Charles Darwin University Animal Ethics Committee

Standard Operating Procedure:

Turtle Monitoring Field Guide (DBCA, 06/2022)

Version No:	
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Please note: this SOP has been developed for animal use in WA. Consideration should be taken to the specific conditions of the region in which your work is being conducted, and modifications to procedures made accordingly to ensure the best welfare of the animal and safety of the project participants. Any modifications required should be outlined in the project application. Consideration should particularly be given to the weather conditions of the Northern Territory and the presence of extreme hazards such as crocodiles.

CHARLES DARWIN UNIVERSITY AUSTRALIA

Turtle monitoring field guide

edition 4

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Introduction

Thank you for participating in field monitoring of turtles with the Department of Biodiversity, Conservation and Attractions (DBCA). Your time will help our efforts to conserve marine turtles, which are threatened with extinction world-wide.

The aim of the DBCA marine turtle program is to increase the conservation and protection of the marine turtle populations in the Pilbara and the Kimberley via:

1- surveying, monitoring and research at key nesting sites, and in particular monitoring turtle activity levels and assessing nesting population status and trends through time.
2- reducing interference to key breeding and feeding locations.
3- establishing information and education programs and building a culture of awareness and stewardship for marine turtle conservation.

Volunteers, who are the key to the success of the turtle monitoring program, need to be familiar with the *Code of Conduct* for turtle monitoring and turtle observation (see Chapter 10 and Appendix 2). They also need training to:

- identify the species of turtle from tracks left in the sand
- determine suspected nests and non-nesting emergences (false crawls)
- identify nest predation and disturbance
- apply a flipper tag and/or PIT tag on a turtle
- deploy a satellite transmitter/logger on a turtle
- collect skin biopsy
- excavate nests
- record and manage data.

Chapter 1: Monitoring methods

The *Marine Turtle Program* uses a capture-mark-recapture (CMR) survey technique combined with a standard 'morning after' beach survey technique (*IUCN/SSC Marine Turtle Specialist Group 1999, SWOT handbook)*. The primary objectives of these methods are to:

- estimate the abundance, survival rate, breeding frequency of female turtles of each species that nests within the studied area
- estimate the abundance and distribution of turtle nests, on key sections of beach, over specified time intervals, for each species that nests within the area
- identify the relative significance of specific nesting beaches to each species
- identify any temporal changes relating to nesting season and spatial changes in nesting distribution amongst species
- quantify predation and disturbance.

Capture-mark-recapture (CMR) survey technique involves volunteers walking defined sections of beach during the turtle nesting period and:

- applying flipper tags and PIT tags on nesting females
- measuring nesting females
- recording tagged turtle sightings.

'Morning after' beach survey technique involves volunteers walking defined sections of beach at sunrise every morning during the turtle nesting period and recording:

- the total number of tracks per species and a GPS location for each one
- the number of successful nests per species and a GPS location for each one
- the number and location of disturbed nests
- potential causes of nest disturbance
- presence of predators
- the number of hatched nests

In addition to these tasks, volunteers might be asked to:

- report on marine fauna stranding
- help collect skin biopsy on nesting females
- help deploy satellite tags/loggers on nesting females
- take egg/hatchling measurements
- help excavate nests.

The data is entered into a database that allows for analysis. A summary report is generated at the end of each season to monitor trends and focus on management issues of nesting turtles in these areas.

The following chapters give detailed advice for volunteers and outline the important role they play in the program. Standard monitoring procedures and methods are essential to ensure the success and validity of the turtle monitoring program. The following chapters describe in detail the procedures to be adhered to.

Chapter 2: Monitoring locations

The turtle monitoring field guide is designed for all the nesting sites monitored within the DBCA marine turtle program.

2.1 Hierarchical classification

Each nesting site is divided spatially into sections and sometimes subsections based on turtle nesting activity in the area and accessibility. The volunteer coordinator will make sure volunteers are familiar with the nesting site and how it is divided before starting the monitoring.

2.2 Sections and subsections to be monitored

Volunteers monitor subsections or sections usually varying from 500m to 6km. Sections are given a priority rating and the coordinator will ensure the higher priority sections and subsections are monitored continuously throughout the season. It is important to have a continuous dataset for each section every season otherwise data analysis may be compromised. In the field, the boundaries of each subsection will be marked with clear identifiable markers, these may vary between nesting sites. The locations of the markers for a field site are stored in the supplied GPS units.

2.3 Preparing for monitoring

Prior to monitoring, the coordinator will advise each volunteer which subsection they are required to monitor.
All designated subsections must be walked from start to finish unless other arrangements have been made with the coordinator.
Monitoring begins at the subsection at the time designated by the coordinator.

Chapter 3: 'Morning after' beach survey technique

3.1 Overview of 'morning after' beach survey technique

An overview of the technique is available as a flow chart (Appendix 3). It provides a simple example of each step required to complete the data sheet whenever a fresh/new turtle track or an old damaged nest has been found.

3.2 Monitoring equipment

To ensure that all equipment and information is readily available to volunteers rostered for turtle monitoring duties, standard kits and tablets have been prepared and are available to each team.

The numbered monitoring kits are the responsibility of each team to sign out and in, after the contents of the kit have been checked and verified as present against the checklist.

Each kit includes:

- GPS
- Spare batteries for GPS
- Camera
- Spare pencil
- Pencil sharpener
- Eraser
- Clipboard*
- Turtle field guide

or

- Tablet
- Tape measure
- Turtle field guide
- Emergency contacts

All equipment should be routinely calibrated.

*Each clipboard contains:

- Data sheet
- Turtle Stranding and Mortality Report
- Marine Fauna Stranding and Mortality Report
- Turtle Rescue Assessment Checklist
- Tide chart (optional)
- Map of section (optional)
- Emergency contacts
- Attached pencil
- Ruler attached to outside of folder.

3.3 Step-by-step monitoring procedures

If using a tablet, please download and read instructions at http://wastd.readthedocs.io/data_collectors.html , then read information below.

If using a datasheet, please follow the steps below:

Step 1: On arrival at monitoring subsection

1. Record volunteers' names, date, starting time, location name
2. If surveying a section, for example northwards of a section marker, draw an imaginary line perpendicular from the marker to the water's edge and do not include any nests or tracks that are south of this line as these will be included in a different section, thereby avoiding duplicate records. If a track crosses two sections, only the person with the return track in their section is to record it and cross both tracks.
3. Start walking the beach at the latest high tide line.

Step 2: Identify the incoming (emerging) track and the outgoing (returning) track

Identify the emerging and returning tracks by observing which direction the sand is pushed. There are five observations to assist in determining the direction of the track:

1. As a turtle crawls, it pushes sand backward with each flipper stroke.
2. If one track is shorter it may be the emerging track, depending on the times of the recent high and low tides.
3. If tracks overlap, the returning track will be on top.
4. Sand is always thrown back over the emerging track at a digging site.
5. Arrow theory: for green turtle tracks draw a line along the angle of the front flipper mark to the centre of the track on both sides. The arrow created denotes the direction of travel (Figure 1). For loggerhead and hawksbill tracks the arrowhead will be at the top of the "J" shape made by their rear flippers (Figure 3 and Figure 4).

<u>Step 3</u>: Identify species by track type

Follow the path taken by the turtle using the clearest parts of a turtle track to identify the species. There are five species of marine turtles that nest on the beaches in the Pilbara and Kimberley regions: the flatback turtle *(Natator depressus),* the green turtle (*Chelonia mydas*), the loggerhead turtle *(Caretta caretta),* the hawksbill turtle *(Eretmochelys imbricata)* and extremely rarely the olive ridley turtle (*Lepidochelys olivacea*). The tracks of each species are distinguished by the patterns of flipper, tail and other drag marks left in the sand as well as width (Figure 2; Figure 3; Figure 4; Figure 5). Note that additional factors such as terrain and flipper injuries may alter usual track appearance.

The track made by each species generally falls within a characteristic size range. This can be used as an aid in identifying turtle species when used along with other track features.

Green turtle	**95–144cm**
Loggerhead turtle	**70–124cm (average of 94cm)**
Hawksbill turtle	**70–85cm**
Flatback turtle	**90–100cm**

When measuring the track with a tape measure, measure between the two outer edges of the track (Figure 1). Note: if measuring hawksbill or loggerhead tracks, measure from the outer edge of the rear flipper marks (as front flipper marks are not a characteristic feature for these tracks). For green turtle tracks, measure the outer edges of the front flipper marks.

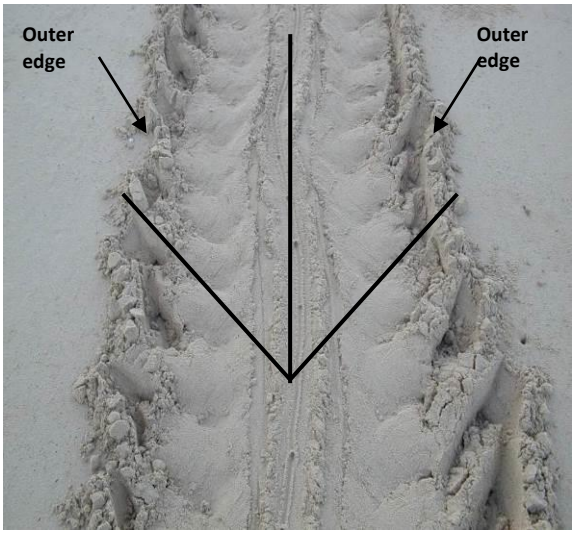


Figure 1: Measuring track width and arrow theory showing direction (green turtle track)

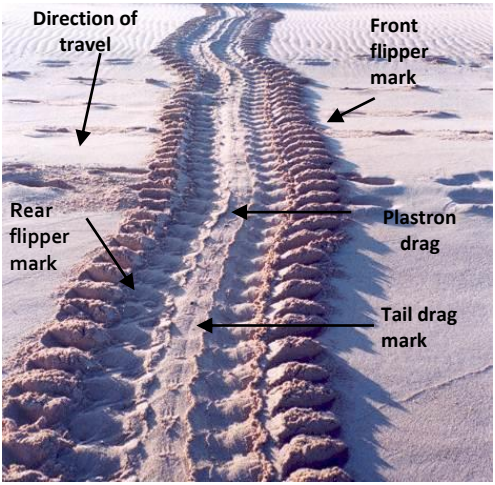
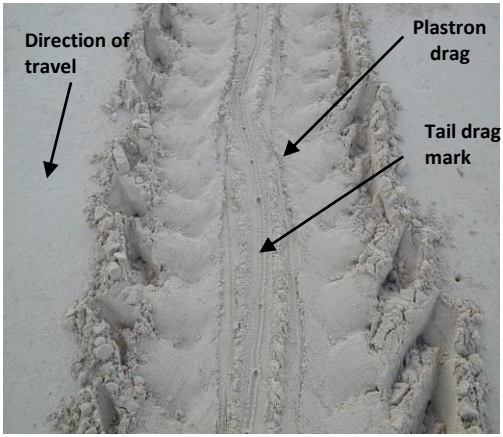
<table>
<tr><th colspan="2">Green turtle track</th></tr>
<tr><td>Green turtles have simultaneous limb movement. The flipper markings are opposite with a smooth central plastron drag mark between them and a distinct tail drag on top, which will look like a solid or broken line with small dots from where the turtle has used the tail to propel herself forward. Track width typically ranges between 95–144 cm. The above features are often more defined in emerge tracks.</td><td> 
</td></tr>
<tr><td>Close-up (wet)
 
Illustration source: Florida Fish and Wildlife Conservation Commission. Sea turtle Conservation Guidelines.</td><td> 
</td></tr>
</table>

Figure 2: Photographs and illustration showing tracks of a green turtle (Chelonia mydas).

<table>
<tr><th colspan="2">Loggerhead turtle track</th></tr>
<tr><td>A loggerhead turtle track is made with an alternate gait. Track width typically ranges between70–124 cm with an average of 94 cm.

