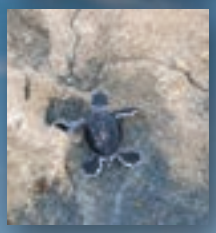
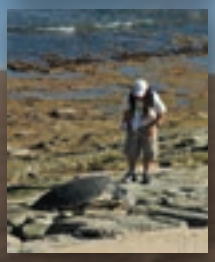
Ningaloo TURTLE PROGRAM

Annual Report 2012/13





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GLOSSARY

Body pit	A depression dug in the sand by a turtle during a nesting attempt.
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.
Combined tracks	Tracks left from both false crawls and nests.
Egg chamber	A deep cylindrical hole which a turtle digs into a primary body pit with her back flippers only. The eggs are deposited here.
Emerging track	Track of a turtle emerging from the ocean onto land.
Entire season	All NTP database season dates and subsections except 1080 baiting data. This included the intensive peak period monitoring and the pre and post peak period monitoring period data.
Escarpment	The edge of a ridge which indicates a filled-in primary body pit.
False crawl	An abandoned nesting attempt not resulting in eggs being laid.
GPS unit	Global Positioning System unit: an electronic navigational device which obtains a position on the earth using satellite signals.
Hatchling	A newly hatched young turtle.
Pre and post peak period	Monitoring of the weekends either side of the intensive peak monitoring period.
Intensive peak monitoring period	Four-week period centred roughly around the 31st of December, during which monitoring takes places every day.
Nest	A new suspected nesting attempt which we expect has resulted in eggs being deposited.
Nest damage	The nest has been dug up, eggs or fresh empty egg shells are around the nest or eggs are exposed.
Nesting success	The number of suspected nests laid as a percentage of total turtle activities.
Old nest	A suspected nest laid during the current season (but not laid during the previous night) which has been predated on.
Plastron	The underside of a turtle.

Prefrontal scales	Situated on the head of a turtle, anterior to the frontal bone.
Pre-ocular scales	Situated on the head of a turtle, anterior from the eyes.
Primary body pit	A depression dug in the sand by a turtle during a nesting attempt with the aim of laying eggs into it. The egg chamber is located here in a successful nest but a primary body pit can also be left exposed from a false crawl.
Returning track	Track of a turtle returning from the land to the ocean.
Rookery	A significant breeding area for a large number of animals.
Secondary body pit	A depression dug lastly during a successful nesting attempt to cover the primary body pit and egg chamber with sand.
Standardised season	Period which only includes the intensive peak monitoring period so as to make data comparisons possible between seasons which would otherwise have different monitoring timeframes.
Survey effort	Factors in the total number of times monitoring was conducted and the total number of subsections monitored over a specified period of time.
Suspected nest	'Nests' suspected of containing eggs as a result of assessment using standard monitoring techniques. Eggs were not witnessed being deposited into an egg chamber within the structure, hence the 'nests' are referred to as "suspected nests".
Tracks	In the form of false crawls or the tracks left behind during nesting.
Track abundance	The number of recorded turtle tracks (includes false crawl tracks and nest tracks). This term is interchangeable with the level of turtle activity.
Turtle activity	Includes both turtle nests and false crawls.
Turtle tracker	A volunteer competent in identifying turtle species and observing activity during monitoring.
Zoning	Hierarchical spatial classification system of divisions, sections & subsections.

LIST OF ABBREVIATIONS

CCG	Cape Conservation Group Inc.
DEC	Department of Environment and Conservation
EPBC Act	Environmental Protection and Biodiversity Conservation Act 1999
JTC	Jurabi Turtle Centre
NMP	Ningaloo Marine Park
NTP	Ningaloo Turtle Program
NW Cape	North West Cape
WWF	World Wildlife Foundation

1.0. SUMMARY

The Ningaloo Turtle Program was established in 2002 as a collaborative effort between Cape Conservation Group Inc., World Wildlife Fund Australia and the Department of Environment and Conservation, Exmouth District. During the 2012-13 season, NTP sponsors Woodside Energy Ltd. made a significant contribution to the program and BHP Billiton contributed to the supply of a vehicle for the program's use during the peak monitoring period. The primary aim of the program is to promote and ensure the long-term survival of turtle populations within the Ningaloo Region by collecting track data that is then used to determine trends in population fluctuations.

For the purpose of the program, the Ningaloo Region is divided spatially into a hierarchical classification. Within this classification there are four divisions within the Ningaloo Region: North West Cape Division, Cape Range Division, Bundera/Ningaloo Division and Coral Bay Division. Each of these divisions is then further divided into sections and subsections. In 2012-13 only the North West Cape and Cape Range divisions were monitored intensively due to consolidation of the program in 2009-10 (Whiting, 2008). This consolidation is attributed to scientific recommendations and capacity constraints which dictated the long-term viability of the program. Opportunistic monitoring was carried out in the Bundera/Ningaloo and Coral Bay Divisions by DEC. For the purpose of this report, data collected from these divisions has been omitted from the results contained within this report due to inconsistent monitoring.

Forty five volunteers contributed a total of 2819 hours to the Ningaloo Turtle Program in 2012-13. Since commencement of the program a total of 48675 volunteer hours have been contributed to the program. These figures demonstrate the effort of the volunteers over the life span of the program.

The 2012-13 season was relatively quiet with 1023 suspected nests and 2439 false crawls recorded in the Ningaloo Region over the entire season. Turtle activity levels were the third lowest recorded throughout the history of the NTP, with the main attributing factor being that green turtle activity was low in comparison to other seasons. 585 nests were recorded as green turtle nests and 1769 green turtle false crawls which equates to a 24.9% rate of nesting success. The loggerhead turtle had the greatest nesting success rate of 39.5% with NTP recording 304 nests and 466 false crawls – this equates to an average level of activity when compared to other seasons. The hawksbill turtle records accounted for 125 nests and 192 false crawls which resulted in a nesting success 39.4%. Hawksbill activity data for the 2012-13 season was quite high in comparison to other seasons. There is a relatively large inter-annual variation in nesting for green turtles, loggerhead turtles and hawksbill turtles; therefore detecting relatively low changes in population size will often take several decades. Although the increase in hawksbill turtle nesting seems encouraging, this may still be artefact of a relatively short monitoring period or an error in track identification

There were no significant trends in track counts (combined false crawls and suspected nest tracks) or nest counts for green or loggerhead turtles between 2004 and 2013, nesting either at the North West Cape or at Cape Range. There was a significant positive trend in hawksbill track

counts at North West Cape and Cape Range and hawksbill turtle nest counts at Cape Range but not North West Cape.

One nest was recorded as damaged by another turtle, one by a fox and one by a dog, which amounted to 0.3% of the total nests recorded for the season. A total of 1.9% of nests was damaged between 2002 and 2013. Predation levels remained below the 5% sustainable threshold. Note, records of fox and dog predation and nest damage may be underestimated since predation and nest damage is only recorded for new nests, after which any subsequent damage and predation on those nests goes unchecked. Hence these records are not viewed as reliable.

During 2012-13 no stranded turtles were observed and therefore no rescues were conducted. The total number of turtles rescued since 2002 is 226 turtles. Thirty eight turtle mortalities were recorded during the 2012-13 season.

Cyclone Narelle affected program operations during 2012-13. This resulted in the cancellation of the last three days of intensive peak monitoring. The cyclone activity produced large storm surge causing sand erosion and the loss of turtle nests.

2.0. BACKGROUND

2.1. Ningaloo Marine Park

Ningaloo Reef is Australia's largest fringing reef, extending 300 km from the North-West Cape to Red Bluff in Western Australia (Department of Conservation and Land Management (CALM) 2005). Over 500 species of finfish, 600 species of mollusc and 90 species of echinoderms inhabit Ningaloo Reef, as well as many species of coral, crustacean and worms (CALM 2005). The area is also an important habitat for marine mega-fauna such as whale sharks, turtles, dugongs, whales, dolphins, sharks and manta rays. The diversity of marine life combined with the near-shore accessibility of the coral reef system promotes Ningaloo Reef as a prime tourism and conservation location.

In recognition of its unique values and cultural importance to West Australians, approximately 90% of Ningaloo reef was gazetted as a Marine Park in 1987 with the remaining area included within the Marine Park in 2004 (CALM 2005). In June 2011, the World Heritage Committee inscribed the Ningaloo Coast on the World Heritage List, acknowledging it as one of the outstanding natural places in the World. The Ningaloo Coast World Heritage area incorporates Ningaloo Marine Park, Cape Range National Park, Learmonth Air Weapons Range, Muiron Islands Marine Management Area, Muiron Islands, and Jurabi and Bundegi Coastal Parks. The area is one of the most important turtle rookeries in the Indian Ocean, which is also a key reason for the World Heritage listing.

2.2. Marine Turtles of Ningaloo

Of the seven species of marine turtles recognised internationally, four of the species have breeding populations in Western Australia - the green turtle (*Chelonia mydas*), loggerhead turtle (*Caretta caretta*), hawksbill turtle (*Eretmochelys imbricata*) and flatback turtle (*Natator depressus*) (CALM 2005). Green, loggerhead and hawksbill turtles primarily nest along the coast of the Ningaloo Marine Park with occasional records of nesting flatback turtles.

Green turtles are the most abundant species within the area while loggerhead and hawksbill turtles are found in much smaller numbers. The Western Australian population of green turtles is thought to be the largest population in the Indian Ocean (Limpus 2007), which highlights the significance of green turtle rookeries found along the Ningaloo Coast.

Currently all species of marine turtles within Australia are protected under the *Commonwealth Environmental Protection and Biodiversity Conservation Act 1999 (EPBC Act)*, the *Endangered Species Protection Act 1992* and the *Wildlife Conservation Act 1950*. The protection of marine turtles is vested with the Department of Environment and Conservation.

2.3. Marine Turtle Threats

Marine turtles face numerous threats around the world including harvesting for food; entanglement in commercial fishing nets; disturbance to nesting and foraging habitats; human disturbance to nesting turtles and emerging hatchlings, egg collection by humans; predation of

eggs and hatchlings by feral predators (Lutcavage et al. 1997). Marine turtles undertake long migrations of up to 2,500 km from their feeding grounds to their breeding and nesting areas, magnifying their vulnerability to human induced threats (Plotkin 2003; Spotilla 2004). For example, tagged green and loggerhead turtles that nest in Western Australia have been resighted in Arnhem Land and as far north as the Java Sea near Indonesia (Baldwin et al. 2003; Limpus 2007).

Increased anthropogenic threats, coupled with the low fecundity of marine turtles, have resulted in many turtle species being threatened with extinction throughout their distribution around the world (Gulko & Eckert 2003). The International Union for Conservation of Nature (IUCN) Red List classifies green and loggerhead turtles as endangered species whereas the hawksbill turtles are listed as critically endangered. The flatback turtle is not classified as there is insufficient data on their population size (IUCN 2007). Historically, turtle populations in Australia are reported to have declined steadily and significantly (Environment Australia 2003).

Marine turtles and their eggs were commercially harvested in the Ningaloo Region from the early 1950's until 1973, with historical reports suggesting that tens of thousands of turtles were harvested (Limpus 2002; Limpus 2007). The size of turtle populations prior to commercial harvesting has not been quantified due to a lack of data (Dean 2003). Furthermore, monitoring entire populations of turtles is complex given their migratory nature (Girondot et al. 2006). Collecting data on nesting abundance helps to predict long term trends, which ensures a better understanding of turtle populations within the Region and the level of conservation management that they require.

Post commercial harvesting, a key threat to turtle population recovery along the Ningaloo Coast has been predation of eggs and hatchlings by introduced species, in particular the European red fox (*Vulpes vulpes*) (Limpus 2002; Dean 2003; McKinna-Jones 2005). Foxes have been reported to have damaged between 40-70 % of nests on certain beaches (Dean 2003). Uncontrolled predation of turtle nests by foxes can further reduce the chance of population recovery within the Region.

Growing ecotourism in the area has increased public interest with regards to turtle interaction Marine turtles are sensitive to disturbance during the nesting period when adults aggregate in shallow waters and come ashore to nest (Collins 2000). The presence of people on nesting beaches at night using artificial light can cause disturbance to nesting females and hatchlings (Waayers 2003; Johnson et al. 1996; Lorne & Salmon 2007). Nesting female turtles are sensitive to disturbance and can subsequently abandon nesting attempts. This unnecessary expenditure of energy can also potentially reduce their nesting success rate. Hatchlings are also disturbed by artificial light, causing disorientation and possibly causing them to become lost on the beach. This can lead to dehydration and increased risk of predation (Luctavage et al. 1997).

Other unnatural threats include four wheel drive vehicles on beaches, which result in sand compaction and the formation of wheel ruts in which hatchlings may become trapped (Limpus 2002).

3.0. INTRODUCTION

3.1. The Ningaloo Turtle Program

The Ningaloo Turtle Program (NTP) was established in 2002, as a collaborative initiative between Department of Environment and Conservation (DEC) - Exmouth District, Cape Conservation Group Inc. (CCG), Murdoch University and the World Wildlife Fund - Australia (WWF). The mission statement of the program is to predict long-term trends in marine turtle populations along the Ningaloo Coast. This is accomplished through the collection of turtle nesting information such as nesting abundance and disturbance data. This data assists DEC in the reduction of disturbance levels to nesting turtles and therefore improves the conservation of the species breeding in the area.

Volunteers are essential to the maintenance of the program. Based in Exmouth, Western Australia the NTP provides an opportunity for local community, interstate and international volunteers to take part in turtle conservation. Participating volunteers gain practical field experience and learn monitoring techniques and skills that are necessary in turtle conservation.

During the 2012-13 season, Woodside Energy Ltd provided a significant contribution to the program towards costs associated with volunteer endorsements, food and accommodation, website maintenance, community activities, equipment and educational materials. BHP Billiton was also a valued sponsor, contributing to the hire of a vehicle for use by the program throughout the peak monitoring period.

3.1.1. NTP Overarching Goals

- Identify key nesting beaches.
- Monitor population fluctuations between regions and assess trends through time.
- Identify the level of threat of feral predators on nests.
- Implement protection of key nesting beaches in cooperation with DEC.
- Generate and maintain community interaction and support for the program.
- Educate visitors and the community about marine turtles.

3.1.2 NTP Primary Objectives

- Determine the abundance and distribution of nests on key sections of beach over specified time intervals for each species.
- Identify the relative significance of specific nesting beaches to each species.
- Establish the level of disturbance on nests; and
- Determine the impact of human interaction on nesting success of each species.

3.1.3 Consolidation of the Ningaloo Turtle Program

Turtle activity has been monitored along this coastline for the past ten nesting seasons. The survey effort has varied from season to season. In 2008 NTP undertook research into

consolidating the program. Trend analysis showed that the trends in marine turtle populations within the study area could be detected, with a reasonable level of error when monitoring/survey effort was substantially reduced. Survey effort would need to include both the pre and post peak and intensive peak period of the monitoring in order to establish these trends (Whiting, 2008). Therefore the program was consolidated, which included reducing monitoring effort both temporally and spatially.

Since 2008 a typical NTP monitoring season now includes a peak intensive monitoring period of four weeks, which was determined by data analysis from previous seasons nesting patterns. Additionally, there is weekend monitoring during the pre and post peak monitoring periods, which captures early and late fluctuations in nesting activity.

3.2. NTP Zoning

Important nesting beaches were identified through past aerial and ground surveys. For the purpose of the program, the Ningaloo Region is divided into four divisions. These are further divided into sections and subsections. Subsections were determined by natural barriers that separate beaches and car parks. Subsection length is an important consideration and restricted to an average length of 2-3kms so that they are practical to survey on foot. A subsection is defined with a GPS location and NTP totem markers are located at the start and finish point of each one.

3.2.1. North West Cape Division

The North West Cape (NW Cape) Division includes Lighthouse Bay, Hunters, Graveyards and Tantabiddi sections, which are further divided into subsections (see Appendix 1 for further division information).

3.2.2. Cape Range Division

The Cape Range Division encompasses one Bungelup Section, which is divided into three subsections (see Appendix 11 for further division information).

3.2.3. Bundera/Ningaloo Division

The Bundera/Ningaloo Division includes six sections. These sections are classified into subsections. This division has not been monitored by NTP since the 2007-08 season. However, DEC staff have conducted opportunistic monitoring within this division during monthly fox baiting operations. Since then this data has been omitted from the results contained within this report.

