Marine Turtle Husbandry and Satellite Tracking

Elizabeth Hall
Taronga Wildlife Hospital
Taronga Conservation Society Australia

ABSTRACT

This paper outlines techniques used when treating sick and injured marine turtles. Topics covered are rescue, transport, housing, water temperature and quality, diet, assisted feeding, treatment regimes, preparation for release and identification. Preliminary findings and maps from the project Satellite Tracking of Marine Turtles released from Taronga Wildlife Hospital are also included.

INTRODUCTION

Marine turtles are representatives of a group of marine reptiles that have travelled the world's oceans for over 100 million years. They are an essential part of the marine ecosystem assisting in the maintenance of sea grass beds and coral reefs. In the past 200 years humans have managed to alter the marine environment to such an extent that all the marine turtle species are now listed by the ICUN as species of conservation concern.

In Australian waters Marine turtles are protected under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act).

The Leatherback (*Dermochelys coriacea*), Loggerhead (*Caretta caretta*) and Olive Ridley (*Lepidochelys olivacea*) turtles are each listed as endangered under the EPBC Act which means that these species may become extinct if the threats to their survival continue.

The Green (*Chelonia mydas*), Hawksbill (*Eretmochelys imbricata*) and Flatback turtle (*Natator depressus*) are each listed as vulnerable which means that they may become endangered if threats continue.

Marine turtles have important cultural, nutritional and social significance for Aboriginal and Torres Strait Islander people living in coastal areas and may be hunted under the Native Title Act 1993 (section 211).

A National Recovery Plan for Marine Turtles in Australia was developed by the New South Wales and Queensland Environment Ministers in May 2017. The Recovery Plan outlines research and management actions necessary to stop the decline and support the recovery of marine turtles so that their chances of long-term survival in the wild is maximised.

Due to the global migratory patterns of 6 of the 7 species of marine turtles, international agreements are essential in providing adequate protection for these animals. The Flatback turtle is endemic to Australia and is the only species that does not migrate across international borders. The six species found in Australian waters are listed on the 2000 IUCN (World Conservation Union) Red List of Threatened Animals. The Kemp's Ridley turtle (which is not found in Australian waters) is included on the Red List as critically endangered.

The threats to marine turtles listed below are taken from the National Recovery Plan for Marine Turtles in Australia 2017–2027 Australian Government Department of Environment and Energy.

- Climate change and variability – rising sea temperatures are expected to cause changes to foraging sites from coral bleaching and die off of sea grass, habitat availability, species range, nesting beaches. Increases in sand temperature may result in changes to sex ratios (more females) and decreased hatchling success.
- Marine debris – increasing numbers of turtles are affected by plastic ingestion and entanglement in nets and lines.
- Chemical and terrestrial discharge – the release of pollutants dumped into the marine environment.
- International take – smuggling of marine turtles is still a huge problem in many countries
- Terrestrial predation – foxes, dogs, cats, pigs, dingoes, crocodiles and birds.
- Fisheries bycatch – identified as one of the major threats to marine turtles - large number of turtles caught accidentally in trawling nets will in most cases die
- Light pollution – bright lights cause disorientation of hatchling turtles.
- Habitat modification – Resorts, mining, ports, housing.
- Indigenous take – Indigenous communities are becoming more involved in monitoring numbers
- Vessel disturbance – propeller strike is not uncommon
- Noise interference – chronic loud noises from port facilities
- Recreational activities – scuba diving, 4 wheel driving
- Diseases and pathogens – A number of diseases have been identified being caused by poor water quality and pollutants in sea grass beds. Fibropapillomatosis and infectious diseases such as coccidiosis.
- Cold stunning – temperature changes

Species Identification

To enable accurate records, treatment and feeding it is essential to identify the species of marine turtle that is admitted. At times identification of hatchlings can be challenging.
Following is a very brief description and identification key for turtles found in Australia:-

<u>Green turtle (*Chelonia mydas*)</u>
Adult: Carapace is a high dome. Colour is light to dark green with dark mottling. Plastron colour is cream-white. Hatchling: Black-dark brown with white margins, white plastron. Front flipper marks nearly equal width to hind flipper marks.

The genus Chelonia includes 2 subspecies: the East Pacific green turtle *C. mydas agassizii* from Baja California to Peru and west to the Galapagos Islands, and the green turtle *C. mydas* in the rest of the world's range (9)

<u>Loggerhead turtle</u>
Adult: Carapace is longer than wider. Colour is red-brown to brown. Plastron colour is yellow. Hatchling: Dark brown with 5 costal scales and dark plastron with 3-4 infra marginal scales.

<u>Flatback turtle</u>
Adult: Carapace is a low dome, smooth with upturned edges. Colour is grey to pale-grey or olive. Pre-ocular scales. Plastron is creamy-yellow. Hatchling: Olive-green, scales with broad black margin. Plastron is a solid white.

Hawksbill turtle

Adult: Carapace has thick overlapping scales. Colour is olive green or brown and is extensively variegated with brown/black markings. Adult plastron is yellow or white with black spots. Hatchlings: Dark brown.

Olive Ridley turtle

Adult: Carapace is circular. Colour is grey-green with no conspicuous markings. Plastron colour is cream-white. Hatchling: Charcoal-grey/black-brown on both sides.

Leatherback turtle

Adult: Carapace is long and pointed. Long ridges run down the length of carapace. Colour is a uniform black-brown. Soft leathery skin. Hatchlings: Finely beaded, black with white markings on the carapace ridges and plastron.

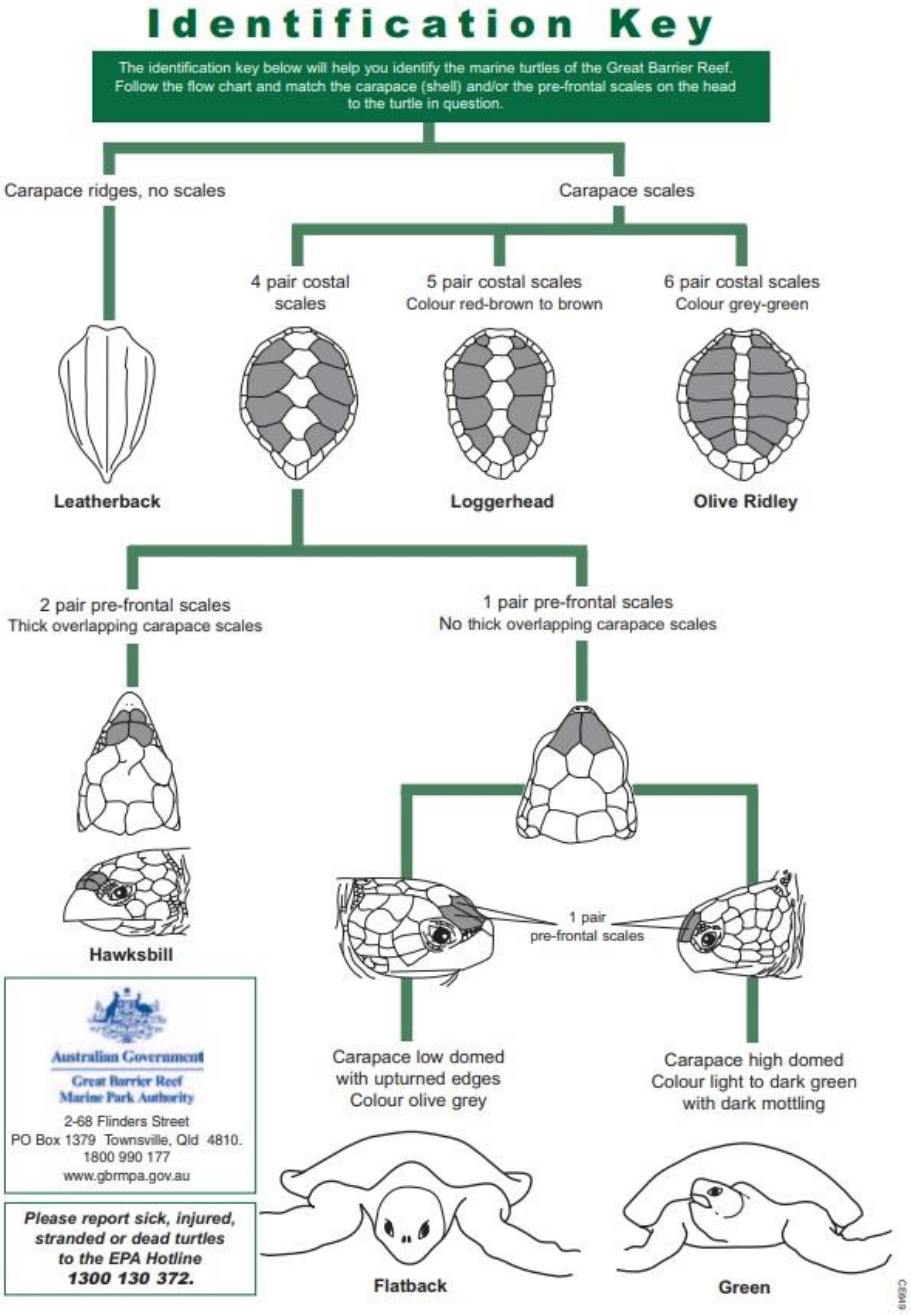

Figure 1. Australian Government, Great Barrier Reef Marine Park Authority, Identification Key Marine Turtles.

Biology

Hatchling turtles dig their way to the surface and make a dash to the ocean. Once they reach the ocean the hatchling is imprinted to the inclination of the earth's magnetic field at the nesting beach (23). Hatchlings may also be imprinted to the smell of the sand or the water that they first contact as they leave the beach (12).

When they reach the ocean they swim continuously for 36 hours to get out of coastal waters and away from predators. They swim off shore in search of clumps of seaweed where they are

camouflaged while they feed on small invertebrates (31). During the next 10-12 years they lead a pelagic existence swimming both actively and passively and feeding around ocean upwellings (31).