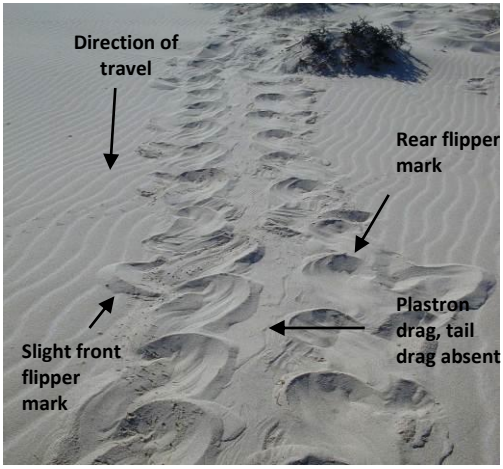
Flipper indents appear more ’swirly’ than that of the green (as the rear flipper indents are the main feature of the track), are further apart and are alternate (not in line). Tail drag is not present.</td><td> 
</td></tr>
<tr><td>Close-up
 
Illustration source: Florida Fish and Wildlife Conservation Commission. Sea turtle Conservation Guidelines.</td><td> 
</td></tr>
</table>

Figure 3: Photographs and illustration of tracks of a loggerhead turtle (Caretta caretta).

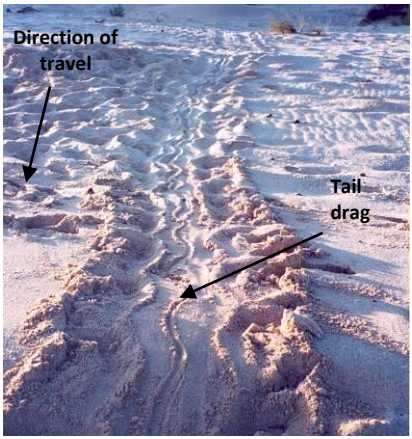
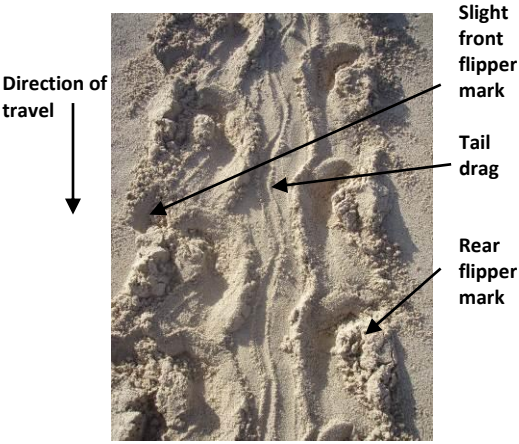
<table>
<tr><th colspan="2">Hawksbill turtle track</th></tr>
<tr><td>A hawksbill turtle track is very similar to the loggerhead track, made with an alternate gait. Tail drag is however present as a wavy mark near the centre of the track, which may be continuous or broken. Track width is typically narrower, ranging between 70–85 cm. Imprint is usually lighter and the inner edges of rear flipper marks appear squarer than those of the loggerhead.</td><td> 
</td></tr>
<tr><td>Close-up
 
Illustration source: Florida Fish and Wildlife Conservation Commission. Sea turtle Conservation Guidelines.</td><td> 
</td></tr>
</table>

Figure 4: Photographs and illustration of tracks of a hawksbill turtle (Eretmochelys imbricata).

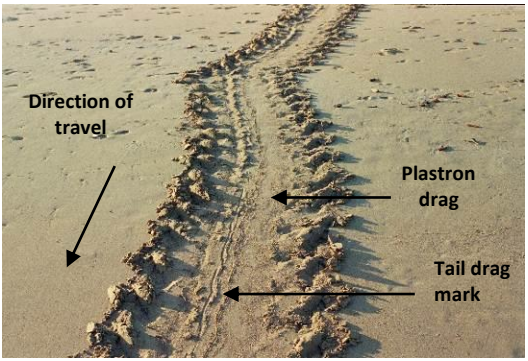
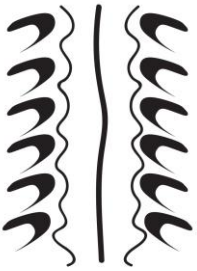
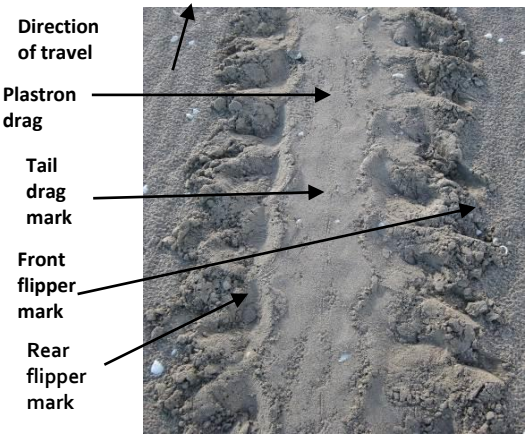
<table>
<tr><th colspan="2">Flatback turtle track</th></tr>
<tr><td>The flatback turtle can leave either an alternate or opposite gait, or a combination of both. The gait depends upon the speed at which the turtle is moving and the slope of the beach. Flatback tracks have a larger space between flipper marks than a green turtle, the track is slightly narrower than for green turtles and the front flippers do not extend as far out from the main track. The track is relatively shallow, as with the body pit. Track width is variable but typically ranges between 90-100cm. Tail drag can be present or not.</td><td> 
</td></tr>
<tr><td>Close-up
 
It may be difficult to differentiate between flatback and green turtle tracks without previous experience. Please take photographs and supply to the coordinator if you are unsure.</td><td> 
</td></tr>
</table>

Figure 5: Photographs and illustration showing tracks of a flatback turtle (Natator depressus) travelling up the beach in wet sand.

<u>Step 4</u>: Taking photographs for identification

If in doubt, take a photo!

A photograph should be taken and shown to a more experienced person when:

- Turtle tracks or animal prints cannot be identified
- You are unable to determine if nesting attempt was successful
- You are unable to determine if nest has been damaged.

It is important that you do not try to guess if you are unsure of the species, or if the nesting attempt was successful or not, etc…and instead clearly write on the datasheet that you are unsure/ unknown.

Method for photographing track and prints:

a) Animal prints: place the ruler next to the prints before taking photograph.

b) Turtle track:
- Choose the best part of the track for a clear photograph.
- Photograph to be taken with back to the sea and facing landward (Figure 6(a)).
- Place ruler across track on landward side, and step back approximately 1m.
- Turn camera sideways for portrait photo.
- Line up the ruler with the bottom of the photograph frame so it appears in the photo (Figure 6(b)).

c) Record the camera and photograph frame numbers on datasheet.

6(a) **6(b)**

Figure 6: Images showing (a) the position in which to take photographs for track identification; and (b) what to capture in the camera viewfinder.

<u>Step 5</u>: Determination of nesting or false crawls (non-nesting emergence)

All five turtle species, that nest on beaches within the Pilbara and Kimberley Regions, share similar nesting habits, however there are generally differences in nest sizes. For example:

- Green turtles dig a large, deep body pit (Figure 7(a) and Figure 10), and can have a nest mound several metres long.
- Loggerhead turtles dig a medium-sized, shallower body pit (Figure 7(b) and Figure 11(a)).
- Hawksbill turtles dig a small, shallow body pit. Hawksbills are small, quick turtles and the size of their nest mound will be much smaller than that of a green (Figure 11(b)).
- Flatback turtles have medium-sized body pits, depending on the position on the beach (lower on the beach = shallow; higher on the beach = deeper).

It is important to remember that all marine turtles are individuals and no two nests will be the same. The shape of the nests can vary from circular to elongated oval shape. Terrain and obstacles may also change the appearance of a nest.

a) Nesting crawl field signs

Follow the path taken by the turtle and look for the following characteristics:

- Evidence of front flippers misting sand back over emerging track.
- Evidence of a nest mound and an escarpment (the rim around the nest mound). This helps determine the location of the eggs. There must be evidence that the primary body pit has been filled-in or covered with sand from the secondary body pit. The secondary body pit is generally shallower and less conical than a primary body pit, as it is the turtle's last throw of sand and her exit point. The amount of sand moved should not be able to fit back into the secondary body pit because some of this sand has also been moved from the primary pit, which is now covered over.
- Sand thrown in the vicinity of the secondary body pit. The sand which is thrown during nest covering generally has higher moisture content and more aeration than the dry sand on the beach surface (not the case after rain).
- Vegetation that may have been dug up. If vegetation is still rooted in the ground above where the egg chamber should be, it can be assumed that no nest is present in that spot.

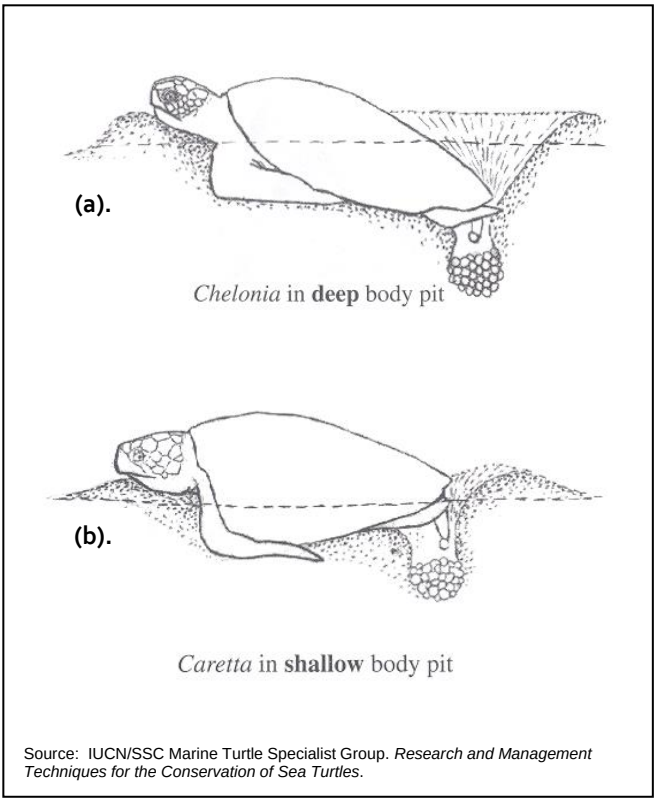
See illustration (Figure 8) and photographs (Figure 10; Figure 11(a) and 11(b)) showing examples of nesting crawl and successful nesting.

b) Signs of false crawl (non-nesting emergence)

Observe the entire crawl carefully and look for any of the following characteristics:

- very little or no sand disturbed, other than the crawl itself; or
- U-shaped or a simple arc shape crawl with no digging; or
- considerable sand disturbed from digging and evidence of body pitting but no evidence of covering; or
- considerable sand disturbed from a digging effort, but with a smooth-walled or abandoned/open egg chamber (15–25 cm diameter) in the centre of a pit within the disturbed area – this is often deeper and more conical-shaped in appearance than the secondary body pit of a successful nest.

See illustration (Figure 9) and photographs (Figure 14) showing examples of false crawls and body pits (unsuccessful nesting attempt).



Source: IUCN/SSC Marine Turtle Specialist Group. *Research and Management Techniques for the Conservation of Sea Turtles*.

Figure 7: Illustration of two typical nesting positions of marine turtles, (a) green (*Chelonia mydas*) and (b) loggerhead (*Caretta caretta*) turtle, showing the differences in depth of body pits.

