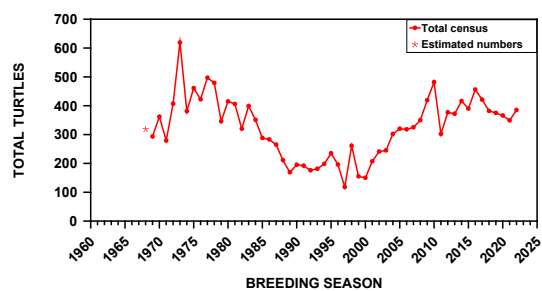


# QUEENSLAND TURTLE CONSERVATION PROJECT: DATA REPORT FOR MARINE TURTLE BREEDING ON THE WOONGARRA COAST, 2022-2023 BREEDING SEASON



*Caretta caretta* : WOONGARRA COAST  
TOTAL ANNUAL NESTING POPULATION (TAGGING CENSUS)



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**Cover photo:**

Images of Mon Repos Beach and the monitoring team at work and illustration of some the data collected.

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## EXECUTIVE SUMMARY

During the 2022-2023 turtle breeding season, 385 Loggerhead turtles, 10 Flatback turtles and 1 Green turtle were recorded ashore for breeding on the Woongarra Coast beaches.

The long term histories of individual Loggerhead turtles displayed a strong trend towards the females being larger in carapace length, returning at shorter remigration intervals, laying more clutches of eggs per season and laying more eggs per clutch in response to an increase in the number of recorded breeding seasons.

A record number of doomed clutches of eggs (897) were relocated to more elevated incubation sites to minimise clutch loss to erosion and flooding, or to dark beaches to minimise the risk of hatchlings disoriented towards coastal lighting.

These relocated clutches were equivalent to rescuing  $64.0 \pm 2.5\%$  of the seasonal marine turtle egg production on the Woongarra Coast for the 2022-2023 breeding season.

### **Concern is expressed regarding trends in the Loggerhead nesting population:**

- Reduction in the size of the annual nesting population since 2016.
- The increase in annual recruitment rate of young females into the 2022-2023 breeding population warrants further investigation in the foraging areas to assess its significance.

### **Abnormal nesting behaviour that could be the result of excessive sky glow impact on the nesting turtles is of concern and warrants investigation:**

- Nesting success was at a satisfactory level (>60%) at all beaches except for Loggerhead turtles at Oaks Beach.
- Loggerhead and Flatback turtles visiting Mon Repos Beach (naturally dark) displayed a very high fidelity to visiting only that beach throughout the season in contrast with turtles that displayed extremely low fidelity to nesting at only a single nesting beach when they came ashore for nesting at Oaks, Nielson Park, Bargara, Kellys and Archies Beaches (beaches directly illuminated by urban lighting and skyglow).

As a result of changes in staffing and logistics for the conduct of the monitoring and research studies on the Woongarra Coast for the 2022-2023 summer, the collation of incubation success and environmental monitoring data are not available for analysis at this time. These aspects of the annual monitoring program will be reported at a later date.

# QUEENSLAND TURTLE CONSERVATION PROJECT: DATA REPORT FOR MARINE TURTLE BREEDING ON THE WOONGARRA COAST, 2022-2023 BREEDING SEASON

## 1. INTRODUCTION

The Woongarra Coast is a primary index site for monitoring and researching the Loggerhead turtle, *Caretta caretta*, within the southwest Pacific genetic stock and a secondary index site for nesting Flatback turtles, *Natator depressus* within the eAust genetic stock (Department of Environment and Science, 2021). Systematic monitoring of these turtles commenced in 1968.

The Loggerhead turtle is listed as *endangered* under both Queensland and Commonwealth conservation legislations while the Flatback turtle is listed as *vulnerable*. While the studies commenced with an emphasis on defining the biology of the Flatback turtle (Bustard and Limpus, 1969), Loggerhead turtles dominate the current conservation considerations for marine turtles on the Woongarra Coast.

Loggerhead turtle breeding within the South Pacific Ocean forms an independent genetic stock that does not interbreed with other Loggerhead turtles elsewhere within the Pacific or Indian Oceans (FitzSimmons and Limpus, 2014. [Figure 1](#)). Loggerhead turtle breeding within the South Pacific Ocean is restricted to eastern Australia and New Caledonia, with the majority of the nesting occurring in eastern Australia.

The Woongarra Coast is one of five significant concentrations of Loggerhead turtle breeding in eastern Australia ([Figure 2](#)) and currently supports approximately 50% of annual Loggerhead turtle breeding in eastern Australia (Limpus *et al.* 2013).

The functioning of the Loggerhead turtle nesting in eastern Australia needs to be understood within the context of the complex life history that takes this population into diverse habitats throughout the South Pacific region and the associated diversity of threats to which it is exposed ([Figure 3](#)). While breeding success at the nesting beaches contributes to the functioning of the next generation that will return to breed in about 30 years' time, the next generation has to survive well as:

- Small post-hatchlings travelling along the East Australian Current (with exposure to ingestion of floating plastic debris) down the eastern Australian coast and eastward past New Zealand at about six months of age and out into the wider South Pacific Ocean.
- Larger post hatchlings foraging in the plankton rich waters of the eastern Pacific Ocean off Chile and Peru (with exposure to fisheries bycatch in longline and gill net fisheries).
- Large post-hatchlings returning back across the South Pacific (still exposed to longline fisheries bycatch) to recruit into shallow coastal foraging areas of the Coral Sea – Tasman Sea region at about 16 years of age.
- Large immature and adult Loggerhead turtles foraging on benthic invertebrates in shallow coastal waters of the Gulf of Carpentaria, Coral Sea and Tasman Sea (exposed to fisheries bycatch [crabbing, trawling], boat strike, decline in quality of coastal habitats in response to extreme weather events).
- Adults on their migrations of up to 2,600 km from their widely dispersed foraging areas to their traditional breeding sites.

In response to the diverse threats to the Loggerhead turtle, spanning multiple national jurisdictions across the entire South Pacific, the UNEP Convention for Conservation of Migratory Species (CMS) approved in 2014, the ***Single Species Action Plan for the Loggerhead Turtle (Caretta caretta) in the South Pacific Ocean*** (UNEP/CMS/Resolution 11.21; UNEP/CMS/COP11/Doc 23.2.2/Rev.1/Annex 2) (CMS, 2014). As a signatory state to CMS, the

Australian Government is expected to implement this Action Plan. This report summarises part of the Queensland Government's contribution to implementation of the Single Species Action Plan for the Loggerhead Turtle in the South Pacific Ocean.

## 2. METHODS

The Woongarra Coast contains nine small crescent sand beaches in an otherwise 22 km of rocky coastline between the Burnett and Elliott Rivers in northern Hervey Bay, south Queensland ([Figure 4](#)). The inter-tidal areas of these beaches and the majority of the adjacent sub-tidal waters are within the Great Sandy Marine Park. The longest of these beaches is Mon Repos beach (1.6 km) where the nesting habitat occurs, in part, within the Mon Repos Conservation Park that is managed by Queensland Parks and Wildlife Service (QPWS) within the Queensland Department of Environment and Science (DES). The remaining beaches are principally within esplanades managed by the Bundaberg Regional Council, except for Kellys Beach where the nesting habitat extends into the seaward margin of privately owned properties.

Standard methodologies of the DES Queensland Turtle Conservation Project (QTCP) within Threatened Species Operations (Limpus *et al.* 1983; Limpus, 1985, Limpus *et al.* 2022) were followed for this project, monitoring nesting females and their clutches. Statistical procedures follow Zar (1984). Proportional data were presented as the value  $\pm$  95% confidence interval.

Monitoring teams included QPWS staff and QTCP volunteers with training in the methods being implemented. DES is indebted to the tireless efforts of the large team of local volunteers who patrolled the beaches, tagged the turtles, relocated doomed eggs, and recorded data at the Burnett Heads, Bargara and Elliott Heads beaches and are managed by the Burnett Mary Regional Group (BMRG).