When they reach approximately 40 cm in carapace length (species variation) they swim back to coastal waters spending the next 20-30 years foraging. Marine turtles are slow to reach sexual maturity, taking 20-50 years before they return to the nesting beach where they hatched to begin their lives as breeding adults (31).

Anatomy and Physiology

Adult marine turtles use insulation and blood flow to control body temperature (30). Hatchlings and juveniles are not able to insulate as well as adults hence larger turtles can cope better with colder water temperatures. Green and Loggerhead turtles keep their body temperature slightly higher than that of the ocean (15). Water temperatures of less than 8°C can cause cold stunning and most species do not tolerate cold water temperatures. The exception is the Leatherback that manages to conserve enough body heat to forage in cold waters.

On land marine turtles can quickly overheat and it is reported that the upper limit of their thermal tolerance is 40°C (15).

Salt glands situated next to their eyes help compensate for ingestion of salt water and excess salt is excreted as tears which is often visible on examination. The nasal passages close when diving (30).

Marine turtles have limbs modified as hydrofoils and a huge pectoral girdle to accommodate the muscles that move the front flippers (15). Important gastrointestinal physiology is included in the section on tube feeding.

Marine turtles are sensitive to pain and are not able to communicate through sound (8).

Each flipper has a single claw which is used to scrape off organisms such as barnacles. It is important that these organisms are removed while they are still trying to settle on the carapace or plastron because one they are securely attached they cannot be scraped off. This claw is can be used (particularly by Loggerheads) to scratch the person restraining them.

TARONGA WILDLIFE HOSPITAL DATA

Taronga Wildlife Hospital receives approximately 40 marine turtles each year that are admitted after being found sick and injured on beaches or floating in the ocean or waterways. They are brought to the hospital by National Parks and Wildlife staff, members of wildlife groups, veterinarians and other members of the community.

Records from the Taronga Wildlife Hospital Wildlife Rehabilitation Database from 2002 to 2018 show that 363 marine turtles were admitted to the hospital with the following species breakdown:

Green turtles	243
Hawksbill turtles	72
Loggerhead turtles	32
Flatback turtles	14
Olive Ridley turtles	2

The majority of marine turtles admitted to Taronga Wildlife Hospital are hatchling, juvenile and sub-adult Green turtles.

363 turtles were presented between 2002 and 2018, and only 55 of these turtles were adults.

The measurements used to determine the age of the turtles was as follows using SCL (straight carapace length) Hatchlings 4–13cm; 13–20cm post hatchling stage; 20–65cm juveniles; 65-90cm sub adult, and adults >90cm.

Of the 55 adults received for treatment, 10 adults were presented dead after drowning in shark nets. Three adults were presented after a meningoencephalitis event in 2002 and 11 from a coccidiosis event in 2003. If we remove these 24 turtles from the equation the result is that of 339 marine turtles presented only 31 of these were adults.

The Australian Registry of Wildlife Health has received 38 turtles for necropsy after being removed from the shark nets off Sydney from 2007 to 2018. The necropsy findings for these turtles was drowning – they were in good body condition.

The turtles were found at locations stretching from Port Stephens in the north of New South Wales to Batemans Bay in the south. Some areas appear to be hotspots for rescue but this could be relevant to the number of people frequenting these locations.

The most common reasons turtles are received alive at TWH are (28):

- Impaction - Ingestion of marine debris (plastic, fishing line, hooks)
- Entanglement – fish line and nets
- Parasitic infection
- Emaciation
- Pneumonia
- Flotation
- Boat strike
- Neonatal stranding
- Neurological
- Cold shock

RESCUE

Marine turtles requiring rescue are usually in a severely debilitated state. Healthy turtles are difficult to catch and usually not encountered unless they are suffering from sudden cold shock. Debilitated turtles are commonly found covered in barnacles indicating that they have been floating for many weeks and are often presented in an extremely dehydrated and malnourished state.

When rescuing marine turtles it is important that there are enough people to lift the turtle onto a blanket or purpose made marine turtle mat for transport. Turtles can also be placed in plastic tubs. Any injuries to the carapace (e.g. boat strike) should be covered with clean material so that the carry mat straps or towels covering the turtle do not exacerbate the injury and cause the turtle discomfort during transport. The turtle's head can be covered with a small towel ensuring that the nostrils are not obstructed.

Debilitated turtles may have a significant barnacle load on their carapace, plastron and sometimes on their flippers, head and even covering their eyes. Tempting though it may be to remove these barnacles it is important to note that the turtle carapace is made of keratin, the same protein substance in our fingernails and is sensitive to pain. Scraping and pulling barnacles off could cause the turtle considerable discomfort and may result in subsequent infection. Turtles with high barnacle loads are usually too weak to respond and this can be misinterpreted as not feeling the discomfort. Some barnacles dig deeply in the carapace and plastron and should be killed in fresh water rather than being forcibly removed.

TRANSPORT

Wild turtles will become stressed during rescue and transport even if they do not exhibit the usual signals or noises that other species show. Noise should be kept to a minimum and the turtle should not be left on the ground in high traffic areas for longer than necessary. The transport box or crate should be covered with a towel and people should not be allowed to touch the turtle. Bright lights (eyes can be covered with soft towel) abrupt movements and sudden temperature changes should be avoided. Care must be taken not to scrape the plastron on rough surfaces - foam rubber, towels or blankets can be used as padding.

If the weather is very hot, a damp towel can be draped over the turtle but care should be taken not to vary the temperature too quickly. Remove the towel if the turtle feels cold to touch. Damp or wet towels are not recommended unless the weather is very hot. It is important that turtles being transported or placed in air conditioned environments (vehicles, hospitals) do not have wet towels over them as wet towels become freezing cold very quickly and there is a danger that the turtle's body temperature will drop dangerously low due to evaporative cooling (29). Rapid warming (or cooling) can cause significant shifts in blood pH and electrolytes) (29).

There should be minimum noise in the transport vehicle and the turtle must be transported inside the cabin of the vehicle not outside in the tray of a utility where it will be exposed to noise, temperature changes and wind.

When the turtle arrives at the facility it may need time to rest before a thorough examination can be made. The turtle should be placed in a warm dry and quiet environment to recover, rubber matting and towels can be placed on the floor for comfort, lights turned off and doors closed.

Human Health and Safety

Marine turtles should be handled with caution. Even a sick, injured or weak turtle can inflict a severe bite or flipper slap to an inexperienced handler or a person who is unfamiliar with their behaviour.

Critically ill marine turtles (which is the majority of turtles being rescued) can harbour a variety of bacteria, viruses, and parasites such as salmonella and mycobacteriosis (4).

The following preventive measures are recommended to prevent disease transfer:

- Wear latex or nitrile gloves when handling sea turtles, carcasses, tissues or fluids
- Wear waterproof outerwear to protect clothing from contamination
- Cover surface wounds with protective dressings

- Wash exposed skin and clothing after handling sea turtles
- Seek medical attention for bites, cuts, and other injuries, and inform medical attendants of the injury's source

Licencing
In New South Wales (and in all states in Australia) it is necessary to hold a rehabilitation licence to treat and house marine turtles. Housing marine turtles longer than what is necessary to organise transport is restricted to facilities that have a rehabilitation licence and specialist facilities to house and treat marine turtles.

RECORD KEEPING
Detailed records are required from the time of encounter until release and including post release monitoring (satellite tracking data). Records include encounter information (videos and photos can be helpful), treatment notes, rehabilitation behaviours, feeding charts, water quality and maintenance, cleaning regimes, identification, post release monitoring,

Morphometrics are essential at the time of admission and include the following:
straight carapace length (SCL), straight carapace width (SCW), curved carapace length (CCL), curved carapace width (CCW), forelimb length (FLL), hind limb length (HLL), head length (HL), head width (HW), See Figure 2. Other measurements required are plastron length, plastron width, plastron to vent, plastron to tail tip.

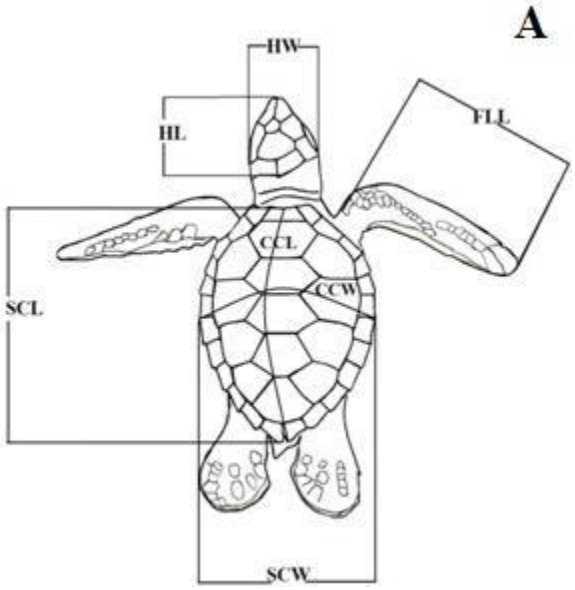

Figure 2. Morphometrics. Sex determination of Green Turtles (Chelonia mydas) hatchlings on the basis of Morphological characters. Sonmez B, Turan C, Yalcin S, Turan F, Research Gate 2016.

HANDLING
Movement of turtles within a facility can be done by hand-holding the turtle or using a cargo net, stretcher, blanket, plastic tub, wheeled platform, or any other safe, secure transport mechanism that will not jostle the turtle or allow the flippers to flail around. At Taronga we use plastic tubs

to carry them to the treatment room and return and a purpose made turtle mat (figure 3). Ensure that no covers, towels or strapping of mats is in contact with open wounds and care should be taken not to exacerbate any wounds or injuries the turtle may have. Whatever transport mechanism is used, it must be strong enough for large turtles and made of materials that will not damage the animal or allow turtles to become entangled.