3.2.4. Coral Bay Division

The Coral Bay Division is divided into two sections: Batemans Bay and The Lagoon. These sections are classified into one or more subsections. This division has not been monitored by NTP since the 2008-09 season. DEC staff have conducted opportunistic monitoring within this division during monthly fox baiting operations, but for the purpose of this report these data have not been included.

4.0. VOLUNTEER COORDINATION 2012-13

4.1. Program Management

In 2012-13, the program was jointly managed between DEC and CCG. The project management was conducted by the DEC, District Nature Conservation team, with the Nature Conservation Ranger coordinating the program. Weekly management support was also provided by other District staff.

4.2. Volunteer Participation & Accommodation

During 2012-13 volunteers contributed a total of 2819 hours to the program, totalling 48,675 hours since monitoring began in 2002. Volunteer contribution has significantly reduced in the past four seasons (Figure 1). This can be attributed to the consolidation of the program and reduction in survey effort both spatially and temporally since 2009-10 along with the discontinuation of the Jurabi Turtle Centre (JTC) program as an element of NTP operations. It should be noted that these figures do not include the Department of Environment and Conservations staff time and costs. The variation in volunteer hours between the last three seasons can be partially attributed to the varying levels of turtle activity on the beaches; i.e. – more activity generally means it takes longer to monitor.

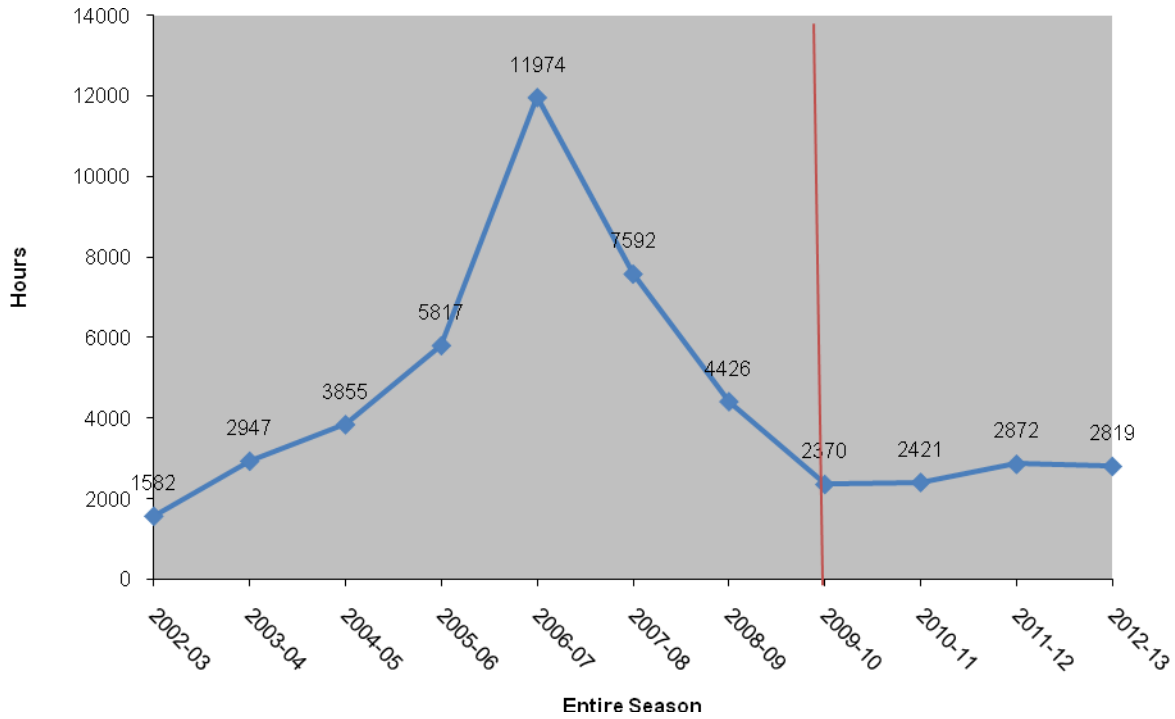


Figure 1: NTP volunteer hours contributed per year 2002-13. The red line shows the year the program was consolidated.

This season a total of 45 local and external volunteers assisted with NTP operations - monitoring, training, data entry and administration (Figure 2).

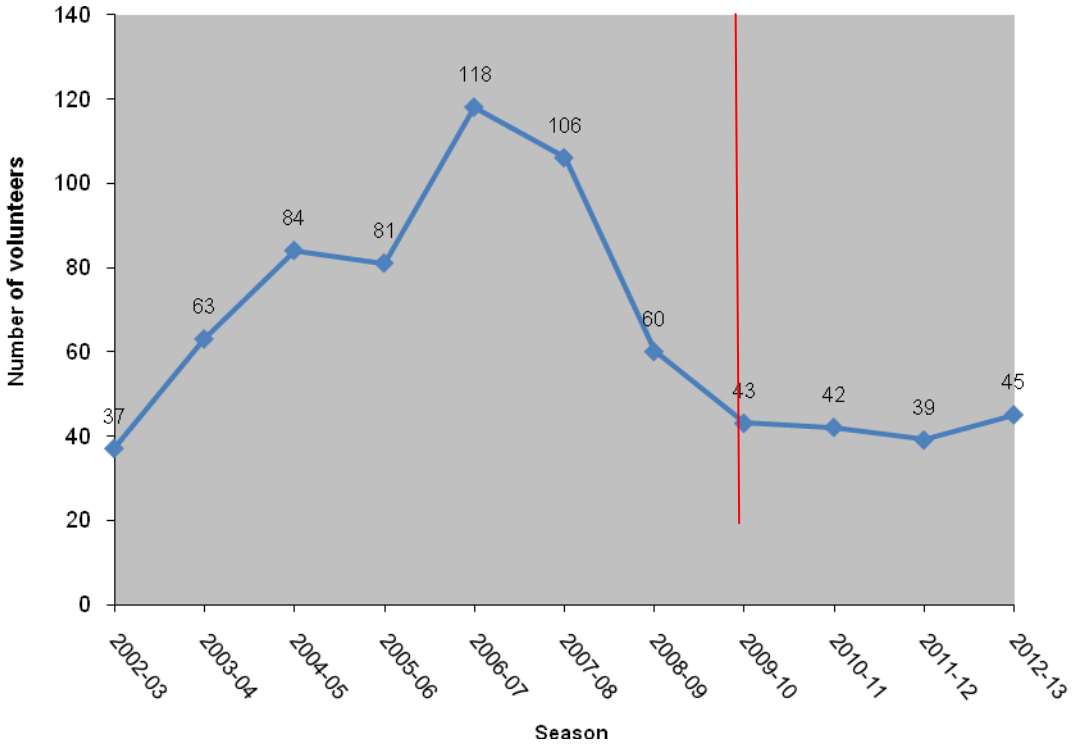


Figure 2: The number of NTP volunteers per year 2002-13. The red line shows the year the program was consolidated.

Of the 41 volunteers that participated in 2012-13, 63% were locals of Exmouth, 14% were external volunteers from other areas in Western Australia, 14% came from interstate and 7% came from overseas. The age of volunteers ranged from 18 to 63.

The local community plays an integral role in the longevity of the current NTP. Twenty six local volunteers participated in the pre and post peak weekend monitoring. Six of these volunteers were also trainers and assisted in training locals and external volunteers.

External volunteers paid a participation fee of $1300, which subsidised their accommodation costs. They were housed at the Exmouth Villas for their eight-week stay, along with the NTP Team Leaders.

All external volunteers participated in remote camping at the Bungelup Camp. Volunteers rotated between camp shifts on a four day, three night roster. Local volunteers were not provided with accommodation.

4.3. Volunteer Training and Assessment

It is a prerequisite that NTP participants have a good understanding and a sound knowledge of monitoring techniques and turtle nesting activity to accurately record findings. Volunteers undertake an induction which includes the following:

- A background briefing on NTP and its operations, Exmouth Township and surrounding area including Ningaloo Marine Park and Cape Range National Park.
- Occupational health and safety policies and procedures.
- NTP monitoring procedures.
- Participation in a Jurabi Turtle Centre (JTC) tour and a briefing on the DEC Code of Conduct for beach-based marine turtle observations.
- A temporary copy of the NTP Turtle Monitoring Field Guide (CCG 2007).
- Practical training by DEC staff in radio and Global Positioning System (GPS) use.

NTP volunteers were trained prior to the four week intensive peak monitoring period. Each participant was required to undertake a minimum of three training sessions followed by a practical competency-based assessment. Once qualified, they were deemed competent as "Turtle Trackers" and were provided with a certificate of competency and a NTP t-shirt. Additional training sessions were available if required, to ensure that volunteers were confident to accurately survey a subsection unaccompanied.

This season training and assessment was facilitated by five DEC staff and four local volunteer trainers. Together they awarded competency to eleven local volunteers and 14 external volunteers (one team leader already had their competency).

5.0. Monitoring Methods and Data Collection

5.1. Identification of Suspected Nests and False Crawls

- To determine turtle nesting activity, volunteers surveyed beaches at sunrise. Turtle tracks and nest markings in the sand from the previous evening were recorded. Track and nest markings allow volunteers to identify the presence of female green, loggerhead, hawksbill or flatback turtles.
- A nest was determined by the presence of a nest mound and additional key nest features such as an escarpment and a shallow secondary body pit (CCG 2007). The term nest is used but the eggs aren't actually witnessed to be laid. Therefore error can be expected as turtles can sometimes create the appearance of nests without depositing any eggs into them (Whiting pers.com. 2012). Due to this the term 'suspected nest' is used interchangeably with 'nest' throughout the report.
- The position of the nest was recorded using a GPS and its location on the beach was noted: (I) intertidal, (H) high tide area, (E) edge of vegetation, or (D) dunes and beyond.
- If a nest was not located with the associated turtle track and the turtle had abandoned any nesting attempt and returned to the water, this activity was recorded as a false crawl.
- Once the turtle activity was identified and recorded as either a nest or a false crawl, volunteers marked off the activity by drawing a line in the sand (across the neck of the nest away from the egg chamber, or through the track in the case of a false crawl) to avoid double counting of turtle activities on subsequent beach surveys.
- All turtle activity was recorded on the NTP monitoring data sheet, which was then entered into the NTP database at a later stage (Appendix 4).
- Other observations and general comments such as: a turtle still nesting on the beach, presences of hatchlings, comments relating to a photograph taken, illegal activities sighted on the beach were also recorded on the data sheet.

5.2. Identification of Predation and Predator Prints

- Evidence of damage to new nests and old nests along with the potential cause of damage were recorded on the NTP monitoring data sheet. This included the presence of fresh eggshells, partially consumed eggs, and significant holes dug within the immediate locality of the egg chamber (CCG 2007). The level of damage recorded is not viewed as an accurate figure because during monitoring new nests were checked for signs of predation but old nests were only recorded on an incidental basis, during the monitoring of the new nests. Therefore there is a high likelihood that some of the disturbance to old nests went undetected, resulting in underestimates of true predation levels.
- Any prints within a 5m radius of the nest, including dog (D), fox (F) or human (H) prints were recorded.
- Fox and/or dog presence in any subsection was also recorded. A single dog or fox can walk along a stretch of beach for many kilometres, subsequently leaving prints on a number of subsections within a single evening. Therefore, the presence or absence of

fox and dog prints was recorded and did not indicate the number of individual animals present on a beach in one evening.

- This season volunteers were required to complete a DEC "Dangerous Fauna Record Sheet" for every dingo sighting. The locality, date, time and observer are recorded, along with the identifying characteristic of the animal and observed behaviour, if relevant.

5.3. Data Entry

- All data recorded on each NTP data sheet was entered into a Microsoft Access database which is managed by DEC - Exmouth District. The database allows for information to be retrieved via queries and the generation of summary reports.
- Data was entered according to the date, division, section and subsection on the data sheet. Along with all turtle activity details including species type, nest location coordinates, details of predation, general comments, the presence of fox and dog tracks and the number of false crawls (Appendix 4).

5.4. Rescues and Mortalities

- Volunteers occasionally encountered stranded turtles, which they assisted back to the ocean. Nesting turtles were likely to become stranded in either the rocky shoreline or behind the sand dunes. Purpose-made turtle stretchers were kept in the two NTP vehicles throughout the season and were used to carry stuck turtles when rescued from these situations. Volunteers were required to complete a DEC "Marine Turtle Stranding or Mortality Datasheet" form for every stranded or deceased turtle that was encountered.
- Volunteers were also required to complete a DEC "Marine Wildlife Stranding and Mortality Datasheet" for all other deceased wildlife – i.e. dolphins, whales, dugongs, sea birds, sharks and sea snakes that they encountered.

5.5. Tagged Turtles

- During the 1986-87 turtle nesting season the Western Australian Marine Turtle Project (WAMTP) was introduced by DEC (formally known as CALM) 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 were checked for tags wherever possible, without disturbing the turtle (preferably when the turtle is returning to the water's edge). Tagged turtles were recorded on the Tagged Turtle Resighting datasheet for DEC's West Australian Turtle Research Program (Appendix 5). The locality, date and observer were recorded, along with the left and right tag numbers, turtle species, time of observation, turtle activity and nest location if relevant.

5.6. Trend Analysis Methodology

Annual nesting abundance was calculated for the 2010-11, 2011-12 and 2012-13 seasons using two methods. Firstly, a generalized additive model was applied to the data to predict nesting abundance throughout the season. Generalized additive models were used to fit a cubic smoothing spline with 4 degrees of freedom to the daily track count data (this is combined track and suspected nest data) using the *mgcv* package in R (Bjorndal et al.1999; Hastie and Tibshirani 1990; Wood 2006). Generalized additive models were fitted to the available data, using start (15 November) and endpoints (15 March) weighted by 1000 with all other data weighted by 1. The fitted function was then used to predict the number of nesting attempts throughout the season, and was summed to give an estimate of the annual number of tracks per year.

Secondly, the annual nesting abundance was calculated using a linear regression model to correlate nesting abundance between the intensive peak period of monitoring and annual nesting (pre and post peak periods). The linear regression models were developed using methods and data described in Whiting (2008), with each equation calculated specifically to the slightly different intensive survey periods during the 2010-11, 2011-12, and 2012-13 seasons.

Confidence limits for annual abundance estimates from linear regression models were predicted using errors from 2003-2007 data (Whiting 2008). Monitoring during the 2008-09 and 2009-10 seasons was not conducted daily throughout the season and therefore not used to estimate error. When the counts from the period 1st December - 28th February are extrapolated to get counts for the full nesting season (15th November - 15th March), the associated level of error is unknown because full season track counts have not been previously conducted. Therefore, the error in abundance projections underestimates the total sampling error.

Although the majority of survey effort focused on the peak of the nesting season in each of the 2010-11, 2011-12 and 2012-13 seasons, monitoring was also conducted sporadically between the beginning of November and the end of March to investigate nesting surrounding the peak monitoring period. When counts were not conducted on consecutive mornings, it is often difficult to distinguish the previous night's nesting from nesting prior to this. In an attempt to identify the nesting count outliers, which were likely to include several nights of nesting, the spread in nightly nesting during the consecutive counts was investigated using the coefficient of variation as a measure of the spread.

The coefficient of variation was calculated as the standard deviation of the two day's counts divided by the mean of the two day's counts. The coefficient of variation was calculated for each two consecutive days during the intensive survey period and the maximum was used as the maximum variation for the season. Any consecutive counts with a coefficient of variation exceeding this value was considered an outlier and excluded from further analyses.

Trends in track counts and nest counts were investigated using linear regression models to show significance or otherwise of trends. Power analyses were conducted using the program TRENDS (Gerrodette 1993a, b), using a two-tailed significance test to detect increases or declines in the annual counts. The program TRENDS requires input of a measure of the inter-annual spread in data, defined as the coefficient of variation. The coefficient of variation was

calculated using data detrended with a linear model so dispersion was not overestimated. The coefficient of variation was calculated as the standard deviation of the residuals divided by the mean of the original data.

6.0. MONITORING RESULTS

6.1. Survey Effort

6.1.1. Survey Effort 2012-13

In 2012-13 monitoring was conducted in the NW Cape Division (26-41 days) and Cape Range Division (22-26 days), depending on the weather conditions and availability of volunteers (Table 1).

