requires that the nests be relocated. Consider moving the nests when one or more of the following situations occurs:

- a) Heavy poaching has occurred in the nesting area during previous nesting seasons.
- b) The nest is too close to the sea. For successful hatching, eggs should be laid well above the average high tide level.
- c) The nest is close to artificial lighting.
- d) Beach cleaning equipment is used near the nest.
- e) Local populations of turtle egg predators such as crabs, pigs, lizards, etc., destroy a high percentage of nests.
- f) Human use of the beach, including vehicle traffic, is intense.
- g) Plant roots obstruct the upper part of the beach in a way that might block successful hatchling emergence.

Relocated eggs may have a lower than normal hatching success, but careful and rapid handling and transport of eggs reduce risks of relocation. Eggs can be removed during laying and before the turtle covers the nest. Taking care not to disturb the nesting turtle, deftly scoop the eggs out of the bottom of the hole or catch them gently in a plastic bag as they drop from the vent. Or, eggs may be excavated and retrieved from marked nests.

When excavating a turtle nest in which the egg pit was not precisely marked during laying, the following cautions are recommended:

- a) Use extreme care in attempting to locate the eggs. To avoid punctures, only experienced personnel should use a probe to find eggs. Digging by hand is preferable. In many cases, the egg pit is on the seaward side of the nest, about 0.5 m deep. Leatherbacks and green turtles, however, bury their eggs deeper. Unless there is considerable time to dig by hand, probing may be necessary. The probe should be a wood or metal rod about 0.75 cm in diameter and 1 to 1.5 m in length. Whether probing or digging, be careful not to trample the nest area and compact the sand which will make locating the egg pit even harder. Once the probe starts "giving way" as it is pushed slowly through the sand, extract it immediately to avoid puncturing any eggs. If any eggs are punctured, remove them and all spilled egg contents to prevent the clutch from rotting.
- b) Once the eggs are located, excavate them by hand. A shovel will break many eggs. Handle and transport eggs quickly, but with

utmost care. Place them on top of a thin layer of beach sand in a rigid container such as a styrofoam, wooden or cardboard box, or a strong basket. Shade eggs while excavating them on hot days. Hatchlings have a better chance to survive when eggs are removed and reburied within about six hours after laying.

If eggs are more than about six hours old, few will survive relocation unless they are kept with the upper surface or pole upright (i.e., without rotation). Maintain this orientation at all times when removing them from the nest, placing them in the container and transporting them. The top of eggs can be marked with a pencil. Put them in the new nest with the same axial orientation.

#### D.1.6.1 Beach Hatcheries

A beach hatchery should be located in a well-drained, unshaded level area that is free from vegetation. Although many designs for in-ground hatcheries have been used, the following design criteria are widely accepted (see also Figure 19).

- a) The hatchery should be enclosed completely (sides and top) with aluminized or vinyl-covered wire mesh screen to keep out egg and hatchling predators.
- b) The sides of the enclosure should be sufficiently strong to keep out mammalian predators such as raccoons and pigs. The sides should extend about 0.5 meter into the sand to keep out crabs and other burrowers.
- c) Nests within the hatchery should be planted above the level of ground water, but not in completely dry sand as some moisture is essential for hatching. During very dry weather the nests might need to be moistened with a sprinkling can containing fresh water.
- d) Wasted space should be avoided to reduce construction costs. However, when a hatchery is to be used throughout the nesting season, nest space should probably not be reused unless debris from earlier nests has been removed. The enclosure must be large enough to allow nests to be located about one meter apart to avoid trampling by personnel working the hatchery.
- e) An artificial nest should resemble a natural nest in depth, diameter and shape. Each egg in the artificial nest should be in contact with other eggs. An enclosure of strong wire netting (having an approximate opening of 1 cm) should encircle each nest. The circle should be about 60 cm in diameter and 30 cm high, with the lower 5 to 10 cm buried in the sand. Emerging turtles will be trapped within the circle and should be counted before release. Most hatchlings emerge from the nest simultaneously, but stragglers may appear during the following few days. Always check all nests for any emerged hatchlings very early in the morning (no later than about 9 a.m.) and remove any

hatchlings promptly or the sun and hot sand will kill them. Five days after the initial emergence, excavate the nest and count any infertile eggs or dead embryos. Ghost crabs or other burrowing predators may have ruptured other eggs so the number of whole infertile eggs plus the number of hatchlings will not always equal the total number of eggs in the clutch.



Figure 19. Example of a protected beach hatchery. Photo by J. Fletemeyer.

Natural nests may be excavated in the same way after the young emerge, but exact calculation of the hatching success is seldom possible unless the eggs were counted as they were laid and the emerging hatchlings were also counted accurately.

To preserve a dead hatchling found in an excavated nest, inject 25 percent formalin into the body cavity through the soft umbilical area. If a hypodermic syringe is not available, the plastron can be cut open. Submerge it entirely in 10 percent formalin for storage. To retain it for taxonomic study or other purposes, transfer it to alcohol. Sometimes a very freshly preserved hatchling's sex may be determined by histological section, although few laboratories currently are equipped to do such studies.



#### D.1.6.2 Enclosed Hatchery Buildings

Although this Manual recommends incubating turtle eggs in a beach hatchery with artificial nests that closely simulate the natural nests as described above, sometimes such incubation techniques are impractical. When necessary, eggs can be incubated in containers in an enclosed building. Some researchers question this practice, however.

An enclosed hatchery must have good ventilation to maintain ambient temperatures that equal beach nest temperatures; research has shown that the temperature range affects the sex ratio of the hatchlings. Styrofoam "cool-boxes" offer incubating eggs fairly good protection from temperature fluctuations in an enclosed hatchery. The containers should be approximately 30 x 25 x 20 cm (internal dimensions). Adequate but possibly less desirable alternatives are small plastic garbage cans or plastic 20-liter (5 gallon) buckets.

When transferring a clutch of eggs to an incubation container, observe the following guidelines:

- a) Drill or punch several small holes through the bottom of the container to facilitate drainage.
- b) Line the bottom of the container with inorganic fine-mesh screen, such as nylon, to keep in the sand and to keep out ants.
- c) Spread about 3 cm of beach sand on top of the mesh screen.
- d) Place the eggs on top of the sand layer. Duplicating the position in which they were laid in the natural nest is crucial. Small nests may be incubated in individual containers, while larger nests (e.g., 150 eggs) should be equally divided into two containers.
- e) Cover the top layer of eggs with fine-mesh screening (same as in b) to keep subsequent sand layer (see f) from settling between them.
- f) Finally, carefully pour at least 3 cm of sand over the top mesh screen. Put on box cover. Have at least 5 cm air space between sand and cover. Check the sand's moisture content by pinching the surface of the sand with the thumb and forefinger. If a small peak of sand remains after the finger pressure is released, the moisture content is right. If the peak collapses, the sand is too dry, and sand that is too wet will not form a peak. Moisten the sand with a sprinkling can containing fresh water.
- g) Store filled containers off the ground or floor, preferably on wooden racks or shelves. Do not stack containers on top of each other.
- h) Two days before anticipated emergence, remove top mesh screen. Replace cover on box and leave in place until emerged hatchlings are to be released.