The head of turtle should be directed away from you. Marine turtles can inflict severe bites so avoiding the mouth is essential. It is important to get a secure hold as the turtle will probably flap its flippers when being moved and they can be very powerful, sometimes slapping the handler with their flippers and using the claws on the flippers to gauge into the handler (particularly Loggerhead turtles).

Hold the turtle with its head and mouth pointing forward and one hand under the front of the carapace and the other hand at the back of the carapace near the tail. (figure 4) Holding the turtle on either side of the carapace is not secure because the turtle can hit the handler with its powerful front flippers. Turtles that are being rehabilitated and are regaining condition and strength will often be very feisty and a far cry from the placid sick animal that was first encountered. Therefore, the handler should be prepared for the turtle's behavior to alter.

Turtles should only be restrained for as short a period of time as possible during diagnostic procedures. Most of the turtle's strength comes from the front flippers, so restraint is usually focused there. To properly restrain a turtle, maintain a firm hold on the front flippers, near the shoulders. Flippers can also be held against the carapace to restrict movement. A towel can be used for restraint by folding the two front edges of the towel over the fore flippers. A small wash cloth can be placed over the turtle's head and eyes during handling. When restraining for blood taking hold the flippers firmly and extend the head straight out with a firm but gentle continuous movement. Keep movements and sudden noises to a minimum.

Small turtles, in particular, can break their humerus if not restrained properly. For injections the head is held to the opposite side (i.e. the head should be directed left for an injection in the right shoulder) or firmly held down to prevent movement.

Rubber tires can be used as comfortable padding for treatment and transport but turtles should not be left unattended on tires or treatment tables as they may be very quiet one minute and then suddenly flap vigorously launching themselves off the table.

If the turtle starts to flap its flippers vigorously and will not settle, place a towel or cloth over the head and put slight pressure on the back of the head and lean your body against the middle of the carapace, being mindful not to restrict breathing or exacerbate any injuries the turtle may have. Very gently pressing on the eyes through clean non-abrasive cloth can also calm the turtle. Avoid sudden movements and loud noises. Sometimes allowing the turtle to flap for a short time is beneficial and then resume treatment when they stop flapping.

When returning a turtle to a pool or tank do not angle the turtle's body head first into the water because the turtle will crash into the opposite wall of the tank. Place the turtle with its head touching the tank wall or alongside the wall.

Equipment used for handling should be washed and disinfected and your hands should be thoroughly cleaned and washed after handling.

Figure 3 Turtle carry mat. Photo E Hall

Figure 4. Turtle hold. Photo: Taronga Media Dept

CLINICAL EXAMINATION

A thorough clinical examination is required by a veterinarian or an experienced veterinary nurse on arrival or soon afterwards depending on condition of the turtle and transport stress.

Out of water Examination:

Overall body condition: normal underweight or emaciated. Turtles with severe weight loss have decreased muscle and fat tissue. (29) In the neck area at the back of the scull a prominent occipital process becomes very obvious in thin turtles (29). Neck muscles look more obvious with weight loss and the soft tissue of the fore flippers and shoulder is reduced. In very thin animals the plastron may be sunken and ulcerated.

Head and eyes: look for cataracts and sunken eyes indicating dehydration.

Inside of mouth: To open the turtle's mouth for examination hold the upper rhamphotheca (top section of the upper beak) stable and apply gentle steady downward movement to the lower jaw. Gentle pressure or a tap on the nose sometimes causes the turtle to open its mouth. A padded mouth chock may be required to hold the mouth open. Note the smell of the mouth and throat. Listen for respiratory sounds.

Carapace and Plastron: Boat strike to the carapace and obvious major trauma to other parts of the body will require a thorough examination and will need extra care to be taken during restraint. Head position, locomotion, jaw strength, limb strength and posture should be noted. When examining the carapace and plastron note any discoloration, scrapings and dents. Amount of barnacles and other biomass should be noted.

Normal responses to note out of water are vigorous co-ordinated flipper and head movements and the normal protective rear flipper clasp reflex.

In water Examination

Swimming ability particularly floatation issues or uneven buoyancy and inability to dive. There may be frantic and vigorous flapping of flippers and a desire to get out of the water especially if buoyancy issues prevent them raising their heads to breathe. Ability to navigate the pool environment and to stay submerged on the bottom of pool.

Nasal excretion, expulsion of water and food regurgitation should be observed.

Weight:

Turtles should be weighed on arrival. If the barnacle load is heavy the turtle's weight will affected when the barnacles are removed or fall off.

Morphometrics:

Should be taken as soon as practically possible after arrival.

Blood samples:

The most common sites for intravenous access is the dorsal cervical sinuses which runs parallel to the muscular ridges of the neck. It is advantageous to hold the turtle with its head positioned lower than the body so that the sinuses fill with blood (15). The neck can be extended and the site swabbed with alcohol.

Blood work: At Taronga Wildlife Hospital routinely it is a complete blood count (including looking for blood parasites) and biochemistry.

Radiography:
X-rays enable examination of the presence of fish hooks, abnormal gas distention of the stomach and intestine and abnormal lung appearance. (15) Crab shells, squid beaks and barnacles will show up on radiographs but plastic and other marine debris is more insidious and indication of a blockage may require barium examination. Radiographic views taken at TWH are D/V, A/P and right lateral.

Contrast radiography can be performed through a Barium series examination. If there is a suspected impaction or foreign body, barium can be useful to highlight the problem. The turtle can be force fed barium via tube, in capsules or inside squid and fish so that the passage of the barium can be noted via radiographs over several hours and days and may enable the site of a blockage to be found.

Faecal sample:
If the turtle defecates during examination it is a good opportunity to collect a faecal sample. Collection of faecal matter from the pool can be done with a small pool scoop or pool net. At Taronga Wildlife Hospital the faecal sample is submitted to our laboratory for wet preparation and flotation tests to detect parasites. Anything found in the turtle's pool should be examined closely. Many turtles will excrete pieces of plastic, fishing line and netting. Even tiny hatchlings will excrete marine debris so a thorough examination of the pool and any faecal matter should be done prior to cleaning in the morning and another check during the day as turtles may re-ingest the material if left in the pool for any length of time.

Biota examination and removal:
The turtle should be placed in fresh water for 2-3 days after arrival to kill the barnacles and other biota on the carapace and plastron. Cleaning of the carapace can be done very carefully with a sponge or other piece of cleaning equipment that will not damage the turtles.

HOUSING

Intensive Care Housing
Marine turtles can be housed in a variety of pools and tubs. Round or oval pools are preferred so that turtles do not get stuck in the corner of the pool and circular pools enable the turtles to swim around the pool continuously without banding into the sides.

Some turtles will be too weak to be placed in deep water because they are unable to raise their heads to breathe. Turtles that are weak and debilitated can be placed in a pool that is raised at one end (e.g. on bricks) and their cloaca positioned in the water and their heads resting out of the water. This enables the turtle to hydrate by absorbing water through their cloaca. Place their heads on towels at the high end out of the water.

Turtles in intensive care should not be housed together until cleared of transmissible disease and strong enough to swim away from each other.

Pools should be disinfected once a week and between turtles with Virkon-S ® 1:50 strength.

Marine turtles should be housed in clean sea water (seawater is 30 ppt - parts per thousand). If sea water is not available tap water can be made up with marine salt at a dilution of 7 cups to 50 litres of water to create 30 ppt.

Ensure that the pools are free of entangling objects such as heaters and heater chords. Position rocks, ledges, and other structures in the pool in such a way that the turtle cannot become wedged or trapped underneath them.

Shower boxes may also be constructed to hold debilitated turtles. Shower boxes are pools with foam padding lining the bottom and drains or containers underneath that allow continuous water spray over the turtle without water accumulating in the box – keeping the turtle wet and preventing it from drowning (8).

Hatchlings can be housed in glass fish aquariums with inbuilt filters and heaters. They should always be housed separately until cleared of disease. Very weak turtles (that will drown) may need to be placed in a container on warm wet padding (warmth should be maintained) or in a warm quite room or hot box until well enough to be housed in water.

Ultra Violet light

Pools should be positioned next to windows that can be opened to allow access to sunlight. Hatchlings, in particular, require direct sunlight through an open window or exposure to a UV lamp for 30 minutes each day. The turtles should be monitored to ensure they do not get too hot during this time.

A UV-meter can monitor the strength and diameter of UV output. Surface readings should not exceed natural sunlight (200-450 mw/cm2 is a good target). If access to direct sunlight or artificial is insufficient, a veterinarian may recommend dietary supplements of calcium and vitamin D.

Care should be taken to keep the bulb 3-4 ft above the water surface, as any splashed water hitting the bulb will cause it to shatter.

To enable light exposure for turtles held indoors without windows or artificial bulbs some turtles may be able to be taken outside and given access to sunlight. This will depend on the health of the animal and the environment outside. Turtles should be in a stable condition as movement may cause additional stress. Turtles should be supervised at all times when outside.

Pool sizes

The following sizes are a general guide to the minimum required for housing marine turtles in a hospital environment (4):

10cm SCL turtle needs a tank with ≥ 929 square cms of surface area
45cm SCL turtle needs a tank with ≥ 23225 square cms of surface area
50cm SCL turtle needs a tank with ≥ 28799 square cms of surface area
65cm SCL turtle needs a tank with ≥ 47380 square cms of surface area
90cm SCL turtle needs a tank with ≥ 114271 square cms of surface area

Holding pools should not contain any non-food items that could be ingested by a turtle. Turtles will attempt to eat just about anything. Be sure that nothing except intended food is put into or falls into a tank; this includes material that could be either ingested immediately or broken apart and ingested.

The drains and intake pipes of holding tanks should be constructed or securely shielded such that a turtle cannot become trapped and be held underwater by them.

