

**INCREASE THE UNDERSTANDING OF THE GREEN TURTLE POPULATION IN PORT
CURTIS – YEAR 1 (2016) FINAL REPORT
GPC ERMP CONTRACT No. CA14000241**



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DEPARTMENT OF ENVIRONMENT AND HERITAGE PROTECTION



Cover photographs:

Scenes from the population monitoring of green turtles, *Chelonia mydas*, at Port Curtis May - September 2016. Photo Credits: Colin Limpus, Taka Shimada and Nancy FitzSimmons

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POPULATION IN PORT CURTIS – YEAR 1 (2016) FINAL REPORT
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Executive summary

This is the 1st year (2016) of a four year study funded by Gladstone Ports Corporation's (GPC) Ecosystem Research and Monitoring Program (ERMP) to the Queensland Department of Environment and Heritage Protection (EHP) to conduct integrated research and monitoring of foraging green turtles in Port Curtis.

- Turtles were captured at multiple locations within Port Curtis including Pelican Banks, Boyne River Estuary, Facing Island, Quoin Island and Wiggins Island areas.
- A total of 364 captures of green turtles representing 328 individual turtles were made during four field trips to the Port.
- The presence of green turtles foraging in the upper Boyne River Estuary had not been previously recognised.
- Adult female green turtles that had been previously tagged while nesting within the southern Great Barrier Reef (Northwest, Wreck and Lady Musgrave Islands) were captured foraging within the Port.
- Foraging green turtles in Port Curtis presented in the expected size range for green turtles recorded foraging in other coastal bay in Queensland: size range in Port Curtis, CCL = 39-114 cm with adult sized turtles being most abundant at Pelican Banks and Wiggins Island and small immature turtles dominating the catches in the vicinity of mangroves.
- Green turtles recruited from the open ocean dispersal life history phase to residency as benthic foraging turtles within Port Curtis with mean CCL = 44.8 cm.
- The majority of green turtles foraging in Port Curtis are immature turtles of both sexes.
- Adult green turtles had a mean CCL of 95.6 cm for males and 102.2 cm for females.
- The results from the field trip during the main courtship season for green turtles in eastern Australia (October) indicated that Port Curtis is not a significant aggregation area for green turtles at courtship and mating time.
- The green turtles foraging within Port Curtis displayed a very diverse vegetarian diet across the multiple sampling sites, with diet varying seasonally and between localities within the Port.
- Green turtles were recorded foraging on seagrass (*Zostera muelleri* subsp. *capricorni* and *Halophila ovalis*), mangrove (*Avicennia marina* propagules; *Rhizophora stylosa* propagules and apical shoots) and a range of algal species (Chlorophyte: *Ulva polyclada*. Rhodophyte: *Catenella nipae*, *Hyneia* sp. and *Gracillaria* sp.)
- Seventeen turtles had fractured carapaces consistent with having been hit by a moving vessel and all of fractures were consistent with having

been caused by vessels such as are used within the recreational sector of the boating community.

- Five turtles entangled in fishing line or ingested fishing line were captured. Four were rescued and released at their capture sites.
- Thirteen turtles presented with green turtle fibropapilloma disease tumours.
- Twenty nine green turtles presented in poor body condition from widely scattered locations within the Port
- Incidental data was collected on other turtle species (loggerhead and hawksbill turtles), dugong and inshore dolphins.
- With the strong tidal runs experienced during these field studies, it has been identified that tunnel netting will not be a reliable fishing techniques for capturing turtles in the turbid water areas of Port Curtis.

Introduction

This is the 1st year of a four year study funded by Gladstone Ports Corporation's (GPC) Ecosystem Research and Monitoring Program (ERMP) to the Queensland Department of Environment and Heritage Protection (EHP) to conduct integrated research and monitoring of foraging green turtles in Port Curtis. Four planned field trips for 2016 were completed during 3-12 May, 2-11 June, 13-22 September and 6-15 October. The research has been conducted within inter-tidal and sub-tidal waters at six main sites within the Port: Pelican Banks off the southeast corner of Curtis Island, waters surrounding Wiggins Island, Quoin Island and the eastern shore of Facing Island, waters off the Boyne Estuary and the Boyne River adjacent to the Bruce Highway bridge.

Methods

The standard methodology developed for the capture of turtles via turtle rodeo (Limpus, 1978) has been followed during the field trips. Standardised EHP data collection for turtle identification, tagging, measurement of curved carapace length (CCL) and weight and assessment of health status of all turtles has been conducted and gonads were examined to determine sex and breeding status for a selection of turtles following methods described by Limpus *et al.* (1994, 2005).

- All captured turtles were double tagged on their flippers, measured and assessed for external evidence of disease and injuries.
- Each capture was logged for date, latitude and longitude of capture and the capture method.
- The data collected from captured turtles have been added to the growing EHP turtle data base on foraging turtles in Port Curtis.

October is the peak period for green turtles aggregating at traditional courtship areas within the southern GBR region (Limpus, 1993; Limpus *et al.* 2013). The outer Fitzroy River estuary within Port Alma has been identified as a minor courtship aggregation site for green turtles in the past (EHP marine turtle research data base). To assess whether or not green turtles aggregate within Port Curtis for courtship/mating activity, during the 8-14 October study period:

- All observed turtles were scored for foraging and/or courtship behaviour.
- All adult males and females were scored as to whether or not they were in breeding condition for the 2016 courtship period, based on gonad condition and/or body condition (Limpus *et al.*, 2015).

Additional collaborative studies were undertaken to enhance our understanding of the population dynamics of this foraging green turtle population in Port Curtis and to support other contracted studies by GPC ERMP:

Green turtle habitat use study:

This was the 3rd year of a three year study funded by GPC's ERMP to James Cook University (JCU) with EHP as collaborating partners.