### **D.1.7 Release of Hatchlings**

As hatching time approaches, monitor nests daily for emergences from both in-ground and indoor hatcheries. During cool, overcast or rainy weather, many hatchlings might emerge by day. As a rule, transport them immediately after emergence to a suitable site on the beach and release them. Keeping them too long retards their neonatal activity level; they will either fail to move when placed on the beach, or will be too sluggish to avoid predators. On beaches where hatchlings released during the day are subject to excessive predation (from birds, fish, etc.), many hatchery managers release them after sunset.

Released turtles may become disoriented, not only during their move to the water but also at sea. Carefully select a release site that is relatively free from natural predators. Do not release turtles near artificial lighting, piers, oil rigs or lighted offshore structures.

There is no consensus among turtle biologists on the best method for releasing hatchlings. Some maintain that natural conditions should be duplicated as closely as possible. They advocate liberating the newly hatched turtles high on the nesting beach so that if this phase plays a critical role in "imprinting," the turtle will return to the beach when it matures. Other researchers recommend taking the hatchlings by boat and releasing them beyond the surf line to avoid the high concentration of predators often found on the beach and in the surf. Both techniques should be used and in some cases combined; allow some turtles to run to the sea on their own, and release others beyond the surf line. If a large hatchery is being operated, do not release all hatchlings in the same place, but distribute them randomly at points well away from the hatchery area to avoid attracting predators.

## **D.2 Incidental Catch**

### **D.2.1 Background**

In some areas, incidental catch appears to be a major mortality factor for sea turtles. Turtles that become trapped in nets during shrimp trawling and fish seining may be injured or drowned. In addition to being an obvious problem for turtles, their incidental catch may interfere with commercial fishing operations and damage the gear.

### **D.2.2 Avoidance of Incidental Catch**

This problem may be partly if not completely avoided and, consequently, the mortality reduced in three ways:

- a) Areas frequented by large numbers of turtles can be identified and fishing activity in such areas restricted. Restrictions may be necessary only during certain seasons if the turtles concentrate for feeding or nesting only. Some shore-based fishermen who set nets near the beach leave their nets set during the

night to ease their work load. Turtles are often caught on their way in to the nesting beach. In Suriname, fishermen have cooperated willingly by raising their nets at night after the problem was explained to them.

- b) Trawl nets and other fishing gear should be pulled up more frequently. A turtle rescued from a net in less than one hour of trawling normally has a good chance of survival.
- c) Use of an excluder device on trawl nets reduces incidental catch significantly. The most effective device uses a trap door in the top of the trawl that opens to release large, heavy objects such as turtles and then closes again. Information on this can be obtained from the Southeast Fisheries Center, National Marine Fisheries Service, 75 Virginia Beach Drive, Miami, Florida 33149, U.S.A. Request NOAA Technical Memorandum NMFS, EFC-71 which contains detailed instructions on how to assemble, install and use an excluder device made from easily obtainable material.

### D.2.3 Resuscitation of Apparently Drowned Sea Turtles

The time it takes to drown a turtle held under the surface by a trawl or other net is variable. The metabolism, and thus the oxygen demand, of a submerged turtle depends upon several factors, principally ambient temperature and activity level. Turtles caught in very cold waters, particularly dormant individuals dredged from winter hibernation sites, probably have a low oxygen demand and can survive for some time in a trawl. On the other hand, a turtle caught in a trawl in the tropics or in temperate zones during the summer has a high temperature, a higher metabolism and thus a shorter survival time in a trawl net. In addition, efforts to outswim an approaching net and struggles to free itself once trapped further increase its oxygen demand and dangerously shorten survival time.

Sea turtles caught in set nets or trawl nets may appear dead when brought to the surface or on the deck of a vessel. These animals do not move and their breathing and heartbeat cannot be observed without special instruments. Apparently lifeless turtles, however, may not actually be dead but may be moribund (approaching death). Field observations have demonstrated that many are only comatose and often may be revived.

To resuscitate an apparently comatose or drowned turtle, place it belly-down on the deck. Prop up the rear end so that the head is considerably lower than the tail. In this position, gravity can draw the water out of the turtle's lungs. Place the turtle in shade. An alternative resuscitation method is to place the turtle on its back and repeatedly push on the plastron with the foot to force the water from the lungs. However, some turtles, for reasons that are still poorly understood, die of anoxia without ever drawing water into the lungs while forcibly submerged. Comatose turtles will die if returned to the sea. Keep any apparently lifeless sea turtle out of the water for at least 24 hours and practice resuscitation, if possible, for 24 hours before presuming the turtle dead.

Sea turtles caught in nets and brought to the surface from very cold waters (less than 14°C) may have been hibernating in bottom mud. They may be dormant or comatose. If they are simply thrown back to the cold water, some or all of them might die from hypothermal stress. Until the physiology of this apparent hibernation is more thoroughly researched and understood, protect any sea turtles brought up from cold waters by temporarily storing them in warmer water before returning them to the sea.

### D.3 Legislation and Enforcement

Successful sea turtle conservation depends on action at local, national and international levels. The primary goal is to give adequate protection to turtles at all life stages, and to ensure that growth, and especially reproduction and recruitment, occur with minimal interference. In addition, human use, exploitation and marketing of turtles and turtle products must be rigorously controlled until turtle populations increase and sustainable yields can be calculated and controlled. A few countries, such as Costa Rica and the United States, have completely prohibited capturing or molesting sea turtles, and have banned imports or exports of sea turtles and their products for commercial purposes.

#### D.3.1 National Conservation Legislation

Detailed suggestions for sea turtle conservation legislation to suit the conditions in all countries cannot be given here, but in general protective legislation should:

- a) Protect sea turtle nesting, foraging and migration habitats.
- b) Give nesting females maximum protection during the breeding season on beaches and in inshore waters.
- c) Give maximum protection to nests.
- d) Regulate capture at sea. Capture at sea often causes less damage to populations than captures on beaches or the taking of eggs, but it still poses a threat and should be regulated. Complete bans on capture may be necessary where turtles are considered endangered.
- e) Regulate or prohibit all aspects of commercial marketing of turtles or their parts. Regulations should specifically forbid "holding," "offering for sale," or "causing to be offered for sale," any turtle or turtle product that is not legal.
- f) Impose penalties for violating protective legislation that are sufficiently severe to prevent offenders from dismissing them as "the cost of doing business."

