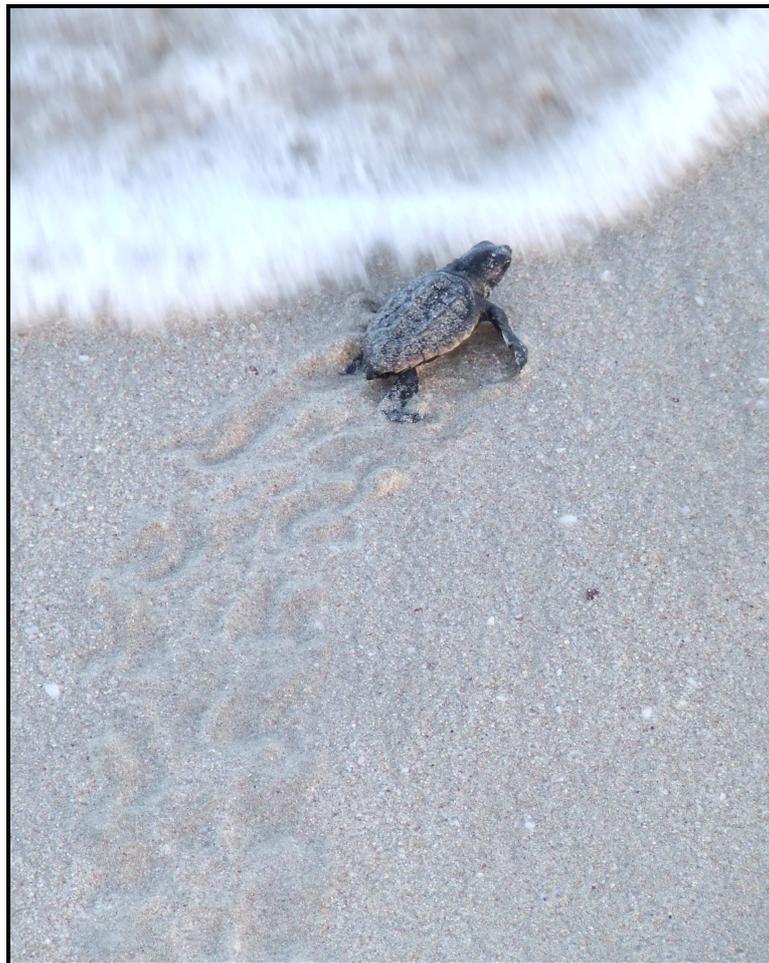


**GNARALOO MARINE TURTLE RESEARCH
PROGRAM
BEACH MONITORING
NESTING SEASON 2008/09**



FINAL REPORT

DOCUMENT REVISION AND ISSUE RECORD

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¹ Also provided with copies of: (1) Animal Pest Management Services (**APMS**), Report on *Fox Control Program for Gnaraloo Station, Turtle Predation Minimisation Project*, December 2008 and (2) APMS, Report on *Fox Control Program for Gnaraloo Station, Turtle Predation Minimisation Project*, January 2009.

² Ibid.

³ Also provided with copies of: (1) *Gnaraloo Marine Turtle Monitoring Access Database 2008/09* (based on the Ningaloo Turtle Program Database developed by DEC Exmouth, 2008), (2) *Gnaraloo Marine Turtle Monitoring Excel Database – Nest Activity 2008/09*, (3) *Gnaraloo Marine Turtle Monitoring Excel Database – Final Results 2008/09*, (4) APMS, Report on *Fox Control Program for Gnaraloo Station, Turtle Predation Minimisation Project*, December 2008 and (5) APMS, Report on *Fox Control Program for Gnaraloo Station, Turtle Predation Minimisation Project*, January 2009.

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ABSTRACT

The marine turtle nesting activities of the Gnaraloo region for the 2008/2009 season are concluded in this report.

Statistics in relation to the species composition of the nesting population have concluded that the predominant nesting turtle is the Loggerhead turtle (*Carretta carreta*).

The density, frequency and distribution of turtle nests throughout the study area resulted in 368 successful nests recorded, with the peak of nesting in mid January 2009.

The common incubation period for the Gnaraloo region was found to be 59 - 61 days and the predatory pressures on the nests and emerging hatchlings were also studied.

BACKGROUND

Gnaraloo Station is located adjacent to the *Ningaloo Marine Park (NMP)*, in remote north western Australia. The NMP has significant marine turtle rookeries, with Loggerhead (*Caretta caretta*), Green (*Chelonia mydas*) and Hawksbill (*Eretmochelys imbricata*) turtles consistently nesting in significant numbers along the Ningaloo coast. The Loggerhead is an endangered species (refer to IUCN Red List) while the Green and Hawksbill turtles are listed as vulnerable species.

Gnaraloo Station commenced its marine turtle research program during the 2008/09 breeding season after receiving *Envirofund Round 10* funding from the Australian Government in 2008. The *Gnaraloo Marine Turtle Research Program* is an initiative of the Gnaraloo leaseholder undertaken under the guidance and direction of the Department of Environment and Conservation (Western Australia) (**DEC**). Outcomes of the project include biodiversity protection, conservation of endangered species, community engagement through volunteers and increased public awareness of conservation issues. Gnaraloo Station provides financial and in-kind contributions to the project.

The *Gnaraloo Marine Turtle Research Program* is based on the *Ningaloo Turtle Program*, a community monitoring partnership program in Exmouth between DEC, the Cape Conservation Group and WWF. Under arrangements with the Gnaraloo leaseholder, DEC provides ongoing scientific and technical advice and support to the Gnaraloo program whilst Gnaraloo executes the beach monitoring program, including attracting and managing the required community volunteers, data collection and entry into databases as well as end-of-

season reporting. DEC undertakes an onsite inspection of the Gnaraloo program during the annual monitoring season.

The *Gnaraloo Marine Turtle Research Program* is supported by the *Gnaraloo Fox Control Program* which was commenced during the 2008/09 breeding season due to the *Envirofund Round 10* funding and to *Caring for our Country, Community Coastcare* funding received from the Australian Government in 2009. Gnaraloo Station also provides financial and in-kind contributions to this project.

The *Gnaraloo Fox Control Program* is a partnership program between the Gnaraloo pastoral leaseholder and DEC. This feral predation control program is fundamental to the Gnaraloo turtle monitoring program and not directed at enhancing economic or pastoral production. The sole objective of the *Gnaraloo Fox Control Program* is to protect the rookeries of threatened marine turtle species at Gnaraloo.

ABOUT THE GNARALOO TURTLE TRACKER TEAM AND WORK DURING 2008/09

Gnaraloo Station developed a *Turtle Volunteer Recruitment Program* in 2008 to attract, recruit and retain the volunteers required for the research work at Gnaraloo during the 2008/09 breeding season. After consideration and review of numerous applications from Australia and worldwide, Gnaraloo selected Patrick Becker and Grant Paterson to form the *Gnaraloo Turtle Tracker Team 2008/09*, comprising of a Team Leader and a Second-in-Command. Patrick and Grant qualified as Marine Scientists from Murdoch University, Western Australia, during November 2008 whereupon they commenced the turtle tracking work at Gnaraloo Station. Patrick was appointed as the Team Leader given his previous training and monitoring experience as a volunteer turtle tracker under the *Ningaloo Turtle Program* in Exmouth.

Under the guidance, instruction and co-ordination of Karen Hattingh, the senior environmental scientist providing advice to Gnaraloo Station on an ongoing basis⁴, the Gnaraloo turtle tracker team developed the research program for the 2008/09 breeding season at Gnaraloo. This work included sourcing and review of numerous DEC reference documents and other support materials prior to commencement of the onsite work in order to

⁴ Gnaraloo Station is unique as a non-mining owned pastoral station with a fulltime environmental scientist on staff (this has been so since 2005 when the current leaseholder took over the lease).

develop the required Gnaraloo protocols and procedures for the work. This resulted in the *Gnaraloo Marine Turtle Monitoring Protocol 2008/09*. This protocol is strictly based on the beach monitoring and data management practices developed by DEC for the *Ningaloo Turtle Program* in Exmouth.

Thereafter, the *Gnaraloo Turtle Tracker Team 2008/09* executed the daily onsite beach monitoring, data collection and database entry work. The Gnaraloo program required 4 months of daily monitoring along the coastline, from 1 December 2008 to 31 March 2009. Data sets from the beach monitoring activities were entered daily into a site copy of the *Ningaloo Turtle Program Database* that has been developed by DEC Exmouth.

Support was provided to the *Gnaraloo Turtle Tracker Team*, from time to time, by local, national and international community volunteer turtle trackers who participated with the program for short periods of time during the season.

One of the volunteers who participated with the Gnaraloo program in a personal capacity, Keely Markovina, is a certified *Turtle Scout and Trainer of volunteer turtle trackers* under the *Ningaloo Turtle Program*. Keely attended the Gnaraloo program for a week in December 2008 at its commencement in order to observe the manner in which the beach monitoring work was undertaken, the entry of daily monitoring data into the site copy of the *Ningaloo Turtle Program Database* and to provide guidance to the Gnaraloo turtle tracker team where required. During this time, she provided training and certification of Grant Paterson as a *NTP Turtle tracker*. Keely also undertook demonstrations and training of Karen Hattingh and Paul Richardson, the Gnaraloo leaseholder, in beach track monitoring. Keely returned to site for another week during January 2009.