The Queensland Marine Turtle Strategy 2021-2031 (Department of Environment and Science, 2021) sets a management goal to "Maintain, adapt and strengthen existing direct management efforts at key individual nesting beaches and foraging grounds for each genetic stock to implement management practices that promote:

- successful hatching of at least 70% of clutches laid (including rescuing doomed eggs where feasible); and
- mean hatchling emergence success in excess of 80% from clutches producing hatchlings."

Unpublished monitoring of ovarian follicles across the laying of successive clutches by individual Loggerhead females within a nesting season using ultrasonography indicate that a female commences resorption of mature ovarian follicles (atresia) after approximately eight nesting crawls with digging of body pits, irrespective of whether or not laying occurs (CJL unpublished data). If a Loggerhead turtle lays an average of approximately four clutches per season, it is assumed that she should lay these clutches during less than eight attempted nesting crawls if she is to maximise her seasonal egg production. This would be equivalent to a nesting success exceeding 57%.

On the basis of the above, a nesting population will be considered to be performing satisfactorily if there is:

- successful hatching of at least 70% of clutches laid (including rescuing doomed eggs where feasible);
- mean hatchling emergence success in excess of 80% from clutches producing hatchlings and
- adult nesting success exceeding 60%.



## Data management

DES maintains the QTCP database which collates data on marine turtle tagging and sightings from nesting beaches, foraging grounds, courtship areas and stranded turtles. The data are coded into a relational database to facilitate statistical analysis. The data is routinely analysed to investigate:

- distribution and abundance of nesting by beaches,
- trends in size of nesting populations and other demographic parameters,
- description of population characteristics by study year, and
- threatening processes.

## Nesting activity

Nesting activity was recorded at all nesting beaches along the Woongarra Coast during the entire potential breeding season from early October 2022 to May 2023. Monitoring of nesting occurred nightly and additionally during the cooler hours of the day.

Procedures included:

- Flipper tagging following the standard methods reported by Limpus (1992). Adult turtles left the beach with a minimum of two titanium tags manufactured by Stockbrands Australia in the front left and right flippers, generally proximal to the flipper scute closest to the body. If scar tissue from previous tagging made this position unsuitable, tags were applied distally to this scute or on hind flippers.
- Flipper tagging using monel tags with this nesting population commenced in 1968 but these tags only lasted a few years before they were lost to corrosion. The introduction of double tagging with titanium tags in 1981 has enabled long term recognition of the individual nesting turtles (Limpus, 1992). Past studies have established that since 1982, any turtle nesting on the Woongarra Coast that is untagged and does not have tag scars from lost previously applied tags, has a 98% probability of being a first time breeding turtle. This has enabled the assigning a year for commencement of breeding to these first time tagged females with a high level of confidence.
- Passive Integrated Transponder (PIT) tags manufactured by Animal Electronic I.D. Systems were injected into the upper left (or occasionally right) shoulder (just below the carapace) of nesting Flatback and Green turtles and a limited number of high priority Loggerhead turtles.
- Curved carapace length (CCL  $\pm$  0.1 cm) was measured from the skin/carapace junction at the anterior edge of the nuchal scale, along the midline, to the posterior junction of the two post-vertebral scutes at the rear of the carapace, using a flexible fibreglass tape measure. Any *Chelonibia* barnacles living along the midline of the carapace were removed prior to measuring.
- Any damage to the turtle or unusual features were recorded and photographed when logistics permitted.
- A nest tag (flagging tape ~20 cm long) with the date of laying and a tag number of the turtle (Limpus, 1985) was placed in the nest during oviposition for most clutches. The nest tag enabled identification of individual clutches of eggs when excavated following hatchling emergence some two months later.
- A subset of clutches was counted, and ten eggs were selected to represent a cross-section of eggs from top to bottom of the nest. Each selected egg was weighed ( $\pm$  0.1 g) on a digital balance and measured for maximum and minimum diameter ( $\pm$  0.1 mm) with vernier callipers. To minimise movement induced mortality of eggs, all handled eggs were returned to their respective nests within two hours of being laid and with the minimum of rotation (Limpus *et al.*, 1979).

- When clutches were counted, nest depths from the beach surface to the top of the eggs and to the bottom of the nest were measured with fibreglass flexible tape measures ( $\pm 1$  cm).
- Nest locations were recorded by triangulation measurements from pairs of numbered posts along the crest of the upper dune and extending for the full length of Mon Repos, Oaks, and Archies Beaches.
  - No surface markers were placed on individual nests.

### **Rescuing of doomed eggs**

Since the late 1980s, it has been standard management for the majority of clutches of eggs that are laid below or close to the high tide level on the Woongarra Coast to be relocated to more secure incubation sites higher up the dunes. This relocation was completed within 2 hours of the eggs being laid and with minimum rotation of the eggs (Limpus *et al.*, 1979; Pfaller *et al.*, 2008). The majority of the relocation of clutches was managed by DES staff and trained volunteers.

Because of the high risk of hatchlings heading inland from Nielson Park, Bargara and Kellys Beaches, the majority of clutches of eggs laid on these beaches were relocated to a darker beach, either Mon Repos or Archies Beaches, on the night that they were laid or approximately three weeks later.

### **Beach cooling: Incubation cages and hatcheries**

QPWS maintains four standard shaded, predator-proof cages ([Figure 5A](#)) at Mon Repos, and two shaded, open-sided hatcheries ([Figure 5B](#)) at Mon Repos, to provide some clutches with a cooler incubation environment. The shading on the cages and hatcheries was provided by 50% shade cloth. The predator-proof cages were enclosed in aluminium mesh with 70 mm diameter mesh size allowing self-release of hatchlings emerging from the enclosed nests.

Additional shaded predator-proof cages have been installed at Archies, Elliott Heads, Moore Park and at Wreck Rock beaches with the assistance of the Bundaberg Regional Council and Gidargil Land and Sea Rangers to provide increased protection of eggs from potential fox, dog and varanid depredations.

Location of incubation cages and hatcheries at Mon Repos, 2022-2023 breeding season:

- Cage 1: sector 1, top of 2<sup>nd</sup> dune, shaded by *Casuarina* from approximately midday onward.
- Cage 2: Sector 8, 1<sup>st</sup> dune, shaded by *Casuarina* from approximately 2 pm onward.
- Cage 3: Sector 10, 1<sup>st</sup> dune, not shaded by the forest until after approximately 5 pm.
- Cage 4: Sector 14B, 2<sup>nd</sup> dune, shaded by *casuarina* after approximately 12:30 pm.
- Hatchery 1: Sector 9C, 1<sup>st</sup> dune, receives shade from the forest after approximately 4:30 pm.
- Hatchery 2: Sector 13C, 1<sup>st</sup> dune, receives shade from *Casuarina* after 3:30 pm (Wood *et al.* 2014).

Clutches were relocated and buried at 60 cm spacing and at a depth to the bottom of the artificial nest of 60 cm into the cages and hatcheries from different distances along Mon Repos Beach. Ropes with knots at 60 cm spacing were placed across the ground within each cage and hatchery to guide the positioning of the relocated clutches. A nest tape with tag number and date laid was placed within each clutch of eggs and tied to the knot on the rope above.

The cages at Mon Repos have space for approximately 30 relocated clutches while each hatchery can accommodate up to 100 clutches at a time.

## **3. RESULTS**

### **Marine turtle nesting populations on the Woongarra Coast, 2022-2023.**

In this season, turtle nesting on the Woongarra Coast commenced on 04 November 2022 and continued until the last nesting on 08 April 2023 ([Table 1](#)).

The marine turtle hatchling emergence from nests on the Woongarra Coast commenced on 31 December 2022 and ceased on 21 May 2023 ([Table 1](#)).

Based on the whole of nesting season capture-mark-recapture nightly tagging of all turtles encountered, a total of 396 individual marine turtles of three species were recorded ashore for nesting on the Woongarra Coast beaches during the 2022-2023 breeding season ([Table 2](#)).