A nation or region starting a sea turtle conservation program should begin by reviewing all pertinent existing legislation. In the

archives of some countries are a tangle of old regulations--outdated, confused, generally unknown or ignored, but still technically in force. Such legislation may regulate fisheries, sale of foodstuffs, activities within coastal or marine areas and so on. If updated and rigorously enforced, these regulations may well give sea turtle populations their needed protection.

When some exploitation of turtles is inevitable, there is an honest difference of opinion regarding conservation priorities--whether it is better to allow some eggs to be harvested, to stress protection of small turtles (i.e., with a minimum legal size), or emphasize protecting larger breeding turtles (i.e., with a maximum legal size). The final decision will reflect cultural and biological considerations. Whatever extent and type of exploitation is permitted, however, must be linked to positive conservation action. For example, if controlled capture of turtles at sea during the non-breeding season is permitted, active protection--by nesting beach patrols and, if necessary, by hatcheries--during their breeding season is vital.

#### **D.3.2 International Conservation Legislation**

Existing international legislation can support national sea turtle conservation programs. Planners should familiarize themselves with various international conventions, and encourage their governments to ratify and enforce them. Because sea turtles migrate across national boundaries, international cooperation is essential.

Some of the existing relevant or potentially relevant conventions are:

**a) Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) (1973)**

This Convention was designed to control international trade in endangered species, and their products and parts. Species threatened with extinction, listed in CITES Appendix I, are subject to strict trade regulation. All sea turtles are now included in this list. The last two sea turtle populations accorded this protective status were the Australian populations of *Chelonia mydas* and *Chelonia depressa* which were added to Appendix I at the CITES meeting in New Delhi in 1981.

As of December 1982, 77 nations have signed CITES, though a few have taken legal exception to the specific listings of several sea turtle species regarding trade regulation.

**b) Convention on the Conservation of Migratory Species of Wild Animals (1979)**

This Convention provides direction and guidelines for conservation of migratory animals, including sea turtles, and provides a mechanism through which nations can unilaterally act to conserve endangered migratory species. *Lepidochelys kempi* and *Dermochelys coriacea* are listed in Appendix I of the Convention as endangered species requiring immediate

protection, and all Cheloniidae and Dermochelidae are listed in Appendix II as species needing protection in certain areas.

**c) African Convention on the Conservation of Nature and Natural Resources (1968)**

This Convention theoretically offers a great deal of protection to sea turtles throughout the African continent; these species are listed as Class A (protected) species. In practice, several flaws exist: sea turtle eggs are excluded from coverage; nationals of Parties to the Convention are not covered when they operate outside their national territory; and the Convention's regional application does not cover all the sea turtle species involved. To date, 20 African nations have signed this Convention.

**d) Other International Conventions and Laws**

Several other conventions could be used to support national conservation efforts. Some have regional rather than global importance. One that has great potential application, but which, unfortunately, does not presently cover any sea turtle species is the Convention on the Conservation of Nature in the South Pacific.

In addition, Conventions and Treaties that ultimately may contribute to sea turtle conservation, include:

- i) The Convention on Nature Protection and Wildlife Preservation in the Western Hemisphere
- ii) The Convention on Wetlands of International Importance.
- iii) The Convention Concerning the Preservation of the World Cultural and Natural Heritage.
- iv) The Law of the Sea Treaty. Once it becomes international law, this treaty will affect Internal Waters, Territorial Seas, Exclusive Economic Zones, and the High Seas. Thus, it will embrace all sea turtle habitats except nesting beaches. Although not primarily a conservation treaty, it will help clarify and focus conservation responsibility for coastal resources such as sea turtles by allowing 200-mile exclusive economic zones for coastal nations.

**D.3.3 Techniques for Setting Up Turtle Reserves**

The legal procedures for establishing turtle reserves and refuges clearly differ from country to country. Several government programs proven effective in many countries are listed here; each nation can evaluate them in terms of its own local conditions. Laws or regulations protecting sea turtle habitats should be accompanied by legislation to protect the turtles themselves and their eggs. Enforcement patrols are necessary on intensively used nesting beaches. The patrols may be coordinated with biological research.

- a) **National Parks.** These include designated areas where an ecosystem of national importance is maintained as undisturbed as possible. Both commercial and recreational exploitative activities are generally prohibited, though certain long-established activities in newly-designated park areas may be permitted for various reasons. Visitors to national parks are required to obey rules designed to protect the natural systems from damage. Many countries have established national parks which include and protect some of the world's most impressive landscapes and most important concentrations of wildlife.

Provincial and state governments may also establish parks and sanctuaries that can be as important and well-managed as national parks.

- b) **Wildlife Refuges.** These areas may offer valuable protection for sea turtle breeding and nesting habitats. Recreational hunting and/or fishing is often permitted, but this does not interfere with turtle protection.
- c) **Private Beach Ownership.** Private conservation initiatives offer a nesting beach good protection when one or more concerned landowners purchase property adjacent to the beach, and as far seaward as ownership laws allow. This is particularly effective when national parks have a seaward extension sufficient to protect turtles in adjacent waters as well as on land. If the foreshore is privately owned, preventing access to a beach from the sea is difficult; turtles may be poached either on the beach or just after they re-enter the sea. Private initiatives, however, only last as long as landowners cooperate; it is generally better to base protective measures in law. Private conservation efforts, nonetheless, sometimes have a greater permanency than government programs.
- d) **Beach Construction Setback Lines.** Forbidding construction too close to the sea's edge not only avoids property destruction but also protects dunes and turtle nesting habitats.
- e) **Other Measures.** In the United States, several additional programs protect marine habitats of turtles. For instance, in an area designated as a Critical Habitat, federal activities or activities related to federal programs are barred if they are likely to jeopardize the continued existence of an endangered or threatened species. Two other useful federal programs are the Marine and Estuarine Sanctuaries. In a Marine Sanctuary, exploitation of marine species is prohibited (sometimes with certain exceptions). In an Estuarine Sanctuary, adjacent land is purchased and both terrestrial and marine habitats are protected. Where protected areas already exist that include sea turtle nesting or foraging areas, conservation effort could be concentrated in these.

#### D.4 Care of Sea Turtles in Captivity

This section describes culture of captive sea turtles for research and conservation purposes. Commercial culture is outside the scope of this Manual.

##### D.4.1 Culture Techniques and Requirements

Hatchling sea turtles can be raised in captivity if water quality, temperature (minimum 20°C), sanitation, and diet are appropriately controlled. Experience has shown that some species are easier to raise than others: green turtles and loggerheads are probably the easiest, Kemp's ridleys are difficult, and leatherbacks are definitely the hardest to raise in captivity.

