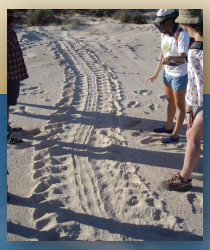
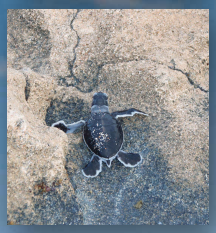
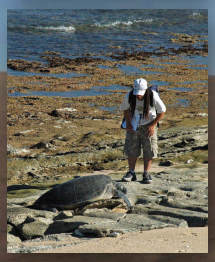
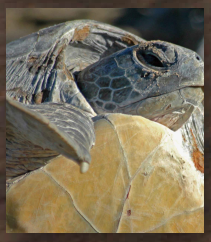
Ningaloo TURTLE PROGRAM

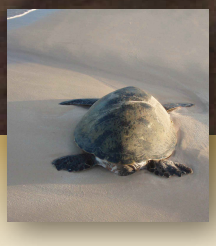
ANNUAL REPORT 2007-2008











Wildlife Link
The Tony & Lisette Lewis Foundation

CAPE CONSERVATION

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WWF

Coastwest

Government of Western Australia
Department of Environment and Conservation

RANGELANDS
NRM Co-ordinating Group

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The Department of Environment and Conservation
WWF-Australia

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Gnulli Native Title Working Group – The program is conducted on the traditional lands of the Jinigudira, Thalanji and Baiyungu people. We thank them for their traditional custodial role and continuing support for turtle conservation.

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Natural Heritage Trust
Coastwest
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Bhpbilliton
Tony and Lisette Lewis Foundation WildlifeLink

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Executive Summary

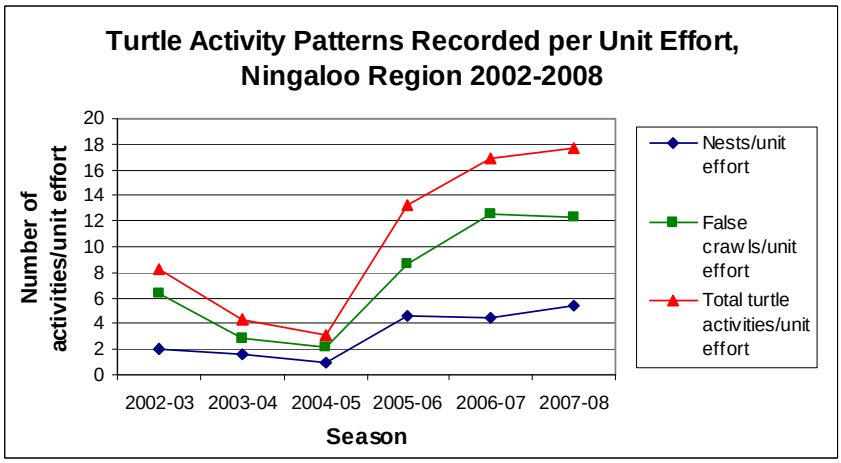
The Ningaloo Turtle Program (NTP) was established in 2002 as a collaboration between the Cape Conservation Group (CCG), the Department of Environment and Conservation (DEC) Exmouth District Office and WWF-Australia.

During the 2007-08 season the NTP involved the morning monitoring aspect of the Ningaloo Community Monitoring Turtle Program but excluded the night time observation aspect at the Jurabi Turtle Centre, resulting in a slight reduction in volunteer numbers and hours contributed to the program. The North West Cape, Bundera and Coral Bay divisions were monitored in the Ningaloo region between the 1st of December 2007 and the 28th of February 2008.

Over the six seasons of operation since its commencement in 2002 the NTP has continued to collect data as part of the process to determine long term trends in marine turtle nesting and estimated turtle population numbers in the Ningaloo region.

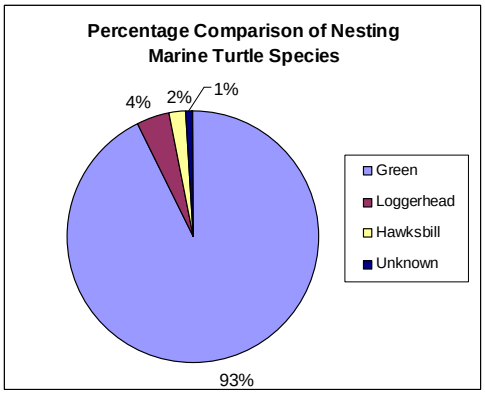
A total of 6277 nests and 14230 false crawls were recorded in the 2007-08 NTP season, of which 5,596 nests and 13,427 false crawls were recorded in the North West Cape division, 610 nests and 749 false crawls were recorded in the Bundera division and 71 nests and 54 false crawls were recorded in the Coral Bay division. In addition to the highest abundance of turtle nesting, the North West Cape division also experienced the highest nesting density (followed by the Bundera division and then the Coral Bay division) according to the collected data. Green turtles were responsible for 18394 activities (nests and false crawls), loggerhead turtles for 1746 activities and hawksbill turtles for 292 turtle activities. Green turtles have consistently been recorded to produce the majority of nests in the Ningaloo region over all seasons, with the exception of the 2004-05 season in which loggerhead turtle activity levels were similar to that of green turtles.

Based on several assumptions and basic estimates, the turtle nesting numbers recorded this season equate to approximately 1843 - 2669 green, 70 – 104 loggerhead and 44 – 64 hawksbill nesting female turtles in the North West Cape division during the 2007-08 season. Based on the same assumptions and method of calculation for other seasons there has been a general increase in the number of turtles recorded since the commencement of the NTP. This same upward trend applies for green and hawksbill turtles but loggerhead numbers have been more variable and have decreased since a peak in the 2005-06 season. The total level of turtle activity recorded per unit effort decreased between 2003 and 2005, possibly due to ENSO-related events affecting food quality and quantity.

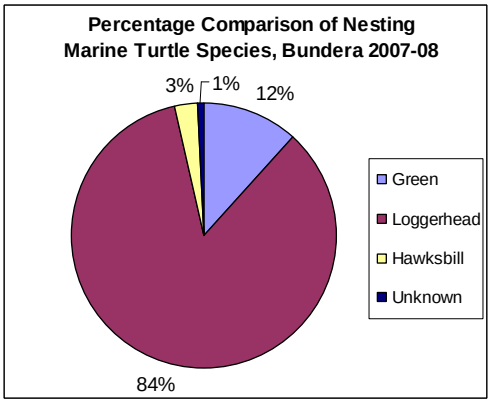


Numbers of nests, false crawls and total turtle activities recorded per year (adjusted for survey effort) since the commencement of the Ningaloo Turtle Program.

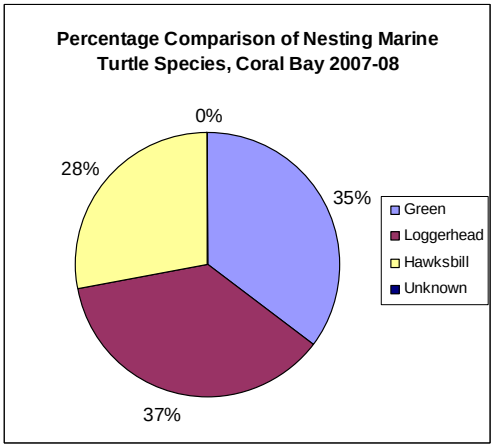
Throughout the 2007-08 season green turtles were responsible for the majority (93%) of nests recorded in the North West Cape division on a weekly basis. This trend was reflected in all other seasons thus verifying that green turtles are the most abundant species to nest along this section of the coastline. In the Bungelup division loggerhead turtles were responsible for 84% of the total number of nests recorded and this trend is also reflected in the data collected for all seasons. This supports the observation identified in previous NTP reports that Bungelup is a significant loggerhead turtle rookery. This season levels of all three turtle species were relatively evenly recorded within the Coral Bay division but there is a general trend across seasons for loggerhead turtles to be the most abundant species to nest in the area.



The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the North West Cape division during the 2007-08 nesting season.

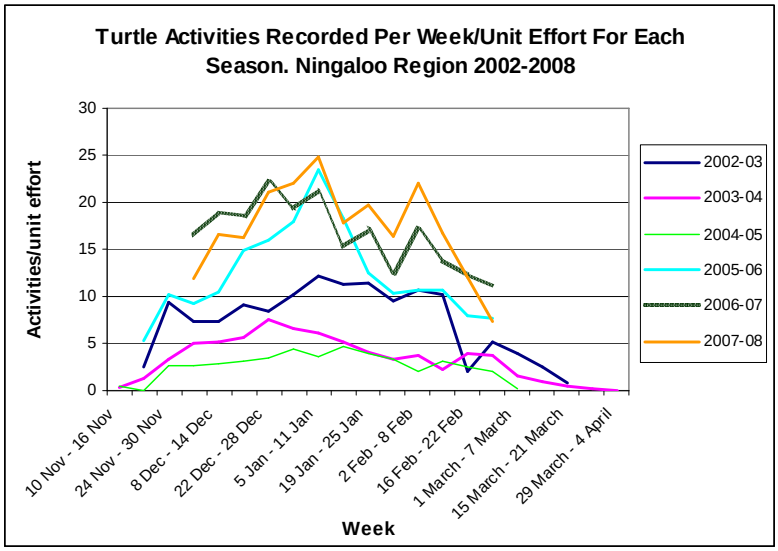


The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the Bundera division during the 2007-08 nesting season.



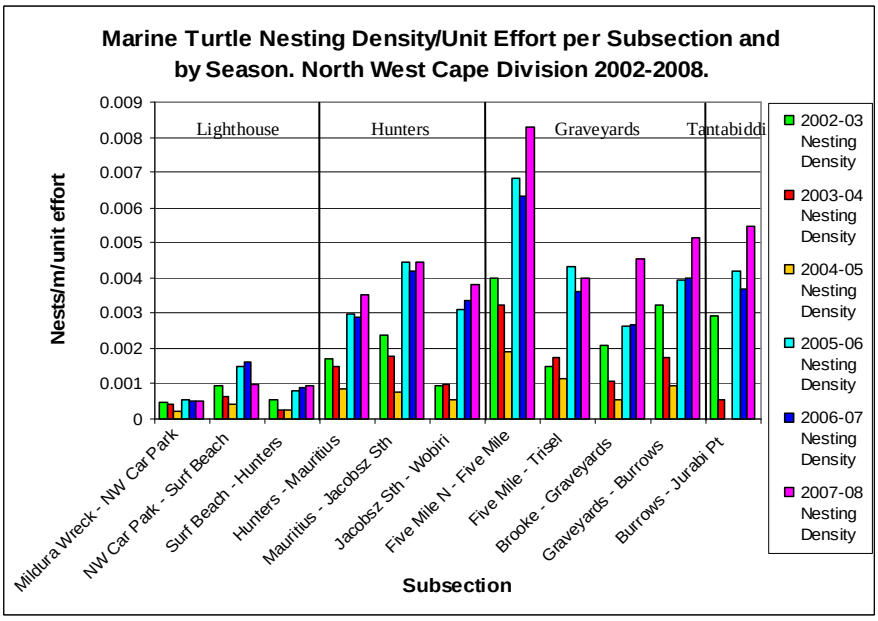
The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the Coral Bay division during the 2007-08 nesting season.

The nesting peak of marine turtles in the Ningaloo region has generally occurred between the 5th and the 11th of January in all monitored seasons. The nesting peak for the North West Cape division generally occurred between the 5th and 18th of January, whereas in the Coral Bay division it occurred between the 29th of December and the 11th of January. Regarding the Bundera division, nesting level trend lines suggest that the nesting peak occurred before the commencement of monitoring in the 2002-03 and 2007-08 seasons and between the 15th of December and the 11th of January for all other seasons.



Total number of turtle activities (adjusted for survey effort) recorded per week, in each season in the Ningaloo region between 2002 and 2008.

In the North West Cape division this season the highest nesting density was recorded in the Graveyards section (1.39 nests/m) followed in order of decreasing density by the Hunters (1.22 nests/m), Tantabbidi (1.21 nests/m) and Lighthouse (0.31 nests/m) sections. The same trend has been observed for all monitored seasons. Green turtles nested in the highest density within the Graveyards section but loggerhead and hawksbill turtles nested in the highest density in the Hunters section.

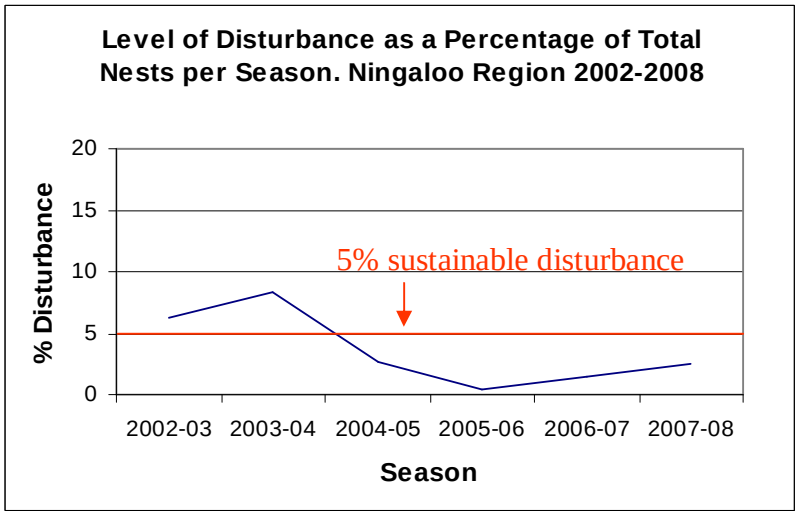


Nesting density/unit effort recorded per subsection for each season in the North West Cape division between 2002 and 2008.

Very low levels of turtle activity were recorded in the Coral Bay division throughout the season but the Lagoon section experienced a slightly higher nesting density (0.025 nests/m) than the Batemans Bay section (0.005 nests/m). This was the trend observed for all three species. Only one section (Bungelup) was monitored in the Bundera division, within which a low nesting density was recorded (0.11 nests/m).

By using information on peak nesting times and areas, monitoring effort can be reduced to concentrated periods which encapsulate both the peak nesting period and areas containing the densest turtle activity. Future endeavours of the Ningaloo Turtle Program include reducing temporal and spatial monitoring effort and extrapolating additional data using predictive modelling techniques.

During the 2007-08 season 157 nests were recorded as damaged in the Ningaloo region, the majority of which (135) occurred in the North West Cape division. The highest numbers of damaged nests were located in areas of high nesting density thus indicating density-dependant predation. The majority of these nests were damaged by ghost crabs. One of the highest levels of nest disturbance was recorded this past season; however this is attributed to the increase in the number of nests recorded per unit effort because since the 2004-05 season the recorded level of nest disturbance has remained under the sustainable level of 5% of the total number of nests produced. Therefore this indicates that the fox baiting program implemented in the North West Cape division in 2004 has remained effective.



Percentage of nests recorded to be disturbed per season in the Ningaloo region between 2002 and 2008.

Eighteen turtle mortalities were recorded in the 2007-08 season and eleven marine turtles were rescued by NTP volunteers. This marks a reduction in both the number of mortalities and rescues recorded since previous seasons, despite a higher level of turtle activity recorded on the beaches.

Four tropical cyclone events affected the Ningaloo coastline throughout the 2007-08 season and it is estimated that these events caused a loss of approximately 1144 – 1490 nests, being 18.2 – 23.7% of the total nests recorded for the season.

The NTP had another successful season with 106 volunteers contributing 7592 hours of their time to the NTP, maintaining a general upward trend in the volunteer numbers and hours contributed. A high level of international interest in the program continues and support from the local community continues to be a major factor contributing to the success of the program.

Key recommendations for upcoming seasons include the following:

- Continue to monitor the beaches of the Ningaloo coastline in order to gain a (>) 10 year dataset which will enable the determination of long term nesting trends and an estimate of the size of the breeding turtle population in the Ningaloo region. This will thereby assist with the conservation of marine turtles and the management of issues pertaining to their successful conservation.

- Decrease spatial and temporal monitoring periods and extrapolate additional data using predictive modelling techniques to maximize the efficiency of the NTP. Monitoring should continue in at least the Hunters, Graveyards and Bungelup sections for a period which includes at least the first half of January.

- Continue fox baiting in the North West Cape, Bundera and Coral Bay divisions, to maintain the current low level of fox predation on nests and hatchlings.

- Do cross-checks of monitoring data on random subsections periodically throughout the monitoring season to verify the quality of data collected.

- Incorporate further research into the NTP on topics such as hatchling survivorship rates and the level of damage caused by cyclonic events.

- Maintain a consistent approach to monitoring throughout seasons and ensure that all trainers are clear and consistent with this approach.

- Clarify to all trainers and volunteers exactly what constitutes ghost crab predation and instruct them on the appropriate recording of these incidences.

- Maintain an effective level of communication between all NTP members, the local community and volunteers.

1.0 INTRODUCTION

1.1 Ningaloo Marine Park

The Ningaloo Marine Park (the Marine Park) is located off the North-West Cape of Western Australia and covers an area of approximately 263 343 hectares (Department of Conservation and Land Management 2005). The Marine Park was originally gazetted in 1987 to protect the Ningaloo reef: Australia's largest fringing reef that stretches 260km along the Western Australian Gascoyne coastline. The boundaries of the Ningaloo Marine Park were altered in 2004 to include the entire Ningaloo reef (Department of Conservation and Land Management 2005).

The Ningaloo region is an area renowned for its beauty and high level of marine biodiversity. The Ningaloo Management Plan reports a total of over 500 species of finfish, 600 species of mollusc and 90 species of echinoderms to occur within the Ningaloo Marine Park, as well as many species of coral, crustacean and worms (Department of Conservation and Land Management 2005). The area is also important habitat for charismatic mega-fauna such as whale sharks, turtles, dugongs, whales, dolphins, sharks and manta rays (Department of Conservation and Land Management 2005). These species attract many visitors to the region.

The Ningaloo reef is subjected to increasing anthropogenic pressures due to its close proximity to the coast and the growing level of tourism to the area. Eighteen sanctuary zones are currently in place to protect the values and integrity of the Marine Park (Department of Conservation and Land Management 2005). In addition several individual species are provided varying levels of protection. Currently all species of marine turtles are protected under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act), the *Endangered Species Protection Act 1992* and the State *Wildlife Conservation Act 1950*. The protection of marine turtles is vested with the Department of Environment and Conservation (DEC) (Department of Conservation and Land Management 2005).

1.2 Marine turtles of the Ningaloo Marine Park

Seven species of marine turtles exist internationally but only the green (*Chelonia mydas*), loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*) and flatback (*Natator depressus*) turtles have breeding populations within Western Australia (Collins 2000; Environment Australia 2003). The main species that nest on the beaches within the Ningaloo Marine Park are the green, loggerhead and hawksbill turtles (
Figure 1 a - c) (Cape Conservation Group Inc. 2007). Flatback turtles also nest occasionally on the coast but are primarily found further north, along the Pilbara coastline (
Figure 1 d) (Cape Conservation Group Inc. 2007).

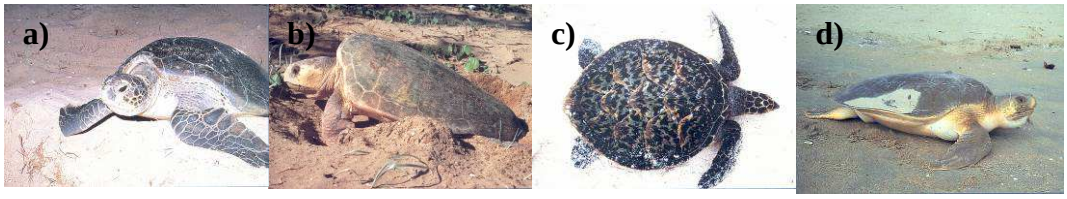


Figure 1: Marine turtles of the Ningaloo region: a) green turtle (*Chelonia mydas*), b) loggerhead turtle (*Caretta caretta*), c) hawksbill turtle (*Eretmochelys imbricata*), d) flatback turtle (*Natator depressus*) (Limpus cited in Cape Conservation Group Inc. 2007).

All species of turtles found in the Ningaloo region are listed as threatened species under the EPBC Act (Department of Conservation and Land Management 2005). The International Union for Conservation of Nature (IUCN) Red List classifies green and loggerhead turtles as endangered species whereas the hawksbill turtles are critically endangered and flatback turtles are not classified as they are listed as data deficient species (IUCN 2007).

Sea turtle habitat can be classified into four types: near-shore aggregation habitat, feeding grounds for adults and juveniles (10 years or older), nesting and inter-nesting grounds, and early juvenile nursery and developmental habitat (0-10 years) (Pendoley Environmental 2005). Ideally these habitats should be free from human influences that can kill, injure, or disturb the turtles. Turtles are most vulnerable during the nesting period as adults aggregate in shallow waters and come ashore to nest, and as hatchlings make their way to the water (Collins 2000). Marine turtles face several threats and disturbances of an anthropogenic nature. This is a serious issue because they are long-lived, slow to mature and also face several natural threats at both the juvenile and adult life stage (Environment Australia 2003). Thus the additional pressure from human-related threats can lead to significant depletions of turtle populations. It is believed that populations have already significantly declined in Australian waters (Environment Australia 2003).

Natural threats include hatchling predation by birds, crabs and goannas, adult predation by sharks, natural changes to nesting environments such as sand temperature, and disease (Mau 2003). The main anthropogenic related threats to Australian turtles have been identified as: harvest by indigenous Australians, unsustainable harvest by people in the Asia/Pacific region, bycatch of turtles in fisheries operations such as trawling, predation of eggs by introduced animals such as foxes, boat strikes, coastal development, loss of habitat, deteriorated water quality and marine pollution (Collins 2000; Environment Australia 2003).

Disturbance is also a significant threat. Lighting from torches and cars can light up the beach and cause disturbance to nesting females and disorientation to hatchlings (Pendoley Environmental 2005; Howlett 2006). The presence of people on the beach can also disturb nesting females, in which case they usually abandon nesting (Mau 2003). This causes wasted energy expenditure and a lowered nesting success rate. Over time disturbance can also lead to changes in nesting habitat (Mau 2003). Other issues related to disturbance include 4WD's on the beach, which may run over nests or create wheel ruts in which hatchlings can become stuck and disoriented (Howlett 2006). The disorientation of hatchlings can lead to their death through dehydration or increased exposure to predation.

In efforts to provide additional focus on the conservation and management of marine turtles in the Ningaloo region the local conservation group, the Cape Conservation Group (CCG), have worked with the Department of Environment and Conservation (DEC) and WWF-Australia in the development of the community based Ningaloo Turtle Program (NTP).

1.3 The Ningaloo Turtle Program

The Ningaloo Turtle Program (NTP) was formally established in 2002 after CCG successfully applied for a grant from the Threatened Species Network (WWF 2003). It is a collaborative project between the CCG, the DEC Exmouth District Office and WWF-Australia. Additional funding and in-kind support is provided by Rangelands NRM Co-ordinating Group, Natural Heritage Trust, Coastwest, the Shire of Exmouth and BHPBilliton.

The Ningaloo region was previously identified as a significant area for turtle nesting. Aerial surveys were conducted along the coastline of the area during 2001-02 and 2002-03 to establish the abundance of emerging turtles along all these beaches (Waayers 2003). These surveys were conducted as part of a PhD project and were supported through funding from the Australian Government's Natural Heritage Trust. Beach surveys were then necessary to identify the nesting turtle species, quantify the nesting effort and success, and to verify whether the area is a significant turtle rookery. Therefore the standard operating procedures for the NTP were implemented.

The NTP is a community-based volunteer program involving local community volunteers as well as external volunteers from throughout Australia and overseas. Since its commencement the participation and interest in the program has grown considerably.

The NTP was originally a community-based monitoring and education program comprising of the Ningaloo Community Monitoring Program and the Jurabi Turtle Centre. Currently the NTP only involves the monitoring aspect as the program no longer includes the Jurabi Turtle Centre. The aims and goals of the NTP are as follows:

Aim: To promote the long-term survival of turtle populations.

Goals:

i. Identify key nesting beaches,
ii. Monitor populations and assess trends at key index sites,
iii. Identify the level of threat of feral predators on nests,
iv. Implement effective protection of important nesting beaches in cooperation with the management agency,
v. Generate and maintain community support for the program and for the conservation of marine turtles and their habitats,
vi. Educate visitors and the community about marine turtles (Cape Conservation Group Inc. 2007).

Volunteers in the NTP are trained in aspects of monitoring including the identification of turtle tracks, false crawls, nests and signs of predation; turtle rescues; data recording and data entry. Monitoring is undertaken for three divisions of the Ningaloo region: the North West Cape, Bundera and Coral Bay (Figure 2).

The primary objectives of morning monitoring are to:

1. Determine the abundance of nests on specific sections of beach over specified time intervals for each species;
2. Identify the relative significance of specific nesting beaches to each species;
3. Establish the level of predation on nests; and
4. Determine the impact of human interaction on nesting success of each species (Cape Conservation Group Inc. 2007).

The 2007/08 turtle monitoring season commenced on the 1st December 2007 and ran until the 28th February 2008. This report will describe the methods used in all aspects of monitoring and volunteer participation, the results obtained from the 2007-08 season morning monitoring and volunteer effort and demographics.

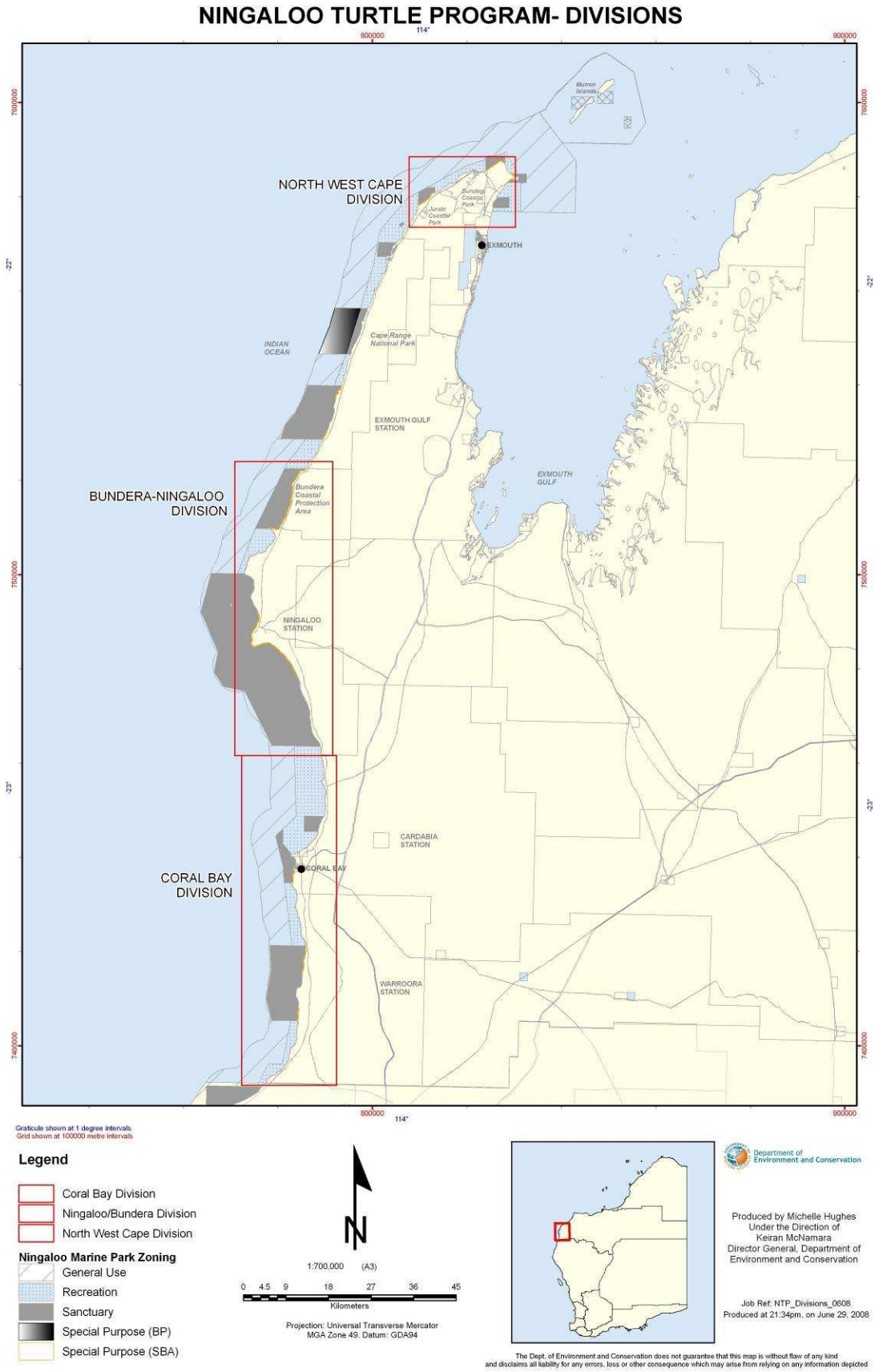


Figure 2: The three divisions monitored during the 2007-08 NTP season.

2.0 METHODS

The following sections outline the methods involved in volunteer recruitment, training and assessment; morning monitoring and data collection; turtle rescues; dealing with deceased turtles; recording previously tagged turtles; data entry; and data checking and analysis.

2.1 Volunteers

The functioning of the NTP is reliant on participation by local and external volunteers. Local volunteers participate on days that are suitable to them and many have participated in several seasons. External volunteers are required to commit to the program for a period of at least one month in order to ensure adequate training and assessment. The program is run by the Ningaloo Turtle Program Co-ordinator, an employee of DEC. The co-ordinator is assisted by team leaders, who are required to participate for a period of three months as part of a volunteer internship placement.

2.1.1 Volunteer recruitment

Several local volunteers involved in the 2007-08 turtle nesting season were also involved in previous seasons. These volunteers, as well as external volunteers from the 2005-06 and 2006-07 seasons, were contacted via email prior to the commencement of the 2007-08 season in order to inform them of the opportunity of participating in the upcoming season as volunteers or team leaders. Any other individuals who had enquired about the program during the off-season were also contacted by email.

Since the NTP commenced operation in the 2002-03 season potential volunteers have been informed of the program through the CCG, community notice boards, workshops, information days and local media such as newspaper articles and posters. External volunteers have also been informed of the NTP through presentations at Western Australian universities, newsletters and websites.

2.1.2 Volunteer accommodation

During the 2007-08 season external volunteers were offered accommodation at the Exmouth Villas. All groups except the first group stayed at a rental house for the first week of their stay due to the overlap period with the previous group, during which the villas were occupied. During the remaining three weeks the volunteers were accommodated at one of two villas at a subsidized rate of $80 per week. The volunteers were accommodated in the same location in order to increase social activities and group relations.

Those who were offered team leader internships were provided accommodation at a separate villa within the same complex for the duration of the season. The cost of this accommodation was covered by DEC. Team leaders were also provided with a food and travel allowance to cover the expense of getting to Exmouth from Perth.

2.1.3 Volunteer training and assessment

All volunteers in the NTP were required to have a good understanding of turtle nesting activities and a thorough knowledge of monitoring techniques in order to provide adequate scientific data. Accordingly volunteers underwent an induction and three training sessions in the first week following their arrival.

The induction provided a basic introduction to the Exmouth area, the NTP, occupational health and safety procedures and issues, and monitoring procedures. During the induction volunteers were also shown an educational DVD on the Code of Conduct for turtle interactions and provided with their own temporary copy of the NTP Turtle Monitoring Field Guide. This was followed by a practical training session in correct radio etiquette and Global Positioning System (GPS) use. The next day comprehensive training commenced in the field, based on the NTP Turtle Monitoring Field Guide. Volunteers were taught on a practical basis by qualified NTP trainers over three separate training days. This was followed by a competency-based field assessment by a qualified NTP assessor. In some cases additional training sessions were found to be necessary to ensure volunteers were confident to monitor beaches unaccompanied and capable of producing reliable data. In total 13 new local volunteers and 49 external volunteers gained competency as NTP turtle trackers throughout the season. Qualified turtle trackers were given certificates and official NTP monitoring t-shirts.

In the 2007-08 season there were eleven trainers, six assessors and four train-the trainers. NTP volunteers were trained throughout the turtle nesting season by at least two of the NTP trainers and assessed by one of the NTP assessors. Five of the trainers became qualified as competent NTP trainers during the 2007-08 season through training and assessment by at least two of the train-the-trainers. In addition, two of the assessors gained competency as NTP assessors during the season.

2.1.4 Volunteer transport

Volunteers were transported to morning monitoring activities in a 14-seater minibus that was hired by DEC for the NTP. Additional vehicles were necessary on training days due to the increase in numbers of volunteers during those days. DEC vehicles were used for this purpose. Some volunteers also drove their own cars on occasion so they could make it back to town in time for personal commitments. In this case reimbursements were provided for fuel costs at a rate of 40 cents per kilometre.

DEC vehicles were also booked as a means of transporting the Camp Ground Team Leader and volunteer participants to the Bungelup remote camp to monitor the Bundera division. The vehicles were used for the duration of the camps.

2.1.5 Volunteer social events

Social activities were organized for every Sunday by the team leaders for the benefit of the volunteers. Events ranged from fancy dress parties, barbeques, snorkelling trips, afternoon hikes, local swimming pool days, pool competitions, pub nights, a Christmas lunch, a reef retreat day and attendance at an Australia day concert. There were also two Secret Santa events organized between the volunteers of the first and second groups because they participated in the program around the Christmas period. Social activities were found to enhance interaction between volunteers, team leaders

and the NTP volunteer co-ordinator. This enabled friendly relations between NTP participants, aimed at enhancing communication levels.

2.2 Co-ordination of the Ningaloo Turtle Program

A full time coordinator of the NTP was employed by the DEC (with support from CCG) in the 2007-08 season. The coordinator was hosted in the DEC Exmouth office which facilitated the role with access to valuable advice and resources. The employment of a coordinator allowed for an increased focus on volunteer recruitment, training, accommodation, transport, data collection and the day to day running of the program including coordination of the remote camp. The coordinator is also responsible for budgeting, marketing, promotion, reporting and fundraising for the NTP. The continuation of the full-time position has proven successful. The provision of team leaders to help the coordinator has enabled a sustained monitoring effort with positive feedback received.

The coordinator was assisted in the physical day to day running of the program by three university students completing internships with the program. The interns were selected to be two Team Leaders and one Camp Ground Leader. They were responsible for different aspects of the program including the morning community monitoring, remote camps and social activities. The internships were invaluable for both the NTP and the students involved. New skills, knowledge and experience were gained by the students and the program benefited greatly from the enthusiasm, dedication and organisation contributed by the students.

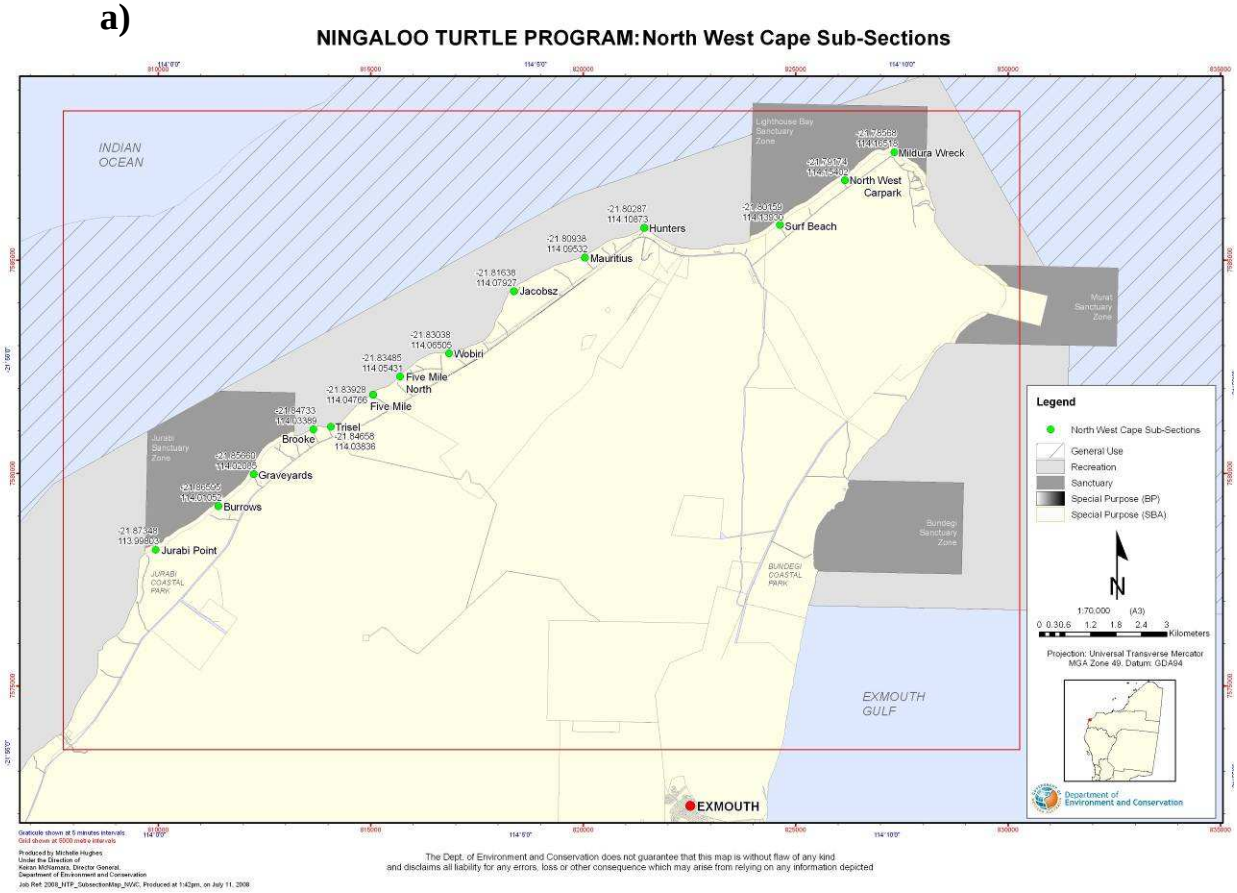
2.3 Ningaloo Turtle Program turtle monitoring and data collection

During the 2007-08 season morning monitoring was the principal activity of the NTP as the Jurabi Turtle Centre (JTC) was no longer run by the program. Volunteers monitored sections of the Ningaloo coastline in order to identify turtle species, assess the abundance of turtle activities, record turtle mortalities, identify feral predation and nest disturbance and conduct turtle rescues when necessary. This data was recorded during monitoring and later entered into a database.

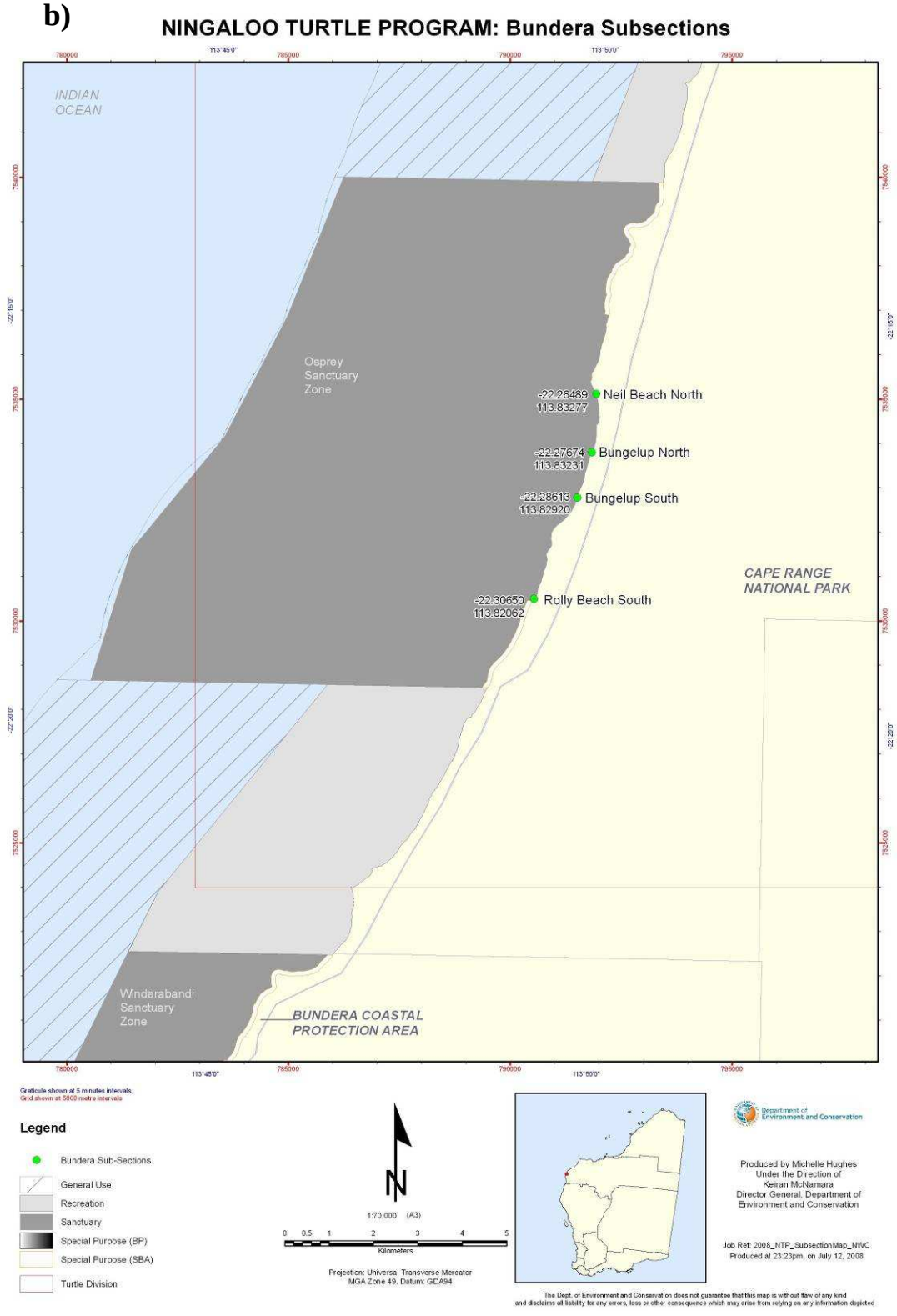
2.3.1 Monitored sections

The Ningaloo region is divided into a spatial hierarchy of divisions, sections and subsections based on information collected in aerial surveys conducted in the past to indicate areas with a high density of turtle activity. The NTP turtle monitoring operates along the North West Cape, Bundera and Coral Bay divisions of the Ningaloo Marine Park. These divisions are further divided into sections and sub-sections (Figure 3 a-c). The start and finish of each subsection are marked by turtle totem markers.

a)


NINGALOO TURTLE PROGRAM: North West Cape Sub-Sections
INDIAN OCEAN
Mildura Wreck
North West Carpark
Surf Beach
Hunters
Mauritius
Jacobsz
Wobiri
Five Mile North
Five Mile
Trisel
Brooke
Graveyards
Burrows
Jurabi Point
EXMOUTH
EXMOUTH GULF
Legend
North West Cape Sub-Sections
General Use
Recreation
Sanctuary
Special Purpose (BP)
Special Purpose (SBA)
Kilometers
Department of Environment and Conservation
The Dept. of Environment and Conservation does not guarantee that this map is without flaw of any kind and disclaims all liability for any errors, loss or other consequence which may arise from relying on any information depicted

b)


NINGALOO TURTLE PROGRAM: Bundera Subsections
INDIAN OCEAN
Osprey Sanctuary Zone
-22.26489 113.83277 Neil Beach North
-22.27674 113.83231 Bungelup North
-22.28613 113.82920 Bungelup South
-22.30650 113.82062 Rolly Beach South
CAPE RANGE NATIONAL PARK
Winderabandi Sanctuary Zone
BUNDERA COASTAL PROTECTION AREA
Graticule shown at 5 minutes intervals
Grid shown at 5000 metre intervals
Legend
Bundera Sub-Sections
General Use
Recreation
Sanctuary
Special Purpose (BP)
Special Purpose (SBA)
Turtle Division
N
1:70,000 (A3)
0 0.5 1 2 3 4 5
Kilometers
Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94
Department of Environment and Conservation
Produced by Michelle Hughes
Under the Direction of
Kieran McNamara
Director General, Department of
Environment and Conservation
Job Ref: 2008_NTP_SubsectionMap_NWC
Produced at 23:23pm, on July 12, 2008
The Dept. of Environment and Conservation does not guarantee that this map is without flaw of any kind
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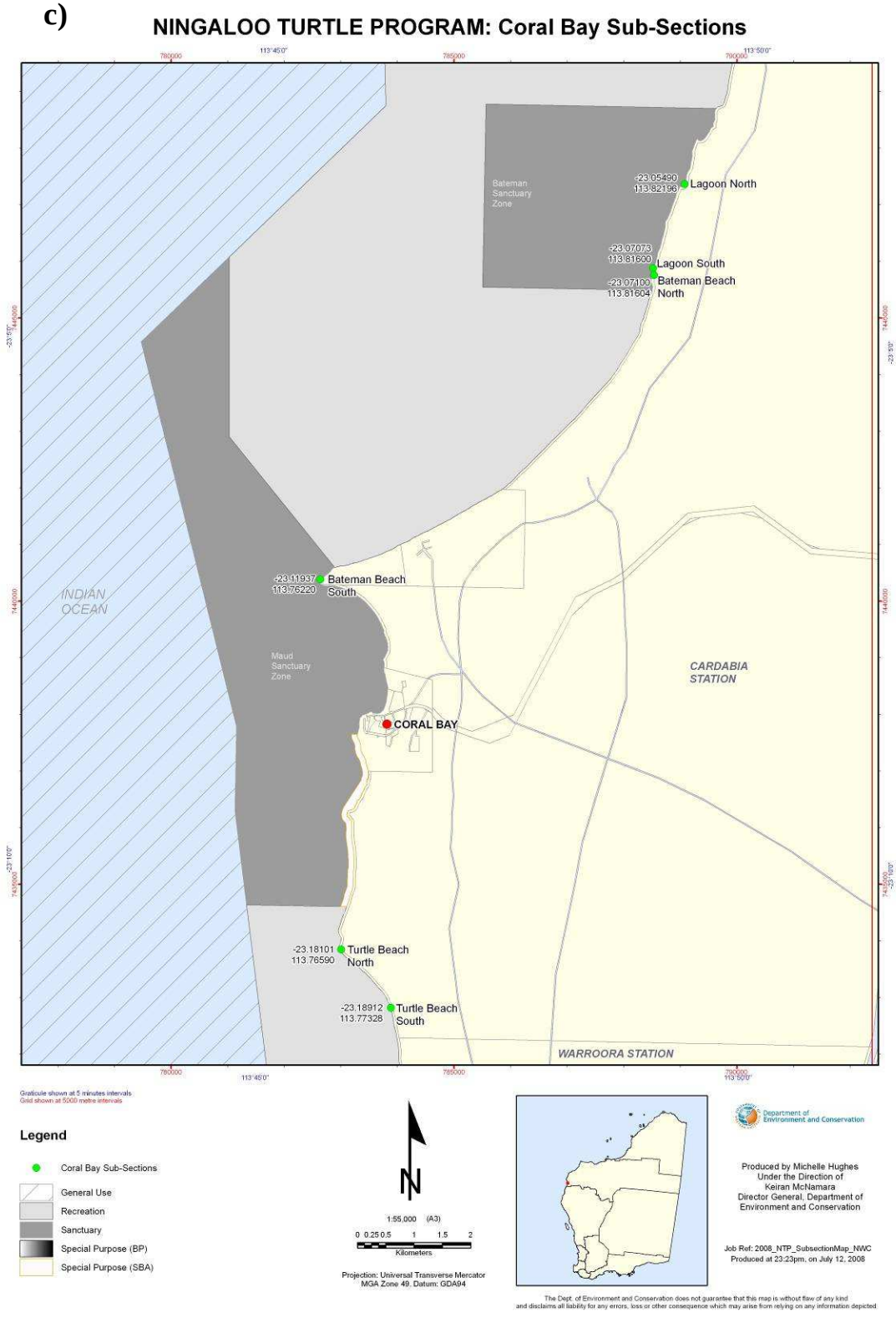

Figure 3: Totem markers for subsections of the a) North West Cape division, b) Bundera division and c) Coral Bay division.

2.3.1.1 North West Cape

The North West Cape division encompasses the Lighthouse, Hunters, Graveyards and Tantabiddi sections. These sections are further divided into subsections as shown in Figure 4. The turtle totem locations and distance of each subsection are provided in Table 1. Beaches were originally divided into these subsections based on factors such as geographical barriers that separate beaches, the locations of car parks and the distance and time required to monitor the subsections.