Stages of successful nesting

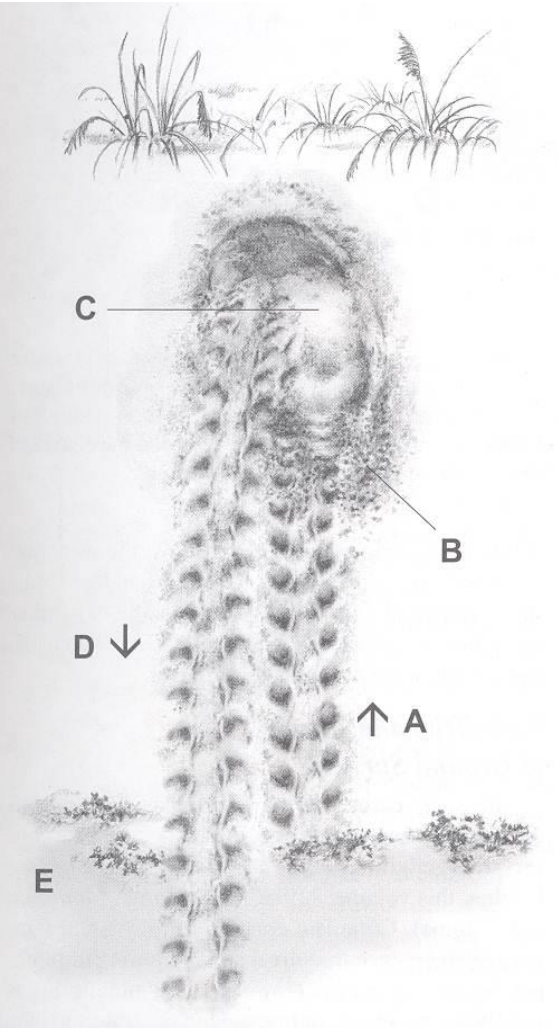


Figure 8: Illustrated example showing stages of successful loggerhead (Caretta caretta) nesting, with (A) emerging crawl; (B) sand misted or thrown back over the emerging crawl; (C) a secondary body pit, nest mound and escarpment, with sand thrown in the vicinity; and (D) returning crawl. (E) marks the high tide line.

Source: IUCN/SSC Marine Turtle Specialist Group. *Research and Management Techniques for the Conservation of Sea Turtles*.

False crawls

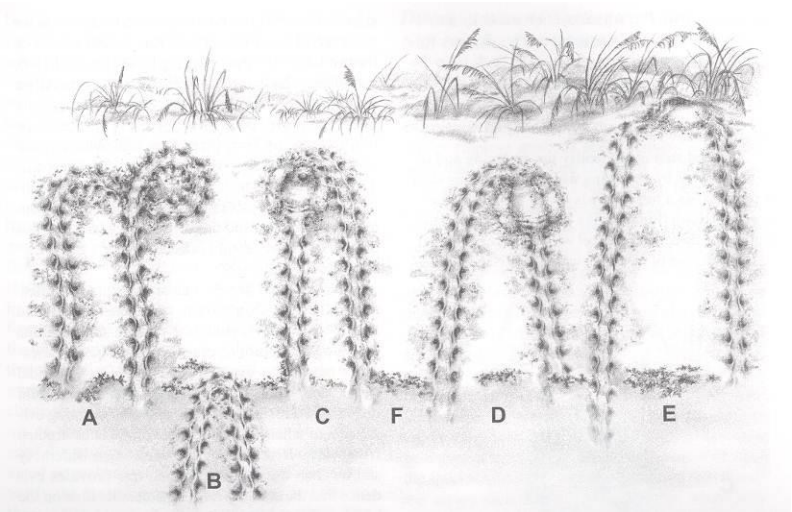


Figure 9: Illustrated examples of false crawls (non-nesting emergences) made by loggerhead turtles (Caretta caretta) including: (A) extensive wandering with no body pitting or digging; (B) U-shaped crawl to the high tide line; (C) considerable sand disturbance, evidence of body pitting and digging with a smooth-walled egg chamber and no evidence of covering; (D) considerable sand disturbance and evidence of body pitting and digging and no evidence of covering; (E) marks the site of a crawl where the relative lengths of the emerging and returning crawls are the same; (F) marks the high tide line.
Source: IUCN/SSC Marine Turtle Specialist Group. *Research and Management Techniques for the Conservation of Sea Turtles*.

Examples of nests

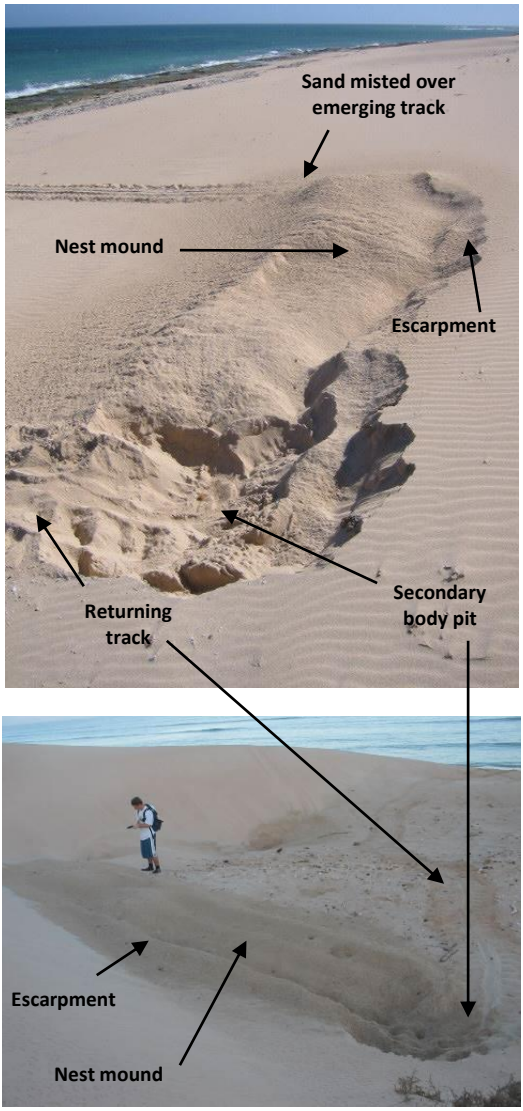


Figure 10: Photographs of green turtle nests

11(a)

11(b)

Figure 11: Photographs of (a) loggerhead and (b) hawksbill turtle nests

Figure 12: Photograph of flatback nest (Hannah Hampson, DBCA)

Example of Hatched Nest

Figure 13: Photograph of hawksbill hatchling tracks (Hannah Hampson, DBCA)

Examples of primary body pits (false crawls)

Figure 14: Photographs of abandoned primary body pits (false crawls)

<u>Step 6</u>: Position of nest on the beach

Once the nest has been identified, the position needs to be recorded. There are four zones from the edge of the water to the fore dune in which nests and body pits are found:

1. **Below high-water mark – Intertidal (I)**
   From the water's edge to below the high tide line. The high-water mark can be found by looking up the beach for watermarks or where fresh debris and seaweed have been deposited.
2. **Above high-water mark – High water mark to edge of vegetation (H)**
   From above the high tide line to the edge of the vegetation. To determine where the edge of the vegetation is, stand at the nest and draw a visual line either side along the vegetation. Be aware that there may be some bushes within the H area but they are distinctly removed from the actual dune vegetation.
3. **Edge of vegetation to base of dune (E) – Slope**
   From the vegetation line back to the base of the fore dune.
4. **Base of dune and beyond (D) – In vegetation**
   From the base of the fore dune's seaward face and beyond (towards land).

Record the position that the actual egg chamber is in, rather than the secondary body pit. If the nest appears to be on the boundary of two positions, ***choose the position that is closest to the sea***. Nesting position information is important for determining where different species prefer to nest and potential nest loss rates after storm surge. It is of course possible that the nesting beach looks different from this typical profile, in that case, identify the different zones of the beach profile and describe them on your datasheet using a diagram like the one below.

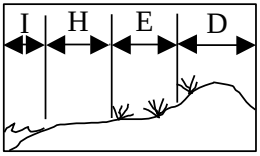


Figure 15: Diagram showing the four zones for identifying where the position of a nest is located

Step 7: Recording the GPS location

It is essential that the GPS location of nests be recorded. This must be done using the following steps:

1. Turn on GPS at nesting site and allow GPS time to acquire satellite signals – must be accurate within 0–8m. Check GPS is in decimal degrees and WGS84 (Chapter 9).
2. Hold GPS over the egg chamber.
3. Record GPS coordinates on the datasheet.

For more instructions on using a GPS, refer to Chapter 9.

Step 8: Nest damage

A predated nest is generally characterised by fresh yolky eggshells or partially consumed eggs littering the nesting site. They may have claw or teeth marks on them. There may also be whole eggs on the surface that have been exposed by storm surge/tide or dug up by another turtle while nesting in the same spot (See Figure 16 for examples). However, even a significant hole dug in the immediate vicinity of the egg chamber needs to be recorded as it can lead to egg mortality due to a change in nest microclimate (unless it is a ghost crab hole, in which case do not record it).

Foxes, dogs, goannas, other predators and humans can cause significant impacts when it comes to damage of turtle nests. To assist with identification of prints, refer to photographs in Figure 17. Note ghost crab predation is not recorded and neither are old eggshells present without any signs of disturbance (they can get windblown or naturally exposed after hatching).

Record the nest as damaged, attribute the cause if known, and write a good description of what you can see (e.g. 20 eggshells scattered around, digging into the nest and fox prints next to dig). The nest may be new (laid last night) or old (laid any time prior to last night). You may be able to identify the turtle species if the turtle track is still present or if hatchling remains are present and can be identified. Cover over the shells and any holes before you leave so they are not recorded twice.

Signs of predation

Digging and fresh eggshells

Exposed whole eggs

Digging into nest and predator prints

Hatchling remains and fresh broken eggshells

Digging and hatchling remains

Fresh eggshell

Figure 16: Examples of different signs of turtle nest predation

(a) Identification of prints – predator

Fox

Dog

Cat

Goanna

Human (knees and handprint)

(b) Identification of prints – other

Kangaroo

Echidna

Rabbit

Figure 17: (a) Photographs of predator prints; and (b) other fauna prints that are commonly seen in localised coastal areas

Step 9: Hatched nest

A hatched nest is characterised by hatchling tracks leaving the emergence crater (see Figure 13). The tracks should form a wide "V" (sometimes called a nest fan) with the point at the emergence crater. Often hatchlings will emerge in large groups which creates the "V". These tracks are often seen to fan out as each hatchling takes a different path to the ocean. Sometimes hatchlings are still present as well as empty egg shells. Record each hatched nest and its location on the datasheet. You may be able to identify the turtle species if hatchlings are still present and can be identified.

Step 10: False crawl tally

When a crawl is determined not to lead to a nest, it should be recorded as a false crawl. It is essential that each pair of tracks (return + emerge = pair) is documented accurately on the datasheet as either a nest or a false crawl in order to identify species, general density of beach use, and ratio of nests to false crawls. Each track should be assessed to determine species and each false crawl (emerging plus returning track = crawl) recorded on the datasheet.

Step 11: Marking the tracks

After each crawl is evaluated and documented, **the tracks must be marked to avoid duplicate reporting** by volunteers monitoring on successive mornings. To accomplish this, a section of the upper track should be marked by making a deep 3m long line in the sand parallel to the sea **well above the high tide mark** using your foot across both the emerge and return tracks (see Figure 18). If many tracks are overlapping in dense activity areas or a turtle has travelled a considerable distance, you may need to cross the tracks in several places to make it less confusing for subsequent monitoring.

Figure 18: Aerial photograph of marked turtle tracks

Note: If tracks have not been crossed the day before monitoring you are only to record the new tracks (and nests) from the previous night (as well as any old damaged nests). You can usually distinguish these from older tracks using the tide line and appearance of the track. However, cross off all old and new tracks and nests you see to make it easier for the next day.

<u>Step 12</u>: Marking the nests

After each nest is evaluated and documented, the nest must be marked. Using your foot, make a deep line in the sand across the nest as close to the secondary body pit as possible (Figure 19).