Because the nesting season commenced with a prominent erosion bank at approximately the upper high tide level on the Woongarra Coast beaches, there was an atypical increase in the number of turtles that laid eggs below or near the spring high tide level. At least 897 clutches of doomed marine turtle eggs were relocated to more elevated incubation sites to minimise clutch loss to erosion and flooding, or to dark beaches to minimise the risk of hatchlings disoriented towards coastal lighting:

- **Mon Repos**, 667 clutches : 532 higher on dunes, 71 to shaded hatcheries, 64 to predator-proof cages
- **Oaks Beach**, 105 clutches: 67 higher on dunes, 38 to predator-proof cage
- **Nielson Park**, 28 clutches: 1 higher on dunes; 27 to predator-proof cage at Archies Beach
- **Bargara**, 8 clutches: 1 higher on dunes; 7 to predator-proof cage at Archies Beach
- **Kellys Beach**, 30 clutches: 1 higher on dunes; 29 to predator-proof cage at Archies Beach
- **Archies Beach**, 42 clutches: 12 higher on dunes, 29 to predator-proof cage, 1 to predator-proof cage at Mon Repos
- **Rifle Range Beach**, 1 clutch: 1 higher on dunes
- **Innes Park**, 7 clutches: 6 higher on dunes, 1 to shaded hatchery at Mon Repos
- **Elliott Heads**, 9 clutches: 9 to predator-proof cage.

These relocated clutches were equivalent to rescuing  $68.8 \pm 2.5\%$  of the seasonal marine turtle egg production on the Woongarra Coast for the 2022-2023 breeding season. In the absence of our rescuing these doomed eggs, the 2022-2023 breeding season on the Woongarra Coast potentially would have experienced the greatest reduction in hatchling production on record for a summer with no significant cyclone erosion of the coast.

These rescued clutches included 135 clutches relocated into the shaded predator-proof cages ( $n = 64$ ) and shaded hatcheries ( $n = 71$ ) at Mon Repos; 38 to the shaded predator-proof cage at Oaks Beach; 29 to the shaded predator-proof cage at Archies Beach and 9 to the shaded predator-proof cage at Elliott Heads.

### 3.1 LOGGERHEAD TURTLES, *Caretta caretta*

#### Breeding population size

A total of 385 Loggerhead turtles were recorded ashore for breeding on the Woongarra Coast beaches this summer. The long-term trends in the annual nesting census data ([Figure 6](#)) from the 1970s to 2022, illustrates the major decline in annual numbers of nesting Loggerhead turtles attributed primarily to otter trawl by-catch mortality. The compulsory use of Turtle Exclusion Devices (TEDs) has been regulated via Australian and Queensland fisheries across northern Australia, Torres Strait and eastern Queensland since 2001 (Limpus, 2008). As a consequence,

recent Loggerhead turtle nesting numbers on the Woongarra Coast had recovered to a size that is comparable to those of the early 1980s by 2016. However, while there has been an unexplained decline in the size of the annual Loggerhead turtle nesting population on the Woongarra Coast over the previous five breeding seasons there has been a slight increase in nesting numbers during the 2022-2023 breeding season.

The annual recruitment rate of Loggerhead turtles (= proportion of turtles recorded breeding for the first time on the Woongarra Coast) was  $0.33 \pm 0.05$  for the 2022-2023 breeding season. This index of recruitment into the adult female breeding population had declined by approximately 50% over the past two decades but has shown an increase for this summer ([Figure 7](#)). The increase in proportion of first time breeding females on the Woongarra Coast is an encouraging sign for the populations and probably accounts for the increase in breeding numbers recorded for the 2022-2023 breeding season.

### **Reproductive parameters**

The size range of the nesting Loggerhead turtles are summarised in [Table 3](#); [Figure 8A](#). The mean CCL of 95.2 cm is typical of the eastern Australian Loggerhead nesting population. Nesting females tended to increase in carapace length with increasing number of breeding seasons recorded as an index of reproductive age ([Table 4](#)).

The nesting Loggerhead turtles averaged 3.8 clutches laid per female for the summer ([Table 3](#); [Figure 8B](#)). Nesting females tended to increase the number of clutches laid per season with increasing number of breeding seasons recorded ([Table 5](#)).

The nesting Loggerhead turtles averaged 126.8 eggs per clutch ([Table 3](#)) The occurrence of yolkless and multi-yolked eggs in clutches was uncommon. Nesting females tended to increase the number of eggs per clutch with increasing number of breeding seasons recorded ([Table 6](#)).

The nesting Loggerhead turtles averaged 4 years between recorded seasons ([Table 3](#); [Figure 8D](#)) which is longer than expected. Nesting females tended to decrease the number of years between breeding seasons with increasing number of breeding seasons recorded ([Table 7](#)).

### **Nesting behaviour**

The proportion of marine turtle nesting crawls and nesting success by Woongarra Coast beaches during the 2022-2023 breeding season are summarised in [Table 8](#).

The vast majority ( $78.2 \pm 1.9\%$ ) of the Loggerhead turtle nesting attempts occurred on Mon Repos Beach and the remaining 21.8% of the nesting crawls were spread over the remaining seven beaches ([Table 8A](#)). Mon Repos has been the primary beach supporting Loggerhead turtle nesting on the Woongarra Coast in all years since systematic monitoring of turtle nesting began in 1968 ([Figure 9](#)).

Satisfactory nesting success was recorded for Loggerhead turtles nesting at Mon Repos, Nielson Park, Bargara, Kellys, Archies and Elliott Heads Beaches for the 2022-2023 season while unsatisfactory, low nesting success was recorded at Oaks Beach ([Table 8A](#)). It is a continuing concern when numerous turtles turned around at mid-beach and returned to the sea without laying eggs in the absence of observed physical disturbance (e.g. absence of people or dogs; absence of obstructions such as erosion banks or beach debris). The role of sky glow over a nesting beach as a disturbance factor impacting marine turtle breeding success warrants investigation. The poorest nesting success was recorded at Oaks Beach where the shallow depth of sand over the underlying basal rock layer is a significant contributing factor to low nesting success.

Loggerhead turtles that came ashore to nest on the Woongarra Coast displayed a reduced fidelity to nesting at an individual nesting beach with 62.8% of Loggerhead turtles visiting only a single beach throughout the entire nesting season ([Table 9A](#)). Flatback turtles continued to display high fidelity (90%) to nesting at a single beach for the entire summer. There were very extreme differences in Loggerhead turtle fidelity to individual beaches within the Woongarra Coast: 62.8% at Mon Repos in contrast with 17.7% at Oaks Beach and 21.1% at the combined Neilson park, Bargara, Kellys and Archies Beaches ([Table 9B](#)). The extremely low nesting beach fidelity is associated with the beaches in close proximity to urban lighting and associated skyglow at Oaks, Neilson Park, Bargara, Kellys and Archies Beaches.

Turtles with the longest recorded reproductive life span that bred on the Woongarra Coast during the 2022-2023 summer were:

- Loggerhead turtle, **T2460**: 39 year reproductive life span, commenced breeding in the 1983-1984 breeding season, with 18 recorded breeding seasons.
- Flatback turtle, **X8473**: 45 year reproductive life span, commenced breeding in the 1977-1978 breeding season, with 18 recorded breeding seasons.

Of special interest is Loggerhead turtle **T732**, a turtle with 41 years of history in our data:

- 1981: recruited from open ocean to benthic foraging on Heron Reef as an immature female.
- 1981-1994: captured numerous times within Heron Reef lagoon as it grew to adulthood and commenced preparation for 1<sup>st</sup> breeding 13 year after arrival from the open ocean
- 1994-1995: 1<sup>st</sup> breeding season, migrated to nest at Mon Repos.
- 1994-2022: migrated between Heon Reef and Mon Repos for successive breeding seasons.
- 2022-2023: 8<sup>th</sup> breeding season on the Woongarra Coast, with 22 years of breeding history.