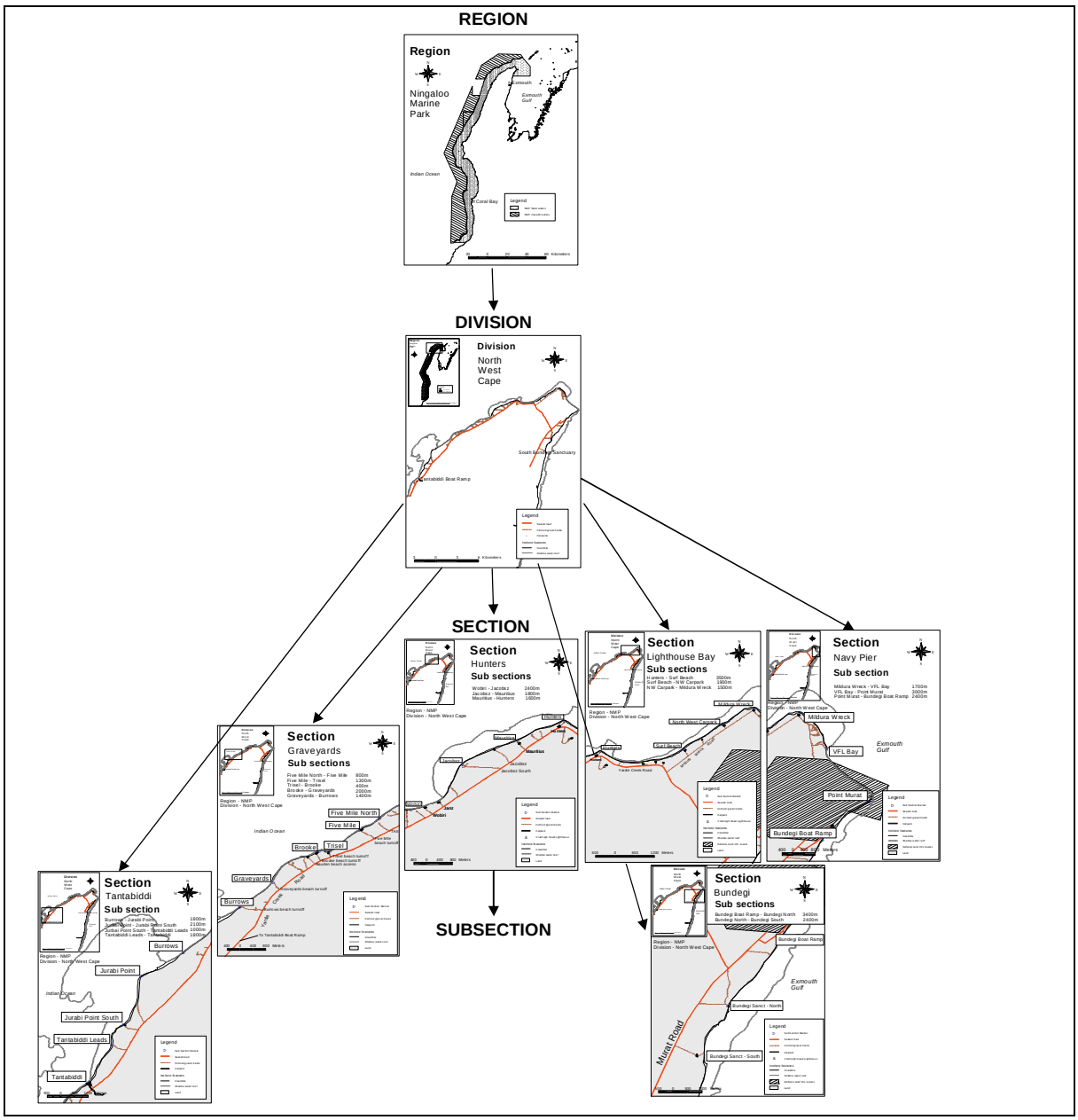

Figure 4: Hierarchical representation of the North West Cape Division.

Table 1: Location and distance of each subsection monitored during the 2007-08 season in the North West Cape division.

Subsection	Location of northern totem	Location of southern totem	Distance (m)
Mildura Wreck - North West car park	21.78568 S; 114.16518 E	21.79174 S; 114.15402 E	1500
North West car park - Surf Beach	21.79174 S; 114.15402 E	21.81590 S; 114.13930 E	1900
Surf Beach - Hunters	21.81590 S; 114.13930 E	21.80287 S; 114.10873 E	3500
Hunters - Mauritius	21.80287 S; 114.10873 E	21.80938 S; 114.09532 E	1600
Mauritius - Jacobsz South	21.80938 S; 114.09532 E	21.81638 S; 114.07927 E	1800
Jacobsz South - Wobiri	21.81638 S; 114.07927 E	21.83038 S; 114.06505 E	2400
Five Mile North - Five Mile	21.83485 S; 114.05431 E	21.83928 S; 114.04766 E	800
Five Mile - Trisel	21.83928 S; 114.04766 E	21.84658 S; 114.03836 E	1300
Brooke - Graveyards	21.84733 S; 114.03389 E	21.85660 S; 114.02085 E	2000
Graveyards - Burrows	21.85660 S; 114.02085 E	21.86595 S; 114.01052 E	1400
Burrows - Jurabi Point	21.86595 S; 114.01052 E	21.87348 S; 113.99803 E	1800

The NTP turtle monitoring season ran continuously for thirteen weeks in the North West Cape Division, between the 1st of December 2007 and the 28th of February 2008 with the exception of Christmas day, Boxing Day, New Years day, and the day following Australia day, during which no monitoring was undertaken. The duration of all previous NTP seasons are provided in section 3.1.6.

2.3.1.2 Bundera

The Bundera division encompasses the Bungelup section, which is divided into three subsections (Figure 5). The totem locations and distance of each subsection are provided in Table 2.

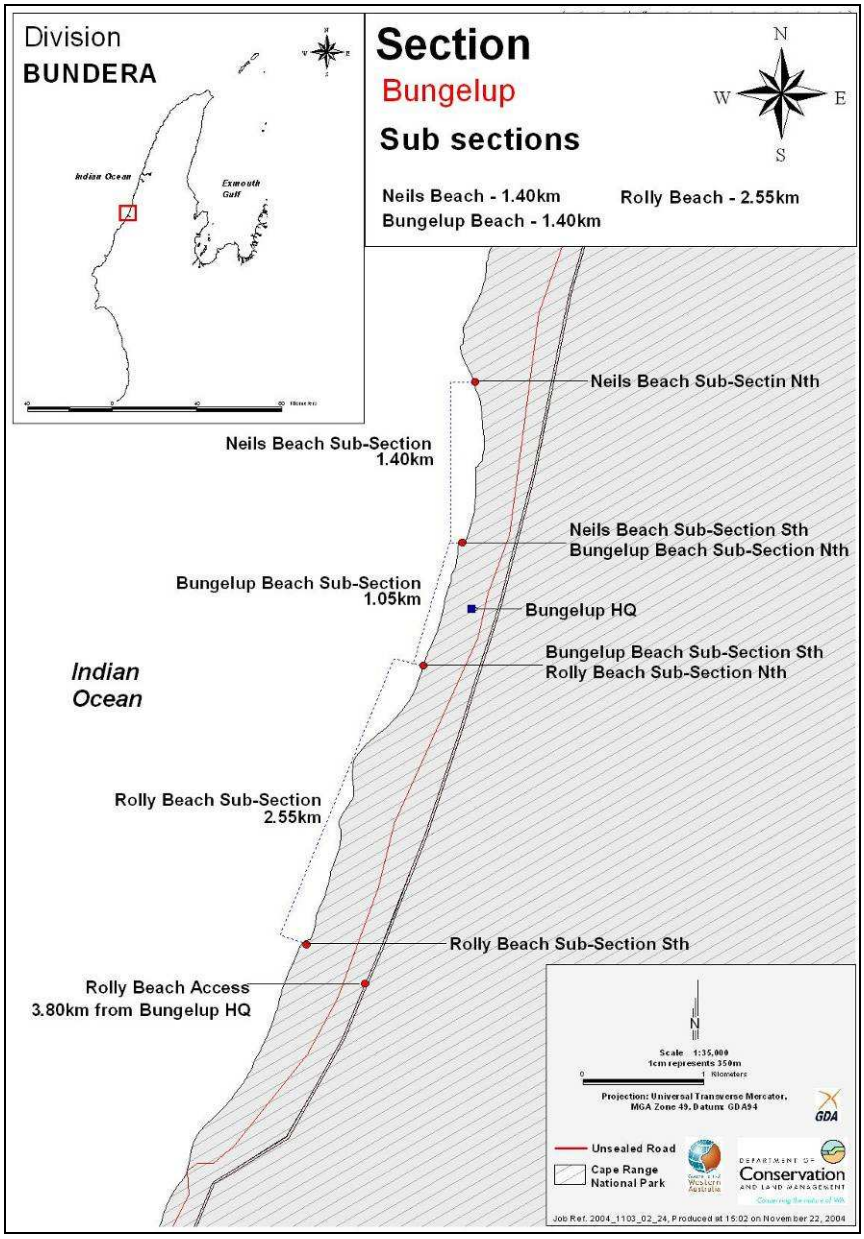

Figure 5: Location of the Bundera division and the associated subsections.

Table 2: Location and distance of each subsection monitored during the 2007-08 season in the Bundera division.

Subsection	Location of northern totem	Location of southern totem	Distance (m)
Neils North - Bungelup North	22.26489 S; 113.83277 E	22.27674 S; 113.83231 E	1400
Bungelup North - Bungelup South	22.27674 S; 113.83231 E	22.28613 S; 113.8292 E	1400
Bungelup South - Rollys	22.28613 S; 113.8292 E	22.30650 S; 113.82062 E	2550

Turtle monitoring in the Bundera division was undertaken by volunteers participating in remote camping at the Bungelup Rangers Camp, located 6km north of Yardie Creek. One or two volunteers accompanied the Camp Ground Team Leader for a one

week period each. During the 2007-08 season eleven Bungelup remote camps operated between the 10th of December 2007 and the 11th of February 2008. Camps did not operate on Christmas day, New Years Eve, New Years day or Australia day. The dates of each camp are provided below:

Camp 1: 10th – 15th December 2007
Camp 2: 16th – 22nd December 2007
Camp 3: 23rd – 24th December 2007
Camp 4: 26th – 30th December 2007
Camp 5: 2nd – 5th January 2008
Camp 6: 6th – 12th January 2008
Camp 7: 13th – 19th January 2008
Camp 8: 20th – 25th January 2008
Camp 9: 27th January – 2nd February 2008
Camp 10: 3rd – 6th February 2008
Camp 11: 7th – 11th February 2008

2.3.1.3 Coral Bay

The Coral Bay division is divided into three sections: Batemans Bay, Lagoon and Turtles Beach. These sections are each classified into one or more subsections (Figure 6). During the 2007-08 season only the Batemans Bay and Lagoon sections were monitored and Beach 1, 2 and 3 subsections within the Lagoon section were grouped into one subsection during data entry: Batemans North – Oyster Bridge. Therefore only the Batemans North – Oyster Bridge and Batemans South – Batemans North subsections will be discussed in this report. The totem locations and distance of each subsection monitored this season are provided in

Table 3.

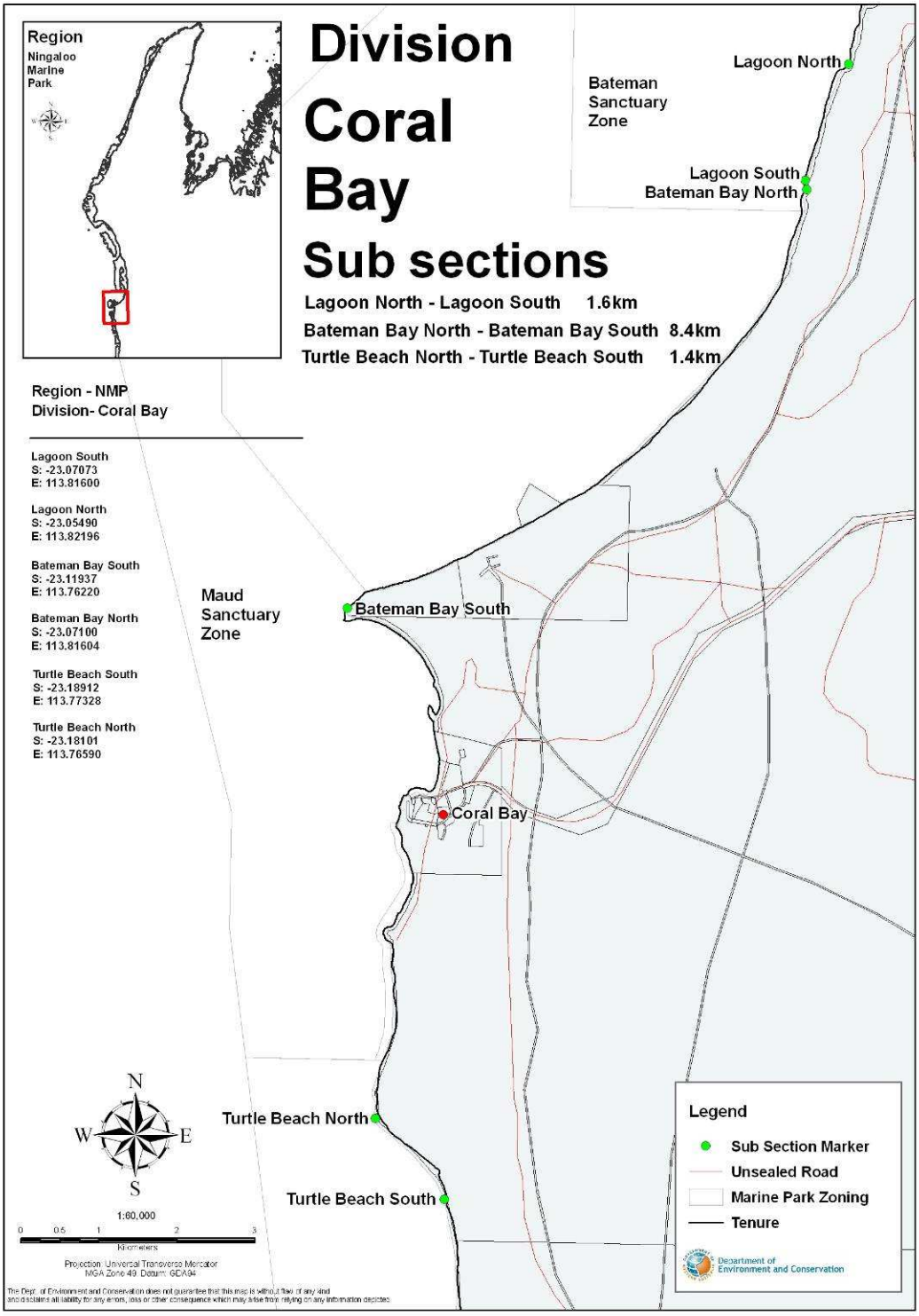

Figure 6: Location of the Coral Bay division and the associated sections and subsections: Beach 1, 2 and 3 subsections (Lagoon section); Batemans South – Batemans North subsection (Batemans section); and Turtle Beach North – Turtle Beach South subsection (Turtle Beach section).

Table 3: Location and distance of each subsection monitored during the 2007-08 season in the Coral Bay division.

Subsection	Location of northern totem	Location of southern totem	Distance (m)
Oyster Bridge - Batemans North	23.05490 S; 113.82196 E	23.07073 S; 113.81600 E	1200
Batemans North - Batemans South	23.07100 S; 113.81604 E	23.11937 S; 113.76220 E	8050

Turtle monitoring in the Coral Bay division was conducted by residents of Coral Bay. The 2007-08 monitoring season was run between the 1st December 2007 and the 28th February 2008. No monitoring occurred on Christmas day, Boxing Day, New Years day, and the day following Australia day. An additional 41 days were also missed due to a lack of participants on those days.

2.3.2 Monitoring techniques

Volunteers monitored the Ningaloo beaches according to a roster system completed by the NTP Coordinator or Team Leader. At least one volunteer was needed for each subsection. Volunteers were required to meet at a central location each morning where they would then catch the NTP bus to their subsections allocated for the morning. Between the 1st of December 2007 and the 31st of January 2008 volunteers met at 6:00am but as of the 1st of February this was changed to 6:30am as the sun rose later and the amount of light available at 6:00am was no longer adequate to monitor the beaches.

Once at their designated subsections competent volunteers followed the standard NTP monitoring techniques, in accordance with the NTP Turtle Monitoring Field Guide. After all of the volunteers had completed their subsections and finished collecting data they returned to Exmouth on the NTP bus. Data sheets were collected for data entry and monitoring kits were organized for the following morning. Standard monitoring techniques used in the NTP are outlined in the following sections. For a more comprehensive description of techniques refer to the NTP Turtle Monitoring Field Guide.

2.3.2.1 Monitoring equipment

Standard monitoring kits and clipboards have been developed for use by volunteers during morning monitoring activities in the NTP. These are provided in backpacks to volunteers rostered on for morning monitoring, according to subsection. Each backpack also contains a first aid kit, a rubbish bag and a handheld UHF radio.

The monitoring kits contain the following contents:

- GPS unit
- Spare alkaline batteries for the GPS
- Numbered disposable camera
- Tape measure
- Spare pencil
- Eraser

- Pencil sharpener
- Pair of latex gloves

Each subsection is designated a separate clipboard, with additional generic clipboards for the training and assessment of volunteers. Each clipboard designated to a subsection contains the following:

- NTP data sheets
- Subsection map and waypoints sheet
- Marine Turtle Stranding and Mortality Datasheet
- Marine Wildlife Stranding and Mortality Report
- Communication log
- Tagged Turtle Resighting sheet
- Turtle track identification key
- Data sheet key
- Predator tracks identification key
- Hatchling identification key
- Turtle rescue checklist
- Tide chart
- List of monitoring subsections and their distances
- Emergency contacts list
- Attached pencil
- Ruler attached to outside of folder

2.3.2.2 Identification of turtle tracks

As turtle tracks are encountered on the beaches volunteers identify the direction of travel and the turtle species by observing features of the track. Characteristics of the track are used for this purpose, including the gait pattern, track width and tail drag marks. The characteristics of green, loggerhead, hawksbill and flatback turtle tracks are outlined in Figure 7

Figure 7: Characteristics of green, loggerhead, hawksbill and flatback turtle tracks (Cape Conservation Group Inc. 2007).

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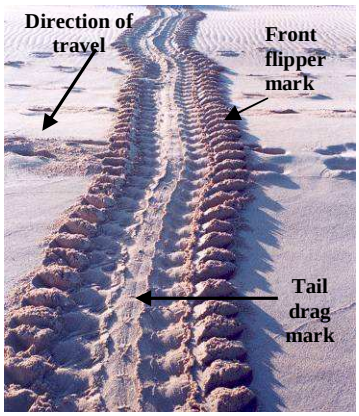
If the turtle tracker is unable to identify the turtle species a photograph is taken with a numbered digital camera, which is later observed by qualified NTP members to assist with identification. In this case the clearest part of the track is chosen and the monitoring clipboard is placed across the track with the ruler in clear view. The turtle tracker stands with their back to the sea and takes a photograph with the ruler in the bottom of the photograph frame (Cape Conservation Group Inc. 2007). The photo frame and camera number are recorded on the data sheet.

After the turtle species has been identified volunteers follow the returning track as part of the process to determine if a successful nesting attempt has occurred. The

return track is followed rather than the emerging track in order to determine the last activity of the turtle.

GREEN TURTLE TRACK

Green turtles have a simultaneous limb movement. The track is opposite with a centre drag mark from the tail, which is either a solid or broken line. Track width is variable but typically ranges between **95 and 144 cm**.



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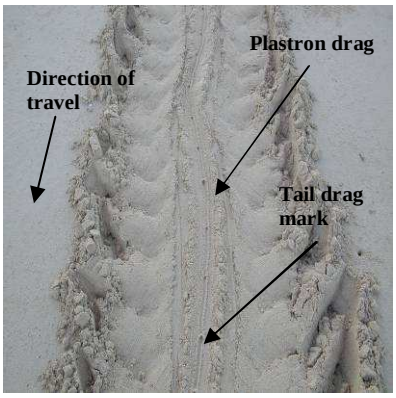
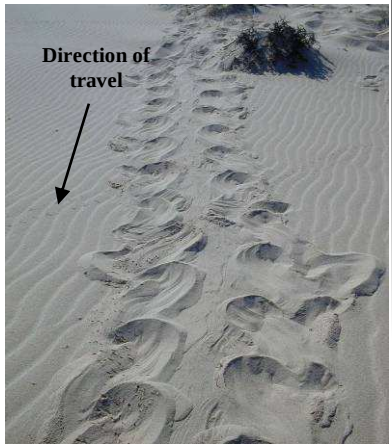


Illustration source: Florida Fish and Wildlife Conservation Commission. *Sea turtle Conservation Guidelines.*

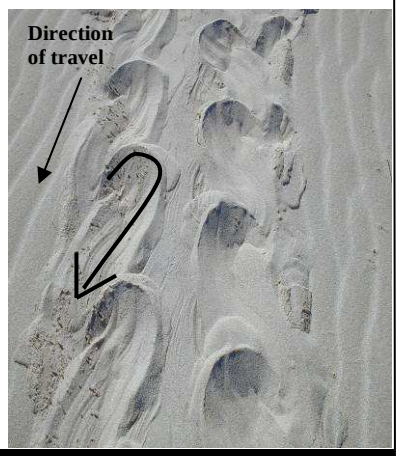
LOGGERHEAD TURTLE TRACK

A loggerhead turtle track has an alternate gait. Tail drag may be present or absent. Track width typically ranges between **70 and 124 cm,** with an average of 94 cm.



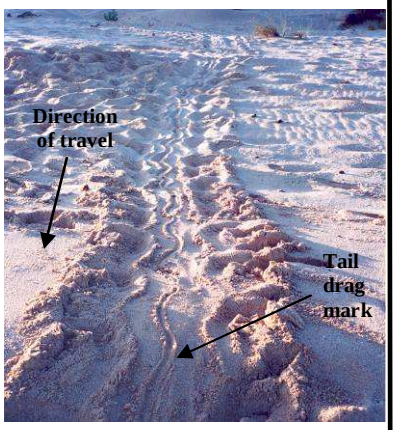
CLOSE-UP

Illustration source: Florida Fish and Wildlife Conservation Commission. *Sea turtle Conservation Guidelines.*

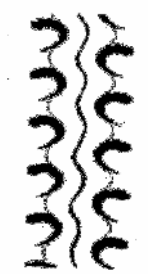


HAWKSBILL TURTLE TRACK

A hawksbill turtle track is very similar to the loggerhead track with alternate gait. Tail-drag mark may be absent, but when present is a wavy mark near the track centre. Track width is typically narrower than the loggerhead track, ranging between **70 and 85 cm**.



CLOSE-UP



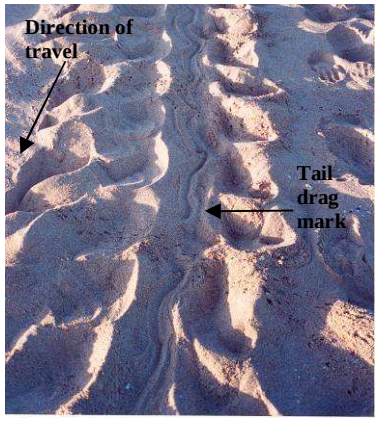
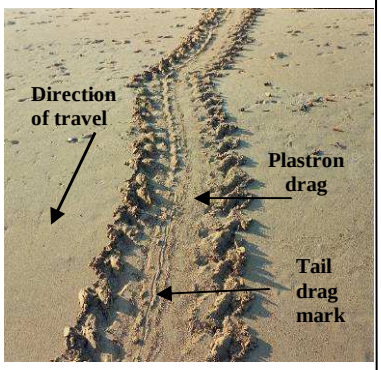


Illustration source: Florida Fish and Wildlife Conservation Commission. *Sea turtle Conservation Guidelines.*

FLATBACK TURTLE TRACK

The Flatback turtle can leave either an alternate or opposite gait, or a combination of both. The track is similar to green turtles but slightly narrower and the front flippers do not extend as far out from the main track. The track is relatively shallow as with the body pit. Track width is variable but typically ranges between **90 and 100cm.**



CLOSE-UP (WET)

Please note: It may be difficult to differentiate between flatback and green turtle tracks without previous experience. Please photograph if unsure.

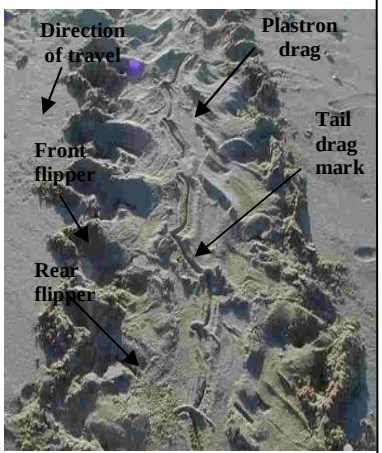


Figure 7: Characteristics of green, loggerhead, hawksbill and flatback turtle tracks (Cape Conservation Group Inc. 2007).

2.3.2.3 Identification of successful nests and false crawls

A female turtle that emerges on land will either successfully produce a nest or will return to the water after an unsuccessful or no attempt at producing a nest. In the case of the latter it is referred to as a 'false crawl'. During training volunteers are taught to recognize characteristics of nests and false crawls.

Signs used in the NTP to identify a successful nesting attempt include the following:

- Evidence of sand flicked back over the emergence track
- Evidence of an escarpment and filled-in primary body pit
- Presence of a shallow secondary body pit
- Sand thrown in the vicinity of the secondary body pit (i.e. – the sand covering the nest may be more aerated and has higher moisture content than the surrounding sand. There may also be evidence of uprooted vegetation) (Cape Conservation Group Inc. 2007).

Signs used in the NTP to identify a false crawl include the following:

- Very little or no sand moved other than around the track
- A u-shaped or simple arc-shaped crawl pattern
- Evidence of digging a primary body pit but no evidence of covering (Note: primary body pits are often steeper and have a typical cone-shape in comparison to secondary body pits which are typically shallow with a flatter bottom).
- Presence of an open egg chamber in the centre of a primary body pit (Cape Conservation Group Inc. 2007).

Once the turtle tracker has identified the species and whether a nest or false crawl has been produced it is recorded in the NTP data sheet (see Appendix 10.1 for a copy of the NTP data sheet).

If the turtle activity is identified as a false crawl a mark is put in the appropriate tally box for the responsible turtle species: green, loggerhead, hawksbill or unknown turtles. If the activity is identified as a nest the position of the nest is obtained using the handheld GPS unit supplied in the monitoring kit. The GPS is held above the area where the egg chamber is estimated to be for approximately one minute and the latitude and longitude co-ordinates are recorded on the data sheet. Coordinates are recorded in decimal degrees to five decimal places and the map datum WGS 84 is used. The position of the nest in relation to the beach is also recorded based on a classification scheme of four basic beach zones (Figure 8):

- **Intertidal zone (I)** – The area between the waters edge and the high water mark.
- **High water mark to edge of vegetation (H)** – The area between the high water mark and the edge of the clear vegetation line.
- **Edge of vegetation to base of dune (E)** – The area between the edge of the vegetation line to the base of the foredune.
- **Base of dune and beyond (D)** – The area landwards of the base of the foredune (Cape Conservation Group Inc. 2007).

In cases where the nest is on the boundary of two beach zones the zone closest to the sea is recorded.

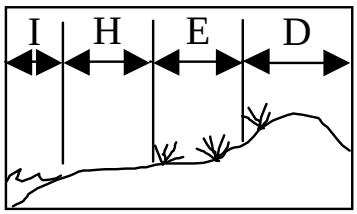


Figure 8: Representation of the four zones used to classify the position of a turtle nest on the beach (Cape Conservation Group Inc. 2007).

Any other relevant observations such as a turtle still nesting on the beach, comments relating to a photograph taken, sighting of tags on a turtle, or sightings of stranded or dead turtles are recorded in the 'any other observations' or 'general comments' sections on the data sheet.

Once a nest or false crawl has been recorded a line is drawn in the sand through the turtle track in at least one position above the high tide mark in order to show the turtle activity has already been recorded. Similarly, nests are marked by making a deep line across the nest near the secondary body pit.

2.3.2.4 Identification of predation and prints

Once the position of the nest has been recorded it is checked for signs of damage. This includes the presence of eggshells, partially consumed eggs, and significant holes dug in the immediate locality of the egg chamber (Cape Conservation Group Inc. 2007). A 'yes', 'no' or 'unsure' is recorded in the box for nest damage on the data sheet next to the relevant nest entry. If the recorder is unsure if the nest is damaged a photograph is taken using the procedure outlined in Section 2.3.2.2.

Damage may also be observed to old nests. In this case the nest is recorded as per usual, however the nest is recorded as an old nest rather than a new one and in many cases it is not possible to identify the species of turtle that produced the nest

The turtle tracker will also record any prints of potential predators within a 5m radius of the nest, including dog (D), fox (F), goanna (G) or human (H) prints (Figure 9). Cats are generally not classified as predators of the nests because they are not known to dig up the eggs.

Figure 9: Potential predator prints: a) dog, b) fox, c) goanna, d) human and e) cat (Cape Conservation Group Inc. 2007).

The presences of dog or fox prints in any location of a subsection are recorded in Table A on the NTP data sheet (Appendix 10.1). Dog and fox prints can look similar

in appearance so volunteers are taught to identify the difference using the following features:

Dog/dingo (

Figure 10 a)

- Small gap between the central pad and the toe pads,
- Front paw prints are larger than the hind paw prints, and
- Claws are larger than those of the fox.

Fox (

Figure 10 b)

- Larger gap between the apex of the central pad and two middle toes in comparison to that of dog prints, due to the presence of hair between the pads,
- Front paw prints are larger than hind prints,
- Narrower and more oval than dog prints, and
- Claws are smaller than those of the dog (Triggs 2004).

a) **b)**

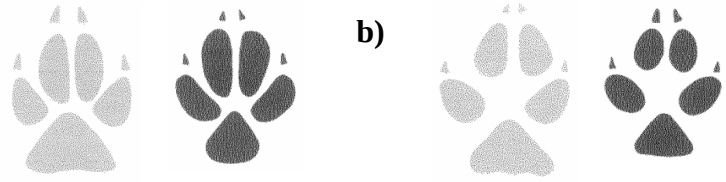


Figure 10: Front (left) and hind (right) paw prints of a dog (a) and a fox (b) (Triggs 2004).

2.3.3 Rescues and mortalities

Occasionally turtle trackers encounter stranded or dead turtles on their subsection during morning monitoring activities. In either of these cases a Marine Turtle Stranding or Mortality Datasheet is filled out. If other deceased wildlife is encountered, including dolphins, whales, dugongs, turtles, sea birds, sharks and sea snakes, a Marine Wildlife Stranding and Mortality Datasheet is completed by recording the type of animal, its location, condition, measurements and the recorder's details.

In the case where a deceased turtle is encountered the date, time and exact location of observation are recorded, along with the condition of the carcass, species type, distinguishing features, tag numbers if present, sex, maturity, photograph numbers, disposal of the turtle, additional notes, contact details of the recorder and measurements of the carapace, tail and head. The curved carapace length is measured along the midline of the shell from the anterior edge to the posterior edge; the curved carapace width is measured across the widest part of the shell; the tail length is measured from the carapace to the posterior tip of the tail; and the maximum head width is measured along the widest part of the head. If it is viable photographs are taken of any injuries and possible causes of death, and of the carapace and head for identification of the turtle.

Volunteers are taught to identify turtles by observing the costal scales on the carapace and the prefrontal scales on the head (Figure 11). Green, loggerhead, hawksbill and flatback turtles are distinguished by the following features:

Green turtles (*Chelonia mydas*)

- Four pairs of costal scales
- One pair of prefrontal scales
- High domed carapace
- No preoccular scales
- Green colouration

Loggerhead turtles (*Caretta caretta*)

- Five pairs of costal scales
- Two pairs of prefrontal scales
- Red-brown to brown colouration
- No pores in scales of bridge

Hawksbill turtles (*Eretmochelys imbricata*)

- Four pairs of costal scales
- Two pairs of prefrontal scales
- Thick overlapping carapace scales

Flatback turtles (*Natator depressus*)

- Four pairs of costal scales
- One pair of prefrontal scales
- Low domed carapace with upturned edges
- Preoccular scale present
- Olive grey colouration (Limpus 1995 cited in Cape Conservation Group Inc. 2007).

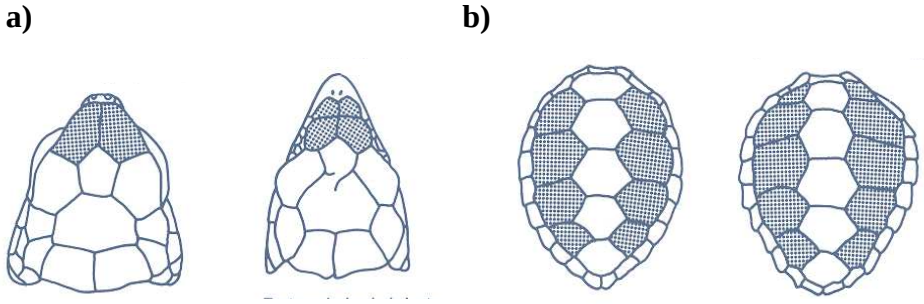


Figure 11: Left to right: a) One and two pairs of prefrontal scales; b) Four and five pairs of costal scales (Limpus 1995 cited in Cape Conservation Group Inc. 2007).

Turtles are often encountered on the beaches during monitoring activities so volunteers are taught during training to distinguish the difference between resting and stranded turtles. According to the NTP monitoring procedures turtles are classified as stranded if they are:

- Over the back of a large steep dune;
- Wedged in rocks unable to move;
- Upside down on their back away from the waters edge; or
- Upside down on their back near the waters edge with the tide going out.

In the case of a stranding, a team leader and at least three other volunteers form a turtle rescue team. An initial step in the rescue process is to take measurements of the turtle if possible. The turtle is then put on a sling and moved to an appropriate location (i.e. - the water or a flat part of the beach so she can make her own way to the water). The datasheet is filled out with the same details as required when recording deceased turtles.

2.3.4 Climatic events

Climatic events such as cyclones can cause storm surges which can inundate turtle nests located close to the normal astronomical high tide level. During the 2007-08 season, Cyclone Nicholas came close to the Ningaloo coastline. After this event the NTP Volunteer Coordinator and Team Leaders estimated a rough percentage of beach area that was affected by the storm surge. The numbers of nests located in the affected beach zones were calculated for a period of sixty days prior to the event until the day the event occurred. This is based on the incubation period of nests: 45 – 65 days (Spotila 2004). The estimated percentage of nests affected by the climatic event was then calculated.

It is recommended for future seasons that beaches are assessed after all cyclones, storms and other high swell conditions to assess whether the beaches have been affected. Observers that have a good knowledge of the beaches prior to the climatic events should assess the beaches after the events have occurred and subsequently estimate the percentage of nests affected in each beach zone.

2.3.5 Tagged turtles

During the 1986/87 turtle nesting season the Western Australian Marine Turtle Project (WAMTP) was introduced by the Department of Conservation and Land Management (now known as DEC) in order to gather information on the distribution and abundance of Western Australian marine turtle populations and the movements of individual turtles. Turtles were tagged at several locations in WA such as the Lacepede, Muiron, Barrow, Varanus, and Rosemary Islands, the North West Cape, Exmouth Gulf and Cape Thouin. Tagging was conducted over several intermittent turtle nesting seasons with varying intensity at the tagging locations.

Turtles encountered on the beaches during NTP monitoring activities are checked for tags when it is possible to do so without disturbing the turtle. Tagged turtles are recorded on the Tagged Turtle Resighting datasheet for the DEC's West Australian Turtle Research program. The locality, date and observer are recorded, along with the left and right tag numbers, turtle species, time of observation, turtle activity and nest location if relevant.

2.4 Data entry

All data recorded on the NTP data sheets is entered into a Microsoft Access database hosted by DEC, Exmouth District. The database allows for information to be retrieved via standard queries and through the output of summary reports.

Data is entered according to the date, division, section and subsection on the data sheet. The presence of fox and dog tracks is entered if appropriate, the number and species of false crawls is entered, and then all nesting details are entered including species type, nest location coordinates and the associated confidence level, nest

position on beach, whether the nest is new or old, nest disturbance, track type/s of any predator/s recorded, and any other comments and observations.

Data was entered into the turtle monitoring database by NTP volunteers after morning monitoring activities. Two people were required for this task to ensure adequate data entry: one to read out the data from the sheet and the other to enter it into the database. Volunteers were trained in data entry techniques as part of their initial NTP training. As a further precaution all data entries were checked by one of the Team Leaders or the NTP Volunteer Coordinator.

2.5 Data checking and analysis

As part of the data checking procedures a Microsoft Excel database was created in which nesting, predation and track data was entered, and summary reports were created. After the data was entered in the turtle monitoring database every entry was checked manually and then cross checked against the Microsoft Excel database.

The data collected during the 2007-08 NTP season was analysed and the results for turtle activities and predation per division, turtle mortalities and rescues, and volunteer effort and participation are provided in the following sections.

3.0 RESULTS

The results for the turtle activity data collected along the Ningaloo coast in the 2007-08 season is provided in the following sections. The season ran between the 1st of December and the 28th of February during which monitoring occurred on 85-86 days in the North West Cape division, 46-47 days in the Bundera division and 45 days in the Coral Bay division (
Table 4).

Table 4: Survey of effort for the Ningaloo region during the 2007-08 NTP nesting season.

Division	Section	Subsection	Number of days monitored
NW Cape	Lighthouse	Mildura Wreck - NW Car Park	86
		NW Car Park - Surf Beach	86
		Surf Beach - Hunters	85
	Hunters	Hunters - Mauritius	86
		Mauritius - Jacobsz Sth	86
		Jacobsz Sth - Wobiri	86
	Graveyards	Five Mile N - Five Mile	86
		Five Mile - Trisel	86
		Brooke - Graveyards	86
		Graveyards - Burrows	86
	Tantabiddi	Burrows - Jurabi Pt	86
Bundera	Bungelup	Bungelup Nth - Neils Nth	47
		Bungelup Sth - Bungelup Nth	47
		Bungelup Sth - Rollys	46
Coral Bay	Coral Bay	Batemans Sth - Batemans Nth	45
		Batemans Nth - Oyster Bridge	45

Data was collected on nesting, false crawls, disturbance, damage to nests and predator presence for each division of the coast: North West Cape, Bundera and Coral Bay. In addition, data was collected on turtle mortalities, tagged turtle resighting and volunteer participation in the NTP.

3.1 Turtle activity data

For the purposes of this report turtle activity is classed as false crawls or successful nesting. Over the 2007-08 NTP turtle monitoring season a total of 6277 nests and 14230 false crawls were recorded for the Ningaloo region between the1st of December and the 28th of February. This equates to an average of 483 nests recorded each week. This is shown in Figure 12.

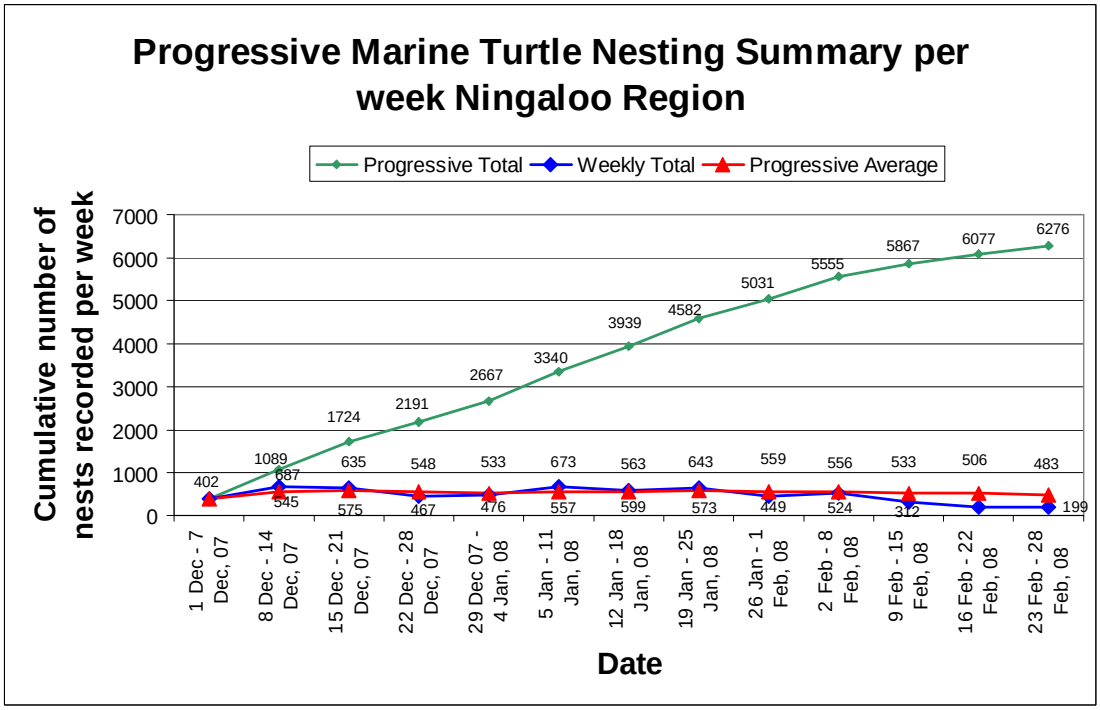


Figure 12: Average and total cumulative number of marine turtle nests recorded for the Ningaloo region during the 2007-08 nesting season.

The boundaries of each division and the nesting density for each subsection can be seen overlain on GIS images of the respective Ningaloo regions in Appendix 10.3.

Figure 13 shows the distribution of nests and false crawls over the three divisions. A total of 5,596 nests and 13,427 false crawls were recorded in the North West Cape between the 1st of December 2007 and the 28th of February 2008, which are 89.1% and 94.4% of the totals recorded in the Ningaloo region respectively. At Bundera 610 nests and 749 false crawls were recorded between the 11th of December 2007 and the 11th of February 2008, which are 9.7% and 5.3% of the totals for the Ningaloo region respectively. The Coral Bay monitoring period was the same as that for the North West Cape, during which 71 nests and 54 false crawls were recorded, equating to 1.1% and 0.4% of the totals for the Ningaloo region respectively.

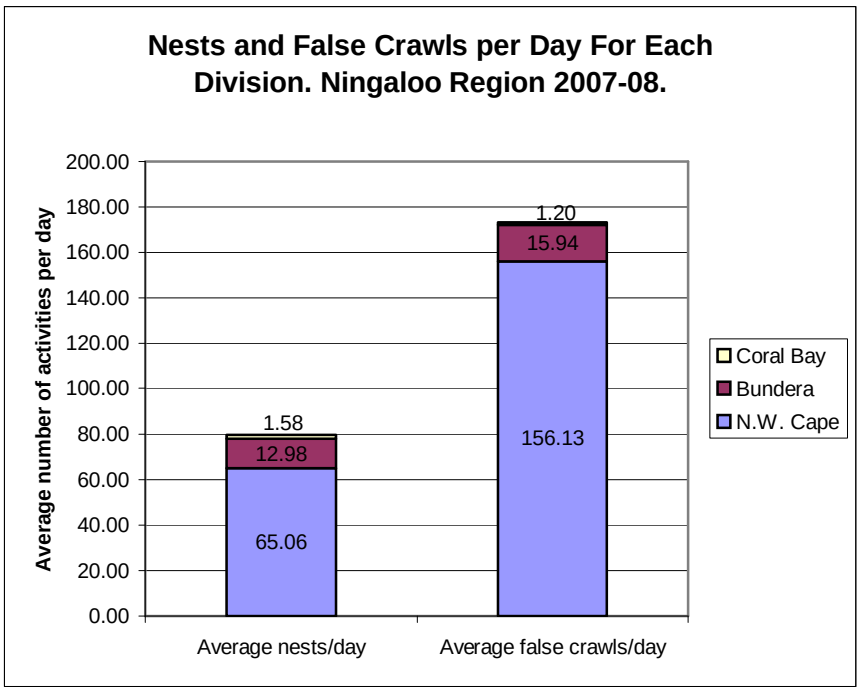


Figure 13: Average number of nests and false crawls per division for the Ningaloo region during the 2007-08 nesting season.

False crawl numbers were consistently higher in comparison to the number of successful nests throughout the season. A percentage comparison of nests and false crawls for each monitoring week is provided in Figure 14.

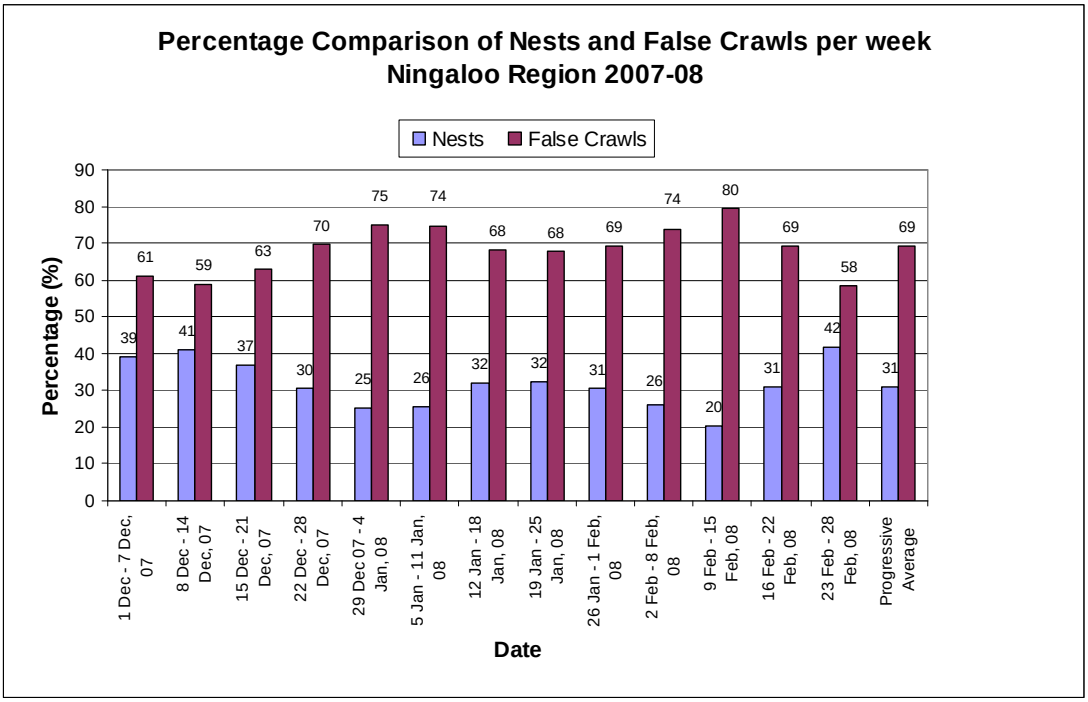


Figure 14: Percentage comparison of nests and false crawls for the Ningaloo region in the 2007-08 nesting season.

The most abundant marine turtle species recorded to nest along the Ningaloo coast is the green turtle, followed by the loggerhead turtle and the hawksbill turtle. Figure 15 shows the percentage comparison of marine turtle species recorded to nest in the

Ningaloo region per week. Green turtles were consistently the most abundant, reaching up to 97% of the total nests recorded for the region. Loggerhead turtles were more abundant in the data collected for the Bundera region; however the monitoring season for this division was shorter than that of the North West Cape and Coral Bay by 27 days. The total number of turtle activities recorded for each species is provided for each division of the Ningaloo region in Table 5.

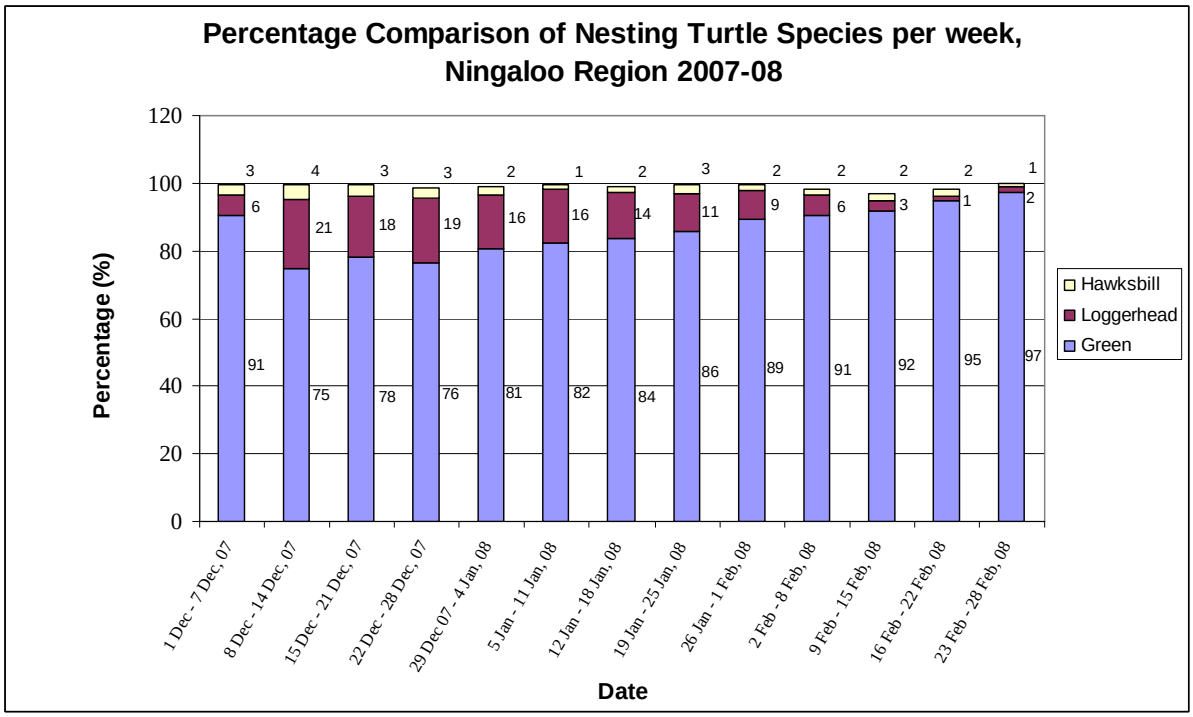


Figure 15: Percentage comparison of nesting marine turtle species per week for the Ningaloo region in the 2007-08 nesting season.

Table 5: Total number of nests and false crawls produced per turtle species in each division of the Ningaloo region in the 2007-08 nesting season.

	Turtle Species		
Division	Green	Loggerhead	Hawksbill
North West Cape	18150	564	229
Bundera	190	1137	27
Coral Bay	54	45	36

3.1.1 North West Cape division

During the 2007-08 season a total of 5595 nests and 13427 false crawls were recorded in the North West Cape division, with a range of 199-582 nests and an average of 430.4 nests recorded per week (Figure 16). The average number of false crawls recorded each week was 1032.8 and ranged between 277 at the end of the season and 1789 during the peak. There was no particular peak in nesting, as it remained fairly constant until the end of the season when the number of nesting turtles decreased. The number of false crawls produced each week fluctuated noticeably, with a peak in total turtle activities between the 5th and 11th of January when 2371 turtle activities were recorded, and a second peak between the 2nd and 8th of February with 1950 turtle activities recorded (Figure 16).