- a) **Space.** Young sea turtles of some species are very aggressive in captivity. Kemp's ridleys in particular may violently and repeatedly bite each other if crowded. The resulting lesions may become infected and result in poor growth rates and an excessive number of deaths. Kemp's ridleys should be raised in individual containers. To diminish aggression to some degree in other species, use floating vegetation that allows turtles to hide from each other, and weight the food so that it sinks. Turtles bite each other mainly during the excitement of surface feeding. With hatchlings, the water must be shallow until they can dive to feed.

The space each turtle needs depends on the number of turtles kept together and other circumstances, so it is difficult to prescribe a fixed rule. A guideline is to provide a hatchling about one cubic foot (or 30 liters) of water and a subadult 18 cubic feet (or 2/3 cubic meter). Careful observation usually reveals whether turtles are crowded; if they are unable to swim freely or develop necrotic lesions on their necks and flippers, the density probably should be decreased.

When raising turtles in an outdoor tank, shade part of the tank from the sun unless the tank is very deep. If predators pose a risk, particularly to small turtles, cover the tank with netting. If possible, roof the tank completely.

Land areas are not desirable in tanks for rearing young turtles, because the turtles may crawl out on them and become dehydrated.

Leatherbacks do not adapt well to captivity; they swim into the walls of any enclosure and injure themselves severely. Attempts to rear them should not be made except under exceptional circumstances. Draping enclosure wells with a flexible material helps protect the turtles from injury. Sponge rubber "curtains" are not recommended because of their tendency to accumulate organic matter.



- b) **Sanitation.** Hatchlings of all species are sensitive to water pollution and will suffer if pathogens reach high levels. Housing the turtles in "crawls" or other cages that are constantly flushed by sea water reduces pollution. Turtles, however, may escape during storm or other high tides while young turtles housed in tanks on land are more secure. If possible, install a system to supply clean sea water continuously. Flushing and completely refilling the tanks once or twice daily is an acceptable alternative. In inland installations where sea water must be conserved or other water used, a closed circulation system with adequate filtration and sterilization gives satisfactory results. Do not allow organic matter to accumulate in tanks. Pass-through systems should be drained and sterilized periodically, and tanks drained daily should be sterilized before refilling.
- c) **Salinity.** Where estuarine water is used for captive rearing, the salinity should be monitored. Hatchlings are very sensitive to low levels of salinity; yearlings and older turtles are much more tolerant. Salinity of seawater is approximately 35 parts per thousand. Do not keep turtles in water with a salinity of less than 20 parts per thousand for any extended period.
- d) **Health.** A detailed discussion of health care and disease control in captive turtles is beyond the scope of this Manual. In general, isolate sick animals and keep them in scrupulously clean sea water. External lesions will heal faster if painted with concentrated Gentian Violet or if the turtle is immersed in a solution of potassium permanganate (1 to 3 grams in 200 liters of sea water) until the lesions darken. Weekly, biweekly, or daily immersions in a potassium permanganate solution greatly prevents disease in captive turtles. A dilute silver nitrate solution can also be used, which also darkens the tissue.
- e) **Feeding.** Post-hatchling turtles appear to be opportunistic feeders, and two species, green turtles and loggerheads, have been raised on diets of jellyfish. Most species in captivity can be fed proprietary food, pelleted food ("Trout Chow," etc.); filleted, skinned and boned non-oily fish, or the meat waste from crab or shrimp processing. Vegetable matter such as algae, lettuce, mangrove, *Sesuvium* leaves, seaweeds, and turtle grasses can supplement the diet of some species, particularly green turtles. Turtles raised on pelleted or artificial diets should be fed more natural food, if possible, for a few days or weeks before release.

Leatherbacks of all ages apparently require a highly specialized diet. As they are unable to digest fibrous food, they must be fed jellyfish or similar substances. Do not feed leatherbacks fish or plants, because they cannot digest such material.

It is emphasized that this section is not a complete or detailed Manual on rearing sea turtles in captivity. Anyone

contemplating a major turtle-rearing operation should visit facilities where turtles are being raised and consult in detail with their curatorial staffs.

#### **D.4.2 Turtle Aquaculture for Conservation or Population Restoration Efforts**

A topic much debated among turtle conservationists is the "head-start" procedure, whereby turtles are raised in captivity through the very vulnerable early months of life and then released.

By circumventing natural predators of young turtles, head-start programs may increase survival to maturity. However, this is still an unproven technique, because no clear-cut case has been reported of a head-started turtle reaching maturity and reproducing. Also, for head-starting to be proven to be a useful conservation tool, it must be shown that a greater percentage of hatchlings will reach maturity and reproduce successfully if they are head-started than if they develop naturally. Recent evidence suggests that green turtles and Kemp's ridleys released from a head-start program can function normally and integrate themselves into wild populations of sub-adults. Yet doubt remains as to whether turtles that spend the first months of their lives in captivity will have conditions of their natal beaches adequately imprinted in their adult behavior. The concern is that they might not migrate to appropriate locations nor come ashore to nest when mature, assuming that imprinting takes place.

This manual stresses that protection of natural populations and their habitats takes priority over head-start programs.

In deciding whether a given turtle population is suitable for head-start procedures, consider the following:

- 1) Head-start programs are expensive and demanding. The expense is justified only when the population is severely depleted and lacks protection from commercial exploitation.
- 2) It is suggested that no more than about 5 percent of the eggs laid should be head-started. The rest should be allowed to hatch and the young to reach the sea as naturally as possible.
- 3) All usual precautions must be taken to ensure maximum hatch of eggs (see section D.4.1 on hatchery techniques). After releasing the young, permit them to crawl down the beach from which the eggs came. Then gather them for release as they enter the sea. This may prove to be a meaningless exercise, but until researchers understand how turtles locate their nesting beaches, conservationists should mimic nature as closely as possible.

In addition to following the captive cultivation techniques recommended in section D.4.1, head-start programs should make an effort to prevent turtles from becoming too accustomed to one type of food. The curator also should prevent the turtles from associating him with feeding time, because this may later cause the turtles to form inappropriate responses to humans.

The duration of a head-start program depends in part on the facilities available. If a significant number of turtles are to be kept for more than a year, extremely spacious facilities and abundant regular food supplies are necessary. Most head-started turtles are released after six to fifteen months. Some programs keep them for from only a few days to two weeks, just enough time for them to absorb the yolk sac and acquire the ability to dive easily when threatened by birds. Such brief captivity, however, is not recommended because, while it may give the young turtle an advantage in avoiding predators, it presents the risk that the turtle will exhaust both its "infantile swimming frenzy" and its neonatal food reserves in captivity which it needs in order to reach its feeding habitat in good condition.

Before releasing head-started turtles, if they are large enough to carry a tag easily, tag them with the Monel flipper tags of appropriate size. Record each turtle's size and weight carefully so that later comparison can be made between captured head-started specimens and other turtles.