Following the decimation of the eastern Australian Loggerhead turtle nesting population, recovery of the annual nesting numbers commenced following the compulsory regulation of the use of TEDs in the prawn trawl fisheries of northern Australia, Torres Strait, and eastern Queensland in 2001. As a consequence, 356 (92.5 ± 2.6%) of the Loggerhead turtles with a known reproductive life span commenced their breeding life since 2001 (Figure 10A). The excessive Loggerhead turtle mortality across decades throughout the majority of the foraging distribution prior to 2001 is interpreted as the underlying reason for there being only 7.5% of older turtles (>21 year reproductive life) still migrating to this major breeding site.

There was a marked decline in the proportion of turtles returning to breed after more than three breeding seasons (Figure 10B). There was no tight correlation between the reproductive life span of the adult female Loggerhead turtle and the number of recorded breeding seasons. It is presumed that the variability in reproductive life span/number of recorded breeding seasons will be influenced by environmental factors operating across the multiple foraging areas supporting these turtles prior to their breeding migrations.

### **Boat strike injuries in the inter-nesting habitat**

None of the season's nesting Loggerhead turtles were recorded with fresh vessel strike injuries inflicted within the adjacent inter-nesting habitat while preparing their clutch of eggs for laying.

### **Rescued turtle**

On the night of 05 January 2023, Loggerhead turtle, QB2869, was dragged off the nest because she had been inhaling dry sand that was causing extreme breathing difficulties. Her head was imbedded into the sand dune margin of the body pit she had been filling. She returned to lay an additional clutch on 17 January 2023.

### Loss of clutches and eggs from turtle nesting activity

At least 33 incubating Loggerhead clutches were dug into during subsequent nesting activities of Loggerhead turtles. In each case only part of the incubating clutch was destroyed by the nesting turtle. As in past seasons, egg destruction by nesting turtles represented the loss of only a small proportion of the total season's Loggerhead egg production on the Woongarra Coast.

### 3.2 FLATBACK TURTLES, *Natator depressus*

Ten Flatback turtles were recorded ashore for breeding on the Woongarra Coast beaches this summer ([Table 2](#)). The small annual Flatback turtle nesting population on the Woongarra Coast continues to fluctuate but remains within the range recorded over the last half century ([Figure 11](#)). Nine of these Flatback turtles nested at Mon Repos while the tenth laid eggs on both Kellys and Archies Beaches. The Flatback turtles display high nesting success (82%; [Table 8B](#)).

[Table 10](#) summarises the reproductive parameters of this small nesting population at the southern extremity of the breeding range for eAust genetic stock of Flatback turtles for the 2022-2023 breeding season. The reproductive parameters recorded for this season continue to fall within the normal range for these parameters for this stock (Limpus, 2007).

### 3.3 GREEN TURTLES, *Chelonia mydas*

One previously untagged Green turtle was recorded nesting on the Woongarra Coast during the 2022-2023 breeding season.

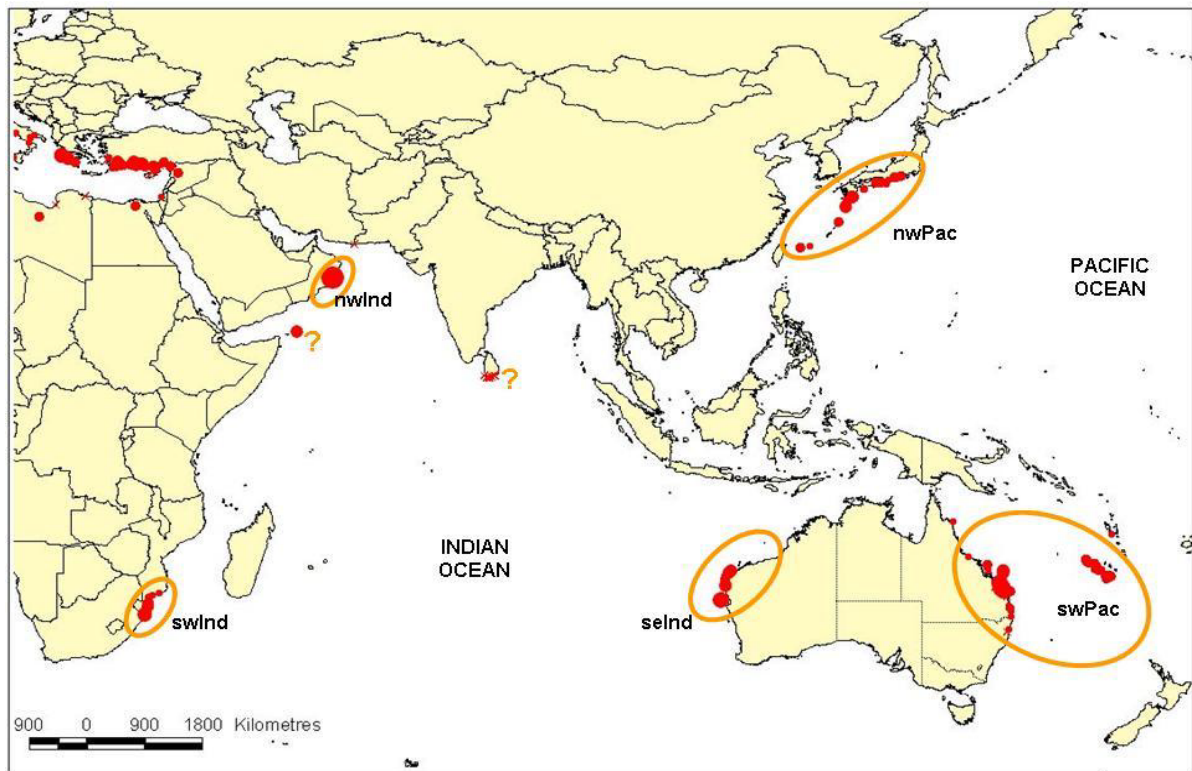
[Table 11](#) summarises the reproductive parameters of this small nesting population towards the southern extremity of the breeding range for sGBR genetic stock of Green turtles for the 2022-2023 breeding season. The reproductive parameters recorded for this season continue to fall within the normal range for these parameters for this stock.

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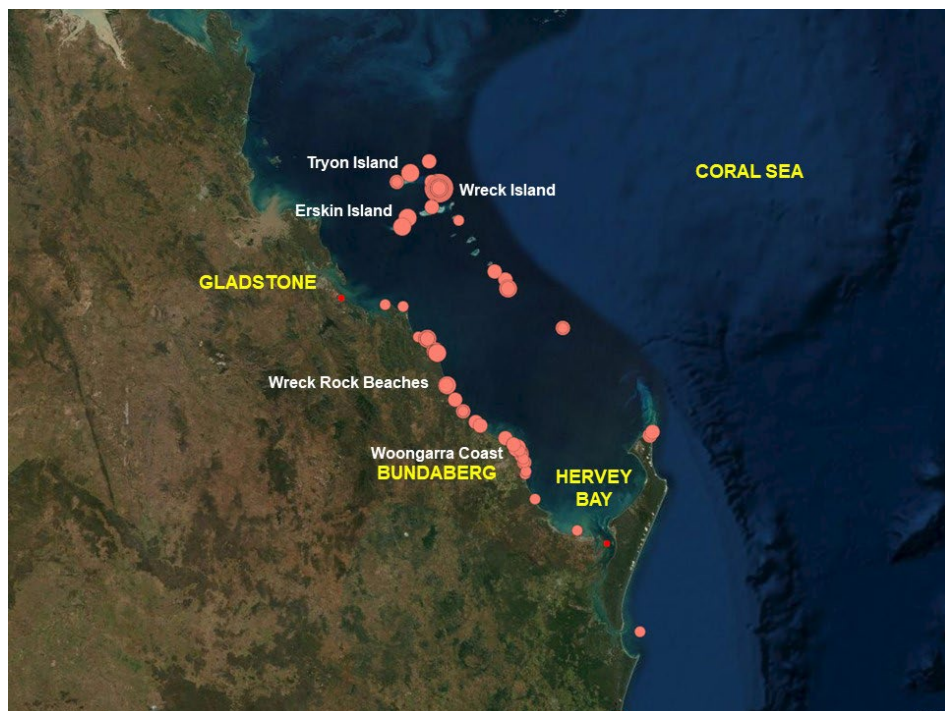
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**FIGURES**