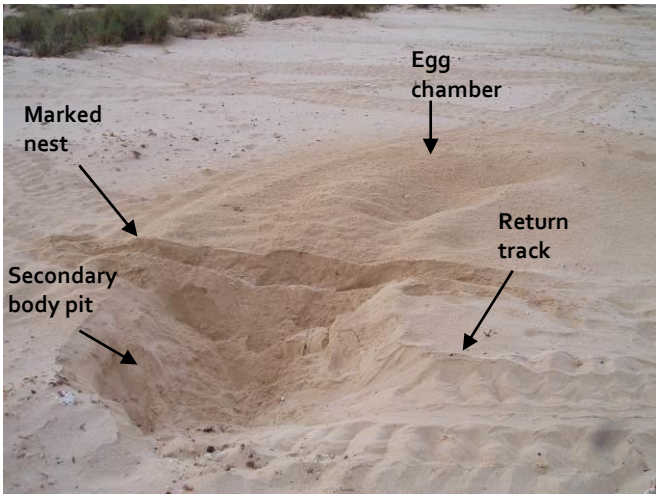


Figure 19: Photograph of a turtle nest that has been marked through the 'neck' of the nest to show it has been recorded

<u>Note</u>: areas of high activity

In areas where many turtle tracks are overlapping (Figure 20), and it is difficult to follow individual tracks due to congestion, it may be necessary to use the tally trick.

Walk along the high tide mark and count how many emerge and return tracks there are for each turtle species, making a tally as you go. Ensure that you have matching tallies equating to a total number of track pairs (i.e. 10 emerge and 10 return tracks = 10 turtles that have visited the beach). If the totals don't match you may have missed a track or there may be a turtle still nesting in the area.

Next, walk through the entire area and thoroughly scout for any new turtle nests. Note the species and record the nests as per usual procedures, crossing off as you go. Finally, subtract the number of nests from the total number of turtles that have visited the beach and tally that number of false crawls per species, record on the datasheet (e.g. 10 green turtles had visited the beach and 4 nests were seen during scouting and have been recorded. Therefore 6 green false crawls need to be recorded).

Figure 20: Area of high track congestion where the tally trick would be use

Chapter 4: Turtle and hatchling identification

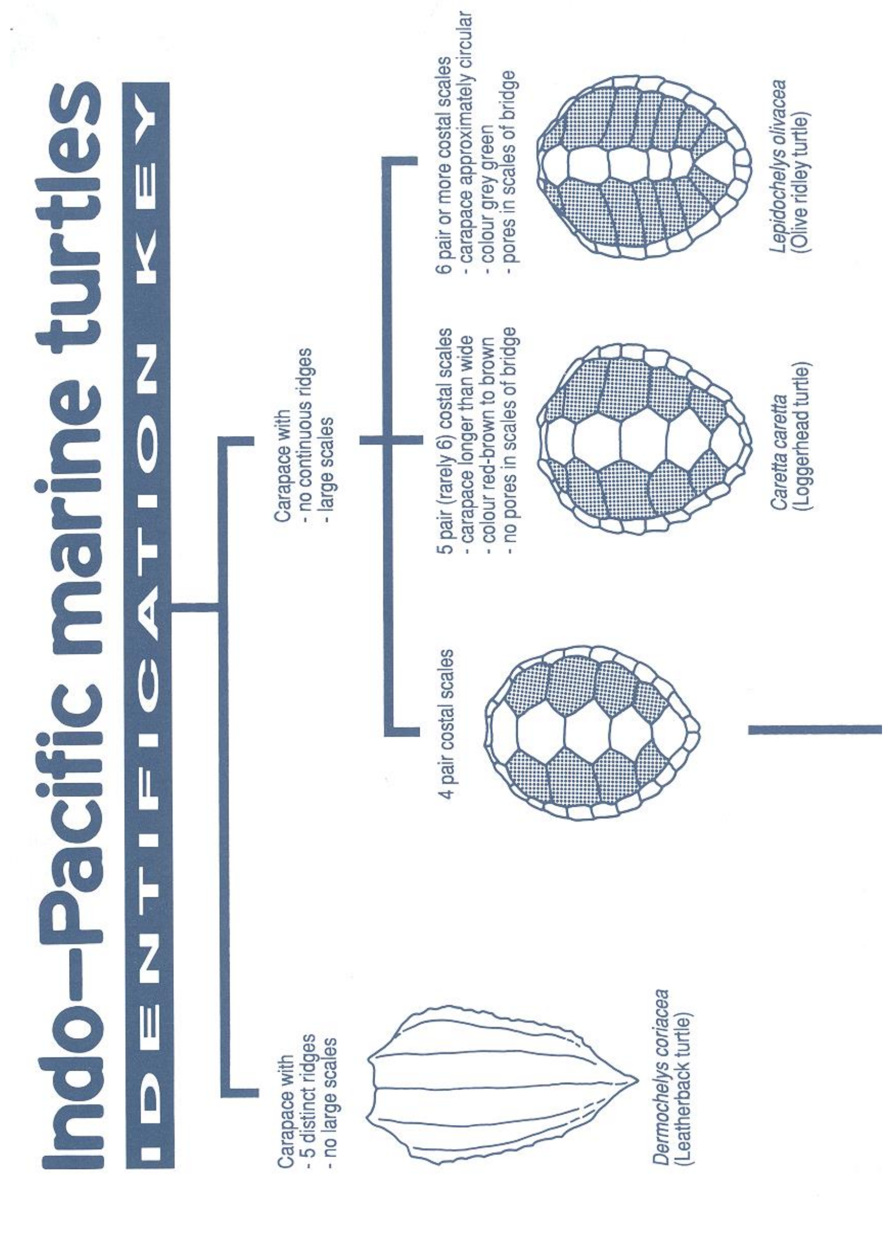
Use the identification key (Figure 21), the turtle species photographs (Figure 22), hatchling illustrations (Figure 23) and hatchling photographs (Figure 24) to assist with species identification.

If absolutely necessary, a photograph may be taken and shown to a more experienced person.

Method for photographing a turtle:

a) Wait until the animal has finished nesting and covering her nest and is about to go back to the sea.
b) Use red lights instead of the camera flash.
c) Take a close-up of the head from forward and above to clearly show the prefrontal scale pattern.
d) Take a full frame photo of the carapace from above to one side clearly showing the costal scale pattern.
e) Take a side shot of the head showing the scale pattern around the eye.
f) After taking a picture of the animal, take a picture of the flipper tag for identification.
g) Record the camera and photograph frame numbers on data sheet.

4.1 Identification key



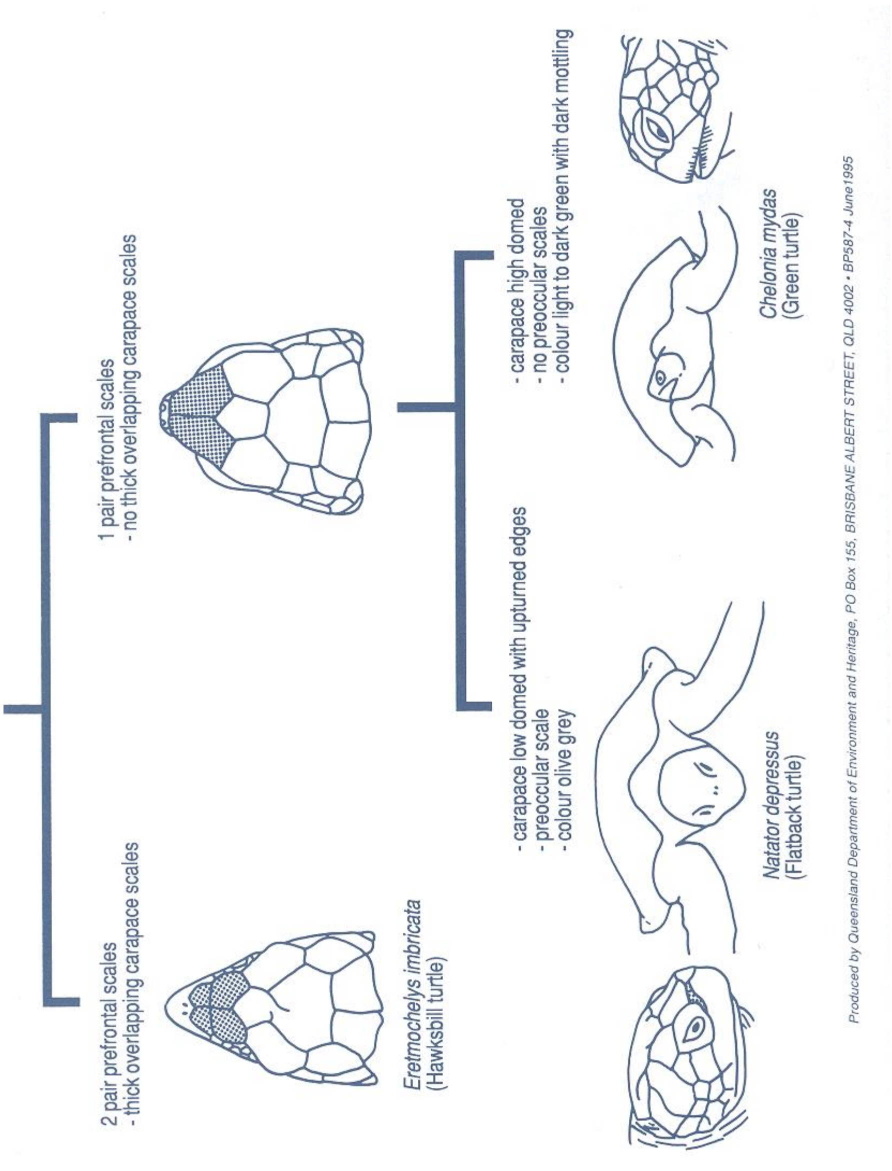


Figure 21: Identification key to marine turtles of the Indo-Pacific region.
(Source: Environmental Protection Agency. Copyright © Col Limpus, Queensland Parks and Wildlife Service).

4.2 Turtle identification photographs

Green turtle (*Chelonia mydas*)

Loggerhead turtle (*Caretta caretta*)

Hawksbill turtle (*Eretmochelys imbricata*)

Flatback turtle (*Natator depressus*)

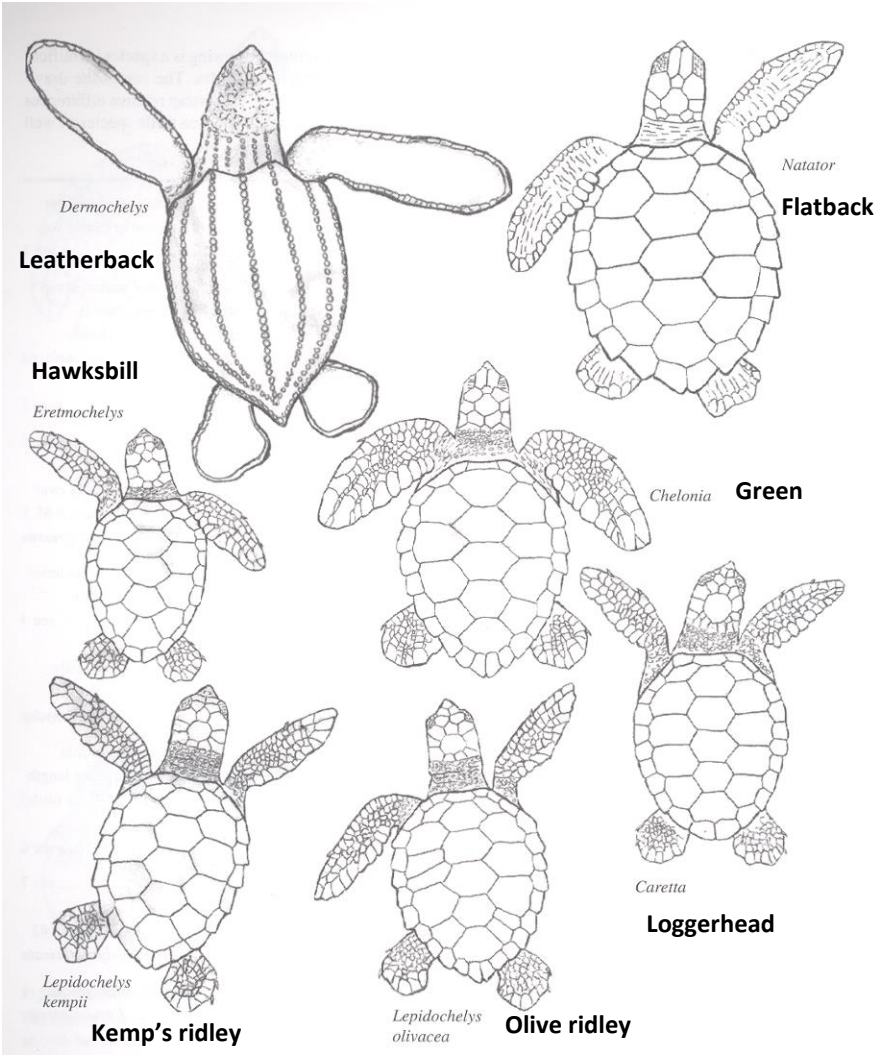
Olive Ridley turtle (*Lepidochelys olivacea*)

Leatherback turtle (*Dermochelys coriacea*)

Figure 22: Photograph identification of the six turtle species found in Australian waters and the Indo-Pacific region. Source: Adapted from Environmental Protection Agency. Copyright © Col Limpus, Queensland Parks and Wildlife Service. *Indo-Pacific marine turtles.* BPS87-4June1995.