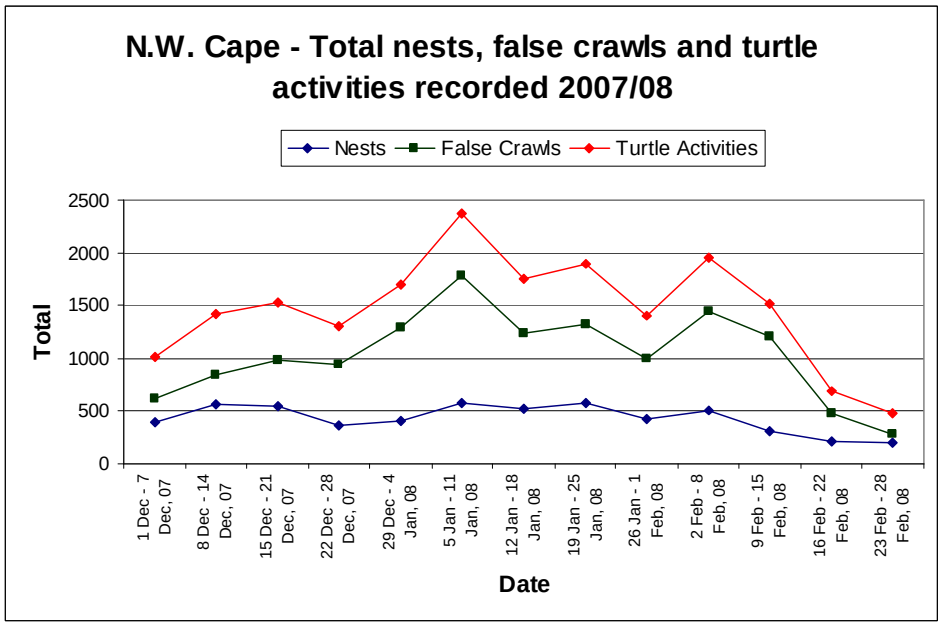


Figure 16: The total number of nests, false crawls and total turtle activities recorded per week for the North West Cape division in the 2007-08 nesting season.

Throughout the 2007-08 nesting season the majority of recorded nests were produced by green turtles, followed by loggerhead turtles and then hawksbill turtles. Nests recorded for unknown species were not common. Figure 17 shows the percentage composition of the total number of nests produced for each turtle species. Throughout the duration of the season the percentage comparison of nesting turtle species remained relatively constant (Figure 18). Green turtles produced between 92-97% of the total nests recorded per week, whereas loggerhead turtles produced between 1-7%, hawksbill turtles produced between 0-4% and 0-3% of the total nests produced on a weekly basis were recorded as unknown turtle species.

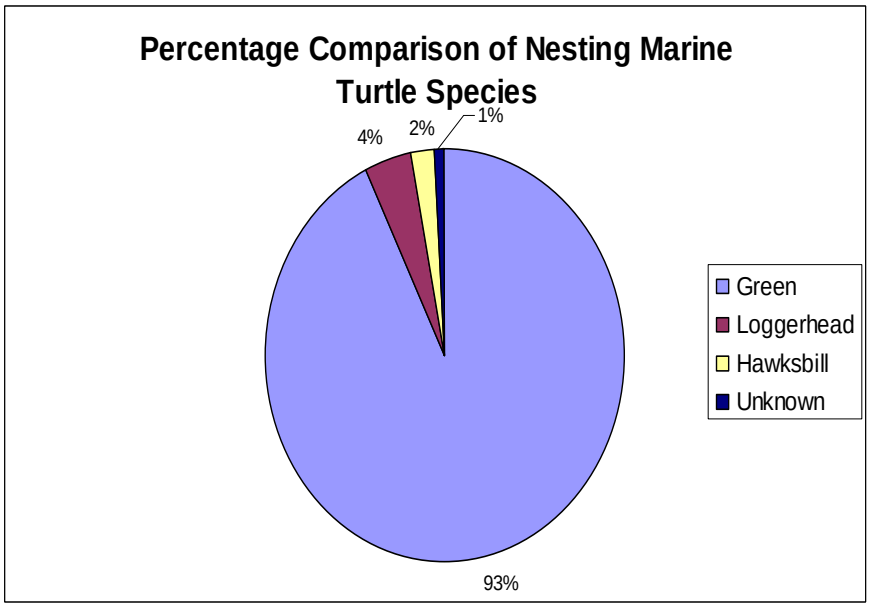


Figure 17: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the North West Cape division during the 2007-08 nesting season.

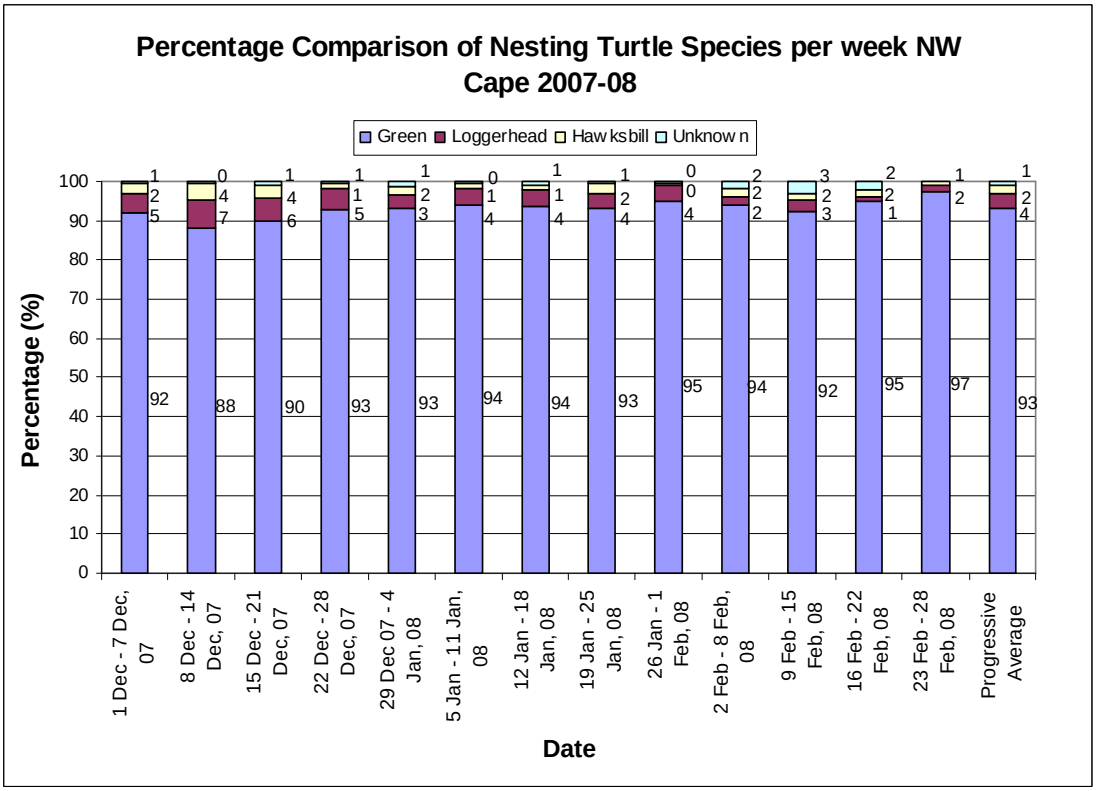
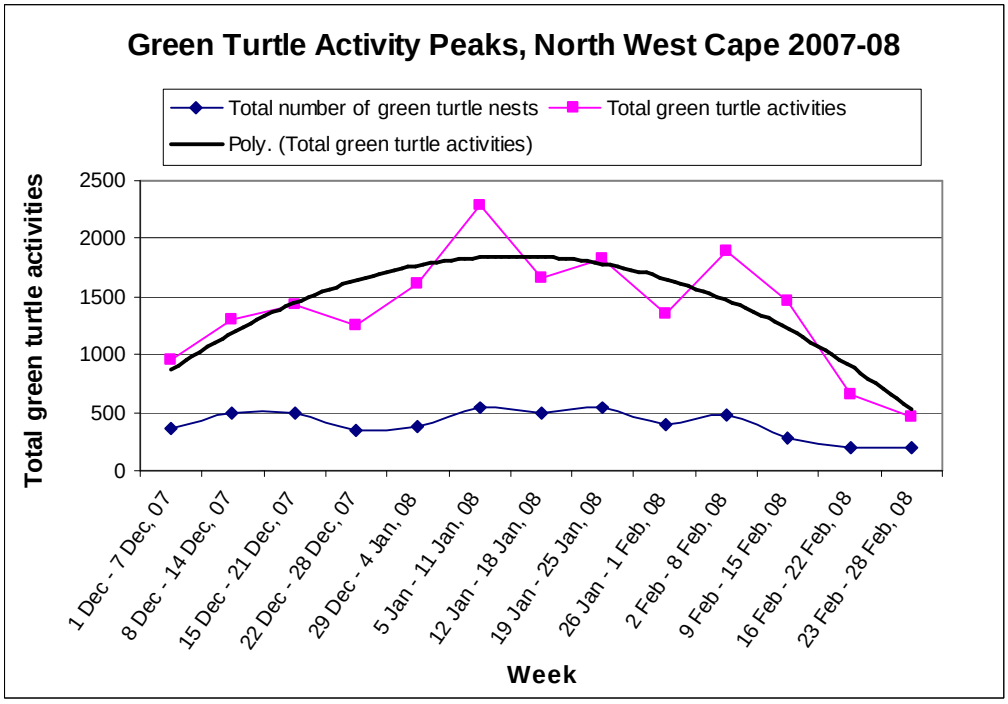


Figure 18: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species per week as recorded for the North West Cape division during the 2007-08 nesting season.

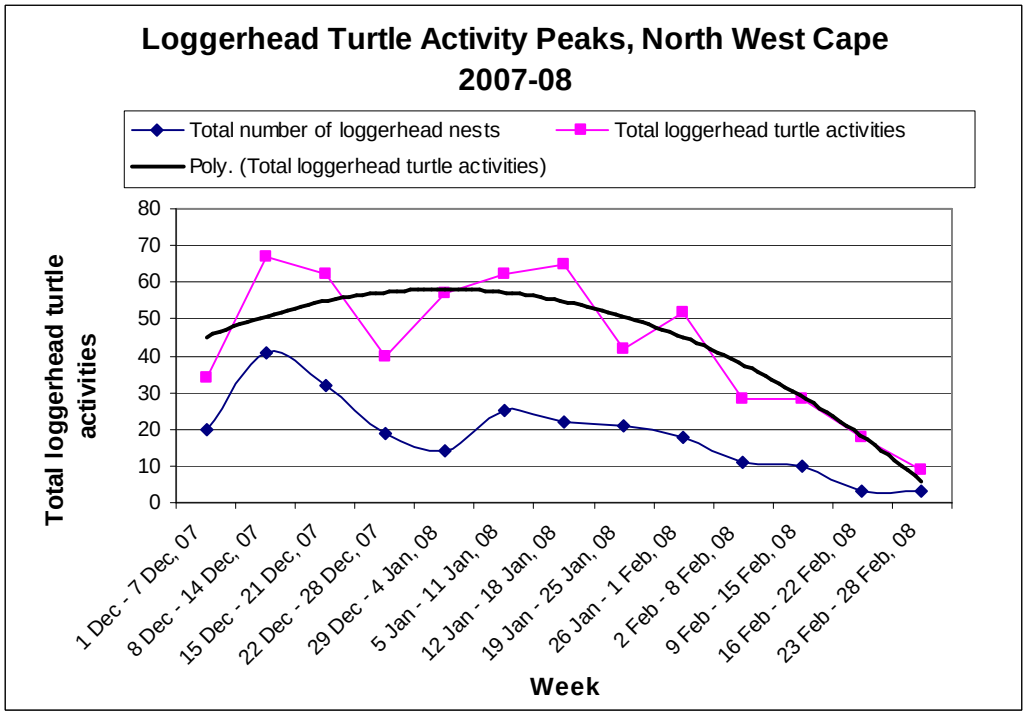
Overall the total nesting activity in the North West Cape remained relatively constant throughout the 2007-08 nesting season (Figure 16). The majority of the turtle activities were recorded for green turtles. The turtle activity patterns for green, loggerhead and hawksbill turtles are provided separately in
Figure 19,
Figure 20 and Figure 21 below. Due to the difficulty in distinguishing between loggerhead and hawksbill turtle tracks any turtle activities associated with tracks with an alternate gait are combined in
Figure 22.

Green turtles had a distinct peak of activity between the 5th and 11th of January with 2,289 activities recorded. Loggerhead turtles had two peaks: firstly between the 8th and 14th of December with 67 recorded activities, followed by 65 activities recorded between the 12th and 18th of January. Hawksbills had a peak of activity between the 8th and 21st of December with 76 recorded activities. Turtle activities relating to tracks with an alternate gait also were at a peak between the 8th and 21st of December.



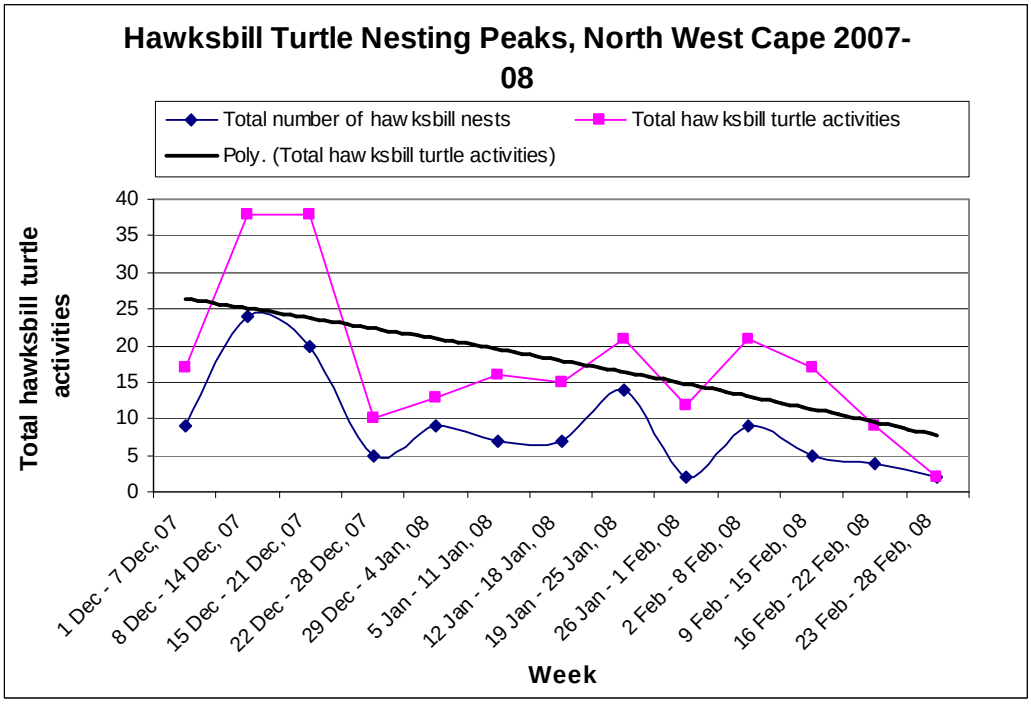
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 19: Green turtle activity levels recorded per week in the North West Cape division during the 2007-08 nesting season.



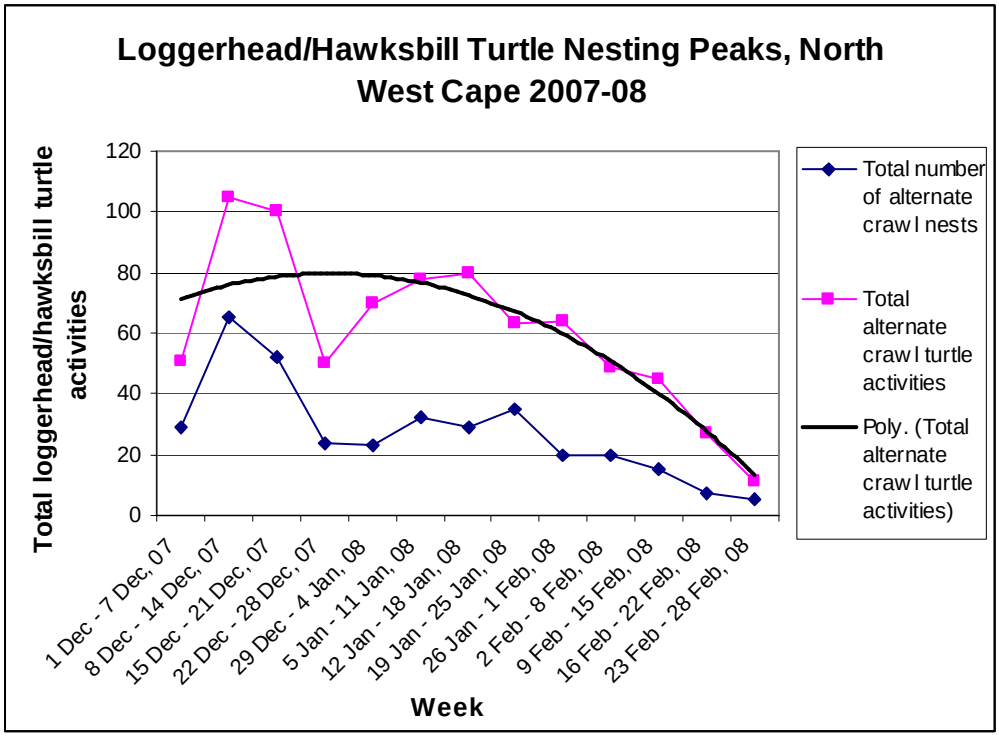
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 20: Loggerhead turtle activity levels recorded per week in the North West Cape division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 21: Hawksbill turtle activity levels recorded per week in the North West Cape division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 22: Turtle activity levels recorded for turtles with an alternate track per week in the North West Cape division during the 2007-08 nesting season.

The majority of turtle activities were recorded in the Jacobsz South – Wobiri subsection within the Hunters section (Figure 23). However, in total the majority of activities were recorded in the Graveyards section. Green turtle activities were most abundant in the Jacobsz South – Wobiri subsection and both loggerhead turtle

activities and hawksbill turtle activities were most abundant in the Hunters – Mauritius subsection (Figure 23).

The subsections and sections differ in lengths depending on the allocated areas to be monitored. The nesting density for each subsection is provided in Figure 24. The greatest number of nests recorded per meter of beach monitored occurred in the Five Mile – Five Mile North subsection with 2.12 nests recorded per meter. In total the Graveyards section had the highest density of nesting with 1.39 nests recorded per meter, followed by the Hunters section with 1.22 nests recorded per meter. The Tantabiddi and Lighthouse sections had the lowest nesting density with 1.21 and 0.31 nests recorded per meter respectively. The lowest nesting density was recorded in the most northern subsection: Mildura Wreck – N.W. Car Park with 0.21 nests per meter. Therefore nesting was concentrated in the middle sections.

The highest density of green turtle nests was recorded in the Graveyards section with 1.35 nests produced per meter. Both the loggerhead and hawksbill turtles were recorded to nest most densely in the Hunters section with 0.05 and 0.02 nests recorded per meter respectively. More specifically green turtles nested in the highest density at the Five Mile – Five Mile North subsection with 2.03 nests produced per meter and both loggerhead and hawksbill turtles nested in the highest density at the Hunters – Mauritius subsection with 0.07 and 0.03 nests produced per meter respectively.

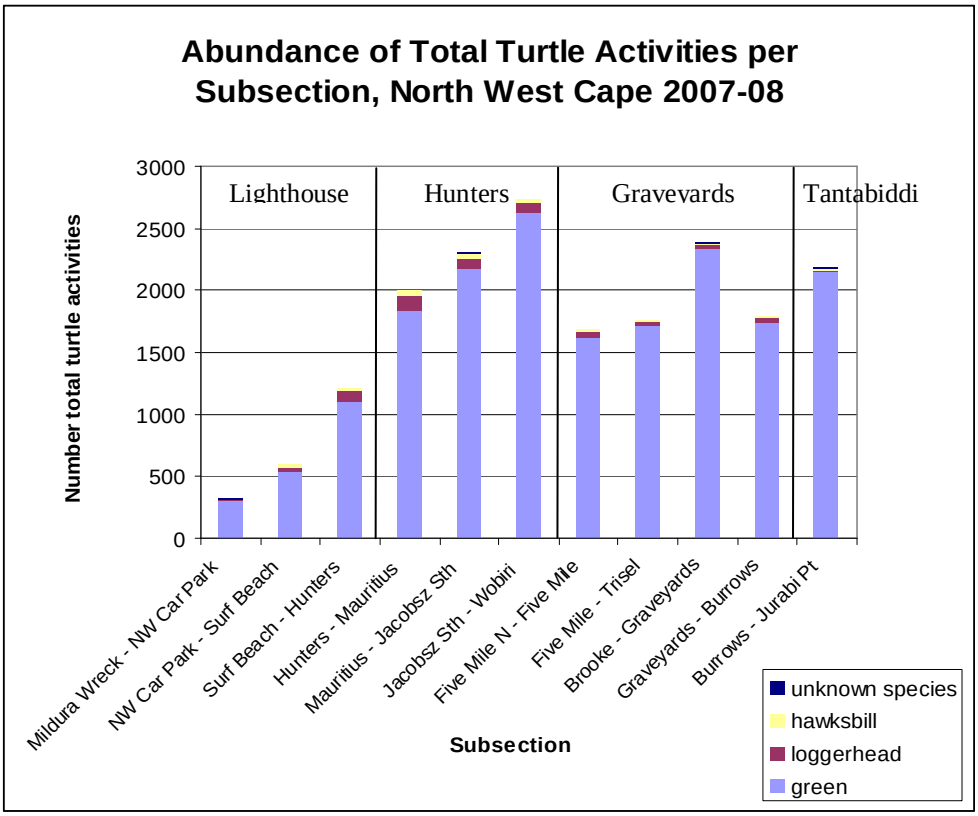


Figure 23: The abundance of turtle activities recorded for each species per subsection in the North West Cape division during the 2007-08 nesting season.

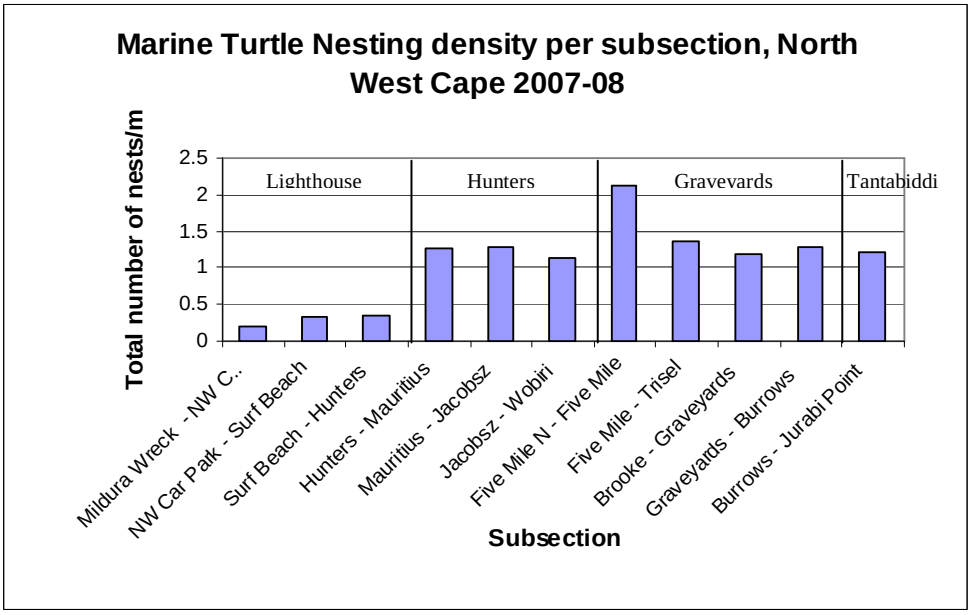


Figure 24: Nesting density recorded per subsection in the North West Cape division during the 2007-08 nesting season.

In the North West Cape division the majority of turtles were found to nest in the zone between the edge of the vegetation line to the base of the foredune (48.0%), followed by the zone between the high water mark and the edge of the vegetation line (37.8%) (Figure 25). A total of 12.2% of nests were located landwards of the base of the foredune, and 2.0% of nests were located in the intertidal zone between the waters edge to the high tide mark. The position of the nest on the beach was not defined for less than 0.1% of the total nests recorded.

Green turtles most frequently nested in the zone between the edge of the vegetation to the base of the foredune, followed by the zone between the high water mark and the edge of the vegetation line with 48.9% and 36.5% respectively. Loggerhead, hawksbill and unknown turtle species all nested most frequently in the zone between the high water mark and the edge of the vegetation line (51.3%, 55.9% and 64% respectively), followed by the zone between the edge of the vegetation line and the base of the foredune (37.8%, 41.5% and 18% respectively).

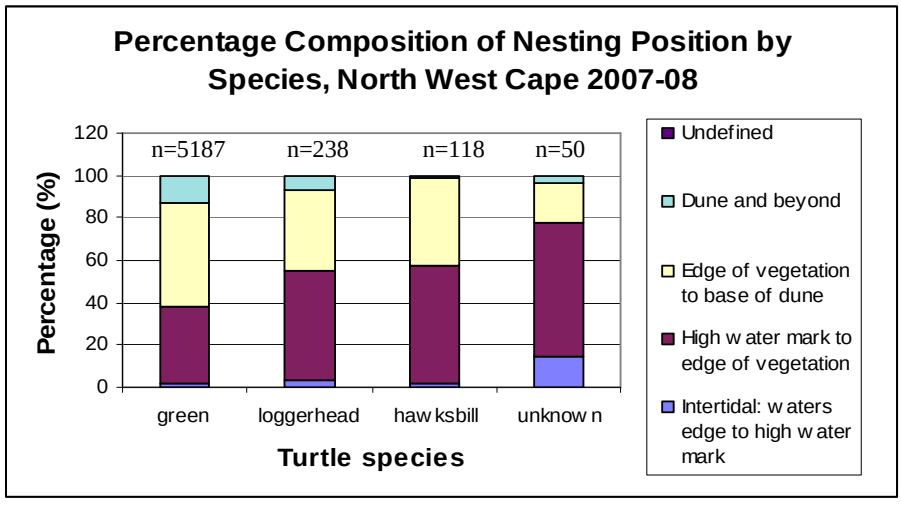


Figure 25: Percentage composition of nesting position by species in the North West Cape division during the 2007-08 nesting season.

During the period of monitoring the ratio of nests to false crawls was 0.42 nests to each false crawl produced, with the best ratio recorded in the last week with 0.72 nests produced to each false crawl.
Figure 26 shows the nesting success rate recorded per week for each species in the North West Cape division. Green turtle nesting success was greatest in the last week of monitoring (23rd – 28th February 2008) with a nesting success rate of 41.81%. Loggerhead turtle nesting success was highest in the first two weeks of monitoring (1st – 14th December 2008). Hawksbill nesting success rates were more variable with peaks during the 29th December 2007 – 4th January 2008 and the 19th – 25th January 2008 with 69.23% and 66.67% respectively. The highest peak for hawksbill nesting success was in the final week of monitoring (23rd – 28th February 2008) with 100% nesting success, however only two nests and no false crawls were recorded in that week.

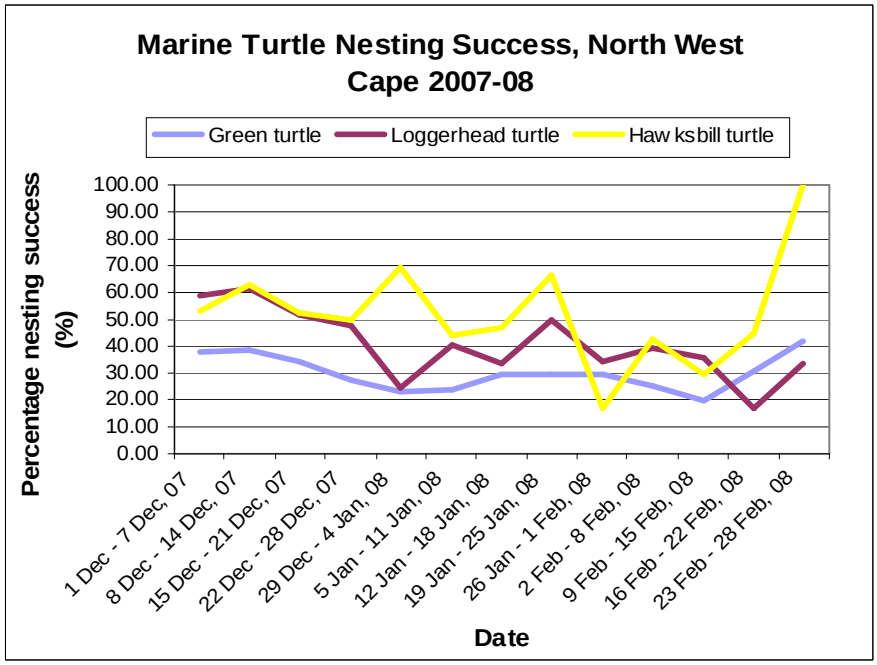


Figure 26: Marine turtle nesting success recorded for each species per week in the North West Cape division during the 2007-08 nesting season.

A total of 157 nests were recorded as damaged in the Ningaloo Region, 135 of which were located in the North West Cape division. A range of 2 - 26 nests were damaged per week in this division, with an average of 10.4 nests damaged per week. The greatest numbers of damaged nests were recorded in the Jacobsz Sth – Wobiri and the Graveyards – Burrows subsections with 44, and 30 nests recorded as damaged respectively (
Figure 27). The majority of disturbed nests in the North West Cape divisions were damaged by ghost crabs. The percentage composition of causes of nest damage is provided in
Figure 28.

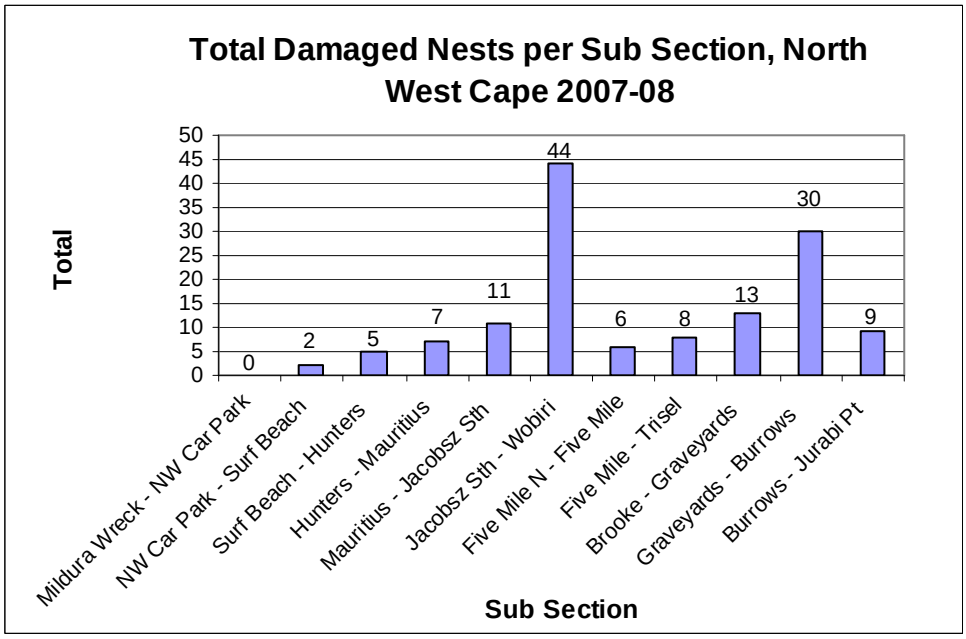


Figure 27: Total number of damaged nests in the North West Cape division during the 2007-08 nesting season.

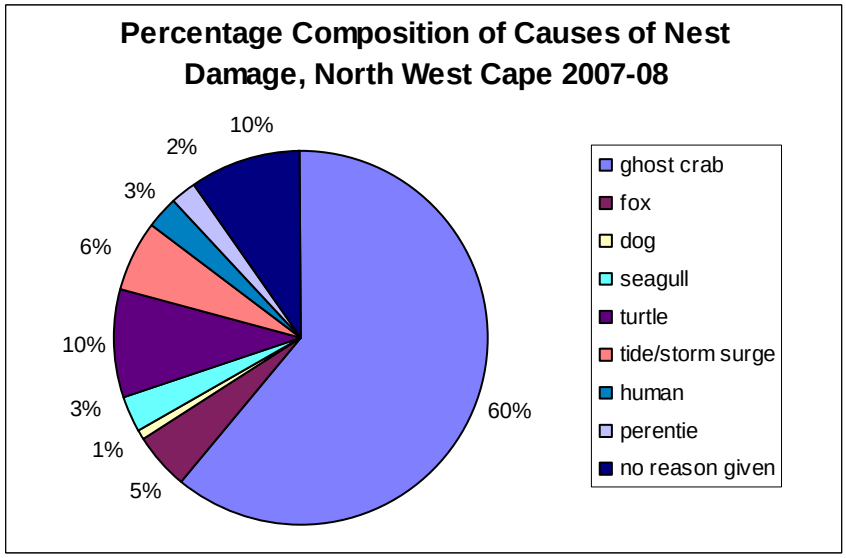


Figure 28: Percentage composition of the cause of nest damage in the North West Cape division during the 2007-08 nesting season.

The total number of potential predator tracks that were sighted within a 5m radius of new and old turtle nests is provided for each subsection in
Figure 29. In total there were 324 dog, 297 fox, 103 human, 99 ghost crab, 33 perentie, 9 cat and 3 vehicle tracks sighted within 5m radii of turtle nests recorded in the North West Cape division. The greatest number of dog (91), fox (86) and ghost crab (28) tracks were seen around nests within the Graveyards – Burrows subsection; Five Mile – Trisel had the highest recorded number of perentie tracks (14); Hunters – Mauritius had the highest recorded number of human prints near nests (32); Jacobsz Sth – Wobiri had the most cat tracks recorded around nests (3); and the only vehicle tracks sighted within a 5m radius of nests were recorded on the Surf Beach – Hunters subsection (3). In total the greatest number of potential predator tracks were sighted

around nests within the Graveyards – Burrows subsection (211 tracks) followed by the Jacobsz Sth – Wobiri subsection (146 tracks).

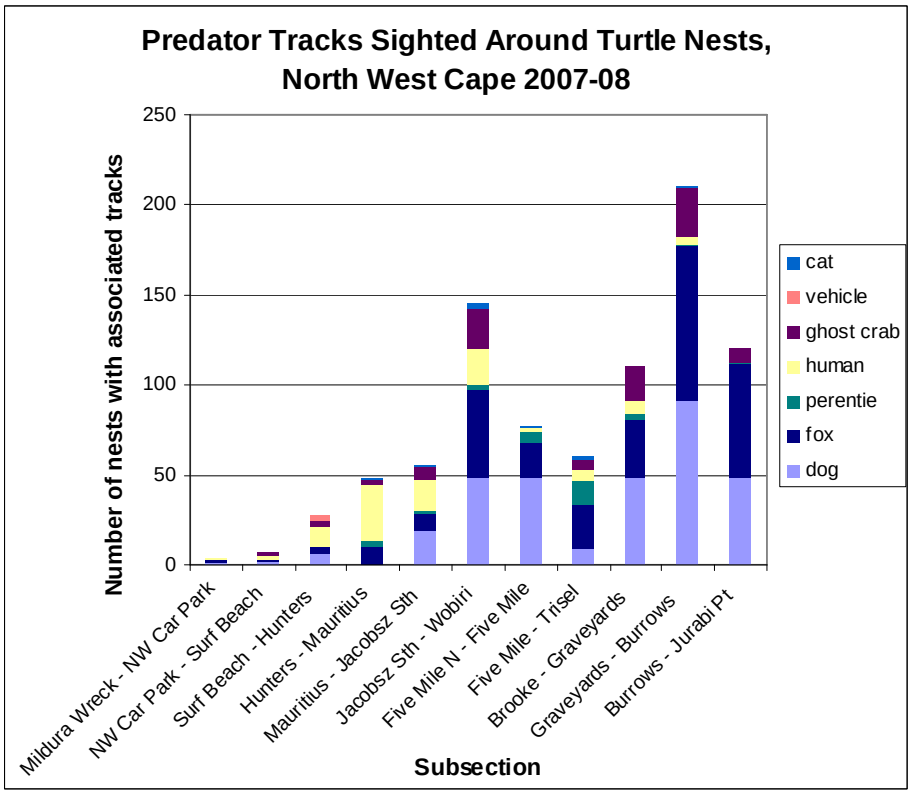


Figure 29: Total number of predator prints sighted within a 5m radius of turtle nests recorded in the North West Cape division during the 2007-08 nesting season.

Fox and dog prints were identified and recorded on the Ningaloo Coast a total of 730 times, with 632 of these prints recorded on the North West Cape. Fox prints were recorded on 287 occasions and dog prints were recorded on 326 occasions. An average of 22.1 and 25.1 incidences were recorded per week where fox and dog tracks were identified respectively. Fox and dog tracks were most abundant on the Jacobsz Sth – Wobiri and the Graveyards – Burrows subsections (Figure 30).

A regression analysis showed that there was a positive correlation between the total number of nests and the total number of fox and dog tracks sighted in the North West Cape division during the 2007-08 season ($R^2 = 0.5446$) (Figure 31). Figure 32 shows the total number of times fox prints have been sighted on each subsection (287 in total) in comparison to the number of times fox prints have been sighted within a 5m radius of damaged nests (27 in total). Out of these 27 damaged nests only 7 were reported to be caused by foxes.

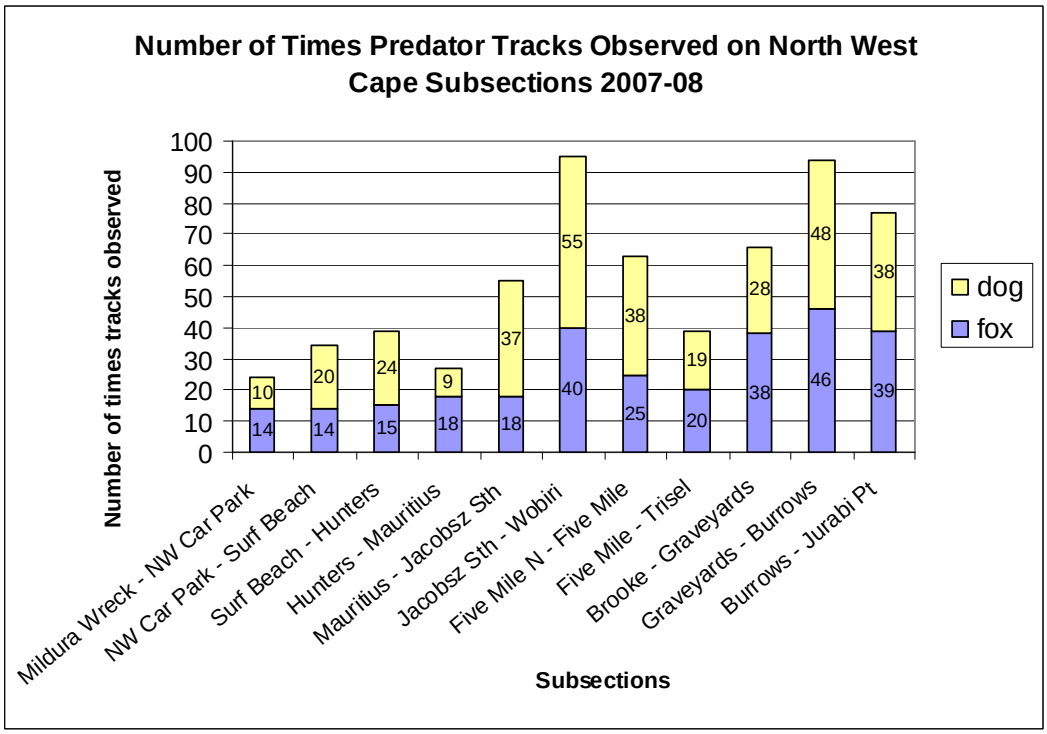


Figure 30: Number of days where fox and dog prints were identified per subsection in the North West Cape division during the 2007-08 nesting season.

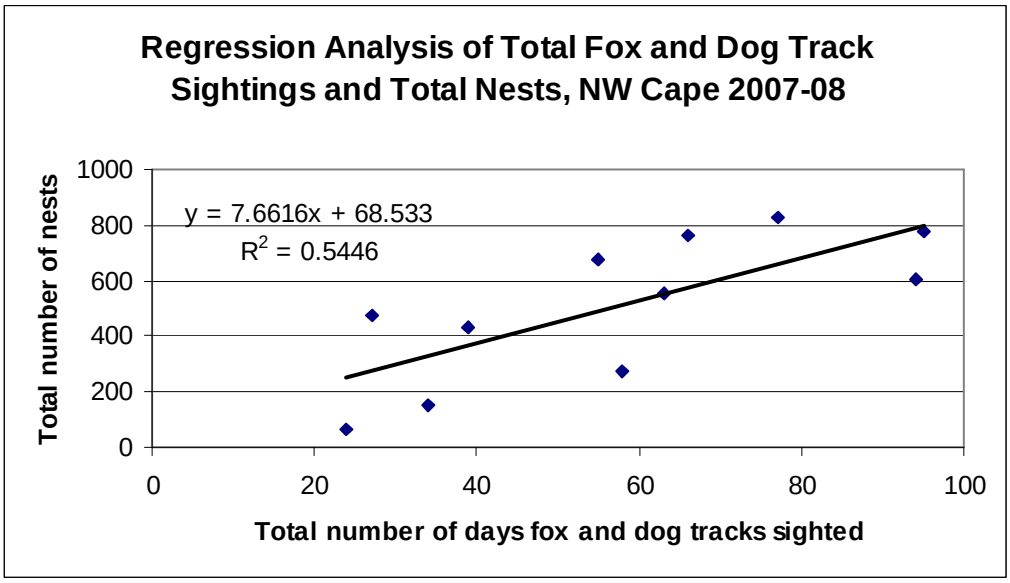


Figure 31: Regression analysis of the correlation between the total number of nests and fox and dog tracks recorded in the North West Cape division during the 2007-08 nesting season.

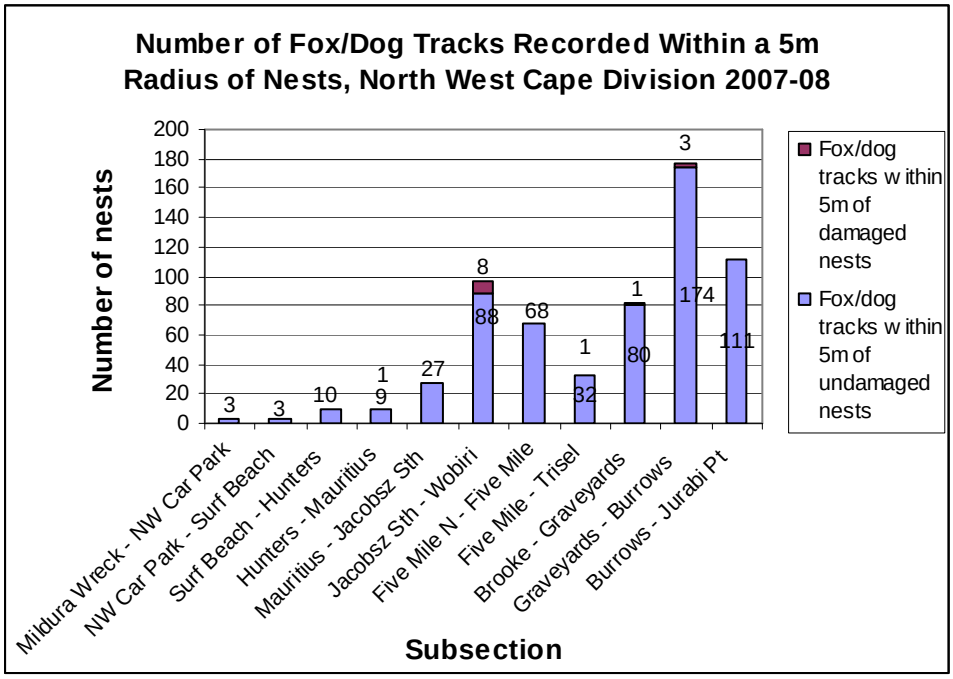


Figure 32: The level of presence of foxes and dogs within a 5m radius of undamaged nests compared to damaged nests, in the North West Cape division 2007-08.

3.1.2 Bundera division

During the 2007-08 season a total of 610 nests and 749 false crawls were recorded in the Bundera division, with a range of 24 - 117 nests and an average of 67.8 nests recorded per week (Figure 33). An average of 83.2 false crawls was recorded each week with a weekly range between 24 near the end of the season and 158 during the peak. The greatest number of nests was recorded at the beginning of the Bungelup monitoring season (11th – 17th December 2007). The number of nests recorded gradually decreased throughout the season. The number of false crawls produced each week fluctuated more noticeably, with peaks in both false crawls and total turtle activities at the start of the season (11th – 17th December 2007) with 136 false crawls and 253 total turtle activities recorded and between the 8th and 14th of January 2008 with 158 false crawls and 240 total turtle activities recorded (Figure 33).

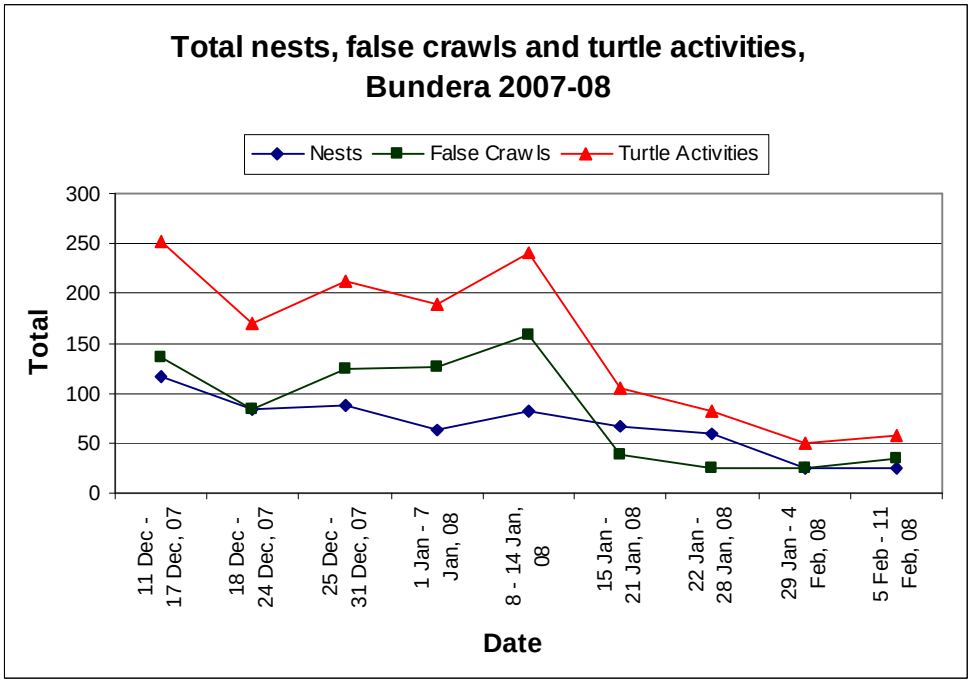


Figure 33: The total number of nests, false crawls and total turtle activities recorded per week for the Bundera division in the 2007-08 nesting season.

Throughout the 2007-08 nesting season the majority of recorded nests were produced by loggerhead turtles, followed by green turtles and then hawksbill turtles. Nests recorded for unknown species were not common.
Figure 34 shows the percentage composition of the total number of nests produced for each turtle species. Throughout the duration of the season the percentage comparison of nesting turtle species remained relatively constant (Figure 35). Loggerhead turtles produced between 77-96% of the total nests recorded per week, whereas green turtles produced between 4-21%, hawksbill turtles produced between 0-9% and 0-5% of the total nests produced on a weekly basis were recorded as unknown turtle species.

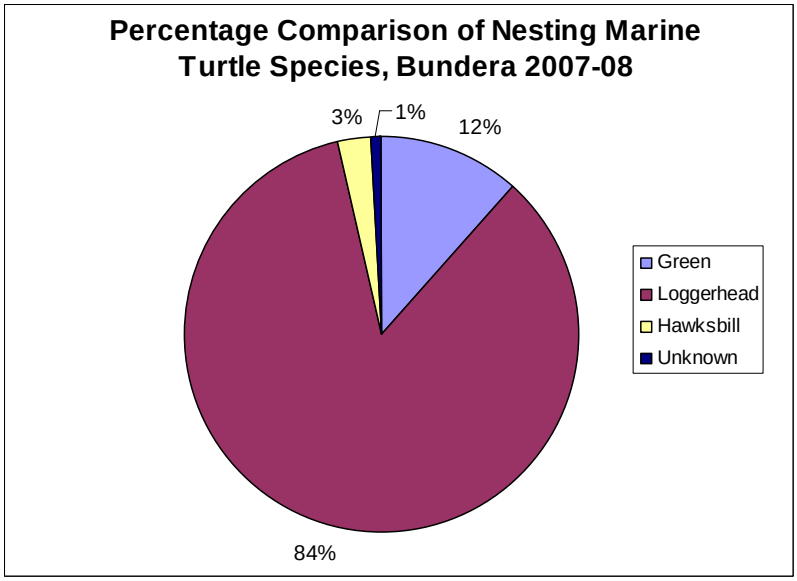


Figure 34: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the Bundera division during the 2007-08 nesting season.