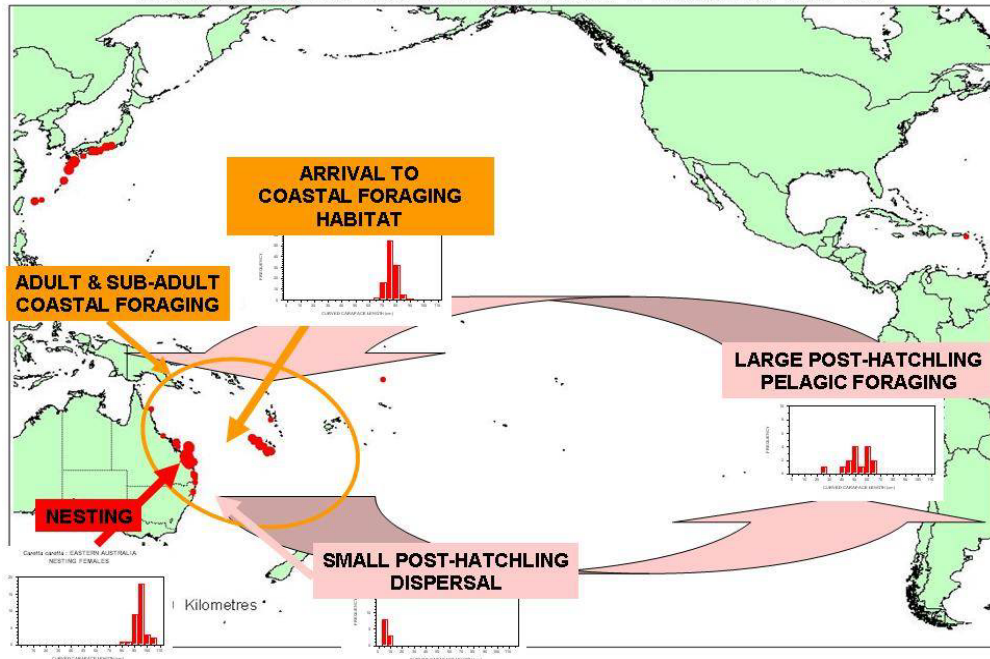
**Figure 1: Genetic stocks (management units) of Loggerhead turtles, *Caretta caretta*, within the Pacific and Indian Oceans (FitzSimmons and Limpus, 2014).**



**Figure 2: Nesting distribution of Loggerhead turtles, *Caretta caretta*, in central-south Queensland with the five principal nesting sites identified (TurtleNet, 8 Oct 2023).**



**LOGGERHEAD TURTLE, *Caretta caretta*  
TRANS PACIFIC MIGRATION IN SOUTH PACIFIC OCEAN**



**Figure 3: Summary of the life history dispersal of the SW Pacific genetic stock of Loggerhead turtles (CMS, 2014).**



**Figure 4: Map of the locations of the marine turtle nesting beaches on the Woongarra Coast.**



Figure 5A. Hatchery cage (C1), sector 1, dune crest.



Figure 5B. Open hatchery (H1), north Beach, sector 9c.

Figure 5: Shaded incubation structures on Mon Repos Beach.

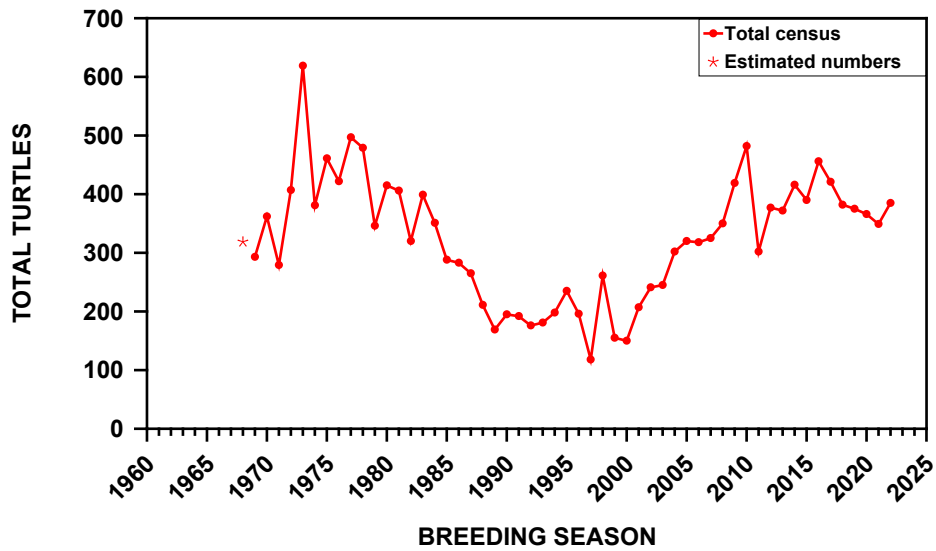


Figure 6: Summary of changing breeding numbers of Loggerhead turtles, *Caretta caretta*, on the Woongarra Coast, 1968-2022.

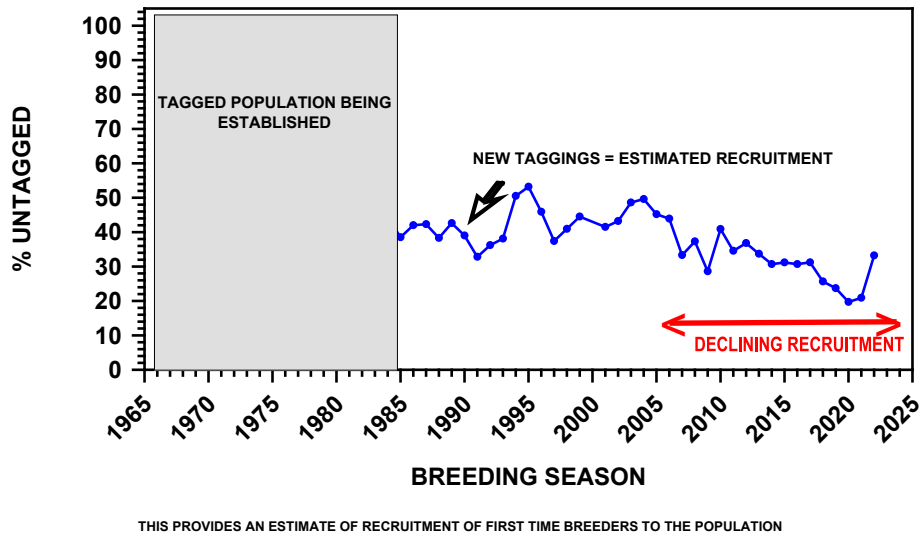
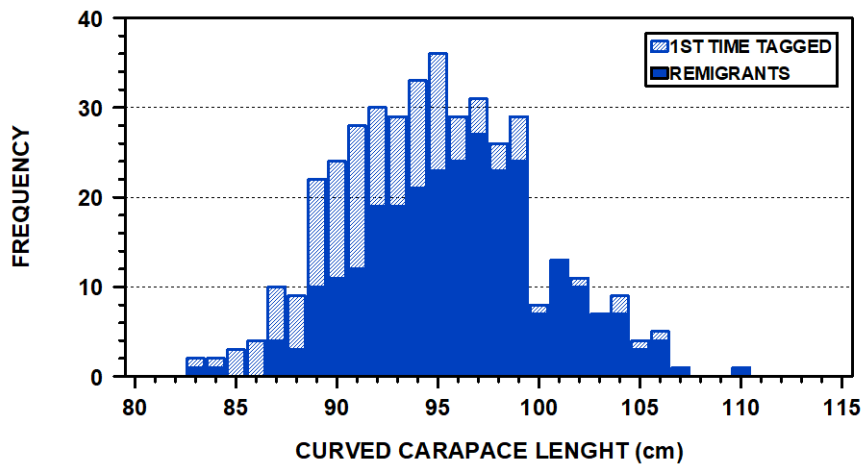
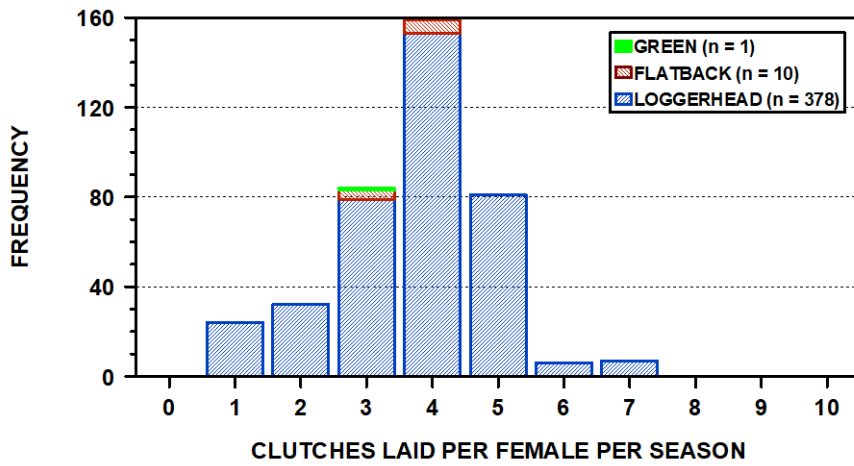