Table 1: Number of days monitored for NW Cape and Cape Range Divisions per subsection, 2012-13 for the standardized and entire season.

Division	Section	Subsection	Number of days monitored standardized season	Number of days monitored entire season*
North West Cape	Lighthouse	Mildura Wreck – North West Car park	26	35
		North West Car park - Surf Beach	26	36
		Surf Beach – Hunters	26	35
	Hunters	Hunters – Mauritius	26	37
		Mauritius – Jacobsz South	26	37
		Jacobsz South - Wobiri	26	37
	Graveyards	Five Mile - Five Mile North	26	40
		Five Mile - Trisel	26	41
		Brooke - Graveyards	26	39
		Graveyards - Burrows	26	41
	Tantabiddi	Burrows - Jurabi Point	26	41
Cape Range	Bungelup	Bungelup North - Neils North	25	26
		Bungelup South - Bungelup North	25	26
		Rollys- Bungelup South	25	25
TOTAL			361	497

From the 17th December 2012 – 11th January 2012 intensive peak period monitoring was conducted seven days a week by team leaders and external volunteers, with a DEC staff member assisting every second to third day. Local volunteers were also encouraged to participate in the program during the intensive peak period. Volunteers were rotated between NW Cape and Cape Range Divisions (NW Cape Division map Appendix 8.1 and Cape Range Division map Appendix 8.2).

Intensive peak monitoring was due to continue until the 13th January however was cut short by two days on the NW Cape and three days in the Cape Range Division due to Cyclone Narelle. The system never reached the mainland however large swell and storm surge caused erosion to the nesting beaches.

Outside of the intensive peak period monitoring, pre and post peak weekend monitoring was undertaken on the 10th & 11th and 24th & 25th November 2012, 08th & 9th December 2012. The post monitoring weekends occurred on the 2nd & 3rd and 16th and 17th February and 9th & 10th March 2013. Pre and post peak monitoring was solely undertaken by local volunteers along the NW Cape Division only. DEC staff were rostered to fill gaps where possible to provide added capacity, or the northern most three subsections (between Mildura Wreck and Hunters) were omitted from monitoring, due to the lower turtle nesting density within these subsections.

6.1.1.1. North West Cape Division

- A minimum of 10 volunteers are required to adequately survey each of the 11 subsections within the NW Cape Division.
- A 12-seater minibus was required for the duration of the intensive peak monitoring period to transport external volunteers to and from the NW Cape monitoring sites.
- Several DEC vehicles were required to transport local volunteers to and from monitoring throughout the entire season including pre and post peak weekend monitoring and intensive peak period monitoring.
- On numerous occasions volunteers chose to use their own vehicle without receiving any reimbursement for fuel costs or additional expenses relating to their vehicle.
- Monitoring hours were between 5:30am – 10:30am depending on amount of nesting activity and number of turtle strandings discovered on that day.

6.1.1.2. Cape Range Division

- One team leader accompanied by a maximum of two volunteers was required to monitor each of the 3 Bungelup subsections within the Cape Range Division.
- A DEC vehicle was used at the Bungelup camp throughout the 4 week intensive peak monitoring period.
- Monitoring hours were approximately between 5:30am – 10:30am depending on the amount of nesting activity and number of turtle strandings.

6.1.1.3. Bundera/Ningaloo Division and Coral Bay Division

- During 2012-2013 intensive peak monitoring period monitoring did not occur within the Bundera/Ningaloo and the Coral Bay Division due to continued reductions in survey effort during the 2012-13 season. Please refer to the survey effort section for further details.
- DEC field staff conducted opportunistic turtle monitoring during monthly fox baiting operations in these divisions, but for the purpose of this report this data has been omitted from the results.

6.1.2. Survey Effort 2002-13

Survey effort figures incorporate both the number of days and the number of subsections monitored within that day. Some figures throughout this report are adjusted by survey effort in

order to make fair comparisons between seasons (i.e. because the number of days for which monitoring occurred, and the number of subsections monitored each day may vary between seasons). The survey effort for all dates and subsections during 2002-2013 is 10312 (Figure 3, Table 2). However, since the commencement of the NTP in 2002, there has been a reduction in the program's survey area and effort to maximise on efficiencies. In 2008, research was undertaken to determine the minimum amount of survey effort and area required to adequately predict long term trends in the marine turtle population within the Ningaloo Region. The results indicated that subsections and survey effort could be reduced compared to that of previous seasons (Whiting, 2008).

Therefore the survey period in 2009-10 and successive seasons since then have been reduced to the four week block of intensive peak period monitoring and pre and post peak monitoring weekends. Monitoring was reduced to only high density nesting beaches, which excluded Bundera and Coral Bay Divisions. This can be seen in Figure 3 where the red line shows the year the program was consolidated.

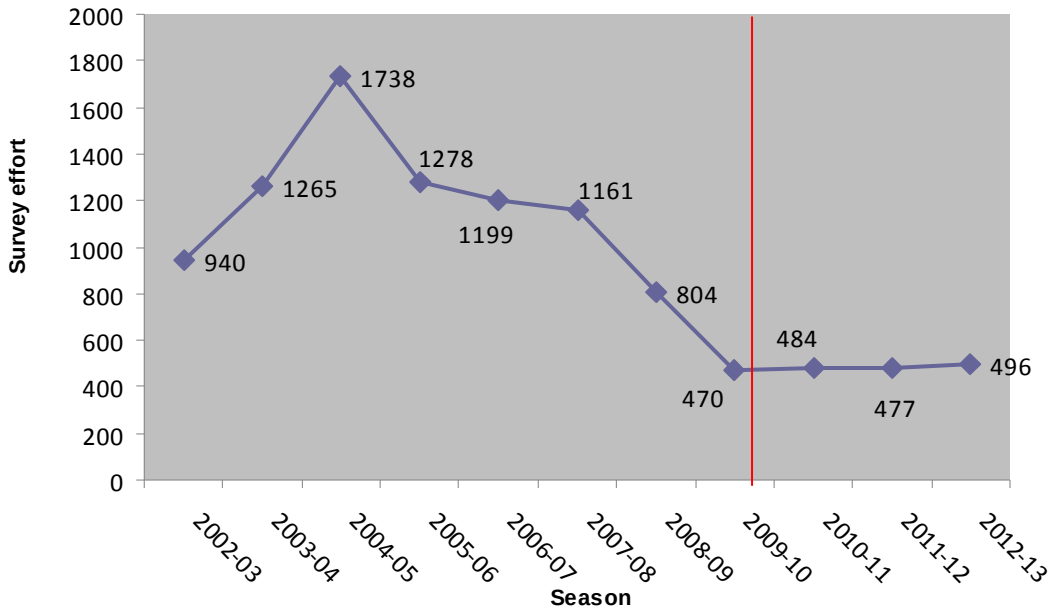


Figure 3: Seasonal survey effort for all dates and subsections 2002-13

Due to the change in effort and to make previous session's data comparable to recent data, survey effort per subsection is the unit of measure. Refer to Table 3 for standardised season dates, survey effort, and subsections monitored.

Table 2: Survey effort and turtle activity 2002-13 entire season (all data and subsections)

Season		2002/03	2003-/04	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13	TOTAL
Survey Dates for entire season		18/11/02-16/04/03	11/11/03-30/03/04	3/11/04-18/03/05	21/11/05-28/02/06	1/12/06-28/02/07	1/12/07-28/02/08	7/12/08-1/03/09	7/11/09 - 27/03/10	6/11/10-27/03/11	12/11/11 11/03/12	10/11/12 - 10/03/13	
Division	**Section**												
North West Cape	Graveyards	165	375	374	368	341	336	234	160	153	144	161	**2811**
	Hunters	248	263	271	271	256	252	173	117	114	109	111	**2185**
	Lighthouse Bay	127	137	215	260	222	251	147	83	93	97	106	**1738**
	Navy Pier	N/A	86	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**86**
	Tantabiddi	115	3	N/A	85	86	84	58	38	37	36	41	**583**
Cape Range	Bloodwood	N/A	4	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**4**
	Bungelup	1	49	152	114	120	140	124	72	87	91	77	**1027**
	Turquoise Bay	N/A	16	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**16**
	Boat Harbour	N/A	N/A	203	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**203**
Bundera/ Ningaloo	Carbaddaman	7	N/A	204	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**211**
	Janes Bay	13	24	12	29	22	4	N/A	N/A	N/A	N/A	N/A	**104**
	Norwegian Bay	2	1	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**3**
	Whaleback Beach	N/A	7	8	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	**15**
Coral Bay	Batemans Bay	103	100	117	51	76	47	34	N/A	N/A	N/A	N/A	**528**
	Lagoon	103	100	116	51	76	47	34	N/A	N/A	N/A	N/A	**527**
	Turtle Beach	56	100	66	49	N/A		N/A	N/A	N/A	N/A	N/A	**271**
Total survey effort		**940**	**1265**	**1738**	**1278**	**1199**	**1161**	**804**	**470**	**484**	**477**	**496**	**10312**
Number subsections monitored		22	29	28	20	19	19	18	14	14	14	14	**211**
Green nests		1539	1552	788	4695	4349	5254	6297	571	2732	6594	585	**34956**
Green false crawls		5404	3086	2533	9948	14395	13156	12608	1451	6507	22865	1769	**93722**
Total Green activity		**6943**	**4638**	**3321**	**14643**	**18744**	**18410**	**18905**	**2022**	**9239**	**29459**	**2354**	**128678**
Green nesting success %		22.2%	33.5%	23.7%	32.1%	23.2%	28.5%	33.3%	28.2%	29.6%	22.4%	24.9%	**27.2%**
Hawksbill nests		48	81	100	108	157	156	336	202	189	65	125	**1567**
Hawksbill false crawls		49	60	139	71	153	145	207	202	132	84	192	**1434**

Total Hawksbill activity	**97**	**141**	**239**	**179**	**310**	**301**	**543**	**404**	**321**	**149**	**317**	**3001**
Hawksbill nest success %	49.5%	57.4%	41.8%	60.3%	50.6%	51.8%	61.9%	50.0%	58.9%	43.6%	39.4%	**52.2%**
Loggerhead nests	288	387	777	1068	540	795	580	288	405	382	304	**5814**
Loggerhead false crawls	429	359	1040	925	477	954	486	471	388	715	466	**6710**
Total Loggerhead activity	**717**	**746**	**1817**	**1993**	**1017**	**1749**	**1066**	**759**	**793**	**1097**	**770**	**12524**
Loggerhead nesting success	40.2%	51.9%	42.8%	53.6%	53.1%	45.5%	54.4%	37.9%	51.1%	34.8%	39.5%	**46.4%**
Unidentified nests	29	123	59	42	33	61	38	8	18	7	7	**425**
Unidentified false crawls	44	20	82	45	19	29	12	8	9	4	12	**284**
Total Unidentified activity	**73**	**143**	**141**	**87**	**52**	**90**	**50**	**16**	**27**	**11**	**19**	**709**
Unidentified nesting success	39.7%	86.0%	41.8%	48.3%	63.5%	67.8%	76.0%	50.0%	66.7%	63.6%	36.8%	**59.9%**
Total all species nests	**1904**	**2180**	**1724**	**5913**	**5279**	**6266**	**7252**	**1069**	**3343**	**7049**	**1023**	**43002**
Total all species false crawls	**5925**	**3536**	**3794**	**10989**	**15044**	**14284**	**13314**	**1451**	**7038**	**23668**	**2439**	**101482**
Total all species activity	**7829**	**5716**	**5518**	**16902**	**20323**	**20550**	**20566**	**2520**	**10381**	**30717**	**3462**	**144484**

Table 3: Survey effort and turtle activity 2002-13 standardised season (only includes the intensive peak period monitoring data and specific subsections)

NTP Season		2002/03	2003/04	2004/05	2005/06	2006/07	2007/08	2008/09	2010/11	2010/11	2011/12	2012/13	TOTAL
Survey Dates intensive peak period monitoring dates		16/12/02-12/01/03	15/12/03-11/01/04	20/12/04 - 16/01/05	19/12/05 - 15/01/06	18/12/06 14/01/07	17/12/0-13/01/08	15/12/08 11/01/09	14/12/09 - 10/01/10	20/12/10 16/01/11	19/12/11 15/01/12	17/12/12 11/01/13	
Division	**Section**												
North West Cape	Graveyards	57	100	112	107	100	100	96	70	108	112	104	1066
	Hunters	72	78	84	81	75	75	72	50	81	84	78	830
	Lighthouse Bay	53	34	56	77	75	75	72	39	77	84	78	720
	Tantabiddi	9	N/A	N/A	27	25	25	24	17	27	28	26	208
Cape Range	Bungelup	0	11	71	66	69	60	60	30	79	84	75	605
Total survey effort		**191**	**223**	**323**	**358**	**344**	**335**	**324**	**206**	**372**	**392**	**361**	**3068**
Number subsections monitored		11	12	12	14	14	14	14	14	14	14	14	147
Flatback nest		0	0	0	0	0	0	0	0	0	0	2	2
Flatback false crawl		0	0	0	0	0	0	1	0	0	0	0	1
Total Flatback activity		0	0	0	0	0	0	1	0	0	0	2	3
Flatback activity adjusted by survey effort		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00
Flatback nesting success		0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Green new nests		587	475	266	1548	1650	1721	3103	239	2270	5683	422	17964
Green new nests adjusted by survey effort per day		3.1	2.1	0.8	4.3	4.8	5.1	9.6	1.2	6.1	14.5	1.2	5.9
Green false crawls		1821	1328	785	4217	5138	4959	5226	634	5322	20501	1314	51245
Total Green activity		2408	1803	1051	5765	6788	6680	8329	873	7592	26184	1736	69209
Green activity adjusted by survey effort per day		12.6	8.1	3.3	16.1	19.7	19.9	25.7	4.2	20.4	66.8	4.8	22.6
Green nesting success %		24.4%	26.3%	25.3%	26.9%	24.3%	25.8%	37.3%	27.4%	29.9%	21.7%	24.3%	26.0%
Hawksbill new nests		17	14	31	45	67	48	193	98	155	60	114	842

Hawksbill new nests adjusted by survey effort	0.1	0.1	0.1	0.1	0.2	0.1	0.6	0.5	0.4	0.2	0.3	0.3
Hawksbill false crawls	20	14	49	33	80	38	119	106	109	79	183	830
Total Hawksbill activity	37	28	80	78	147	86	312	204	264	139	297	1672
Hawksbill activity adjusted by survey effort per day	0.2	0.1	0.2	0.2	0.4	0.3	1.0	1.0	0.7	0.4	0.8	0.5
Hawksbill nesting success	45.9%	50.0%	38.8%	57.7%	45.6%	55.8%	61.9%	48.0%	58.7%	43.2%	38.4%	50.4%
Loggerhead new nests	52	78	324	544	306	380	320	136	383	368	282	3173
Loggerhead new nests adjusted by survey effort	0.3	0.3	1.0	1.5	0.9	1.1	1.0	0.7	1.0	0.9	0.8	1.0
Loggerhead false crawls	141	128	449	484	244	557	218	214	349	681	432	3897
Total Loggerhead activity	193	206	773	1028	550	937	538	350	732	1049	714	7070
Loggerhead activity adjusted by survey effort per day	1.01	0.92	2.39	2.87	1.60	2.80	1.66	1.70	1.97	2.68	1.98	2.30
Loggerhead nesting success	26.9%	37.9%	41.9%	52.9%	55.6%	40.6%	59.5%	38.9%	52.3%	35.1%	39.5%	44.9%
Unidentified new nests	1	10	14	21	13	17	21	3	15	3	6	124
Unidentified new nests by survey effort per day	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.0
Unidentified false crawls	2	7	36	18	9	12	7	3	9	4	9	116
Total Unidentified activity	3	17	50	39	22	29	28	6	24	7	15	240
Unidentified activity adjusted by survey effort per day	0.0	0.1	0.2	0.1	0.1	0.1	0.1	0.0	0.1	0.0	0.0	0.1
Unidentified nesting success	33.3%	58.8%	28.0%	53.8%	59.1%	58.6%	75.0%	50.0%	62.5%	42.9%	40.0%	51.7%
Total new nests (all species)	**657**	**577**	**635**	**2158**	**2036**	**2166**	**3637**	**476**	**2823**	**6114**	**826**	**22105**
Total new nests (all species) adjusted by survey effort per day	**3.4**	**2.6**	**2.0**	**6.0**	**5.9**	**6.5**	**11.2**	**2.3**	**7.6**	**15.6**	**2.3**	**7.2**

Total false crawls (all species)	**1984**	**1477**	**1319**	**4752**	**5471**	**5566**	**5571**	**957**	**5789**	**21265**	**1938**	**56089**
Total activity (all species)	**2641**	**2054**	**1954**	**6910**	**7507**	**7732**	**9208**	**1433**	**8612**	**27379**	**2764**	**78194**
Total turtle activity adjusted by survey effort per day	**13.83**	**9.21**	**6.05**	**19.30**	**21.82**	**23.08**	**28.42**	**6.96**	**23.15**	**69.84**	**7.66**	**25.49**

6.2. Turtle Activity

6.2.1. Turtle activity 2012-13

6.2.1.1. North West Cape Division

A total of 752 suspected nests and 2021 false crawls were recorded within the NW Cape Division during 2012-13 (Table 4). Green turtles showed by far the greatest nesting activity in the NW Cape Division (both nests and false crawls) being responsible for 83.8 % of total nests laid, followed by loggerhead turtles (8.9%), then hawksbills (6.5%), flatbacks (0.07%) and 0.6 % of nests were unidentified.