- Eleven GPS satellite telemetry tags with depth data loggers were deployed on green turtles for mapping habitat use and behaviour within Port Curtis during the May and October 2016 field trips.
- All captured turtles were examined for previously attached satellite tags, depth data loggers and/or acoustic tags and were assessed for external damage associated with the use of these tags and photographed.
- Data analyses and communication of results from this telemetry study will be led by Dr Mark Hamann and Dr Taka Shimada at JCU.

Dugong satellite telemetry:

This was the 3rd year of the collaborative JCU-EHP dugong satellite telemetry studies, partially funded by GPC to JCU.

- Satellite tags were carried on the catch boats for opportunistic deployment on dugongs should they be encountered in areas suitable for capture.
- No dugongs were captured for attachment of satellite tags during this study period.

Green turtle diet study:

This diet study is conducted as part of PhD studies by Owen Coffee, University of Queensland, with supervision by Dr David Booth and Dr Colin Limpus.

- Food samples were collected opportunistically from the mouths of turtles at capture.
- Gastric lavage samples (Forbes and Limpus, 1993) were collected from a representative sample of turtles of all size classes across the study sites to assess dietary variation within the Port Curtis region.
- Skin tissue and blood samples (Owens and Ruiz, 1980) were also collected from these turtles as well as samples of food species for stable isotope analysis to assess food web dynamics.
- Samples were preserved and taken to UQ for analysis.
- The detailed analyses and reporting of results will be led by PhD student Owen Coffee.

Turtle health studies:

A range of separate studies that will inform on the health of the turtles have been facilitated within the framework of the current GPC ERMP study:

- *UQ School of Veterinary Science studies:* Blood samples were collected for blood chemistry and haematological assessment of green turtle health within Port Curtis. Dr Mark Flint led the gonad examination facets of the study to determine sex, maturity and breeding status of the turtles using laparoscopy.
- *UQ ENTOX studies:* Blood and carapace scute samples were collected for investigating toxicological assays to assess the effects of chemical contaminants in turtles.
 - Additional funding support for these health studies will be provided by the LNG Long Term Turtle Monitoring Program (LTTMP).
 - The analysis of the data and reporting of results from these two studies will be led by staff and post-graduate students at UQ in the School of

Veterinary Science and the National Research Centre for Environmental Toxicology (ENTOX).

- Dr Mark Flint will provide the overarching supervision of these studies.
- *Griffith University (GU) studies*: Tissue samples were collected for research investigating species-specific cell-based toxicological assays to assess the effects of chemical contaminants in marine megafauna and investigate novel techniques for assessing contaminant exposure in these animals.
 - Data analyses and communication of results will be led by Dr Jason van de Merwe and PhD students Kim Finlayson and Stephanie Chaousis at GU.

Barnacle stable isotope studies:

This stable isotope study is within the framework of PhD studies by Ryan Pearson, Griffith University, with supervision by Dr Rod Connelly, Dr Jason van de Merwe and Dr Colin Limpus. The study is exploring the potential for turtle barnacle isotopes to inform on the geographical distribution of habitats in which the turtles live.

- Turtle barnacles and turtle skin samples were collected for research investigating stable isotope ratios with a view to understanding the distribution of turtle foraging areas used by turtles in eastern Australia.
- Data analyses and communication of results will be led by PhD student Ryan Pearson at GU with supervision by Dr Rod Connolly and Dr Jason van de Merwe.

Animal Research Ethics approvals

- All turtle research activities were undertaken in accordance with the standard practices approved under the Department of Agriculture and Fisheries (DAF) Animal Experimentation Ethics Committee (AEC):
Queensland Turtle Conservation Project Queensland Turtle Conservation Project SA 2015-11-524, 525, 526, 528, 529, 531.
- Dugong telemetry will be conducted under JCU AEC Permit: **A2071**

JCU, GU and UQ research teams have their own University AEC approvals for aspects of the work not addressed under EHP approvals.

Water temperature recording:

A Vemco Minilog II temperature data logger was deployed on 19 September 2016 in the southern drainage channel on the Pelican Banks (23° 46.520'S, 151° 18.125'E) in Port Curtis to record water temperature at ~20 cm above the benthos and programmed to record at 30 min intervals. At this setting, this data logger can record data continuously across 10 years.

- The data logger was attached to a steel ring in a concrete block with a 1 m tether to a small float labelled "EHP 0427 002 633".
- It was set to commence readings at 18:00 hr, 19 September 2016. Recording at this depth will log the water temperatures to which foraging green turtles are exposed while feeding on seagrass.

Water conditions within Port Curtis

Water turbidity varied widely across the spatial scale of the Port and temporally in response to the twice daily tidal cycle, the changing tidal range across the lunar cycle, wind speed and direction and runoff from recent rains.

The lowest turbidity water was found on the Pelican Banks and at the mouth of the Boyne River, especially with an incoming tide. Capture of turtles by the turtle rodeo method is restricted to the shallower waters where it is possible to see the bottom and hence see foraging turtles at the bottom. Sites for attempted capture of turtles are selected on a daily basis with respect to the tidal cycle for the day and wind direction and speed.

No sites have yet been found within the Western Basin and The Narrows where the water was clear enough to capture turtles by the turtle rodeo method.

It had been anticipated that turtles could be captured by tunnel-netting within the turbid waters of the Western Basin and The Narrows. This netting technique involves placing large lengths of net at a fixed location for the duration of the falling tide to capture turtles as they move off the inter-tidal flats. However it has been found that because of the high velocity tidal currents within the Western Basin area, it will not be practicable or cost effective for capturing turtles by this method in this area.