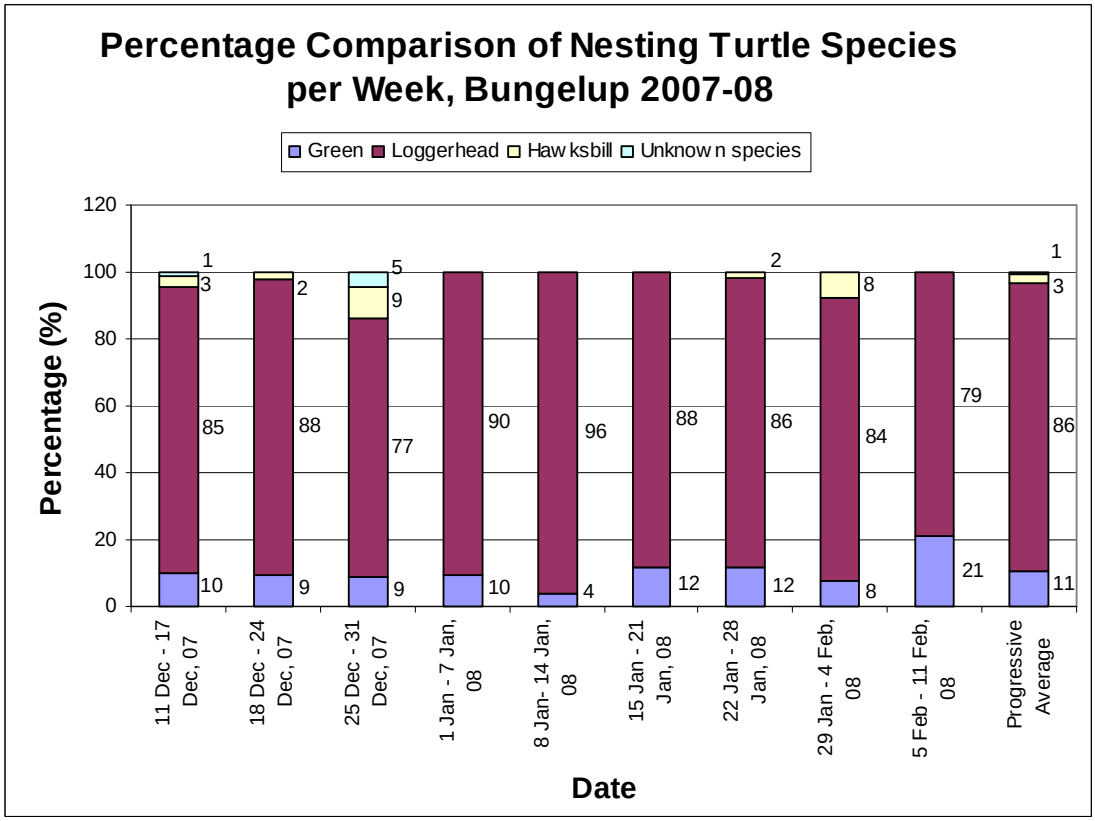
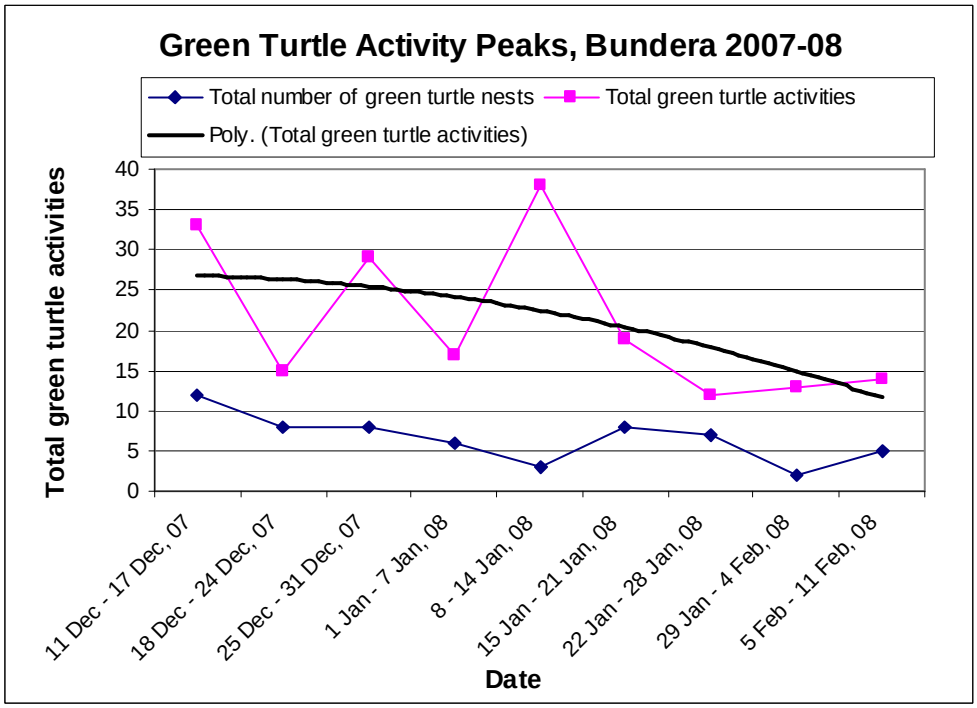


Figure 35: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species per week as recorded for the Bundera division during the 2007-08 nesting season.

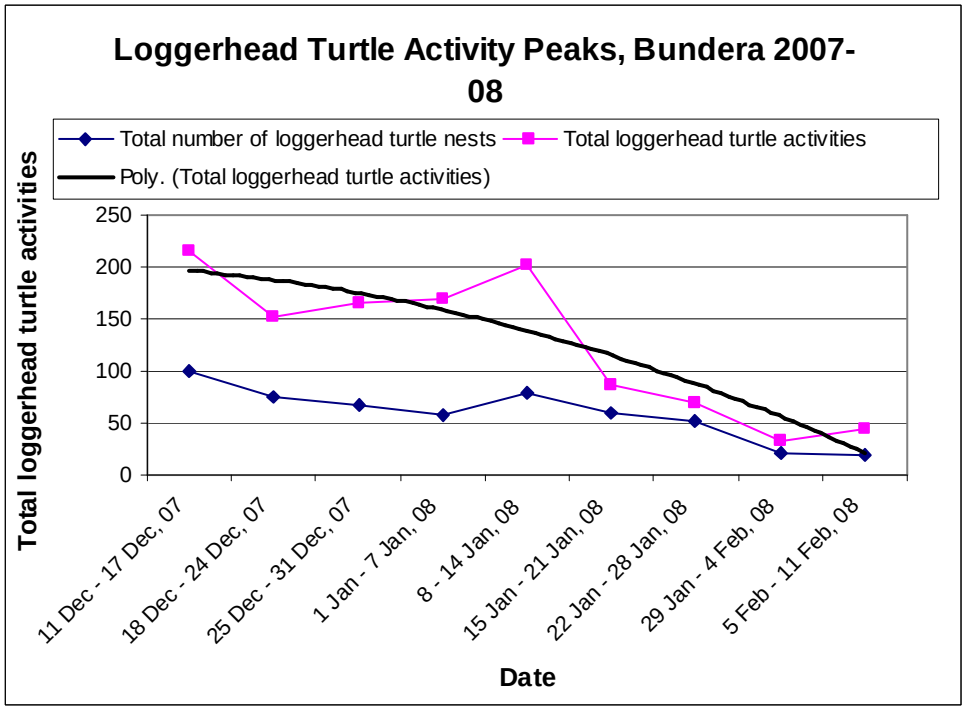
Overall the total nesting activity in the Bundera division gradually declined throughout the 2007-08 nesting season (Figure 33). The majority of the turtle activities were recorded for loggerhead turtles. The turtle activity patterns for green, loggerhead and hawksbill turtles are provided separately in
Figure 36,
Figure 37 and Figure 38 below. Due to the difficulty in distinguishing between loggerhead and hawksbill turtle tracks any turtle activities associated with tracks with an alternate gait are combined in Figure 39.

For the first 5 weeks of monitoring at Bundera the number of green turtle activities recorded fluctuated greatly, reaching a peak between the 8th and 14th of January 2008 with 38 activities recorded. Loggerhead turtle activities peaked during the first week of monitoring at Bundera (11th - 17th of December 2007) with 215 activities recorded, followed by a second peak of 202 activities recorded between the 8th and 14th of January 2008. Hawksbill turtle activities reached a single peak of 14 activities recorded between the 25th and 31st of December 2007; on either side of this peak minimal hawksbill activity was recorded. Turtle activities relating to tracks with an alternate gait showed the same trend that was recorded for loggerhead turtles.



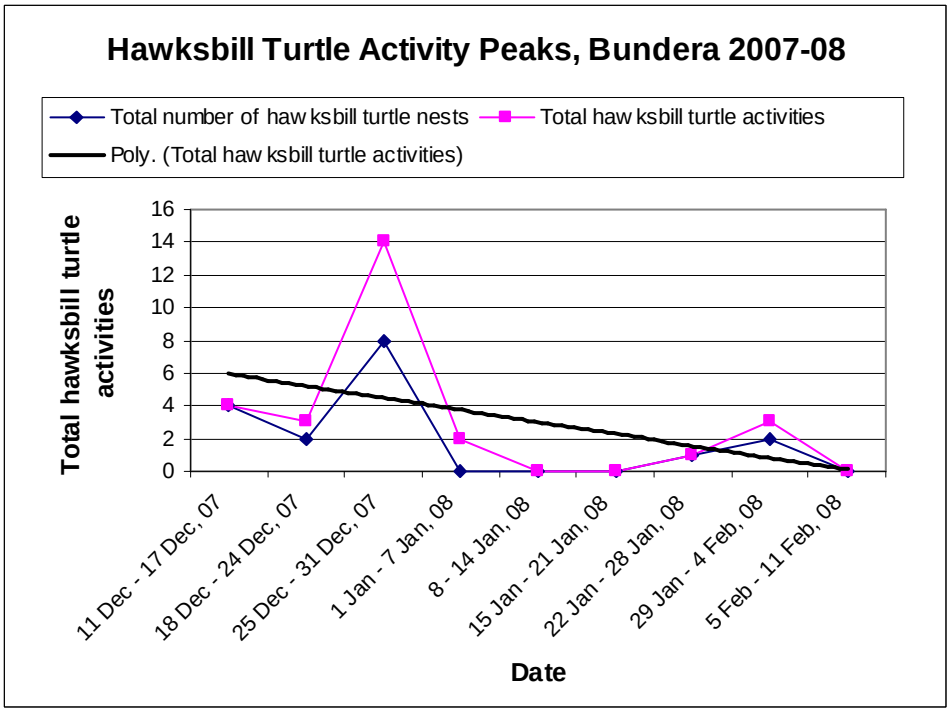
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 36: Green turtle activity levels recorded per week in the Bundera division during the 2007-08 nesting season.



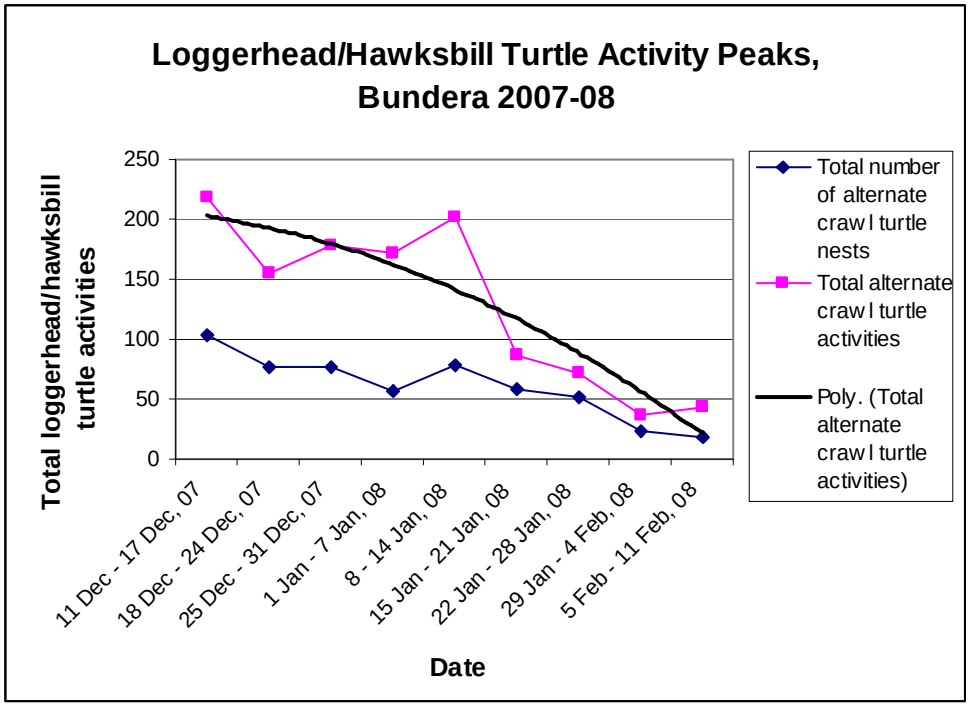
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 37: Loggerhead turtle activity levels recorded per week in the Bundera division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 38: Hawksbill turtle activity levels recorded per week in the Bundera division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 39: Turtle activity levels recorded for tracks with an alternate gait, per week in the Bundera division during the 2007-08 nesting season.

Within the Bungelup section the majority of turtle activities were recorded in the Bungelup Sth - Rollys subsection with a total of 223 nests and 312 false crawls in comparison to the 211 nests and 256 false crawls recorded in the Bungelup Sth –

Bungelup Nth subsection and the 176 nests and 181 false crawls recorded in the Bungelup Nth – Neils Nth subsection (

Figure 40). Green turtle nests were most abundant in the Bungelup Sth - Rollys subsection and loggerhead turtles nests were most abundant in the Bungelup Sth – Bungelup Nth subsection. Hawksbill turtle nest numbers did not differ much between the subsections with 6, 6 and 5 nests recorded in the Bungelup Nth - Neils Nth, Bungelup Sth – Rollys and Bungelup Sth - Bungelup Nth subsections respectively.

The subsections differ in length depending on the allocated areas to be monitored. The nesting density for each subsection is provided in Figure 41. The greatest number of nests recorded per meter of beach monitored occurred in the Bungelup Sth – Bungelup Nth subsection with 0.15 nests recorded per meter. The Bungelup Nth - Neils Nth subsection had a density of 0.13 nests recorded per meter and the Bungelup Sth – Rollys subsection had a density of 0.09 nests recorded per meter. The total Bungelup section had a density of 0.11 nests recorded per meter of beach monitored. Therefore nesting was concentrated in the middle subsection.

The highest density of green turtle nests was recorded in the Bungelup Sth – Rollys subsection with 0.02 nests produced per meter. Loggerhead turtles were recorded to nest most densely in the Bungelup Sth – Bungelup Nth subsection with 0.14 nests produced per meter. Hawksbill turtle nests were recorded to be the densest in the Bungelup Nth - Neils Nth subsection with less than 0.01 nests produced per meter.

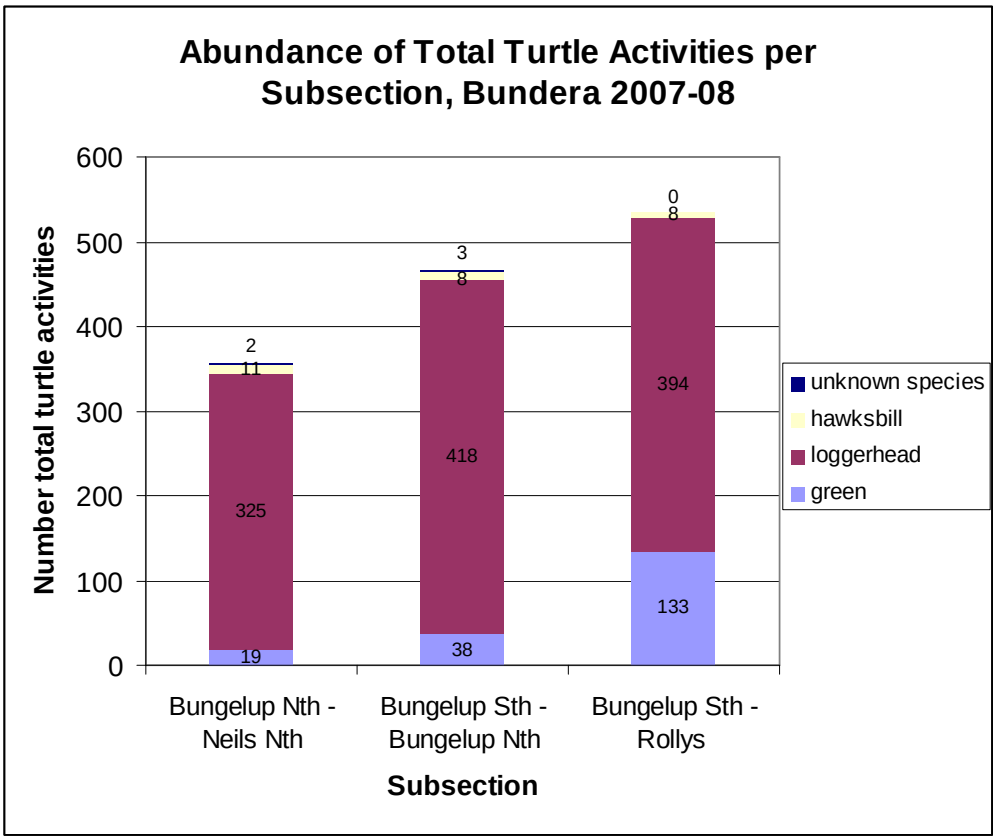


Figure 40: The abundance of turtle activities recorded for each species per subsection in the Bundera division during the 2007-08 nesting season.

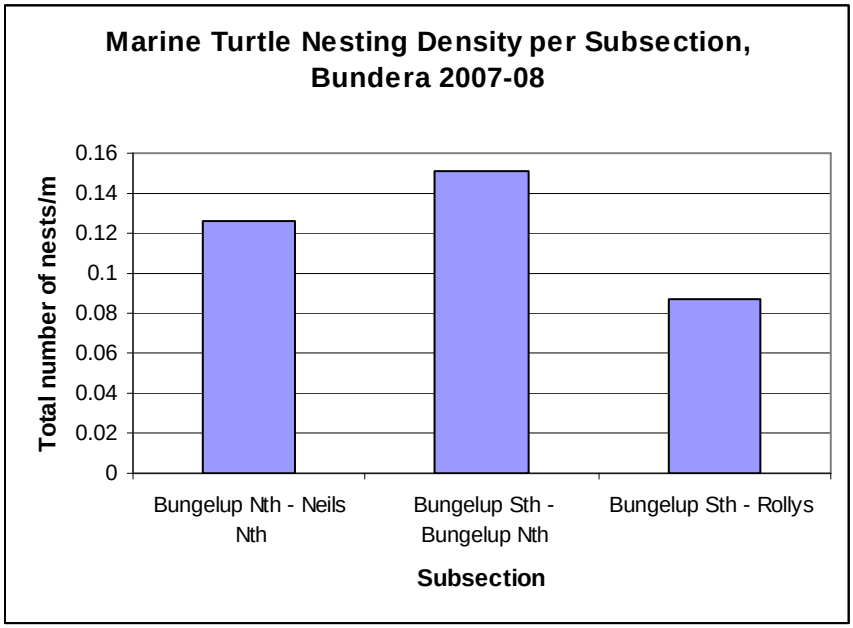


Figure 41: Nesting density recorded per subsection in the Bundera division during the 2007-08 nesting season.

In the Bundera division the majority of turtles were found to nest in the zone between the edge of the vegetation line to the base of the foredune (52.5%), followed by the zone between the high water mark and the edge of the vegetation line (34.1%) (Figure 42). A total of 10.3% of nests were located landwards of the base of the foredune, and 2.8% of nests were located in the intertidal zone between the waters edge to the high tide mark. The position of the nest on the beach was not defined for 0.2% of the total nests recorded.

Green turtles most frequently nested in the zone between the edge of the vegetation to the base of the foredune, followed by the zone landwards of the base of the foredune with 54.2% and 27.1% respectively. Loggerhead and hawksbill turtles nested most frequently in the zone between the edge of the vegetation to the base of the foredune (53.0% and 47.1% respectively), followed by the zone between high water mark and the edge of the vegetation line (36.0% and 35.3% respectively). Nests recorded for unknown turtle species were most common between the high water mark and the edge of the vegetation line (80%), followed by the intertidal zone (20%).

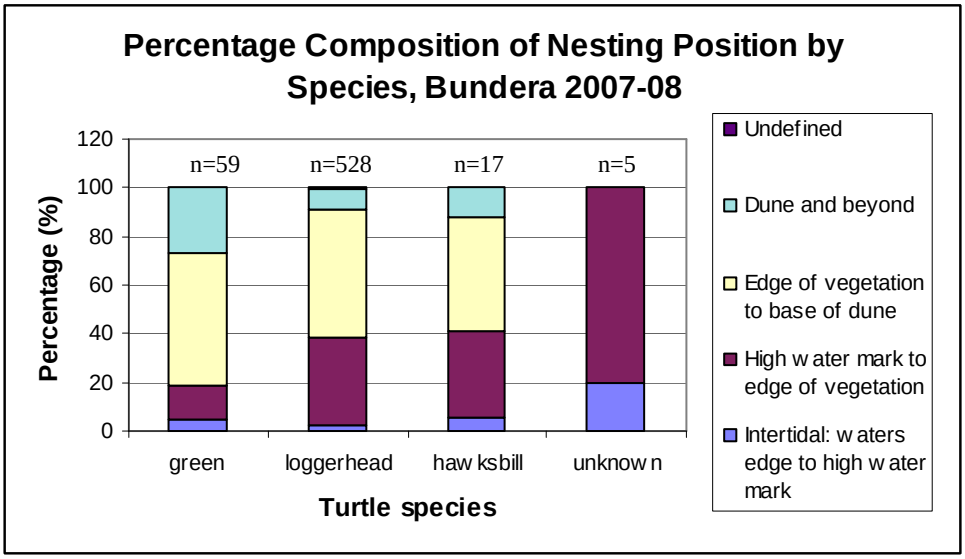


Figure 42: Percentage composition of nesting position by species in the Bundera division during the 2007-08 nesting season.

During the period of monitoring the ratio of nests to false crawls in the Bundera division was 0.81 nests to each false crawl produced, with the best ratio recorded between the 22nd and 28th of January 2008 with 2.46 nests produced for every false crawl. Figure 43 shows the nesting success rate recorded per week for each species in the Bundera division.

Green turtle nesting success was greatest between the 22nd and the 28th January 2008 and the 18th and 24th December 2007 with nesting success rates of 58.33% and 53.33% respectively. Loggerhead turtle nesting success was highest in the three week period between the 15th January and the 4th February 2008 with a range of 63.64% - 72.86%. Hawksbill nesting success rates peaked at the beginning of the season (11th – 17th December 2007) and again between the 22nd and 28th of January 2008 with 100% success rates. However it should be noted that during these periods only four and one nests were recorded respectively and on both occasions no false crawls were recorded. During the middle of the season (1st – 21st January 2008) and at the end of the season (5th – 11th February 2008) hawksbill nesting success rates dropped to 0% but during the majority of this time no nests or false crawls were recorded.

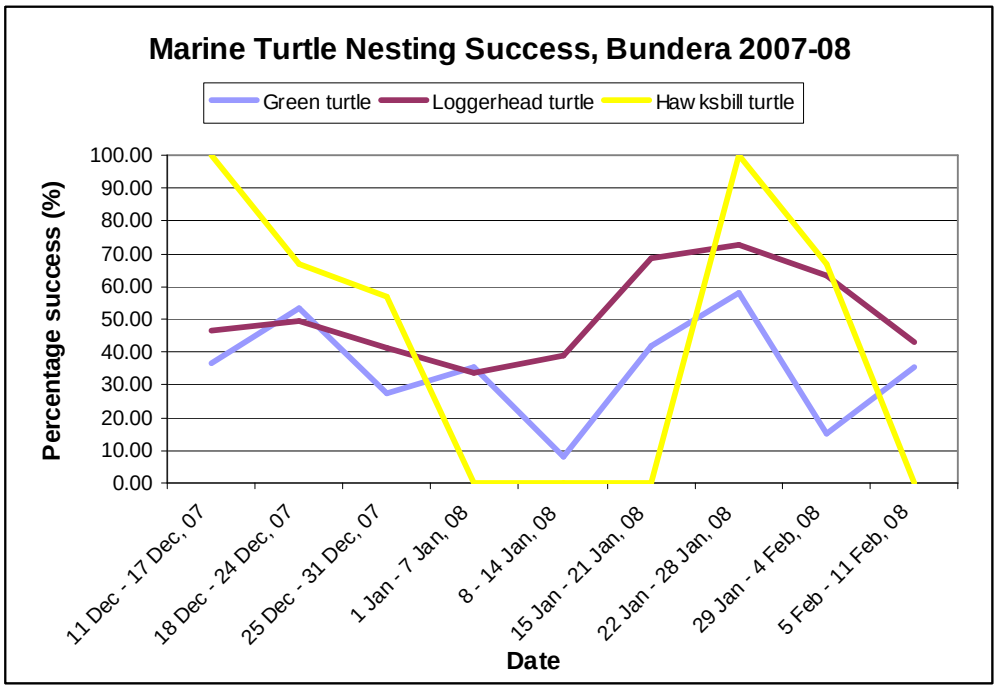


Figure 43: Marine turtle nesting success recorded for each species per week in the Bundera division during the 2007-08 nesting season.

A total of 157 nests were recorded as damaged in the Ningaloo Region, 20 of which were located in the Bundera division. A range of 0 - 5 nests and an average of 2.2 nests were damaged per week in this division and the damaged nests constituted 3.3% of the total number of nests recorded for the region. The greatest number of damaged nests was recorded in the Bungelup Sth – Bungelup Nth subsection with 12 damaged nests (Figure 44). The majority of nests were damaged by ghost crabs (13 nests). Additionally one nest was recorded to be damaged by a dog and one nest was reported to be damaged by a goanna (Figure 45). No causes were defined for the remainder of damaged nests.

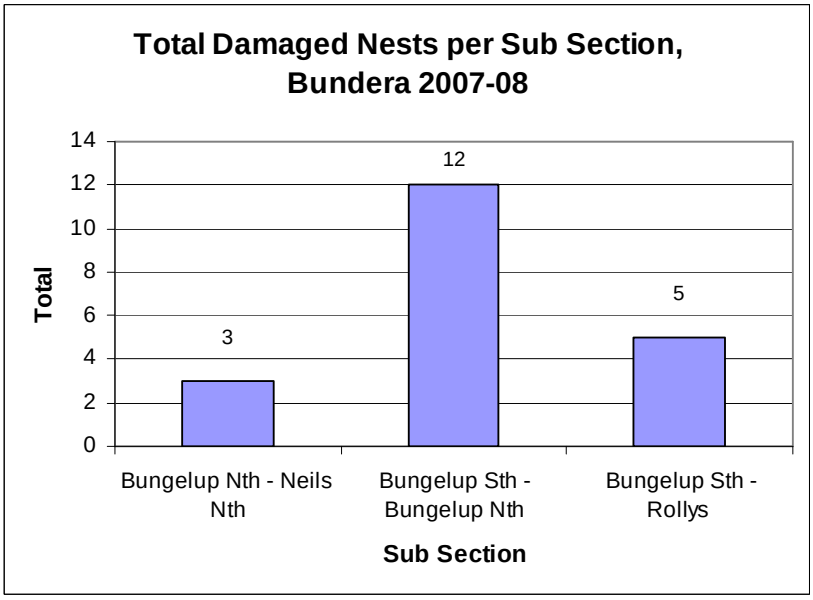


Figure 44: Total number of damaged nests in the Bundera division during the 2007-08 nesting season.

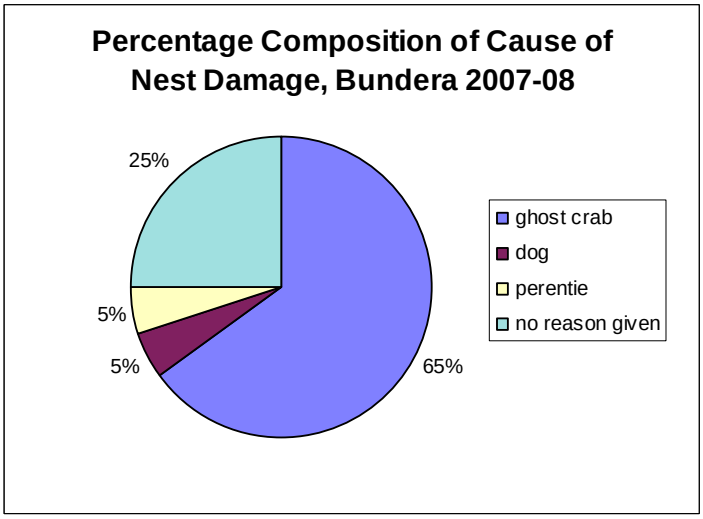


Figure 45: Percentage composition of cause of nest damage in the Bundera division during the 2007-08 nesting season.

The total number of potential predator tracks that were sighted within a 5m radius of new and old turtle nests is provided for each subsection in Figure 46. In total there were 54 fox, 13 ghost crab, 10 human, 8 perentie, 2 dog, and no cat or vehicle tracks sighted within 5m radii of turtle nests recorded in the Bundera division. The greatest number of fox tracks (23) and the only dog tracks recorded around nests in the Bundera division (2) were located in the Bungelup Sth – Rollys subsection; the greatest number of human (6) and ghost crab tracks (9) were seen around nests within the Bungelup Sth – Bungelup Nth subsection; and the highest recorded number of perentie tracks (6) were seen in the Bungelup Nth – Neils Nth subsection. In total the greatest number of potential predator tracks were sighted around nests within the Bungelup Sth – Bungelup Nth subsection (37 tracks) followed closely by the Bungelup Sth – Rollys subsection (29) and the Bungelup Nth – Neils Nth subsection (21 tracks).

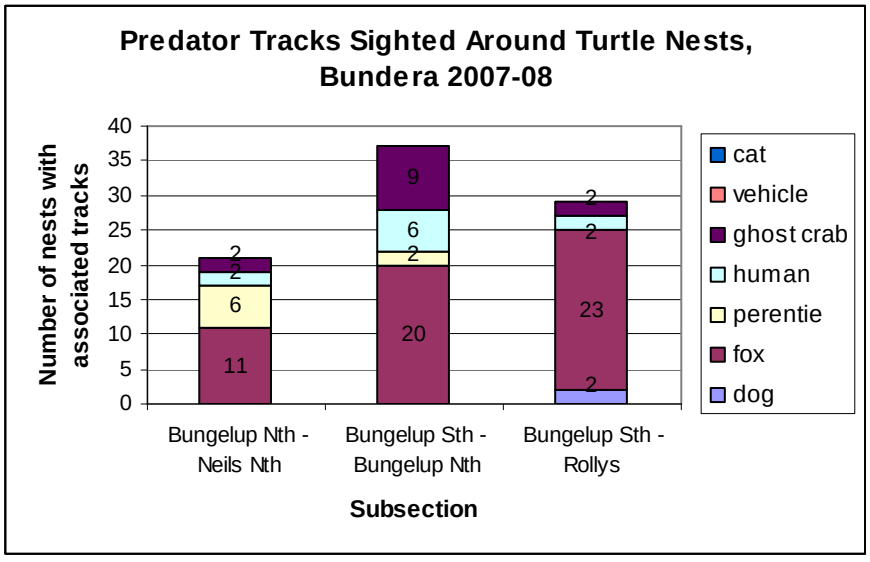


Figure 46: Total number of predator prints sighted within a 5m radius of turtle nests recorded in the Bundera division during the 2007-08 nesting season.

Fox and dog prints were identified and recorded on the Ningaloo Coast a total of 730 times, with 91 of these prints recorded at Bundera. Fox prints were recorded on 83 occasions and dog prints were recorded on 8 occasions. An average of 9.2 and 0.9 incidences were recorded per week where fox and dog tracks were identified respectively. Fox tracks were most abundant on the Bungelup Sth – Rollys subsection; the abundance of dog prints did not vary much between subsections (Figure 47).

A regression analysis on the correlation between the number of nests and the number of predator tracks could not be performed for the Bundera division due to the small amount of data considering there are only three subsections. Figure 48 shows the total number of times fox prints have been sighted on each subsection (83 in total) in comparison to the number of times fox prints have been sighted within a 5m radius of damaged nests (6 in total). Out of these 6 damaged nests none were reported to be definitely damaged by foxes.

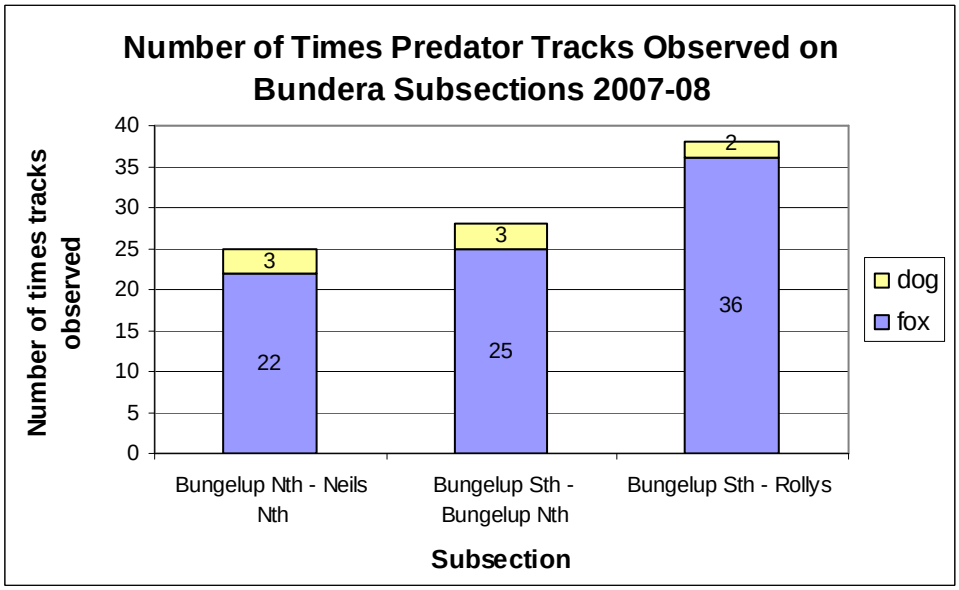


Figure 47: Number of days where fox and dog prints were identified per subsection in the Bundera division during the 2007-08 nesting season.

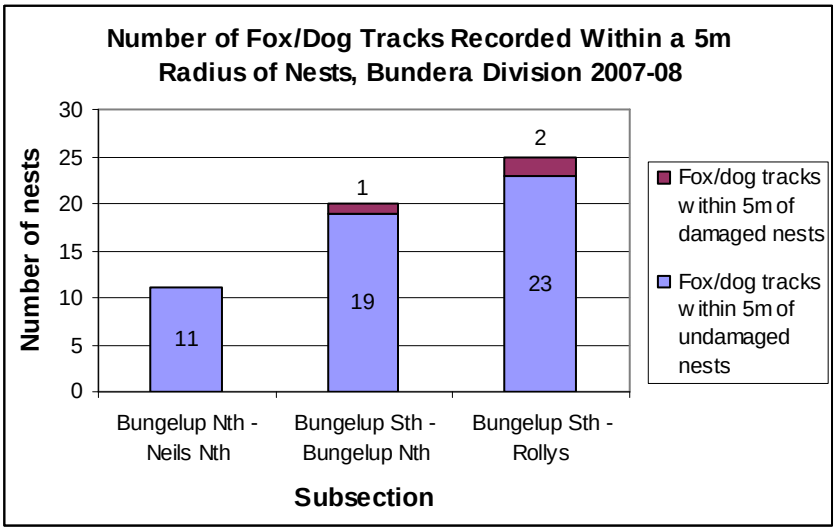


Figure 48: The level of presence of foxes and dogs within a 5m radius of undamaged nests compared to damaged nests, in the Bundera division 2007-08.

3.1.3 Coral Bay division

During the 2007-08 season a total of 71 nests and 54 false crawls were recorded in the Coral Bay division, with a range of 0 - 11 nests and an average of 5.5 nests recorded per week (Figure 49). An average of 4.1 false crawls was recorded per week with a weekly range between zero near the end of the season and 16 during the peak. The greatest numbers of nests were recorded at the beginning of the monitoring season (1st – 7th December 2007) and between the 22nd December 2007 and the 11th January 2008 with 11 and between 9 - 10 nests recorded for each of these periods respectively. The abundance of false crawls produced a similar trend to that of nests with peaks in both false crawls and total turtle activities at the start of the season (1st – 7th December 2007) with 6 false crawls and 17 total turtle activities recorded and between the 5th and 11th of January 2008 with 16 false crawls and 25 total turtle activities recorded (Figure 49).

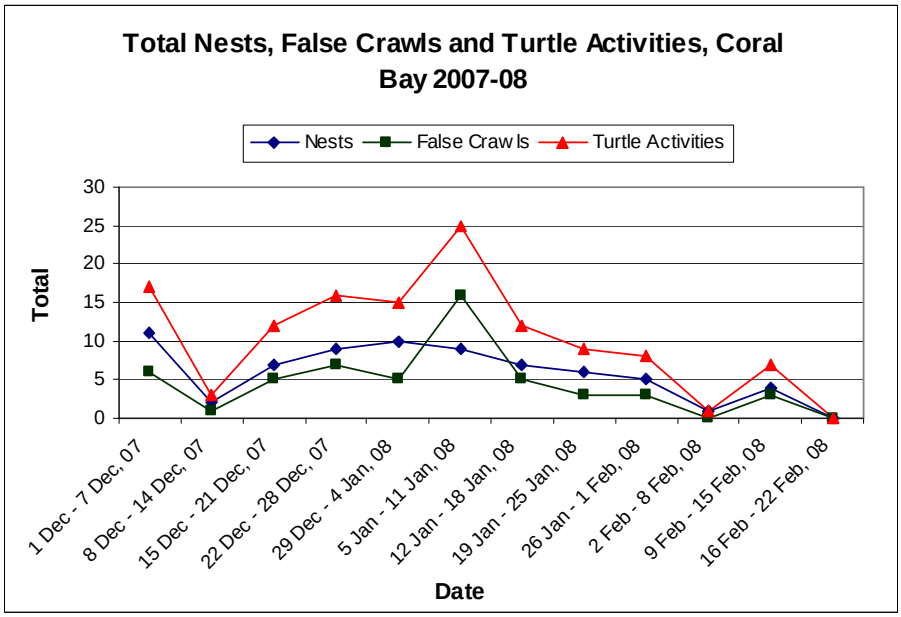


Figure 49: The total number of nests, false crawls and total turtle activities recorded per week for the Coral Bay division in the 2007-08 nesting season.

Throughout the 2007-08 nesting season the total number of nests recorded at Coral Bay was produced relatively evenly by loggerhead turtles, green turtles and hawksbill turtles with 37%, 35% and 28% of nests being laid by these species respectively (Figure 50). No nests were recorded to be laid by unknown species. Throughout the duration of the season the percentage comparison of nesting turtle species varied week to week (Figure 51). Loggerhead turtles produced between 0-100% of the total nests recorded per week, green turtles produced between 0-67%, and hawksbill turtles produced between 0-60%.

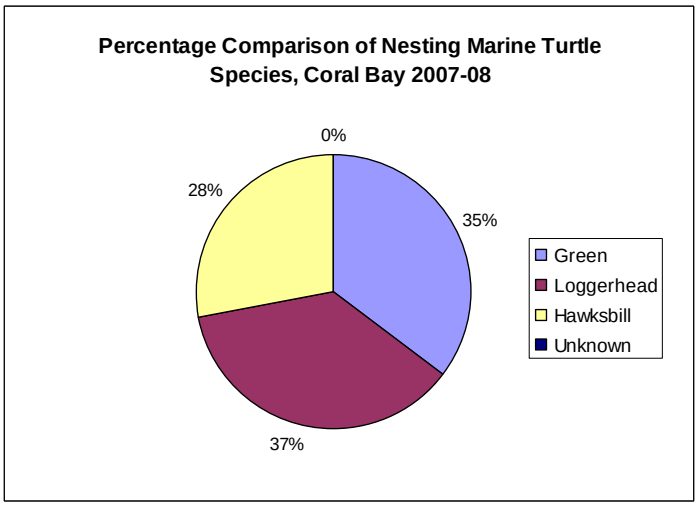


Figure 50: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species as recorded for the Coral Bay division during the 2007-08 nesting season.

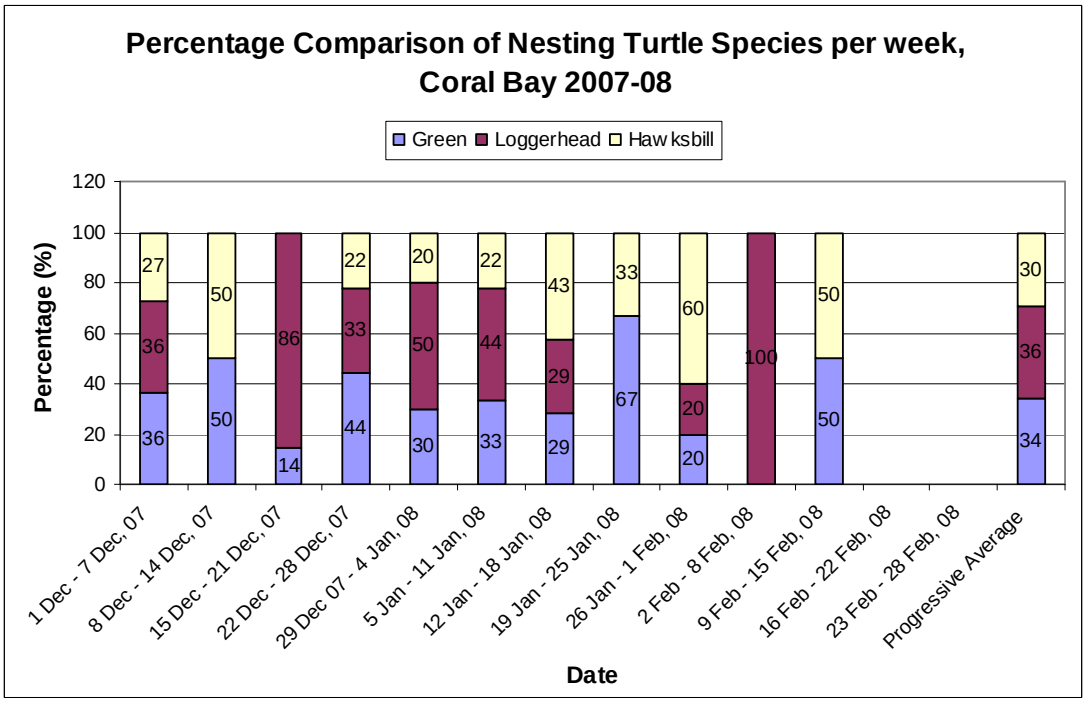
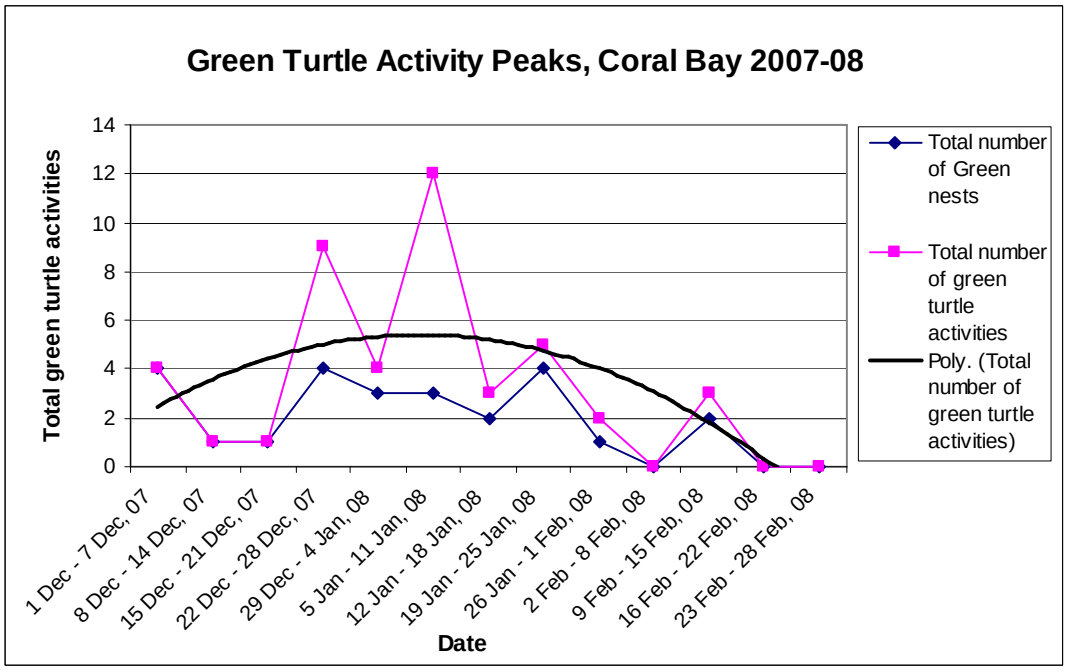


Figure 51: The percentage comparison of nests produced by green, loggerhead, hawksbill and unknown turtle species per week as recorded for the Coral Bay division during the 2007-08 nesting season.

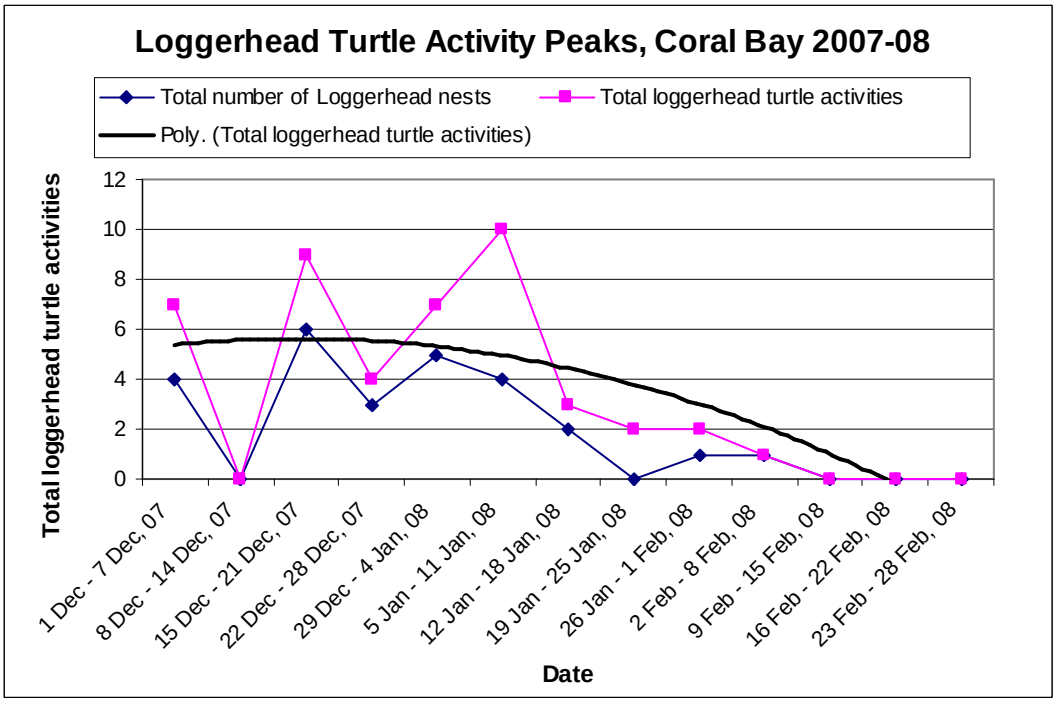
Overall the total nesting activity in the Coral Bay division remained relatively low throughout the 2007-08 nesting season (Figure 49). The proportions of total turtle activities recorded for each species of marine turtle were fairly evenly distributed. The turtle activity patterns for green, loggerhead and hawksbill turtles are provided separately in
Figure 52,
Figure 53 and
Figure 54 below. Due to the difficulty in distinguishing between loggerhead and hawksbill turtle tracks any turtle activities associated with tracks with an alternate gait are combined in
Figure 55.

Throughout the 2007-08 season the abundance of turtle activities at Coral Bay remained consistently low. The peak of green turtle activity was reached between the 22nd and 28th of December 2007 and the 5th and 11th of January 2008 with 9 and 12 recorded activities respectively. Loggerhead turtle activities peaked between the 15th and the 21st of December 2007 and the 5th and 11th January 2008 with 9 and 10 activities recorded respectively. Hawksbill turtle activities were most abundant during the first week of monitoring (1st – 7th December 2007) and between the 12th and the 18th January 2008 with 6 activities recorded during both of these periods. Minimal activity was recorded for all species in the final two weeks of the monitoring season, however it must be noted that monitoring only occurred on one day in the period between the 16th and the 22nd February 2008 and monitoring was not conducted between the 23rd and 28th of February 2008 at Coral Bay. Turtle activities associated with tracks with an alternate gait showed the same general trend as that of loggerhead and hawksbill turtles, with the level of activity gradually declining throughout the monitoring season.