4.3: Hatchling identification illustrations

Hatchling identification illustrations



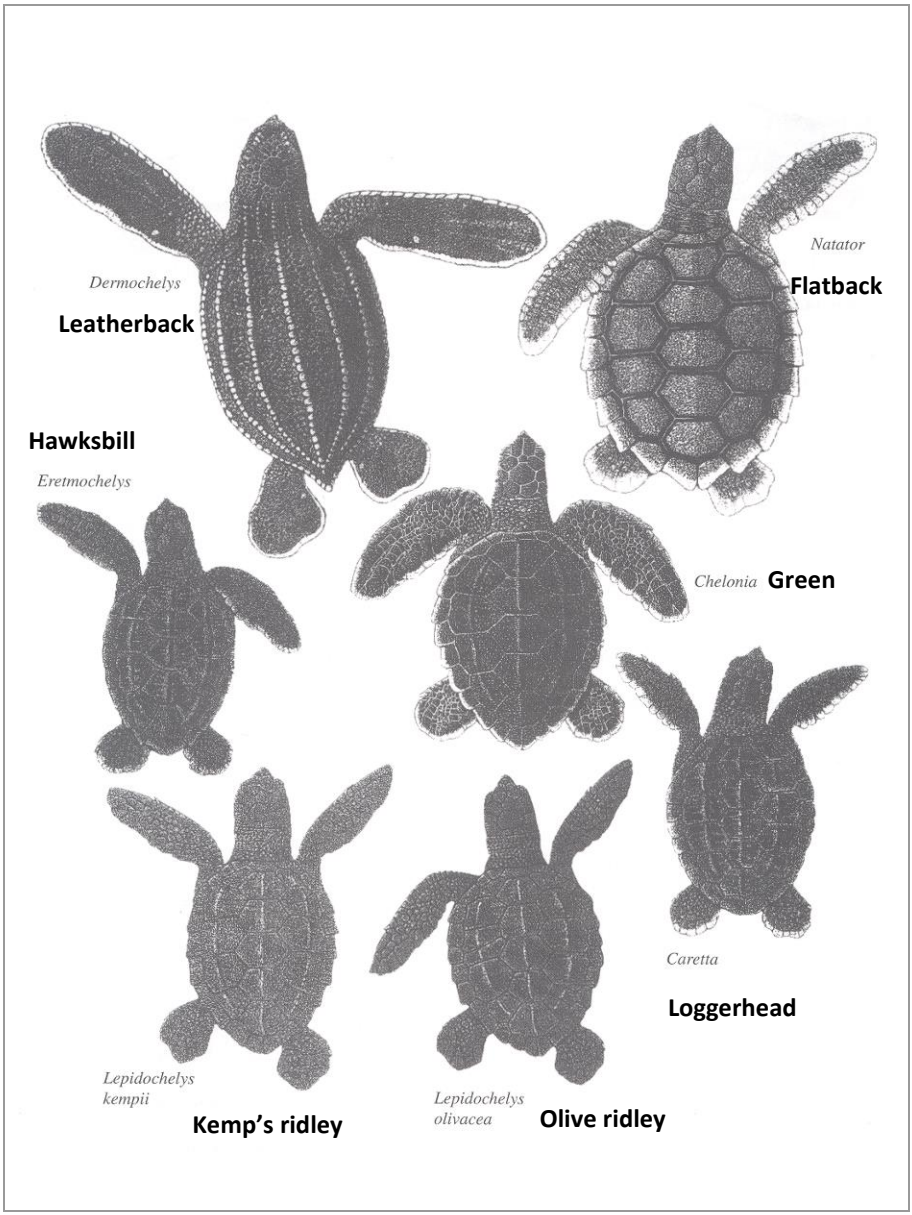


Figure 23: Turtle hatchling identification illustration

4.4 Hatchling identification photographs

Green turtle hatchling

- 4 pairs of costal scales
- 1 pair of prefrontal scales
- prominent white margins along the flippers and carapace

Loggerhead turtle hatchling

- 5 pairs of costal scales
- 2 pairs of prefrontal scales
- 3 distinct ridges on carapace
- dark all over
- 4–5cm long

Hawksbill turtle hatchling

- 4 pairs of costal scales
- 2 pairs of prefrontal scales
- overlapping carapace scales
- dark all over

Flatback turtle hatchlings

- 4 pairs of costal scales
- 1 pair of prefrontal scales
- prominent white margins along the flippers and carapace
- dark margins around the carapace scales creating a honeycomb appearance

Figure 24: Photograph identification of hatchlings

Chapter 5: Capture-Mark-Recapture survey technique

Capture-mark-recapture is a population sampling technique commonly used to estimate the size of turtle populations. Marine turtles can be individually marked using a tag in the flipper and/or a PIT tag. The first stage of this method is to capture (i.e. tag) an initial random sample of turtles. During the second stage, a second random sample of turtles is captured. Some of these captured turtles will be already tagged and others will not. We then use a mathematical equation based on these numbers to determine an estimate of the total number of turtles in the population. The tag data can also provide information on the population dynamics, nesting biology, movements and residency of marine turtles. This type of tagging is most commonly carried out on beaches where female turtles nest but can also be carried out at foraging grounds, for instance.

5.1 Overview of 'Capture-Mark-Recapture" survey technique

An overview of the technique is available as a flow chart (Appendix 4 and Appendix 5). It provides a simple example of each step required to complete the data sheet whenever a previously tagged/new turtle has been encountered.

5.2 Monitoring equipment

To ensure that all equipment and information is readily available to volunteers rostered for turtle monitoring duties, standard kits and clipboards will be prepared and available to each team.

The numbered monitoring kits are the responsibility of each team to sign out and in, after the contents of the kit have been checked and verified as present against the checklist.

Each kit includes:

- Tagging pliers
- Flipper tags and PIT tags
- Long nosed pliers
- Tape measures
- Pencils, sharpener and eraser
- Hand held radio
- PIT tags applicator and scanner
- Sharps disposal containers
- Counter
- Spare batteries
- Gloves
- Towel (optional)
- Paint marker pen or spray paint (optional)

All equipment should be routinely calibrated.

Each clipboard contains:

- Data sheet
- PIT tag checklist
- Turtle Identification Sheet
- Emergency contacts
- Attached pencil

5.3 Step-by-step tagging procedures:

Step 1: On arrival at monitoring section

1. If surveying a section, for example northwards of a section marker, draw an imaginary line perpendicular from the marker to the water's edge and do not include any turtles that are nesting south of this line as these will be included in a different section, thereby avoiding duplicate records.
2. Start walking the beach along the high-water mark with your light off

Step 2: Locating and approaching turtles

1. Walk the beach as instructed by the coordinator, preferably with no light or low intensity lights. Do not shine lights into the water or over the beach, because turtles will actively avoid bright lights and may not emerge from the water or may return to the water if already on the beach.
2. If a turtle is emerging from the water when it is found, remain still or slowly back away. Wait at a distance, until the animal is well up the beach slope, before attempting to approach it from behind. If a turtle track is sighted, follow the track and approach from behind. Keep a low profile to prevent the turtle from being startled.
3. The appropriate time to approach and tag a turtle varies with the skills and experience of the animal handler, species of turtle, density of nesting (which can vary widely between seasons) and presence of other beach users, such as tourists. The appropriate time to confirm species identity, check for tags and tag turtles must be determined by the most experienced team member. Generally, the best time to take measurements and apply tags is either during egg laying or after completion of actual laying as during these stages female turtles are the least sensitive to light, gentle handling and noise.

4. Equipment should be carried on your person (in a bag or tool belt), but if this is not possible, place any equipment a distance away from the turtle, to prevent the turtle from trampling the gear when returning to the water.
5. Some tagging teams apply paint marks on the carapace to show that it has recently been tagged and it should not be disturbed. Others drag a line through the track of the turtle (above the high-water mark) to show that the turtle has been recorded. Look for a paint mark or drag line to determine if the turtle has been processed.

Step 3: Confirming species identity

1. Typically, a track is observed before the turtle is seen. If possible, species identification should be ascertained from the track, and a determination made as to whether or not the track is "fresh." If the track is "fresh" and the turtle has not yet been processed, go to point 2.
2. Ascertaining whether the track is an "up" or "down" track will facilitate locating the turtle and/or nest.
3. Once the turtle is found, species identity should be confirmed and the phase of the nesting cycle should be determined. Use the turtle identification sheet if in doubt (Figure 21).
4. Record species identity and phase of the nesting cycle on the datasheet.

Step 4: (optional) Determining clutch size

1. When the turtle starts laying, lie down behind the turtle, use a red light and count eggs using a manual counter.
2. A clutch is defined as the number of eggs laid into the nest, excluding yolkless eggs. Yolkless eggs are very small eggs (usually smaller than ½ the diameter of normal eggs) containing mostly albumen and a few granules of yolk encapsulated by a shell. Yolkless eggs should be counted at the same time as the other eggs (i.e. as they are laid) but reported separately. Multi-yolked eggs should be counted as a single egg.

Step 5: Checking for tags

1. Maintain a low profile and, when possible, quietly approach the animal from behind. Check to see if the turtle has tags on its front flippers, staying behind the turtle when moving from one side to the other.
2. Check to see if the turtle has PIT tags using the scanner. Turn the scanner on and press the "reading" button (Figure 28). Move the scanner over the turtle's body at a distance of approximately 1 – 2 cm. The scanner should be moved over the turtle at all angles (45° left and right, up and down). If there is a tag it will typically be located in the upper deltoid on both shoulders, however if there is no reading, continue to scan the entire shoulder and around the head and flipper areas as tags can migrate.
3. If a PIT tag is located the reader will beep and the number of the tag will be displayed on the screen. If a tag is not present scan for the entire length of time until the scanner beeps and displays 'no tag found'.
4. If PIT or flipper tags are present, record the tag numbers on the datasheet. If possible, tagger should read the number aloud clearly and distinctly for the recorder, who should then repeat it back, while writing it down, so that any errors can be checked and corrected immediately. Record each tag number exactly as it appears (i.e. including any hyphens). Be careful with letters and numbers that are easily confused.
5. Scan the same location several times to ensure you found any potential second PIT tags in the same shoulder.
6. For turtles other than flatback turtles, some turtles only have one flipper tag and some have up to four. If only one old tag is present, another tag must be applied to the other flipper. If an old tag is migrating out (Figure 30); not well clinched; or appears as if it will soon be lost, then another (new) tag should also be attached to that flipper, beside the old tag. If both tags are insecure on a double-tagged turtle, apply two more tags, one on each flipper. In the case of flatback turtles only, no new tags are to be applied where one or more are already present.
7. If no flipper tags are present, a tag should be applied on each flipper. In the case of flatback turtles only, only one new tag should be applied; this goes in the left front flipper (see step 8). Before fitting a new tag, check to see if there is any evidence of the turtle having lost a tag, e.g. a tag scar. You might see a V-slit in the flipper scale, a small depression or line in the centre of the scale or feel scar tissue – usually about the size and shape of a pea. It is important to record any tag scars on the datasheet. It is a good idea to make a sketch of that portion of the flipper edge on the data sheet.