Discussions with local fishers have established that it will be possible to capture turtles within the Western Basin and The Narrows by other standard netting methods used by commercial fishers. EHP has commenced procedures for obtaining a DAF Fisheries Permit to use a range of commercial netting techniques within Port Curtis.

Results

Over the four field trips there were a total of 364 captures of green turtles representing 328 individual turtles (Table 1). Of these, 17 turtles were recaptured on one or more occasions within 2016. Most turtles were captured on the Pelican Banks (n = 162, 49.4%), followed by Boyne River Estuary (n = 53, 16.2%) and Facing Island (n = 51, 15.5%). Capture locations covered a broad area within each sampling site (Figure 1a). Locations of observed, but not caught green turtles, included areas where the turbidity and/or depth of the water precluded the capture of turtles (Figure 1b).

Figure 2 provides a photographic illustration of the range study methods that were employed within this study.

Movements: Five turtles were recorded making significant spatial shifts between recapture events:

Recaptures of three adult female green turtle provided new information regarding breeding migrations by turtles that forage within Port Curtis:
T70052: adult female green turtle, CCL = 101.4 cm.

- She has a 23 year history within the Queensland Turtle Conservation data base, having been previously recorded nesting at Lady Musgrave Island during three breeding seasons: 1993-1994, 2002-2003 (10 yr remigration interval), 2013-2014 (11 yr remigration interval).
- She has now been recaptured foraging on the Pelican Banks during May and September 2016.
- Visual examination of her gonads using laparoscopy revealed that she had not bred in the last two breeding seasons and was not preparing to breed in this coming 2016 breeding season.

T70804: adult female green turtle, CCL = 108.7 cm.

- She has a 24 year history within the Queensland Turtle Conservation data base, having been previously recorded nesting at Wreck Island during the 1992-1993 breeding season.
- She has now been recaptured foraging on the Pelican Banks during October 2016.
- Visual examination of her gonads using laparoscopy revealed that she had not bred in the last two breeding seasons and was not preparing to breed in this coming 2016 breeding season.

T88971: adult female green turtle, CCL = 98.6 cm.

- She has a 21 year history within the Queensland Turtle Conservation data base, having been previously recorded nesting at North West Island during the 1995-1996 breeding season.
- She has now been recaptured foraging on the Pelican Banks during October 2016.
- Visual examination of her gonads using laparoscopy revealed that she had not bred in the last two breeding seasons and was not preparing to breed in this coming 2016 breeding season.

One immature green turtle was recorded making a significant shift in its foraging area within Port Curtis:

QA45574: pre-pubescent, immature green turtle, CCL = 44.9 cm.

- It was originally tagged foraging on Pelican Banks on 15 May 2014.
- It was recaptured at the mouth of the Boyne River on 5 May 2016, a change in foraging area across ~19 km.

One immature male green turtle displayed strong fidelity to a localised foraging area after having been removed from the Port waters for ~2 weeks:

QA27988: pre-pubescent, immature male green turtle, CCL = 40.8 cm.

- It was originally captured as a basking turtle on the inter-tidal flats at the mouth of the Boyne River on 7 April 2016.
- It was mistakenly assumed to be a debilitated turtle and transferred to the Quoin Island Turtle Rehabilitation Centre (QITRC) for care for 16 days. It was released from QITRC at the adjacent beach on 23 April 2016 and ~19 km from its home foraging area.
- It was recaptured while foraging over the inter-tidal flats at the mouth of the Boyne River on 13 October 2016.

Past telemetry: Two immature green turtles were recaptured that had been captured while foraging on the Pelican Banks and deployed with satellite tags within the GPC ERMP funded study in 2015. They were recaptured while foraging on the Pelican Banks in October 2016. Both turtles had shed their satellite tags via shedding of the outer layers of the carapace scales, leaving no visible evidence of the tags having been attached:

QA58239: pre-pubescent, immature male,

- CCL = 77.8 cm when deployed with the satellite tag (149086) on 16 July 2015.
- CCL = 78.7 cm when recaptured on 9 October 2016.

QA58295: pre-pubescent, immature female,

- CCL = 83.8 cm when deployed with the satellite tag (149089) on 11 July 2015.
- CCL = 83.6 cm when recaptured on 8 October 2016.

Size: As is a characteristic of all green turtle foraging areas in Queensland, green turtles with a CCL < 40 cm were rarely captured within Port Curtis (Figure 3). Considerable variation in the size distribution of turtles was observed across the sites. Pelican Banks and the waters around Wiggins Island had the broadest distribution of turtles ranging in size from small immatures to large adults, CCL = 39-114 cm (Figures 3a, 3d). Only immature turtles were caught around Facing and Quoin islands (Figures 3b, 3c) and mostly immature turtles were caught off the Boyne Estuary and upstream in the Boyne River (Figure 3e).

Green turtles recruited from the open ocean dispersal life history phase to residency as benthic foraging turtles within Port Curtis with mean CCL = 44.8 cm (Table 2). Adult green turtles had a mean CCL of 95.6 cm for males and 102.2 cm for females (Table 2). These sizes lie within the size range for the respective life history phases recorded at other foraging areas for green turtles within the southern GBR region (Limpus *et al.*, 2013).

Sex and maturity: Sex and maturity was determined by gonad examination and/or morphology and body condition for 195 of the turtles captured within Port Curtis during 2016: 95 males, 99 females and 1 asexual turtle with no detectible gonads. These results are within the range recorded with other green turtle foraging populations in the southern GBR region within recent decades (reviewed by Limpus, 2007, Limpus *et al.*, 2013). The majority of the green turtle foraging population in Port Curtis consists of immature turtles of both sexes (Figure 4).