Water Temperature and Quality

Water temperature should not be raised too quickly. In southern parts of Australia severely debilitated turtles are encountered in winter and are extremely cold when presented. These turtles should be placed in water that is approx. 21°C and then gradually increase the temperature over a number of days increasing it by 1ºC per day. The optimum water temperature for treating turtles is 26°C.

Turtles can be kept at temperatures between 25 and 30°C. Water that is too cold suppress immunity, delay healing and depress the appetite. Water that is too warm can cause hyperthermia. If attempting to get the GIT moving to remove debris or other blockages the water temperature can be gradually raised to 30°C.

Aquarium heaters can be used in small tanks and these can be covered with PVC piping with holes drilled into them (so that the turtles do not bite the heaters and so that the turtle does not come in direct contact with the heater and burn itself). Care should be taken that the turtle does not get tangled up in the heater chords. Once a turtle is well enough to be swimming around in the pool it is time to move it to a larger pool with external heating and filter systems.

Frequent water changes will be required if the turtles are being treated with Barium and are defaecating often.

At Taronga Wildlife Hospital we use aquarium heaters for the small pools and external aquarium heaters and sand filters for the larger pools. Small external filters and heaters adapted for a glass fish aquarium are used for the hatchling turtle tanks.

Water pH should be maintained between 7.5 and 8.5. The inside surfaces of the pools must be free of toxic substances, such as lead or copper paints. Chlorine levels greater than 1.0 ppm can irritate the turtle's eyes (8).

Rehabilitation pools - See section on Rehabilitation

NUTRITION

Turtles presented in a debilitated state and suffering from dehydration may require fluids to be administered subcutaneously or intracoelomically. At TWH, we use Reptile Fluids that are made up as follows: 2 parts 5% glucose, 2 parts 0.9 % saline and 1 part Hartmann's fluids. 15ml/kg for large turtles, 25 ml/kg for small turtles daily if needed.

Knowledge of the natural diet and foraging behavior of marine turtles is essential when managing their nutrition during intensive care and rehabilitation.

Whenever possible it is advantageous to feed marine turtles their natural diet. This of course is not always practical or possible during treatment and rehabilitation. Jelly fish, sponges and small invertebrates will sometimes stimulate them to feed and they can then be transferred onto their treatment diet.

The suggested amount is 3% body weight per day to maintain condition and up to 5% to gain condition

Natural diets

Green turtles adults - herbivorous, algae, seagrass and mangroves. Juveniles: small invertebrates, pelagic crustaceans, jellyfish and molluscs.

Green turtles are extraordinary because they are carnivorous when young and then at approximately 40 cms (SCL) they transfer to an herbivorous diet consisting mainly of sea grass and algae.

Young Green turtles living in the open ocean feed on small invertebrates. When they are older and leave the open ocean to reside in coastal waters they switch from a carnivorous diet to a herbivorous diet. In order to do this they undergo modifications to their digestive system over time. The large intestine nearly doubles in length so that it is able to properly digest the plant material. Along with a larger colon there are also valves that slow the rate of passage of the food allowing more absorption. Green turtles have bacteria in their gut that breaks down cellulose so that the nutrients can be easily digested. (16) Turtles are often admitted to TWH at this stage of development and necropsy findings have sometimes shown a GIT full of undigested sea grass.

Green turtles consistently ingesting a mixed diet (vegetable and animal matter) would almost certainly develop a different microbial community capable of degrading the various complex carbohydrates and proteins required to digest each food item efficiently (16).

Hawksbill turtles: Omnivorous - sponges (main diet) soft corals, soft bodied invertebrates and algae. They will eat jellyfish, shrimp and molluscs but can be fed chopped fish and squid for ease while in care.

Loggerhead turtles: Carnivorous – benthic invertebrates – down to 55 m. Post hatchling and juvenile stages they feed on crustaceans and molluscs and algae, jellyfish, molluscs, fish, crustaceans and sponges and can be fed as per Hawksbill Turtles.

Flatback turtles: Carnivorous - jellyfish, squid, soft corals and sea cucumbers. Can also be fed as per Hawksbills.

Olive Ridley turtles: Carnivorous - crustaceans, molluscs, fish, small crabs, jellyfish, sea stars.

Some turtles will eat fish and squid waved in front of them (with tongs) however other turtles may require tube feeding or force feeding. This is assessed on a case by case basis.

Tube feeding

Turtles that are unable to eat, or will not eat on their own, may require tube or force feeding. This is assessed on a case by case basis and the decision should be made by the treating veterinarian. Tube feeding marine turtles has its challenges and information on gastro-intestinal anatomy is helpful in understanding the resistance felt in the esophagus when attempting to push the tube or food down. It is important to be gentle using slow movements and feeling your way with sensitivity.

All species have powerful jaws and some species such as Loggerheads have wide plates for crushing food such as shells and crustaceans. Hawksbill turtles have hooked beaks and jaws that are comparatively narrow and this allows them to access food in narrow rock crevasses. Green turtles have serrated beak margins for shearing vegetation (15).

All marine turtles have backward pointing papillae lining the esophagus which enables them to trap the food while they expel seawater out of their mouth and nares. The cardiac sphincter is kept closed to prevent the food and seawater entering the stomach until the seawater has been expelled. Then the sphincter relaxes allowing the food to enter the stomach. (5) The contraction of the esophagus and the backward pointing cornified papillae and the closing of the cardiac sphincter all make tube feeding challenging and it needs to be done with sensitivity and care. The sharp left lateral bend in the esophagus at the gastroesophageal junction also makes navigating the tube challenging (5).

The following procedure can be followed:

- Selecting a tube: The tube length and diameter will need to be appropriate for the size of the turtle. Usually the tubing is 30-76 cm long and diameter somewhere between a catheter tube and a garden hose. One end should be small enough for a catheter tip syringe to fit inside. Various sizes of equine stomach tubes work for most turtles except very small ones. More rigid tubes are required because soft tubes will not pass down the turtle's throat.
- Bite Block: A block is needed to prevent the turtle from biting down on the tube and to protect the person tubing. This can be made from a piece of PVC pipe or a wooden chock wrapped with vet wrap. It the turtle is small a 3 ml syringe covered in vet wrap can be used. Some blocks have holes in the middle to pass the tube through but I find these difficult to manage as the tube may need to be manipulated once in the mouth.
- The liquid diet chosen will depend on the turtle's health status. At Taronga Wildlife Hospital we use a combination of Spark® and AD (Hills AD for debilitated cats). The consistency of the food is partly dictated by what will pass through the tube easily.
- Warm the liquid to room temperature – This can be done by placing the tube with the liquid inside into a measuring jug of warm water.
- The tube will require lubrication with KY® jelly, or other non-toxic water soluble lubricant.
- Measure the feeding tube on the outside of the turtle aligning it with the turtle's nose and then mark the tube at the point that corresponds with the second vertebral scute (see Figure 5). This provides a guide as the how deep to pass the tube and lines up with the anterior portion of the stomach. Marine turtles have an amazing set of esophageal sphincters which make passing a tube to the stomach very difficult.
- Opening the turtle's mouth can be a challenge. Tapping the nose of the turtle will sometimes cause them to open their mouth. The chock should be ready to be placed into the mouth as soon as it has opened wide enough. Spoons and other instruments have been used to pry the mouth open but care should be taken not the damage the turtle. Rope is sometimes needed for larger turtles to hold the mouth open.
- Prop the turtle up at an angle of between 30 and 90. This assists feeding and also helps to prevent regurgitation. Keep the turtle on a head up angle for approx. 5 minutes after feeding. It is important to keep a close eye on the turtle for signs of regurgitation and aspiration at this stage. If the turtle smells particularly foul tilt the turtle downwards and allow the food to run out of the turtle's mouth. Return the turtle to water.

- Smell the turtle's breath for signs of halitosis, which can indicate regurgitation and aspiration. If there is a foul smell and/or food is regurgitated stop tube feeding, tilt the turtle with its head down to allow the food to run out, and return the turtle to the pool.
- When all the food has been pushed down the tube (extra air will probably be required) gently remove the tube (pinch the tube before removal to prevent remaining tube contents from leaking onto the glottis at the base of the tongue), remove the bite block, and return the turtle to shallow water. Weak turtles should also be placed in water, even if only for a few minutes. Being in water allows the turtle to clear its throat and safely expel excess food and fluids through its nose and mouth.

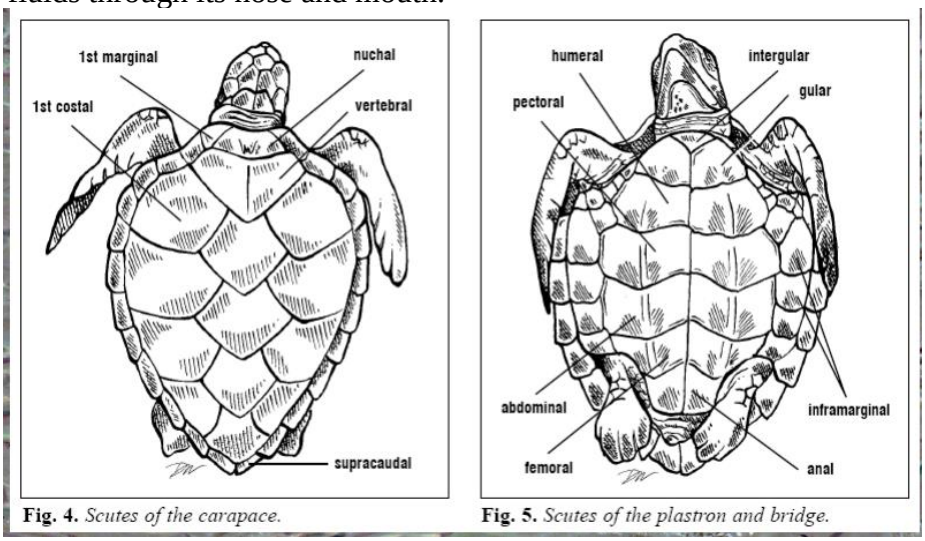

Fig. 4. *Scutes of the carapace.* **Fig. 5.** *Scutes of the plastron and bridge.*