Table 4: The total number of activities (suspected nests and false crawls) recorded for each species within the North West Division, NTP 2012-13 entire season.

North West Cape Division	Turtle Species					
	Green	Hawksbill	Loggerhead	Flatback	Unidentified	Total
New nests	580	69	94	2	7	752
False crawls	1745	112	153	0	11	2021
Total activity	**2325**	**181**	**247**	**2**	**18**	**2773**

The greatest number of nests was within the Graveyards Section (291), followed by Hunters Section (262), Tantabiddi Section (102) and Lighthouse Bay Section (97). The greatest number of false crawls was within the Graveyards Section (960) followed by Hunters Section (560), Lighthouse Bay Section (309) and Tantabiddi Section (190) (Figure 4). For individual nest locations see maps in Appendix 7, 8, 9 and 10.

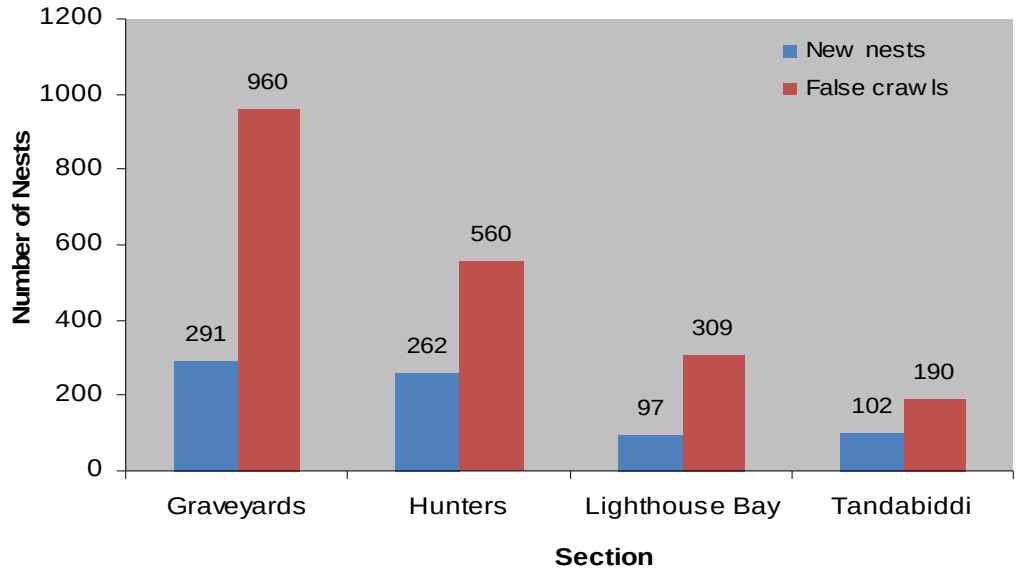


Figure 4: Comparison of nesting activity (suspected nests and false crawls) recorded in each NW Cape Section, NTP 2012-13 for entire season.

Green turtles accounted for 77.13 % of recorded nests along the North West Cape Division, followed by loggerhead (12.50%), then hawksbill turtles (9.17 %) and unidentified species (0.93%). A small percentage of nesting activity was recorded from flatback turtles (0.27%) (Figure 5).

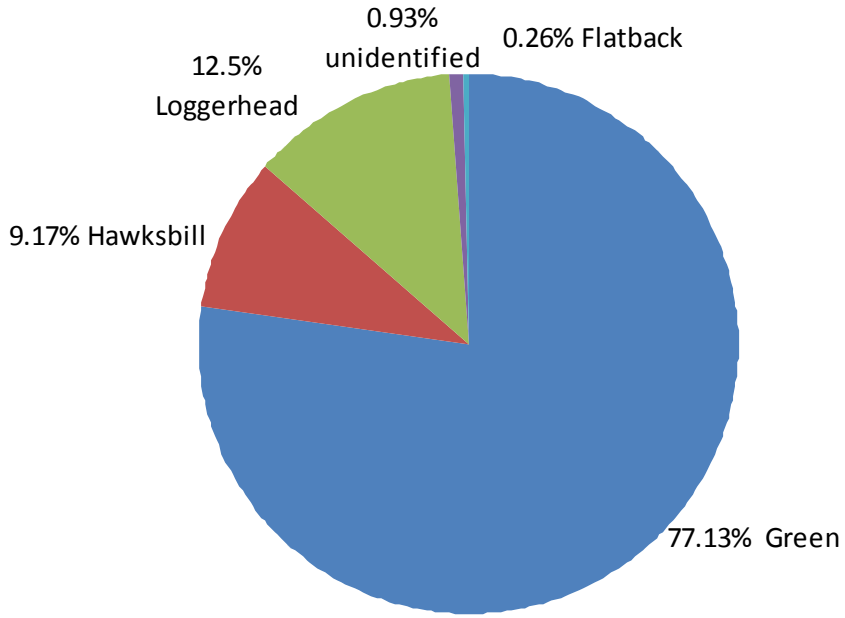


Figure 5: Percent comparison of species nests for North West Cape Division, 2012-13 entire season

6.2.1.2. Cape Range Division

A total of 271 suspected nests and 409 false crawls were recorded in the Bungelup Section (Cape Range Division) during the 2012-13 NTP (Table 6). Loggerhead turtles showed the greatest nesting activity in the Bungelup Section (both suspected nests and false crawls) with (76%), followed by hawksbill (19.7%) and green (4.3%) turtles.

Table 5: The total number of activities (suspected nests and false crawls) recorded for each species within the Cape Range Division, NTP 2012-13 entire season.

Cape Range Division	Turtle Species				
	Green	Hawksbill	Loggerhead	Unidentified	Total
New nests	5	56	210	0	271
False crawls	24	78	307	0	409
Total activity	**29**	**134**	**517**	**0**	**680**

The highest number of nests and false crawls were recorded in the Rollys Beach subsection (102 nests and 148 false crawls) followed by Neils Beach subsection (96 nests and 141 false crawls) and Bungelup Beach subsection (73 nests and 120 false crawls) (Figure 6). For individual nest locations see Appendix 11.

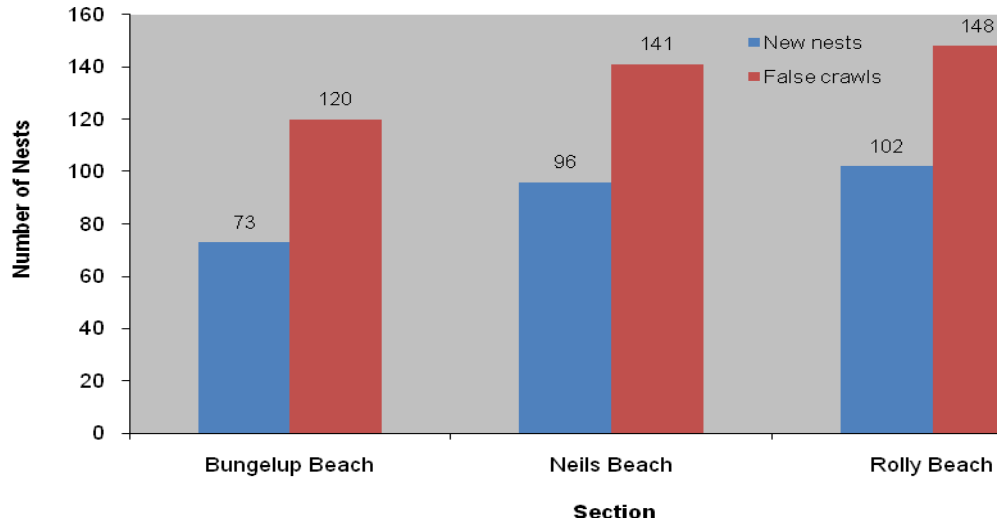


Figure 6: Comparison of nesting activity (suspected nests and false crawls) recorded within each Cape Range Division (Bungelup Section), NTP 2012-13.

Loggerhead turtles accounted for 77.49% of recorded nests along the Cape Range Divisions, followed by hawksbill (20.66) and green turtles (1.85%) (Figure 7).

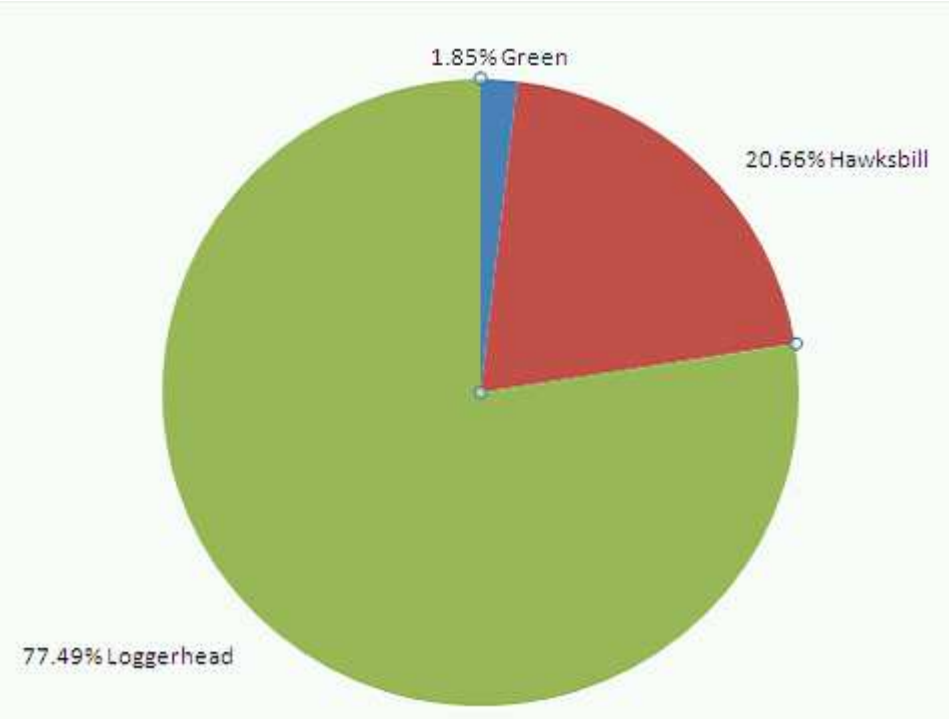


Figure 7: Percent comparison of species for Cape Range Division, 2012-13.

6.2.1.3. Ningaloo Region (North West Cape and Cape Range Division)

Green turtles accounted for 57.2% of recorded nests in the Ningaloo Region, followed by loggerhead turtles (29.7%) then hawksbill turtles (12.2%) and flatback turtles (0.2%). A small percentage of nesting activity was recorded as unknown (0.7%) (Table 6 and Figure 8).

Table 6: The total number of nests recorded for each species within the Ningaloo Region (NW Cape and Cape Range Divisions), NTP 2012-13.

	Turtle Species					
Division	**Green**	**Hawksbill**	**Loggerhead**	**Unidentified**	**Flatback**	**Grand Total**
Cape Range	5	56	210	0	0	271
North West Cape	580	69	94	7	2	752
Grand Total	**585**	**125**	**304**	**7**	**2**	**1023**

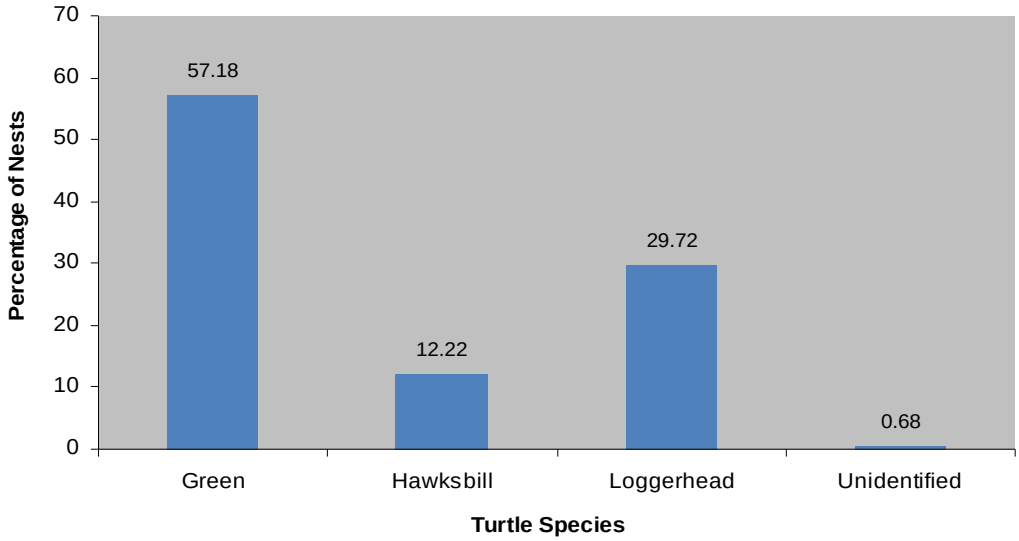


Figure 8: Percentage comparison of nests recorded for each species within the Ningaloo Region (NW Cape and Cape Range Divisions), NTP 2012-13.

Similarly green turtles had the highest records of false crawls (1769) followed by loggerhead turtles (460), hawksbill turtles (190) and unidentified species (11) (Table 7 and Figure 9).

Table 7: The total number of false crawls recorded for each species within the Ningaloo Region (NW Cape and Cape Range Divisions), NTP 2012-13

	Turtle Species					
Division	**Green**	**Hawksbill**	**Loggerhead**	**Unidentified**	**Flatback**	**Total**
Cape Range	24	78	307	0	0	409
North West Cape	1745	112	153	11	0	2021
Total	**1769**	**190**	**460**	**11**	**0**	**2430**

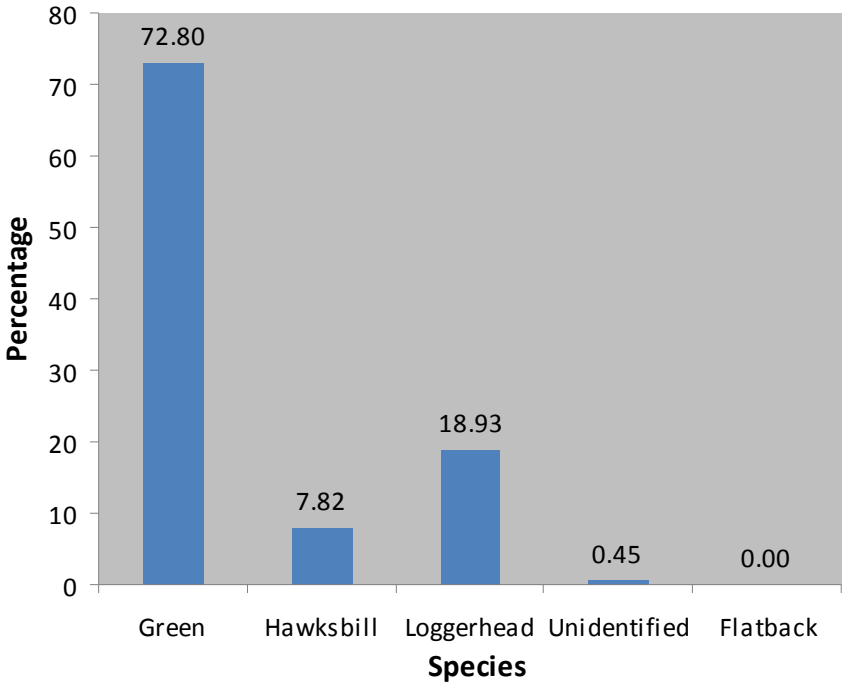


Figure 9: Percentage comparison of false crawls recorded for each species within the Ningaloo Region (NW Cape and Cape Range Divisions), NTP 2012-13.