Figure 7: Proportion of first time tagged adult female Loggerhead turtles, *Caretta caretta*, within the annual breeding population on the Woongarra Coast, based on capture-mark-recapture analysis. Proportion of first time tagged individuals is used as an index of recruitment to the annual breeding population.

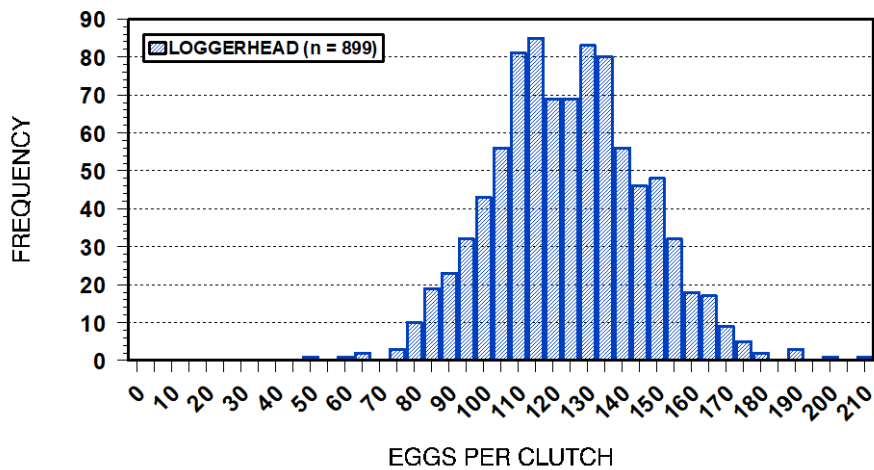


8A. Curved carapace length for the total annual nesting population.

Figure 8: Reproductive parameters for Loggerhead turtles, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season.

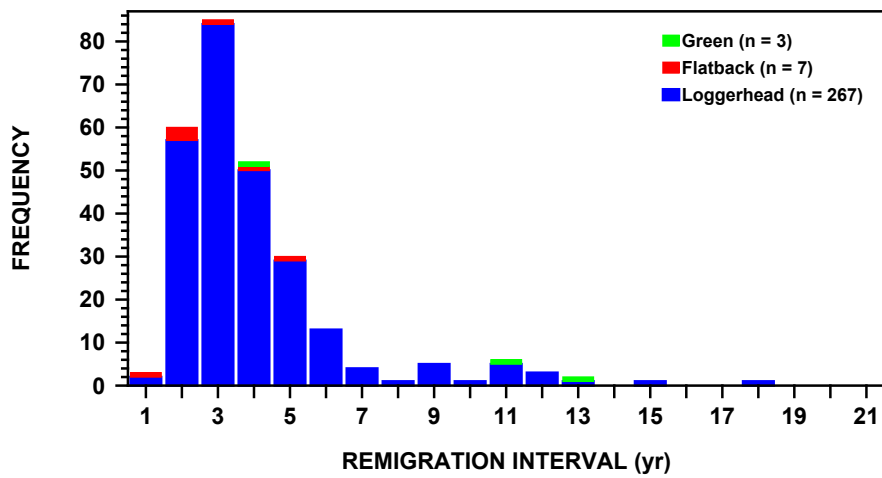


8B. Number of clutches of eggs laid recorded for each female within the breeding season.



8C. Number of eggs per clutch.

Figure 8. Continued



8D. Remigration interval (years between successive breeding seasons).

Figure 8. Continued

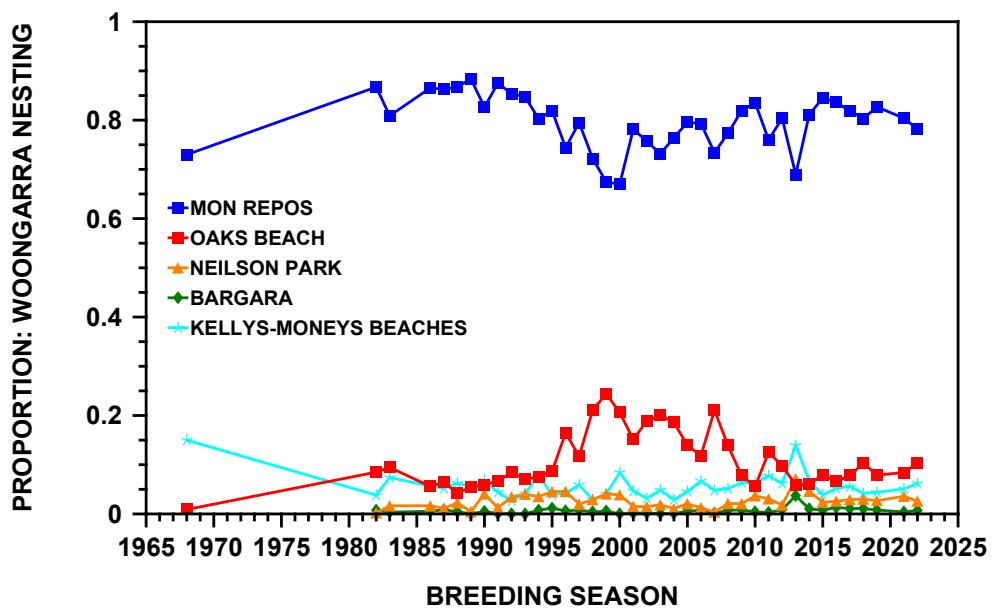
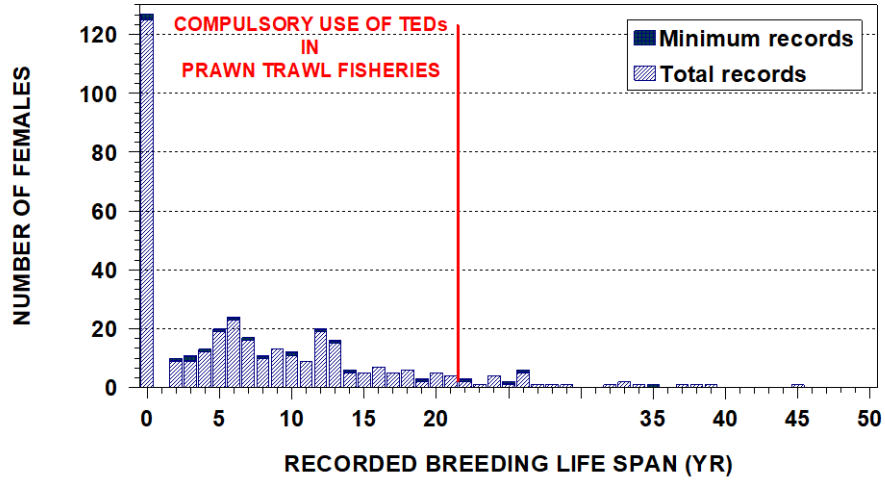
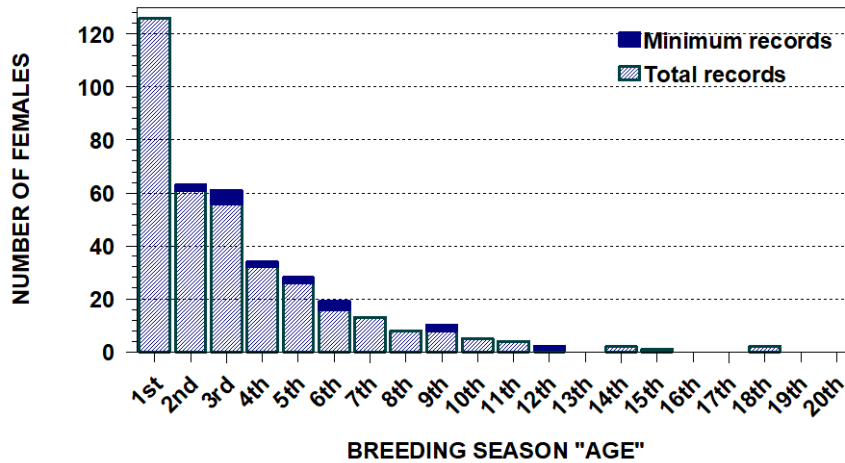