Karen Hattingh undertook two site inspections of the Gnaraloo turtle program during the 2008/09 season (at the commencement of work during November - December 2008 to design and set-up the program with the Gnaraloo turtle tracker team and again during February 2009 to review the on-ground activities). The Gnaraloo team produced summary reports with the preliminary results throughout the season for consideration and review by Karen.

Roland Mau and Kirsty Dixon of DEC Exmouth undertook a site inspection of the Gnaraloo program on 4-5 February 2009. This included review of the monitoring activities and discussions around use of the *Ningaloo Turtle Program Database*, including changes

identified as necessary by the Gnaraloo team and requests for minor amendments to the database to include Gnaraloo specifics.

Karen attended the 29th *Symposium on Sea Turtle Biology and Conservation*⁵ in Brisbane during February 2009. Thereafter, review and consideration occurred by the Gnaraloo team of relevant additional reference materials and documents, and the *Gnaraloo Marine Turtle Monitoring Protocol 2008/09* was revised and updated to adapt the beach monitoring program to include required changes and additions, for example, night patrols to sample nest emergence success rates and percentages of crab predation of hatchlings.

At the end of the Gnaraloo turtle nesting and hatching season, the *Gnaraloo Turtle Tracker Team 2008/09* produced this report with details of data, results and recommendations for required adjustments to the program in future. This report, as well as a copy of the *Gnaraloo Marine Turtle Monitoring Access Database 2008/09*⁶, with results of the season's work at Gnaraloo, are provided to DEC Exmouth for inclusion in and contribution to the scientific baselines for marine turtle populations on the Gnaraloo coastline, along the entire Ningaloo coastline and for consideration by DEC in its management planning activities. It is understood that DEC enters all collected data into its *Ningaloo Turtle Program Database* and generates a summary report at the end of annual breeding seasons to identify key nesting habitats, relative significance, trends and management issues.

Patrick Becker and Grant Paterson are passionate and enthusiastic scientists that are dedicated to research and the preservation of threatened marine species. They contributed considerable time and effort in the construction and operation of the *Gnaraloo Marine Turtle Research Program* with the goal to provide reliable and beneficial data to assist in the management of populations of marine turtles on both Gnaraloo beaches and to the wider worldwide scientific community.

Gnaraloo Station acknowledges and greatly appreciates the contributions made by Patrick and Grant towards the establishment of baseline scientific information for marine turtle populations for an area, namely the Gnaraloo coastline, where there is no existing verified turtle data or information. Their commitment was steadfast even during extreme site events

⁵ International Sea Turtle Society, *29th Symposium on Sea Turtle Biology and Conservation*, Brisbane, 17 -19 February 2009.

⁶ The Gnaraloo database is based on the *Ningaloo Turtle Program Database* developed by DEC Exmouth (2008).

THE REAL THING
Gnaraloo
WESTERN AUSTRALIA

such as the major bush fire at Gnaraloo during January 2009 which was contained after a week's intense fire fighting efforts. Gnaraloo suffered extensive damage as a result of the fire, including to pastoral infrastructure, but gratefully there were no loss of life or damage to 3Mile Camp or to the Homestead buildings. Whilst the turtle tracker team greatly assisted Gnaraloo with its fire suppression efforts, there was loss of only 1 monitoring day, which is to the team's credit.

1. INTRODUCTION

The abundance of marine turtle species have been declining worldwide and as such, sufficient protection of key nesting and breeding areas must be explored. The mapping and monitoring of key nesting areas is of crucial importance in the conservation of turtle species in order to determine which areas are in need of management and subsequent protection.

Gnaraloo Station is a 90,000 hectare coastal pastoral station located in the north west of Western Australia, approximately 150km north of Carnarvon. This working pastoral station which has newly established a marine turtle research program, liaises directly with various government departments and the wider scientific community. This is a fledging program in the first year of implementation, with the goal to become a long term study with the aim to assist in turtle conservation.

The program that has been developed for Gnaraloo involves the monitoring of marine turtle nests, false crawls, predation and hatching success. It is undertaken over a four month period from December 2008 to March 2009. This non invasive monitoring program is intended to promote the long term survival of turtle populations by establishing a baseline set of data of turtle nesting activities along the Gnaraloo coastline.

The primary aims of the *Gnaraloo Marine Turtle Research Program* are as follows:

- assess the conservation status of the local turtle population;
- determine key nesting beaches;
- highlight trends in the population;
- establish the degree of feral predation on nests and emerging hatchlings; and
- determine nesting success within the area.

The long term goal is to develop an effective local management framework for the protection of nesting turtles within the Gnaraloo area. This program also helps to generate and maintain community support for the conservation of marine turtles and their habitats.

2. METHODOLOGY

Scientific procedure and protocols undertaken in this study were undertaken as per the instructions outlined in the *Gnaraloo Turtle Monitoring Protocol 2008/09* (Gnaraloo Station, Becker *et al.* 2008),

which was developed under the guidance and direction of Karen Hattingh, and as per the Ningaloo *Guide to Turtle Track Beach Monitoring in Australia* (DEC, Lewis *et al.* 2008).

3. RESULTS

Note: Data collected and statistical analysis concluded from the Gnaraloo Marine Turtle Research Program 2008/09 is independent of previous work by turtle volunteers on Gnaraloo Station. The results presented in this report provide year 1 of a scientific baseline with which comparison may occur of future data.

3.1 Beach Monitoring

3.1.1 Summary of Total Study Area

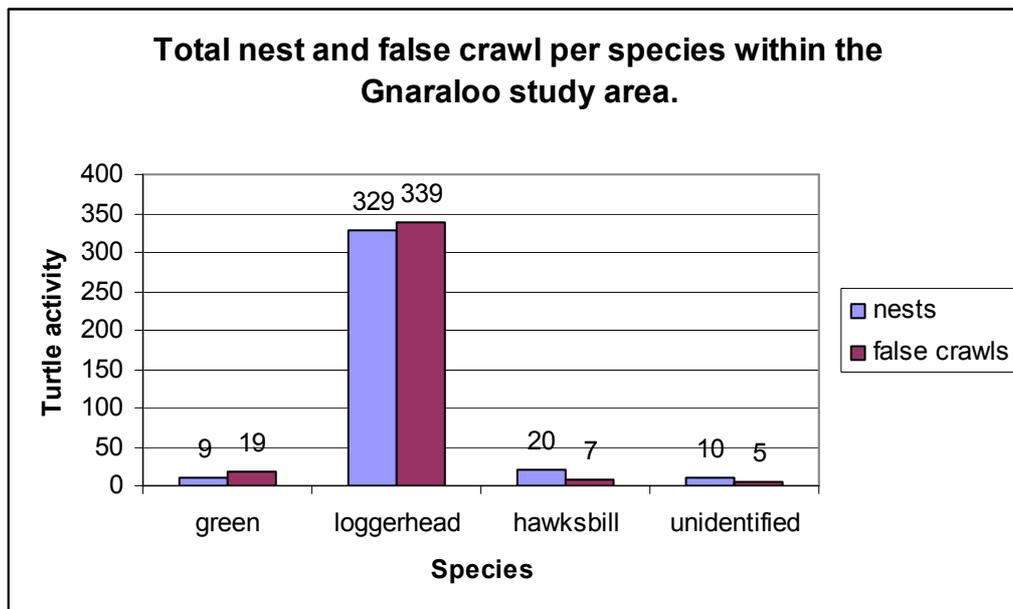


Figure 3.1: Total number of nests and false crawls per species within the Gnaraloo study area

Through the duration of the 2008/09 season, 368 nests and 370 false crawls were recorded in total.

Loggerhead turtles (*Carretta carreta*) were found to be the most prolific nesting turtle, with 329 nests and 339 false crawls (refer Figure 3.1). A relatively small number of Hawksbill (*Eretmochelys imbricata*) and Green Turtles (*Chelonia mydas*) were also recorded nesting within the study area and 10 nests were unable to be identified.