6.2.2. Turtle Activity 2002-13

The NTP has recorded 43 002 suspected nests and 101 482 false crawls (total activity: 144 484) over all season dates and subsections since commencement of the program in 2002 (Table 3). Green turtles are by far the most abundant species with a total of 128 678 nests and false crawls recorded, followed by loggerhead activities 12 524 and hawksbill activities 3 001. A total of 709 activities have been recorded as unidentified species (Table 3).

When comparing data standardised by subsection and survey effort occurring over the intensive peak monitoring period 2002-13, NTP has recorded a total of 22,105 nests and 56,089 false crawls (activity 78,194) since commencement of the program in 2002 (Table 3 and Figure 8). When comparing the activity over the past eleven years the 2012-13 season was the third lowest season since 2002 Figure 10), the second lowest for false crawls and forth lowest for nests (Figure 11). Green turtles are by far the most abundant species with a total of 51, 245 activities (nests and false crawls), followed by loggerhead activities 7,070 activities and hawksbill activities 1,672. A total of 240 activities have been unidentified (Table 3).

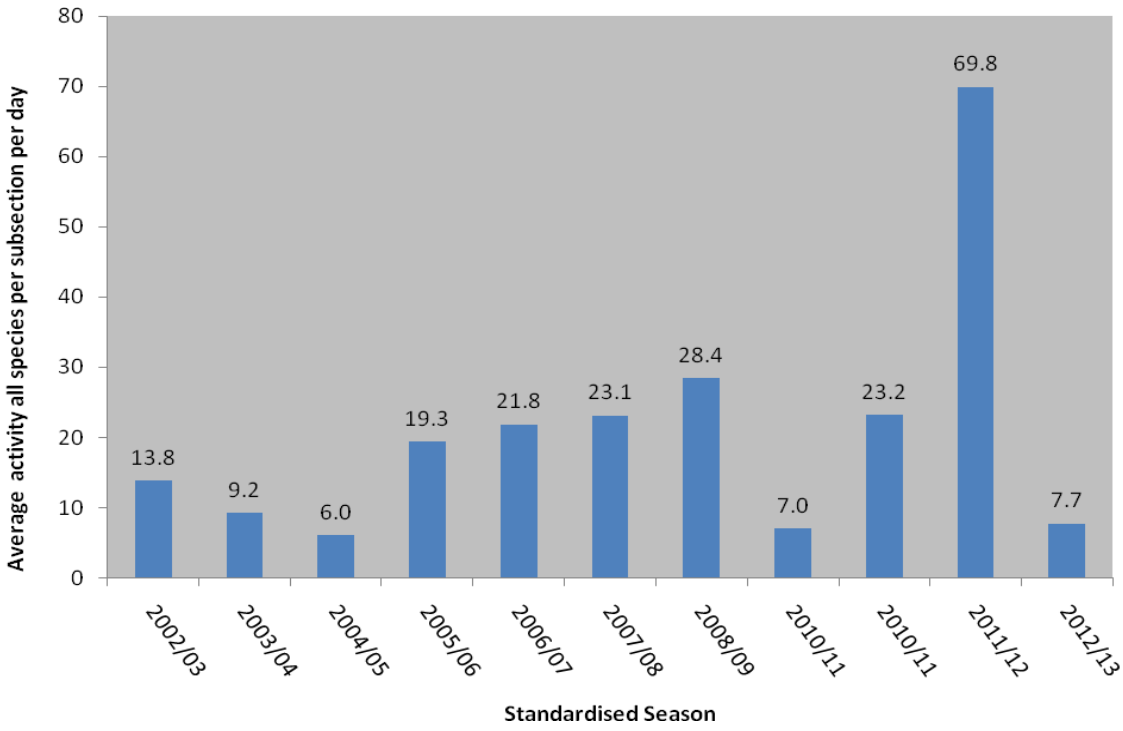


Figure 10: Seasonal green, loggerhead and hawksbill turtle activity (nests and false crawls) standardised by survey effort during the intensive peak monitoring period.

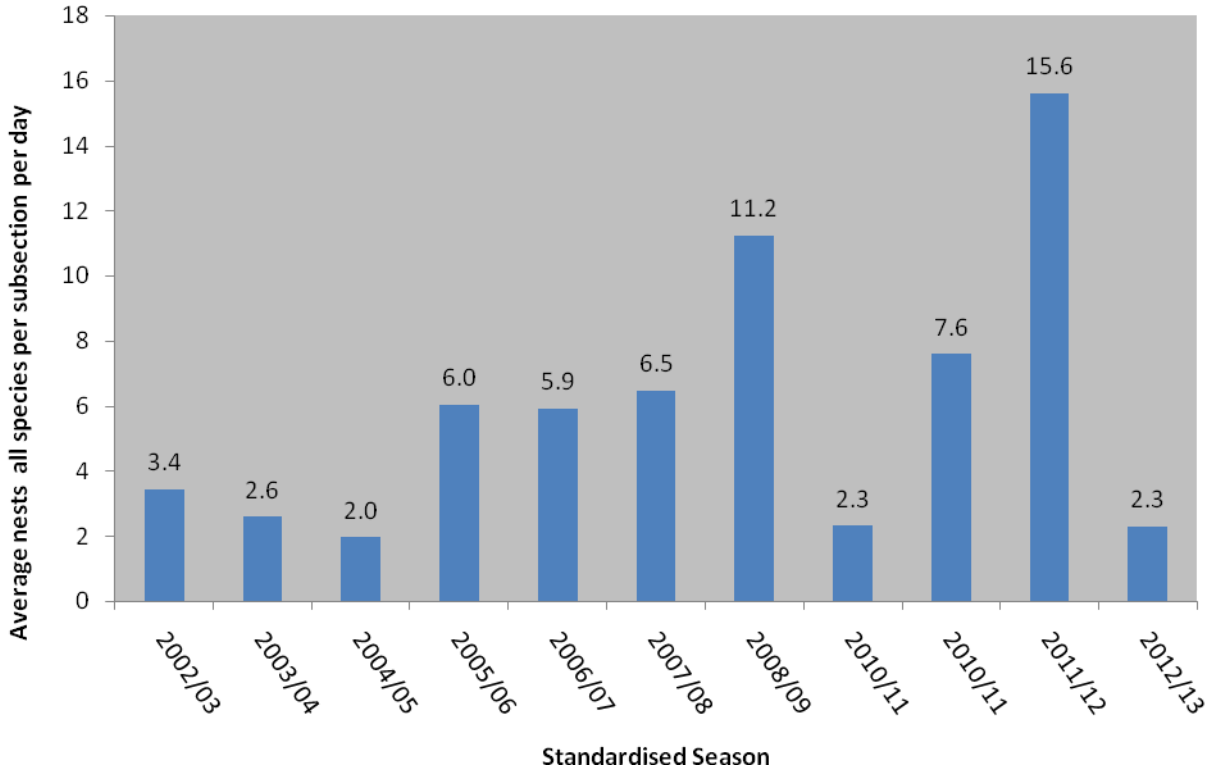


Figure 11: Seasonal green, loggerhead and hawksbill nests standardised by survey effort during the intensive peak monitoring period

6.2.2.1. Green Turtles

When comparing standardised seasons, the green turtle had the third lowest level of activity recorded during 2012-13 (Figure 12).

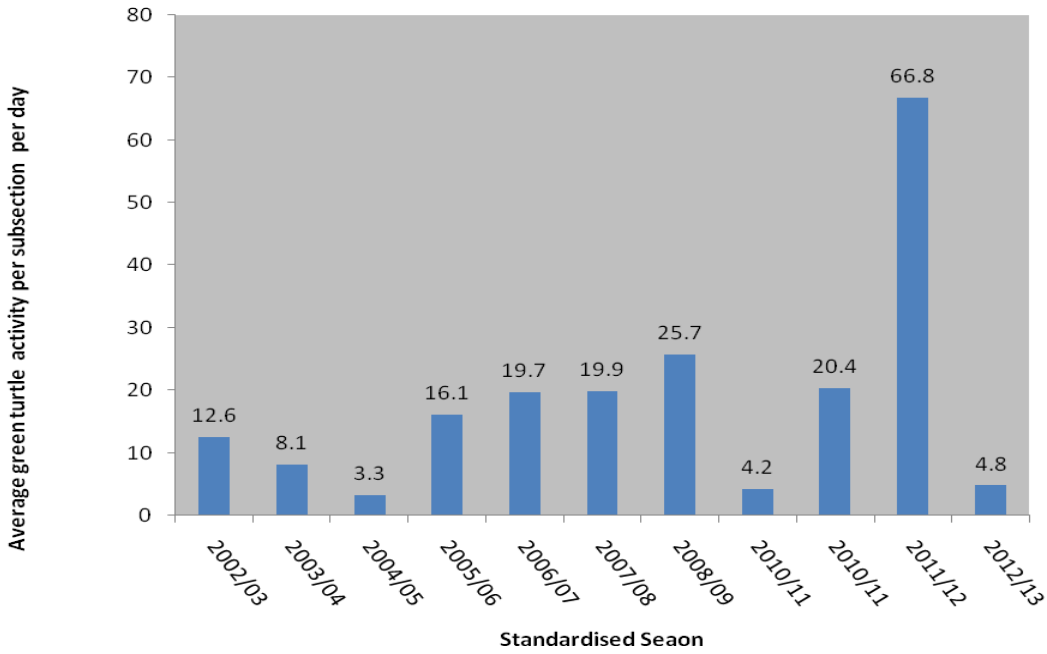


Figure 12: Seasonal green turtle activity (nests and false crawls) standardised by survey effort during the intensive peak monitoring period.

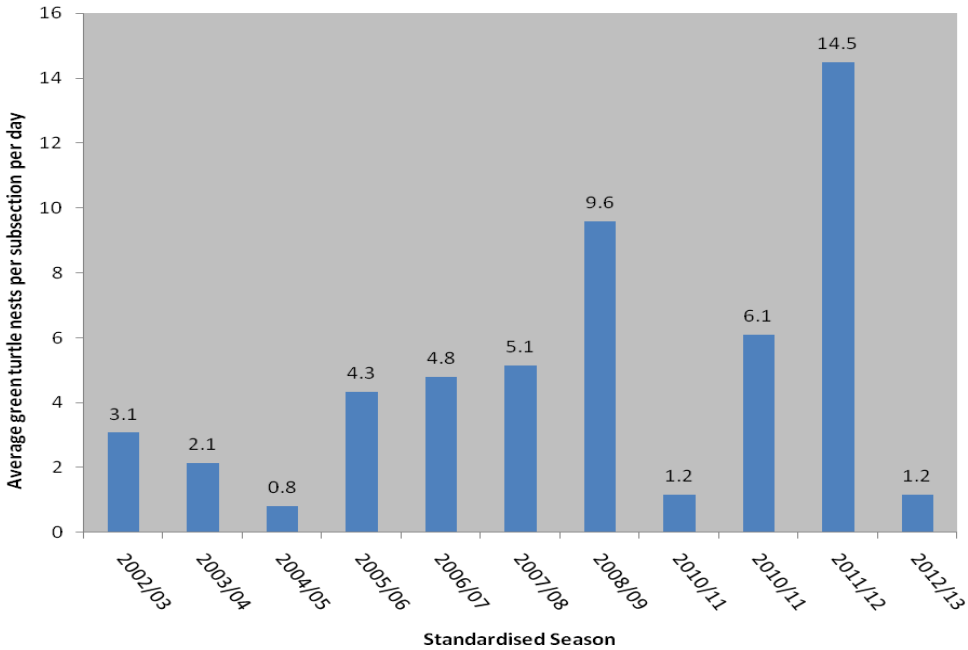


Figure 13: Seasonal green turtle nests standardised by survey effort during the intensive peak monitoring period.

6.2.2.2. Hawksbill Turtles

Since the commencement of NTP, the level of hawksbill turtle total activity and nesting has varied between seasons (Figure 14 and Figure 15).

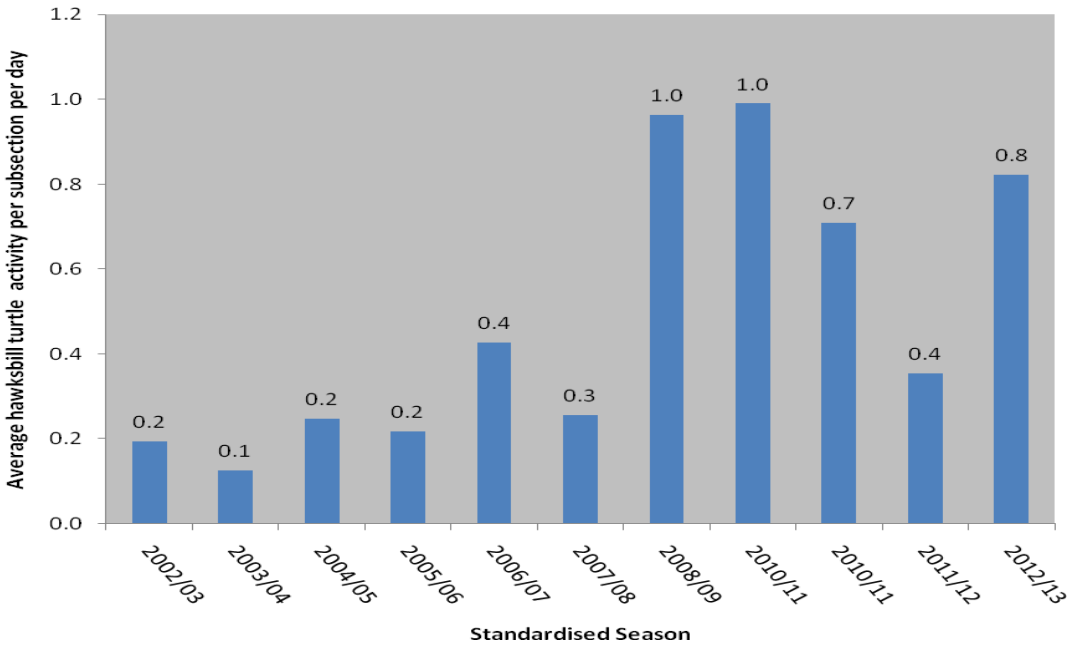


Figure 14: Seasonal hawksbill activity (false crawls and nests) standardised by survey effort during the intensive peak monitoring period.

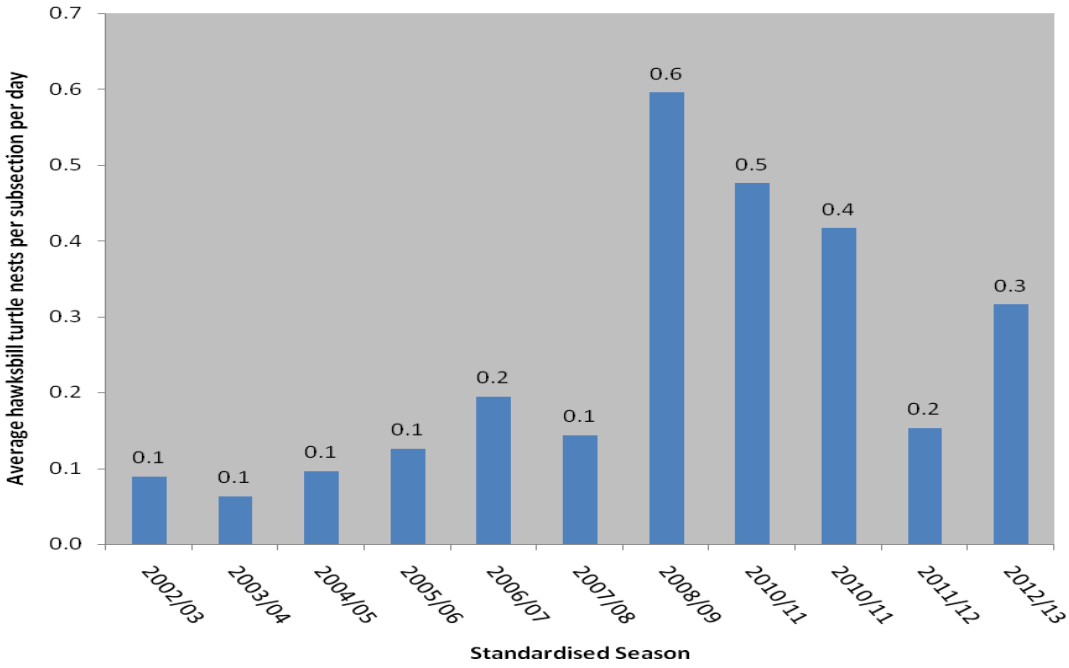


Figure 15: Seasonal hawksbill nests standardised by survey effort during the intensive peak monitoring period.