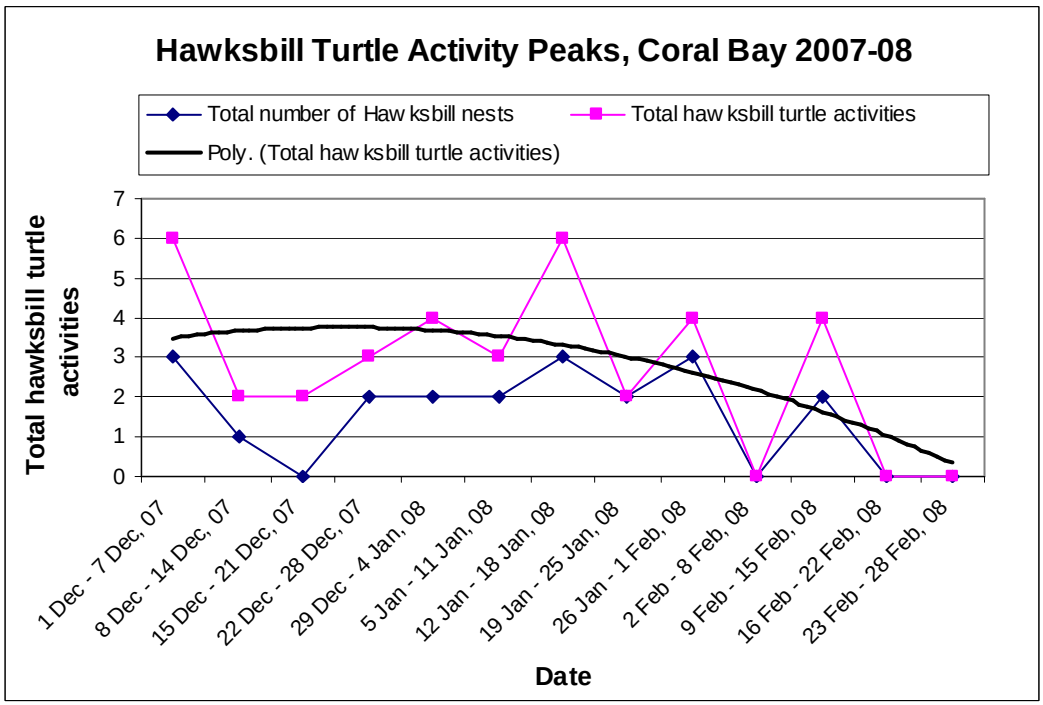
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 52: Green turtle activity levels recorded per week in the Coral Bay division during the 2007-08 nesting season.



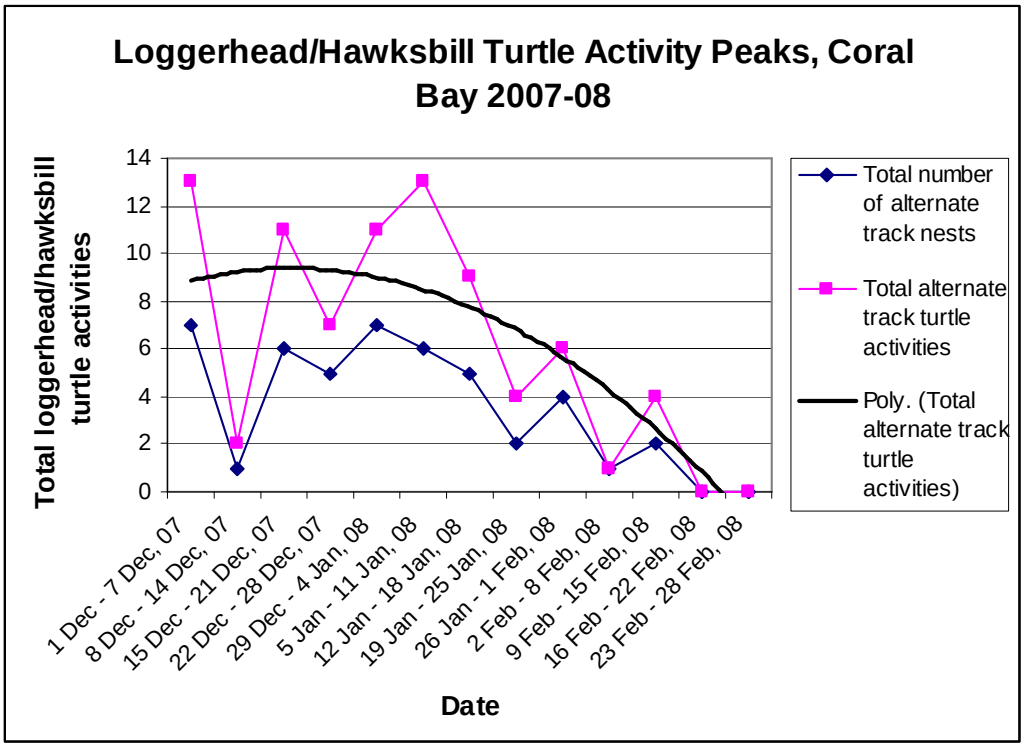
NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 53: Loggerhead turtle activity levels recorded per week in the Coral Bay division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 54: Hawksbill turtle activity levels recorded per week in the Coral Bay division during the 2007-08 nesting season.



NB: Total turtle activities include the total number of nests and false crawls recorded.

Figure 55: Turtle activity levels recorded for tracks with an alternate gait, per week in the Coral Bay division during the 2007-08 nesting season.

Within the Coral Bay division the majority of turtle activities were recorded in the Batemans Sth – Batemans Nth subsection with a total of 41 nests and 30 false crawls in comparison to the 30 nests and 24 false crawls recorded in the Batemans Nth – Oyster Bridge subsection (Figure 56). Green, loggerhead and hawksbill turtle nests were all more abundant in the Batemans Sth – Batemans Nth subsection, but numbers did not vary by much between the two subsections for all three species.

The subsections differ in length depending on the allocated areas to be monitored. The nesting density for each subsection is provided in Figure 57. The greatest number of nests recorded per meter of beach monitored occurred in the Batemans Nth – Oyster Bridge subsection with 0.025 nests recorded per meter. The Batemans Sth – Batemans Nth subsection had a density of 0.005 nests recorded per meter. The total Coral Bay division had a density of 0.008 nests recorded per meter of beach monitored.

The Batemans Nth – Oyster Bridge subsection contained the highest density of marine turtle nests for all species recorded with 0.010, 0.008 and 0.007 nests recorded per meter of beach for green, loggerhead and hawksbill turtles respectively. For the Batemans Sth – Batemans Nth subsection 0.002, 0.002 and 0.001 nests were recorded per meter of beach for green, loggerhead and hawksbill turtles respectively.

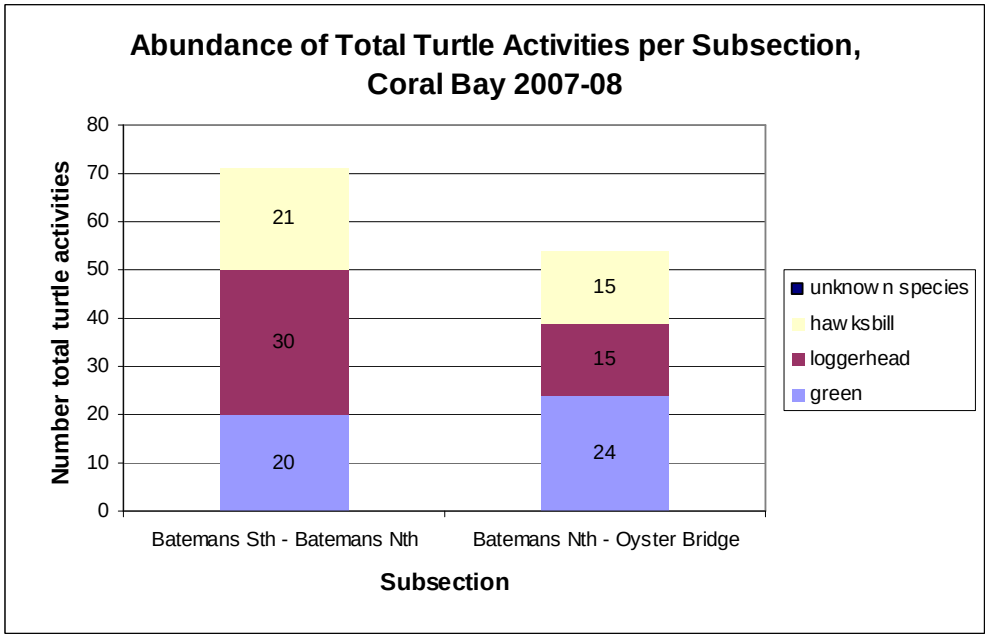


Figure 56: The abundance of turtle activities recorded for each species per subsection in the Coral Bay division during the 2007-08 nesting season.

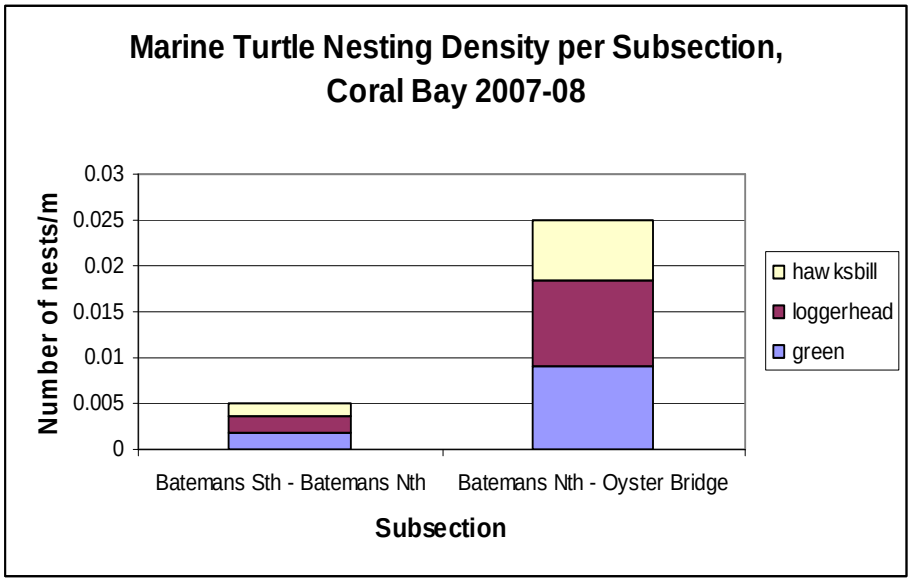


Figure 57: Nesting density recorded per subsection and by species in the Coral Bay division during the 2007-08 nesting season.

In the Coral Bay division the majority of turtles were found to nest in the zone between the edge of the vegetation line to the base of the foredune (56.3%), followed by the zone between the high water mark and the edge of the vegetation line (35.2%) (Figure 58). A total of 8.4% of nests were located landwards of the base of the foredune, and 0% of nests were located in the intertidal zone between the waters edge to the high tide mark.

Green, loggerhead and hawksbill turtles nested most frequently in the zone between the edge of the vegetation to the base of the foredune (60.0%, 50.0% and 60.0% respectively), followed by the zone between the high water mark and the edge of the vegetation line (32.0%, 46.1% and 25.0% respectively). No nests were recorded for unknown turtle species.

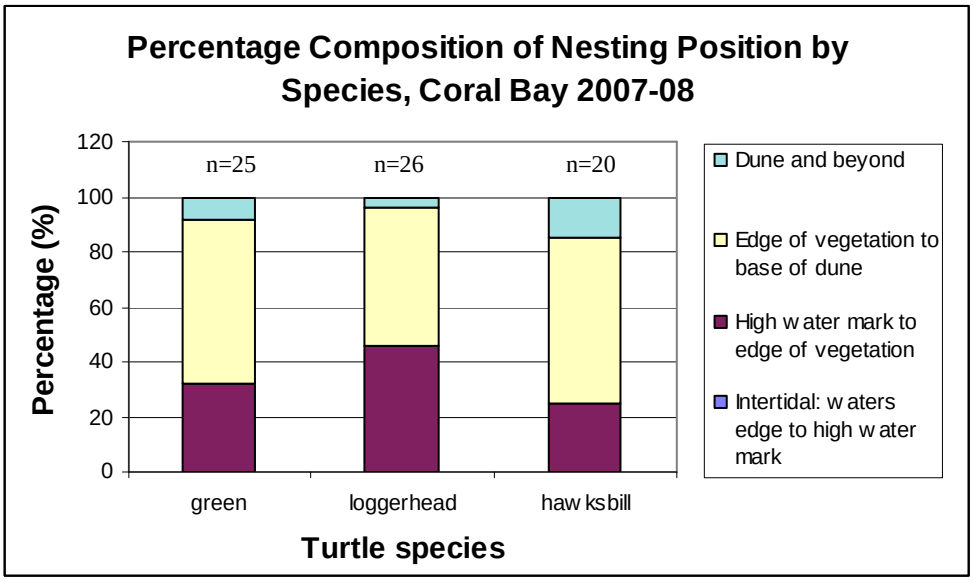


Figure 58: Percentage composition of nesting position by species in the Coral Bay division during the 2007-08 nesting season.

During the period of monitoring the ratio of nests to false crawls in the Coral Bay division was 1.3 nests to each false crawl produced, with the best ratio recorded in the second, fifth and eighth weeks (8th – 14th December 2007, 29th December – 4th January and the 19th – 25th February 2008) with 2 nests produced to each false crawl. Figure 59 shows the nesting success rate recorded per week for each species in the Coral Bay division. The final two weeks of the season (16th – 28th February 2008) were not included because no nests or false crawls were recorded during this period.

The nesting success rates were variable throughout the monitoring season for all species of marine turtles recorded at Coral Bay, with the success rates of green, hawksbill and loggerhead turtles all ranging between 0-100%. Green turtle nesting success was greatest between the 1st and the 7th December 2007 and the 15th and 21st of December 2007 with a nesting success rate of 100% for both periods. Loggerhead turtle nesting success reached 100% between the 2nd and 8th of February 2008. The hawksbill nesting success rate peaked between the 19th and the 25th January 2008 with a 100% success rate. All three species experienced nesting success rates of 0% during certain periods of the season, however it should be noted that in these incidences no nests and only 0 -2 false crawls were recorded.

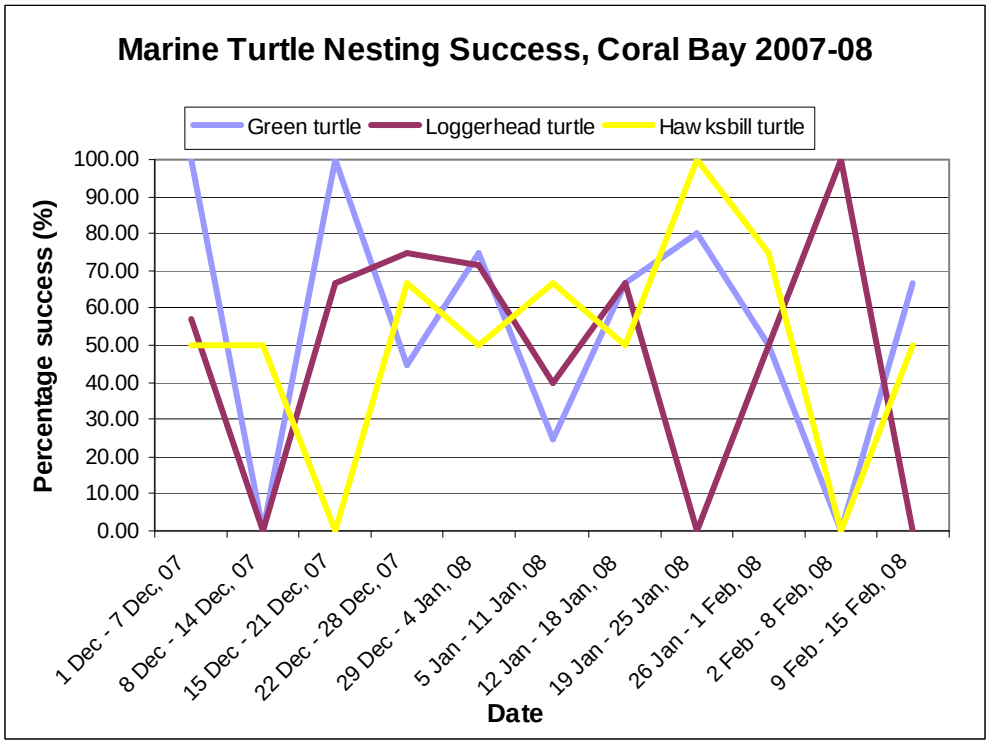


Figure 59: Marine turtle nesting success recorded for each species per week in the Coral Bay division during the 2007-08 nesting season.

The total number of potential predator tracks that were sighted within a 5m radius of new and old turtle nests is provided for both subsections in Figure 60. In total there were 9 dog, 3 fox, 1 human, 1 perentie, and no cat, ghost crab or vehicle tracks sighted within 5m radii of turtle nests recorded in the Coral Bay division. Overall the greatest number of fox (3) and dog tracks (6) were sighted in the Batemans Nth – Oyster Bridge subsection and the only human and perentie tracks sighted around nests were located in the Batemans Sth – Batemans Nth subsection. In total there was little difference between the numbers of predator tracks recorded around nests in the Coral Bay subsections with a total of nine tracks recorded in the Batemans Nth – Oyster Bridge subsection and five tracks recorded in the Batemans Sth – Batemans Nth subsection.

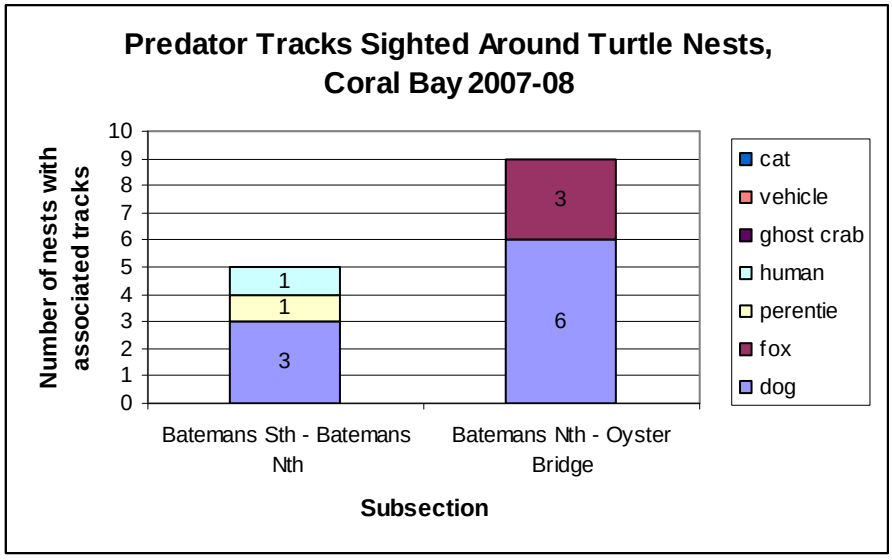


Figure 60: Total number of predator prints sighted within a 5m radius of turtle nests recorded in the Coral Bay division during the 2007-08 nesting season.

A total of 157 nests were recorded as damaged in the Ningaloo Region, two of which were located in the Coral Bay division. This equates to an average of 0.15 and a range of 0 – 2 nests that were recorded as damaged per week. These nests were recorded between the 9th and the 15th of February 2008 in the Batemans Nth – Oyster Bridge subsection and both were reported to have been dug up by a dog. The damaged nests constituted 2.8% of the total number of nests recorded for the region.

Fox and dog prints were identified and recorded on the Ningaloo Coast a total of 730 times, with 26 of these prints recorded at Coral Bay. Fox prints were recorded on 15 occasions and dog prints were recorded on 11 occasions. An average of 1.1 and 0.8 incidences were recorded per week where fox and dog tracks were identified respectively. The abundance of predator tracks did not vary much between the Batemans Nth – Oyster Bridge and Batemans Sth – Batemans Nth subsections (Figure 61). Fox prints were not recorded within a 5m radius of either of the damaged nests (Figure 62).

A regression analysis on the correlation between the number of nests and the number of predator tracks could not be performed for the Coral Bay division due to the small amount of data considering there are only two subsections.

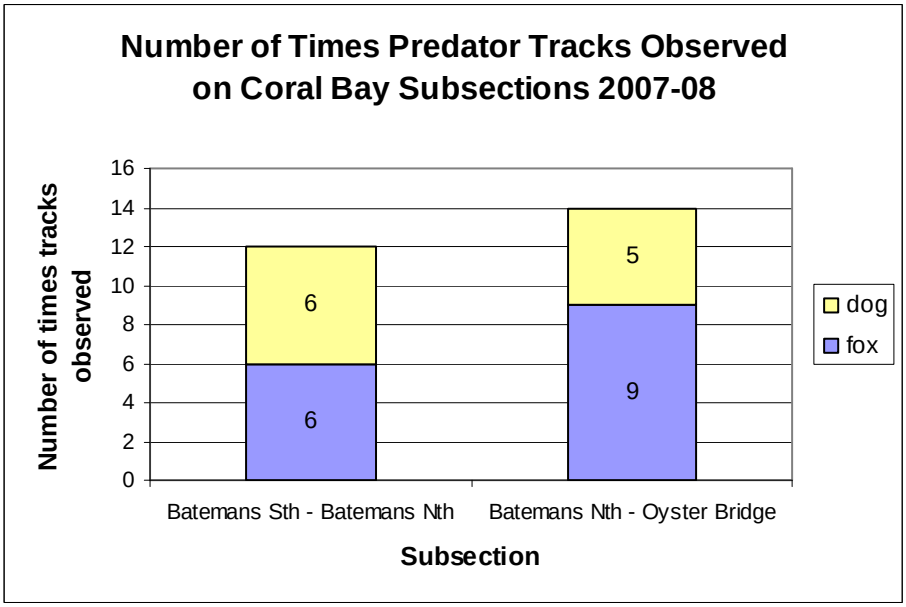


Figure 61: Number of days where fox and dog prints were identified per subsection in the Coral Bay division during the 2007-08 nesting season.

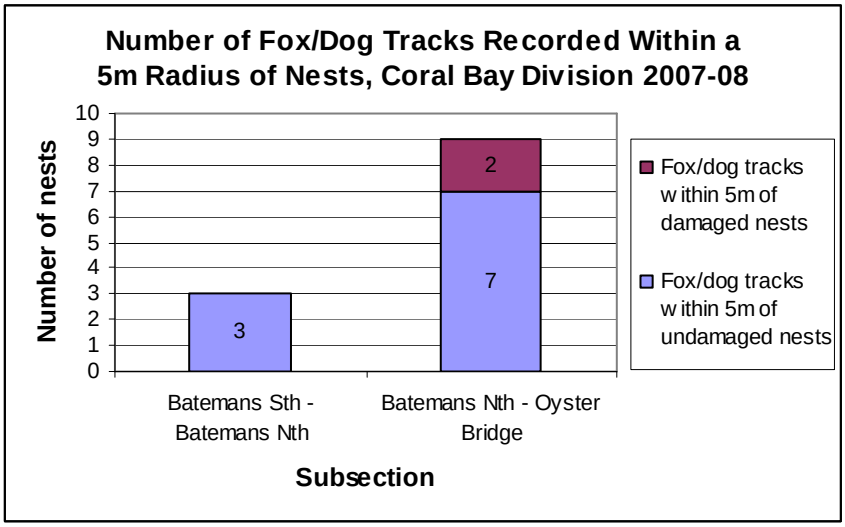


Figure 62: The level of presence of foxes and dogs within a 5m radius of undamaged nests compared to damaged nests, in the Coral Bay division 2007-08.

3.1.4 Rescues and mortalities

Eleven successful turtle rescues were executed in the Ningaloo region during the 2007-08 NTP nesting season. Turtles were rescued from behind steep dunes or rocky crevices. The locations of these rescues are provided in Figure 63. On two occasions turtles were rescued from secondary body pits after it appeared that they had partially buried themselves in sand. All rescued turtles were mature females and all were green turtles except for two loggerhead turtles which were rescued in the Bungelup Sth – Rollys subsection in the Bundera division.

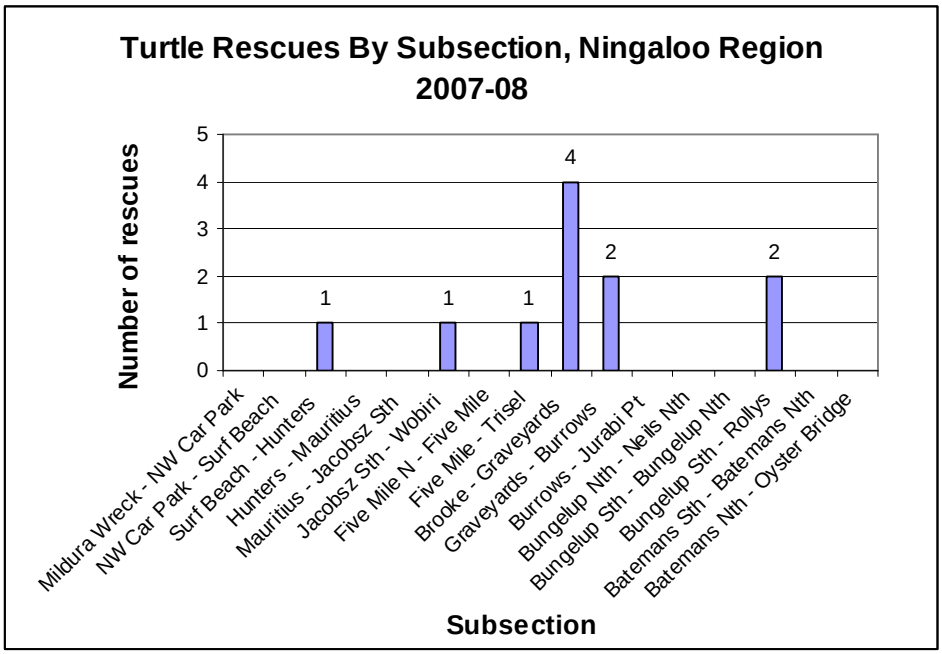


Figure 63: Locations of turtle rescues conducted in the Ningaloo region during the 2007-08 nesting season.

A total of eighteen turtle mortalities were recorded in the Ningaloo region during the 2007-08 nesting season, consisting of sixteen green turtles, one loggerhead turtle and one hawksbill turtle. The deceased turtles included ten adult females, one female of an unknown maturity, one adult male, three juveniles of unknown gender and three adults of unknown gender. The locations of the mortality reports are provided in Figure 64. The majority of mortalities were recorded in the Jacobsz – Wobiri subsection in the North West Cape division. All mortalities were recorded in the North West Cape division.

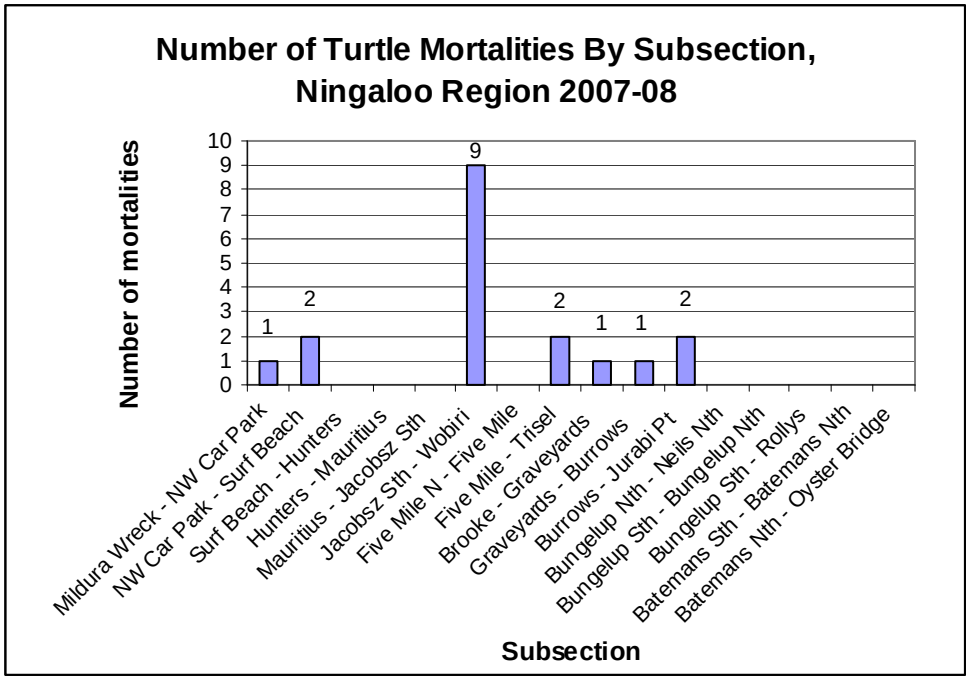


Figure 64: Locations of turtle mortalities reported in the Ningaloo region during the 2007-08 nesting season.

3.1.5 Climatic events

Four tropical cyclone events occurred near the North-Western area of Australia during the 2007-08 turtle nesting season. Cyclone Nicholas occurred within the closest vicinity to the Ningaloo coastline. The beaches were only assessed for storm surge damage after this event, therefore details of the possible effects of the other cyclone events are not provided.

On the 19th of February 2008 Tropical Cyclone Nicholas (Category 2) past Exmouth 45 km from the coastline (Commonwealth of Australia 2008). An assessment of the beaches after the event had occurred lead to an estimate of the level of damage to turtle nests by a storm surge associated with the cyclone: approximately 100% of nests in the I beach zone (intertidal area; between low and high tide levels) and 60-80% of nests in the H beach zone (area between the high tide mark and the edge of vegetation). Between the 22nd December 2007 and the 19th of February 2008 a total of 1733 and 104 nests were recorded to be laid in the H and I zones respectively. Therefore it is estimated that 1144 - 1490 nests were lost due to climatic events over the 2007-08 turtle monitoring season, which equates to 18.2 – 23.7% of the total nests recorded over the season.

3.1.6 Comparison to previous seasons

Since the commencement of the Ningaloo Turtle Program there has been a degree of variability associated with the duration and dates of the NTP seasons. Table 6 shows the dates of commencement and completion for each season, the number of days during which monitoring occurred on at least one subsection, survey effort and the number of subsections that were monitored at some stage during each season. The graphs included in the following sections, which involve seasonal comparisons of total figures recorded, are adjusted for survey effort.

Table 6: Details of the survey effort for each NTP season since the implementation of the program.

Season	Dates	Number of days where monitoring occurred	Survey effort	Number of subsections monitored
2002-03	18/11/2002 - 16/04/2003	132	941	22
2003-04	11/11/2003 - 30/03/2004	147	1291	29
2004-05	03/11/2004 - 18/03/2005	124	1738	28
2005-06	21/11/2005 - 28/02/2006	97	1278	20
2006-07	01/12/2006 - 28/02/2007	87	1213	19
2007-08	01/12/2007 - 28/02/2008	84	1158	19

*Note: Survey effort includes a combination of the number of days monitoring took place and the number of subsections monitored on those days.

A total of 23280 nests and 53966 false crawls have been recorded during the NTP monitoring seasons between 2002 and 2008. There has been a general increase in the number of total turtle activities recorded since the first NTP season with the exception of the 2003-04 and 2004-05 seasons (Figure 65). During the 2007-08 season there was an increase in the number of nests recorded in the Ningaloo region in comparison to previous seasons. This season 6277 nests were recorded, in comparison to 5452 recorded in the 2006-07 season and 5908 in the 2005-06 season, which is an increase of 13% and 6% respectively. When differences in survey effort are accounted for the level of turtle nesting has increased by 5% and 31% since the 2006-07 and 2005-06 seasons respectively.

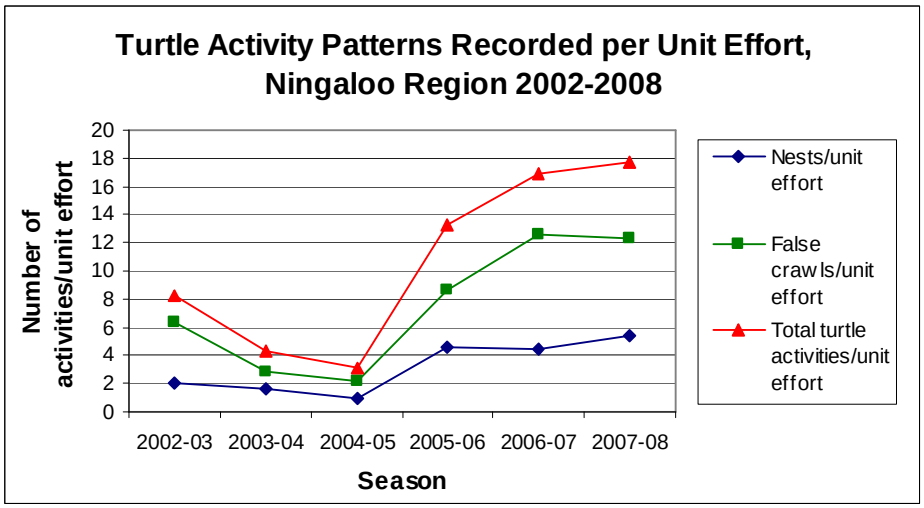


Figure 65: Numbers of nests, false crawls and total turtle activities recorded per year (adjusted for survey effort) since the commencement of the Ningaloo Turtle Program.

The green turtle has consistently been the most abundant marine turtle species to nest in the Ningaloo Region since the commencement of the Ningaloo Turtle Program (Figure 66). The loggerhead turtle, hawksbill turtle and flatback turtle nest in lower numbers in the region.

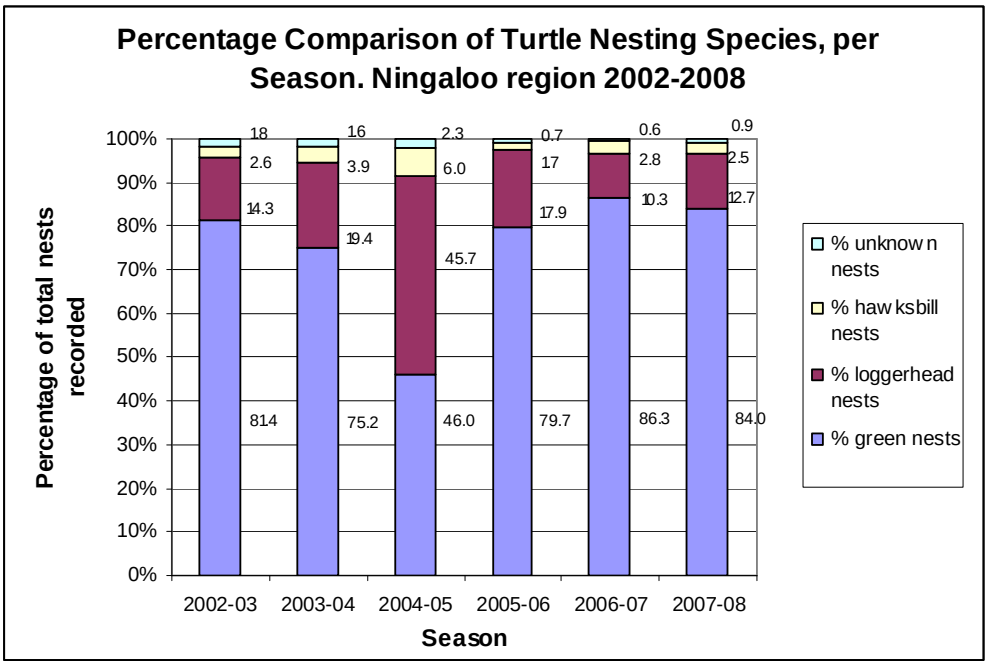


Figure 66: Percentage comparison of nesting marine turtle species in the Ningaloo region between 2002 and 2008.

In general the greatest turtle activity is recorded in the North West Cape division. However, when levels of nesting are adjusted for survey effort per division and per season the greatest level of nesting per unit effort is recorded for both the North West Cape and Bundera divisions in all seasons (Figure 67). A consistently lower level of nesting has been recorded in the Coral Bay division throughout all seasons of the NTP. The Cape Range, Waroora and Gnaraloo divisions were only monitored in the 2003-04 season.

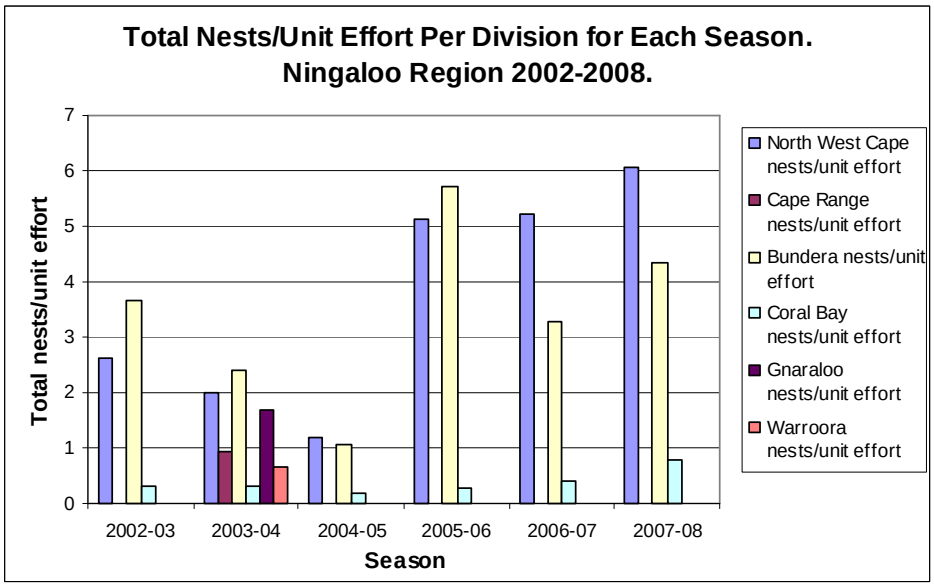


Figure 67: Total number of nests (adjusted for survey effort) recorded per division, in each season in the Ningaloo region between 2002 and 2008.

The total level of turtle activities recorded in the Ningaloo region per week is shown in Figure 68. In general the highest level of marine turtle activity is experienced around the 5th to the 11th of January. Turtle activity patterns have been similar over the past few seasons.

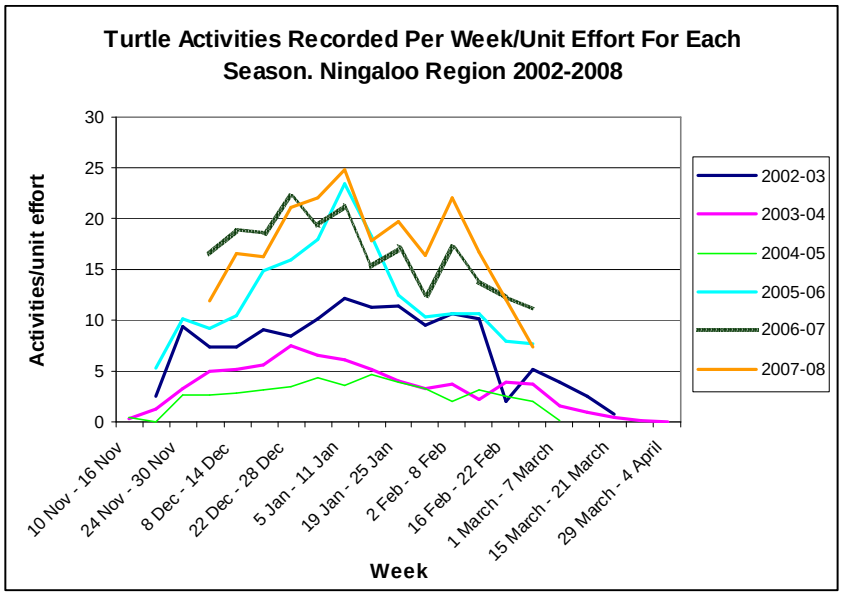


Figure 68: Total number of turtle activities (adjusted for survey effort) recorded per week, in each season in the Ningaloo region between 2002 and 2008.

Throughout the Ningaloo region green and loggerhead turtles predominantly nested in the zone between the edge of the vegetation and the base of the foredune (average 53.5% and 47.4% respectively over the six seasons), followed by the zone between the high water mark and the edge of the vegetation (average 35.5% and 38.8% respectively over the six seasons) (Figure 69 and Figure 70). Hawksbill turtles predominantly nested in the zone between the high water mark and the edge of the vegetation (average 51.9% over the six seasons) followed by the zone between the edge of the vegetation and the base of the foredune (average 39.2% over the six seasons) (Figure 71).

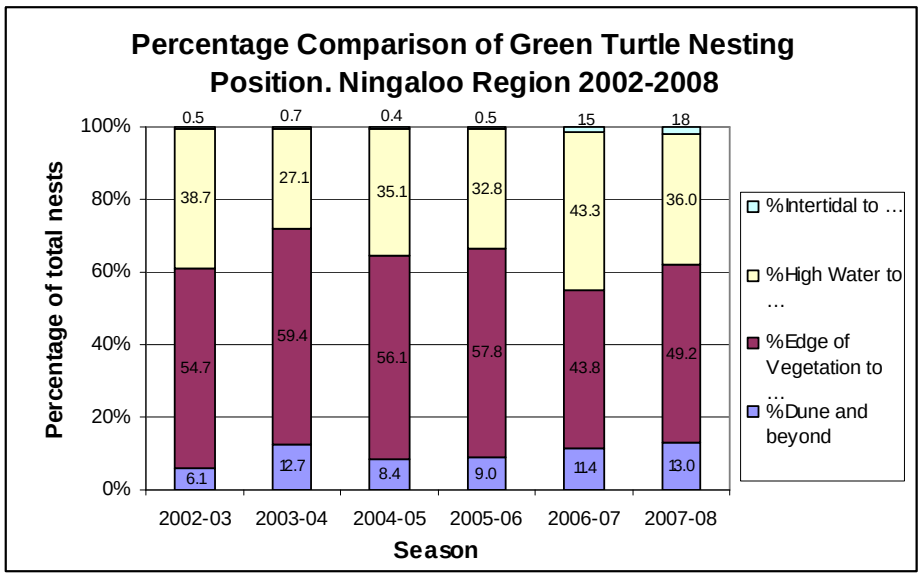


Figure 69: Percentage comparison of the nesting position of green turtles, for each season in the Ningaloo region between 2002 and 2008.

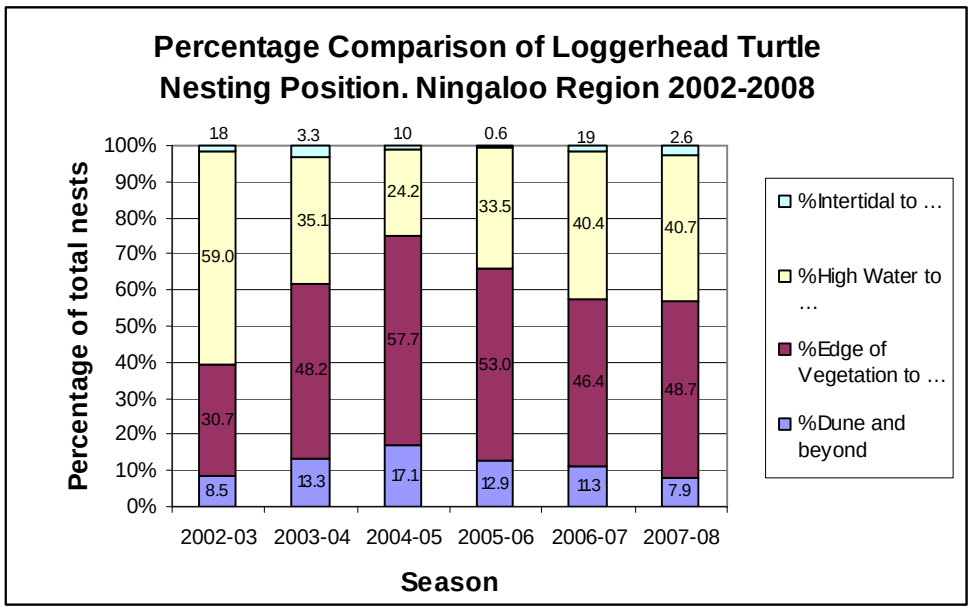


Figure 70: Percentage comparison of the nesting position of loggerhead turtles, for each season in the Ningaloo region between 2002 and 2008.

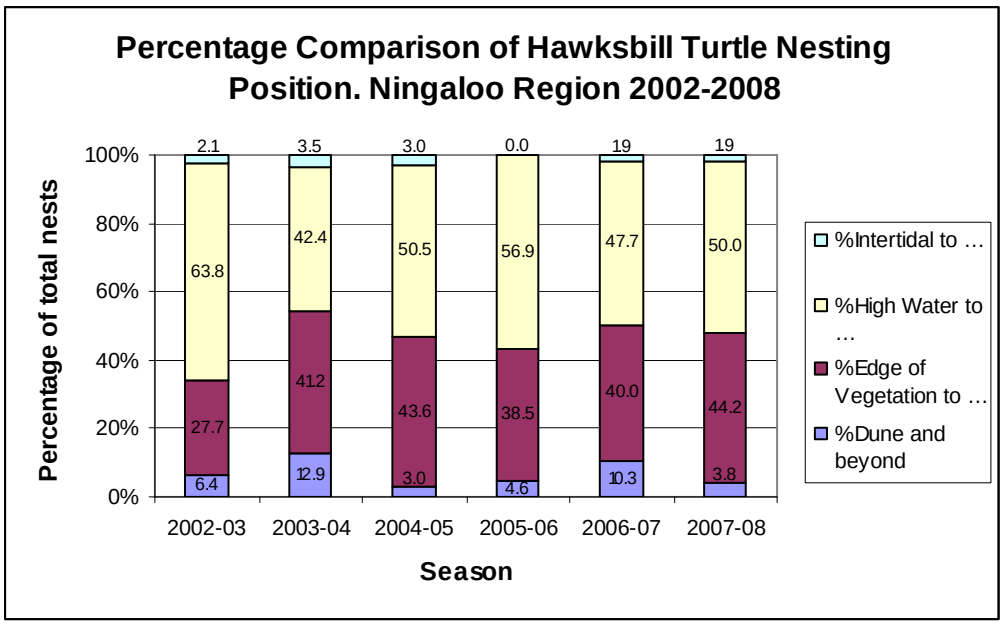


Figure 71: Percentage comparison of the nesting position of hawksbill turtles, for each season in the Ningaloo region between 2002 and 2008.

A total of 584 nests have been recorded as damaged during the NTP monitoring seasons between 2002 and 2008. The majority of these were recorded in the 2003-04 and 2007-08 seasons with 179 and 159 damaged nests recorded respectively (Figure 72). Figure 73 shows that the percentage of nests recorded as damaged has remained under the sustainable level of disturbance since the 2004-05 season.

In total the primary causes of nest damage have been recorded as foxes and ghost crabs with 38.6% and 25.8% of the total level of damage attributed to foxes and ghost crabs respectively between 2002 and 2008 (Figure 74). Over the past three seasons the proportion of damage attributed to ghost crabs has increased whilst the level attributed to foxes has decreased.

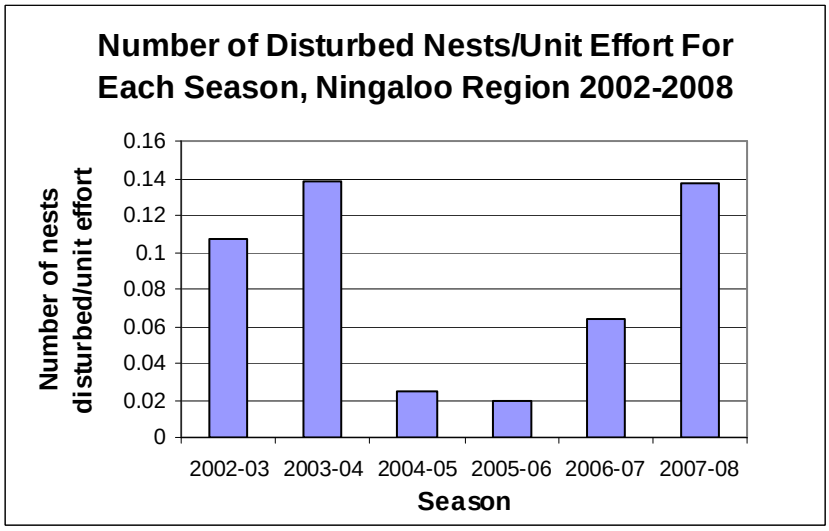


Figure 72: Number of disturbed nests (adjusted for survey effort) per season in the Ningaloo region between 2002 and 2008.

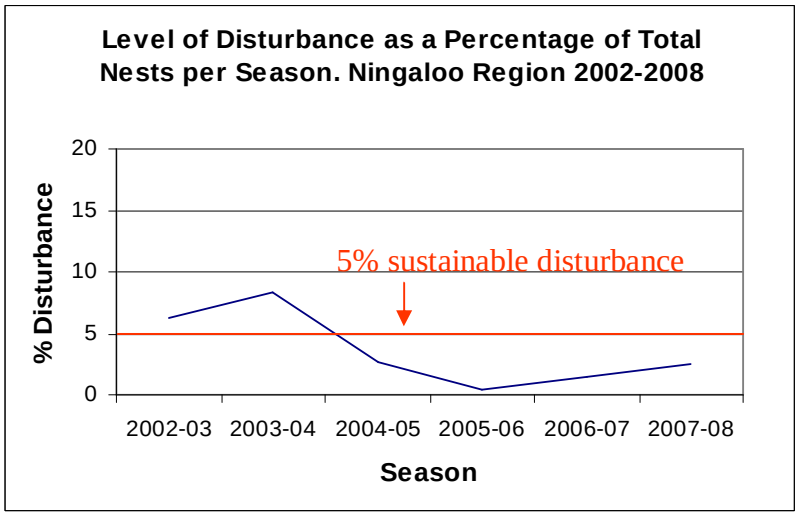


Figure 73: Percentage of nests recorded to be disturbed per season in the Ningaloo region between 2002 and 2008.