Courtship: During the 7-14 October study period within Port Curtis, 127 green turtles were captured and an additional 137 sightings were made of green turtles that were not captured. None of these 264 observations of green turtles involved turtles engaged in courtship/mating behaviour. None of the adult green turtles captured (n = 25) were in breeding condition for the 2016-2017 breeding season:

- None of the 11 adult males were in a sperm production/sperm storage phase of a reproductive cycle as would occur if they were males that had aggregated for courtship.
- None of the 14 adult females were fat and none carried mature (fully yolked) ovarian follicles as would occur if they were females that had aggregated for courtship on route to their nesting beaches and none of them had fresh courtship injuries on their anterior carapace.

The breeding status of these adult green turtles during 7-14 October in Port Curtis was consistent with:

- Non-breeding adult green turtles for the year had remained within their home foraging area in Port Curtis.

- Adult green turtles preparing for the 2016-2017 breeding season had already migrated to breeding locations outside of Port Curtis.

On 16 October 2017, after the completion of the October field studies, a mounted pair of green turtles was photographed while basking on the Pelican Banks by visitors flying low over the Banks (Figure 5). This is the first record in the Queensland Turtle Conservation Data Base of mating green turtles within Port Curtis.

Collectively these data indicate that Port Curtis will not be a significant area for aggregation of breeding green turtles for courtship and mating.

Diet: The green turtles foraging within Port Curtis displayed a very diverse vegetarian diet across the multiple sampling sites (Figure 6).

Pelican Banks: Preliminary analysis indicated a predominance of seagrass *Zostera muelleri* subsp. *capricorni* and *Halophila ovalis* with mangrove *Avicennia marina* propagules when this mangrove was fruiting as well as *Rhizophora stylosa* propagules and apical shoots.

Wiggins Island: Diet samples have been exclusively the filamentous chlorophyte *Ulva polyclada* in sampled individuals.

Facing Island/Quoin Island: Preliminary analysis showed a predominance of the Rhodophyte, *Catenella nipae*, which grows on the submerged roots of mangroves *A. marina* and *R. stylosa* and on the rocky reef substrate. *Avicennia marina* propagules featured in the diet when this mangrove's fruit was available.

Boyne Estuary: Dietary samples were composed primarily of Rhodophyta species *Hynea* sp. and *Gracillaria* sp. as well as seagrass *H. ovalis*.

Boyne River: Preliminary analysis showed a predominance of a yet to be identified filamentous Rhodophyte.

Turtle health: Table 3 summarises the frequency of green turtles presenting with direct and indirect evidence of anthropogenic impacts:

- Seventeen turtles had fractured carapaces consistent with having been hit by a moving vessel, including propeller cuts. The majority of these turtles with vessel related injuries were captured on the Pelican Banks. All of the fractures were consistent with having been caused by vessels such as used within the recreational sector of the boating community.
- Five turtles were entangled in fishing line, had a fish hook imbedded in the skin or had ingested fishing line protruding from the mouth. Four of the five turtles compromised by fishing line were captured at the Boyne River study sites.

QA65076: prepubescent immature.

This turtle was captured in the Boyne River at the Highway bridge site with fishing line tightly constricting the left front flipper and cutting off blood circulation with resulting death of tissues in that flipper (Figure 7a). In addition, the turtle had also swallowed the loose end of this fishing line. The turtle was passed to the Gladstone Area Water Board for assessment and possible rehabilitation. Their veterinarian amputated the left flipper in

an attempt to rescue the turtle but it subsequently died in care. A necropsy revealed that the turtle had swallowed ~4 m of fishing line that had caused significant damage to the digestive tract.

- Thirteen turtles presented with green turtle fibropapilloma disease tumours. This disease is linked to a herpes virus infection. Typically turtles are more likely to present with these tumours when they occupy habitats within semi-enclosed coastal waters with an altered catchment. The majority of turtles presenting with these tumours were captured within the Boyne River study sites.

Twenty nine green turtles presented in poor body condition from widely scattered locations within the Port, with four of these turtles being rated as in very poor body condition.

Small numbers of turtles presenting with significant health problems were encountered during each study trip to Port Curtis:

QA64928: prepubescent immature turtle, CCL = 78.1 cm

This immature green turtle showed no external signs of health problems when captured on 5 May 2016. During transportation back to the QPWS workshop at the Marina for weighing and further examination, it ceased breathing and became comatose. This turtle was successfully resuscitated using our standard artificial ventilation method (Figure 7b). It was held overnight for observation and swam off vigorously when released on 6 May 2016. No explanation can be offered as to why this turtle ceased breathing while on board the vessel.

Other Marine Megafauna in Port Curtis

Loggerhead turtles: Three loggerhead turtles were recorded.

- **9 May 2016:** An immature pubescent female (**QA49722**), CCL = 82.0 cm, that had been severely injured by a boat strike was captured on the western side of Facing island (Figure 7c). This turtle, which was in very poor body condition was determined to be unrecoverable and was euthanased by a local veterinarian. This turtle had been feeding on bivalve molluscs. Blood and tissue samples were taken for toxicology and health assessments.
- **11 May 2016:** An immature prepubescent loggerhead turtle (**QA27841**), CCL = 64.7 cm, was captured when floating in weak condition off Tannum Sands by a member of the Public. It was taken into the Gladstone Area Water Board turtle rehabilitation facility. This turtle had recently recruited to residency in Port Curtis from its open ocean pelagic foraging life history phase. The faeces samples collected during successful rehabilitation indicated that it had been feeding on benthic bivalves since arriving in Port Curtis.
- **3 June 2016:** An adult sized loggerhead turtle was observed, but not captured, off the south western corner of Quoin Island,

Hawksbill turtle, *Eretmochelys imbricata*:

A search of rocky reefs bordering the Pelican Banks, Quoin Island and Facing Island during turtle rodeo capturing of green turtles failed to find hawksbill turtles foraging within this habitat type. However, an immature hawksbill turtle

was recorded recruiting to residency in Port Curtis from its former oceanic dispersal life-history phase as the current contract was being negotiated.