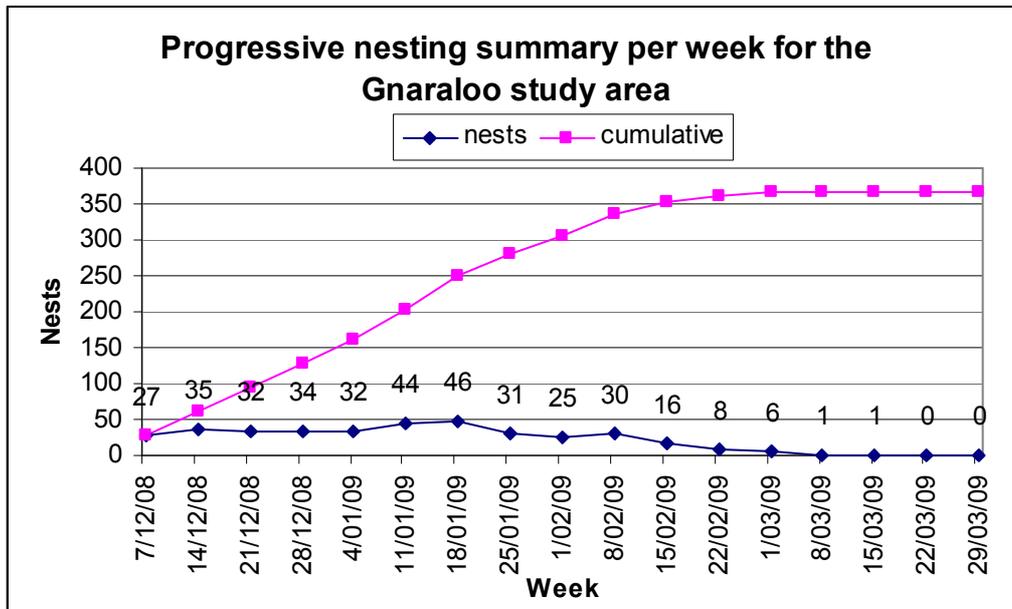


Figure 3.2: Progressive and cumulative summary of nesting activity per week (1 December 2008 to 31 March 2009)

The nesting frequency was relatively constant initially with a peak of 46 nests a week occurring in mid January 2009 (refer Figure 3.2). This intensity gradually abated with no nests recorded after mid March 2009. The cumulative nesting trend also represents this.

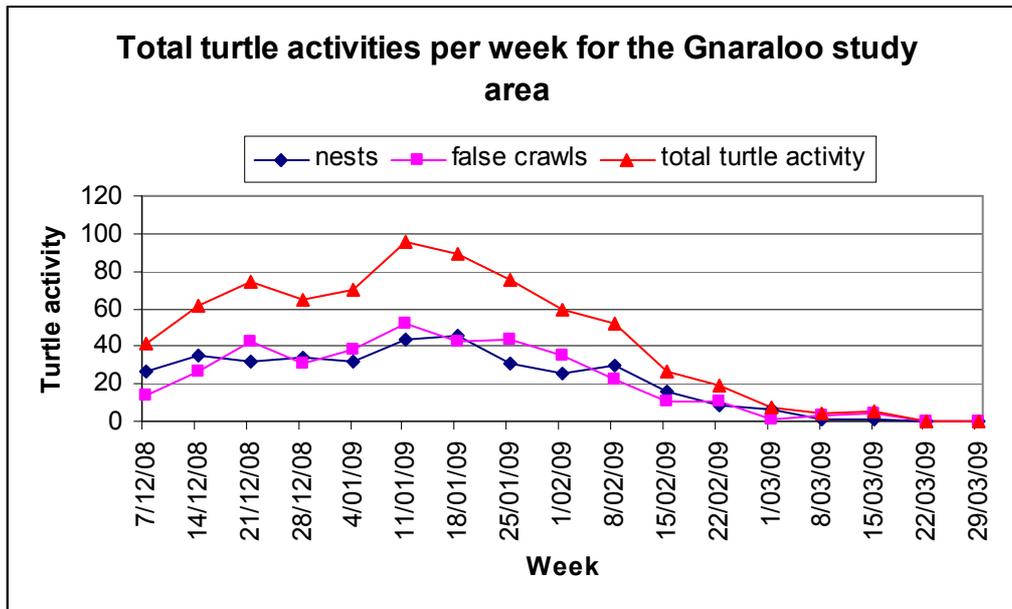


Figure 3.3: Total turtle beach activity per week from 1 December 2008 to 31 March 2009 in the Gnaraloo study area

The nesting activities rose constantly with peak of turtle activity occurred in mid January 2009 and began to decline steadily before finishing mid March 2009 (refer Figure 3.3). The false crawl activity also followed this trend.

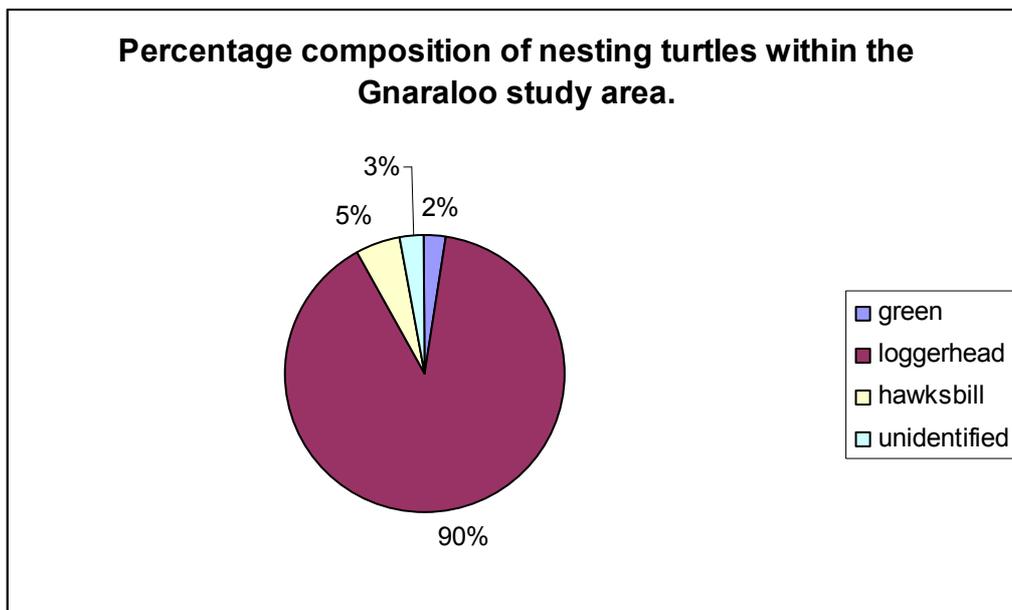


Figure 3.4: Total nesting turtle species composition for the Gnaraloo study area

Throughout the Gnaraloo season's duration, the percentage comparison (refer Figure 3.4), of nesting turtle species was characterised by 90% of the recorded nests produced by Loggerhead Turtles (*Caretta caretta*), 5% by Hawksbill Turtles (*Eretmochelys imbricata*), 3% unidentified and 2% Green Turtles (*Chelonia mydas*).

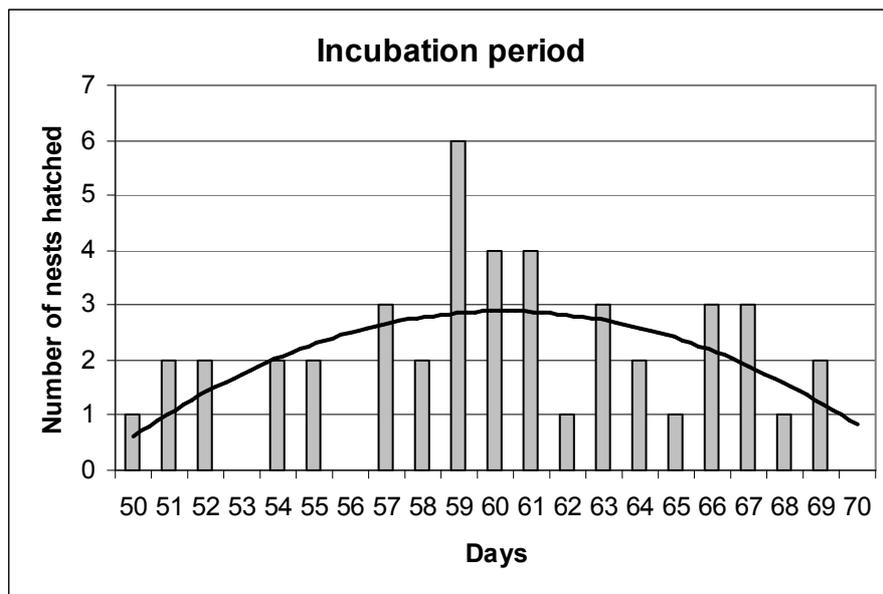


Figure 3.5: Incubation period of Turtle nests within the Gnaraloo study area

The highest frequency of incubation required 59-61 days before the first run of hatchlings (refer Figure 3.5). With the inclusion of possible hatching nests, this figure remained the same with slightly more variation in the data. This was also true for the whole study section with very little difference between Sub-sections.

Table 1: Percent status of nests within Sub-sections and Total Study Area

SUB-SECTION	% PREDATED	% HATCHED	% UNDETERMINED
GBN - BP6	16.67%	50.00%	50.00%
BP6 - BP7	9.32%	44.07%	46.61%
BP7 - BP9	2.35%	19.25%	78.40%
BP9 - BP10	6.45%	22.58%	70.97%
TOTAL STUDY AREA	5.16%	27.99%	67.12%

The predation percentage of the Total Study Area was 5.16% of all recorded nests. 27.99% of nests were observed to hatch during the monitoring period with 67.12% of nests not having recorded disturbance or hatching during the monitoring period, ending on 31 March 2009.