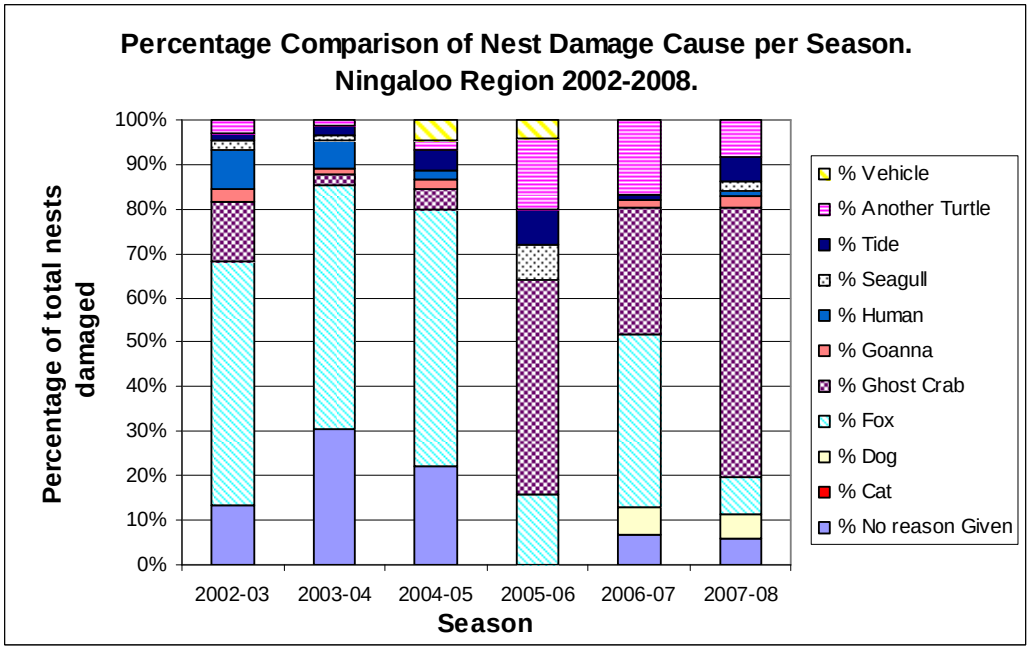


Figure 74: Percentage comparison of the cause of nest disturbance for each season in the Ningaloo region between 2002 and 2008.

3.1.6.1 North West Cape division

Since the commencement of the NTP a total of 19843 marine turtle nests and 50034 false crawls have been recorded in the North West Cape division during the six NTP monitoring seasons. The level of turtle nesting decreased between 2003 and 2005 but has continued to increase since then (Figure 75). Nesting levels recorded in the 2007-08 season are higher than those recorded in any previous turtle nesting season, with an increase of 14% nests/unit effort since the 2006-07 season alone. The number of false crawls/unit effort has decreased by 9% since the 2006-07 season.

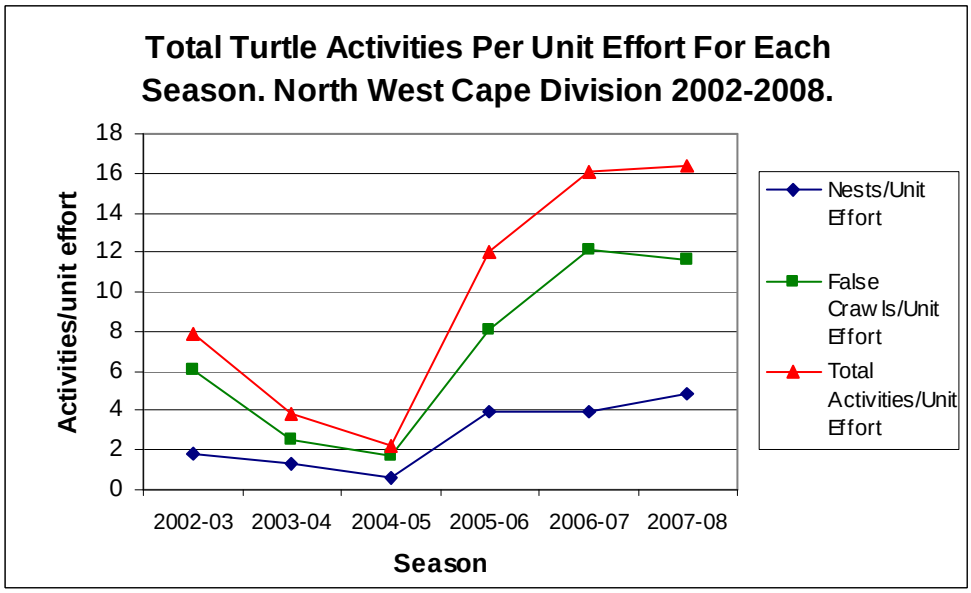


Figure 75: Numbers of nests, false crawls and total turtle activities recorded per season (adjusted for survey effort) in the North West Cape division between 2002 and 2008.

Estimating turtle numbers

The number of nesting female turtles in the North West Cape division within the turtle nesting season has been estimated for the last six NTP seasons in the following way:

Assumptions:

- For each season the numbers of turtle nests recorded were determined for the period of 1st December – 28th February and then used to estimate nesting female turtle numbers.
- It is assumed that 78.5% of the total number of nests laid throughout a season is recorded by NTP volunteers in the period between the 1st of December and the 28th February, based on estimates calculated in the 2005-06 NTP Annual Report.
- It is assumed that on average each female turtle produces the following number of nests per season, according to species: green turtles produce ~ 2.93, loggerhead turtles produce ~3.49, and hawksbill turtles produce ~ 2.74 nests per season (Lutz and Musick 1997).

The following formula was used to determine the best estimates possible based on the assumptions above. In the future these estimates may be reviewed as work is completed on turtle population statistics and extrapolative modelling.

Formula:

1. Total number of nests recorded between the 1st of December and the 28th of February ÷ 0.785 = *x* (where *x* = estimated total number of nests over whole nesting season)
2. *x* ÷ average number of clutches laid per species in one season = estimated number of turtles nesting in season
3. Adjust for error using the standard deviation and sample size used to determine the number of clutches laid per species as provided in Lutz and Musick 1997.

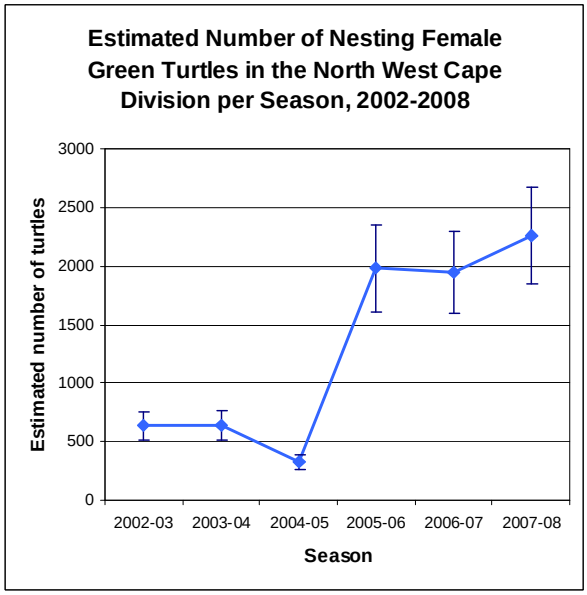
For example, the estimated number of nesting female green turtles in the North West Cape division in the 2007-08 season was calculated in the following way**:**

- Nests recorded: 5190
- Estimated total number of nests laid in the season: 5190 / 0.785 = 6611.465
- Estimated number of female nesting turtles: 6611.465 / 2.93 = 2256

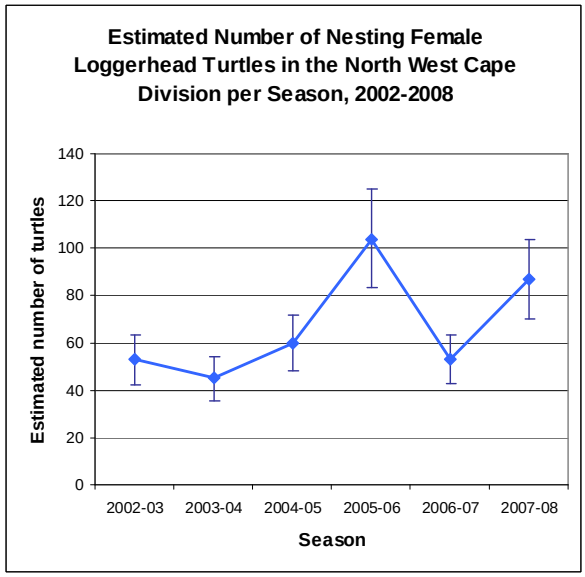
Results:

During the 2007-08 season 2256 green, 87 loggerhead and 54 hawksbill female turtles are estimated to have nested in the North West Cape division. This marks a general increase in turtle numbers since previous seasons, with the exception of the loggerhead turtle for which numbers declined in the 2006-07 season but have increased since (Figure 76 a-c).

a)



b)



c)

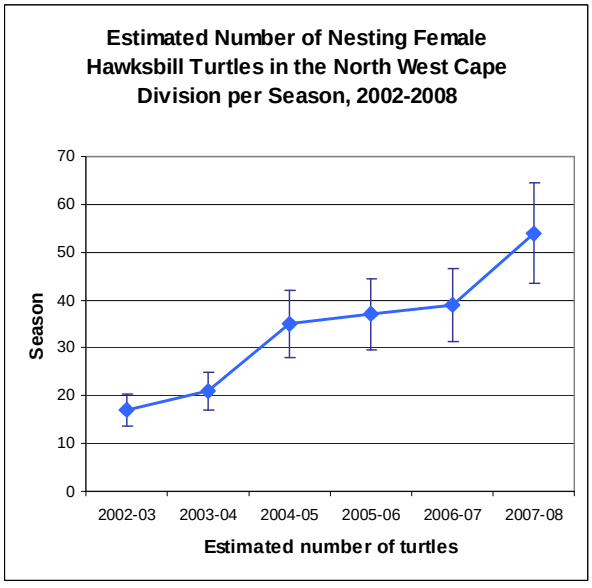


Figure 76: Estimated numbers of nesting female green turtles (a), loggerhead turtles (b) and hawksbill turtles (c) per season in the North West Cape division.

Figure 77 shows the weekly nesting activity recorded in the North West Cape division per season, adjusted for survey effort. The times of peak nesting activity have remained fairly constant throughout the seasons. The peak of nesting during the 2006-07 season was recorded during the 22-28th of December. Nesting peaks for all other seasons were recorded between the 5th and 18th of January.

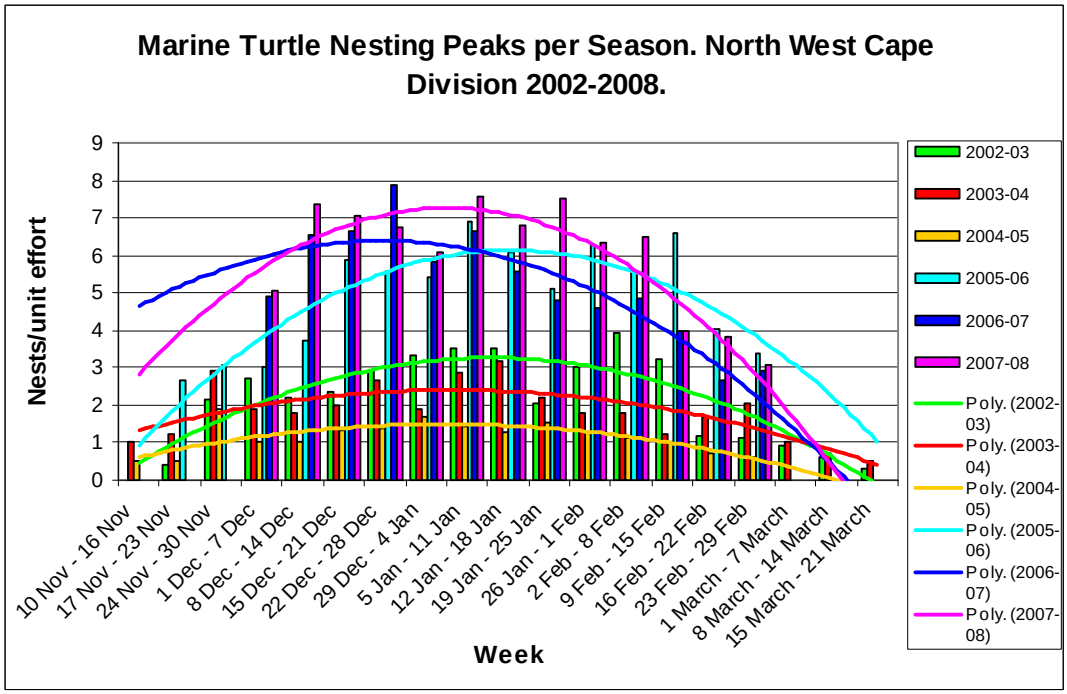


Figure 77: Nesting numbers recorded per week (adjusted for survey effort) and peak nesting activity per season in the North West Cape division between 2002 and 2008.

According to the data collected during all seasons between 2002 and 2008 the majority of turtle nests in the North West Cape division have been recorded in the Mauritius – Jacobsz Sth (2813) and Jacobsz Sth – Wobiri (2617) subsections in the Hunters section. However the highest total density of nests has been recorded in the Five Mile – Five Mile North subsection and the Graveyards section. This trend has been consistent throughout all seasons, as shown in
Figure 78.

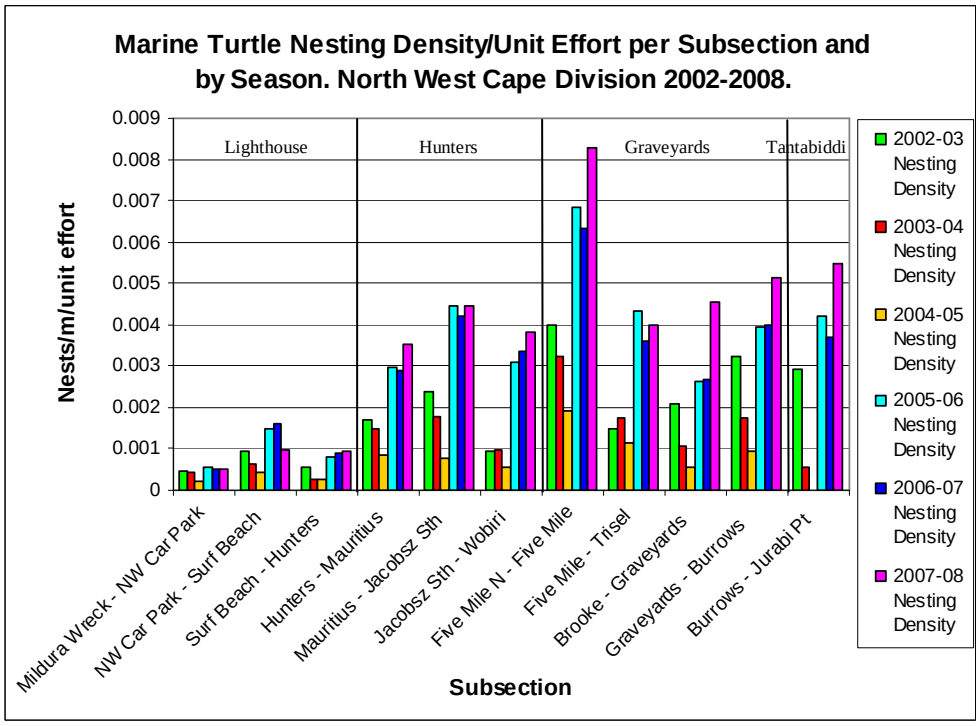


Figure 78: Nesting density/unit effort recorded per subsection for each season in the North West Cape division between 2002 and 2008.

Green turtles have consistently been responsible for the majority of nests recorded in the North West Cape division, having produced between 75% and 95% of the nests each season (Figure 79). Since the commencement of the NTP loggerhead and hawksbill turtles have been recorded to nest in lower numbers in this division.

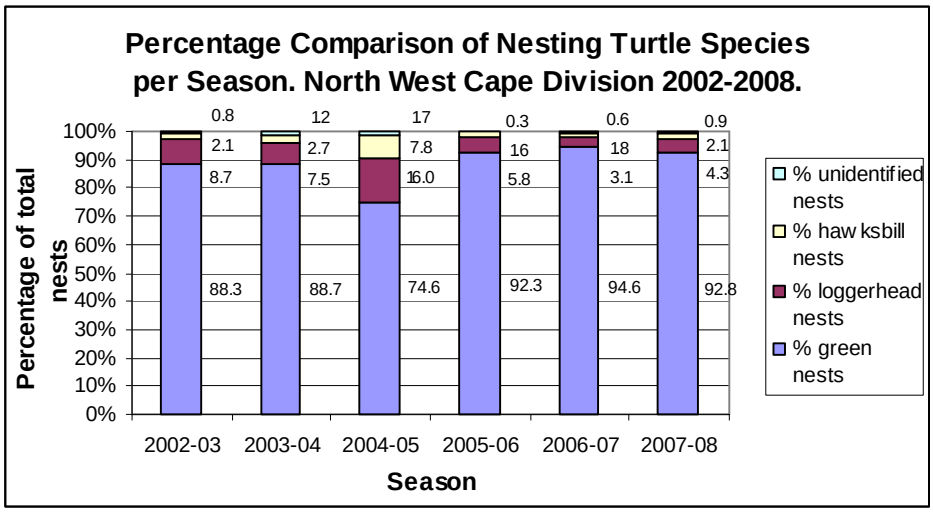


Figure 79: Percentage comparison of nesting marine turtle species per season in the North West Cape division between 2002 and 2008.

Using the data collected in the North West Cape division during all seasons of the NTP the overall (and average) nesting ratio is 0.40 nests to each false crawl produced. Figure 80 shows the nesting success rates recorded for each turtle species per season in the North West Cape. The green turtle nesting success rates recorded for all NTP seasons average at 27.2% and are consistently lower than the nesting success rates of

loggerhead and hawksbill turtles, which average at 42.1% and 47.7% respectively. The success rates for green, loggerhead and hawksbill turtles fluctuate between seasons and have a range of 11%, 18% and 13% respectively.

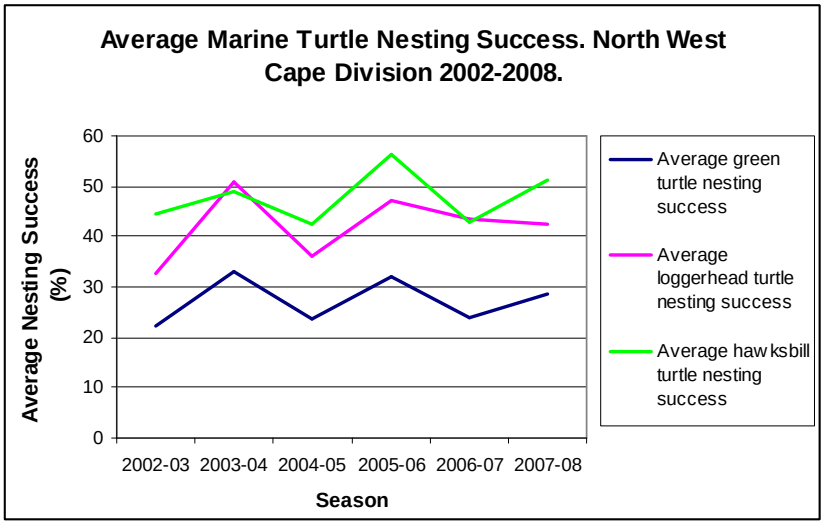


Figure 80: Average nesting success for green, loggerhead and hawksbill turtles per season in the North West Cape division between 2002 and 2008.

The number of fox and dog prints recorded on the North West Cape subsections has increased since the 2004-05 season, according to the presence/absence data recorded throughout the seasons (Figure 81). The majority of the prints (61%) were recorded as fox prints but due to the difficulty in distinguishing between the prints both types have been grouped together.

The level of predation attributed to foxes and dogs has been less variable and remains low (Figure 82). However this has also increased during recent seasons.

Figure 83 shows the level of presence of foxes and dogs around undamaged nests in comparison to damaged nests, according to prints recorded within a 5m radius of nests. Throughout all seasons the majority of prints were recorded near undamaged nests.

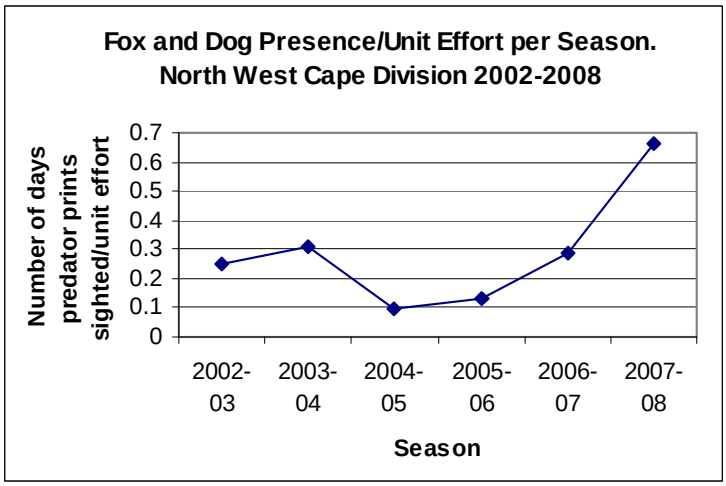


Figure 81: The level of presence of foxes and dogs (adjusted for survey effort) per season in the North West Cape division between 2002 and 2008.

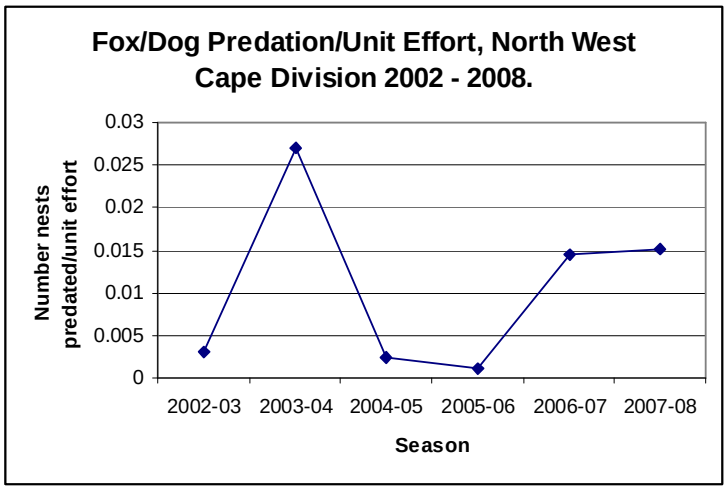


Figure 82: The level of predation attributed to foxes and dogs (adjusted for survey effort), per season, in the North West Cape division between 2002 and 2008.

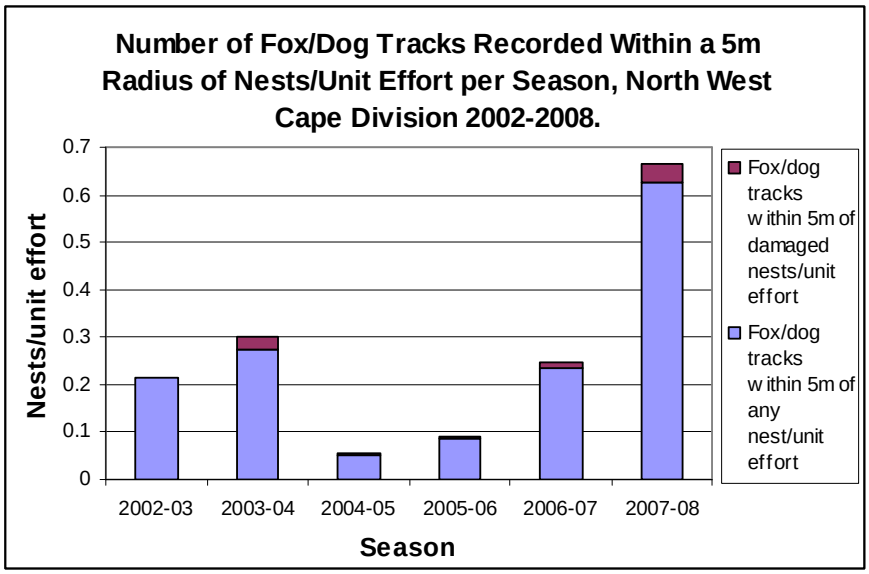


Figure 83: The level of presence of foxes and dogs (adjusted for survey effort) within a 5m radius of undamaged nests compared to damaged nests, per season in the North West Cape division between 2002 and 2008.

3.1.6.2 Bundera division

Since the commencement of the NTP a total of 2749 marine turtle nests and 2866 false crawls have been recorded in the Bundera division during the six NTP monitoring seasons. The level of turtle nesting has fluctuated between seasons, decreasing between 2003 and 2005 and then again in the 2006-07 season (Figure 84). Similar trends are exhibited between the patterns of fluctuation over the seasons for nesting and false crawls.

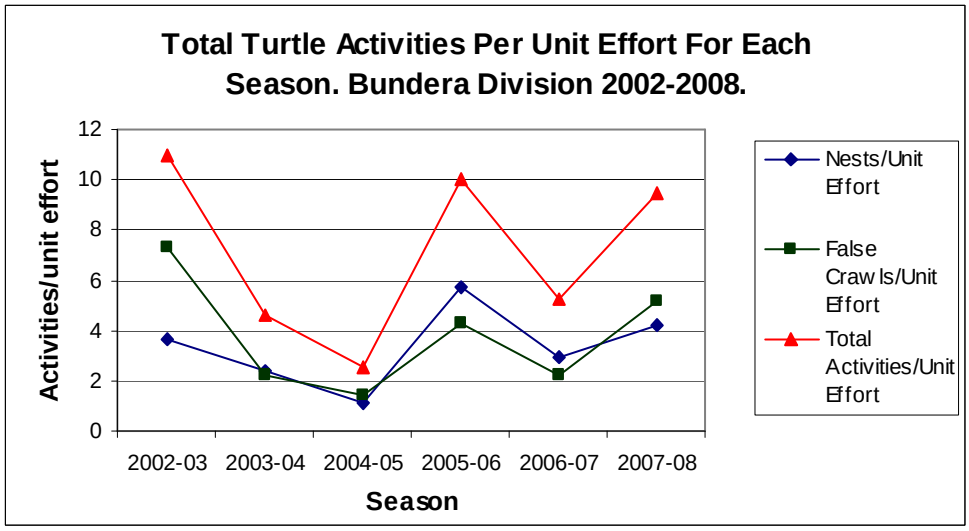


Figure 84: Numbers of nests, false crawls and total turtle activities recorded per season (adjusted for survey effort) in the Bundera division between 2002 and 2008.

Figure 85 shows the weekly nesting activity recorded in the Bundera division per season, adjusted for survey effort. The times of peak nesting activity have varied extensively between seasons. Trend lines suggest the peak nesting time of turtles at Bundera occurred before the monitoring season commenced in the 2002-03 and 2007-08 seasons. In contrast peak nesting occurred at different weeks between the 15th of December and the 11th of January for the seasons between 2003 and 2007.

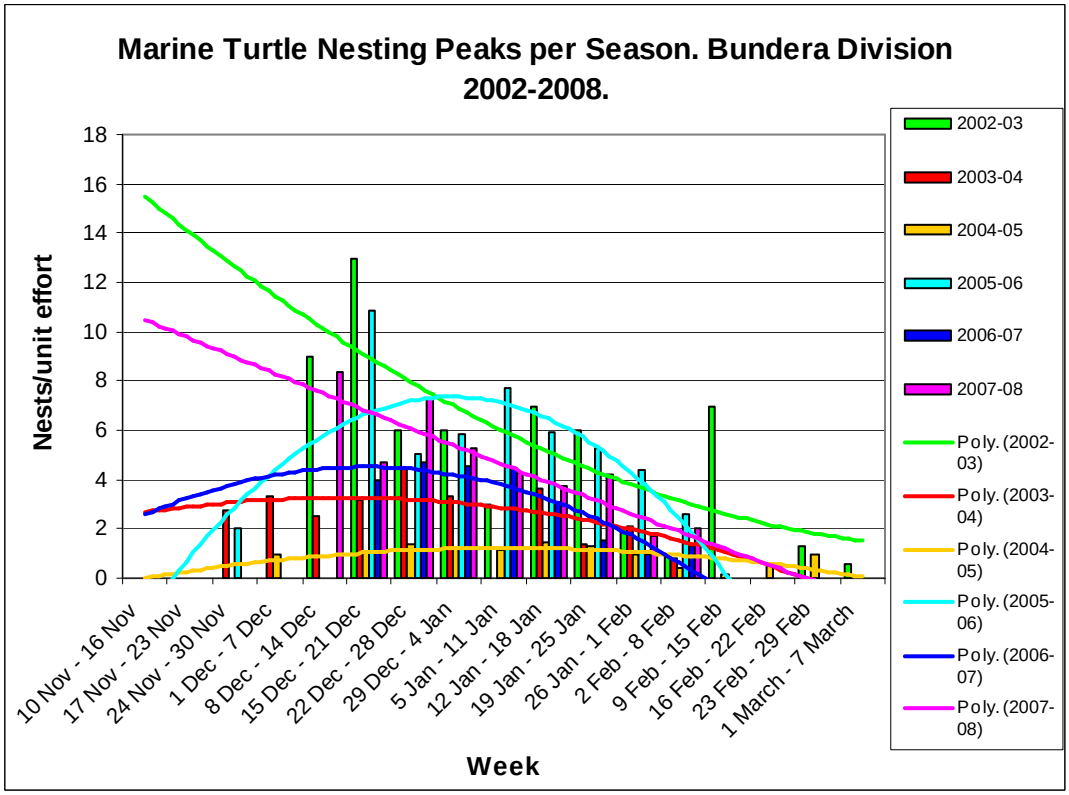


Figure 85: Nesting numbers recorded per week (adjusted for survey effort) and peak nesting activity per season in the Bundera division between 2002 and 2008.

Loggerhead turtles have consistently been responsible for the majority of nests recorded in the Bundera division, having produced between 75% and 92% of the nests

each season (Figure 86). Since the commencement of the NTP green and hawksbill turtles have been recorded to nest in lower numbers in this division.

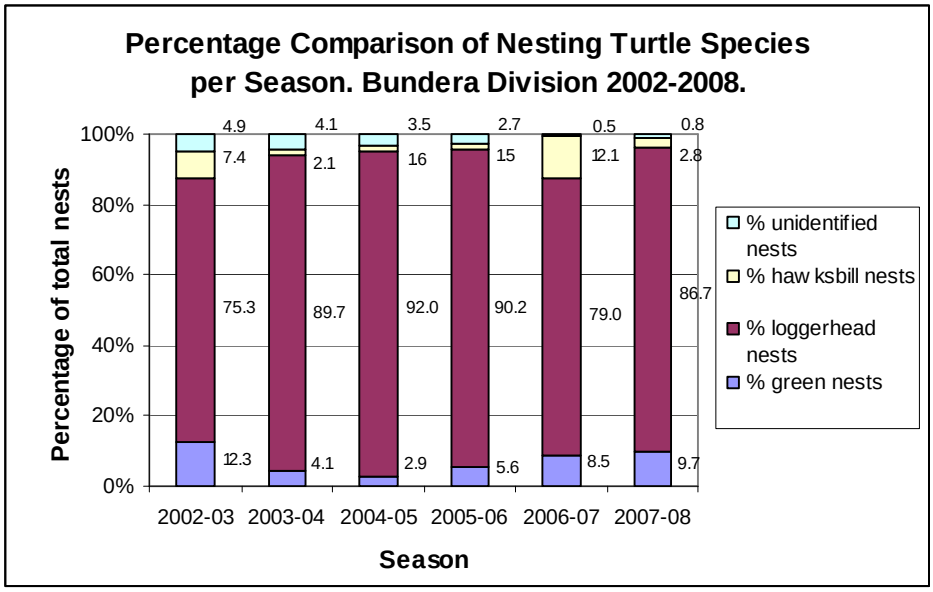


Figure 86: Percentage comparison of nesting marine turtle species per season in the Bundera division between 2002 and 2008.

Using the data collected in the Bundera division during all seasons of the NTP the overall (and average) nesting ratio is 0.96 nests to each false crawl produced. Figure 87 shows the nesting success rates recorded for each turtle species per season in the Bundera division. The green turtle nesting success rates recorded for all NTP seasons average at 36.1% and, with the exception of the 2003-04 season have been generally lower than the nesting success rates of loggerhead and hawksbill turtles, which average at 51.1% and 56.2% respectively. The success rates for green, loggerhead and hawksbill turtles fluctuate between seasons and have a range of 41%, 15% and 45% respectively.

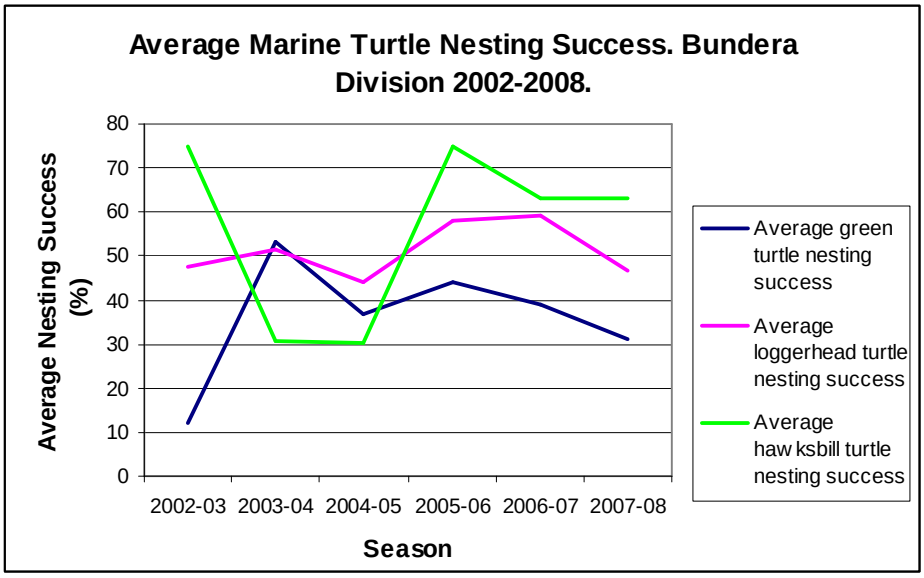


Figure 87: Average nesting success for green, loggerhead and hawksbill turtles per season in the Bundera division between 2002 and 2008.

The number of fox and dog prints recorded on the Bundera subsections steadily declined between 2002 and 2005, but have continued to increase since the 2005-06 season, according to the presence/absence data recorded (Figure 88). The majority of the prints (87%) were recorded as fox prints but due to the difficulty in distinguishing between the prints both types have been grouped together.

The level of predation attributed to foxes and dogs has declined steeply between 2002 and 2004 and has remained low since (Figure 89).

Figure 90 shows the level of presence of foxes and dogs around undamaged nests in comparison to damaged nests, according to prints recorded within a 5m radius of nests. In the 2002-03 and 2003-04 seasons the majority of prints were recorded near damaged nests but in all other seasons fox and dog prints have primarily been sighted in the vicinity of undamaged nests.

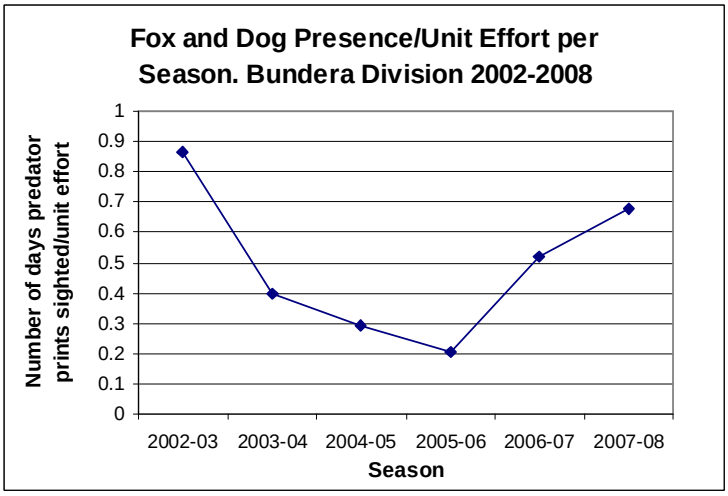


Figure 88: The level of presence of foxes and dogs (adjusted for survey effort) per season in the Bundera division between 2002 and 2008.

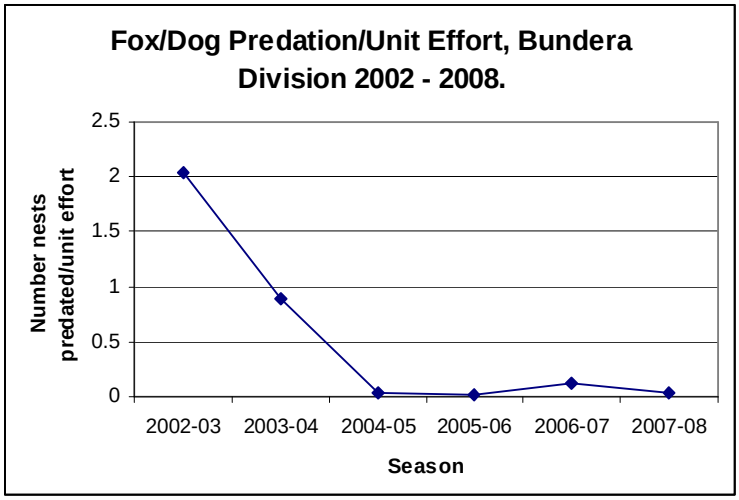


Figure 89: The level of predation attributed to foxes and dogs (adjusted for survey effort), per season in the Bundera division between 2002 and 2008.

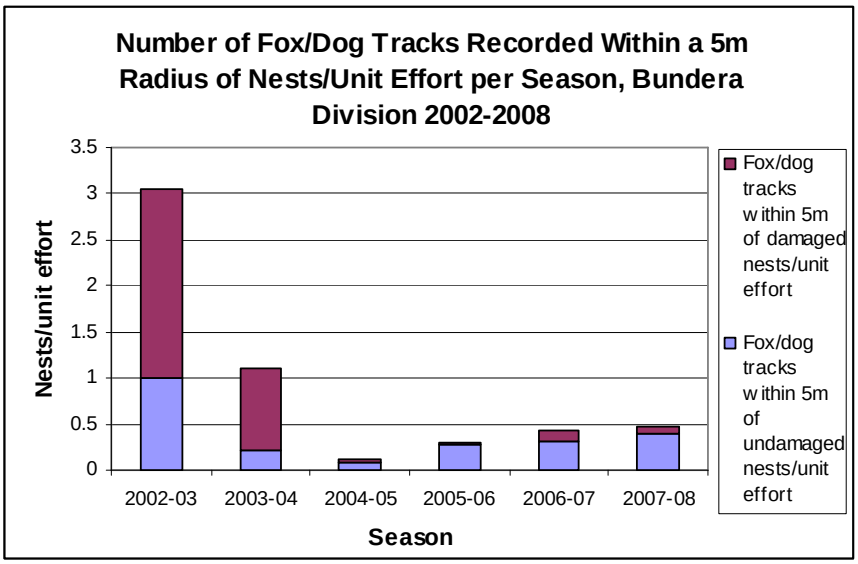


Figure 90: The level of presence of foxes and dogs (adjusted for survey effort) within a 5m radius of undamaged nests compared to damaged nests, per season in the Bundera division between 2002 and 2008.

3.1.6.3 Coral Bay division

Since the commencement of the NTP a total of 413 marine turtle nests and 354 false crawls have been recorded in the Coral Bay division during the six NTP monitoring seasons. The level of turtle nesting decreased in the 2004-05 season but has continued to increase since then (Figure 91). Nesting levels recorded in the 2007-08 season are higher than those recorded in any previous turtle nesting season, with an increase of 49% nests/unit effort since the 2006-07 season alone. The number of false crawls/unit effort has increased by 30% since the 2006-07 season.

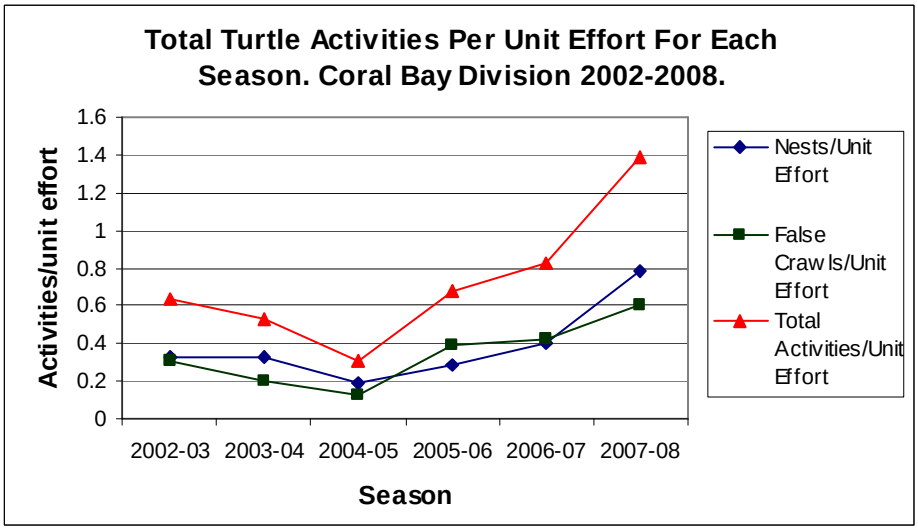


Figure 91: Numbers of nests, false crawls and total turtle activities recorded per season (adjusted for survey effort) in the Coral Bay division between 2002 and 2008.

Figure 92 shows the weekly nesting activity recorded in the Coral Bay division per season, adjusted for survey effort. The times of peak nesting activity have remained fairly constant throughout the seasons, generally occurring between the 29th of December and the 11th of January. In the 2005-06 season less nesting activity was recorded and the peak level of nesting was recorded around the 8th-14th December.

According to the trendline the peak of nesting activity for the 2002-03 season occurred prior to the commencement of monitoring.

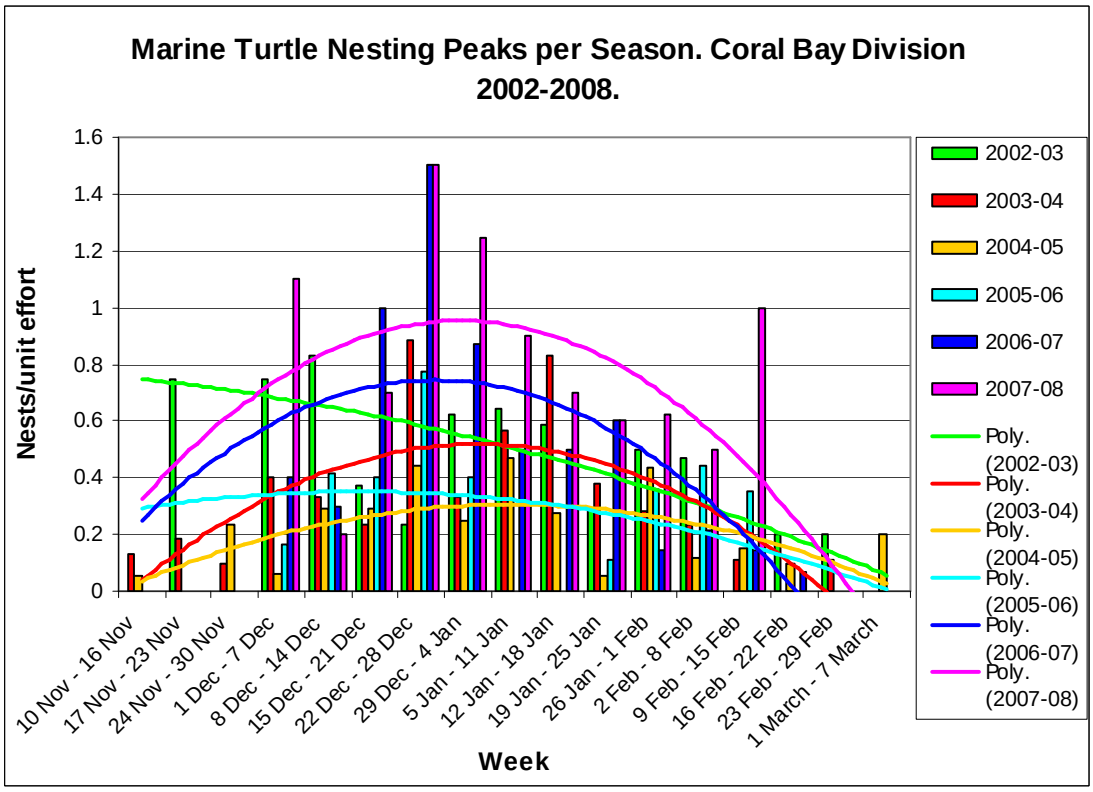


Figure 92: Nesting numbers recorded per week and peak nesting activity per season in the Coral Bay division between 2002 and 2008.

Loggerhead turtles have consistently been responsible for the majority of nests recorded in the Coral Bay division, having produced between 37% and 79% of the nests each season (Figure 93). Generally hawksbill turtles are the second most active species in the area, followed by green turtles.

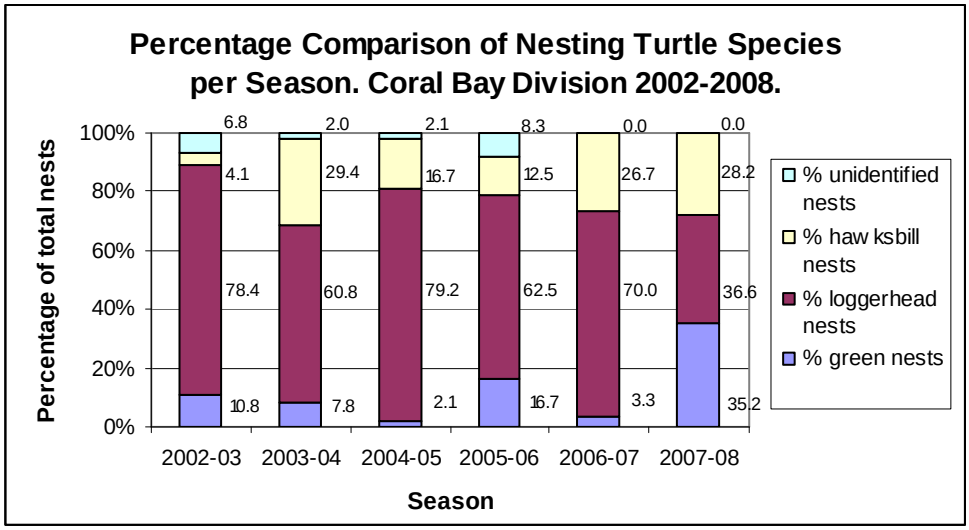


Figure 93: Percentage comparison of nesting marine turtle species per season in the Coral Bay division between 2002 and 2008.

Using the data collected in the Coral Bay division during all seasons of the NTP the overall (and average) nesting ratio is 1.16 nests to each false crawl produced. Figure 94 shows the average nesting success rates recorded for each turtle species per season in Coral Bay. The green turtle nesting success rates recorded for all NTP seasons average at 35.0% and are consistently lower than the nesting success rates of loggerhead and hawksbill turtles, which average at 52.7% and 63.3% respectively. The success rates for green, loggerhead and hawksbill turtles fluctuate between seasons and have a range of 37%, 22% and 45% respectively.

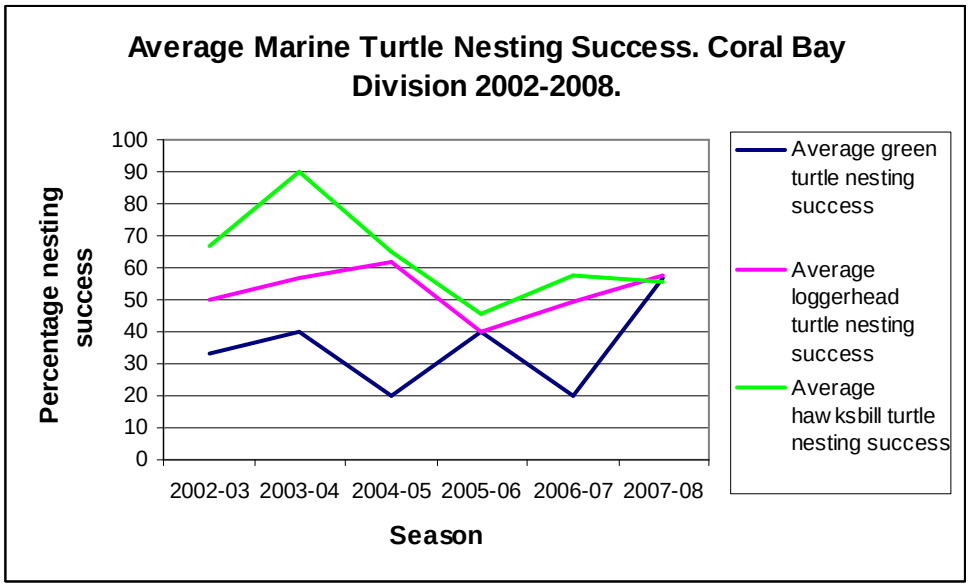


Figure 94: Average nesting success for green, loggerhead and hawksbill turtles per season in the Coral Bay division between 2002 and 2008.

The number of fox and dog prints recorded on the Coral Bay subsections steeply increased in the 2005-06 season, but has decreased in recent seasons, according to the presence/absence data recorded (Figure 95). The majority of the prints (75%) were recorded as fox prints but due to the difficulty in distinguishing between the prints both types have been grouped together.

The level of predation attributed to foxes and dogs has been much less variable as it has remained very low, with maximums of 10 and 8 nests recorded to be damaged in the 2002-03 and 2006-07 seasons respectively (Figure 96).

Figure 97 shows the level of presence of foxes and dogs around undamaged nests in comparison to damaged nests, according to prints recorded within a 5m radius of nests. In the 2002-03 and 2006-07 seasons the majority of prints were seen within 5m of damaged nests but in all other seasons fox and dog prints have primarily been sighted in the vicinity of undamaged nests.