- **18 July 2014:** Release from captive rearing (head-starting) of a post-hatchling hawksbill turtle (CCL = 27.4 cm) that had been captive reared at the Tranquility Island Resort, Moso Island, Vanuatu; **Tags:** R109527, R109538.
- **24 July 2015:** caught by fishing line by a recreational fisher off Gatcombe Head, Facing Island, CCL = 40.3 cm; transferred to Quoin Island Turtle Rehabilitation Centre for hook removal and rehabilitation.
- **28 October 2015:** Released from Quoin Island; rear flipper tag applied: QA27980.

Marine mammals: Opportunistic observations were made of dugong and dolphins in Port Curtis.

- All dugong were observed on the Pelican Banks (Figure 1c).
- Australian humpback dolphins were observed in the vicinity of several sampling sites, with multiple observations during each study trip in Auckland Creek and near Quoin Island (Figure 1d)

Water Temperature

The data logger set in September 2016 was found to have been placed where the data logger was exposed to air temperatures at spring low tides when data was down loaded on 11 October 2016. It was relocated further down the drainage line to avoid exposure at low tides. The placement of this data logger will be adjusted on subsequent sampling trips until it does not expose on the lowest of low tides. Figure 8 illustrates the daily temperature range that turtles were exposed to as they foraged on the Pelican Banks.

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The Department of National Parks, Sport and Racing has supported this project by provision of work space with the Marine Parks Workshop at the Marina for the duration of each study trip. Dr Megan Ellis and Gladstone Ports Corporation have provided storage facilities for equipment between study trips.

Numerous University staff and students and EHP Queensland Turtle Conservation Volunteers assisted with the capture and processing of the turtles: Hector Garrido, James Limpus, Hannah Marshall, Jason van de Merwe, Rachel Miller, Ryan Pearson, John Sergeev and Laura Wenk.

Gidarjil Land and Sea Rangers, in particular Des Purcell, Ron Bulan and Brendon Ross assisted with capture and processing of turtles during each study trip and in a training capacity for improving their skills and capacity for monitoring marine turtle populations.

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References

- Forbes, G. A. and Limpus, C. J. (1993). A non-lethal method for retrieving stomach contents from sea turtles. *Wildlife Research* **20**, 339-343.
- Limpus, C. J. (1978). The Reef. In "Exploration North." Ed. Lavery, H. pp. 187-222. (Richmond Hill Press: Melbourne).
- Limpus, C. J. (1993). The green turtle, *Chelonia mydas*, in Queensland: breeding males in the southern Great Barrier Reef. *Wildlife Research* **20**, 513-23.
- Limpus, C. J. (2007). A biological review of Australian marine turtles. 2. Green turtle *Chelonia mydas* (Linneaus). (Queensland Environmental Protection Agency: Brisbane.)
- Limpus, C. J., Couper, P. J., and Read, M. A. (1994). The green turtle, *Chelonia mydas*, in Queensland: population structure in a warm temperate feeding area. *Memoirs of the Queensland Museum* **35**, 139-154.
- Limpus, C. J., Limpus, D. J., Arthur, K. E., and Parmenter, C. J. (2005). Monitoring green turtle population dynamics in Shoalwater Bay: 2000-2004. *GBRMPA Research Publication* **83**, 1-51.
- Limpus, C. J., Parmenter, C. J., and Chaloupka, M. (2013). Monitoring of Coastal Sea Turtles: Gap Analysis. 2. Green turtles, *Chelonia mydas*, in the Port Curtis and Port Alma region. Brisbane: Department of Environment and Heritage Protection. Report produced for the Ecosystem Research and Monitoring Program Advisory Panel as part of Gladstone Ports Corporation's Ecosystem Research and Monitoring Program. 40 pp.
- Owens, D. W. and Ruiz, G. J. (1980). New methods for obtaining blood and cerebrospinal fluid from marine turtles. *Herpetologica* **36**, 17-20.

Table 1. Summary of green turtles (*Chelonia mydas*) captured by tagging history and study areas in Port Curtis and adjacent waterways for 2016.

| Month | Pelican Banks | | | Quoin Island | | | Facing Island | | | Western Basin | | | Boyne Estuary | | | Boyne River Benaraby | | | TOTAL |
|--------------|---------------|---|--|--------------|---|--|---------------|---|--|---------------|---|--|---------------|---|--|----------------------|---|--|-----------------|
| | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | New tagging | Recapture from Port Curtis, (within year recapture) | Migration recapture from a breeding area | |
| May | 17 | - | - | 3 | - | - | 17 | - | - | 8 | 1 | - | 20 | 2 (1) | - | 8 | - | - | 76 (1) |
| June | 52 | 4 (1) | 1 | 10 | - (1) | - | 28 | - (3) | - | 5 | - | - | 6 | - | - | 1 | - (3) | - | 107 (8) |
| September | 22 | 2 (4) | - | - | - | - | 4 | - | - | - | - | - | 7 | - (1) | - | 2 | - (3) | - | 37 (8) |
| October | 71 | 8 (15) | 2 | 1 | | | 2 | - | - | - | - | - | 20 | 2 (4) | - | 2 | - | - | 108 (19) |
| TOTAL | 162 | 14 (20) | 3 | 14 | - (1) | - | 51 | - (3) | - | 13 | 1 | - | 53 | 4 (6) | - | 13 | - (6) | - | 328 (36) |