Figure 5. External Anatomy of Sea turtles Jeanette Wyneken PHD Florida Atlantic University 2009

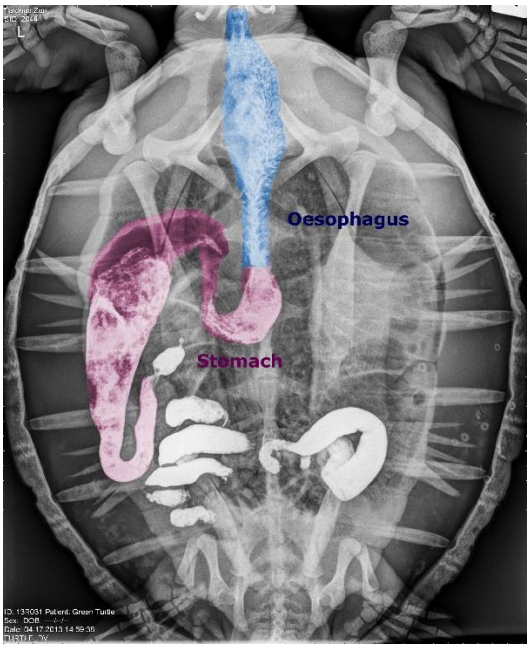

Figure 6. A Guide to Radio Anatomy of the Green turtle (Chelonia mydas) Tamsyn Stephenson, Larry Vogelnest, Mariano Makara, Poster Presentation American Association of Zoo Veterinarians Conference 2015.

Figure 7: Tube feeding Green turtle at TWH. Photo by Libby Hall

Severely debilitated turtles can be tube fed a mixture of Spark ® and Hills A/D ® diet – 0.5-3% of their body weight half and half. The percentage of AD can be increased after the first day however it is often difficult to move the thicker mixture down the tube.

If the turtle is strong enough it can be force fed whole food. Bite sized pieces of fish can be forced down the oesophagus with a pair of tongs. Medications, vitamins and sometimes barium can be placed inside the fish or squid. See notes on tube feeding. A long plastic stick can be used to push the fish down the throat. This can be done every 24 to 48 hours.

It is important that the turtle is held in an upright position during the feeding process and in most cases 3 people will be required, one to hold the turtle, one to hold the chock and the other feeding the tube or fish down the throat. See Figure 7.

Assist Feeding

Turtles occasionally need coaxing before they will eat. Tongs (available for purchase in many lengths) or a sharpened pole (wood, metal) are simple tools that can be used to hold food securely while waving it in front of a turtle's mouth. Once the turtle takes the food, immediately remove the tongs (or pole) from the water.

Hatchlings are often fed a high percentage of their body weight at first, between 8% and 15% and may need to be fed several times each day to meet this target.

Hatchlings (with the exception of leatherbacks) can be fed a variety of crustaceans, mollusks, and fish carefully sized so that they are easy to swallow whole or soft enough to bite off small pieces. Bones and shells are essential, but alternative calcium supplementation may be necessary until the turtle is large enough to swallow bones and shells safely and without difficulty.

During the first 5 to 8 days of life, hatchlings obtain most of their energy and nutrition from a residual yolk sac. For this reason, it is normal for hatchlings not to feed for several days. Once the yolk has been fully absorbed they should be eating within 3 days. If the hatchling does not eat on its own, assistance may be required. Gently opening their mouths and placing the food inside will often stimulate them to feed.

Free Feeding

The most basic feeding method is to toss prepared food into the pool. To promote "foraging", food items should be dispersed and not concentrated in one area. It is recommended that you walk away once the food has been given so that the turtle is less likely to associate human presence with food. Dispose of any seafood not eaten after 20 minutes. Vegetables can be removed for disposal prior to the next meal. Anything not eaten should be weighed and recorded. Food items should not be saved or re used.

Oral Medications and Vitamins

For turtles that are eating on their own, oral medications and vitamins can be given with meals. Vitamin and mineral considerations include Vitamin E, B Complex, A, D3, calcium, and iron, and these should be administered as part of regimen prescribed by a veterinarian.

Pills and capsules can be placed inside the fish gills, cloaca, or muscle or inside a squid mantle. Place medications far enough inside the food item so that they do not fall out. Do not place multiple pills of different types in the same piece because it is important to know how much of each vitamin or drug was ingested. Green Turtles fed primarily vegetables can also be given fish or squid for oral medications and vitamins.

Watch closely to be sure the medication is ingested. To help ensure that medications and vitamins are taken, feed medicated food first (turtles with unstable appetites can be given a piece of non-medicated food first to confirm a readiness to eat). Medicated food is for immediate use and should not be stored. Discard and record uneaten medication.

Turtles should be fed frozen fish because fresh fish contains high parasite burdens - the freezing process kills the parasites. The food should be high quality, unspoiled and not contaminated. The fish should be completely thawed before feeding and any food left over should be discarded. Fish should be cut when it is still sightly frozen as it can become mushy when thawed. Frozen fish should be used within 24 hours of thawing.

Frequency of Feeding

This will depend on the age and health status of the turtle but as a general rule turtles are fed 2-3 times a day while in intensive care and should be given 2-3 – 5 % of their body weight per day. Once in rehab pools the turtles can be fed twice a day.

Nutritional Concerns and Diet options

Michelle Shaw Nutritionist Taronga Conservation Society Australia has recommended the following:

Fish: When feeding thawed frozen fish it will be deficient in thiamine and vitamin E because these are destroyed in the freezing process. These can be supplemented at 100IU vitamin E and 30 mg thiamine per kg of fish fed. Vetafarm ® sea mammal chew (1 chew per 600 g fish) or seabird tablet (1 tablet per 400 g fish) can be used.

To create a balanced diet it is recommended that 5 different fish species are fed. The more varieties of fish the better.

Commercially available Fish food:
Michelle Shaw recommends feeding *Fish Fuel Co* turtle food. This is marketed as an adult food for carnivorous and omnivorous turtles. Michelle has analysed these diets and they appear to be a good balanced product that doesn't require any additional supplementation.

"Fish Fuel Co. Marine Food includes all the essential protein and vitamins and minerals needed for healthy top level carnivores. Quality Marine Food is made from premium quality molluscs, crustaceans and fish with added dietary fibre to keep your fish in the best condition.
Fish Fuel Co. Marine Green fish food contains a variety of plant material including top quality seaweed, spinach and spirulina algae for vegetable loving marine fish. It also contains premium quality protein from a special selection of molluscs, crustaceans and fish and a special multi-vitamin and mineral formula exclusively made for us by leading animal nutrition company Wombaroo for tip top fish health." www.fishfuelco.com.au

Fish Gels (recipes for marine turtles) The Fish Gels listed below are balanced dietary recipes formulated by Michelle Shaw, Nutritionist Taronga Zoo.

Whole fish recipe (does not require additional calcium).

500g	whole oily fish (herring, mackerel, saury, pilchards)
160g	whole whitefish (whiting, whitebait, snapper)
70g	yabbies
1 x 50g	whole egg, hardboiled no shell
1 x 18g	egg yolk
115g	gelatin
1 x	seabird tablet Vetafarm ®
350g	water

- Weigh all ingredients.
- Place in blender until well ground
- Add boiling water
- Blend again
- Pour into lined tray and place in refrigerator until set (12-24 hours)
- Cut into 50 g pieces
- Store in Freezer

Fish fillet recipe (uses fillets of fish and supplements which might be easier to find in pet store)

500g	oily fish fillets (mackerel, herring)
160g	white fish fillets (whiting, snapper, whitebait)
70g	Yabbies'
1	hardboiled egg, no shell
115g	Gelatin
15g	herptivite
12g	calcium carbonate
350g	Water

Combine and freeze as per whole fish recipe. Green vegetables can be added to either of the above recipes.

Medications and Vitamins

Medications given at Taronga Wildlife Hospital consist of the following and are determined by the prescribing veterinarian.

Vitamins:

- 100IU vitamin E and 30 mg thiamine per kg of fish fed. Vetafarm ® sea mammal chew (1 chew per 600 g fish) or seabird tablet (1 tablet per 400 g fish) can be used.
- Vitamin B – 10 mg per kg subcutaneously
- Iron 12 mg/kg IM every 7 days

Anthelmintics:

- Praziquantel 8 mg/kg IM repeat in 14 days for spirorchid flukes.
- Fenbendazole 10 mg/kg PO repeat 14 days for nematodes, roundworms.
- Toltrazuril (Baycox) 25 g/L at 1 ml/kg PO for coccidia.
- Trimethoprim/Sulfa 30 mg/kg IM once daily for 2 days, then 15 mg/kg every other day for 7 doses for coccidian

Other Medications:

- Reptile fluids 15 mg/kg for large turtles, 25 mg/kg for small turtles daily as needed. Reptile fluids consist of 2 parts 5% glucose, 2 parts 0.9% saline and 1 part Hartmanns fluids.
- Meloxicam 0.2 mg/kg IM or SC SID
- Ceftazidime 20 mg/kg q 72 hours IM
- Enrofloxacin 5 or 10 mg/kg q 48 hours IM or SC

REHABILITATION

Once turtles have left intensive care and are cleared of transmissible disease they can be housed together in rehabilitation pools. A close watch should be kept on them to ensure that they do not bite each other or hold each other under the water. Green turtles (juveniles) have been observed at TWH grasping the flippers of other Green turtles in the rehab pools and diving down and holding them under the water.

Feeding observations are necessary to ensure each turtle receives the correct amount of food and vitamins.

Large external heaters and filters are used for turtles that are in rehab pools. These filters require cleaning and replacement of sand and filter materials on regular basis and standard hygiene practices should be followed to ensure the pool is kept clean.