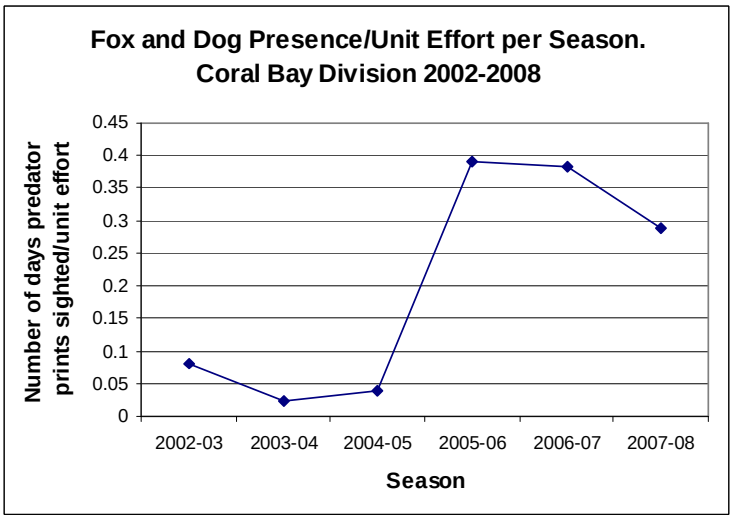


Figure 95: The level of presence of foxes and dogs (adjusted for survey effort) per season in the Coral Bay division between 2002 and 2008.

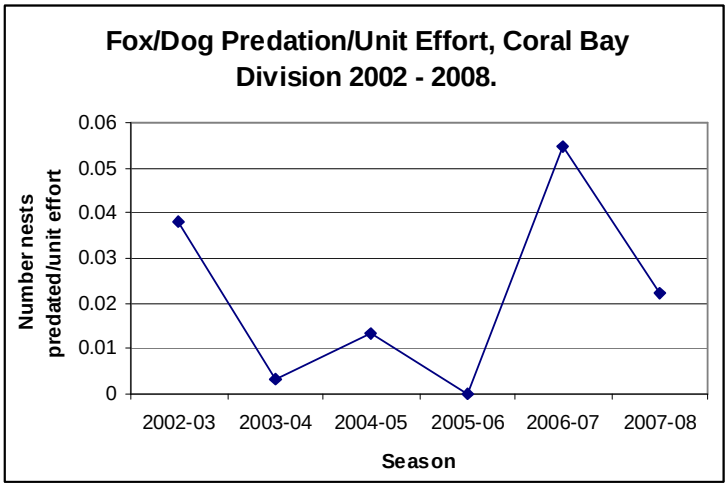


Figure 96: The level of predation attributed to foxes and dogs (adjusted for survey effort), per season in the Coral Bay division between 2002 and 2008.

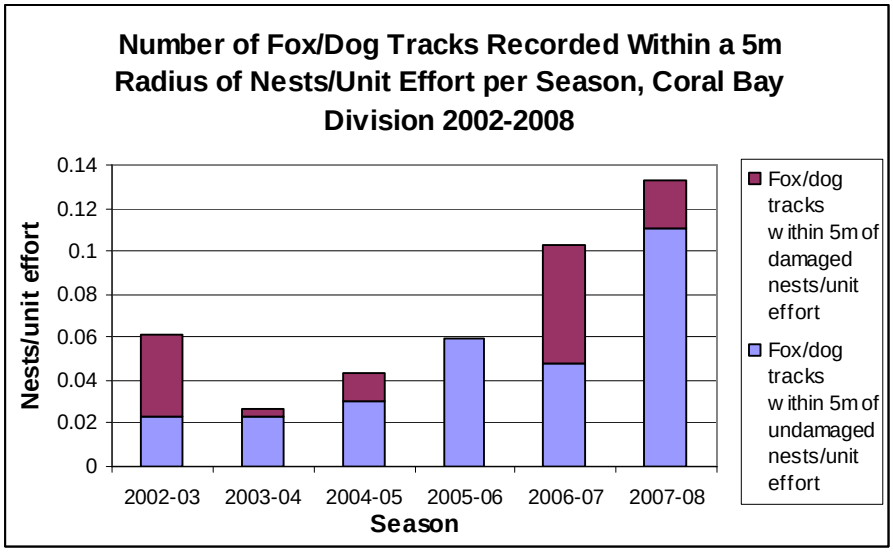


Figure 97: The level of presence of foxes and dogs (adjusted for survey effort) within a 5m radius of undamaged nests compared to damaged nests, per season in the Bundera division between 2002 and 2008.

3.1.6.4 Other divisions

The spatial extent of monitoring activities has varied over the turtle monitoring seasons as knowledge has been gained on areas of focused turtle activity. A full list of all subsections monitored at some stage in the NTP is provided in Table 9, Appendix 10.2.

In the 2007-08 season areas known to experience lower levels of turtle activity were not monitored; this includes the entire Cape Range, Waroora Station and Gnaraloo divisions and certain subsections of the North West Cape, Bundera and Coral Bay divisions. The subsections that were monitored this season are listed in Section 2.3.1: Monitored sections. The Cape Range, Waroora and Gnaraloo divisions were only monitored in the 2003-04 season thus these divisions will not be reported on.

3.2 Tagged turtles resighted

During the 2007-08 NTP season seven tagged turtles were sighted during morning monitoring activities, all of which occurred in the North West Cape division. The details of these sightings are provided in Table 7.

Table 7: Resighting information of turtles tagged in the Western Australian Marine Turtle Project.

West Australian Turtle Research - Nesting Turtles Tagged Turtle Resighting							
Turtle Species	**Gender**	**Tag left**	**Tag right**	**Tagging details**	**Previous Resighting**	**07-08 Season Resighting**	**Comments**
Green	F	WA 9254	WA 9255	Trisel Beach, 9-10th Dec 1988	-	1/02/2008: Five Mile - Five Mile North	One of 28 turtles tissue biopsies for a stock genetics study, WA Marine Turtle Program
Green	F	WA 35123	-	North West Cape	North West Cape	31/01/2008: Five Mile - Five Mile North	10 year Inter-nesting season return interval
Green	F	-	WA 20401	North West Cape, 1992-93 nesting season	North West Cape	25/01/2008: Brooke - Graveyards	15 year Inter-nesting season return interval (ISR) observation
Green	F	WA 51789	WA 18551	Wobiri-Janz beach, 1992-93 nesting season	Monkey Mia 2004 and April 2008	20/01/2008: Hunters - Mauritius	15 year Inter-nesting season return interval (ISR) observation. Caught off Monkey Mia in April 2004 and tagged again by a shark research group. Recaptured by the FIU crew on its feeding ground at Monkey Mia on the 27th April 2008.
Green	F	WA 9210	WA 9211	Trisel Beach, 9-10th Dec 1988	-	21/12/2007: Five Mile - Trisel	One of 28 turtles tissue biopsies for a stock genetics study, WA Marine Turtle Program
Green	F	WA 19030	WA 19029	North West Cape, 1992-93 nesting season	North West Cape	23/12/2007: Burrows - Jurabi Point	15 year Inter-nesting season return interval (ISR) observation
Green	F	-	WA 518	?	?	3/01/2008: Hunters - Mauritius	-

3.3 Volunteer participation

During the 2007-08 NTP season a total of 106 volunteers participated in the program and contributed 7592 hours of their time. Therefore volunteer contribution equates to a monetary value of $151840 if the volunteers were paid at a rate of $20 per hour. The contributions of the team leaders and the local, visiting and external volunteers are provided in Table 8.

Throughout the season volunteers participated in the following activities:

- 'Turtle tracking' – i.e. monitoring the beaches
- Assisting with turtle rescues
- Filling out mortality and tagged turtle resighting reports
- Data entry
- Data checking
- Remote camping at Bungelup camp in the Bundera division
- Regular social events
- Leadership and organizational duties (team leaders) and
- Field methodology trainers and assessors.

Table 8: Volunteer contributions to the Ningaloo Turtle Program provided during the 2007-08 nesting season.

Volunteers	***No. Volunteers***	***Hours***	***Days***	***Volunteer Hours at $20 p/hr***
Local	35	1409.5	355	$28,190
Coral Bay	17	196	104	$3,920
Internship	4	2405.5	256	$48,110
Visiting	2	51.5	14	$1,030
Group 1	11	788.5	187	$15,770
Group 2	13	1034	239	$20,680
Group 3	12	861.5	195	$17,230
Group 4	12	845.5	199	$16,910
Total	106	7592	1549	$151,840

3.3.1 Volunteer numbers

In comparing volunteer numbers over past seasons it is evident that numbers have steadily increased over the years, with a slight decrease during the 2007-08 season (Figure 98). This decrease since the 2006-07 season can be attributed to the NTP not running the Jurabi Turtle Centre, the Jane's Bay camp not operating, and the volunteer numbers being utilized more efficiently for morning monitoring this season in comparison to the 2006-07 season.

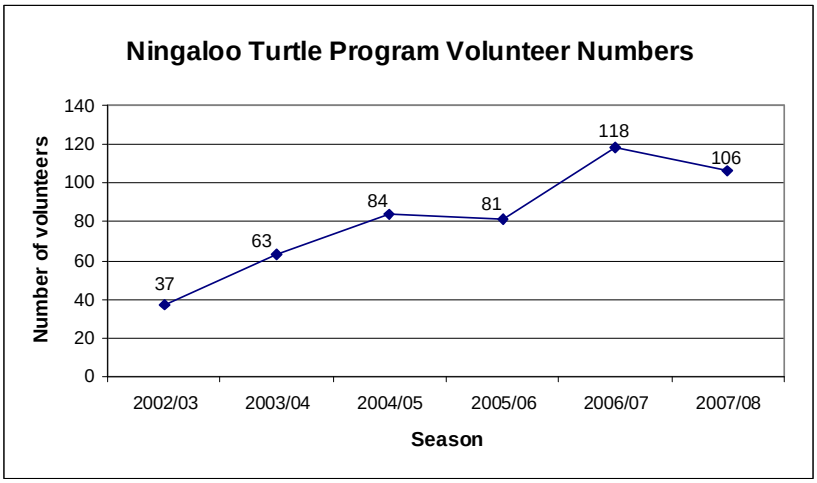


Figure 98: Volunteer participant numbers over the six seasons of operation in the Ningaloo Turtle Program.

3.3.2 Volunteer demographics

Ningaloo Turtle Program volunteers originated from various locations throughout Western Australia, Victoria, New South Whales and the Northern Territory, as well as the UK, USA, Denmark, Taiwan and Hong Kong (Figure 99). Of the 106 registered volunteers 33% were local residents of Exmouth, 16% were residents of Coral Bay, 40% were external volunteers from Western Australia, 6% were from other regions of Australia and the remaining 5% were from other areas of the world.

The majority of volunteers participating in the 2007-08 NTP season were under the age of 30 (60%). The percentage comparison of volunteer ages is provided in Figure 100. The greatest number of volunteers belonged to the 21 – 30 year old age bracket, followed by the 31 – 40 year old and under 20 years old age brackets with 45, 20 and 17 volunteers respectively. The least volunteers were contained in the highest age bracket, with five volunteers being over the age of 60.

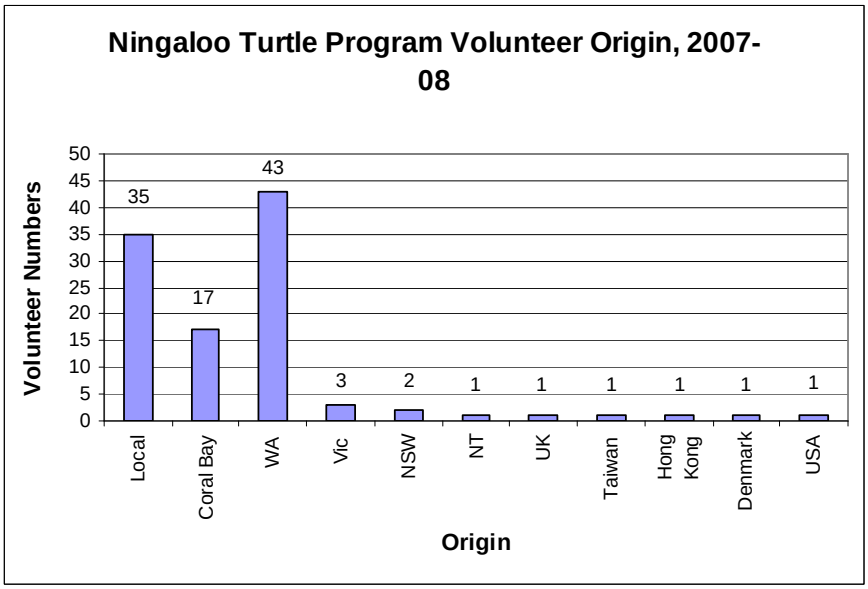


Figure 99 Volunteer participant origin over the 2007-08 season in the Ningaloo Turtle Program.

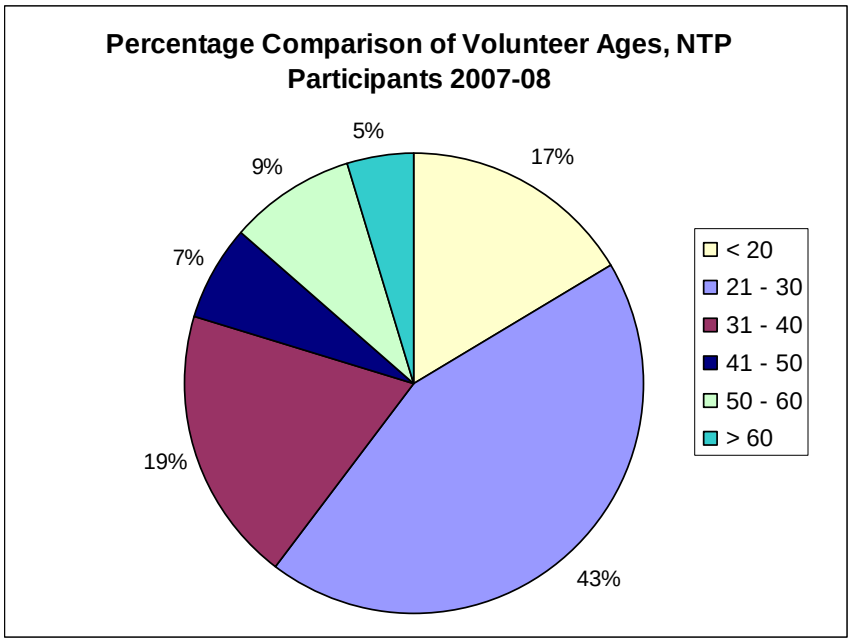


Figure 100: Percentage comparison of ages of Ningaloo turtle program volunteers involved in the 2007-08 NTP season.

3.3.3 Volunteer hours

Since the commencement of the Ningaloo Turtle Program in the 2002-03 season the number of hours contributed by volunteers has gradually increased until the 2006-07 season when the total volunteer hours almost doubled since the previous season, and then decreased again during the 2007-08 season (Figure 101). This decrease in volunteer hours can be attributed to the NTP not operating JTC, and the remote camp at Jane's Bay not operating.

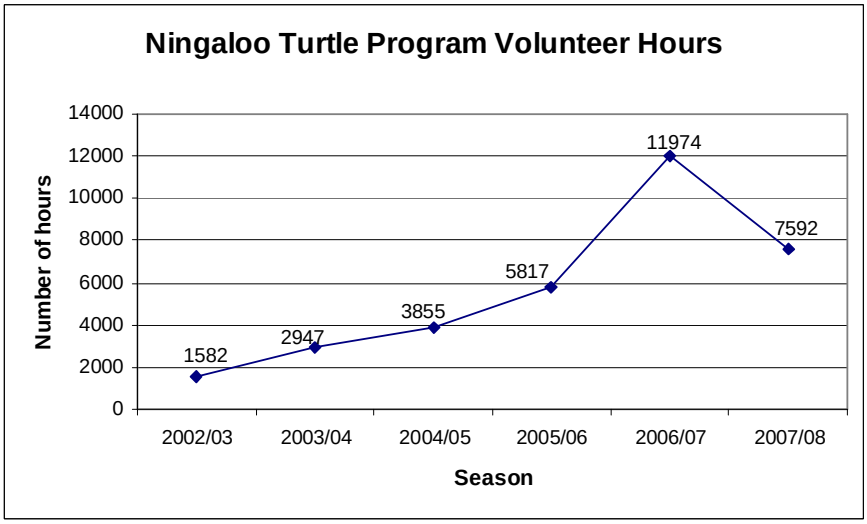


Figure 101: Volunteer participant hours contributed over the six seasons of operation in the Ningaloo Turtle Program.

4.0 DISCUSSION

4.1 Turtle activity data

Green, loggerhead and hawksbill turtles were found to nest in large numbers in the North West Cape and Bundera divisions of the Ningaloo region. Lower numbers of all turtle species were recorded in the Coral Bay division. However it must be noted that the North West Cape division was monitored for 39 days more than the Bundera division and 41 days more than the Coral Bay division. In addition, different monitoring techniques were utilized at Coral Bay and the prevailing weather conditions of the area may differ to that of the other areas. At Coral Bay volunteers monitor the beaches using all terrain vehicles (ATVs); volunteers monitor the North West Cape and Bundera divisions on foot. In addition, Coral Bay beaches often experience strong winds which make the turtle tracks wind-blown and harder to notice. Therefore it can be assumed that turtle tracks were more easily missed considering volunteers travelled at higher speeds on ATVs, turtle tracks may have been wind-blown and several days throughout the season were not monitored.

The green turtle (*Chelonia mydas*) has one genetic stock in Western Australia, which is known to nest between the Lacepede Islands and the Ningaloo coast (Limpus 2002). This green turtle population is one of the largest in the world. During the 2007-08 season green turtles were recorded to nest between the North West Cape and Coral Bay in all subsections monitored, with the highest abundance in the North West Cape division. Nesting was recorded throughout the period between December 1st 2007 and the 28th February 2008.

Loggerhead turtles (*Caretta caretta*) nest between Dirk Hartog Island and Varanus Island in Western Australia amongst a single genetic stock, which is the third largest stock in the world (Limpus 2002). This season loggerhead turtles were recorded to nest in all subsections of the North West Cape, Bundera and Coral Bay divisions. However the highest abundance of total loggerhead turtle activities was recorded in the Bundera division, even though this division was monitored for 39 days less than the North West Cape division. The nesting distribution of this species appears to be focused in a more southerly region of the Ningaloo coast and their nesting distribution ranges further south in comparison to the other species.

Hawksbill turtles (*Eretmochelys imbricata*) have one genetic stock in Western Australia which nests centrally on the Dampier Archipelago (Limpus 2002). Hawksbill turtle activities were recorded in all divisions monitored in the Ningaloo region, but the highest abundance was recorded in the North West Cape division.

Overall the greatest abundance of turtle activity was recorded in the North West Cape division but this can be primarily attributed to the high abundance of green turtle activities, which were most abundant in this region. Overall, the majority of turtle activities are undertaken by green turtles in the Ningaloo region, followed by loggerhead and then hawksbill turtles. Minimal activities were undertaken by flatback turtles as they primarily nest further north, in the Pilbara region (Eckert and Eckert 1993). Monitoring was conducted over a longer period in the North West Cape division. However, this in consideration, the green turtle is the most abundant marine

turtle species in Western Australia (Eckert and Eckert 1993; Prince 1994) and is known to be the predominant species to nest along the northern beaches of the Jurabi coast (Waayers 2003); therefore the trends recorded in the Ningaloo region are consistent with this.

Loggerhead turtles were the most abundant species to nest in the Bundera division. This species has a lower southerly distribution than green turtles and is therefore more abundant in the Bundera division in comparison to the North West Cape division. Hawksbill turtles are present in lower numbers than the other two species in all divisions as they are critically endangered species. This may be partly attributed to the extensive harvest of hawksbill turtles in the late 1800's, early 1900's and the period between 1950 and 1991 as they were targeted for their scale to make 'tortoise shell' (Limpus 2002).

4.1.1 North West Cape division

Green, loggerhead and hawksbill turtles nest regularly in the North West Cape division. The three species have been recorded to nest in the area for six consecutive seasons to date. Nesting by the flatback turtle has also been reported anecdotally on a few occasions. Flatback turtles nest further north along the Pilbara coast.

The data produced during the 2007-08 season indicated that the abundance of green turtles greatly exceeded that of loggerhead and hawksbill turtles in the North West Cape division.

The highest abundance of nests were located in the beach zone between the edge of the vegetation to the base of the foredune (E zone), followed by the zone between the high water mark and the edge of the vegetation (H zone). This is attributed to the nesting pattern of green turtles, the predominant species in the area, which were most abundant in these zones. Loggerhead and hawksbill turtles tended to nest lower on the beach, with the H zone being the most common zone for them to nest in. It is a potential characteristic of loggerhead and hawksbill turtles to nest lower on the beach than green turtles.

The lowest abundance of nests were located within the intertidal beach zone between the waters edge and the high tide mark (I zone), and the beach zone from the base of the foredune and beyond (in a landwards direction) (D zone). This can be explained by factors that influence the selection of nest site: if the nest is placed close to the ocean (I zone) there is a risk that the nest will be inundated and eggs will be lost to erosion; if the nest is placed further inland (D zone) there a higher risk of desiccation, predation on nesting adult females, eggs and hatchlings, and hatchling disorientation (Wood and Bjorndal 1999; Kamel and Mrosovsky 2005). Nest site selection by female turtles is non-random and is especially important considering no parental care is exhibited (Kamel and Mrosovsky 2005). Females choose nests on the basis of a trade-off between the maximization of their own survival and the maximization of the fitness of their offspring (Spencer 2002).

The number of false crawls consistently exceeded the number of nests produced in the North West Cape division. The overall best ratio of nests to false crawls was produced at start and the end of the season, with a drop in the middle of the season. This can be

primarily attributed to the activities of the green turtles. However an increase in nesting success was calculated for all three turtle species in the final week of monitoring.

False crawls are recorded when either the turtle emerges and attempts to dig a primary body pit; or when the turtle emerges and heads back to the water without digging at all. In the latter case this kind of activity can also be produced when a turtle is resting on the beach. During the mating period an abundance of male turtles wait to mate with female turtles in the shallow waters surrounding nesting beaches. Female turtles are often observed resting on the beach near to the shore. However, these two activities cannot be distinguished by the observation of the tracks alone so both are recorded as false crawls. The mating period overlaps with the beginning of the nesting season and many female turtles were observed to be resting on the beaches during December. Therefore it is possible that more false crawls were produced during this period, leading to a lower nesting success ratio than would otherwise have been recorded. If this was the case the highest nesting success would occur at the start of the season. The high success rate at the end of the season may also be attributed to the lower number of false crawls during this period, due to the lower level of resting turtles outside of the peak mating season.

Overall the nesting success rates were higher for hawksbill and loggerhead turtles in comparison to that of green turtles. In the past hawksbill turtles have been observed to appear unaffected by human or natural disturbance in the majority of situations (Kamel and Mrosovsky 2005). Therefore it is possible that hawksbill turtles are less likely to produce false crawls than green turtles. Furthermore, green turtles have been reported to be more susceptible to disturbance than loggerhead turtles (Waayers n.d.). More research is required to confirm if this is the case in the North West Cape division. It must also be noted that hawksbill nesting success rates were more variable because less data was available.

The majority of nests damaged in the North West Cape division were reported to be damaged by ghost crabs (*Ocypode* spp.). These crabs are in high abundance on all beaches within the division and are responsible for the depredation of many nests. There were numerous reports of crab tunnels being present in the immediate vicinity of the egg chambers of nests, as the crabs were targeting the eggs. The crabs also predate hatchling turtles in some cases. The highest numbers of damaged nests were located in the Jacobsz – Wobiri and the Graveyards – Burrows subsections. However the greatest number of nests was located in the Jacobsz – Wobiri subsection and the Graveyards – Burrows subsection had one of the highest densities of turtle nests. Therefore the higher presence of nests provides an increased opportunity for predation to occur on those subsections and suggests that density-dependant nest predation may be occurring. Fox and dog prints were also most commonly sighted on the Jacobsz sth – Wobiri and the Graveyards – Burrows subsections. However, fox prints sighted on the beaches were not usually located within a 5m radius of damaged nests and foxes were not attributed to be the cause of nest damage in most cases.

Dogs were the most common potential predator to be present within a 5m radius of all nests, according to the recorded sightings of potential predator prints in the North West Cape division. Fox, human and ghost crab prints were the next most common. It is likely that dog prints were most common due to the presence of people who take

their dogs to the beach. However it must be noted that ghost crab, cat and vehicle tracks were only recorded around damaged nests whereas dog, fox, human and goanna prints were recorded within a 5m radii of all nests. Therefore the number of ghost crab prints around nests is underestimated, as in reality ghost crab tracks are most likely to be seen within a 5m radius of almost every nest due to the high abundance of the crabs on the nesting beaches.

Human prints were most commonly sighted on the Hunters – Mauritius subsection followed by the Jacobsz sth – Wobiri subsection. The Hunters – Mauritius subsection is located adjacent to the Jurabi Turtle Centre (JTC). Turtle education and interaction tours were operated at JTC three nights a week during the 2007-08 monitoring season. This included scouting the beach for turtles, in accordance with the Turtle Watchers Code of Conduct, in order to observe the nesting process. Therefore a number of human prints on the Hunters – Mauritius subsection are likely to be attributed to JTC activities. The Jacobsz sth – Wobiri subsection was also a common place for turtle self-guided observers to go and scout for nesting turtles because it is easily accessible and well known for turtle activities. This included NTP members, who were offered tours by the Volunteer Coordinator or the Team Leaders on several occasions throughout the season. In addition, training for the TAFE accredited turtle tour guiding course was conducted on the Jacobsz sth – Wobiri subsection.

4.1.2 Bundera division

The Bungelup section has been identified as a significant loggerhead turtle rookery; loggerhead turtles were found to frequent the beaches monitored in the Bundera division during the 2007-08 season. Green and hawksbill turtles nested in lower numbers. The level of total turtle nesting gradually decreased throughout the season, whilst the number of false crawls fell, rose again and then declined towards the end of the season. The highest number of nests and the highest number of total turtle activities were recorded in the first week of monitoring (11^{th} – 17^{th} December 2007). This indicates that the peak of activity was at the start of the season and the beginning of the nesting season may have been missed. The monitoring season at Bundera commences two weeks after the North West Cape and Coral Bay monitoring seasons because it is not feasible to begin earlier due to the training and induction of the camp ground team leader and the organization of camp set-up procedures that occur during this period.

Loggerhead turtles are the predominant species in the Bundera division, producing the majority of nests constantly throughout the season. However the percentage of green turtle nests rose slightly near to the end of the season. This can be attributed to the decline in loggerhead turtle nests during this period. It is possible that the loggerhead turtle nesting season commenced and finished earlier than that of the green turtles. Both loggerhead and green turtle activities peaked between the 8^{th} and the 14^{th} of January 2008, however it is not known what factors may have influenced this.

The highest level of turtle activity was recorded in the Bungelup Sth – Rollys subsection, which was also the area where green turtle activities were focused and the highest nesting density of green turtles occurred. However this was the longest subsection; the overall highest nesting density was recorded in the Bungelup Nth – Bungelup Sth subsection. Hence the highest nesting density was recorded in the

middle subsection of the division, alike to the density observed in the North West Cape division. This trend can be attributed to the activities of the loggerhead turtles, which were most dense in this subsection. Hawksbill turtle numbers were consistently low in all subsections but nesting was densest in the Bungelup Nth – Neils Nth subsection. Therefore the highest nesting density for each species occurred in separate subsections.

Alike to the North West Cape division, the greatest number of nests in the Bundera division was laid in the beach zone between the vegetation line and the base of the foredune (E). This was true for all three turtle species. The next most common beach zone was landwards of the base of the foredunes (D) for green turtles and between the high water mark and the edge of the vegetation line (H) for loggerhead and hawksbill turtles. Therefore this is consistent with the apparent trend that loggerhead and hawksbill turtles have a higher tendency than green turtles to nest in the lower beach zones. Unknown turtle species activities were most abundant in the H and I (intertidal) zones but this can be attributed to the inability to identify tracks that had been washed away in many of these cases. In total the lowest number of nests were located in the I zone, which reiterates the tendency of turtles to avoid this zone due to the risk of eggs being inundated by the tide and lost to erosion, and the increased difficulty for hatchlings to emerge from the nest in wet sand (Wood and Bjorndal 1999; Kamel and Mrosovsky 2005). The D zone was not heavily populated with nests but in several areas of the Bundera subsections the D zone was located quite far back from the high tide line. Therefore in these areas there may have been adequate habitat in the lower beach zones to avoid the greater risk of desiccation and predation associated with the D zone (Wood and Bjorndal 1999; Kamel and Mrosovsky 2005).

The number of false crawls did not always exceed the number of nests produced in the Bundera region. This is dissimilar to the results recorded for the North West Cape division. The highest ratio of nests to false crawls was recorded in the middle of the season when the number of nests produced exceeded twice the number of false crawls produced. This was at a period when both loggerhead and green nesting success rates were at their highest. The nesting success rate of hawksbill turtles fluctuated a lot (0-100%) but can be attributed to the low level of hawksbill turtle activity throughout the season (i.e. – No nests were produced during certain weeks and this would result in a 0% nesting success rate; a 100% success rate could occur if just one nest and no false crawls were produced).

The majority of damaged nests were located in the Bungelup Sth – Bungelup Nth subsection thus coinciding with the greatest nesting density, which is suggestive of density-dependant nest predation. This theory is further supported by the observation that the highest total number of potential predator tracks sighted within a 5m radius of nests was also located within the Bungelup Sth – Bungelup Nth subsection, indicating that predators were in greater abundance in the area where nests were most abundant.

Ghost crabs (*Ocypode* spp.) were the most commonly identified cause of predation and are most likely to be the most common predator on the monitored beaches. The beaches were littered with crab tunnels, some of which penetrated turtle nests. Fox and ghost crab tracks were the most frequently recorded potential predator tracks within the Bundera division. However, it is likely that the number of ghost crab tracks is in excess of the number recorded because ghost crab tracks were only recorded

around damaged nests whereas dog, fox, human and goanna prints were recorded within a 5m radius of all nests. Therefore the number of ghost crab prints around nests is underestimated, as in reality ghost crab tracks are most likely to be seen within a 5m radius of several more nests due to the high abundance of the crabs on the nesting beaches.

Several fox prints were identified along the nesting beaches but these were not usually located within a 5m radius of damaged nests and no nests were reported to be damaged by foxes. Fox and dog prints were most common along the Bungelup Sth – Rollys subsection but the number of fox prints exceeded the number of dog prints. Due to the lack of people in the vicinity of the Bungelup remote camp any dog prints sighted in the Bundera region are assumed to be left by wild dogs such as dingos.

Due to the high level of isolation of the area any human prints sighted within the Bundera region are assumed to be from DEC staff and volunteers who participated in satellite tagging of loggerhead turtles on the beaches adjacent to the Bungelup remote camp. Human prints were most commonly sighted within a 5m radius of nests on the Bungelup Sth – Bungelup Nth subsection, closest to the camp location. The tagging operations required individuals to scout for nesting loggerhead turtles, thus getting within a close proximity to nests.

4.1.3 Coral Bay division

Low levels of turtle activity were recorded for green, loggerhead and hawksbill turtles in the Coral Bay division throughout the 2007-08 season. The numbers of nests and false crawls remained consistently low throughout the season. Any weekly fluctuations in the total turtle activities recorded can mostly be attributed to the inconsistency of monitoring in the area. Monitoring was not conducted on several days, therefore the total number of turtle activities recorded is assumed to be lower than it would have been if monitoring had occurred on a consistent daily basis throughout the entirety of the season. The low numbers may also be attributed to the trend for nesting numbers to decrease in a southerly direction.

The total number of nests consisted of relatively even numbers of green, loggerhead and hawksbill turtle nests. However the percentage composition of nesting species fluctuated on a weekly basis. This again can be attributed to the low number of nests produced each week (i.e. – if only one nest was recorded in a week then the turtle species that produced the nest would be responsible for 100% of the nests produced in the week). Therefore due to the small numbers of nests produced a seasonal trend cannot be assessed for turtle species in Coral Bay.

The total abundances of turtle activities for each subsection were fairly even, however the nesting density recorded in the Batemans Sth – Batemans Nth subsection was much lower than that of the Batemans Nth – Oyster Bridge subsection due to the shorter length of the latter subsection. This was the case for all three turtle species. Therefore the nesting density was lower in the most southern subsection, again supporting the trend of nesting numbers to decrease in a southerly direction.

The majority of nests produced by all three species of turtle were recorded in the beach zone between the edge of the vegetation line and the base of the foredune (E),

followed by the zone between the high water mark and the edge of the vegetation line (H). This was also the case in the North West Cape and Bundera divisions, therefore supporting the trend that turtles avoid the D and I zones due to the lowered nesting success caused by desiccation and predation, and inundation factors for each zone respectively (Wood and Bjorndal 1999; Kamel and Mrosovsky 2005).

The nesting success of marine turtles was variable in the Coral Bay division. Unlike records from the North West Cape division, records from Coral Bay indicate that more nests were produced than false crawls on several occasions. During the second, fifth and eighth weeks the number of nests produced was double that of false crawls. However nesting success rates were variable throughout the season, constantly fluctuating between 0 – 100% for each turtle species. This can be attributed to the low numbers of turtle activities recorded (i.e. - No nests were produced during certain weeks and this would result in a 0% nesting success rate; a 100% success rate could occur if just one nest and no false crawls were produced). Due to the low numbers of turtles that nest in the Coral Bay division the nesting success is more indicative of the success of individual turtles rather than an entire turtle breeding stock.

In total two nests were recorded as damaged in the Coral Bay division. These nests were reported to be dug up by dogs in the Batemans Nth – Oyster Bridge subsection. This was the subsection with the highest density, thus supporting the trend of possible density-dependant nest predation, which was also observed in the other divisions. It is possible that in reality a higher number of old nests were damaged because without tracks leading to the nests it is harder to notice nests and nest damage from a distance on a moving vehicle (volunteers monitor the section on ATVs, driving along the high tide line).

Relatively even numbers of fox and dog prints were recorded in the Coral Bay division, in similar numbers for both subsections. Fox prints were not sighted around either of the damaged nests. A minimal number of potential predator tracks were recorded within a 5m radius of nests. This may be partly due to the low density of nests in the area, causing predators to concentrate on alternative food sources. Or alternatively there may be a low abundance of predators in the area. For example, only one set of human tracks were recorded around nests and this can be credited to the secluded properties of that section of coastline, with low numbers of humans expected to frequent the area. However it must also be considered that the low total number of nests means there is less opportunity to sight predator tracks, therefore the number of predator tracks sighted in the Coral Bay division is expected to be lower than those of the North West Cape or Bundera divisions.

A 1080 baiting program was implemented at Batemans Bay in the 2002-03 season to reduce fox predation on turtle nests and hatchlings (Department of Environment and Conservation 2006). During the 2005-06 season no predation was recorded, therefore the baiting was considered successful as less than 5% of the nests were depredated (Department of Environment and Conservation 2006). During the 2007-08 season 2.8% of nests were recorded to be predated, which is considered an acceptable level.

4.1.4 Rescues and mortalities

Eleven turtles were rescued from rocky crevices and the landward side of large sand dunes during the 2007-08 season. Nesting females can become wedged in between rocks on their way back to the water or unable to make their way back over large sand dunes due to exhaustion or disorientation. Turtles are reptiles thus they are ectothermic, sourcing heat from the external environment (Gulko and Eckert 2004). Extended periods in the sun can lead to death through exhaustion and dehydration. Therefore it is presumed that the rescued turtles would have perished in the sun if they were left unaided.

The highest number of rescues occurred in the Brooke – Graveyards subsection, where in most cases the turtles were rescued from sharp rocks that occur along part of the coastline within that subsection. The Graveyards – Burrows subsection was the site of two turtle rescues. These two subsections contain large sand dunes which turtles have needed rescuing from in the past. Turtles also got stuck in rocks or behind sand dunes in the two additional subsections and one turtle required rescuing from a separate subsection after it had become lost in the car park adjacent to the beach. Two loggerhead turtles required rescuing in the Bundera division after they had partially buried themselves in sand and become immobilized. It is not known why these two incidences occurred.

All turtle rescues performed in the North West Cape division this season involved green turtles. There are a few possible reasons for this: there is a higher abundance of green turtles in the area and thus more chance of them becoming stranded rather than another turtle species; green turtles were frequently noticed to still be nesting or returning to the water during morning monitoring activities whereas loggerhead and hawksbill turtles were generally not seen and therefore were not present to require rescuing; and according to the data collected during the season green turtles were more likely to nest further back on the beach, thus are more likely to become stuck behind large sand dunes in the D zone.

Eighteen turtle mortalities were recorded during the 2007-08 season, the majority of which occurred at the Jacobsz Sth – Wobiri subsection. In this area most deceased turtles were located behind large steep sand dunes, which extend down a long stretch of beach. Several turtles had to be checked in this area to assess if they had to be rescued, however only one rescue was required. The deceased turtles were primarily adult females and are assumed to have wandered along this area during periods when volunteers were not monitoring the beaches.

Six of the deceased turtles were reported to have washed up on the shore. A number of factors may have caused their mortalities including natural predation or disease, boat strikes, consumption of pollution and entanglement in fishing gear. One of the deceased turtles was reported to have been attacked by a shark and another had obvious injuries to the head, possibly caused by a boat propeller.

During the 2007-08 season 11 turtle rescues were recorded in comparison to 40 in the 2005-06 season and 43 in the 2006-07 season; and 18 turtle mortalities were recorded in comparison to 30 in the 2006-07 season. Therefore in comparison to previous seasons less turtles required rescuing and less mortalities were recorded despite the

fact that a greater number of turtle activities were recorded on the beaches monitored in the North West Cape, Bundera and Coral Bay divisions. Further research would be required to assess the reasons behind this.

4.1.5 Climatic events

In addition to the estimated loss of turtle nests due to Tropical Cyclone Nicholas (1144 – 1490 nests) it is likely that weather conditions associated with Tropical Cyclones Pancho, Melanie and Ophelia also detrimentally affected turtle nests. Thus the overall level of damage associated with climatic events is likely to have exceeded the predicted 18.2 – 23.7% damage to the total nests recorded over the season. This demonstrates the susceptibility of marine turtles to natural stressors and threats and emphasizes the need to reduce nest losses and turtle mortalities related to anthropogenic related threats.

It is recommended that in future seasons the beaches are assessed for likely levels of nest damage after all big swell and storm surge conditions. This will give a better insight on the loss of turtle nests due to natural stressors.

4.1.6 Comparisons to previous seasons

Over the six seasons that monitoring has been undertaken by the Ningaloo Turtle Program the general trend has been an increase in the total numbers of nests and false crawls recorded, with the exception of the 2003-04 and 2004-05 seasons, during which the numbers of all turtle activities declined. This may be attributed to climate change related to El Nino Southern Oscillation (ENSO) events which affect the quantity and quality of food sources available to the turtle breeding stock (Limpus et al 2000; Limpus and Nicholas 1987 and Broderick et al 2001 cited in Broderick et al 2003). However, in order to assess long term trends and the size of turtle populations monitoring must be continued over a long term period (> 10 years) because female turtles skip breeding seasons and marine turtles are long lived (Chaloupka and Limpus 2001; Balazs and Chaloupka 2004).

The green turtle (*Chelonia mydas*) has consistently been responsible for the majority of turtle activities recorded in the Ningaloo region, throughout all seasons of monitoring. The highest numbers of nests produced per unit effort have been recorded in the North West Cape and Bundera divisions throughout all seasons. Green turtles are the primary species that nest in the North West Cape division and loggerhead turtles are the primary species that nest in the Bundera division. Therefore this suggests that the green turtle breeding stock is the largest breeding stock of turtle species to nest in the entire Ningaloo region.

In order to effectively manage the conservation of marine turtles in the natural environment peak nesting times and areas of concentrated activity are useful information to acquire. The data collected for each season of monitoring suggests that the peak of turtle nesting activity generally occurs during the 5^{th} – 11^{th} of January. Therefore during this time it is especially important to implement management strategies and undertake action to prevent turtle disturbance. One such example is the ban that is placed on driving on beaches within the Ningaloo Marine Park during the

turtle nesting season. This is particularly important because the collected data shows that green, loggerhead and hawksbill turtles predominantly nest between the high water mark and the base of the dune system, which coincides with a popular zone for 4WD cars to drive on.

The time of peak nesting is also helpful to know in regards to reducing monitoring effort. Using this information beaches can be monitored in concentrated periods which encapsulate both the peak time of nesting and areas containing the densest turtle activity. Future endeavours of the Ningaloo Turtle Program include reducing monitoring effort and extrapolating additional data using predictive modelling techniques.

Patterns of nest disturbance are similar to that exhibited for the level of turtle activity, suggesting possible density-dependant predation. Although nest disturbance has increased in the past season it is related to the increase in the number of nests recorded per unit effort, as the total number of nests disturbed remains under 5% of the total number of nests produced – a result which was not observed during the earliest NTP seasons. A fox baiting program was implemented in the North West Cape division in December 2004 and the level of nest disturbance has remained under 5% of the total nest population since the 2004-05 season. The sustainable level of depredation is considered to be 5% so the current level of disturbance is acceptable (Department of Environment and Conservation 2006).

The majority of nest damage was attributed to foxes in earlier seasons, but in the past three seasons the percentage of total damage caused by foxes has decreased whilst damage caused by ghost crabs has increased. This is another indication that fox predation has been reduced since fox baiting was implemented as the major cause of damage has shifted from that of anthropogenic disturbance to natural disturbance. However this result may also be influenced by the interpretation by individual volunteers of what constitutes a valid case of nest damage.

4.1.6.1 North West Cape division

The patterns of nesting and false crawl numbers recorded over the last six seasons in the North West Cape division is reflective of that exhibited for the entire Ningaloo region, which emphasizes the high level of activity observed in the North West Cape division and the general increase in turtle activity over the seasons, with the exception of the 2004-05 season. This is also reflected in the increase of estimated numbers of nesting female turtles in the North West Cape division over recent seasons, with the exception of the loggerhead turtle, which decreased in numbers during the 2006-07 season.

Green turtles have been the predominant species to nest in this division in all seasons thus the general pattern of turtle activity can be primarily attributed to the activities undertaken by green turtles. Green turtles tend to produce fluctuating numbers of nests per season, possibly due to inter-annual variations in the quantity and quality of available food sources caused by prevailing weather patterns (Limpus and Nicholas 1987 and Broderick et al 2001 cited in Broderick et al 2003). Therefore there is the need for ongoing monitoring to be undertaken in order to see 2-7 yr remigration intervals (Chaloupka and Limpus 2001; Balazs and Chaloupka 2004).

The peak level of nesting activity in the North West Cape division has generally been recorded during the 5th – 18th of January for all seasons. The highest nesting density per unit effort has consistently been recorded in the Graveyards section over all seasons, followed by the Hunters section. Therefore if monitoring effort is to be reduced, monitoring should continue in the Hunters and Graveyards sections for a period which includes at least the first half of January.

Throughout all seasons green turtles have exhibited the lowest level of nesting success and hawksbill turtles have generally showed the highest. This reflects past reports of green turtles appearing more susceptible to disturbance than loggerhead turtles (Waayers n.d.) and hawksbill turtles often being relatively unaffected by human or natural disturbance (Kamel and Mrosovsky 2005).

The presence of fox/dog tracks recorded per unit effort has increased in recent seasons. However the level of predation recorded for foxes and dogs has not varied by much between seasons and has ultimately remained low, with less than 5% of nests reported as damaged for all seasons. Therefore the increase in observed fox/dog presence may be attributed to changes in training techniques (which may have lead volunteers to focus on this aspect more as trainers have changed over the seasons) and datasheet design which now requires volunteers to provide absence/presence data rather than quantitative data on the number of prints observed. The current level of nest predation is considered to be sustainable and the majority of fox/dog tracks recorded within 5m of nests are in the vicinity of undamaged nests, with very little disturbance being inflicted.

4.1.6.2 Bundera division

Turtle nesting and false crawl levels have considerably fluctuated over the seasons of monitoring by the NTP. Nesting and false crawl activities have fluctuated in unison, both of which decreased steeply between 2003 and 2004, and again in the 2006-07 season. However, the range between the numbers of activities recorded per unit effort is not as large as that recorded in the North West Cape division.

Loggerhead turtles are responsible for the majority of the turtle activities in the Bundera division as it is a significant loggerhead turtle rookery. Rookeries of loggerhead turtles tend to produce similar numbers of nesting turtles each nesting season (Ehrhart et al 1996 cited in Broderick et al 2003) whereas green turtle nesting patterns tend to fluctuate on a seasonal basis (Limpus and Nicholas 1987 and Broderick et al 2001 cited in Broderick et al 2003). Therefore the lower range in nesting activity at Bundera conforms to this expectation.

Turtle nesting peaks have varied between seasons in the Bundera division. They tend to occur earlier than those recorded for the North West Cape division and this may be attributed to the difference in key nesting times of green and loggerhead turtles- the predominant species of the North West Cape and Bundera divisions respectively. Nesting activity trend lines indicate that the nesting peaks for the 2002-03 and 2007-08 seasons occurred prior to the commencement of monitoring. Therefore in future seasons monitoring may need to commence earlier in the Bundera division in order to capture the peak nesting period of the loggerhead turtle rookery.

The nesting success results of the three turtle species reflects similar results to those observed in the North West Cape division: hawksbill turtles generally have the highest success, followed by loggerhead and green turtles. Once again this indicates the higher level of sensitivity that green turtles exhibit to disturbance (Waayers n.d.). However the average nesting success rates for all three species are higher in the Bundera division in comparison to the North West Cape division. This may be attributed to the lower level of anthropogenic disturbance in the Bundera division due to the isolation of the area.

The presence of fox/dog tracks recorded per unit effort has increased since 2006. However the level of predation recorded for foxes/dogs declined steeply and has continued to plateau at a low, sustainable level since the 2004-05 season. In earlier seasons the majority of tracks recorded within a 5m radius of nests were predominantly near damaged nests and 55% and 36% of recorded nests were reported to be damaged in the 2002-03 and 2003-04 seasons respectively. However in recent seasons the majority of these tracks have been in the vicinity of undamaged nests and the level of predation has remained under 5%. Thus this reinforces the indication that fox/dog predation has been reduced since baiting was implemented. Therefore the increase in tracks recorded may be an indication of an increased emphasis placed on this during training in recent seasons.

4.1.6.3 Coral Bay division

Coral Bay has consistently experienced lower numbers of turtle activity than the North West Cape and Bundera divisions. Activity patterns reflect those exhibited for the entire Ningaloo region, with activity levels generally increasing over the seasons with the exception of a decline between 2003 and 2005. The majority of turtle activities in the Coral Bay division are performed by loggerhead turtles. A decrease in turtle activities was recorded during the 2004-05 season in all divisions. Therefore due to the difference in the predominant species of each division (green turtles in the North West Cape and Loggerhead turtles in Bundera and Coral Bay) and the similar patterns of decline it is likely that the decline in turtle activities during 2004-05 was caused by a common factor within all three divisions. The remigration intervals of turtles typically vary between 2-5 years depending on the turtle species (Hays 2000). These intervals are believed to be increased and reduced in accordance with the quality and quantity of available food and thus the resultant breeding condition of individual turtles within a breeding stock (Hays 2000). Therefore it is likely that the 2004-05 reduction is indicative of a decrease in food availability, which may be related to large scale ENSO events. An ENSO event was recorded in the 2002-03 season (Commonwealth of Australia n.d.).

Turtle nesting peaks have generally occurred between the 29th of December and the 11th of January in the Coral Bay division, similar to those of the North West Cape division. However for the 2002-03 season trendlines indicate the peak time of nesting occurred before the monitoring season commenced. Monitoring in future seasons may indicate if this was an anomaly or part of a larger cyclic trend.

The nesting success levels of the three turtle species in the Coral Bay division remain consistent with those observed in the other two divisions. Therefore, this again

reinforces the trend of green turtles to have lower nesting success rates in ratio to the number of false crawls produced.

The level of fox/ dog presence and predation have remained low in the Coral Bay division and have therefore there has been minimal fluctuations in the level of these between seasons. A 1080 fox baiting program was introduced in Batemans Bay in the 2002-03 season and fox/dog predation has continued to occur in low numbers since then. However due to the overall low numbers of nests recorded in this division the level of predation has exceeded the sustainable 5% in the 2002-03, 2004-05 and 2006-07 seasons.

4.2 Tagged turtles resighted

The Western Australian Marine Turtle Project (WAMTP) involved the tagging of almost 10 000 turtles during six nesting seasons between 1986 and 1992 (Prince 1993). The majority of these were mature female turtles. Six of the seven tagged turtles resighted during the 2007-08 season have been identified as turtles tagged in the WAMTP; one tag number could not be identified.

The tagged turtles identified this season were six of 1557 turtles tagged along the North West Cape between 1986 and 1992 (Prince 1993). The majority of the tagged turtles (1475) were green turtles and all of the tagged turtles resighted were mature green females. The information collected indicates that these turtles are residents of Western Australian waters, belong to the North West Shelf stock unit, and have very long inter-nesting season return intervals (B. Prince, 2008, pers. comm.).

The information collected through the tagged turtle resighting program helps to achieve the aims of the WAMTP by providing information on the distribution and inter-nesting periods of breeding turtles. However, only turtles encountered to be resting or returning to the water during morning monitoring activities were checked for tags this season. In previous seasons turtles sighted during night time operations at the JTC were also checked for tags. Therefore it is assumed that several tagged turtles that visit the Ningaloo region are not sighted by volunteers and their presence is not recorded. The collection of this information would assist in gaining a better understanding of several aspects of turtle life characteristics, particularly demographics.

4.3 Volunteer participation

The important conservation and monitoring objectives of the Ningaloo Turtle Program would not be achieved without the help of the many volunteers that participate in the program. Volunteer participation for this season alone was estimated at a monetary value of over $151000.

The program would also not be possible without the partnership between the Department of Environment and Conservation, the Cape Conservation Group and the WWF, and funding and in-kind support from Rangelands NRM Co-ordinating Group, Natural Heritage Trust, Coastwest, Shire of Exmouth, bhpBilliton, the Department of Defence and Tony and Lewis Lisette WildlifeLink Foundation.