6.2.2.3. Loggerhead Turtles

Since the commencement of NTP, the level of activity and nesting recorded for loggerhead turtles has varied. Activity has decreased since last year (Figure 16 and Figure 17).

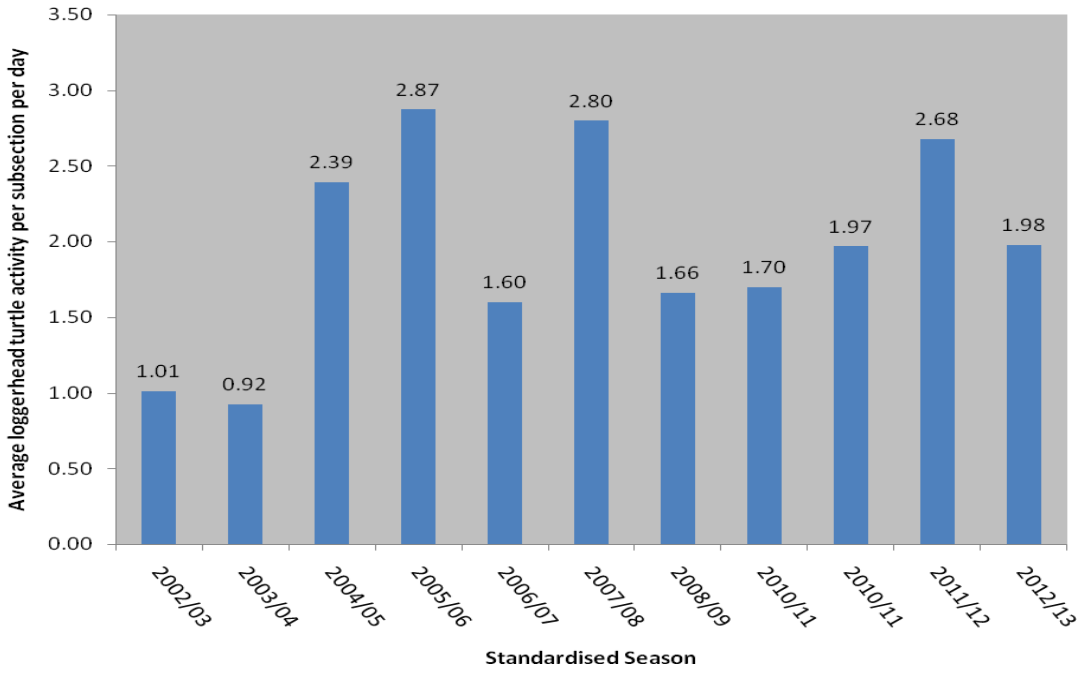


Figure 16: Seasonal loggerhead activity (false crawls and nests) standardised by survey effort during the intensive peak monitoring period.

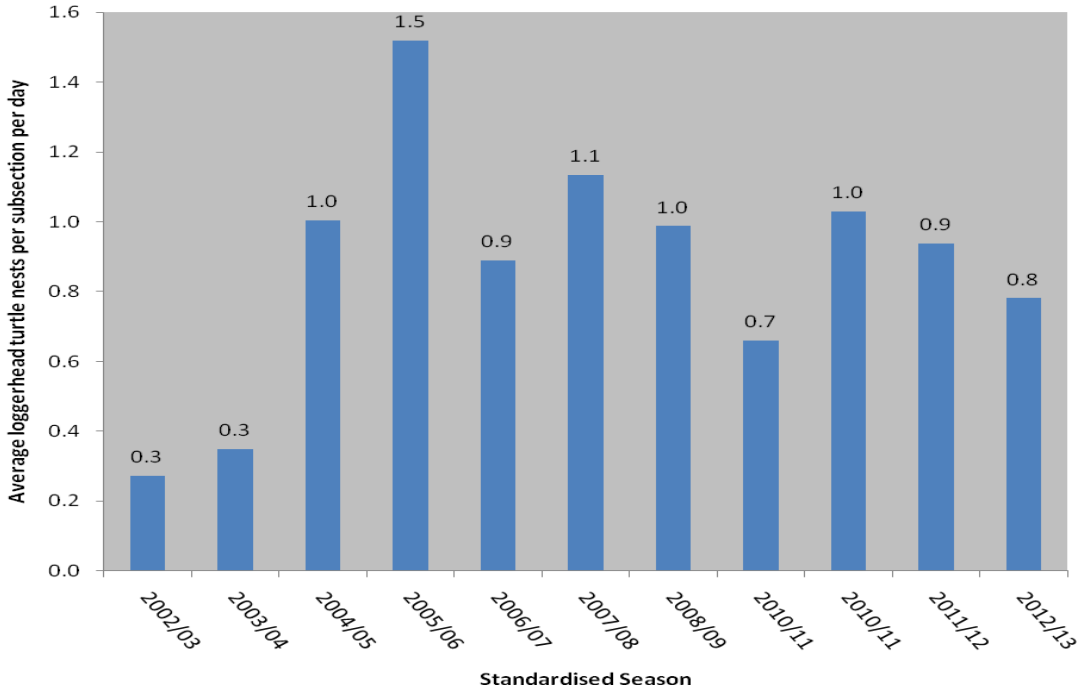


Figure: 17: Seasonal loggerhead nests standardised by survey effort during the intensive peak monitoring period.

6.3. Annual Turtle Activity Analyses

6.3.1. Nightly turtle track abundance

Nightly turtle track abundance for the 2010-11, 2011-12 and 2012-13 seasons are shown in Figure 18 - Figure 20, with the red lines showing the daily turtle track abundance predicted using a generalized additive model. Each figure depicts one series of graphs for the North West Cape Division and the Cape Range Division. These graphs show combined false crawls and suspected nest tracks.

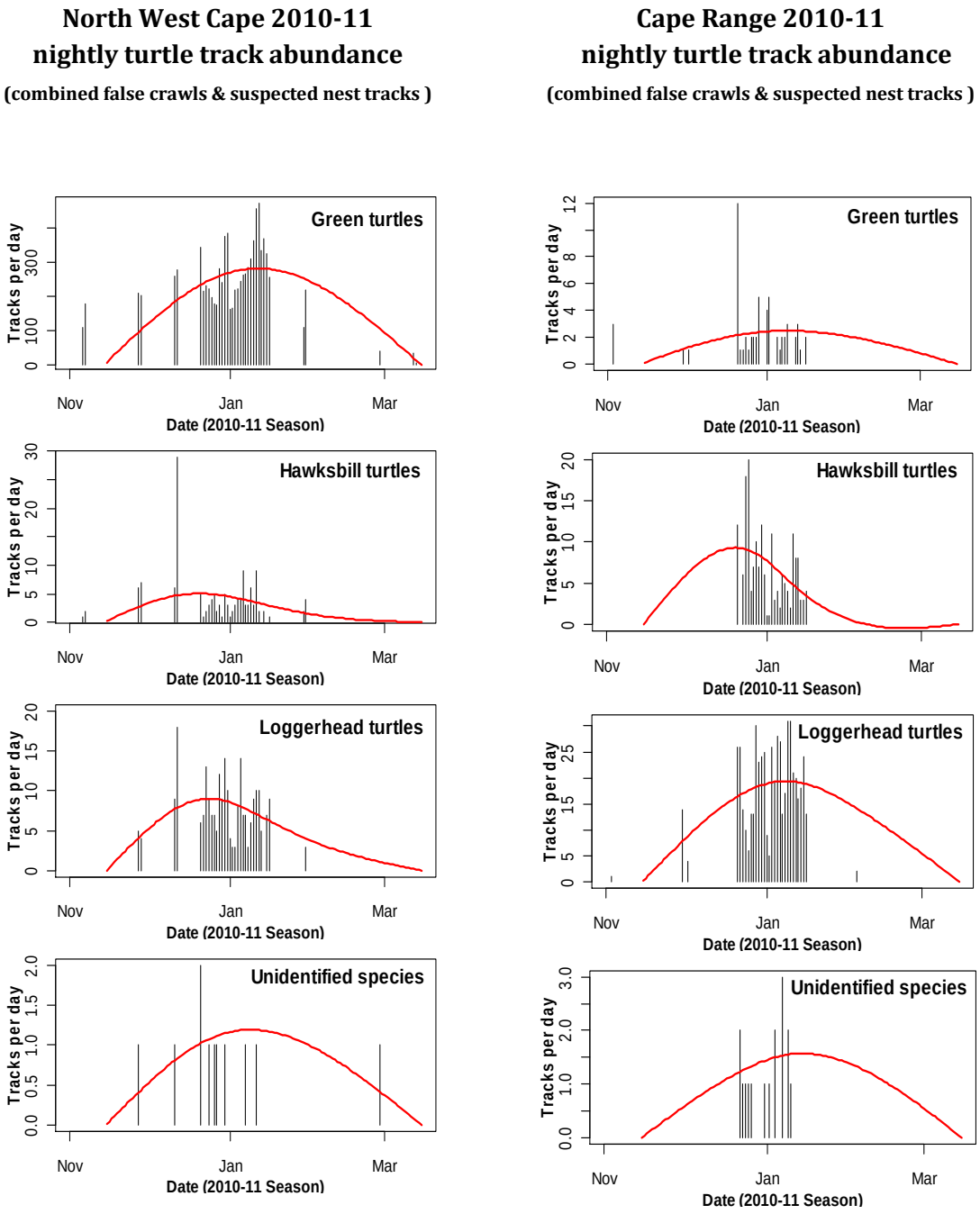


Figure 18: Turtle track abundance and seasonal distribution fit for green, hawksbill, loggerhead and unidentified turtle species during 2010-11. Red line refers to generalized additive model fit with 4 degrees of freedom and null endpoints of 15-November and 15-March weighted at 1000 and all other data weighted at 1.

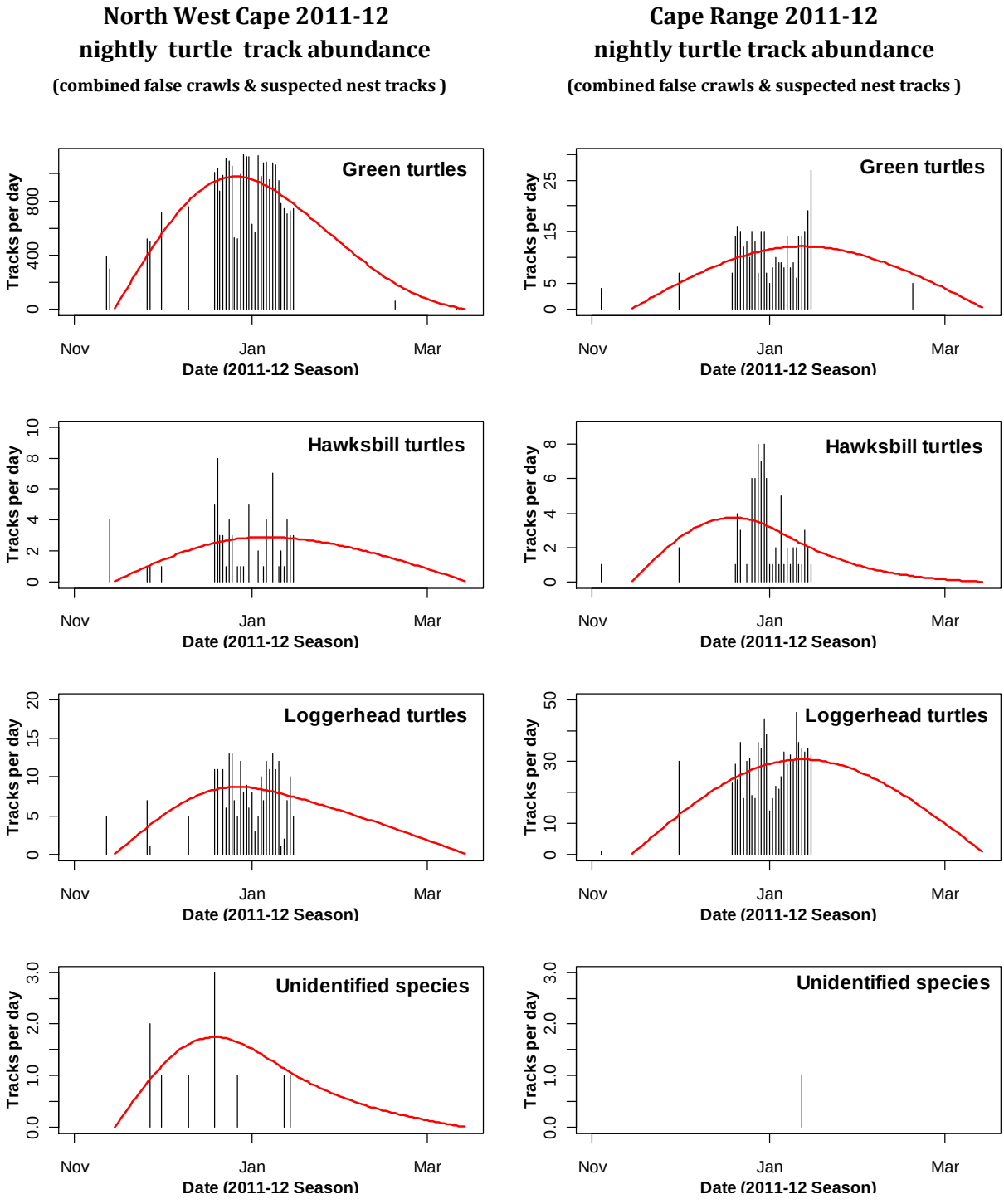


Figure 19: Turtle track abundance and seasonal distribution fit for green, hawksbill, loggerhead and unidentified turtle species during 2011-12. Red line refers to generalized additive model fit with 4 degrees of freedom and null endpoints of 15-November and 15-March weighted at 1000 and all other data weighted at 1.

During the 2012-13 season, consecutive track counts outside the peak period were often higher on the first day of monitoring than the subsequent day (Figure 20). Any counts considered to be outliers were excluded from analyses with the generalized additive model and these values were presented in green.

When monitoring does not occur on consecutive days it is often difficult to ascertain which tracks were left from the previous night and which were older. Therefore track counts outside the peak monitoring period should ideally by done the day after all tracks have been crossed within the survey area (Figure 20).