3.1.2 GBN - BP6

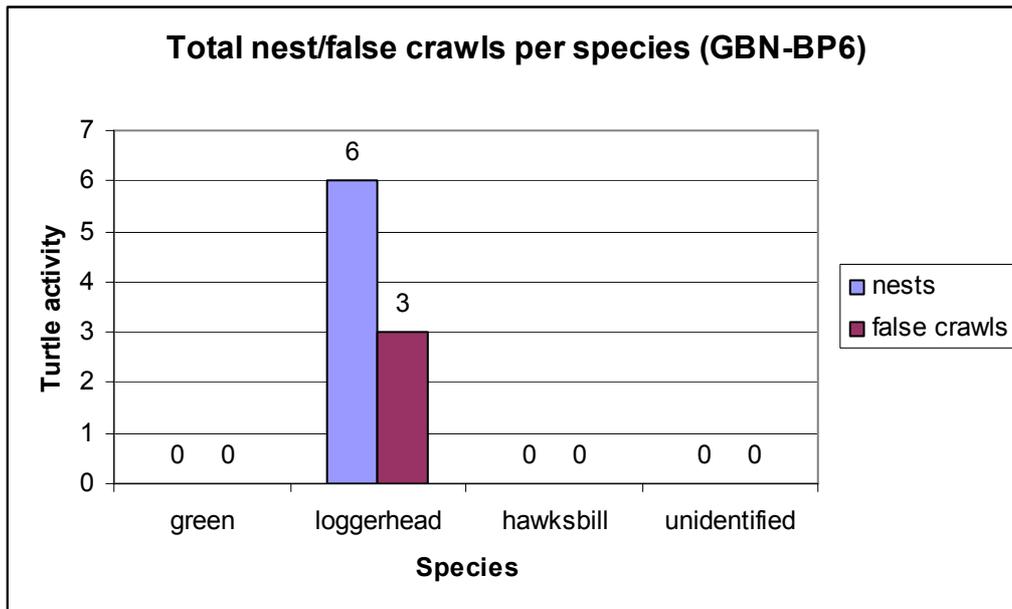


Figure 3.6: Total number of nests and false crawls per species for GBN - BP6

Gnaraloo Sub-section from Gnaraloo Bay North (GBN) to Beach Point 6 (BP6) recorded 6 nests and 3 false crawls within the season (refer Figure 3.6). All of the turtle activity in this Sub-section was Loggerhead Turtles (*Caretta caretta*).

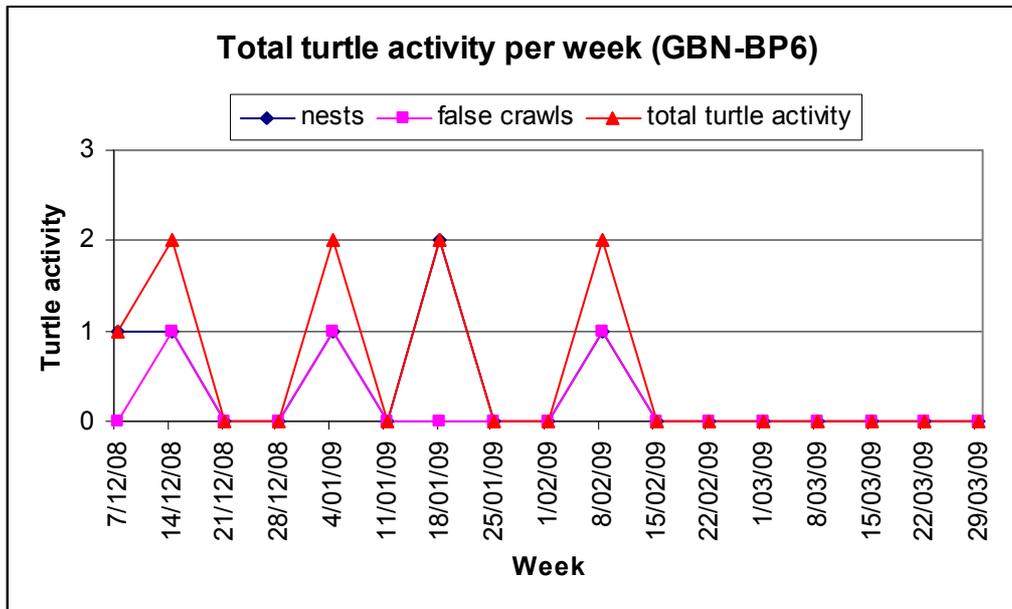


Figure 3.7: Total turtle beach activity per week for GBN - BP6 (01/12/08 to 31/03/09)

The nesting within GBN - BP6 was spasmodic, with the majority of nesting being recorded in December 2008 and January 2009 (refer Figure 3.7). Weeks that false crawls were recorded also coincided with nesting activity.

3.1.3 BP6 - BP7

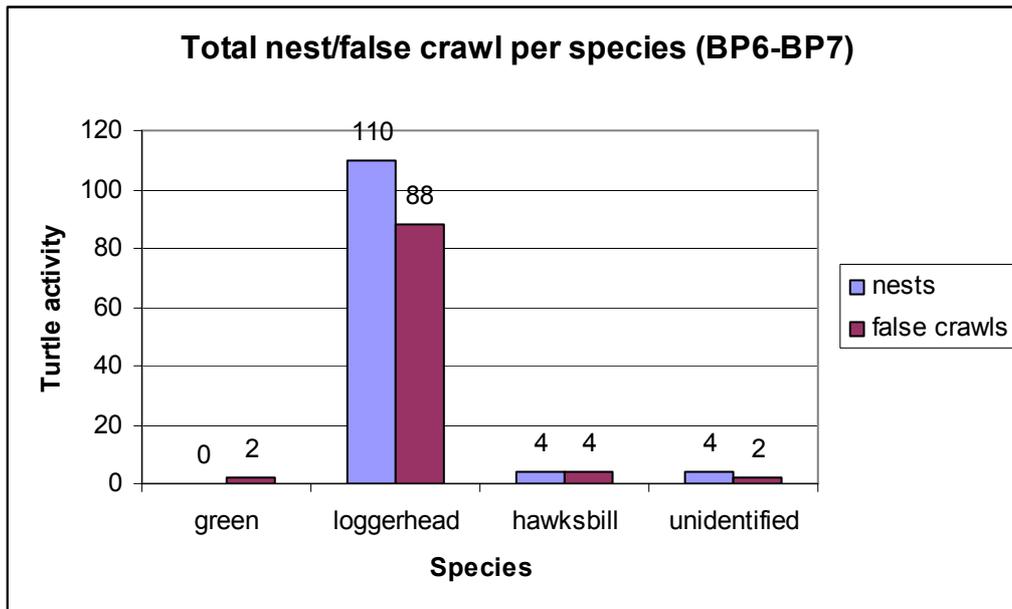


Figure 3.8: Total number of nests and false crawls per species for BP6 - BP7

Gnaraloo Sub-section from Beach Point 6 (BP6) to Beach Point 7 (BP7), recorded 118 nests and 96 false crawls in total throughout the season. The majority of the turtle activity in this Sub-section (refer Figure 3.8) was characterised by Loggerhead Turtles (*Caretta caretta*), with 110 nests and 88 false crawls.

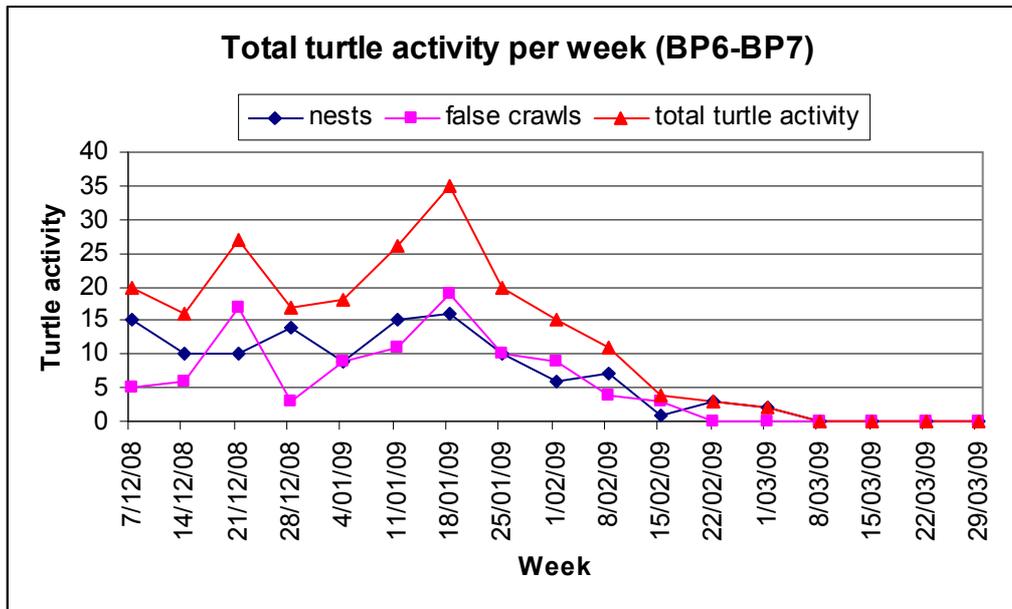


Figure 3.9: Total turtle beach activity per week for BP6 - BP7 (01/12/08 to 31/03/09)

The peak of turtle activity occurred in mid January 2009 before declining steadily and finishing at the beginning of March 2009 (refer Figure 3.9). The false crawl activity also followed this trend.