4.3.1 Volunteer numbers

The volunteer numbers have continued to increase since the Ningaloo Turtle Program was in its first season of operation and the program now generates a high level of interest, resulting in some individuals missing out on a place in the program due to surplus applications. The volunteer numbers decreased slightly this season since the 2006-07 season because fewer volunteers were required. The JTC was not operated by the NTP, unlike previous seasons, so a lower number of volunteers were sufficient to cover monitoring purposes alone. In addition, the remote camp at Janes Bay was no longer run in the 2007-08 season due to the low density of turtle nesting in the area. Therefore the team/campground leader numbers decreased from five to three and total volunteer numbers decreased from 118 to 106 volunteers in the 2006-07 and 2007-08 seasons respectively.

4.3.2 Volunteer demographics

The majority of volunteers participating in the NTP this season were Western Australian residents. In addition six volunteers originated from other areas of Australia: Victoria, New South Wales and the Northern Territory; and five volunteers originated from international locations: the United Kingdom, Taiwan, Hong Kong, Denmark and the United States of America. Volunteers found out about the program through the internet, their friends, universities, previous participants, local posters and DEC.

The highest numbers of volunteers belonged in the 21-30 year old age bracket, followed by the 31-40 and the under 20 year old age brackets, which was also the case in the 2006-07 NTP season. This is partly attributed to the high number of university students that participate in the program.

4.3.3 Volunteer hours

Volunteer hours contributed to the NTP have continually increased since the commencement of the program. However, the hours decreased in the 2007-08 season due to the same reasons as already stated for the decrease in volunteer numbers: the JTC was no longer operated by the NTP and the Janes Bay camp was not in operation this season. This would have accounted for several less hours because the JTC was operated six nights a week during the 2006-07 season; volunteers are awarded 8 hours a day for camp participation; and camp ground leaders are awarded 24 hours a day for the running of the remote camps. However, this season the Bungelup remote camp ran more consistently than in the 2006-07 season, with camps in operation every week between the 10th of December 2007 and the 11th of February 2008.

5.0 RECOMMENDATIONS

Since its commencement the Ningaloo Turtle Program has continued to develop and adapt with new and improved procedures as the seasons have progressed and innovative and more suitable approaches have been realized. At the end of each season a list of recommendations is created for the following season. Recommendations for the 2008-09 NTP season on aspects of monitoring, program organization, data entry and issues pertaining to the program are outlined below.

5.1 Monitoring procedures and fox control

- Continue to monitor turtle activities along the North West Cape, Bundera and Coral Bay divisions in order to obtain a long-term assessment of turtle abundance and activities in the Ningaloo region, thereby assisting with the conservation of marine turtles and the management of issues pertaining to their successful conservation.
- Continue fox baiting in the three divisions, to maintain the current low level of fox predation on nests and hatchlings.
- Do cross-checks of monitoring data on random subsections periodically throughout the monitoring season. Have two different people monitor the same subsection separately and submit the datasheets to be cross-checked to see if the same results were obtained. This would serve as an ongoing assessment of the confidence and capability of volunteers and hence the quality of the data collected.
- Continue to conduct turtle rescues when required and consider listing this as one of the objectives/goals of the program.
- As discussed in the steering group committee meeting, nesting success should be the natural progression in advancing and broadening the NTP. Currently there is six years worth of nesting data and nesting success is a vital part of the nesting process. It is recommend that this is undertaken in future seasons.
- Seagulls are major predators of hatchlings during the period between emergence of the hatchlings from the nest and entrance into the ocean. It is understood that seagull predation is natural and cannot be avoided. Seagulls are associated with coastal towns and typically take advantage of increased human waste. As Exmouth is likely to expand over the next few years it is possible that the seagull population will also increase, which may therefore also result in an increase in the number of hatchlings that are subjected to predation. It is therefore recommended that a basic bird count aimed at sea gulls is incorporated into the monitoring methods and conducted each morning so that a dataset can be started. Then if there is a population increase the data collected will support the theory. More research will have to be undertaken to look at seagull populations and migrations and also to look at the best method for conducting an accurate count.
- After all potentially damaging climatic events, such as cyclones and high swells, an experienced NTP participant with a good knowledge of and high level of familiarization with the beaches should assess the relative percentage of turtle nests affected by the event in each beach zone. This information should be recorded for later use in the assessment of damage to turtle nests as a component of the NTP Annual Report. A standard approach, such as the one outlined in this

report, should be used to assess the level of damage to turtle nests after climatic events.

5.2 Training procedures

- Train more individuals to become trainer trainers. This season only four people were competent to train people to become trainers. These people were not always available and volunteers acquiring competency as trainers are required to be trained by at least two different people amongst at least three training sessions. An additional one or two trainer trainers would probably be sufficient for the upcoming season, depending on the availability of the current trainer trainers.
- Clarify to all trainers and volunteers exactly what constitutes ghost crab predation and instruct them on the appropriate recording of these incidences.
- Provide more training to volunteers on how to distinguish between loggerhead and hawksbill turtle tracks and green and flatback turtle tracks.
- Train volunteers in how to use clipboard sheets and laminates prior to field training. A brief introduction on this information could be conducted during the GPS and radio training session. In addition, volunteers could be given a brief introduction to each individual subsection so they know details prior to monitoring the subsection to ensure their confidence is maintained (i.e. – the Mildura Wreck – Surf Beach subsection requires two data sheets to be filled out: one for Mildura Wreck – North West Car Park and one for North West Car Park – Surf Beach).
- Ensure all volunteers have a go at using all types of radio and GPS units during the training session to ensure competency in using each unit.
- Provide trainer refreshers and calibration at the start of the season. At the start of the season it was requested that all trainers met for a monitoring session to talk about training methods and explanations so that all trainers were giving consistent information whilst training volunteers. This was successful however volunteers still reported that some trainers contradicted each other. It is recommended that the same calibration at the start of the season still takes place. To increase its effectiveness it is recommended that trainers receive updates from the volunteer coordinator on any issues of contradictions; this should be put forth as a discussion forum for all trainers so that they can respond and one correct method can result.
- Provide local volunteers an induction and radio and GPS training as for external volunteers. In previous seasons it has been noted that local volunteers have not received an adequate induction or training in the use of a GPS and radio. This season local volunteers were invited to join induction sessions as well as organized training sessions in GPS and handheld radio use. No response was expressed and the local volunteer induction and training sessions failed. It is recommended that all new local volunteers are invited and strongly encouraged to participate in a similar session in future seasons.
- There has been a consistent issue of volunteers in Coral Bay being inadequately trained in turtle monitoring. This season there was no qualified trainer in Coral Bay to train the volunteers so the volunteer coordinator travelled there to conduct training sessions. However the effectiveness of this was also low because the abundance of nests in Coral Bay is low and sufficient training could not occur. Coral Bay volunteers from previous seasons were also invited to Exmouth to undergo training as trainers so they could train volunteers in Coral Bay; however

this was not successful as the volunteers could not get sufficient time to travel to Exmouth and undergo the training. After this failed all Coral Bay volunteers were invited to travel up to Exmouth to receive training at the N.W. Cape where nesting density is much higher. Volunteers were offered subsidized travel costs and accommodation in Exmouth to encourage them to journey to Exmouth. At the start of the season five Coral Bay volunteers travelled to Exmouth for one training session as they had work commitments and one night was all they could organize. Aside from this no other Coral Bay volunteer travelled to Exmouth to participate in training sessions. This was a major issue that still needs to be addressed if monitoring is to continue in Coral Bay. A recommendation is not apparent; however it would be of help to have at least one trainer in Coral Bay to start the training sessions. It is still recommended that Coral Bay volunteers travel to Exmouth for at least one training session due to the higher abundance of turtle activities in the N.W. Cape

5.3 Data management

- Redesign the NTP data sheets to include separate columns for predator tracks: one for tracks/signs pertaining to possible causes of predation or nest damage (surrounding disturbed nests), and one for potential predator tracks seen within a 5m radius of all nests. This will eliminate some of the confusion in the database and create more concise data in relation to predation issues for the analysis stage of the data. It may also be useful to add seagull tracks, tide damage and damage by other turtles as additional options in the column for causes of nest disturbance in addition to the choices of fox, dog, goanna and human prints.
- Do occasional checks of GPS waypoints during the season as they can be accidentally changed by volunteers. If not this is not noticed and rectified it leads to inaccurate results when volunteers use the go-to function to locate the totem markers.
- In the 2007-08 season data entry was conducted by external volunteers throughout the season. It is recommended that only volunteers that want to enter data are utilized for this task as they are more likely to concentrate thereby entering the data in a more efficient manner and minimizing mistakes. It is also recommended that the volunteers entering the data do not continue for more than an hour so they retain a good level of concentration, again minimizing mistakes. A data entry roster is recommended so that there is always someone present to enter data and excess people do not turn up to complete the same task.
- This season a spreadsheet was created using Microsoft Excel to cross-check the data entered in the database. It was a very useful tool that easily allowed the volunteer coordinator to keep up to date with the season as it progressed. It is highly recommended to enter the data collected onto the cross-check spread sheet on a daily basis (working days) so that the volunteer coordinator can correct any mistakes, identify any problem areas with volunteers and regularly cross-check the data entered into the database.
- In the past few seasons disposable cameras were provided in all monitoring kits. Photos were taken when volunteers were unsure on the determination of turtle species and nesting activities, and when deceased turtles were encountered. At the end of the season 82 photos were developed but were found to be relatively useless as the majority of the photo numbers recorded on the data sheets did not match the actual photo numbers. Therefore most of the photos could not be used

and this process was deemed to be a waste of money and resources. A possible recommendation for future seasons would be to invest in a couple of digital cameras for this purpose. These could be programmed to display the date and time, which could be recorded on the datasheets and used to identify the photos. The majority of volunteers have their own digital cameras and if they were encouraged to use these in required situations the photos could be downloaded and viewed by the volunteer coordinator on the same day as the photos were taken to provide volunteers assistance in the identification of turtle species and nesting activities. Another initiative which may help with the photo issue would be to include an additional column on the data sheet so volunteers can record their level of confidence as high or low for the identification of nests.

5.4 Volunteer education, information and communication

- Provide a few brief presentations to volunteers interested in learning more information on turtle biology and the results from previous seasons monitoring data and what it is used for.
- During the 2007-08 season all volunteers were sent regular updates on the data collected during the current season. This was a basic tool that conveyed how the season was progressing and communicated any issues that were arising. It also served as a discussion forum which allowed volunteers to voice their opinions on current issues. It is recommended that the regular updates (once a month for data updates and as needed for other issues) continue as it was highly appreciated by most volunteers and it was also useful to receive their feedback so they could be addressed as a consensus opinion.
- A meeting between the team leaders and the volunteer coordinator should be held on a regular basis, once a week. This is a very effective way for any issues, ideas and resolutions to be communicated and discussed. This season the team leaders had to be directly asked their opinions but this proved to be effective to adequately discuss any issues. It is recommended that a NTP staff meeting occurs once a week or as often as possible to discuss all NTP matters.
- This season local community liaisons were introduced to increase the amount of local community input into the program. This was very unsuccessful as the added responsibility of organizing local volunteers was not popular. On occasion a meeting was held between the volunteer coordinator and community liaisons to discuss any issues that arose throughout the season; however the regular updates and addressing issues were found to be sufficient means to resolve any issues. It is not recommended to continue with the community liaison prospect unless needed in future seasons.
- It is highly recommended that the volunteer coordinator stress to each volunteer (local, external and especially team leaders) that their door is always open to discuss any matters or ideas as long as they are serious items to discuss. A friendly and welcoming disposition will help when communicating to volunteers, thus forming a more effective working relationship.
- This season a photo competition was initiated to encourage volunteers to take plenty of photos of their experiences in the region and to download them onto the NTP computer prior to their departure. This enabled the creation of a quality photo database as the volunteers were continuously on the beaches and witnessed several amazing events. A prize was offered to the volunteers for the best photo for each group, which were paid for by the volunteer coordinator (this was the

choice of the volunteer coordinator and does not have to be repeated). As the season finished volunteers were asked if DEC could use the photos for educational and non-profit promotional work. The photo competition was very successful and is highly recommended to be continued in future seasons.

- A specific local volunteer feedback form should be created to target the issues directly concerned with the local side of volunteer feedback. The current feedback form is aimed at external volunteers and does not adequately cover local volunteer issues. Local volunteers can participate over many seasons and their feedback is vital for continuing successful relations with the community. It is recommended that a specific local feedback form should be produced.

5.5 NTP organization and procedures

- Continue to build and expand on the current enquiry list in the NTP email account. It was a great source of volunteer recruitment and negated the effort and cost of travelling to Perth to conduct presentations at the universities. It is recommended that in the years to come the professional relations between the universities and NTP staff are taken to a higher level as the majority of recruits are university students.
- This year all team leaders had participated in the NTP during previous seasons. This made the transition and operations at the start of the season very smooth as they already knew what to expect. It also meant that they could be trained as trainers, which was a great help when new groups arrived and required training. It is also recommended that all team leaders are trained to be trainers in future seasons.
- Volunteers this season were housed in the Exmouth Villa complex. It has been requested in previous seasons that volunteers be housed in accommodation that is close to other volunteer housing, comfortable and near the centre of town. The villas covered all facets and catered to all needs. It is recommended to rent at the Exmouth Villas in future seasons. The overlap accommodation was at 7 Learmonth St; a house that slept up to ten people. There were twelve volunteers in each group, thus the additional two people had to move into the Exmouth Villas with the preceding group. This was not successful as volunteers felt out of place in a house with another group that had already bonded. I am not aware of a solution to this problem; however I am not sure that it is required. As long as the volunteers have a bed to sleep on there should be minimal problems.
- This season volunteers were asked to pay for their accommodation prior to their arrival and the commencement of the season. This is highly advised as it reduces financial issues at the start of the season when paying for the accommodation and it increases the security of volunteer participation.
- Pre-arrival information was provided to volunteers to give each volunteer a detailed explanation of what to expect. It is recommended that once the information is finalized it is consolidated to be non-date specific, except for annual dates, and to be organized into a single document that can be downloaded from the website.
- Twelve volunteers per group were sufficient to run the N.W. Cape and the remote camp at Bungelup in the 2007-08 season. If the same monitoring activities are to take place in upcoming seasons the same number of volunteers per group should be adequate. If changes are made a review will be required to estimate a group size adequate enough to cover monitoring activities.

- Each volunteer group stayed for a duration of four weeks. This was found to be sufficient time for volunteers to be trained, conduct adequate monitoring and experience what Exmouth has to offer. At the end of the season volunteers departed Exmouth five days prior to the final monitoring date. It is recommended for the departure date to be the same date as the last monitoring day, however this will be hard to accomplish as the majority of volunteers are university students who are required to return home prior to the end of season to commence studies for the year. Therefore if synchronization of the dates is not possible it may be necessary to end the season earlier to comply with the end date of the final group.
- The Coral Bay Hut staff helped in organizing the NTP Coral Bay monitoring activities from recruitment to rostering. Two-thirds of the way through the season the Coral Bay Hut staff member was no longer there and the NTP was left without anyone to organize Coral Bay operations. It was also extremely hard to organize Coral Bay volunteers from Exmouth as most Coral Bay residents do not regularly check emails or answer phone calls. Therefore towards the end of the season monitoring was very unproductive as it did not occur very often. It is highly recommended that if monitoring in Coral Bay is to continue then hut staff must be present to help in the organization of the entire season. As an alternative, an additional team leader should be recruited to run the NTP in Coral Bay, similar to the remote camp operations. This team leader would greatly benefit if they were able to be trained as either a trainer or assessor to cover the issue regarding training in Coral Bay.
- Standard operating procedures were produced for all facets of the NTP and are highly effective at communicating to volunteers (mainly NTP staff) what procedures are most effective to efficiently run the program. It is highly recommended that the SOPs are updated at the end of each season to match any changes that are made as the program progresses.
- There were many issues in hiring the bus for the season, particularly pertaining to the availability of an appropriate bus to hire and the requirement of individuals to possess a LR class driver license in order to drive the bus, thus limiting the number of people qualified to drive to monitoring activities. It is highly recommended that the NTP, DEC or CCG purchase a bus to negate this continuing issue. A process has already started to get it underway; hopefully it is purchased before the start of next season. A twelve-seater bus is recommended so that anymore in possession of a normal C class full driver license is qualified to drive the bus.

6.0 CONCLUSION

Green, loggerhead and hawksbill turtles each have a single genetic stock in Western Australia. The data collected in the Ningaloo Turtle Program to date indicates that the Ningaloo coastline is an important nesting area for these three species. In particular, the North West Cape division is significant for green turtles and the Bundera division is significant for loggerhead turtles.

The data also indicates that levels of fox predation have decreased since the initial years of monitoring and the primary causes of nest disturbance have shifted from anthropogenic-related disturbance in earlier seasons to natural disturbance in recent years. In addition, the overall level of nest disturbance has remained under 5% for several seasons now, suggesting that disturbance reduction efforts are working. These may include community and tourist education and awareness efforts to reduce human disturbance; and fox baiting programs along the coastline to reduce nest predation by introduced species.

The results recorded in the Ningaloo Turtle Program to date have been derived from the data collected over the past six seasons. This data indicates that turtle numbers and activity levels in the have increased in the Ningaloo region since the commencement of the NTP. However monitoring is required to continue for at least four years into the future to collect the data that will allow a more accurate assessment of the marine turtle breeding population in the Ningaloo region, based on long-term nesting trends recorded in the area. If monitoring is to be spatially or temporally reduced in order to make the program logistically sustainable it is recommended that monitoring primarily continue within the Hunters and Graveyards sections of the North West Cape and within the Bungelup section of the Bundera division. Future monitoring periods should include the period of the 5th to 11th of January as this has been determined to be the average peak nesting period. However, monitoring may also need to be undertaken earlier in the Bundera division in order to determine if the peak nesting season occurs earlier in this division, as indicated in the data collected in the 2002-03 and 2007-08 seasons.

The level of interest in the NTP expressed by individuals continues to increase. Participation in the program by external volunteers aids the effort to spread the message of turtle conservation on an international level. The involvement of the local community is essential in the effective functioning of the program and to promote awareness of turtle conservation along the Ningaloo coastline. Therefore it is recommended that the NTP continue to involve individuals from the Exmouth community and external volunteers from the wider conservation community and that the program continues into the future. Long-term commitments from the community and funding bodies will be necessary to ensure the continued sustainability of the NTP.

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8.0 GLOSSARY

Body pit	A depression dug in the sand by a turtle during successful nesting attempts and some false crawls. A primary body pit may be dug as part of a nest or false crawl (in which case the pit is abandoned). A secondary body pit is dug during a successful nesting attempt to cover the primary body pit and egg chamber with sand.
Carapace	The shell covering the dorsal surface of the turtle.
Costal scales	Large scales lining both sides of the carapace, below the centre row of scales.
Effort	The number of days and subsections monitored throughout the duration of the program.
Egg chamber	A deep hole which a turtle digs into a primary body pit with her back flippers. The eggs are deposited here.
Emerging track	Track of a turtle emerging from the sea onto land.
Escarpment	The edge of a ridge which indicates a filled-in primary body pit.
False crawl	The emergence of a turtle from the water that has not resulted in the production of a nest.
GPS unit	Global Positioning System unit: an electronic navigational device which obtains a position on the earth using satellite signals.
Hatchling	A newly hatched turtle.
Nesting success	The number of successful nests as a percentage of total turtle activities.
Plastron	The underside of a turtle shell.
Prefrontal scales	Situated on a turtle head, anterior to the frontal bone.
Preoccular scales	Situated on a turtle head, anterior from the eyes.
Returning track	Track of a turtle returning from the land to the sea.
Rookery	A significant breeding area for a large number of animals.
Successful nest	A complete turtle nest in which eggs have been deposited.
Turtle activities	Includes both turtle nests and false crawls.
Turtle tracker	Person who has gained competency in the identification of turtle species and activities observed during morning monitoring activities.

9.0 LIST OF ABBREVIATIONS

CCG	Cape Conservation Group
DEC	The Department of Environment and Conservation
EPBC Act	*Environmental Protection and Biodiversity Conservation Act* 1999
JTC	Jurabi Turtle Centre
NTP	Ningaloo Turtle Program
The Marine Park	Ningaloo Marine Park
WWF	World Wildlife Foundation

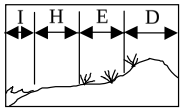
10.0 APPENDICES

10.1 Copy of the NTP data sheet

Ningaloo Community TURTLE MONITORING PROGRAM DATASHEET Daily Report Page…..of…...

Starting

Date: _____ Sub/Section: _____



Finishing

Recorder: _____ Sub/Section: _____

Start Time _____ Finish Time: _____

GPS No _____ Camera No/s: _____

TABLE A: FALSE CRAWLS / NON-NESTING EMERGENCES TALLY

	Green	Loggerhead	Hawksbill	Unknown	Fox/Dog Prints (Y/N)
					F
					D
Total					

TABLE B: NESTS

Species Type G/L/H/U	~GPS Position (Datum WGS84) latitude (S)	longitude (E)	New (N) / Old* (O)	Pos. of Nest	Is Nest Damaged? Y/ N / U	Any Prints? D/ F/ G/ H	Photo Frame No.	Any Other Observations?

Comments:

**** Only record old nest data if it has been disturbed.*** **~Please fill in and return even if no nests are recorded!** **111202**

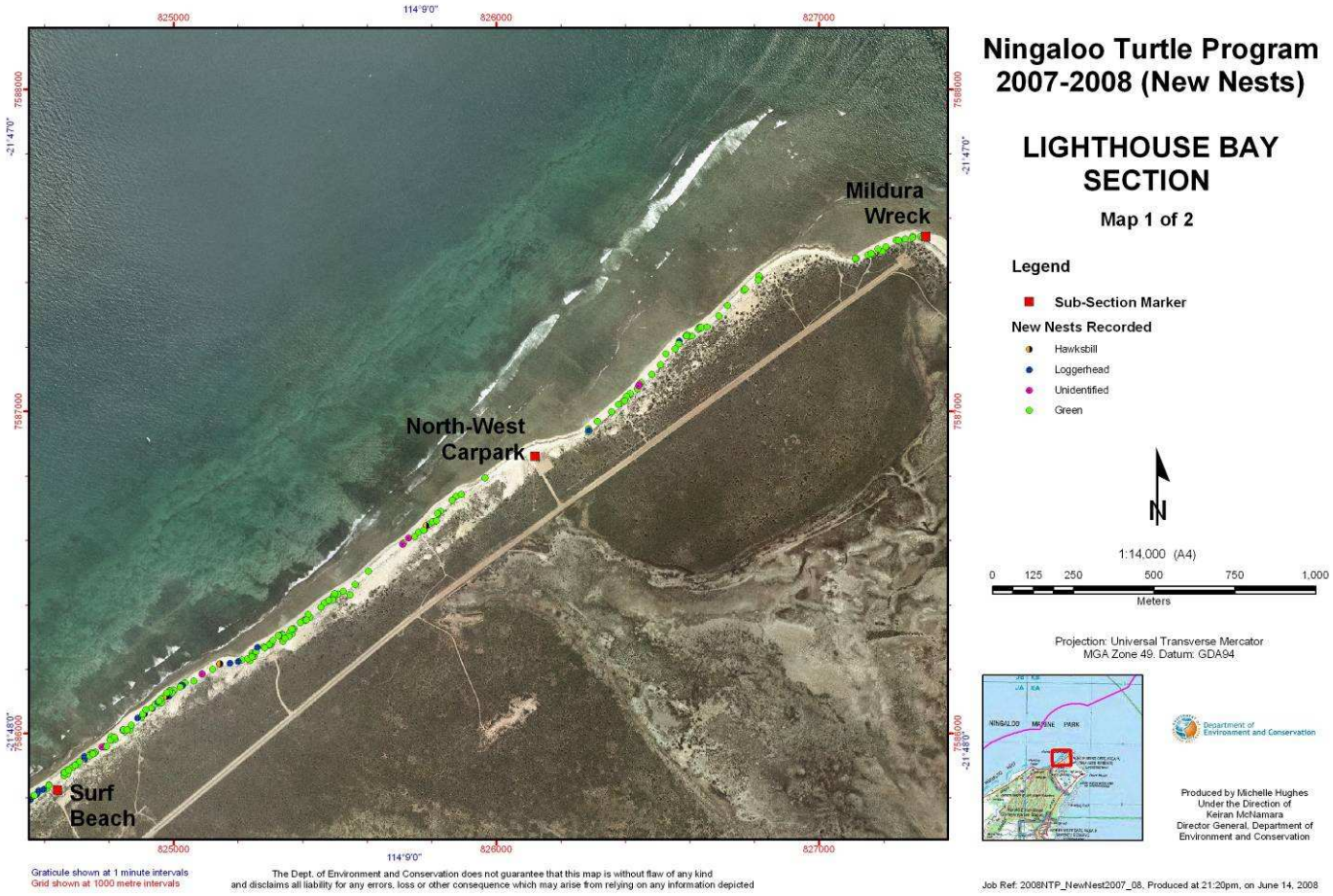
10.2 NTP subsections

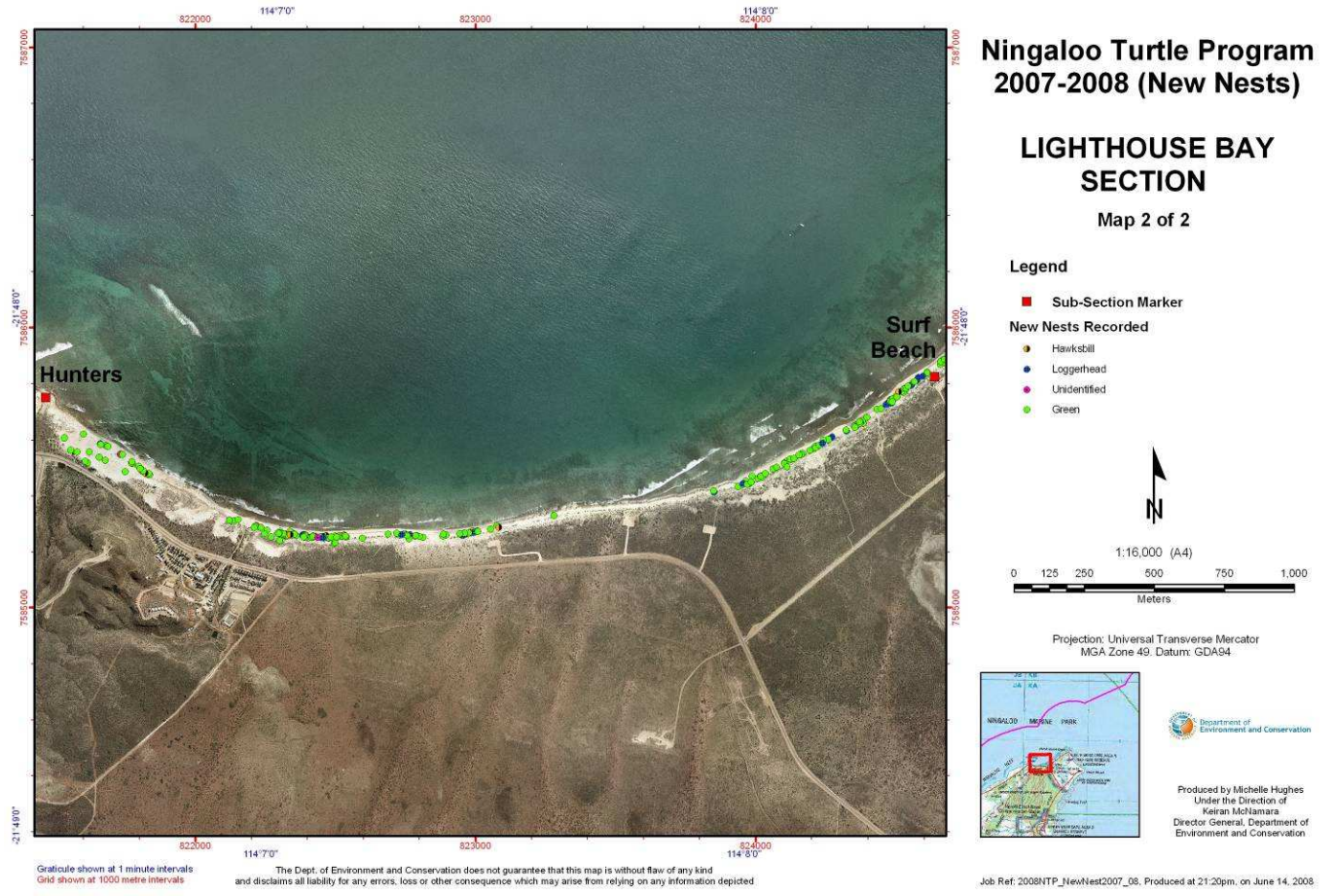
Table 9: Total subsections monitored in the NTP at some stage between 2002 and 2008.

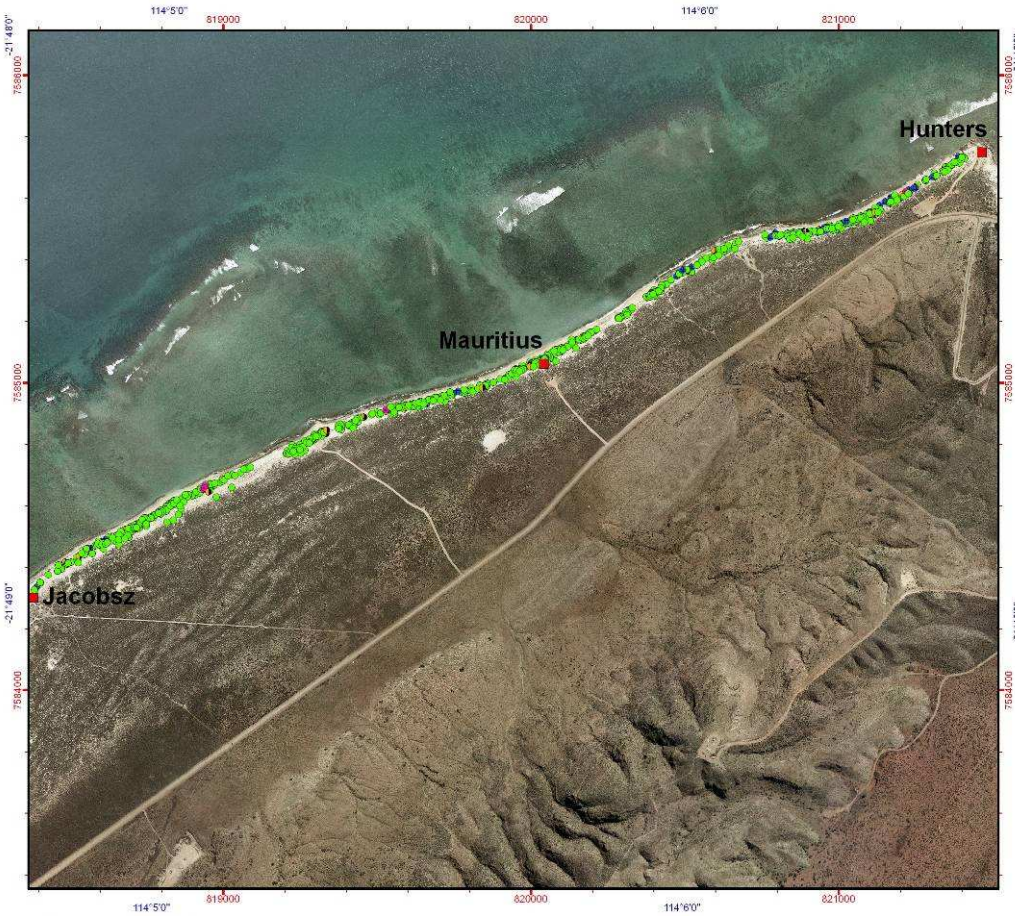
Division	Section	Subsection
North West Cape	Bundegi	Bundegi North - Bundegi Boat Ramp
		Bundegi South - Bundegi North
	Navy Pier	Bundegi Boat Ramp - Bundegi Jetty
		Bundegi Jetty - Point Murat
		Point Murat - VLF Bay
		VLF Bay - Mildura Wreck
	Lighthouse Bay	Mildura Wreck - North West Car park
		North West Car park - Surf Beach
		Surf beach - Hunters
	Hunters	Hunters - Mauritius
		Mauritius - Jacobz South
		Jacobz South - Wobiri
	Graveyards	Five Mile North - Five Mile Car park
		Trisel - Five Mile Car park
		Trisel - Brooke
		Brooke - Graveyards
		Graveyards - Burrows
	Tantabiddi	Burrows - Jurabi Point
		Jurabi Point - Jurabi Point South
		Jurabi Point South - Tantabiddi Leads
		Tantabiddi Leads - Tantabiddi
Cape Range	Turquoise Bay	Turquoise Bay
	Bloodwood	Reef Retreat North
		Reef Retreat South
		Kurrajong
		Pilgramunna
	Bungarra	Osprey
		Bungarra North
		Bungarra South
Bundera	Bungelup	Neils Beach
		Bungelup Beach
		Rolly Beach
	Yardie Creek	Yardie Creek North - Bungelup
		Yardie Creek North - Yardie Creek South
	Boat Harbour	One K
		Shell Beach
		Alli Beach
		Boat Harbour
	Carbaddaman	Doddys
		Sandy Point
		Carbaddaman North
		Carbaddaman South
	Winderabandi	Winderabandi
	Point Billy	Point Billy
	Norwegian Bay	Norwegian Bay
	Janes Bay	Janes Bay
	Whaleback Beach	Whaleback Beach
Coral Bay	Lagoon	Beach One
		Beach Two

		Beach Three
	Batemans Bay	Batemans Bay
Division	**Section**	**Subsection**
Coral Bay	Turtle Beach	Turtle Beach
Waroora Station	Waroora Homestead	Elles Camp Maggies Beach
Gnaraloo Bay	Red Bluff	Red Bluff
Serrurier Island	Serrurier East	S4 - S6 S6 - S2
	Serrurier West	S2 - S3 S3 - S4
	Serrurier South	S2 - S2

10.3 GIS maps of new nests in the North West Cape division







Ningaloo Turtle Program 2007-2008 (New Nests)

HUNTERS SECTION

Map 1 of 2

Legend

- **Sub-Section Marker**

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:15,500 (A4)

0 125 250 500 750 1,000

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

Department of Environment and Conservation

Produced by Michelle Hughes
Under the Direction of
Keiran McNamara
Director General, Department of
Environment and Conservation

Graticule shown at 1 minute intervals
Grid shown at 1000 metre intervals

Job Ref: 2008NTP_NewNest2007_08, Produced at 21:20pm, on June 14, 2008

Ningaloo Turtle Program 2007-2008 (New Nests)

HUNTERS SECTION

Map 2 of 2

Legend

- **Sub-Section Marker**

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:10,000 (A4)

0 60 120 240 360 480

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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Grid shown at 1000 metre intervals

Job Ref: 2008NTP_NewNest2007_08, Produced at 21:20pm, on June 14, 2008

Ningaloo Turtle Program 2007-2008 (New Nests)

GRAVEYARDS SECTION

Map 1 of 2

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:10,000 (A4)

0 62.5 125 250 375 500

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

Department of Environment and Conservation

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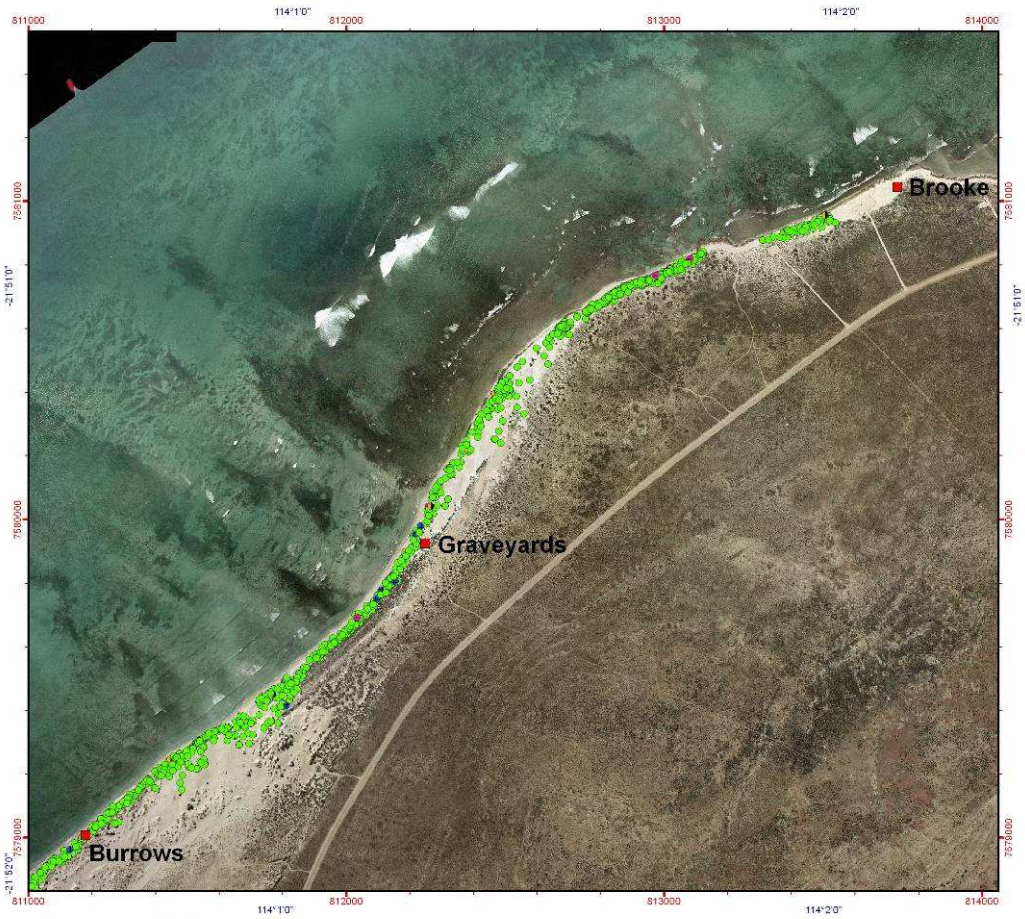
Graticule shown at 1 minute intervals
Grid shown at 1000 metre intervals

Job Ref: 2008NTP_NewNest2007_08, Produced at 21:20pm, on June 14, 2008



Ningaloo Turtle Program 2007-2008 (New Nests)

GRAVEYARDS SECTION

Map 2 of 2

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:15,000 (A4)

0 125 250 500 750 1,000

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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Grid shown at 1000 metre intervals

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Ningaloo Turtle Program 2007-2008 (New Nests)

TANTABIDDI SECTION

Map 1 of 1

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

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Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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Grid shown at 1000 metre intervals

Job Ref: 2008NTP_NewNest2007_08, Produced at 21:20pm, on June 14, 2008

Ningaloo Turtle Program 2007-2008 (New Nests)

BUNGELUP SECTION

Map 1 of 2

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:15,000 (A4)

0 125 250 500 750 1,000

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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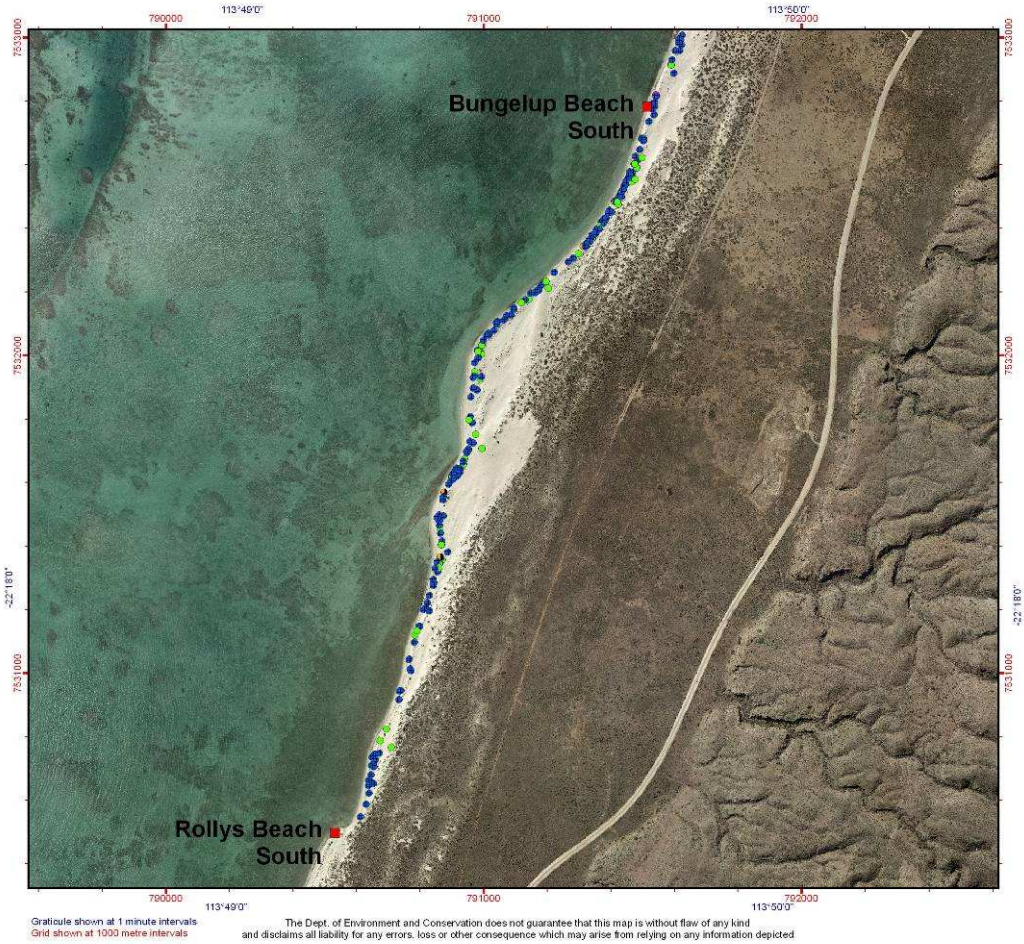
Graticule shown at 1 minute intervals
Grid shown at 1000 metre intervals

Job Ref: 2008NTP_NewNest2007_08, Produced at 21:20pm, on June 14, 2008



Ningaloo Turtle Program 2007-2008 (New Nests)

BUNGELUP SECTION

Map 2 of 2

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:15,000 (A4)

0 125 250 500 750 1,000

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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Grid shown at 1000 metre intervals

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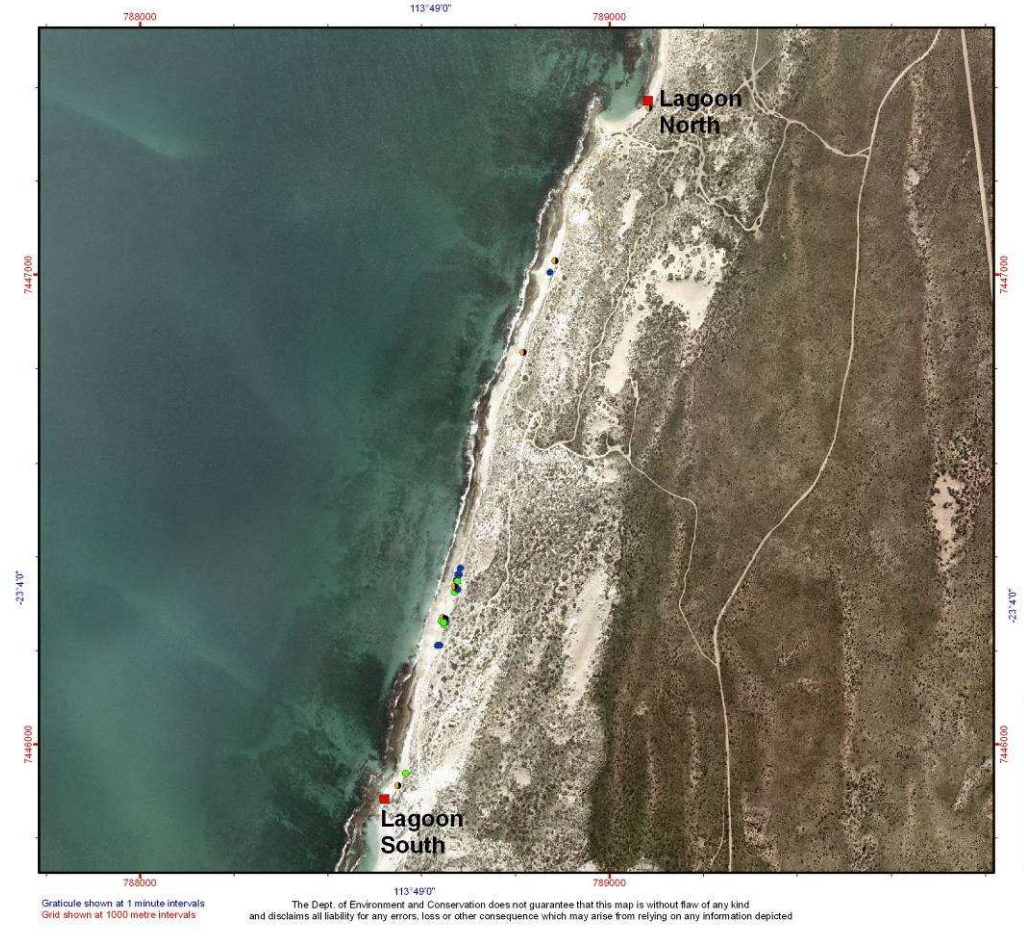

Ningaloo Turtle Program 2007-2008 (New Nests)

LAGOON SECTION

Map 1 of 1

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:10,000 (A4)

0 62.5 125 250 375 500

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

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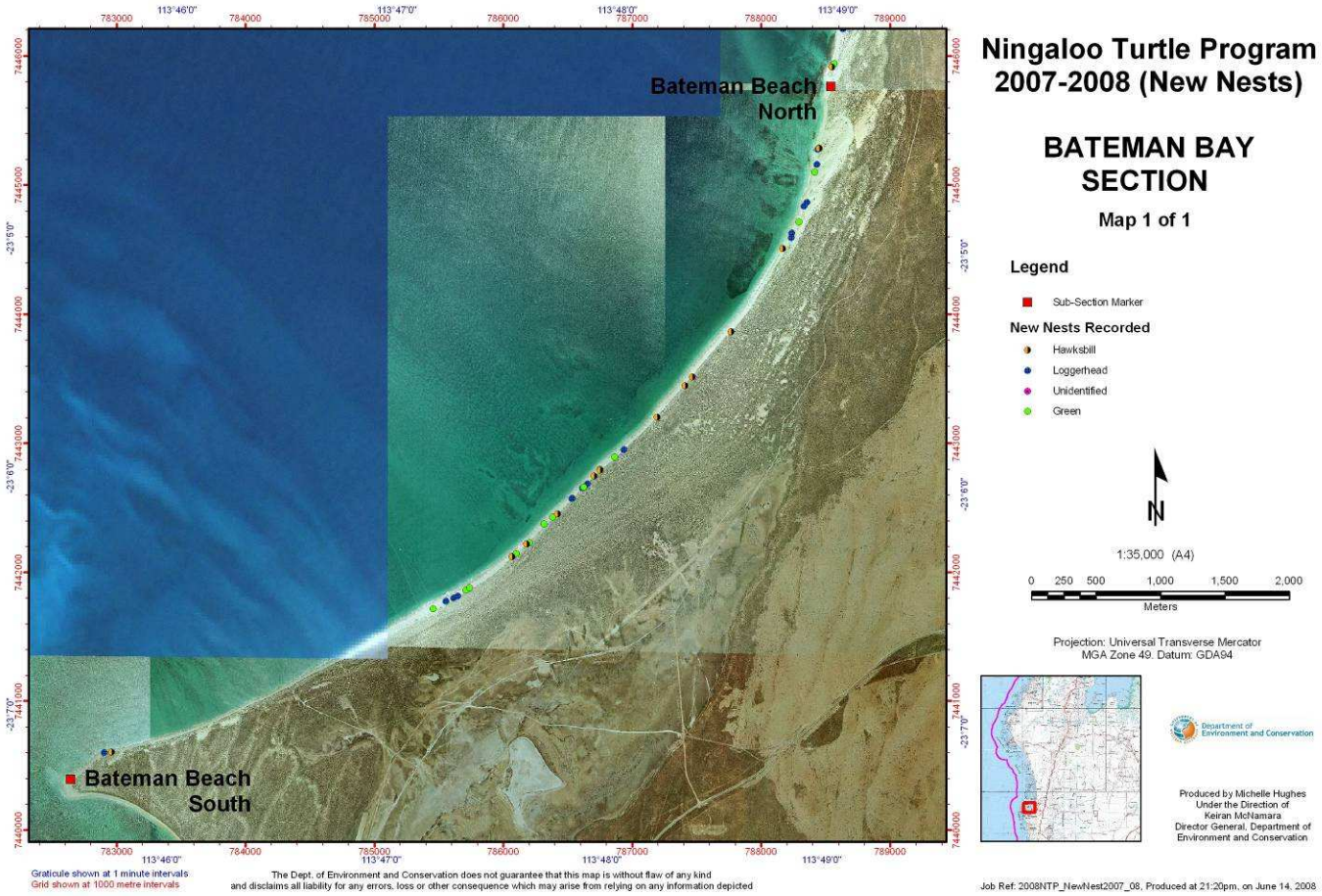

Ningaloo Turtle Program 2007-2008 (New Nests)

BATEMAN BAY SECTION

Map 1 of 1

Legend

- Sub-Section Marker

New Nests Recorded

- Hawksbill
- Loggerhead
- Unidentified
- Green

N

1:35,000 (A4)

0 250 500 1,000 1,500 2,000

Meters

Projection: Universal Transverse Mercator
MGA Zone 49. Datum: GDA94

Department of Environment and Conservation

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Under the Direction of
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Environment and Conservation

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