In the case of flatback turtles only, if there is clear evidence of flipper tag loss, no new flipper tags should be applied.

8. If possible, tags should be applied after measurements and other observations have been taken and recorded (see step 6), but if the turtle is quickly returning to the water, application of tags takes priority over measurements (see step 8). If applying both PIT tags and a flipper tag, apply the PIT tags first where possible.

Step 6: Measuring and inspecting a turtle

1. Measuring should be attempted without restraining the turtle, but if restraint is needed, see Step 8. Remove barnacles along the centreline, using long-nosed pliers, and note this on the datasheet. This is required for accurate measurements. If the barnacles have not been removed from the centreline, the measurement should not be recorded as the true measurement of the turtle. Brush the sand from the midline of the carapace.
2. Measure curved carapace length (CCLmin) and curved carapace width (CCW), as follows:

CCL**min** – Remain on your feet and stand so that your feet are out of the way of the front and hind flippers as the turtle shifts the sand. With the red LED headlight on, hold the zero-end of the tape with metric side uppermost between the thumb and forefinger. Measure from anterior (front) to posterior (rear) of the carapace along the midline. The recommended curved carapace length measurement is minimum curved carapace **(CCLmin)**. Start at the point where the skin on the neck joins the carapace (nuchal scute), lay the tape measure along the midline of the carapace all the way to the **posterior notch at midline** between the supracaudal scales (above tail) (Figure 25) and mark the measurement on tape measure with thumb and finger. If the turtle has a pronounced notch at the posterior edge of the carapace, the CCL measurement is made to the **anterior edge of the notch (CCLmin)**. For hawksbill turtles only, measure from the anterior point at midline (nuchal scute) to the most posterior tip of the supracaudals (i.e. the longest protuberance of the notch), i.e. maximum curved carapace (CCLmax).
Until you have been approved as an animal handler who can measure turtles to within 2mm of accuracy, two people should measure the CCL until they get a consensus of measurement. Adult turtles may grow only 2mm a year, so this level of accuracy is important.

CCW – Stand at the rear of the turtle facing the turtles head. Place your feet either side of the hind flippers so that you are out of their reach. Lean forward so that you straddle the carapace. Brush the sand and remove barnacles from the carapace at its widest part. Place the tape measure at the widest part of carapace and extend to the other side. Slide the tape measure up and down the carapace edge to find

the widest part, wait for the turtle to exhale and mark measurement with thumb and finger. When measuring flatback turtles' CCW, the tape measure is stretched tightly between the outer extremities of the marginal scales, i.e. it is not in contact with the surface of the carapace for the full width.

Maximum head width (optional): place the tape measure across the widest part of the head, as shown in Figure 25.

Tail length (optional): measure from the edge of the carapace (do not start underneath the carapace) to the tip of the tail.

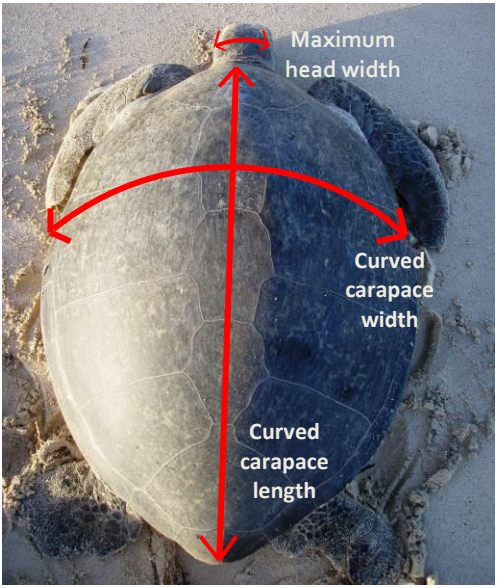


Figure 25: How to measure a turtle

3. Each measurement should be read to the nearest millimetre. The measurer should read the number aloud clearly and distinctly for the recorder who must repeat the measurement back clearly and record it neatly on the datasheet.

4. Check for injuries, fibropapillomas (Figure 26), any other observations of interest and record on the datasheet.

Figure 26: A turtle with fibropapilloma disease. ©Tony Tucker

<u>Step 7</u>: Estimating measurement precision

It is important to estimate and report the measurement precision for each member of the research team. To do so, for a selection of turtles (a minimum of 10) that span the size range of turtles in the study population, each team member should take repeated measures of the turtle (CCL and CCW) and report these measurements on a datasheet.
All instruments should be calibrated frequently.

<u>Step 8</u>: Restraining and tagging a turtle

With experience, and/or in certain circumstances, tags can be attached without restraining the turtle. If this is not possible, and the tagger requests restraint, one person should restrain the turtle, while the other person applies the tags.

1. If restraint is necessary, do so as instructed by the coordinator, since the method can vary depending on the circumstances. Remember that flatbacks and olive ridleys bite. Restrain the turtle by covering its eyes, making sure that its nostrils are exposed, so that it can breathe, and to minimise discomfort. Restrain by facing the turtle, pushing the head back into the carapace and downward, applying only enough pressure to stop the forward movement of the turtle. Fingers must be kept pointing upward, away from the turtle's mouth (Figure 27), as they can be bitten (or even severed) by the turtle.

Figure 27: Example of restraining a loggerhead turtle. Note that the turtle is being restrained from the front, the nostrils are clear and the handler's fingers are pointing up and away from the turtle's mouth.

Beginning in 2020, **WA protocols will become that all flatback turtles are to have two PIT tags; one in the left shoulder and one in the right shoulder**. The lowest number PIT tag is inserted in the left shoulder and the higher number PIT tag is inserted in the right shoulder.

2. Select lowest number PIT tag and scan the tag before opening the packet to ensure the tag is functional. Check the number on the scanner display matches the number on the sticker. Attach a PIT tag sticker to the datasheet.
3. Remove the loaded needle from the wrapper. Check the needle is correctly loaded and screwed in tight to the syringe.
4. Locate the application site on the left shoulder by measuring approximately 1 - 2 finger widths below the sharply curved part of the carapace directly into the muscle (Figure 28). If inserted in the soft tissue the tag can migrate or be damaged.

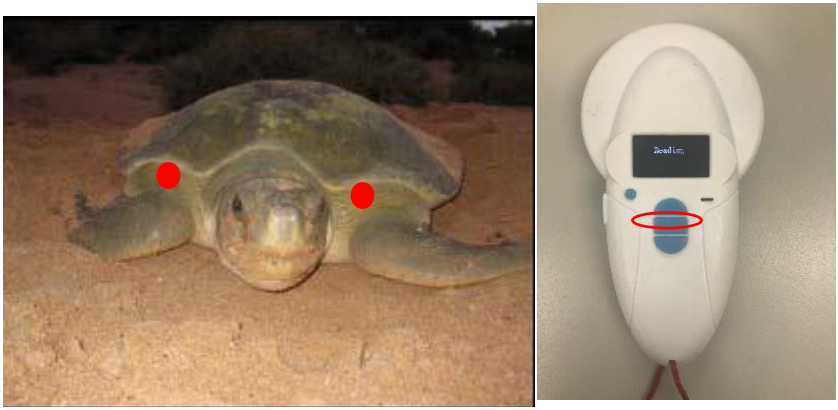


Figure 28: PIT tag application sites (red circles), and PIT tag scanner with « reading » button highlighted is rectangular middle button.

5. Remove the safety cap from the needle. Remove the needle cap and save it to recap. Hold the needle in a horizontal position (i.e. 90 degrees to the turtle's shoulder).
6. The best time to apply a PIT tag is when the front flippers are stationary (e.g. when the turtle is patting down with rear flippers, or when resting during filling in or returning to water). Correct application takes about two seconds.
7. Place one hand on the carapace to steady yourself and to provide leverage when removing the needle from the animal, and with the other hand, in one smooth and confident motion, pierce the skin (Figure 29) and insert the needle fully into the shoulder muscle, while maintaining a horizontal angle (i.e. 90 degrees to the turtle's shoulder) and directing the needle away from the turtle's head.
8. Insert syringe fully before quickly depressing the plunger.
9. Retract the needle immediately, maintaining the same angle at which it entered the body.
10. Firmly massage/press the insertion area to check that the tag was inserted subcutaneously correctly and is not going to pop back out of the needle insertion .If practical, apply a drop of Vetbond or surgical cyanoacryllic glue to seal the exterior of the insertion puncture.
11. Recap and dispose of the needle only into the sharp's disposal container. The needle section can be separated from the plunger by untwisting it at the centre of the needle. The used plunger is not considered medical waste

and can be stored inside the toolbox/backpack and disposed of upon return from beach.

11. Scan the animal with the scanner to ensure the PIT tag is in the animal and is functioning correctly.
12. The tagger should read the PIT number aloud clearly and distinctly for the recorder who must repeat the number back clearly and record it neatly on the datasheet. Peel and stick the barcode label to the datasheet.
13. Repeat process for the right shoulder if does not already have one.

Figure 29: Inserting a PIT tag. Steady yourself and insert the needle in a smooth and confident motion, angling it away from the head. Do not move the needle inside the body. Remove it immediately after depressing the plunger maintaining the same angle at all times.

Flipper Tagging

14. Select tag(s) and check that the numbers are in numerical order and that the tags and locking mechanisms are correctly aligned.
15. Select the tag with the lowest number and position in the pliers. This tag is applied to the turtle's left front flipper. A tag with a highest number is applied to the turtle's right front flipper. This ordering is preferable whenever possible (although not vital) as it helps when trying to decipher incomplete or incorrect records.
16. If other factors mean that only one tag can be applied to a turtle, this must be applied to the left front flipper. "New" (i.e. not previously tagged)

flatback turtles only receive one flipper tag, applied to the left front flipper. Recaptured flatback turtles do not receive any new flipper tags, unless none have been applied previously. If there is evidence of previous flipper tags on flatback turtles, i.e. tag scars, no new tags are to be applied.

17. Insert tag into tag applicators. Use your forefinger to pull the tag into the applicators until a click is heard. The tag should fit comfortably with a reassuring click when inserted correctly into the tag applicators. Check the tag to ensure it is placed in the tag applicators the correct way up: number must be on the topside of the flipper and the DBCA address must be on the bottom of the flipper. Check that the tag's spike aligns with the hole and the semicircular depression. This may require a couple of attempts depending on the batch of tags and the model of the applicators.

18. A second person can extend the left front flipper to avoid any unnatural alignment and / or gathering of the skin and underlying flipper tissue before you attempt to affix a tag. If the flipper cannot be fully extended, only experienced taggers should insert the tag.

19. Position the tag as instructed by the coordinator, as requirements can vary depending on the presence and condition of old tags, species of turtle and nature of the monitoring and research. Apply the tag on the trailing edge of the front left flipper, in or next to the scale closest to the body (Figure 30). The tag should not overhang the bottom edge of the flipper, to minimise the chances of fouling or getting caught and falling out.

Figure 30: Green turtle flipper showing new tag inserted in the centre of the scale, because the old tag has grown out with the scale (Photo by A Vitenbergs).

20. Squeeze the tag applicators so that the sharp part of the tag pierces through the flipper and passes into the hole in the opposite end of the tag, where it bends over and locks into place.

21. The handles of the taggers are released immediately in anticipation of a flinch reaction by the turtle. Do not hold the handles together trying for a more secure crimping of the tag as this will tear the skin and annoy the turtle. The flinch reaction varies from turtle to turtle and ranges from no reaction to a forward thrust of the flipper and an exhalation.