3.1.4 BP7 - BP9

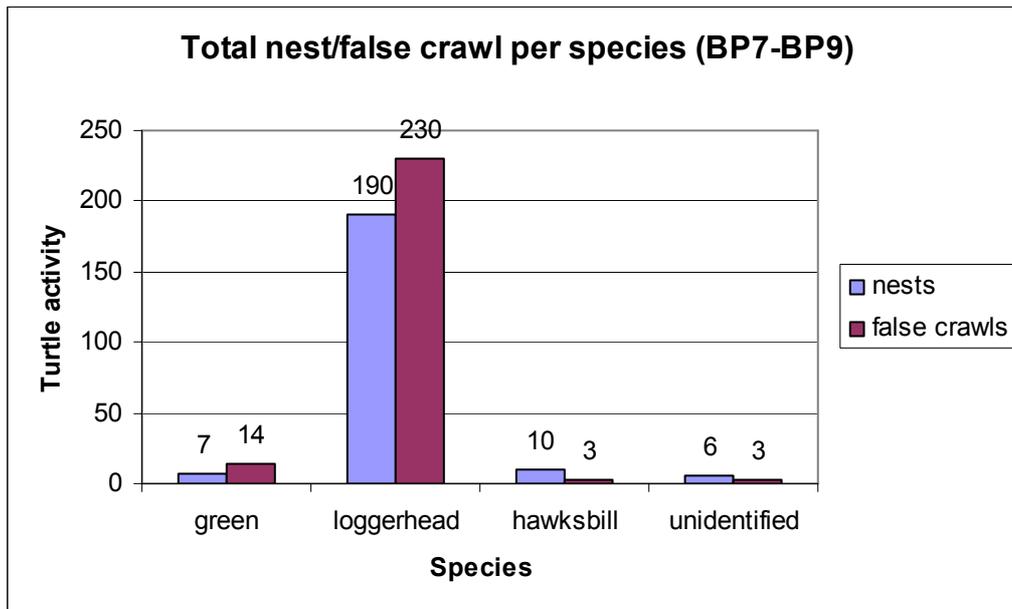


Figure 3.10: Total number of nests and false crawls per species for BP7 - BP9

Gnaraloo Sub-section from Beach Point 7 (BP7) to Beach Point 9 (BP9) recorded 213 nests and 248 false crawls in total throughout the season. The majority of the turtle activity in this Sub-section (refer Figure 3.10) was characterised by Loggerhead Turtles (*Caretta caretta*), with 190 nests and 230 false crawls.

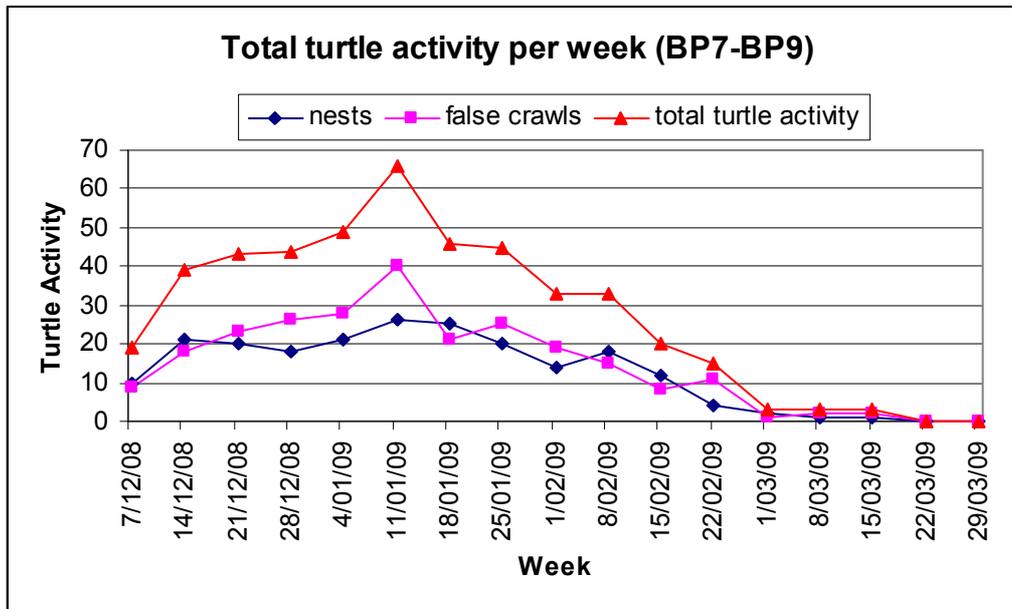


Figure 3.11: Total turtle beach activity per week for BP7 - BP9 (01/12/08 to 31/03/09)

The nesting activities within this section rose constantly and the peak of turtle activity occurred in mid January 2009, which began to decline steadily before finishing mid March 2009 (refer Figure 3.11). The false crawl activity also followed this trend.

3.1.5 BP9 - BP10

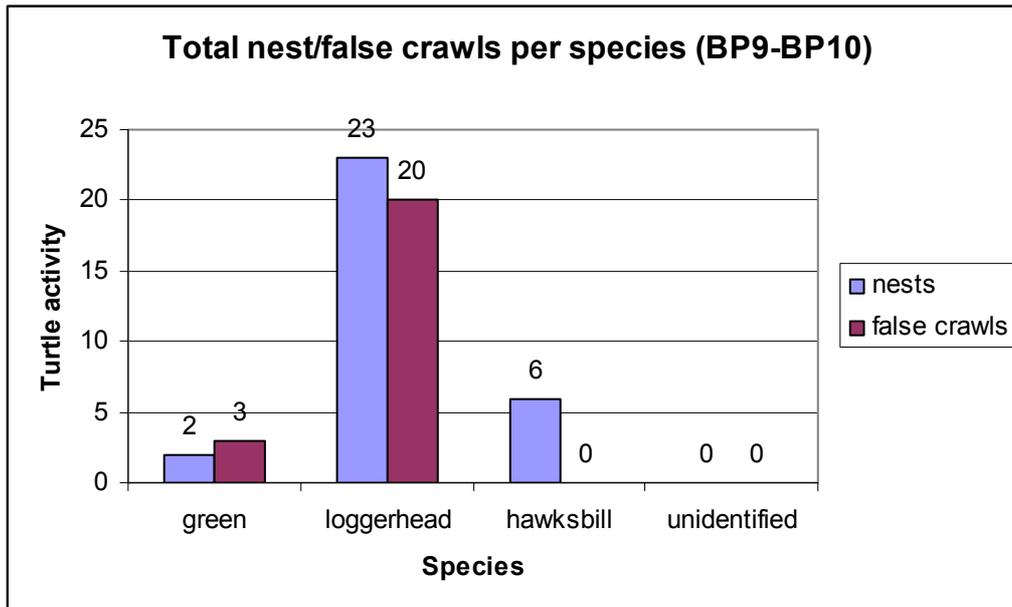


Figure 3.12: Total number of nests and false crawls per species for BP9 - BP10 (01/12/08 to 31/03/09)

Gnaraloo Sub-section from Beach Point 9 (**BP9**) to Beach Point 10 (**BP10**) recorded 31 nests and 23 false crawls in total throughout the season. The majority of the turtle activity in this Sub-section (refer Figure 3.12) was characterised by Loggerhead Turtles (*Caretta caretta*), with 23 nests and 20 false crawls. 6 Hawksbill (*Eretmochelys imbricata*) nests were also recorded in this section.

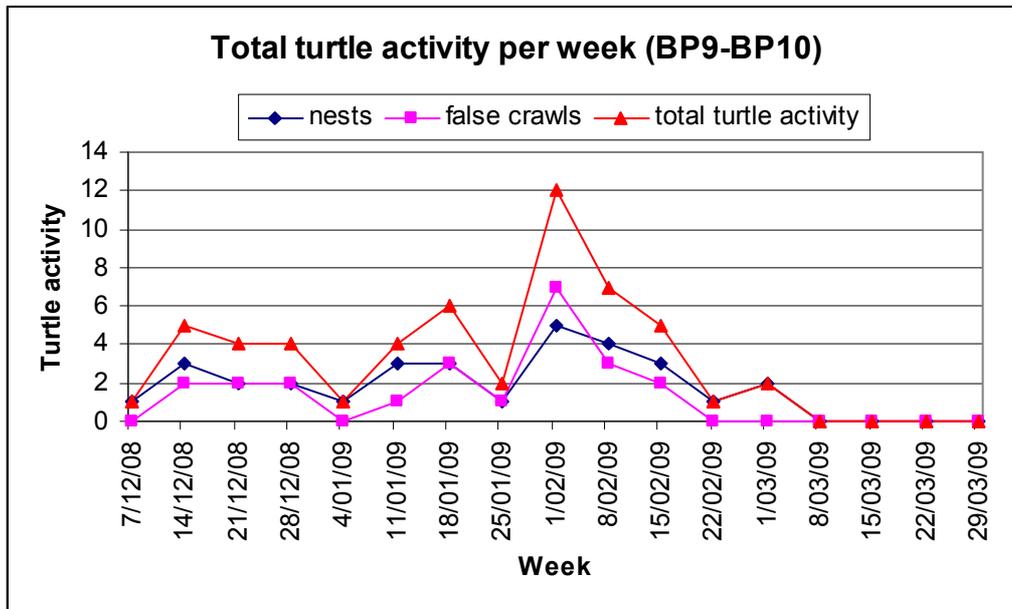


Figure 3.13: Total turtle beach activity per week for BP9 - BP10

The nesting activities within this section were varied initially, with the peak of turtle activity occurring at the beginning of February 2009 and began to decline steadily before finishing mid March 2009 (refer Figure 3.13). The false crawl activity also followed this trend.