Table 2. Size of green turtles (*Chelonia mydas*) at identifiable key developmental phases of their life history within Port Curtis recorded during 2016.

| Life history phase | Curved carapace length (cm) | | | |
|--|-----------------------------|--------------------|------------|-------------|
| | Mean | Standard deviation | Range | Sample size |
| Immature turtles that have recently recruited to residency within Port Curtis from oceanic pelagic dispersal | 44.80 | 6.122 | 40.3-59.3 | 8 |
| Breeding adults | | | | |
| • Males | 95.62 | 4.846 | 85.9-105.3 | 27 |
| • Females | 102.24 | 4.777 | 96.0-114.6 | 25 |

Table 3. Summary of green turtles (*Chelonia mydas*) recorded with evidence of health problems when captured within Port Curtis and adjacent waterways for 2016.

| | Pelican Banks | Quoin Island | Facing Island | Western Basin | Boyne Estuary | Boyne River Benaraby | TOTAL |
|--|---------------|--------------|---------------|---------------|---------------|-------------------------|-------|
| Direct anthropogenic impacts | | | | | | | |
| Fractures to carapace | 14 | | 1 | 2 | | | 17 |
| Entangled or ingested fishing line or hooks | | | | 1 | 2 | 2 | 5 |
| Indirect anthropogenic impacts | | | | | | | |
| Green turtle fibropapilloma tumours | | | | 1 | 8 | 4 | 13 |
| Turtles in reduced body condition | | | | | | | |
| Poor body condition | 7 | 5 | 6 | | 7 | | 25 |
| Very poor body condition | | 1 | 2 | 1 | | | 4 |



1a. Locations where green turtles were captured.



1b. Locations where green turtles were observed but not captured.



1c. Locations where humpback dolphins were observed.



1d. Locations where dugong were observed.

Figure 1. Locations of captured green turtles (a), and observed green turtles (b), Dugong (c) and Australian humpback dolphins (d).



2a. Titanium flipper tag.



2b. Weighing an adult green turtle.



2c. Releasing a turtle with a satellite tag.



2d. Laparoscopy by a registered veterinarian.



2e. Blood sampling.

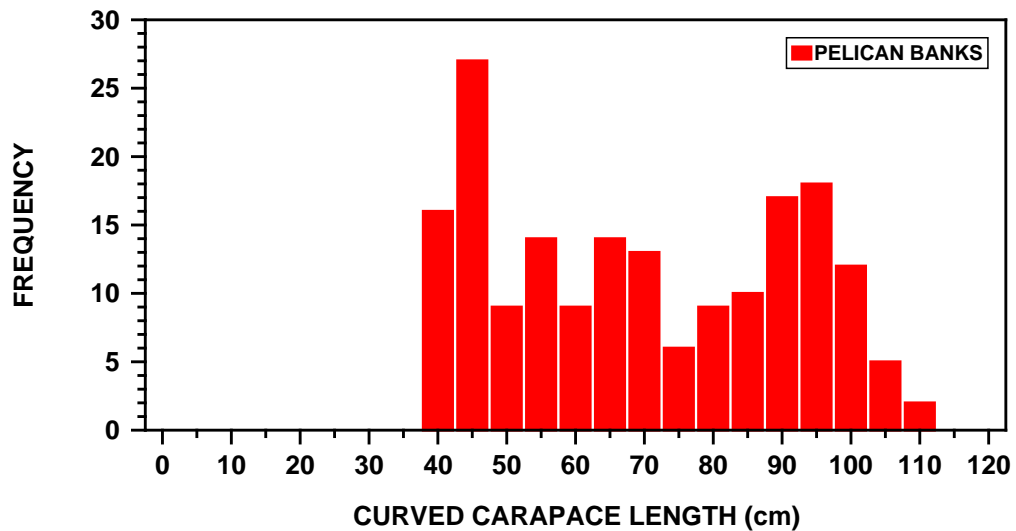


2f. Releasing turtle at Spinnaker Park, witnessed by the public.

Figure 2. Research activities with foraging green turtles (*Chelonia mydas*) in Port Curtis.

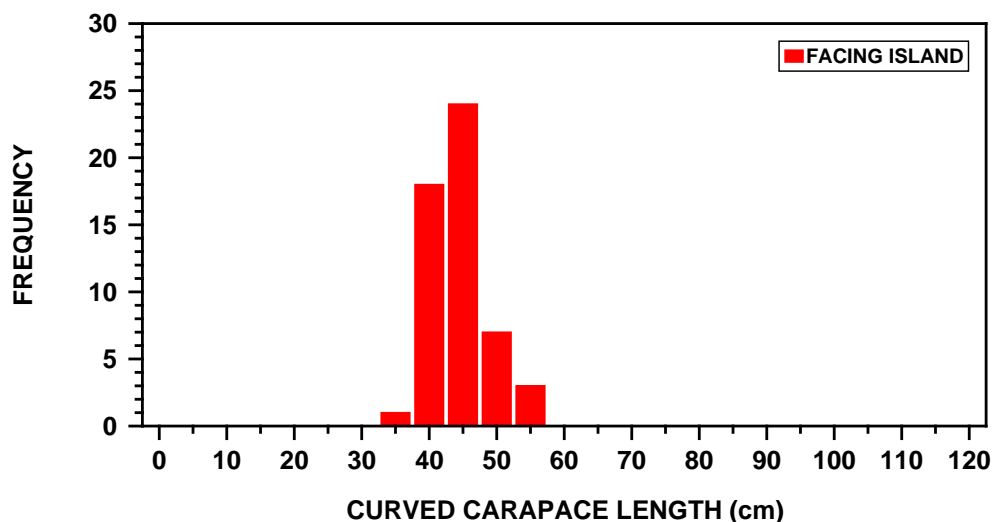
Figure 3. Size distribution of green turtles (*Chelonia mydas*) captured in Port Curtis during the May, June, September and October field trips.