22. Check to confirm that the tag has clinched correctly. Feel the underside of the tag to make sure that the point has locked into place. If the tag has not clinched correctly, this must be remedied, according to the situation and as instructed by the coordinator. The tag may be locked with additional pressure with the tag applicators or removed, straightened and re-applied. However, if the tag is damaged so that it cannot be re-applied, or if the point of a new tag is curled around inside the flesh of the flipper, it must be removed and a new tag inserted. Record the number of the bent tag and the new tag that was successfully applied.

23. Always retain any tags damaged during use and return them to the DBCA officer responsible for dispensing and administering flipper tags via your coordinator.

24. Repeat on the right front flipper for all species except flatback turtles, if you have sufficient tags to apply two to each turtle.

25. The tagger should call the tag number and position clearly and distinctly for the recorder who must repeat the number and position back clearly and record it neatly on the datasheet.

26. If an animal is injured during handling / tagging, treat any superficial wounds with a topical antiseptic (e.g. Betadine®) and record the injury on the datasheet.

27. All remigrant turtles, except flatbacks, should carry a minimum of two securely fixed tags when released. The main purpose of double tagging is to help in understanding the rates at which tags may be lost from turtles. Tag loss in flatbacks has been found to be too high to be a reliable long-term identifier.

28. Once the tags have been applied, move clear and turn your head torches off, so that the turtle can reorient itself and return to the water.

Step 9: Check recorded data

1. Check if all data have been properly and clearly collected. Data entry is difficult if a form is incomplete or difficult to read.
2. Desirable minimum data requirements are: full names of tagger and recorder (NO nicknames), location, date, time, species, tag numbers, activity, position on the beach and carapace measurements.

Summary

Flatback turtles

New turtles

- Turtle leaves the beach with one flipper tag and two PIT tags as a new turtle

Recaptured turtles

- no additional flipper tags are applied when there are clear signs of flipper tags having previously been applied (obvious tag scars)
- turtle leaves the beach with two functioning PIT tags and any original flipper tag(s) or clear tag scar(s).

Other Species

New turtles

- Turtle leaves the beach with two flipper tags

Recaptured turtles

- additional flipper tags are applied to ensure that the turtle leaves the beach with two well applied tags

5.4 Ethical considerations:

To reduce the level of impact of flipper and / or PIT tagging on the welfare of animals, there are a number of ethical considerations that should be addressed when conducting these procedures.

Animal handling

To minimise stress to the turtles, they should only be handled for as long as required to mark them and to collect any necessary measurements (this can usually be completed in a few minutes). Improper restraint, especially when dealing with a

stressed and frightened animal can lead to physiological disturbances, such as hyperthermia, stress, shock and capture myopathy.

Lights, noise and sudden movement

It is important to take the utmost care in the use of lights on the beach. Bright lights, loud noise and sudden movement can stop turtles from coming onto the beach to lay or make them retreat back into the water. Ideally, the turtle's natural behaviours should not be disturbed before it has finished laying, but this is not feasible for all rookeries and circumstances. If a turtle is flipper-tagged while it is laying, it may retain some eggs in the oviduct, which is an unnecessary loss of eggs to the population.

Tag placement

Tags should always be applied as instructed by the coordinator. The flipper and flipper edge must be extended properly when flipper tagging, to avoid unnatural alignment and gathering of the skin and underlying flipper tissue which inhibits the correct alignment of the tag. PIT tagging should be conducted when the front flippers are not moving, it only takes a few seconds and can be done when a turtle is resting in between movements. The needle should be inserted and withdrawn at a horizontal angle away from the head and neck area. Do not move the needle inside the turtle as this can cause internal laceration and bleeding.

Pain, tissue damage and infections

To minimise the potential for infection it is essential to maintain cleanliness of all surgical and puncture techniques. The PIT tag needles are sealed in plastic packaging until the time of use and needles are disposed of and not reused. All equipment should be kept extremely sharp and clean to minimise tearing, bruising, infection and transfer of disease.

Bleeding

Flipper and / or PIT tagging can result in bleeding that needs to be controlled, prior to the animal being released, with pressure at the site, if possible.

Disease precautions

Precautions should be taken to prevent the possible spread of diseases during tagging. All tagging applicators and piercing equipment must be cleaned and disinfected after use, particularly if equipment is to be transferred between projects, or used in different regions.

Chapter 6: Deployment of satellite transmitters and logging units

Satellite transmitters and data loggers can be attached to turtles allowing researchers to gain a better insight into their lifecycle and to assist conservation efforts. Transmitters and loggers can measure data such as location, surfacing intervals, ambient temperature, swim speed, dive depth, dive duration and activity.

6.1 Tracking equipment

Each kit includes:

- Flatback turtles
  - Plastic tub
  - Harness
  - Satellite tracking unit mounted on a plate
  - Bag of 18 magnesium wires
  - Argos pinger
  - Magnets

- Hard-shelled turtles
  - Plastic tub/wooden box large enough to contain turtles
  - Towel
  - Satellite tracking unit
  - Epoxy or fibreglass resin
  - Scouring pad
  - Knife
  - Sand Paper
  - Cloths
  - Ethanol
  - Fresh water
  - Kitchen towels
  - Plastic containers
  - Spatula
  - Anti-fouling paint
  - Brushes
  - Argos pinger
  - Magnets

6.2 Step-by-step deployment of satellite trackers:

Satellite tags will be attached to turtles using standard operating procedures used in Australia and internationally.

1. Locate and approach turtles as outlined in section 5.3, Step 2.
2. Hold the turtle inside the plastic/wooden box in a natural prone position. Tub/box size varies with size of the turtle. Turtles must be kept cool in the shade or in water. A wet cloth may be used to cover the animal's head to keep it calm. Team members need to proceed quickly, calmly and quietly to reduce disturbance to the animal.
3. Check and record flipper tags, PIT tags and any unique markings on the turtle.
4. Measure CCL and CCW.
5. Transmitters should be tested prior to deployment. Paint the top and sides of the transmitter with anti-fouling paint prior to deployment, to help in deterring fouling organisms. Turn transmitter on. Record the date, time and GPS location of attachment.

Harness method

For soft-shelled species like the flatback turtle a harness will be fitted to the turtle (see Figure 31).

6. Each unit is mounted on a plate lined with neoprene wetsuit material. The unit is positioned on the turtle using a harness attached to the plate at six points.
7. Position the unit on the central-anterior portion of the turtle carapace, covering approximately the first and second vertebral scales. This positioning is important in the case of a tracking unit. As the turtle surfaces to breathe the antenna breaks the surface of the water and a salt water switch turns the transmitter on. The salt water switch is located near the antenna and is used to conserve battery power so that the satellite transmitter is not trying to transmit whilst submerged.
8. Harness straps are made from nylon webbing with six straps attached to a central stainless steel ring. Adjust the straps using the Velcro. The zinc staples hold the straps in place. Corrodible staples ensure the harness comes off the turtle after a certain period.


Figure 31: Young flatback turtle equipped with a satellite tag

Adhesion method

For hard-shelled species (loggerhead, hawksbill, green and olive ridley), the unit will be adhered directly to the carapace using epoxy (see Figure 32).

9. A unit will be attached directly onto the carapace where the first and second vertebral scales meet.
10. Remove epibionts (barnacles, algae etc) from the carapace at the mounting and bonding site of the transmitter.
11. Clean the area with a scourer, rinse, then lightly sand with sand paper and scrub and rinse with fresh water.
12. When dry, wipe the area with a cloth damped with fresh water and then with a cloth damped with ethanol. Turtles in the wild regularly rub their carapace against rocks, or against each other, to get rid of algae or epibionts. They therefore usually do not react to the cleaning of their carapace and do not show any signs of distress.
13. Attach unit to the carapace using a quick-setting two-part epoxy resin. Use the epoxy cartridge nozzle and a spatula to apply and smooth a portion of the mixed epoxy onto the bottom of the transmitter. Wait for the epoxy to firm a bit before placing on the carapace, to prevent slippage as the turtle moves around. Place the transmitter on the attachment location. Use only slow-curing epoxies or resins, and apply in thin layers to avoid the risk of thermal injury. Apply beads of epoxy around and over the transmitter and smooth with the spatula. Flare the epoxy in a large oval around the transmitter to maximize surface area and adhesion between the epoxy and the carapace. Push epoxy into any gaps under the transmitter and smooth out. Apply epoxy in two to three thin layers. Wait 10-15 minutes between layers to allow each layer to begin to set and to avoid excessive heat

production during curing. Pay particular attention to the hydrodynamics of the attachment to reduce drag.

14. Wait, at least, until epoxy does not adhere to the finger when touched. Paint the epoxy and transmitter with an antifouling paint. Take care not to get paint directly on the carapace. Do not apply paint over the transmitter's saltwater switches or the antenna.

15. Turtle may be released once paint does not adhere to the finger when touched. Check to make sure the turtle is in good condition; lift the box up and away from the turtle. All team members should retreat to a higher section of beach and stay quiet with all lights switched off to allow the turtle to orient to the ocean.

Figure 32: Hawksbill turtle equipped with a satellite tag

Chapter 7: DNA sampling

DNA sampling may be used for genetic analysis or stable isotope analysis and can provide important information on stock composition, diet and distribution.

7.1 Sampling equipment

Each sampling kit includes:

- Tubes pre-filled with 70% ethanol and tag
- Gloves
- Disposable 5mm biopsy punch
- Datasheet
- Ziplock bag
- Plastic cutting board with rear flipper drawn on it
- Wire

7.2 Step-by-step sampling

Tissue samples of 0.1-0.2 gram may be removed without risk to an adult turtle, provided that sterile techniques are observed. Skin samples will be taken from the right rear flipper margin of each turtle.

1. Wait until the turtle has finished laying eggs.
2. Slide cutting board beneath stationary rear flipper.
3. Locate two large scales on the trailing edge of a rear flipper. Biopsy site will be the soft wrinkled skin between large scales.
4. Using gloves, take the sample using a 5mm biopsy punch positioned over rear flipper margin. Press punch down firmly to cutting board to cut a snip of tissue from flipper.
5. Following removal of the sample, the defect can be left to heal by granulation.
6. Remove tissue from the punch with a thin wire.
7. For genetic or stable isotope samples, transfer the tissue into pre-filled and numbered ethanol vials. Screw on cap securely. Each turtle sampled goes into its own tube.
8. For satellite-tagged turtles including previously tracked turtles returning to nest, two DNA samples should be collected.
9. Write down the tube ID number and collection date on the datasheet
10. Rinse and dry the cutting board before next use.
11. Return each used punch into the blisterpack wrapper and treat as medical waste. Used gloves are medical waste. Put medical waste into Ziploc bag and deliver to DBCA for disposal.

12. Store collected tubes into a ziplock bag in a refrigerator.

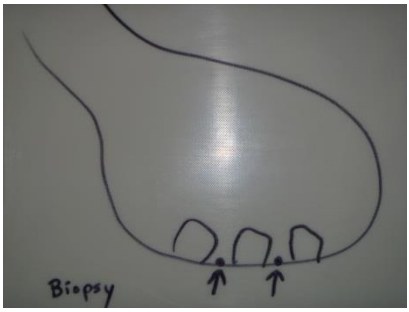


Figure 33: Diagram of a turtle's rear flipper with biopsy locations indicated by arrows. This diagram can be drawn on the cutting board.

Chapter 8: Egg measurements, nest excavation and hatchling measurements

To understand the success of the reproductive effort of sea turtles, the suitability of a specific nesting beach and the health of a nesting population, it is necessary to determine the number of eggs laid, the diameter and weight of eggs, the number that incubate successfully and the number of hatchlings that emerge from nests as well as the number of hatchlings that cross the beach into the water. These data allow determination of mean clutch size as well as hatching and emergence success.

8.1 Sampling equipment

Each kit includes:

- Gloves
- Small callipers
- Brush/cloth
- Electronic balance
- Plastic container
- Pen/pencil
- Ziplock bags
- Wipes for cleaning hands
- GPS
- Spare batteries
- Tablet
- Nest tag
- Cutting board with reference grid
- Small shovel
- Flexible 2m measuring tape
- 25-100m flexible tape measure
- Bucket
- Rope.