3.2 Fox presence and Predation

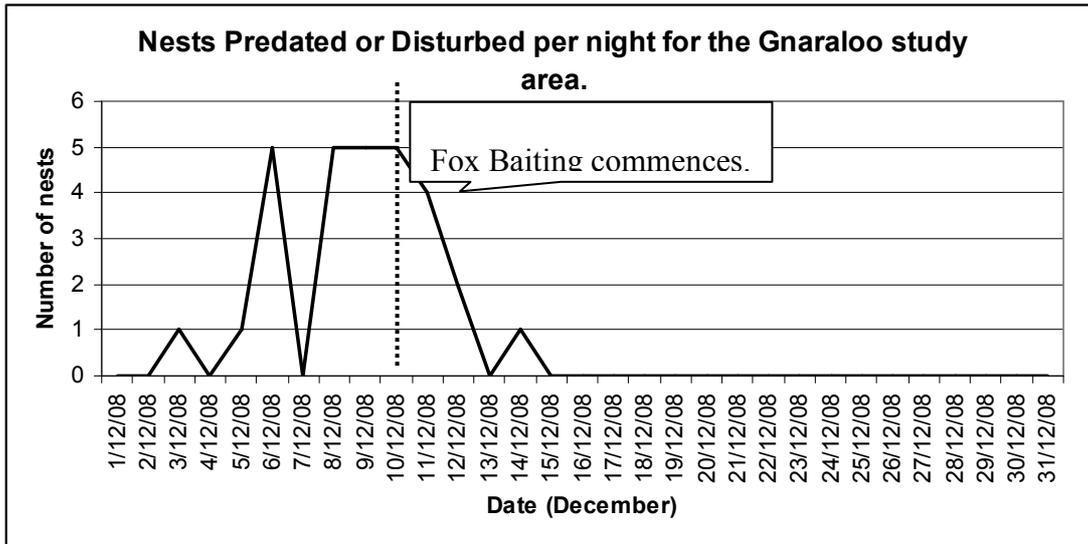


Figure 3.14: Number of nests predated or disturbed by foxes in December 2008

The beginning of the monitoring season experienced fox predation and disturbance throughout the overall Gnaraloo study section, with 29 nests affected in December 2008. The commencement of fox control measures on 10/12/08 was effective (refer Figure 3.14), with an immediate decrease in nest disturbance recorded from 14/12/08 onwards.

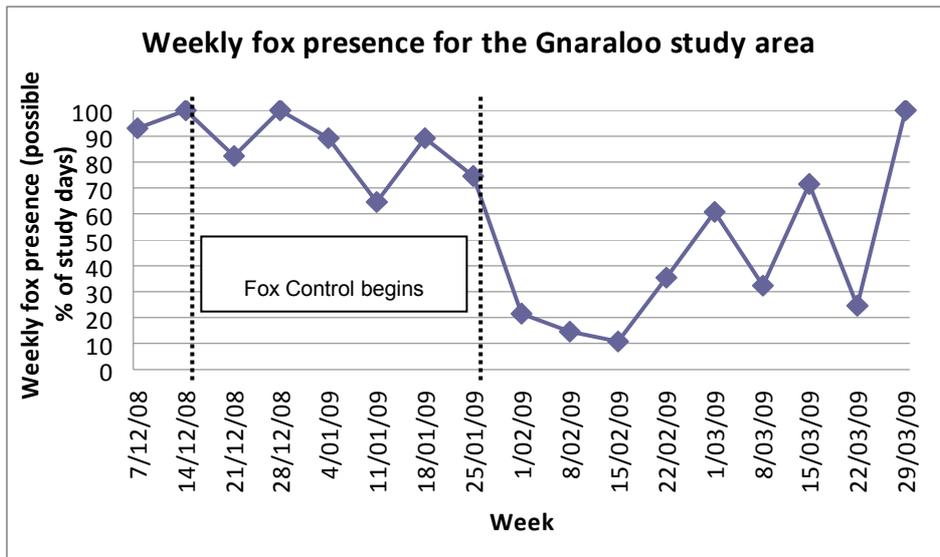


Figure 3.15: Percentage of possible fox presence per week in the Gnaraloo study section

Fox presence was observed on all beaches monitored and was frequent throughout all Sub-sections. The second (repeat) and more intense fox control event during January 2009 was effective in reducing the numbers of foxes on the beaches (refer Figure 3.15). After a period, the numbers steadily increased.

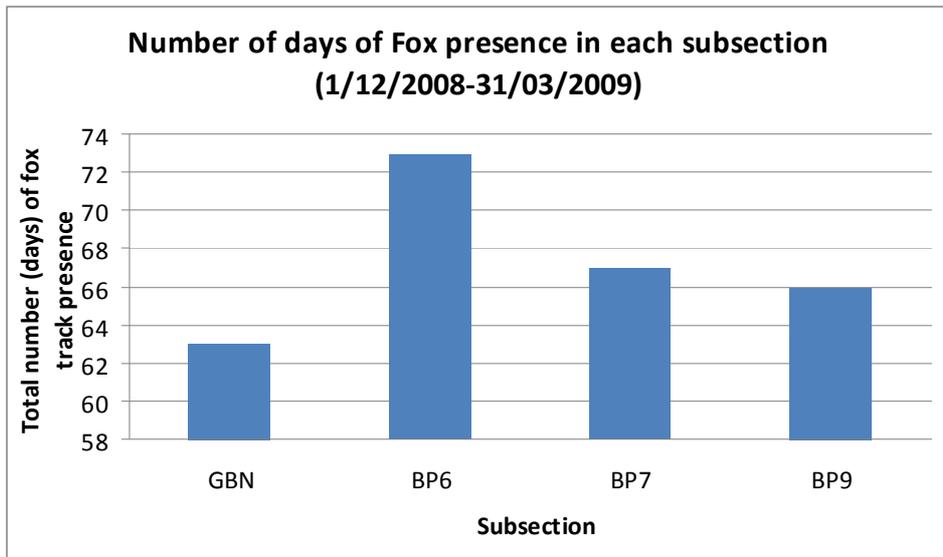


Figure 3.16: Number of days that fox tracks were recorded within Sub-section

The monitoring season consisted of 121 sample days approximately half of which experienced fox presence. Beach Point 6 (**BP6**) recorded the highest number of fox presence days (refer Figure 3.16), although this was very similar in all Sub-sections.

3.3 Night patrols

Table 2: Numbers and percentages of witnessed predation on emerging hatchlings by Ghost crabs

SPECIES	NUMBER OF HATCHLINGS EMERGING	NUMBER OF HATCHLINGS PREDATED	% MORTALITY
<i>Caretta caretta</i>	52	2	3.85%
<i>Caretta caretta</i>	4	1	25.00%
<i>Caretta caretta</i>	38	8	21.05%
<i>Caretta caretta</i>	36	6	16.67%

During the duration of night patrols (for portion of 21 evenings in March 2009, during sunset to sunrise), 4 nests were witnessed hatching (refer Table 1). The degree of ghost crab predation varied between observed nests with the highest predation being 25% and the average hatchling predation 16.64%.

4. DISCUSSION

Total Study Area

The study area selected along the Gnaraloo coastline for inaugural monitoring season 2008/09 comprised of the area Gnaraloo Bay North (**GBN**) to Beach Point 10 (**BP10**). This area was chosen as a suspected significant marine turtle rookery based on advice from DEC Exmouth during November 2008 and given informal Gnaraloo monitoring records since 2001.

The Total Study Area was divided into the following Sub-sections: Gnaraloo Bay North to Beach Point 6 (**GBN - BP6**), Beach Point 6 to Beach Point 7 (**BP6 - BP7**), Beach Point 7 to Beach Point 9 (**BP7 - BP9**) and Beach Point 9 to Beach Point 10 (**BP9 - BP10**)⁷. Whilst GBN – BP7 may be frequented by shore fishermen from time to time, the area BP7 – BP10 is remote with no human presence (presently and historically). Vehicle driving on beaches are not allowed at Gnaraloo.

The total number of marine turtle nests recorded over the course of the 2008/09 season resulted in 368 nests (inclusive of all species) and 370 false crawls (refer Figure 3.1). This gives an indication that within the Gnaraloo Total Study Area 738 turtle beach crawls were evident over the four month beach monitoring period.

These results help to indicate a significant turtle rookery being present at Gnaraloo Station.