Figure 9: Distribution of Loggerhead turtle, *Caretta caretta*, nesting crawls by principal nesting beaches within the Woongarra Coast, 1968-2022 breeding seasons.



10A: Reproductive life span as breeding adults.



10B. Number of breeding seasons per turtle.

Figure 10: Breeding history of Loggerhead turtles, *Caretta caretta*, with known (Total records) and approximate (Minimum records) commencement of reproductive life that nested on the Woongarra Coast during the 2022-2023 breeding season.

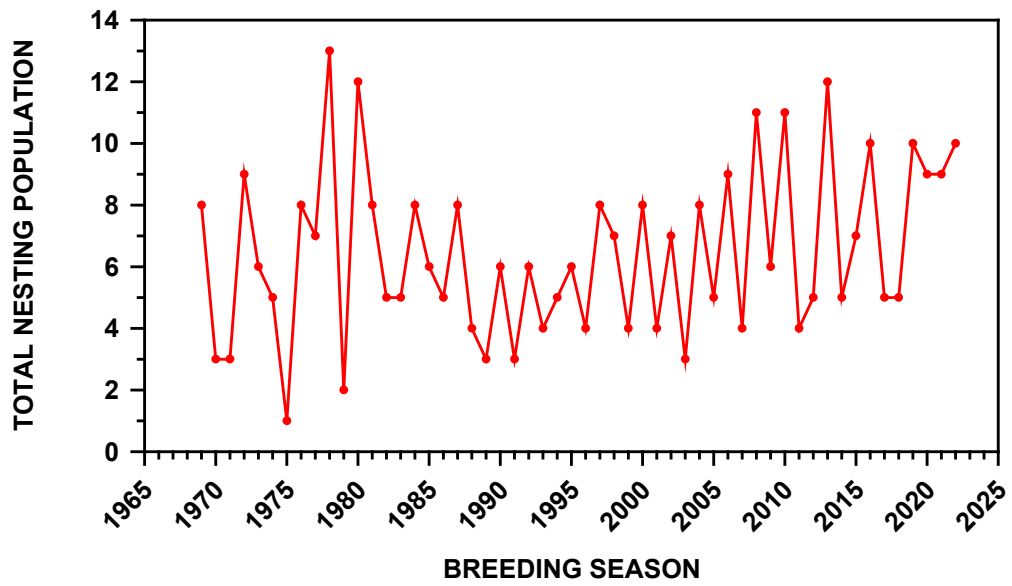


Figure 11: Summary of changing breeding numbers of Flatback turtles, *Natator depressus*, on the Woongarra Coast, 1968-2022.

## TABLES

**Table 1: Summary of the duration of the 2022-2023 marine turtle nesting and hatchling emergence seasons on the Woongarra Coast.**

	<i>Caretta caretta</i> Loggerhead turtle	<i>Chelonia mydas</i> Green turtle	<i>Natator depressus</i> Flatback turtle
first nesting crawl	04 November	18 November	04 November
last nesting crawl	06 April	24 December	06 January
first hatchlings	10 January	28 January	31 December
last hatchlings	21 May	17 February	28 February

**Table 2: Summary of the breeding history of the three species of marine turtles nesting on the Woongarra Coast, 2022-2023 breeding season.**

	<i>Caretta caretta</i> Loggerhead turtle	<i>Chelonia mydas</i> Green turtle	<i>Natator depressus</i> Flatback turtle
1 <sup>st</sup> time tagged turtles (Primary taggings)	128	1	1
Recaptures			
Migration from foraging and 1 <sup>st</sup> time breeding	-	-	-
• Returns from previous season to Woongarra Coast	244	-	9
• Remigrants with lost tags	8	-	-
• Changing nesting colony ○ between seasons	2	-	-
• Changing nesting colony ○ within season	3	-	-
<b>TOTAL</b>	<b>385</b>	<b>1</b>	<b>10</b>



**Table 3: Summary of reproductive parameters of Loggerhead turtle, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season, with data pooled across the age classes.**

	MEASUREMENT				Sample size
	Mean	SD	minimum	maximum	
<b>Curved carapace length (cm)</b>					
1 <sup>st</sup> time tagged	92.7	4.2.	83.3	105.1	131
Remigrant turtles	96.5	4.44	83.0	110.5	272
All turtles	95.2	4.72	83	110.5	406
<b>Other parameters</b>					
Remigration interval (yr)	3.98	2.20	1	13	242
<b>Eggs &amp; clutches</b>					
Number of clutches laid per season per female	3.8	1.17	1	7	378
Eggs per clutch	126.8	21.88	51	210	899
Multi-yolked eggs per clutch	0.04	0.23	0	3	899
Yolkless eggs per clutch	0.08	0.38	0	3	899
Nest depth to top egg	34.1	8.83	5	65	765
Nest depth to bottom	56.2	6.92	35	85	793

**Table 4: Curved carapace length by age class of Loggerhead turtle, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season.**

Age class Breeding season	CURVED CARAPACE LENGTH (cm)				Sample size
	Mean	SD	minimum	maximum	
1 <sup>st</sup>	92.7	4.23	83.3	106.2	131
2 <sup>nd</sup>	94.9	4.72	83.0	105.5	71
3 <sup>rd</sup>	95.6	4.10	88.2	106.7	63
4 <sup>th</sup>	96.0	3.67	89.7	103.8	32
5 <sup>th</sup>	98.1	4.24	89.8	106.2	29
6 <sup>th</sup>	96.5	3.83	91.5	105.2	15
7 <sup>th</sup>	99.8	3.83	94.0	107.4	12
8 <sup>th</sup>	98.3	2.50	93.2	103.1	8

**Table 5: Number of clutches laid per season by age class of Loggerhead turtle, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season.**

Age class Breeding season	CLUTCHES Per SEASON				Sample size
	Mean	SD	minimum	maximum	
1 <sup>st</sup>	3.22	1.22	1	6	144
2 <sup>nd</sup>	3.24	0.97	1	6	67
3 <sup>rd</sup>	3.93	0.91	1	6	57
4 <sup>th</sup>	4.03	1.39	1	6	33
5 <sup>th</sup>	4.38	1.00	3	7	29
6 <sup>th</sup>	4.50	0.67	3	6	10
7 <sup>th</sup>	3.83	1.40	1	7	12
8 <sup>th</sup>	4.00	0.93	2	5	8