If the pools are situated outside shade will be required during warmer months and half the pool can be shaded and half left open to the sun for UV. A cover will also be required to prevent leaves, branches and other animals from entering the pools.

These rehabilitation pools should have filter systems that produce a current that the turtles can swim against to build up strength in preparation for ocean currents. A high water flow rate can assist in reducing bacterial and algal growth.

Temperature can be kept at 26°C until time to drop the temperature to coincide with release site ocean temperatures.

A hide (or several) should be placed in the pool to enable the turtles to rest and shelter underneath it. Rocks and ledges can be suppled for scratching and resting. These objects and structures require cleaning and are usually removed for water changes.

At TWH we have tried several types of brushes suspended on the water surface and in the water for turtles to use for scratching their carapaces. However, in each case the turtles have pulled the broom fibres out of the brushes and either spat them out or ingested them so we do not use.

Feeding mats can be used for green turtles. These are heavy mats with holes for green vegetables to be pushed into to enable turtles to dive down and either bite the food items off or pull them out of the holes.

All leftover food should be removed from the pool after 20 minutes so it does not spoil the water quality.

If it is possible to place turtles in large pools with a strong water filter system (current) or a wave pool this will enable appropriate assessment of the turtle's ability to cope in the ocean. At Taronga we are fortunate to have the use of a very large seal wave pool to assess turtle's swimming and diving ability prior to release. All quarantine protocols are put in place to ensure the turtles are assessed appropriately before release.

EDUCATIONAL PROGRAMS

There are several educational programs run through Taronga Zoo's Education Department that have a marine turtle and in particular a marine debris focus. They incorporate visits to the hospital to view the marine turtles and receive a talk from one of the TWH staff members. Educational programs involving marine turtles and incorporating all stages of treatment and rehabilitation enables a large number of students and teachers to learn about these marine reptiles and the threats they face.

Plastic Predator is a primary school education program now included in the NSW Education primary school curriculum. School children watch a video about marine turtles and visit the turtles in the rehab pools. They see the marine debris that has been collected from inside the GIT

of turtles during necropsy and are taught about the threats to marine turtles. The jars of plastic, netting and fishing line that we have collected from the intestine of marine turtles during necropsy is an excellent tool for raising awareness about plastic ingestion by marine turtles.

In Depth School Science Studies Program is a high school program to encourage year 12 students to learn more about marine turtles and the complex science studies involving marine animals. The students visit the turtles at TWH and learn about the Satellite Tracking Program and other behavioural observations required to care for marine turtles. Discussions about marine debris are also incorporated into this program.

Project Green turtle is a multi-school program for primary and secondary students. It encompasses classroom lecturers, practical components, art work, mentoring, beach cleanups and visits to the hospital to see the turtles, the marine debris and to learn about the satellite tracking programs.

Taronga Wildlife Hospital tours incorporate the marine turtles and the examples of marine debris in the daily paid tours by Taronga zoo visitors.

The Media relations department at Taronga Zoo covers stories on marine turtle treatment, rehabilitation and release including the Satellite Tracking program.

PREPARATION FOR RELEASE

Veterinary clearance and behavioural assessment prior to release includes the following:

- Swimming and diving at speed and with ease.
- Maneuvering under and around objects in the pool
- Remaining on the bottom of the pool resting for extended periods.
- Able to lift its head easily when surfacing
- Able to function well in the ocean temperature of the release site
- When out of water able to move along the ground.
- Feeding well and successfully manipulating food items
- Defaecating and urinating normally
- Weight normal and stable
- Good body condition
- Salt glands functioning
- Disease free – no medications for 14 days
- No open wounds, infections, skin irritations.
- Faecal tests free from internal parasites.
- Blood parameters in normal limits – full blood count and biochemistry

Behavioural observations and assessment prior to release:

The following Ethogram was used to observe 4 juvenile turtles to assess their swimming and diving ability in a large wave pool at Seal Cove, Taronga Zoo.

Behaviour	Description
Swimming submerged	Turtle moves through the water, fully submerged, at a steady pace in relatively horizontal position
Swimming at surface	Turtle moves through the water, with part of its body breaking the surface, at a steady pace in relatively horizontal position
Dive	Turtle swims quickly in a roughly vertical downward position
Agonistic interactions	Chasing, displacing, biting, evasive (Turtle quickly changes direction and/or swims rapidly to avoid approaching conspecific)
Affiliative interactions	Swimming or resting near another conspecific, Pressing chin against the dorsal side of another turtle's carapace or neck.
Rest under water	Turtle is stationary and is not engaged in any other behaviour. No movement under water. Movement of the head and small movements of extremities to maintain stationary are included
Rest at the water surface	Turtle is stationary and is not engaged in any other behaviour. Stationary with parts of the body over water level. May have fore-flippers resting on shell. Usually this behaviour is displayed when going up to the surface for air. Small movements of extremities to maintain position is included in the behaviour.
Rest on land	Stationary with majority of the body on land.
Swim against glass	Swims repeatedly against glass. Head and anterior extremity in contact with glass while swimming. Can be performed under water or at the water surface.
Forage/explore	Outstretched neck and side-to -side movement of head while swimming or remaining stationary. Can be done looking towards the water surface, ground or enrichment.
Hide use	Turtle is in the hide, with or without another conspecific?
Other	All forms of behaviour not listed above
Not seen	Cannot be seen or cannot be identified. Duration of time not visible is noted.

Turtles were watched twice each day on the following dates: The observations were carried out across 5th, 6th, 7th, 8th, 12th 14th, 19th, 26th February 2018 viewing 4 juvenile Green turtles - Nulla, Stephen, Sully and Stan One juvenile loggerhead Jaws was included in the observations on 5th February 2018 only.

Figure 8. Chart 1.

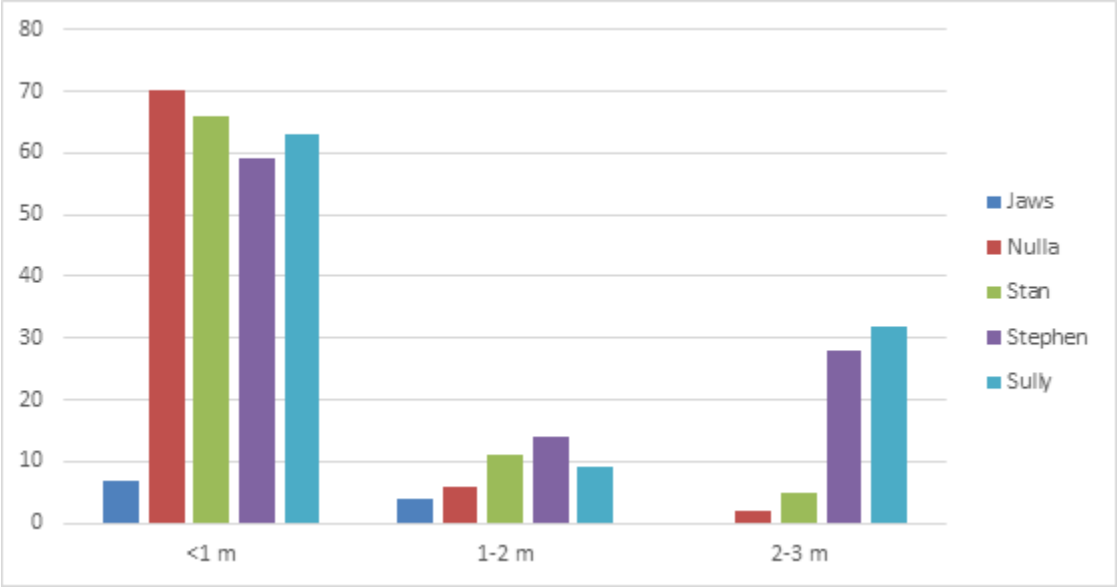

Chart 1 above shows at what depth each turtle spent its time. You can see that Stephen and Sully were the main ones that seemed to spend any time at the greater depth of 2-3m.

Figure 9. Chart 2

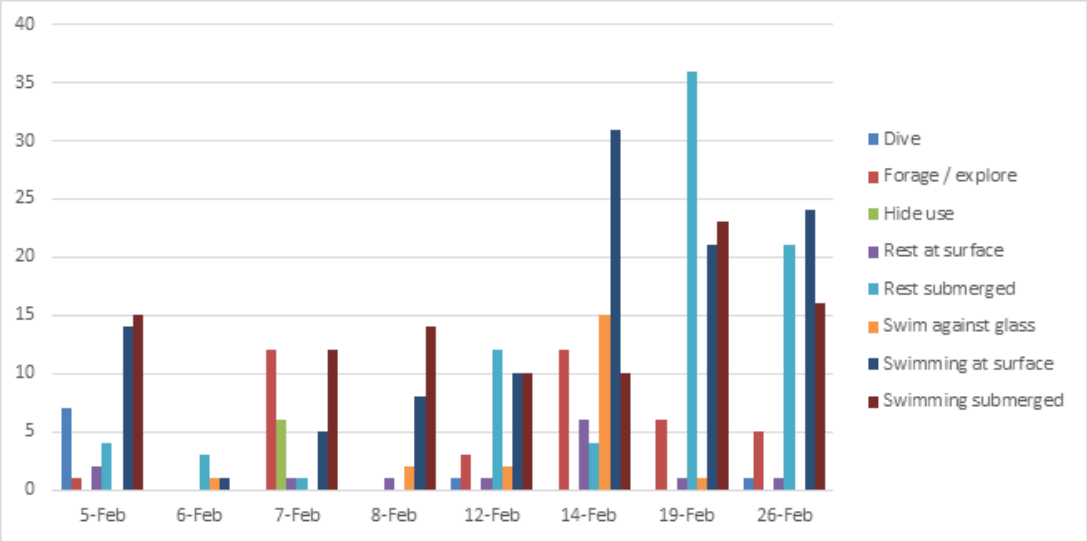

Chart 2 indicates the depth the turtles were at and what type of behavior they were displaying,