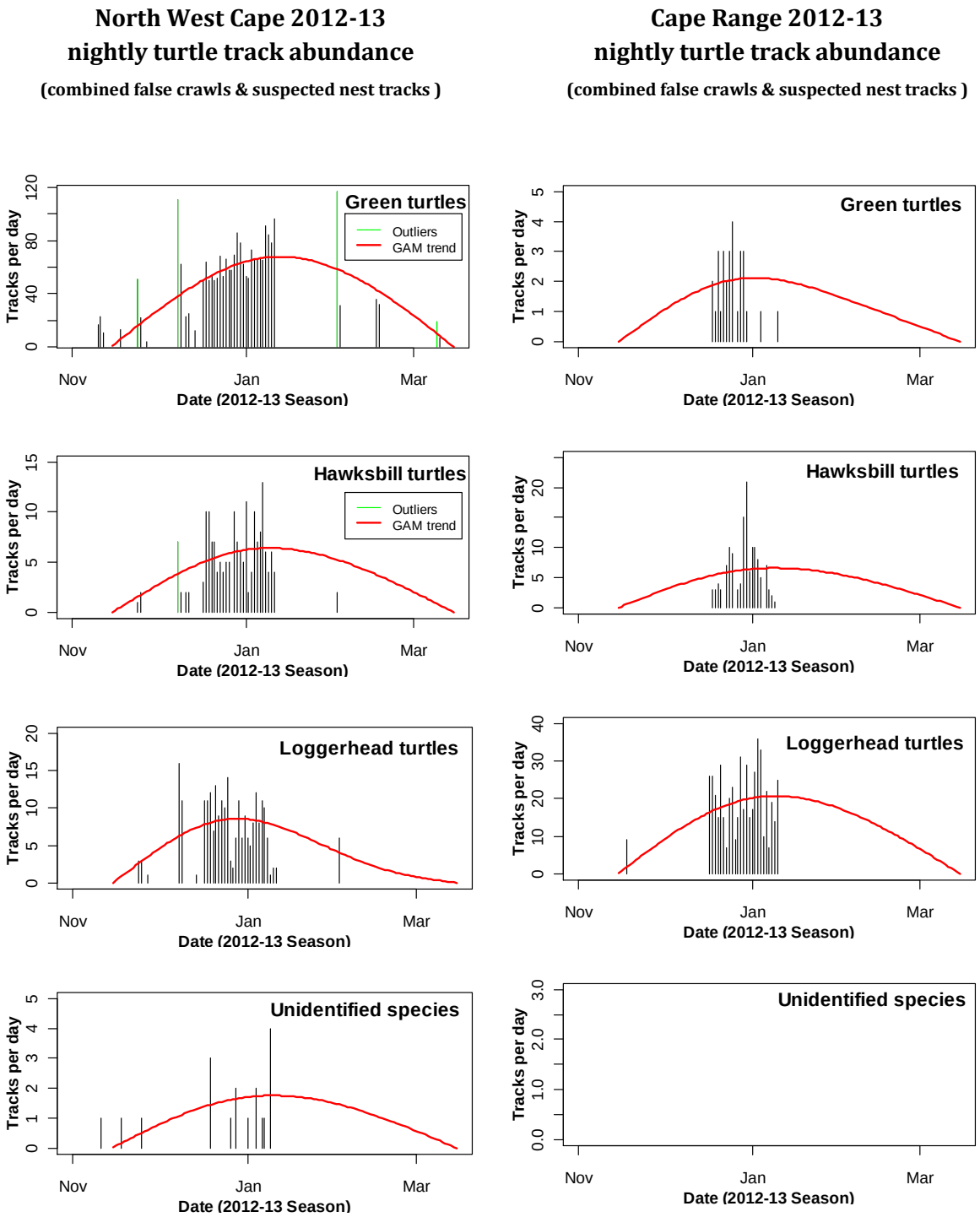
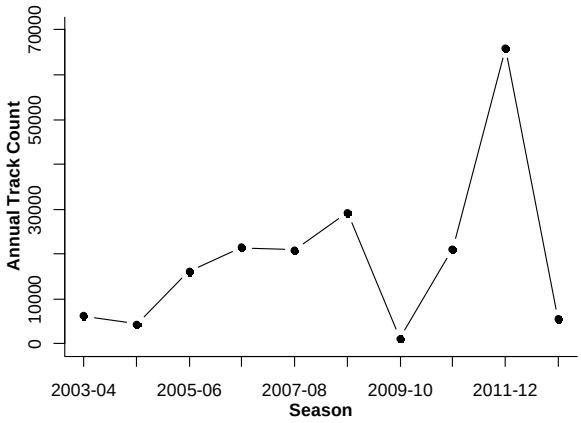


Figure 20: Track abundance and seasonal distribution fit for green, hawksbill, loggerhead and unidentified turtle species during 2012-13. Red line refers to generalized additive model fit with 4 degrees of freedom and null endpoints of 15-November and 15-March weighted at 1000 and all other data weighted at 1.

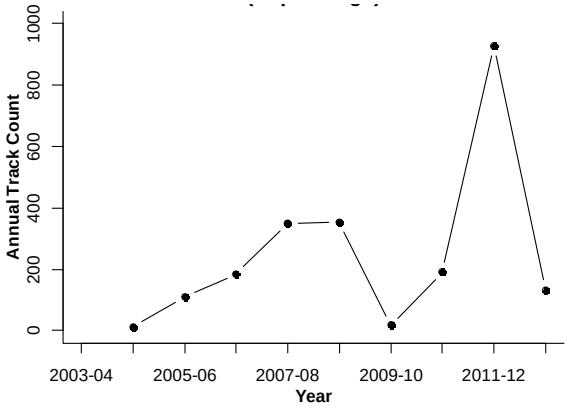
6.3.2. Seasonal turtle track abundance

Green turtle activity during the 2011-12 season was the highest seen over the last ten seasons, with an estimated annual total of nearly 70 000 green turtle tracks (Figure 21) or approximately 15 000 clutches of green turtle eggs (Figure 22). The number of identified species remained low throughout the last three seasons (Figure 23).

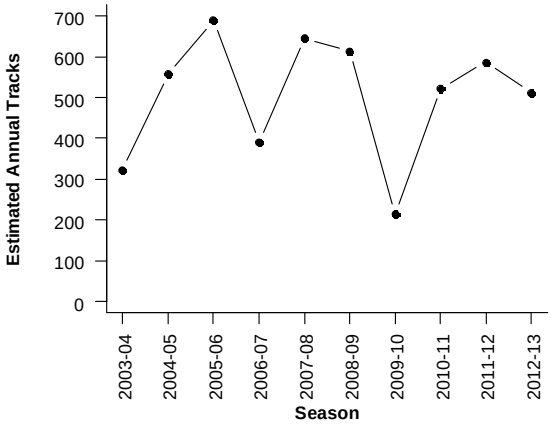
Seasonal green turtle track abundance
North West Cape
(combined false crawls & suspected nest tracks)



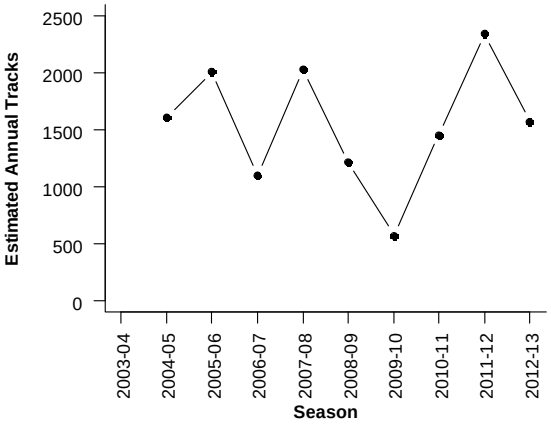
Seasonal green turtle track abundance
Cape Range
(combined false crawls & suspected nest tracks)



Seasonal loggerhead turtle track abundance
North West Cape
(combined false crawls & suspected nest tracks)



Seasonal loggerhead turtle track abundance
Cape Range
(combined false crawls & suspected nest tracks)



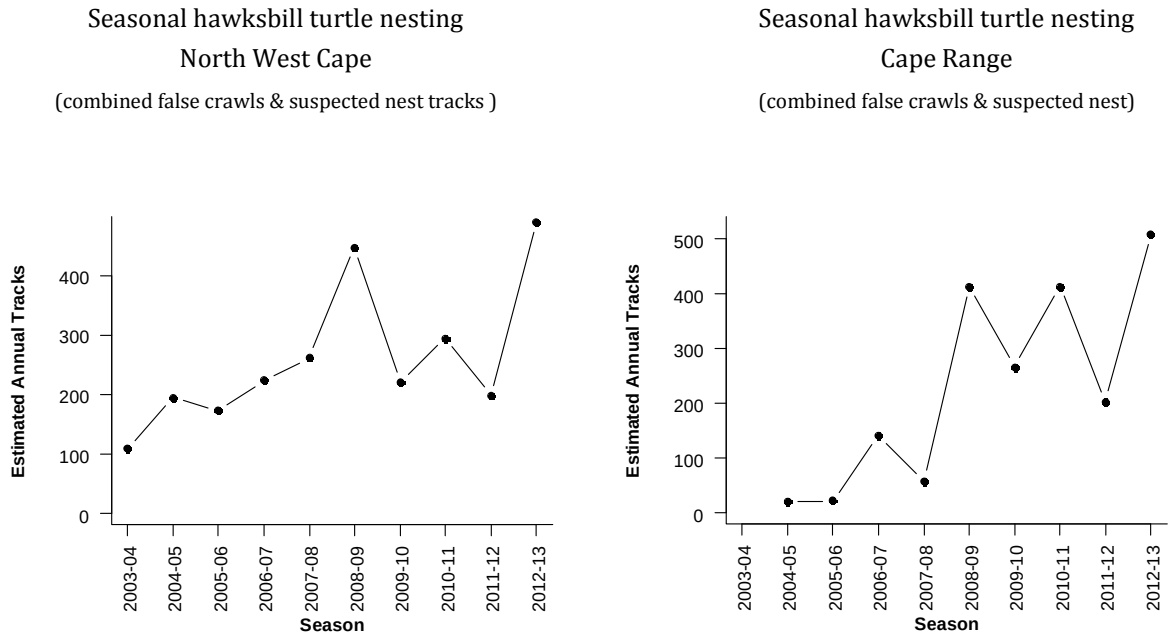
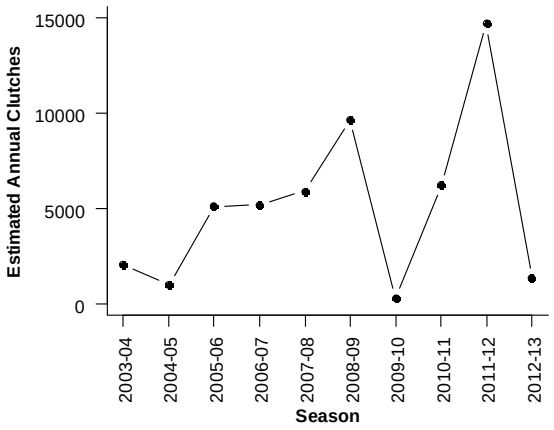


Figure 21: Calculated seasonal abundance of turtle tracks (combined false crawls and suspected nest tracks) at North West Cape and Cape Range divisions within the Ningaloo Region. ***Annual abundances were calculated for each season's activity, assuming the season is mostly restricted to between 15 November and 15 March. Data for the 2008-09 to 2012-13 seasons were calculated using linear regression models and generalized additive models and the means of both methods are displayed with estimated sampling error in predicting nesting between 1 Dec and 28 Feb.***

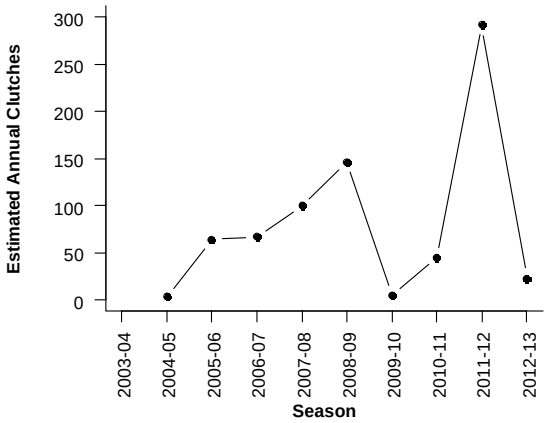
6.3.3. Abundance of suspected nests

Note: False crawls were not combined with the suspected nests in Figure 22 graphs.

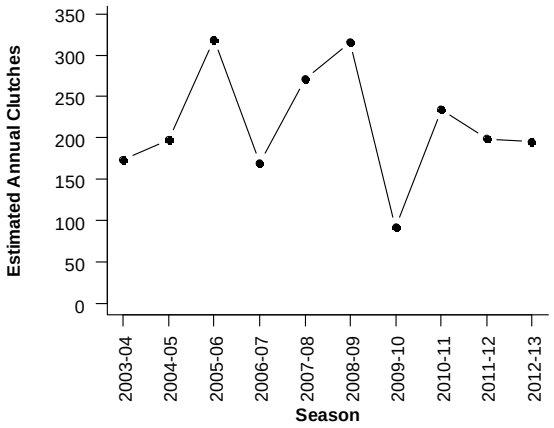
Green Turtle Nests (North West Cape)



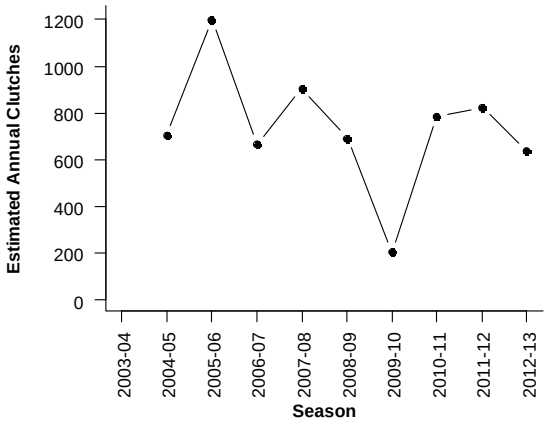
Green Turtle Nests (Cape Range)



Loggerhead Turtle Nests (North West Cape)



Loggerhead Turtle Nests (Cape Range)



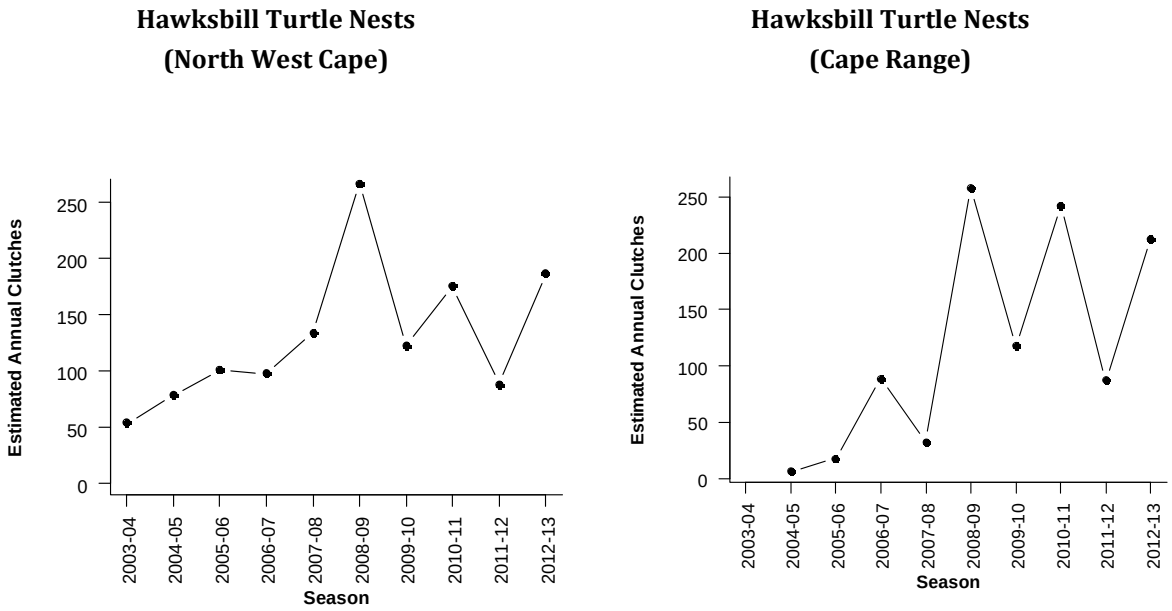
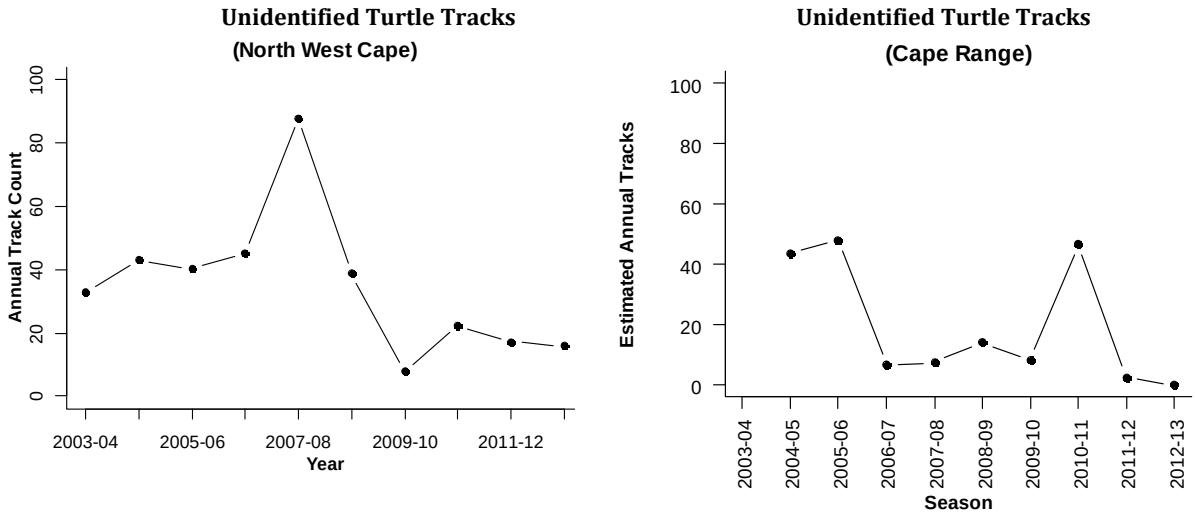