There are two philosophies regarding where to release head-started turtles. The first maintains that they should be placed in water where turtles in the same size-range naturally occur. The other advocates releasing turtles on their nesting beach at a time when hatchlings are emerging naturally. The latter treats the head-started turtles as if they were hatchlings, except that they are large enough to escape avian and certain marine predators. No decisive information is available on the relative merits of the two approaches. Therefore, the best strategy may be to divide the head-started turtles into two groups and apply the first method to one and the second method to the other.

#### **E. Glossary of Terms**

**ABDOMINAL SCUTES** - the third rearmost pair of plastral scutes; the largest of the scutes of the plastron.

**ALVEOLAR** - pertaining to the functional, or biting, part of the jaw.

**ANAL SCUTES** - the rearmost pair of plastral scutes.

**AXILLARY NOTCH** - the notch in the front part of the shell into which the front leg fits and from which it protrudes.

**BEAK** - the horny covering of the jaws, in turtles consisting of a single plate over each jaw surface. Also known as rhamphotheca or tomium.

**BICUSPID** - having two cusps.

**BIFURCATE** - having two branches.

**BODY PIT** - the depression dug by the female turtle during nesting. Body pits are characteristic of different species and range from shallow (ridleys) to rather deep (leatherbacks) and may persist for months under certain conditions. The center of the body pit does not indicate the position of the eggs.

**BRIDGE** - the part of the shell of a turtle that connects the carapace and the plastron.

**CALLOSITY** - a roughened area of skin, sometimes with superficial, sculptured bone exposed or just below the surface.

**CARAPACE** - the dorsal shell of a turtle.

**CARUNCLE** - the horny tubercle on the snout of a baby turtle used to cut through the eggshell.

**CAUDAL** - pertaining to the tail.

**CENTRAL SCUTE** - one of the large scutes extending down the mid-line of the carapace, also called vertebral scutes.

**COSTAL SCUTE** - any of the large plates that form the flanks of a turtle's dorsal shell, or carapace, located between the vertebral scutes and the marginal scutes. Also known as pleurals or laterals.

**CRAWL** - the tracks of the turtle on the beach. See false crawl.

**CUSP** - a sharp projection, typically from the edge of the jaw.

**DEVELOPMENTAL HABITAT** - the place where immature turtles feed and grow prior to reaching adult size. The developmental habitat of sea turtles may or may not correspond to the adult habitat and thus may require special conservation and management measures.

**DISORIENTATION** - the process of using incorrect cues for moving in a particular direction. For instance, hatchling sea turtles will move inland toward street lights instead of correctly toward the sea, and are thus said to be disoriented.

**EMERGENCE** - a. female. The term for the female turtle leaving the water and coming on land to nest.  
b. hatchling. The hatchlings leaving the nest cavity on their way to the sea. This may not necessarily occur immediately after hatching.

**ENDANGERED** - any taxa likely to become extinct within the foreseeable future if those factors responsible for its status continue operating.

**FALSE CRAWL** - the track left by a sea turtle that has ascended a beach but returned to the sea without laying eggs.

**FARMING** - the practice of culturing sea turtles in a closed-cycle system for commercial purposes. Farming does not rely on wild populations except initially, and later occasionally, to increase genetic diversity and avoid problems with inbreeding.

**GROUND TRUTH** - correlation between aerial surveys and beach surveys on a particular section of beach to obtain an estimate of the numbers of nests and false crawls. The number of nests and false crawls from

beach surveys (ground truth) is then compared with the numbers from aerial surveys to gain an index of the accuracy of aerial surveys on sections of beach where beach surveys are not possible or too time consuming.

**GULAR SCUTE** - the frontmost (paired, occasional single) scutes of the plastron, except in sea turtles where the paired gular scutes are separated by an intergular scute.

**HALF-MOON** - a semicircular or otherwise-shaped track made by a turtle that emerged from the sea but turned around and returned almost immediately.

**HATCHERY** - a manmade structure or enclosed area constructed for the incubation of eggs. Hatcheries may be relatively simple (i.e., a fence built around an area to which many nests have been moved) to complex (i.e., a building constructed to hold styrofoam boxes of incubating eggs adjacent to a nesting beach).

**HEAD-STARTING** - the experimental practice of raising hatchling turtles in captivity for the first months of life which may give them a better chance of survival when released.

**IMBRICATE** - overlapping, as the shingles of a roof or the scutes of the carapace of a hawksbill turtle.

**IMPRINTING** - the theoretical procedure by which a hatchling turtle receives a lifelong impression of its natal beach that enables it to recognize appropriate cues and relocate the beach when it matures.

**INCIDENTAL CATCH** - the capture of a species (such as a sea turtle) while fishing for another species (such as shrimp).

**INFRAMARGINAL PORES** - pores located near the rear of the inframarginal scutes. These pores are only found in the ridleys. The pores conduct secretory products to the surface, but the function of these products is unknown.

**INFRAMARGINAL SCUTES** - scutes situated between the marginals of the carapace and the pectoral, abdominal and femoral scutes of the plastron in certain turtles.

**INGUINAL NOTCH** - the notch behind the bridge and in front of the hind limb of a turtle.

**INGUINAL SCUTES** - scutes that form the anterior border of the inguinal notch.

**INTERGULAR SCUTE** - a small scute at the extreme front of the plastron of certain turtles, including sea turtles, that separates or partially separates the gular scutes.

**LATERAL SCUTES** - the large scutes running along each side of the carapace between the marginals and the centrals. Synonyms are costal scutes and pleurals.

"LOST YEAR" - the period of time between hatching and attainment of a carapace length of 20-30 cm during which sea turtles are rarely encountered. May not actually be a period of one year.

MARGINAL SCUTES - the small scutes around the edge of the carapace.

NECROSIS - rotting or death of tissues.

NEURAL BONES - the series of bones, eight or more in number, along the midline of the carapace. Anteriorly they contact the nuchal bone or proneural, and posteriorly they contact the suprapygial bone. In the series may be interrupted.

PECTORAL SCUTES - the pair of plastral scutes that cover the chest area - third pair from the front.

PERIPHERAL BONES - the bones around the edge of a turtle's carapace that lie beneath the marginal scutes.

PHALANGES - the elongate finger or toe bones in the flipper.

PLASTRON - the shell covering the underside of a turtle.

POSTCENTRAL SCUTES - posteriormost scutes on each side of the median line of the carapace, forming the posterior shell margin.

PRECENTRAL SCUTE - anteriormost and median scute on the carapace, included in the shell margin. Synonyms are cervical scute and nuchal.

PREFRONTAL - a bone in the turtle skull that extends from the nasal opening to the anterior part of the orbit; also a scale covering this area.

RANCHING - the process of raising sea turtles from eggs or hatchlings to some set market size for commercial purposes. This is not a closed-cycle system as it continuously relies on wild populations as a source for either eggs or hatchlings.