Figure 10 Chart 3

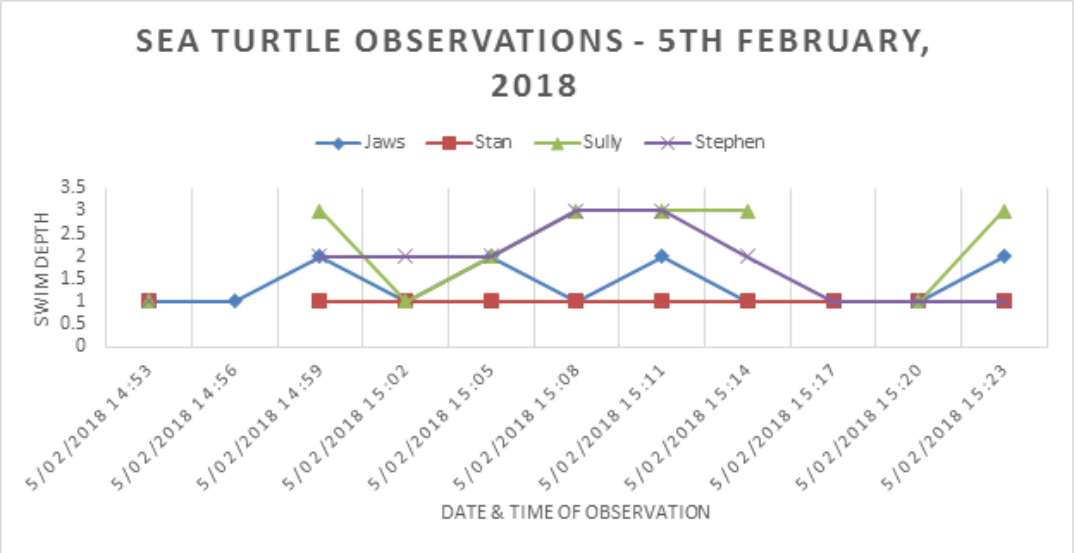

Chart 3 shows observations of depths per day for each turtle. This shows that Sully and Stephen were the mains ones to spend time at depth.

Summary of Observations: It was expected that the two largest turtles Stan and Nulla would spend the most time at depth. However, this was not the case, with the smallest turtle Sully and the second smallest Stephen spending the most time in deep water. Sully has some restriction of movement in her fore flipper due to a healed fracture and large bite wound (section missing) She did not have any difficulty navigating the pool, diving or dealing with the water movement in the pool (wave current is quite strong). Nulla and Stan (the two largest turtles) chose to stay on the steps at a shallower depth. Nulla has most of her left foreflipper missing but coped very well in the deep pool appearing to have no difficulty navigating the pool and diving to the bottom. The turtles were fed in 3 areas of the pool. Another set of observations will be carried out closer the turtles' release date.

Identification prior to Release

Each turtle released from Taronga Wildlife Hospital receives a microchip on the left shoulder (top of neck under carapace edge). They also receive a metal flipper tag on each fore flipper. Satellite tags are attached to turtles prior to release whenever possible.

RELEASE

Turtles released from TWH are placed into the ocean from boats during daylight hours. The release site is determined by the turtle's age class, the time of year and the water temperature. Some turtles require transport to appropriate release sites where turtles of that age would be found at that time of year. Due to the vast movement of juvenile turtles release site choice is an important consideration.

TARONGA WILDLIFE HOSPITAL SATELLITE TRACKING PROGRAM

This research project commenced in 2014 with Kimberly Vinette Herrin and myself as the project collaborators. The aim of the project is to monitor the survival and movement of marine turtles released from TWH after treatment and rehabilitation. This will enable us to gauge the success or otherwise of our treatment and rehabilitation practices and to adjust and improve our techniques and processes over time.

It also aims to track the movement of released turtles and establish migratory and feeding patterns enabling us to identify key habitat requirements which may lead to protection of biologically important feeding and resting sites for these turtles.

Although there has been a significant increase in research into marine turtles over the past decade there are still gaps in our knowledge especially when it comes to juvenile turtle movements. "There is a serious knowledge gap for species such as green turtles (*Chelonia mydas*) (17). Green turtles have geographically diverse foraging grounds and studies suggest that they may use different foraging strategies at different sites (17)." Understanding how green turtles use foraging habitats throughout their range is critical to the population recovery. Increased knowledge of movement patterns and habitat use may be considered a priority for ongoing conservation efforts" (17).

I have included some of the Satellite tracking maps as examples of post release monitoring of marine turtles for survivability and habitat usage. A paper will be written with the satellite tracking findings in due course.

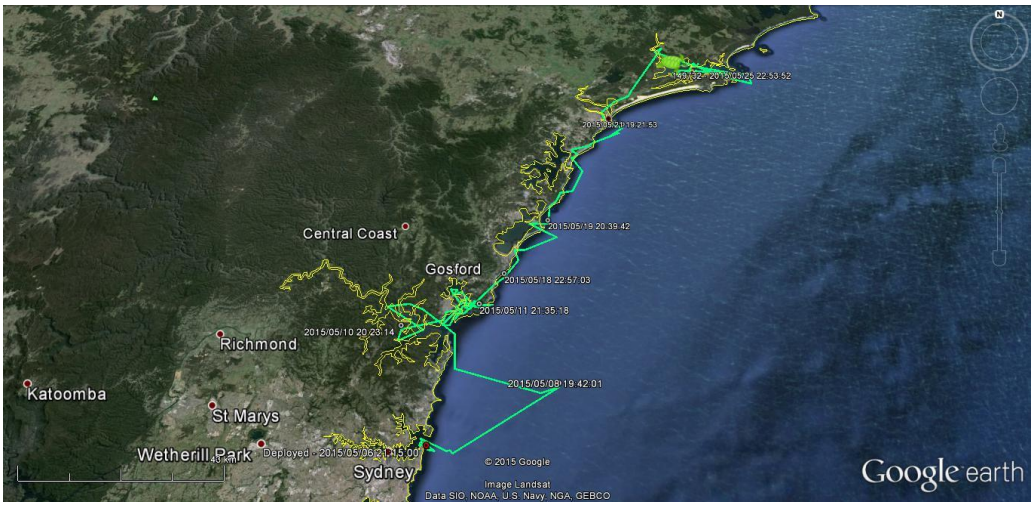

Figure 11. Green turtle satellite tracking map (Shoal Bay plastic ingestion, entanglement and ingestion of hooks – hooks were surgically removed and turtle was defaecating line for 2½ weeks. 8.8 kg – 12.2 kg.) Distance travelled 453.7 km in 9 months.

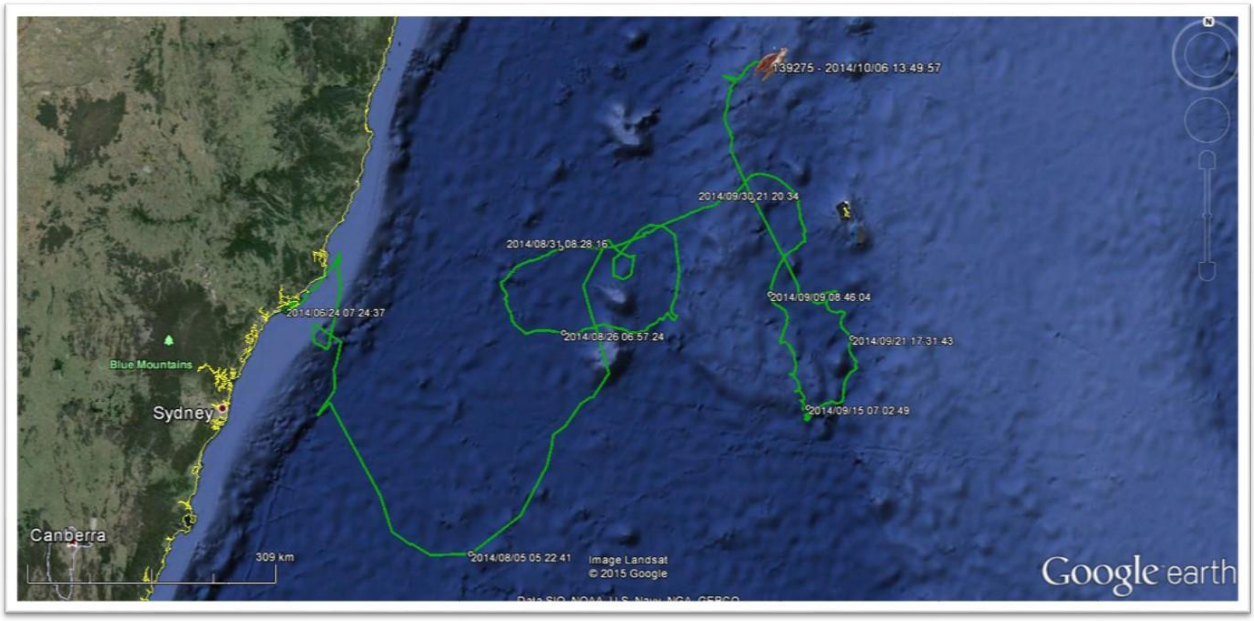

Figure 12. Hawksbill Turtle tracking map Found Kurnell with plastic ingestion. Tracking time 103 days. Distance travelled 3,417 kms.