TURTLE SIZE STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*



3a. Green turtles captured on Pelican Banks in the north eastern area of Port Curtis, encompassing seagrass-algal meadows, rocky reefs and mangrove forest fringe.

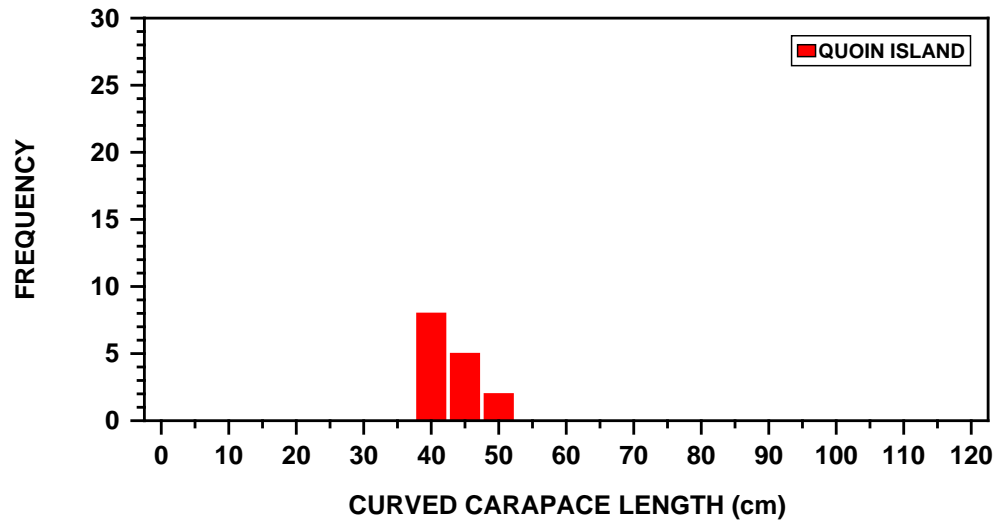
TURTLE SIZE STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*



3b. Green turtles captured along the mangrove fringe on the western side of Facing Island, including some rocky reef.

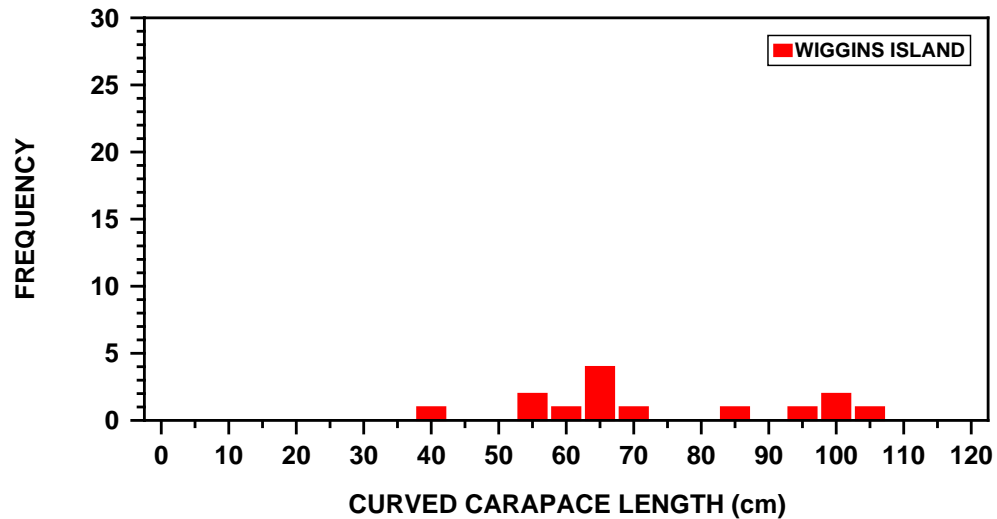
Figure 3. Continued.

TURTLE SIZE STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*



3c. Green turtles captured along rocky reefs and mangrove fringe surrounding Quoin Island.

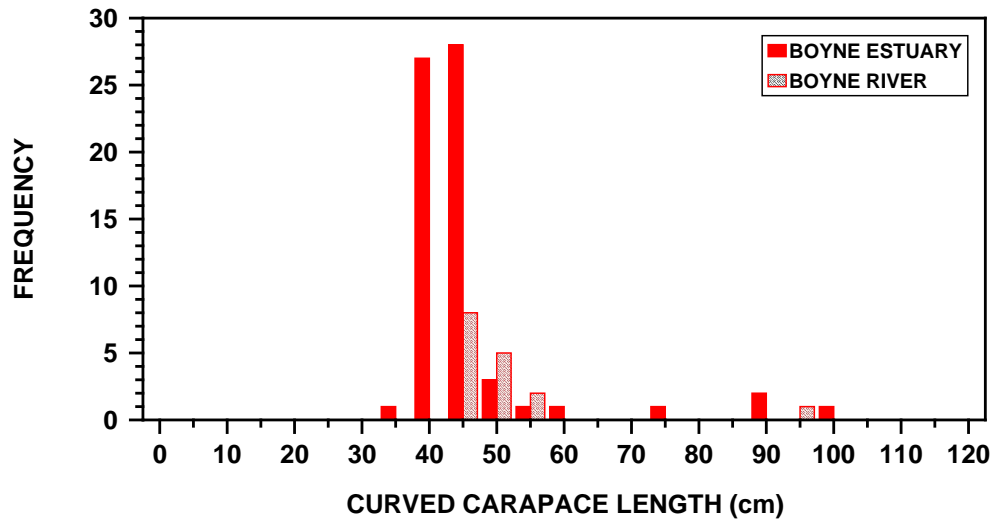
TURTLE SIZE STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*



3d. Green turtles captured in intertidal seagrass-algal meadows at Wiggins Island and bordering the Calliope River estuary.