All equipment should be routinely calibrated.

If using a tablet, please download and read instructions at http://wastd.readthedocs.io/data_collectors.html , then read information below.

8.2 Step-by-step egg measurements (size and weight)

1. A nest can be marked during oviposition by inserting a small rope (or coloured tape) into the egg chamber so that it extends onto the surface of

the beach. Once the turtle has finished filling in the egg chamber and moved ahead, the clutch can be located by following the cord to the eggs and eggs can be gently excavated.

2. Eggs should be handled carefully. Hands should be clean of all chemical residues (e.g., sunscreen, insect repellent, etc.) prior to handling eggs. Gloves should be worn. All handling (excavating, measuring, weighing) of eggs should be completed within 2 hours of oviposition or the eggs should be allowed to remain in situ for at least 45 days to reduce the impact of movement induced mortality.

3. Choose ten eggs at random from each clutch. Care should be taken at all times to minimise rotation of eggs, as this can cause movement induced mortality.

4. If not previously recorded, record the female tag number, date and time nest was laid.

5. Clean each egg of adhered sand. Sand may be wiped off using a cloth (or brush) or by hand.

6. Hold the egg so that the shell is tight by gently pressing a finger against the shell to form a dimple. Use callipers to locate the largest diameter; the smallest diameter is usually located 90 degrees to the axis of the largest diameter, but may be located anywhere around the egg.

7. Record both values. The largest and the smallest diameters should be added together and divided by two to obtain an average.

8. Weigh the egg using an electronic balance with a minimum accuracy of 0.5g. Record the value.

9. If necessary, eggs may be identified by marking them with a soft, blunt pencil or an ink based marking pen.

10. Return the eggs into the nest.

11. If the nest will be excavated following the emergence of hatchlings, insert a nest tag. The nest tag should be written in permanent ink; the label should contain the tag number of the female and nesting date. Record the GPS position of the nest, mark the location of the nest using poles and triangulate its location.

8.3 Step-by-step nest excavation

1. Locate the nest using recorded GPS coordinates and nest markers (i.e. poles). If the hatchlings have emerged from the nest, start excavating the nest. Do not forget to wear rubber gloves. Be careful not to disturb adjoining clutches that are still incubating.

2. Record the depth from the sand surface to the top of the nest with a fibreglass tape.

3. Nest contents should be examined and tallied into the following categories:

   E = Emerged - Hatchlings leaving or departed from nest. Live hatchlings just below the beach surface *(i.e.,* not trapped by vegetation or debris) should be included in the count of hatchlings that successfully reached the beach surface. If weather conditions are favourable a count to the number of hatchling tracks that make it to the high-water mark gives an indication of bird and crab predation.

   S = Shells - Number of empty shells counted (shells that make up more than 50% of the egg size should be counted; shell fragments should not be counted)

   L = Live in nest - Live hatchlings left among shells

   D = Dead in nest - Dead hatchlings that have left their shells

   UD = Undeveloped - Unhatched eggs with no obvious embryo

   UH = Unhatched - Unhatched eggs with obvious embryo (excluding UHT)

   UHT = Unhatched term - Unhatched apparently full-term embryo in egg shell or pipped (with a small amount of external yolk material)

   P = Depredated – Open, nearly complete shells containing egg residue. These shells resemble the torn shells from which hatchlings have emerged, however they usually have holes or small torn areas and contain a quantity of egg material.

   Counting empty egg shells is difficult and contains counting error depending on the skill of the person counting. An estimate of the counting error can be made by counting the shells in clutches in which

the number of eggs was counted at oviposition. The error is the percentage of the difference between the two counts.

4. Record the depth from the sand surface to the base of the nest.

You should wait 5 to 10 days after the expected hatching date before excavating a nest. This will reduce the risk of finding live hatchlings still in the nest and give them a chance to emerge naturally.
If you excavate a nest and find live hatchlings still in the nest:

- if at night, turn all the lights off and release them a meter away from the nest. Ensure they have all reached the water before turning your lights on again.
- if during the day, place the hatchlings in a small container with no lid and with damp sand (no water) at the bottom, place a dark cloth on top of the container and place the container in a cool dark place (e.g. a cupboard in an air conditioned room). It is essential that the hatchlings stay as inactive as possible. Release them at dusk close to their nest if possible or, if not feasible, on the beach several meters away from the water. Keep your lights off until they have all reached the water.

8.4 Step-by-step hatchling measurements

1. Choose ten hatchlings from each clutch. Do not choose hatchlings that have been captured after entering the sea or that have remained in the nest. Process hatchlings as soon as possible after emerging from the sand.

2. Measure straight carapace length (SCL) using callipers from the nuchal scale (i.e. anterior point at midline) to the posterior notch at midline between the supracaudal scales. Care should be taken not to distort the shape of the shell when taking measurements as the shells of hatchlings are very flexible.

3. Record SCLs for each of the 10 hatchlings.

4. Weigh the same 10 hatchlings from each clutch using an electronic balance with an accuracy of 0.5g. Weighing should be done out of the wind.

5. Record weights obtained for the ten hatchlings.

6. Release hatchlings as soon as possible. They should not be kept throughout the next day.

Chapter 10: *Code of Conduct*

10.1 *Turtle Watchers' Code of Conduct*

This *Code of Conduct* is designed to ensure that anyone interacting with female turtles on nesting beaches has an enjoyable and educational experience with minimal disturbance to nesting turtles. The code has been adapted from the one used at Ningaloo and Mon Repos in Queensland and from previous studies at the Jurabi Coastal Park near Exmouth.

Once you arrive on the beach, let your eyes adjust to the available moonlight and stand quietly, with little or no movement as turtles have very good eyesight and are more sensitive to movement than noise.

The current best practice for turtle observation is as follows:

1. Walk along the beach just below the high tide mark, near the water (the tide will wash foot prints away) looking for tracks in the wet sand or turtles.

2. Avoid using any lights, torches or flash photography as this will disturb the turtles. Do not approach or shine lights on turtles leaving the water or moving up the beach. If a turtle is encountered, calmly stop where you are, sit down, and stay very still whilst you wait for her to start digging – 'Stop, drop, be a rock'.

3. Avoid excess noise and sudden movement at all times.

4. When approaching a nesting turtle crawl up behind her on your stomach ('commando crawl') (see Appendix 3 to see at which stages of nesting you can approach the turtle).

5. Always position yourself behind the turtle and stay low (sit, crouch or lie on the sand). If you are getting covered in sand as she digs you are too close!

6. Be patient. She may abandon the nest and dig another one for a variety of reasons including hitting an obstacle or the sand being too dry.

7. Wait until she is laying the eggs before moving closer. She will be quite still when laying her eggs - if sand is spraying or she is using her flippers, she is not laying.

8. Give her enough space to camouflage the nest.

9. Let her return to the ocean without interruption or getting between her and the ocean.

See Appendix 3 for more detailed information on each stage of turtle nesting and how to interact accordingly.

10.2 Emerging hatchlings

All the processes that a hatchling endures from the time it hatches from the egg to emerging from the nest and making its way to the sea are important to its development. It is extremely important that hatchlings are not handled or interfered with in any way during this time. Doing so will interrupt the completion of various developmental stages of the hatchling, thereby threatening its very existence.

During hatchling emergence, you should:

a) Stand back from the nest – do not compact the sand.
b) Don't use lights or flash photography as this will disorientate the hatchlings.
c) Do not touch the hatchlings.
d) Do not get between the hatchlings and the ocean.
e) Let the hatchlings make their own way down the beach- they need to do this to exercise their lungs.
f) Hatchlings can get stuck in footprints so stand to the side rather than crossing their path.

As a volunteer participating in a turtle monitoring program, if you come across hatchlings in distress, e.g. disoriented, at risk of overheating, trapped by an anthropogenic obstacle, you are allowed to assist them reaching the water by removing or moving them away from the obstacle and/or to a cooler place.

10.3 Interfering with turtles

All marine turtles are protected in Western Australia under the *Wildlife Conservation Act 1950*. Any activity that may interfere, disturb or harm them may be illegal if conducted without an appropriate permit.

If you observe any activities which you consider is of concern, please report the incident to the volunteer coordinator or the local DBCA office (see Appendix 6) as soon as possible.

Appendix 1: Glossary

Animal handler	A person listed on an application to the DBCA Animal Ethics Committee, who will be responsible for handling animals during the project.
Carapace	The shell of a turtle.
Costal scales	Large scales down either side of the centre row of scales on the shell of a turtle. Refer to identification key **Error! Reference source not found.**19.
Egg chamber	The deep, hand span-size hole a turtle digs into the primary pit with her back flippers.
Emerging track	Track of a turtle coming up the beach from the sea.
False crawl	An unsuccessful nesting attempt. Primary body pit/s may be present but no eggs have been deposited.
Fibropapillomas	Tumours that occur on the soft tissue of turtles.
Flipper tag	An externally placed tag made from titanium.
Foredune	First dune in a system, on the seaward side.
Nest microclimate	The local climate within the nest/chamber, including temperature and moisture, which effects the incubation of the eggs.
Nest mound	The pile of thrown sand a turtle leaves over her nest.
Nesting crawl	A turtle track which leads to a successful nest.
Nuchal scale	Scale situated above turtle's neck
PIT tag	An internally placed transponder.
Plastron	The underside of a turtle. The plastron may leave a belly drag mark in the sand centred between flipper markings of tracks.
Primary body pit	The pit dug by a turtle at the start of a nesting attempt with the intention of laying eggs into it. This is covered over in a successful nest, or left as an exposed pit after a false crawl.
Returning track	Track of a turtle returning to the sea.
Secondary body pit	The final (shallower) pit left by a turtle once she finishes covering her nest.
Successful nest	A turtle nest in which eggs have been deposited.
Supracaudal scale	Scale situated above turtle's tail
Unsuccessful nest	See *false crawl.*
Vertebral scale	Scales down centre of carapace
Waypoint	A navigational coordinate that has been marked or recoded in the memory of a GPS.
Preoccular scales	Scales on a turtle's head situated anterior from the eyes.
Pre frontal scales	Scales on a turtle's head situated anterior to the frontal bone.

Appendix 2: Turtle Watcher's Code of conduct

Appendix 3: Turtle Track Count Flow Chart

Appendix 4: Turtle Measuring and Inspecting Flow Chart

Appendix 5: Turtle Tagging Flow Chart

Appendix 6: Regional Contact Details

Kimberley Region PO Box 65 Broome 6725 Tel: 9195 5500 Fax: 9193 5027 broome@dbca.wa.gov.au	**East Kimberley District** PO Box 942 Kununurra 6743 Tel: 9168 4200 Fax: 9168 2179 kununurra@dbca.wa.gov.au	**Pilbara Region** PO Box 835 Karratha 6714 Tel: 9182 2000 Fax: 9144 1118 LUP.Pilbara@dbca.wa.gov.au
Midwest Region PO Box 72 Geraldton 6531 Tel: 9964 0901 Fax: 9964 0977 geraldtonrecords@dbca.wa.gov.au	**Swan Region** Locked Bag 104 Bentley DC 6983 Tel: 9442 0300 Fax: 9386 1578 swanregionlanduseplanning@dbca.wa.gov.au	**South West Region** Att: Land Use Planning Officer PO Box 1693 Bunbury 6231 Tel: 9725 4300 Fax: 9725 4351 swlanduseplanning@dbca.wa.gov.au
Warren Region Locked Bag 2 Manjimup 6258 Tel: 9771 7988 Fax: 9771 2677 warren.admin@dbca.wa.gov.au	**South Coast Region** 120 Albany Highway Albany 6330 Tel: 9842 4500 Fax: 9841 7105 albany@dbca.wa.gov.au	**Esperance District** PO Box 234 Esperance 6450 Tel: 9083 2100 Fax: 9071 3657 esperance@dbca.wa.gov.au