The Gnaraloo Total Study Area was predominantly visited by Loggerhead Turtles (*Caretta caretta*) comprising 90% of the turtle nesting activity in the area. Other marine turtles that also frequented the area included Hawksbill (*Eretmochelys imbricata*) (5%) and the Green (*Chelonia mydas*) (2%) respectively (refer Figure 3.4).

A total of 3% of turtle nests were unidentified throughout the course of the study predominantly due to the effects of strong early morning winds and extreme high tides removing the characteristics of the tracks.

The areas of beach between Gnaraloo Bay and Beach Point 10 can therefore be classed as a Loggerhead rookery.

⁷ Refer to *Gnaraloo Marine Turtle Monitoring Protocol 2008/09* for details of the location of the monitoring sections.

Comparison of Sub-sections & Distribution of marine turtles

The distribution of turtle nests over the Total Study Area was non-uniform and higher densities existed on specific beaches (refer Figure 3.1). This may be due to inherent characteristics of the coastline and beaches such as the topography and bathymetry. The greatest density of turtle nests corresponded with beaches that had open access to the ocean [being Sub-sections Beach Point 6 to Beach Point 7 (**BP6 – BP7**) and Beach Point 7 to Beach Point 9 (**BP7 – BP9**)], as opposed to sheltered beaches within the fringing coral reefs [being Sub-sections Gnaraloo Bay North to Beach Point 6 (**GBN - BP6**) and Beach Point 9 to Beach Point 10 (**BP9 - BP10**)].

The beaches with open access to the ocean were often deeper with high wave energy and coarser sand; such is the case with the relatively open stretch of Gnaraloo coastline between BP6 - BP9, which had the highest nesting density of the Total Study Area.

These relationships may prove useful in the selection of future monitoring Sub-sections.

Sub-sections GBN - BP6 and BP9 - BP10 are both areas of low wave energy within embayments with fringing coastal reefs. These subsequently were also related to low turtle activity, with BP9 - BP10 recording 31 nests and 23 false crawls over the 2008/09 season. GBN - BP6 had the lowest turtle nesting over the Total Study Area, which may also be attributed to public access of these beaches and near shore waters.

Sub-sections BP6 – BP9 had the highest nesting density of the Total Study Area during the 2008/09 monitoring season. These beaches have open access to the ocean and are often deeper with high wave energy and coarser sand than Sub-sections GBN - BP6 and BP9 – BP10 that were less frequented by nesting turtles during the 2008/09 monitoring season.

Nesting Disturbance

Foxes

Predation by foxes within the Total Study Area was prevalent at the commencement of turtle monitoring season in December 2008. A total of 29 nests were disturbed by foxes in December 2008. The presence of foxes on the monitored beaches at this time was extremely high with tracks often present on all Sub-sections each day.

Fox disturbances and predation were frequent and distributed throughout the Total Study Area with 20.9% of nests being disturbed or destroyed.

Nests were often repeatedly unearthed over a series of nights until in some circumstances the complete egg chamber was consumed.

Structured fox baiting which commenced on 10 December 2008 proved to be effective, with decreases in the number of foxes on the beaches and an almost immediate reduction in nest predation (refer Figure 3.14). Fox baiting was repeated during January 2009 and no more disturbance was evident throughout the turtle season.

The presence of foxes on the different Gnaraloo Sub-sections was highest at Beach Point 6 (BP6), but evident throughout all sectors.

Although fox baiting was undertaken (during December 2008 and January 2009) and the disturbance of nests ceased, fox tracks were evident throughout the 2008/09 season at all Sub-sections (refer Figure 3.15).

This gives the indication that the fox population is readily replenished from unbaited areas of young foxes finding new territory.

These foxes had not yet developed the ability and knowledge to dig fox nests, and were not as destructive to the turtle nests within the study area although creating predatory pressure on emerging hatchlings. Due to this threat, fox shooting was undertaken by turtle research staff.

Golden Ghost Crabs

The Golden Ghost Crab (*Ocypode convexas*) is prevalent throughout the Total Study Area. It is said to be a natural predator of marine turtle eggs and hatchlings.

The extent of the predation of turtle nests by ghost crabs is largely undescribed in this study due to the discrepancies in determining the point at which it is to be recorded. Determining the point at which a nest is predated by ghost crabs is highly ambiguous as it is common for nests to have some form of disturbance by crabs. Investigation into or monitoring of crab predation was therefore not included in the Scope of Work for this study.

Crab predation is however defiantly evident within each Sub-section that was sampled throughout the study. The extent of this is undetermined.

Refer to the section 'Recommendations' for proposed solutions to this issue.

Nest Status

The nest status figures generated by this report are relevant to the end of the study.

The high percentage of 'Undetermined nests' within the study (67.12%, refer Table 1) is reflective of a variety of pressures: such as beach erosion removing nests, non-recorded predation such as by Ghost crabs and hatching events occurring outside of the monitoring period. Nests that were laid late in the season 2008/09 will not have been recorded as hatching and predation figures are limited to the nests disturbed before the initial fox control event on 10 December 2008. The differences in the comparison between Sub-section results are due to the differing nesting density between each section and the relative size of each section.

Hatchlings

The inaugural research program which commenced during the 2008/09 season conducted both morning beach patrols as well as night patrols (portion of 21 evenings in March 2009) during the turtle hatching period.

This was to provide an indication of the extent of predation by crabs and foxes, and of the relative number of turtles hatching at each emergence.

The results of the incubation period are typical of the north west of Western Australia with most frequent length of time being 59 - 61 days (refer Figure 3.5).

This gives an indication of which nests to target in future night time monitoring sessions to determine predation levels on hatchlings.

It is also noted that after the initial hatching event the nest continued to run over a period of nights, with either a small number of hatchlings emerging at a time or a large run of 50 or more hatchlings.

Through evening monitoring, the level of ghost predation on emerging hatchlings was found to on average of 16.64% (refer Table 2).

There was however only a small sample size, encountering only four nests over the course of the night patrols. The data on predation levels may also not be entirely accurate due to human presence on beaches and the behaviour of ghost crabs. Human presence on the beach during night-time patrols disperses the ghost crabs, giving an inaccurate description of the number of hatchlings being eaten.

Data Integrity

Although the data collection and management protocols set out in the *Gnaraloo Marine Turtle Monitoring Protocol 2008/09* were strictly adhered to, ambiguity in the results was inevitable due to a variety of environmental conditions which impacted on the nests as well as on data collection. This included strong winds, sand drifts, beach erosion and sediment movement due to a variety of factors.

For example, during hatching season, difficulty was experienced using morning beach observations only to accurately and with confidence record nest hatching and emergence success rates and hatchling mortality rates, for example, by Golden Ghost Crab (*Ocypode convexas*). The strong winds blowing parallel to the shore erased turtle tracks very effectively making species identification difficult at times and identifying successfully hatched nests very difficult.

The wind also contributed to a huge degree of sand movement which created large scale sand drifts that buried nests and the associated nest markers. This led to the visual loss of the nest and may have impacted the hatching success of that nest.

The persistent and strong southerly winds characteristic of the turtle nesting season in the Gnaraloo area influenced the recording of data and the nest itself.

As hatchling tracks were often very faint by morning and the only method available for detection of nest emergence was heavy reliance on the observation skills of a particular individual monitor, a low level of confidence exists that the Gnaraloo turtle tracker team for the 2009/10 season would be able to 100% duplicate the detection 'methodology' employed during 2008/09. As such, the methodology employed for data collection of nest hatching success rates and hatchling mortality rates during 2008/09 is considered to be open to error

and inconsistency from year to year. This will affect the consistency of results within a particular season, and also the results from year to year, which will affect the level of confidence that may be ascribed to this monitoring component and the reliance that may be placed in the program's results or in variations shown by the data. Refer to the section 'Recommendations' for proposed solutions to this issue.

Many of the beaches within the study section are also relatively narrow and steep. This results in an increased degree of erosion and sediment movement of the beach profile. The occurrence of spring tides and large swells move large amounts of sediment off the beach and frequently the associated turtle nests. Specific beaches are more susceptible to this than others.

The beaches which are not protected by fringing reefs experience the highest degree of erosion.

This unfortunately often coincides with the highest nesting densities. This impact would be extenuated in a cyclone event with a large degree of nest mortality being experienced.

Monitoring Equipment – Quad Bikes

Gnaraloo Station had 2 quad bikes available for use during the turtle monitoring program 2008/09, a 1-seater quad (pull-start, without computerized systems) and a more recent model 2-seater quad bike (electric start, with computerized systems). However, the latter was not able to be used during the season due to corrosion issues with its computerized and electrical systems. Refer to the section 'Recommendations' regarding this issue.

Due to the extremely corrosive environmental conditions at the isolated location at Gnaraloo, high wear-and-tear was experienced on all mechanised equipment used for the 2008/09 program, including vehicles, the quad bike, automotive instruments and tools. This necessitated ongoing and repeated mechanical assistance and repair work by the *Gnaraloo Mechanical Service and Repairs Workshop*⁸.

⁸ Gnaraloo Station has a fulltime mechanic onsite who operates a fully equipped onsite mechanical workshop.