RARE - taxa with small world populations that, while neither endangered nor threatened, are at risk.

REMIGRATION - the return of adult turtles to a particular breeding area in succeeding years. Depending on the species involved, remigration usually occurs on a one (ridley), two, three, or four (most other species) year cycle. However, there are exceptions: Hawaiian male green turtles remigrate on a one year cycle.

SCUTES - the term for the horny scales covering the bony carapace and plastron, except in the leatherback. The shape of the scutes does not necessarily mirror the shape of the underlying bones, and scutes are named differently from the bones. Both scutes and bones are of taxonomic importance.

SERRATED - having a saw-toothed edge.

**SWIMMING FRENZY** - the heightened period of activity or rapid swimming of hatchlings out to sea following the emergence from the nest. The swimming frenzy lasts up to several days depending on species or population involved and may aid the hatchlings in clearing the surf and reaching developmental habitat.

**SYMPATRIC** - occupying the same geographic area.

**T.E.D.** - an acronym for Turtle Excluder Device. A structure fitted to a trawl specifically designed to reduce incidental catch, including sea turtles, and other non-target objects while maintaining normal levels of shrimp catch. The U.S. National Marine Fisheries Service has developed a T.E.D. that is effective in reducing mortality of turtles while maintaining or actually increasing the catch of shrimp.

**TEMPORAL** - the sides of the skull behind the eyes.

**THREATENED** - taxa likely to become endangered within the foreseeable future. This is basically the same as the "vulnerable" category used by the International Union for the Conservation of Nature and Natural Resources.

**TOMIUM** - the biting surface of a turtle's jaws.

**TORTOISESHELL** - the scutes of the hawksbill turtle used in the manufacture of various items, particularly in jewelry. Green turtle scutes are sometimes also used but are harder to work, are thin and generally do not have the same beauty as genuine tortoiseshell.

**TUBERCLE** - a small lump or knotlike projection.

**VERTEBRALS** - the scutes of the carapace which overlie the backbone of the turtle except in the leatherback. May also be called central or neural scutes.

## F. Sea Turtle References

The following annotated references are included because of the broad scope of contained information and general applicability to this Manual.

*American Zoologist*, Vol. 20, No. 3, 1980.

This symposium volume includes a series of valuable papers on many aspects of sea turtle biology; the conference that led to these papers was unlike most sea turtle conferences in that it concentrated on scientific rather than conservation aspects.

BJORNDAL, K. A. (editor), 1982. *Biology and Conservation of Sea Turtles*. Smithsonian Institution Press, Washington, D.C., 583 pp.

This volume is the most useful and detailed publication on sea turtles ever produced. Worldwide in scope, the included papers were presented in summary form at the World Conference on Sea Turtle Conservation, in November 1979, in Washington, D.C.

BONNET, B., (Updated) 1980. Introduction bibliographique a la physiologie de la tortue verte, *Chelonia mydas* (L.). *Collection Travaux et Documents*, No. 4 (UER Sciences), 31 pp., Centre Universitaire de la Reunion, Universite Francaise de l'Ocean Indien.

A valuable bibliography of the literature on the green turtle published between 1974-1979; includes papers on ecology, exploitation and protection, as well as physiology.

BUSTARD, H.R., 1972. *Australian Sea Turtles, Their Natural History and Conservation*. Collins, London, 220 pp.

A detailed discussion of Australia's abundant sea turtle fauna, of interest to readers worldwide.

CARR, A. F., 1952. *Handbook of Turtles*. Comstock Associates, Cornell University Press, Ithaca, 542 pp.

This has been for years the standard work on all turtles of the United States, including sea turtles.

CARR, A. F., 1956. *The Windward Road*. Alfred A. Knopf, New York. (Reprinted in 1979 by University of Florida Press; with new Preface and new photos, 258 pp).

CARR, A. F., 1967. *So Excellent a Fishe*. Natural History Press, New York, 248 pp.

This is a sequel to *The Windward Road*, giving the answers to some of the questions raised in the earlier book, and discussing progress made in answering others. (Reprinted in 1983 by Charles Scribner's Sons; with new Epilogue and new photos).

CARR, A. F., M. H. CARR, and A. B. MEYLAN, 1978. The ecology and migrations of sea turtles, 7. The West Caribbean green turtle colony. *Bulletin of the American Museum of Natural History*, Vol. 162, 46 pp.



GROOMBRIDGE, B., 1982. *The IUCN Amphibia-Reptilia Red Data Book. Part 1. Testudines, Crocodylia, Rhynchocephalia.* IUCN, Gland, Switzerland, 426 pp.

HIRTH, H. P., 1971. Synopsis of biological data on the green turtle, *Chelonia mydas* (Linnaeus) 1758. *FAO Fisheries Synopsis. No. 85.*

An in-depth summary of available information on the green turtle as of 1971.

HUGHES, G. R., 1974. The sea turtles of South-east Africa. Numbers 1 and 2. *Oceanographic Research Institute Investigational Report. Volumes 35 and 36.*

PRITCHARD, P. C. H., 1971. The leatherback or leathery turtle. *IUCN Monograph, No. 1, 39 pp.*

Although now outdated, this is a useful background document on available information on the leatherback turtle.

PRITCHARD, P. C. H., 1979. *Encyclopedia of Turtles.* T. F. H. Publications Inc., Neptune, New Jersey, 896 pp.

This is the current standard work on turtles of the world. It includes discussion of all species--land, fresh-water, and marine--but the sea turtle chapter is 76 pages long and includes color photos of all the species.

PRITCHARD, P. C. H. and R. MARQUEZ-M., 1974. Kemp's ridley turtle, or the Atlantic ridley, *Lepidochelys kempfi.* *IUCN Monograph, No. 2, 30 pp.*

A useful summary of available information, as of 1974, on the most endangered species of sea turtle.

REBEL, T. P., 1974. *Sea Turtles.* University of Miami Press, Coral Gables, 250 pp.

This is a book-length updating of Ingle and Walton Smith, 1974: Sea turtles and the turtle industry of the West Indies, Florida, and the Gulf of Mexico. Particularly valuable for the detailed bibliography.

RUDLOE, J. J., 1979. *Time of the Turtle.* Alfred A. Knopf, New York, 267 pp. (Reprinted by Penguin Books, 1980).

A highly personal and engaging account of the author's experiences with sea turtles and insights into their mysteries.

SCHULZ, J. P., 1975. Sea turtle nesting in Suriname. *Stichting Natuurbehoud Suriname, Verh. No. 3., 143 pp.*

Seriously interested sea turtle students may wish to read the *Marine Turtle Newsletter.* The current editor is: Dr. Nicholas Mrosovsky, Department of Zoology, University of Toronto, Toronto M5S 1A1, Canada.