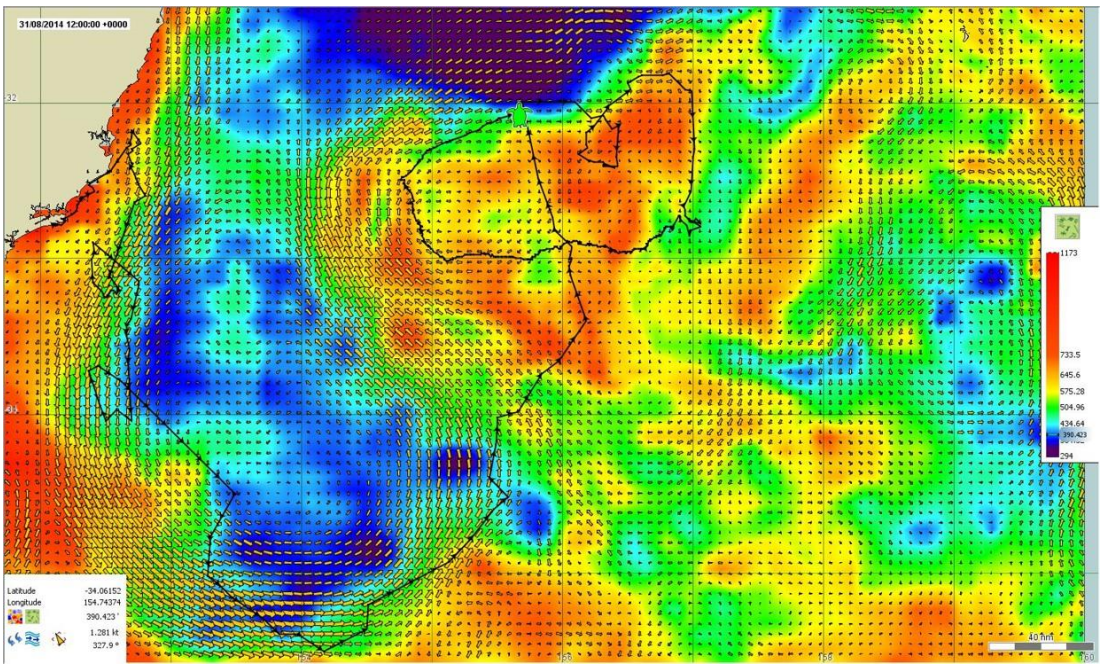

Figure 13. The above map is the tracking map for Hawksbill turtle overlaid onto ocean movement and temperature data. The turtle appears to be feeding on the edges of the cold water up wellings. The turtle uses the ocean currents but also actively swims against the currents to feed..

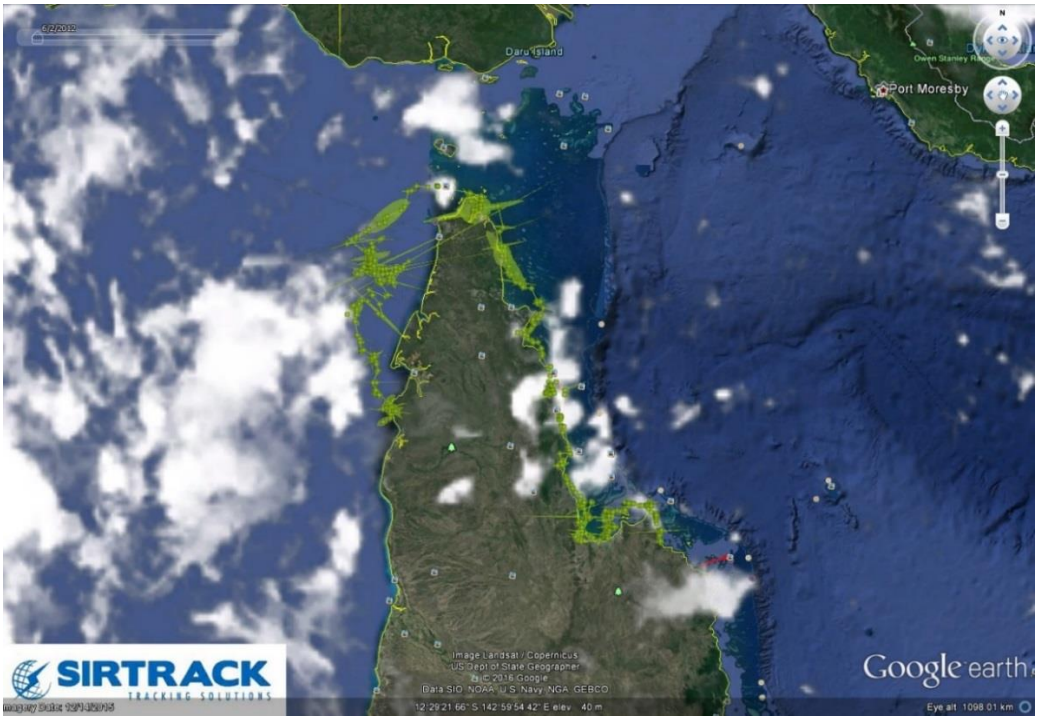

Figure 14. The Olive Ridley turtle in the above map travelled around the northern tip of Australia after being sent to Jennie Gilbert in Cairns for release.

In 2013 Kimberly Vinette Herrin and I tagged 3 Juvenile Loggerhead turtles that were received at Taronga Wildlife Hospital. The tagging was done in conjunction with George Balazs, Pacific Island Fisheries Science Centre, National Oceanic and Atmospheric Administration, Hawaii. These turtles were released from Lord Howe Island because that age class of Loggerhead is found at that location at that time of year. One of the movement maps is included below.

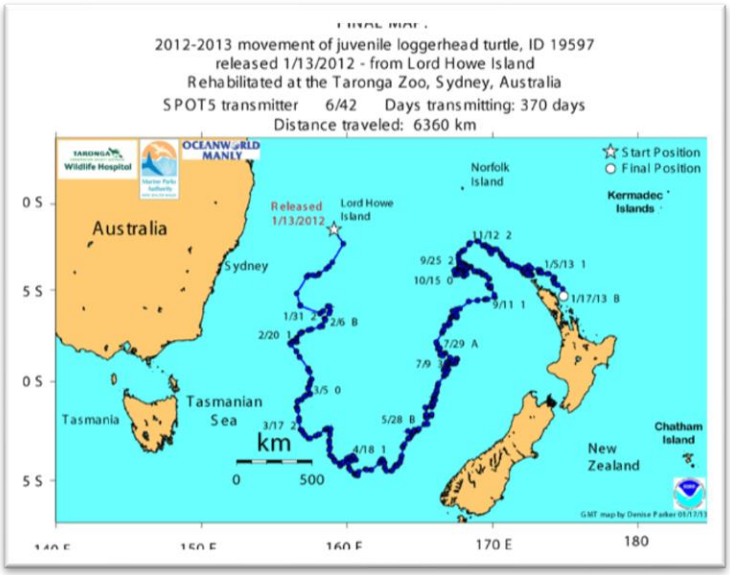

Figure 15. The juvenile loggerhead above travelled 6,2360km in 370 days

At present 11 turtles have been satellite tagged as part of the Taronga Wildlife Hospital Marine Turtle Satellite Tracking project with 7 due to be tagged in 2018. Preliminary findings have shown interesting movements of green turtles and documented that they use habitat in the upper reaches of the Hawkesbury River and coastal areas of Ettalong. 4 Green turtles spent several days in these areas (feeding and resting) before heading north to Port Stephens. Threats to turtles in the Hawkesbury River are boat strike and ingestion of marine debris with a high congestion of boats and holiday makers in the river during the summer months.

The Satellite tracking project findings will be published when additional data is available. The information in this paper is a snap shot of the project to complement the husbandry information and describe the post release monitoring of turtles released from Taronga Wildlife Hospital.

CONCLUSION

Continuing improvements in marine turtle husbandry practices are essential in enabling wildlife rehabilitation programs to make a contribution to the conservation of marine turtles. Education programs can be run in conjunction with marine turtle treatment and rehabilitation to spread the conservation message about the status of these animals. More knowledge of movements and critical habitat preferences of juvenile and sub adult Green turtles in Eastern Australia is required through satellite tracking of released animals.

Marine turtles are listed as species of conservation concern globally. Although they have survived since the dinosaurs and alongside indigenous people for thousands of years in the last 200 years we have contaminated and disturbed their feeding and nesting environments. We are responsible for causing marine turtles to be critically endangered animals. Although scientists and conservation agencies will be required to work collaboratively on a global scale to save marine turtles, individuals and companies can assist by driving change through their choices as consumers. As consumers we have to ability to make powerful silent statements.

The following is a list of actions that can be taken to drive change:

- Avoid purchasing items such as: plastic bottles, food wrapped in plastic, plastic shopping bags, plastic bin liners, small plastic soy sauce containers etc.
- Avoid choosing bio degradable bags as an alternative – these are degradable over time in the soil not the ocean.
- Collect marine debris from beaches, waterways and the ocean
- Work to reduce land based pollution – 80% of marine debris comes from the land
- Reduce impacts of predation on nesting beaches by managing dogs, feral pigs and foxes.
- Buy sustainable fish
- Lobby Governments to invest in climate change solutions
- Lobby Governments not to invest in companies that will destroy turtle habitats
- Lobby governments and councils to remove shark nets
- Vote for political parties and council members that have sound conservation policies
- Donate to conservation programs working in 3rd world countries to address plastic pollution issues
- Invest in (and donate to) research into the monitoring of marine turtles
- Reduce boat speed in areas where there are marine turtles
- Avoid anchoring boats in sea grass beds and corals reefs.
- Dispose of fishing line and hooks responsibly

- Check crab pots regularly
- Report ghost nets
- Avoid 4 wheel driving on turtle nesting beaches
- Ensure developments have low lights that are shaded near nesting beaches
- Ensure that there is no chemical and terrestrial discharge into waterways and the ocean
- Reduce fishery bycatch by selecting appropriate fishing nets
- Work on education programs to increase the communities' knowledge of Marine turtles
- Report, rescue and treat injured turtles

ACKNOWLEDGEMENTS
Staff and volunteers at Taronga Wildlife Hospital – in particular Kimberly Vinette Herrin, Sarah Male and Vanessa Di Giglio.
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I acknowledge the traditional owners of this land, and in particular the saltwater people, for their continuing connection to and respect for the ocean, rivers and country where we now live. I pay my respects to them and their culture and to their elders both past and present.