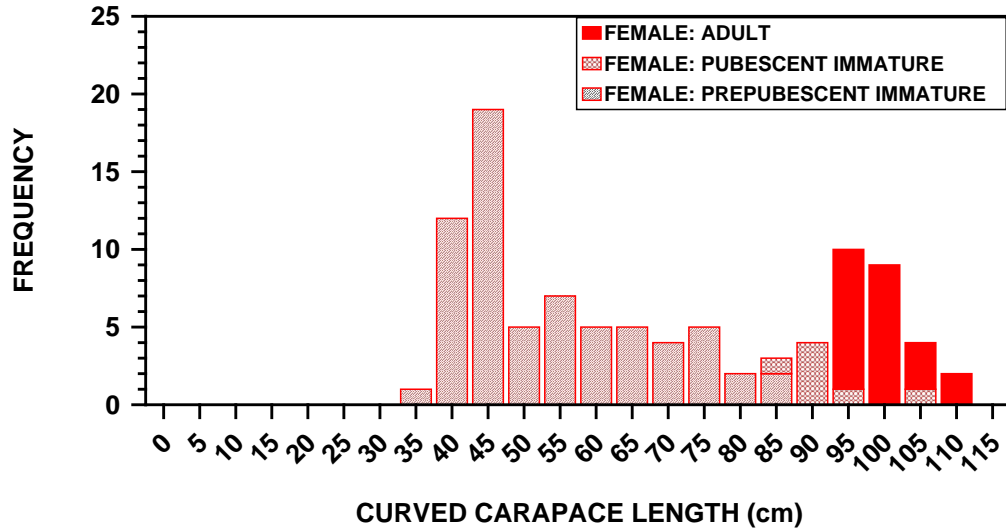
Figure 3. Continued.

TURTLE SIZE STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*



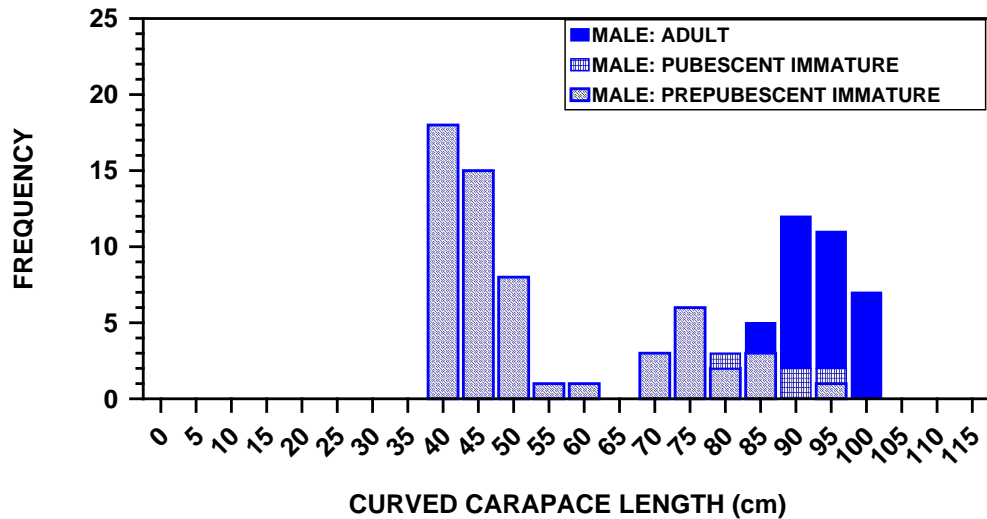
3e. Green turtles captured in intertidal seagrass-algal meadows at the mouth of the Boyne River and algal turfs on the rocky riffle zone in the Boyne River at the highway bridge.

**TURTLE POPULATION STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*, BY SEX & MATURITY**



4a. Females.

**TURTLE POPULATION STRUCTURE: MAY-OCTOBER 2016
PORT CURTIS : *Chelonia mydas*, BY SEX & MATURITY**



4b. Males.

Figure 4. Size distribution by sex and maturity of green turtles (*Chelonia mydas*) captured in Port Curtis during the May, June, September and October 2016 field trips.



Figure 5. Mounted pair of green turtles, *Chelonia mydas*, basking at low tide on the Pelican Banks, 16 October 2016. Photograph by David Slatter and Scott Hails.



6a. Mangroves at high tide.



6b. The Boyne River sampling site.



6c. Dense *Ulva polyclada* on the Wiggins Island intertidal flats.



6d. Seagrass, *Zostera muelleri* subsp. *capricorni* and algae, *Ulva polyclada*, with molluscs on the Pelican Banks.

Figure 6. Green turtle (*Chelonia mydas*) foraging habitat in Port Curtis.



7a. Green turtle (QA65076) captured on 7 October 2016 that had fishing line tightly entangled on the left front flipper resulting in a gangrenous flipper while the other end of the fishing line had been ingested.



7b. Taka Shimada successfully resuscitating a green turtle (QA64928) which stopped breathing for no apparent reason following its capture on 5 May 2016



7c. Loggerhead turtle (QA49722) captured on 10 May 2016 that had been injured by boat strike.

Figure 7. Turtles with severe health problems.



Figure 8. Water temperatures measured 20 cm above the seagrass benthos adjacent to the low tide mark in the southern drainage channel on the Pelican Banks, 19 September – 11 October 2016. Readings from the days when the data logger was exposed to air temperatures at low tide have been blocked out.