5. CONCLUSION

The inaugural 2008/2009 season of the *Gnaraloo Marine Turtle Research Program* successfully gathered baseline data into the nesting population and characteristics of marine turtles in the Gnaraloo area.

Conclusions drawn from this study include that the area has a significant Loggerhead Turtle (*Caretta caretta*) rookery, with 329 successful Loggerhead nests recorded this season. A relatively small number of Hawksbill (*Eretmochelys imbricata*) and Green Turtles (*Chelonia mydas*) were also recorded nesting within the study area. The total number of marine turtle nests recorded over the course of the 2008/09 season resulted in 368 nests (inclusive of all species) and 370 false crawls.

Overall the nesting density and frequency peaked in mid January 2009 before decreasing. Gnaraloo Sub-sections Beach Point 6 to Beach Point 9 (**BP6 – BP9**) were found to record the greatest amount of turtle nesting. As a result of daily monitoring, it was found that throughout the study area the most frequent incubation period is between 59 - 61 days.

The nests within the Total Study Area face a variety of predatory and disturbance impacts. The impacts are environmental, including erosion from tide and swell, and loss of nests due to sand drifts. The nests also face fox predation whether it be deliberate unearthing of the egg clusters within nests or the predation of hatchlings. It is indicated that Golden Ghost Crabs (*Ocypode convexas*) also contribute to turtle mortality with direct burrowing into nests and predation on emerging hatchlings, this needs to be further investigated in future monitoring seasons.

6. RECOMMENDATIONS

Environmental Data – Gnaraloo Weather Station

Access to weather and tide data specific to the Gnaraloo area would be very beneficial to the daily monitoring operations (to collection and recording of the daily fluctuating data parameters) and to incorporation into the statistical and data analysis.

This would be accommodated by the presence of a local small weather collection station (appropriately located in relation to the Total Study Area).

Alternatively, daily access is required to professionally amended meteorological and hydrological data.

The following data needs to be collected and recorded daily during future seasons for each particular Sub-section being monitored:

- temperature;
- wind direction;
- sea temperatures;
- tide and swell conditions;
- heat of the sand in each Sub-section.

Monitoring Equipment - Quad Bikes

The use of quad bikes is necessary for the efficient monitoring of the large and isolated areas comprising the Total Study Area.

Due to the extremely corrosive conditions at Gnaraloo, it is suggested that quad bikes without computerized electrical systems be employed rather than quads with such systems.

With two quad bikes, the daily monitoring would be faster and would also allow for the possible enlarging of the study area.

The feasibility of access into expanded monitoring areas and whether they are nesting beaches would need to be undertaken.

Nesting Disturbance - Fox Control

The timing of fox control measures correlates directly with the degree of predation on nests and fox presence on the beaches.

To have a maximum effect, fox baiting should occur at the beginning, middle and especially at the end of the annual turtle season.

This is due to the vulnerability of hatchlings to fox predation. The annual turtle season is believed to occur from November to April.

Nesting Disturbance - Crab Predation

*The extent of Golden Ghost Crab (*Ocypode convexas*) predation needs to be investigated in future monitoring seasons, during both the nesting period and the hatching period.*

To accurately determine the extent of crab predation during the nesting period, it should be recorded from the start of the season. The degree of interference should also be decided upon at the beginning of the season. For example, if there are 10+ crab burrows into a nest with egg shells present on the beach, then crab predation is evident and should be recorded.

The issue with collecting reliable and unambiguous data into hatchling predation by crabs is the very presence of the monitor on ghost crab activity. The ghost crabs avoid humans and the positioning of the person in relation to the hatchlings and ghost crabs directly interferes with the results.

To accurately collect the true impact of ghost crabs on a hatching nest, it is recommended that consideration occur of temporary installation and use of night vision cameras near potential hatching nests. This would allow for the least amount of interference and hopefully best results.

Future Research

It is recommended that the Gnaraloo track counting research program be expanded in future to investigate additional data parameters.

Research during future monitoring seasons may include:

- hatching and emergence success percentage rates, including hatchling numbers per nest;
- hatchling mortality rates, including the extent of Golden Ghost Crab (*Ocypode convexas*) predation (refer immediately above) in order to determine nesting success rates;
- population and genetic profiling to determine the uniqueness and importance of the Gnaraloo population to the world turtle stock and gene pool;
- tagging to determine migratory pattern, connectivity of the Gnaraloo population with world population and foraging grounds; and
- collation, interpretation and publication of the Gnaraloo monitoring data (including informal records since 2001).

The Gnaraloo Marine Turtle Monitoring Protocol

*To record hatching and emergence success rates and hatchling mortality rates, for example by Golden Ghost Crab (*Ocypode convexas*), with confidence, consider revising the Gnaraloo Marine Turtle Monitoring Protocol 2008/09 to include morning and night patrols during the hatching season 2009/10.*

This is because reliance cannot be placed on hatchling tracks observed during morning patrols (due to environmental conditions such as strong winds, sand drifts and high tides erasing hatchling tracks).

Refer to the recommendations made above under 'Crab Predation' and 'Future Research'.

Additional Monitored Sub-sections along Gnaraloo Coastline

The potential for monitoring additional Sub-sections exists, especially further north of the present Total Study Area.

Marine turtle nests have been observed on the southern part of Cape Farquhar and nearby beaches as well as further north toward the Gnaraloo / Warroora boundary.

The feasibility of monitoring daily in this area would need to be explored as would the possibility of the establishment of a remote camp in this area.

Access through 6Mile Gate

To ensure reliable and constant access through the locked gate at 6Mile to Gnaraloo Sub-sections BP7 – BP10, a second key cut primarily for the turtle monitoring program would be beneficial.

Nest Markers

The use of one colour tape in a chronological order is helpful.

This is especially so toward the end of the turtle season when hatching occurs. When monitoring hatching, the relative age (colour tape) of the nest is helpful to locate nests likely to be hatching.

Literature review for 2009/10 season

It is recommended that the Gnaraloo Turtle Tracker Team(s) 2009/10 review appropriate scientific literature, manuals, protocols and databases prior to commencement of the onsite monitoring work at Gnaraloo.

This includes the following references:

<i>Gnaraloo Turtle Monitoring Protocol 2008/09</i>	Gnaraloo Station, Becker <i>et al.</i> 2008
<i>Guide to Turtle Track Beach Monitoring in Australia</i>	DEC, Lewis <i>et al.</i> 2008
Ningaloo Turtle Program Database, including Gnaraloo sub-component from 2008/09	DEC Gnaraloo Station
Ningaloo Turtle Program website and Turtle Toolbox	DEC, www.ningalooturtles.org.au/

From International Sea Turtle Society, 29th Symposium on Sea Turtle Biology and Conservation, Brisbane, 17 -19 February 2009:

<i>Western Australia's Ningaloo Turtle Program: Cost effective threat based conservation involving community, Government and non-Government Organisations</i>	Roland Mau, Susie Bedford, David Waayers, Raquel Carter, Kate Macgregor, Paul Gamblin, Catherine Samson, Kim Onton, Brooke Halkyard and Amy Lewis
<i>Sea Turtles in the Western Australian Region: What do we now know/still need</i>	Robert Prince
<i>Track Counts: a useful tool for monitoring temporal and spatial trends in sea turtle nesting activity and potential impacts from Industry</i>	Jessica Oates, Kellie Pendoley and Milani Chaloupka
<i>Relative exposure index: an important factor in sea turtle nesting distribution</i>	Julia Santana Garcon, Alana Grech, James Moloney and Mark Hamann
<i>No time to chill out: GPS tracking reveals micro-habitat selection by breeding loggerhead turtles</i>	Gail Schofield, Charles M. Bishop, Kostas A. Katselidis, Panayotis Dimopoulos, John D. Pantis and Graeme C. Hays
<i>Environmental correlates of nesting in loggerhead turtles, <i>Caretta caretta</i></i>	David A. Pike
<i>Climatic change and changes in sea turtle nesting distributions</i>	David A Pike
<i>Survey effort: what are we really missing when we miss turtles on the nesting beach?</i>	Andrea U Whiting, Colin J. Limpus and Milani Chaloupka
<i>Health assessment of nesting loggerhead turtles (<i>caretta caretta</i>) in Western Australia</i>	Sabrina Trocini, Peter Spencer, Stuart Bradley, Kristin Warren, Amanda O'Hara, Susan Perkins and Ian Robertson
<i>Detection of beach-specific magnetic signatures by sea turtles: the key to natal homing?</i>	Kenneth J. Lohmann, Amy J. Horner, Leah Akins and Catherine M. F. Lohmann
<i>Turtle Research Database System (TREDS)</i>	www.sprep.org/turtles/topics/TREDS.htm
<i>Post Nesting Migrations of Hawksbill turtles (<i>Eretmochelys imbricata</i>) in the Strait of Malacca. Satellite Tracking and Analysis Tool (STAT)</i>	Arvind Devadasan, Lau Min Min and Grace S. Duraisingham
<i>The IOSEA online reporting facility: a cutting edge tool for turtle practitioners and decision makers</i>	Douglas Hykle, www.ioc.turtle.org

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Ningaloo Fox Control Program (undated). Department of Conservation and Land Management, Western Australia.

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