MANUAL OF SEA TURTLE RESEARCH  
AND CONSERVATION TECHNIQUES

ANNEX I

COLOR PLATES

NO. 1 - No. 40

- PLATE 1. Adult male loggerhead. Note secondary male sex characteristics--tail extends well beyond a narrow, tapered carapace. Large head and reddish-brown carapace are characteristic of this species. (Photo, L. Ogren).
- PLATE 2. Adult male loggerhead. Cloacal opening is located near tip of tail beyond posterior margin of carapace. Broad head is evident. Black sulfide-stained plastron is result of prolonged contact with silty bottom and is not typical of species. (Photo, L. Ogren).
- PLATE 3. Sub-adult loggerhead. Two pairs of prefrontal scutes between eyes, five pairs of lateral scutes on carapace, and reddish-brown dorsal pigmentation are characteristics of this species. (Photo, L. Ogren).
- PLATE 4. Sub-adult loggerhead. Three pairs of enlarged inframarginal scutes bridging the yellowish plastron are characteristic of this species. Marginate scutes of carapace are common in immature individuals. (Photo, L. Ogren).
- PLATE 5. Juvenile loggerhead. Dorsal scutes have dark brown lines radiating from light centers. Each center is elevated and forms a sharp keel of spine characteristic of this age class. Photograph is of a 10-month-old individual raised in captivity. (Photo, Skidaway Institute of Oceanography).
- PLATE 6. Hatchling loggerheads. Variation in intensity of pigmentation between siblings is evident. Species characteristics regarding scute and scale number and arrangement are similar to adults. (Photo, L. Ogren).
- PLATE 7. Hatchling loggerhead. Specimen is typically colored, but has an extra pair of posterior lateral scutes and an extra pair of enlarged inframarginal scutes. Posterior pair of lateral scutes is asymmetrical. Umbilical scar is present. (Photo, L. Ogren).
- PLATE 8. Juvenile Kemp's ridley and juvenile green turtle. The uniform black carapace is typical for Kemp's ridley up to about 28 cm carapace length (CL). The green turtle exhibits a pattern of broadly radiating streaks on each dorsal scute, which is typical of immature individuals. The head of the green turtle is proportionately smaller than heads of other species. The central keel of the carapace of immature Kemp's ridley is more pronounced than in adults. (Photo, L. Ogren).



1. Loggerhead



2. Loggerhead



3. Loggerhead



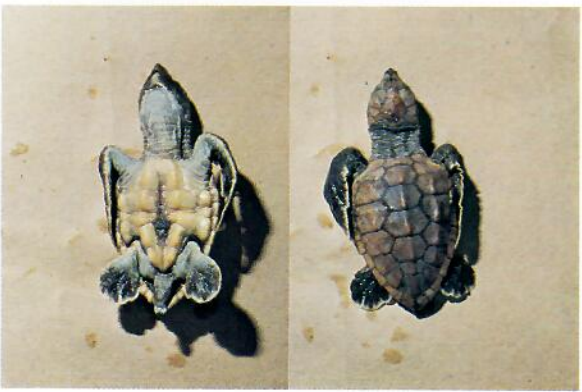
4. Loggerhead



5. Loggerhead



6. Loggerhead

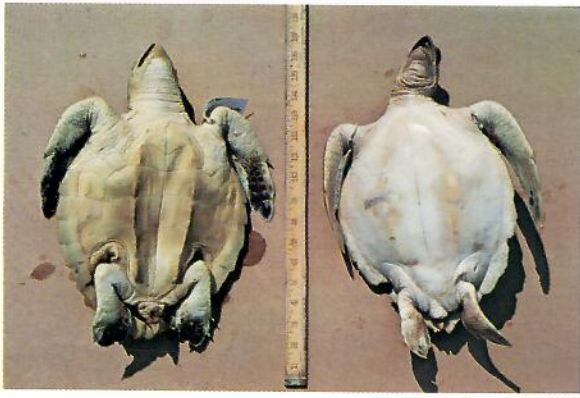


7. Loggerhead



8. Kemp's Ridley (L.), Green (R.)

- PLATE 9. Juvenile Kemp's ridley and juvenile green turtle. Note keels on Kemp's ridley plastron and four pairs of enlarged inframarginal scutes, each with a pore centered on the posterior seam. The smooth, white plastron is typical of immature green turtles. (Photo, L. Ogren).
- PLATE 10. Sub-adult Kemp's ridley. The olive-gray carapace of this older individual has replaced the black juvenile pattern except along the seams of the scutes. Distinct oval-shaped carapace, with five pairs of lateral scutes, and two pairs of prefrontal scutes are characteristic of this species. (Photo, L. Ogren).
- PLATE 11. Sub-adult Kemp's ridley. The yellowish plastron is typical of older individuals. Four pairs of enlarged inframarginal scutes bridging the plastron are present. The inframarginal pores are not clearly visible in this photograph. (Photo, L. Ogren).
- PLATE 12. Sub-adult Kemp's ridley. The small orbit located high on the skull above the deep upper jaw (supralabial scale) creates a parrot-like appearance--thus the Spanish vernacular name for this species, Tortuga Lora. The grey dorsal pigmentation of this immature individual is transitional between the black juvenile and light olive-green adult. (Photo, L. Ogren).
- PLATE 13. Juvenile Kemp's ridley. The three elevated keels on the carapace, black dorsal pigmentation, and white plastron are typical of this age class. Photograph is of a nine-month-old individual (10 cm CL) raised in captivity. (Photo, L. Ogren).
- PLATE 14. Hatchling Kemp's ridley. Kemp's and olive ridleys are the only species that have uniformly dark or black hatchlings. The five pairs of lateral scutes are typical for this species. Umbilical scar is present. (Photo, L. Ogren).
- PLATE 15. Adult olive ridley. The dark olive carapace and the large and variable number (6-9) of lateral scutes are typical of this species. The oval-shaped carapace is characteristic of both ridley species. (Photo, P. Pritchard).
- PLATE 16. Adult male hawksbill. Note the brightly patterned carapace with thick, overlapping scutes. Scutes in juveniles and older mature individuals are not overlapping. Hawklike narrow jaws and four pairs of lateral scutes are characteristic of this species. Elongate tail is exposed beyond posterior margin of carapace. (Photo, Miami Seaquarium).