**Table 6: Number of eggs per clutch by age class of Loggerhead turtle, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season.**

Age class Breeding season	EGGS Per CLUTCH				Sample size
	Mean	SD	minimum	maximum	
1 <sup>st</sup>	122.1	26.88	65	176	370
2 <sup>nd</sup>	122.1	19.81	51	165	145
3 <sup>rd</sup>	125.1	21.53	72	175	129
4 <sup>th</sup>	131.8	20.31	88	174	76
5 <sup>th</sup>	134.8	22.98	76	200	57
6 <sup>th</sup>	133.8	29.39	78	210	31
7 <sup>th</sup>	139.2	22.02	94	191	27
8 <sup>th</sup>	126.0	22.41	69	163	23

**Table 7: Remigration interval by age class of Loggerhead turtle, *Caretta caretta*, nesting on the Woongarra Coast, 2022-2023 breeding season.**

Age class Breeding season	REMIGRATION INTERVAL (yr)				Sample size
	Mean	SD	minimum	maximum	
1 <sup>st</sup>	-	-	-	-	-
2 <sup>nd</sup>	5.15	2.55	2	13	62
3 <sup>rd</sup>	3.98	1.65	2	8	57
4 <sup>th</sup>	3.52	1.72	1	8	31
5 <sup>th</sup>	3.72	2.26	1	12	29
6 <sup>th</sup>	4.60	3.17	2	13	10
7 <sup>th</sup>	2.67	1.11	2	6	12
8 <sup>th</sup>	2.25	1.58	2	6	8

Table 8: Marine turtle nesting distribution and nesting success on the Woongarra Coast, 2022-2023 breeding season.

8A. Loggerhead turtle, *Caretta caretta*.

Beach	NESTING CRAWLS (tracks)				
	Nesting success (%) ( $\pm$ 95% CI)	Laid	did not lay	uncertain nesting success	Total tracks (% by beach $\pm$ 95% CI)
Oaks	54.1 $\pm$ 7.0%	106	90	-	196 (10.3 $\pm$ 1.4%)
Mon Repos	73.7 $\pm$ 2.2%	1092	385	4	1481 (78.2 $\pm$ 1.9%)
Nielson Park	65 $\pm$ 13%	32	17	-	49 (2.6 $\pm$ 0.7%)
Bargara	-	9	5	-	14 (0.7 $\pm$ 0.4%)
Kellys	78.4 $\pm$ 11.3%	40	11	-	51 (2.7 $\pm$ 0.7%)
Archies	88.1 $\pm$ 7.8%	59	8	-	67 (3.5 $\pm$ 0.8%)
Rifle Range	-	1	-	-	1 (0.01%)
Innes Park	-	11	2	1	14 (0.7 $\pm$ 0.4%)
Elliott Heads	-	13	5	1	19 (1.0 $\pm$ 0.4%)
<b>TOTAL</b>	<b>71.9 <math>\pm</math> 2.0%</b>	<b>1363</b>	<b>526</b>	<b>6</b>	<b>1895</b>

8B. Flatback turtle, *Natator depressus*.

Beach	NESTING CRAWLS (tracks)				
	Nesting success (%)	Laid	did not lay	uncertain nesting success	Total tracks (% by beach)
Oaks	-	-	-	-	0
Mon Repos	82%	32	7	-	39 (90%)
Nielson Park	-	-	-	-	0
Bargara	-	-	-	-	0
Kellys	-	2	-	-	2 (5%)
Archies	-	2	-	-	2 (5%)
Rifle Range	-	-	-	-	0
Innes Park	-	-	-	-	0
Elliott Heads	-	-	-	-	0
<b>TOTAL</b>	<b>84%</b>	<b>36</b>	<b>7</b>	<b>-</b>	<b>43</b>

Table 8: Continued  
8C. Green turtle, *Chelonia mydas*.

Beach	NESTING CRAWLS (tracks)				
	Nesting success (%)	Laid	did not lay	uncertain nesting success	Total tracks
Oaks	-	-	1	-	1
Mon Repos		1	2	-	3
Neilson Park	-	1	-	-	1
Bargara	-	-	-	-	0
Kellys	-	-	-	-	8 (18%)
Archies	-	-	-	-	10 (22%)
Rifle Range	-	-	-	-	0
Innes Park	-	-	-	-	0
Elliott Heads	-	-	-	-	0
<b>TOTAL</b>	<b>-</b>	<b>2</b>	<b>3</b>	<b>-</b>	<b>5</b>

Table 9: Nesting beach fidelity and change of nesting beach by 382 Loggerhead turtles, *Caretta caretta*, and 10 Flatback turtles, *Natator depressus*, and 1 Green turtle, *Chelonia mydas*, individually identified by tag number when ashore for nesting on the Woongarra Coast, 2022-2023 breeding season.

9A. Number of beaches visited by individual turtles.

Number of beaches visited for nesting attempts by each turtle	Loggerhead		Flatback		Green	
	Number of turtles	Proportion of the total Woongarra Coast population ( $\pm$ 95% CI)	Number of turtles	Proportion of the total Woongarra Coast population	Number of turtles	Proportion of the total Woongarra Coast population
1	240	62.8 $\pm$ 4.8 %	9	90 %	-	-
2	114	29.8 $\pm$ 4.6 %	1	10 %	-	-
3	24	6.3 $\pm$ 2.4 %	-	-	1	100%
4	4	1.1 $\pm$ 1.0 %	-	-	-	-
5	-	-	-	-	-	-
Total	382		10		5	

9B. Fidelity to individual beaches on the Woongarra Coast.

Beach	Loggerhead			Flatback			Green		
	Total turtles that commenced the season at this beach	Total turtles that used this beach only	Fidelity to an individual beach (%) ( $\pm$ 95% CI)	Total turtles that commenced the season at this beach	Total turtles that used this beach only	Fidelity to an individual beach (%)	Total turtles that commenced the season at this beach	Total turtles that used this beach only	Fidelity to an individual beach (%)
Oaks	34	6	17.7 $\pm$ 12.8%	-	-	-	-	-	-
Mon Repos	293	224	76.5 $\pm$ 4.9%	9	9	-	1	0	-
Individual Bargara Beaches	52	11	21.1 $\pm$ 11.1%	1	0	-	-	-	-
Innis Park	1	1	-	-	-	-	-	-	-
Elliott Heads	1	1	-	-	-	-	-	-	-

**Table 10: Summary of reproductive parameters of Flatback turtle, *Natator depressus*, nesting on the Woongarra Coast, 2022-2023 breeding season, with data pooled across the age classes.**

	MEASUREMENT				Sample size
	Mean	SD	Minimum	Maximum	
<b>Curved carapace length (cm)</b>					
All turtles	93.4	2.24	91.0	98.5	9
Remigration interval (yr)	3.67	1.13	2	6	9
<b>Eggs &amp; clutches</b>					
Number of clutches laid per season per female	3.60	0.49	3	4	10
Number of eggs per clutch	53.9	8.43	34	78	32
Nest depth to top egg	32.5	9.06	13.0	45.0	26
Nest depth to bottom	52.0	7.25	33.0	64.0	28

**Table 11: Summary of reproductive parameters of Green turtle, *Chelonia mydas*, nesting on the Woongarra Coast, 2022-2023 breeding season, with data pooled across the age classes.**

	MEASUREMENT				Sample size
	Mean	SD	minimum	maximum	
<b>Curved carapace length (cm)</b>					
All turtles	106.2	-	-	-	1
Remigration interval (yr)					0
<b>Eggs &amp; clutches</b>					
Number of clutches laid per season per female	2	-	-	-	1
Number of eggs per clutch	147	-	-	-	1