9. Kemp's Ridley (L.), Green (R.)



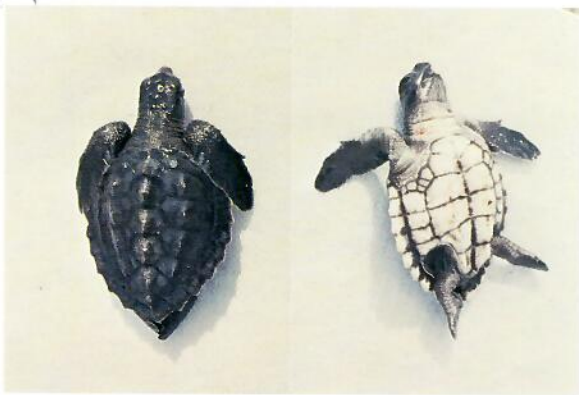
10. Kemp's Ridley



11. Kemp's Ridley



12. Kemp's Ridley



13. Kemp's Ridley



14. Kemp's Ridley



15. Olive Ridley



16. Hawksbill

- PLATE 17. Adult male hawksbill. Note the elongated tail with the terminal cloacal opening (vent). The plastron and ventral area are yellow. The narrow jaws are characteristic of this species. (Photo, Miami Seaquarium).
- PLATE 18. Adult hawksbills. Color variation between individuals is great. Two pairs of prefrontal scales between the eyes are present in all of these individuals and are characteristic of this species. (Photo, P. Pritchard).
- PLATE 19. Adult female hawksbill. Bright or wet appearance of carapace temporarily lost while nesting. Note that the tail does not extend well beyond carapace. (Photo, L. Ogren).
- PLATE 20. Hatchling hawksbills. Variation in coloration between individuals is evident. Superficially, these individuals resemble loggerhead hatchlings, but can be identified by their four, not five, pairs of lateral scutes. (Photo, L. Ogren).
- PLATE 21. Hatchling hawksbill. Dorsal and ventral coloration and scute number and arrangement are typical. Note that the four pairs of lateral scutes on the carapace are all about equal in size. (Photo, L. Ogren).
- PLATE 22. Adult female green turtle. Relatively small head and four pairs of lateral scutes on carapace are characteristic of this species. Color of carapace has changed from immature pattern (Plate 8) to an olive-brown with a scattering of dark spots. Carapace of this species varies from light brown to almost dark. (Photo, P. Pritchard).
- PLATE 23. Adult female green turtle. Color and pattern temporarily obscured by drying of carapace while nesting. Small, rounded, and symmetrically shaped head is characteristic of this species. Female lacks the elongated tail. (Photo, L. Ogren).
- PLATE 24. Adult male green turtle. Light yellow ventral area is characteristic of the adults of this species. The sexually dimorphic and muscular tail of the male and distal position of cloacal opening are evident in photograph. (Photo, L. Ogren).



17. Hawksbill



18. Hawksbill



19. Hawksbill



20. Hawksbill



21. Hawksbill



22. Green



23. Green



24. Green



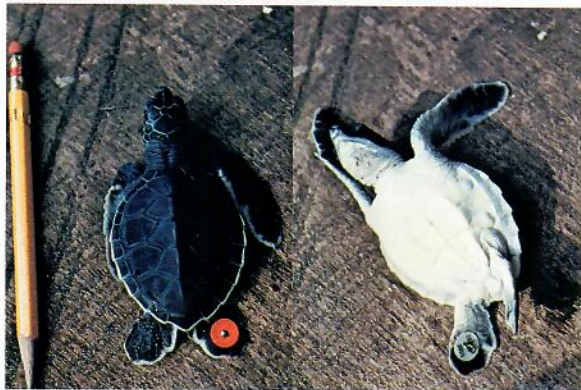
- PLATE 25. Adult green turtle. Unique scale pattern of the head for this species is clearly depicted by the single pair of prefrontal scutes between the eyes. Biting edge of the lower jaw is serrated (not visible in photograph) and is unique to this species. (Photo, P. Pritchard).
- PLATE 26. Juvenile green turtle. This individual falls within the size range of the age class commonly referred to as "yearling." This is about the smallest size that occurs in coastal waters other than hatchlings migrating away from their natal beach. (Photo, L. Ogren).
- PLATE 27. Post-hatchling green turtle. The color and scute arrangement of this three-week old individual is typical of newly emerged hatchlings. Note the four pairs of lateral scutes and single pair of prefrontals, which are characteristic of this species. (Photo, L. Ogren).
- PLATE 28. Adult female leatherback. Black dorsal area flecked with white spots and the absence of scutes are characteristic of this species. The seven dorsal longitudinal ridges run parallel to the body axis. (Photo, P. Pritchard).
- PLATE 29. Adult female leatherback. Some individuals are distinctly darker dorsally than others, but the ventral region is predominantly lighter in color. Four of the longitudinal ridges can be seen on the right side of this individual. The front limbs are very long and the skin is rubbery to the touch. (Photo, L. Ogren).
- PLATE 30. Adult female leatherback. The unusual tooth-like cusps on the upper jaw are visible in this photograph. The pinkish cast to the central area is most conspicuous where the dark pigment is absent. (Photo, P. Pritchard).
- PLATE 31. Juvenile leatherback. Photograph is of a several-month-old individual raised in captivity. A mosaic of small scutes is present in hatchlings, but is shed after one or two months. (Photo, P. Pritchard).
- PLATE 32. Hatchling leatherbacks. This typical color pattern for hatchlings remains almost unchanged in the adult, except that the light markings on the dorsal ridges and flippers become obscure or disappear. The hatchlings are densely covered with a mosaic of small deciduous scales. (Photo, L. Ogren).



25. Green



26. Green



27. Green



28. Leatherback



29. Leatherback



30. Leatherback



31. Leatherback



32. Leatherback

- PLATE 33. Adult flatback. The characteristic three postocular scales are evident in this individual. The green turtle usually has four. (Photo, C. Limpus).
- PLATE 34. Subadult flatback. The juvenile pattern has changed to a uniform olive-bluff carapace without markings. The borders between the carapace scutes are indistinct. (Photo, P. Pritchard).
- PLATE 35. Juvenile flatback. This species is larger at hatching than the green turtle and soon loses the unique dorsal markings and coloration. (Photo, P. Pritchard).
- PLATE 36. Adult male black turtle. The intensity of black pigment is characteristic of this species. The flipper injuries were caused by bites of other males competing for access to the female mounted by this individual. (Photo, P. Pritchard).
- PLATE 37. Adult male and female black turtle. Note the heavily pigmented carapace and dorsum of both individuals. The male's tail is much longer than the female's. (Photo, P. Pritchard).
- PLATE 38. Adult female black turtle. The heavy set of barnacles is unusual in the green turtle. The deep "mating scar" in the shoulder region is from the nail on the male's foreflipper used in grappling the female. (Photo, P. Pritchard).
- PLATE 39. Hatchling black turtle. Coloration is similar to the green turtle, but the plastron soon darkens with age. (Photo, P. Pritchard).
- PLATE 40. Adult hawksbill. The narrow jaws are characteristic of this species--an adaptation for feeding on reef prey such as sponges. (Photo, P. Pritchard).



33. Flatback



34. Flatback



35. Flatback



36. Black Turtle



37. Black Turtle



38. Black Turtle



39. Black Turtle



40. Hawksbill

W. A. T. S.