Figure 22: Number of suspected nests laid for turtles nesting at North West Cape and Cape Range divisions within the Ningaloo Region. *Annual abundance data were calculated for each season's nesting assuming the season is mostly restricted to between 15 November and 15 March. Data for 2008-09, 2009-10, 2010-11, 2011-12 and 2012-13 seasons were calculated using linear regression models and generalized additive models. The means of both methods are displayed.*

6.3.4 Unidentified turtle species activity abundance

Track activity



Suspected nests

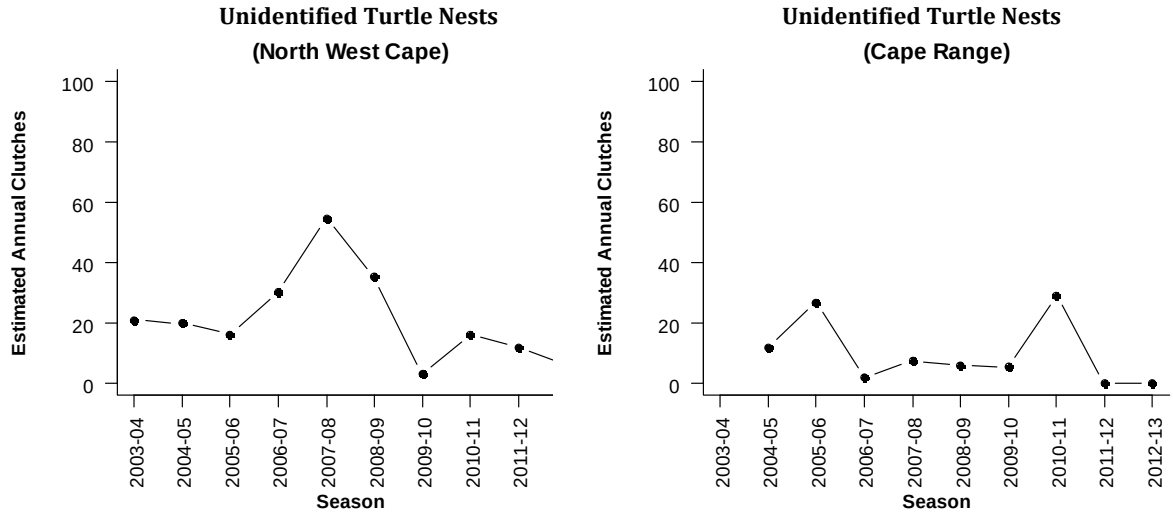
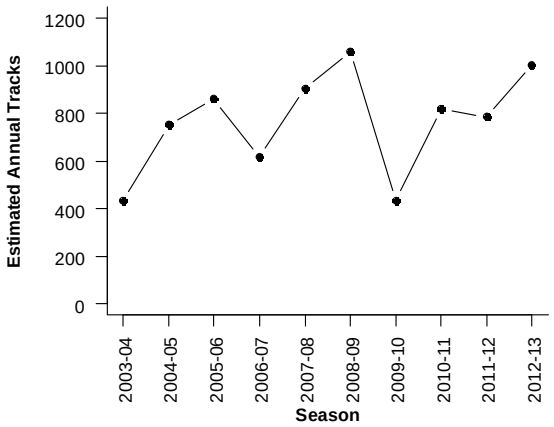


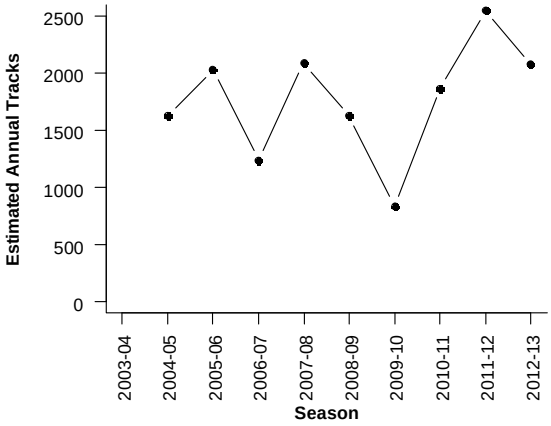
Figure 23: Abundance of tracks and suspected nests laid for unidentified turtle species at North West Cape and Cape Range divisions within the Ningaloo Region. ***These are absolute counts rather than counts using modelling, therefore are different to the calculated abundance depicted in Figure 18 - 22 above.***

As it may be difficult to distinguish between hawksbill and loggerhead turtle tracks, the counts of loggerhead and hawksbill tracks are combined in Figure 24.

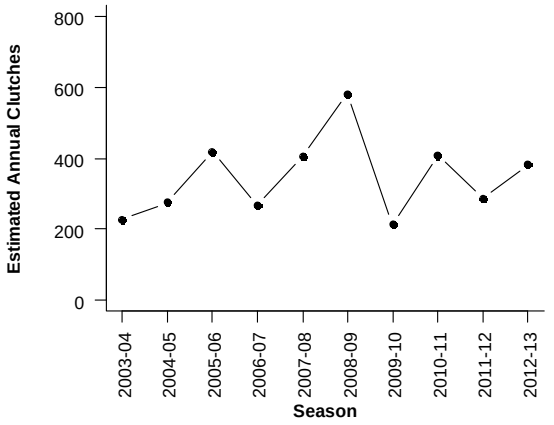
Combined Hawksbill and Loggerhead Turtle track counts (North West Cape)



Combined Hawksbill and Loggerhead Turtle track counts (Cape Range)



Combined Hawksbill and Loggerhead Turtle nest counts (North West Cape)



Combined Hawksbill and Loggerhead Turtle nest counts (Cape Range)

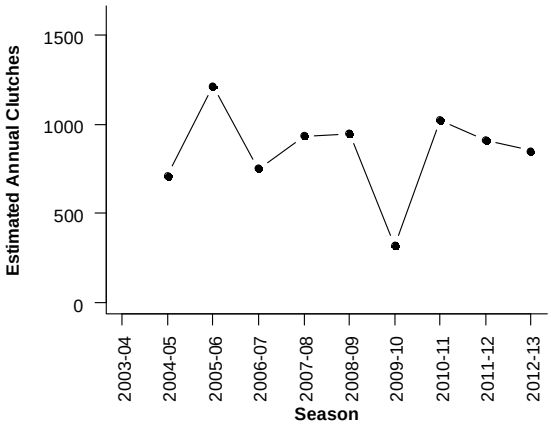


Figure 24: Number of total tracks and nests for turtles at North West Cape and Cape Range divisions within the Ningaloo Region. *Annual abundance data were calculated for the entire season's nesting, assuming the season is mostly restricted to between 15 November and 15 March. Data for 2008-09, 2009-10, 2010-11, 2011-12 and 2012-13 seasons were calculated using linear regression models and generalized additive models and the means of both methods are displayed. Year refers to the year in which the season started.*

6.3.5. Trends in nesting abundance

The ten seasons of data now collected at North West Cape and Cape Range allow an indication of the average number of turtles coming ashore annually (Table 8), and early indication of trends in the population. Given the relatively large inter-annual variation in nesting for green turtles, loggerhead turtles and hawksbill turtles, detecting relatively low changes in population size will often take several decades. For example, a 3% per year decline in abundance will take 29 years to detect for green turtles, 22 years to detect for loggerhead turtles and 20 years to detect for hawksbill turtles using significance level of 0.05 and power of 0.9 (Whiting 2010). The significance level refers to the probability of rejecting a null hypothesis when it is actually true whereas power is the probability that a test rejects the null hypothesis when it is false. Detecting trends in turtle populations at Ningaloo is further hindered by counting nesting activity during the day rather than counting individual turtles at night or substantiating whether eggs were laid by seeing the eggs. This increases the uncertainty in annual counts and therefore decreases the power and confidence of concluding about apparent trends. This uncertainty could potentially be reduced by verifying the accuracy of counting nests using a night time survey observing nesting turtles, or a capture-mark-recapture program may be useful as a second measure of nesting activity at Ningaloo. A pilot nesting success study was conducted during the 2012-13 season and the results of this will be reported elsewhere.

Given the logistic constraints in conducting a capture-mark-recapture study caused by the large spatial spread in nesting and reasonably large numbers of turtles, a viability assessment would be desirable before a capture-mark-recapture study was initiated.

Table 8: Average estimated number of tracks and nests for green, loggerhead and hawksbill turtles nesting at Ningaloo between the 2003-04 and 2012-13 seasons for the dates 15th November to 15th March.

	Green	Loggerhead	Hawksbill
Number of tracks			
North West Cape	19184 (s.d.= 18929)	506 (s.d.= 151)	261 (s.d.= 120)
Cape Range	253 (s.d.= 281)	1546 (s.d.= 543)	227 (s.d.= 184)
Suspected number of nests			
North West Cape	5158 (s.d.= 4451)	217 (s.d.= 70)	130 (s.d.= 63)
Cape Range	83 (s.d.= 91)	734 (s.d.= 262)	118 (s.d.= 97)

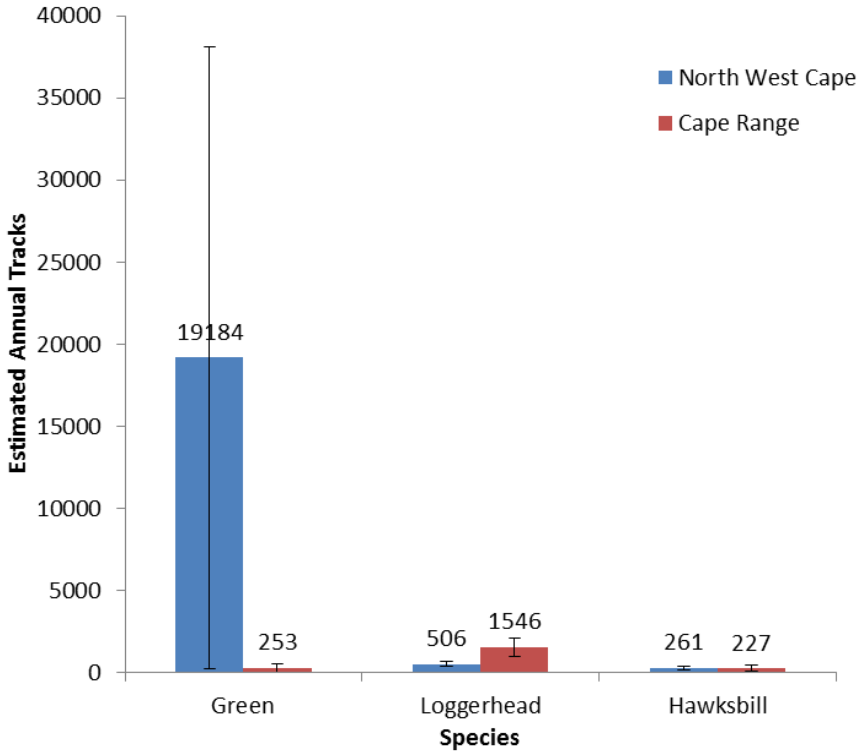


Figure 25: Average estimated number of tracks (combined tracks and suspected nests) for green, loggerhead and hawksbill turtles nesting at Ningaloo between the 2003/04 and 2012/13 seasons from the 15th of November until the 15th of March.

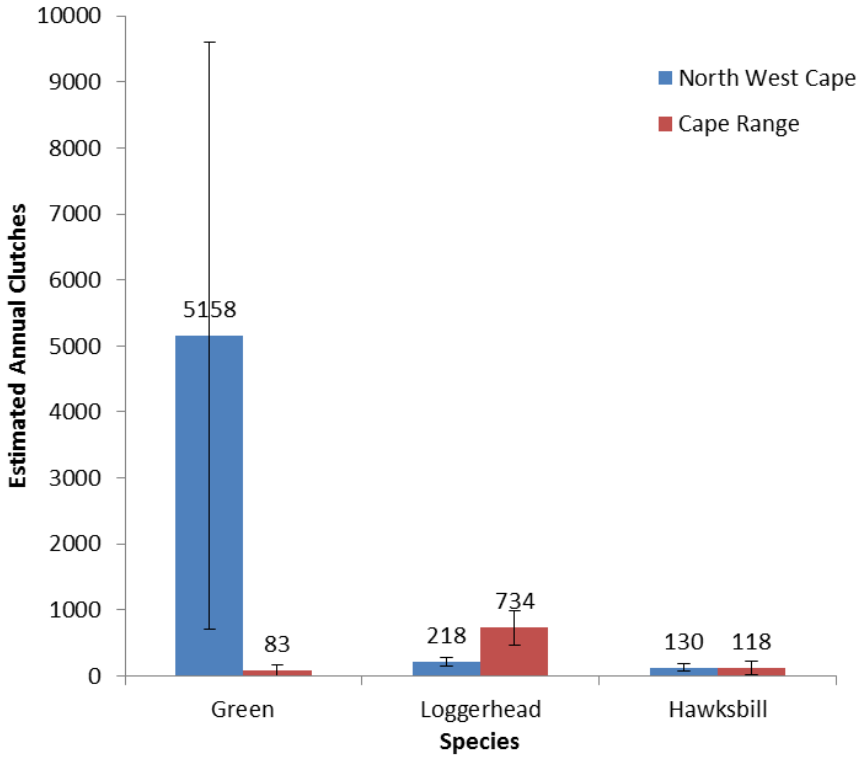


Figure 26: Average estimated number of suspected nests for green, loggerhead and hawksbill turtles nesting at Ningaloo between the 2003/04 and 2012/13 seasons from the 15th of November until the 15th of March.

There were no significant trends in track counts or nest counts for green or loggerhead turtles, nesting either at the North West Cape or at Cape Range (Table 9). There was a significant positive trend in hawksbill track counts at North West Cape and Cape Range and hawksbill turtle nest counts at Cape Range but not North West Cape (Table 9, Figure 27). Linear regression models showed an overall fractional increase in hawksbill turtle track counts of 1.59 and 41.24 times at North West Cape and Cape Range respectively. The increase in the number of suspected nests of hawksbill turtles at Cape Range was 8.38 times.

Although the increase in hawksbill turtle nesting seems encouraging, this may still be an artefact of a relatively short monitoring period or an error in track identification. As it may be difficult to distinguish between hawksbill and loggerhead turtle tracks, verifying track identification through observing turtles would be desirable to increase confidence in the apparent trend.

Table 9: Significance of linear regression models fit to annual abundance data at North West Cape and Cape Range. Power analyses show power for the given trend with a 0.05 significance level. Asterisks refer to statistically significant relationships.

Species	North West Cape		Cape Range	
	Tracks	Suspected nests	Tracks	Suspected nests
Green	P=0.27; Power= 0.39	P=0.33; Power= 0.26	P= 0.25; Power= 0.53	P= 0.41; Power= 0.21
Loggerhead	P= 0.86; Power= 0.05	P=0.77; Power= 0.06	P= 0.98; Power= 0.05	P= 0.40; Power= 0.12
Hawksbill	P=0.04*; Power= 0.85	P=0.11; Power= 0.56	P=0.009*; Power> 0.99	P= 0.048*; Power> 0.99

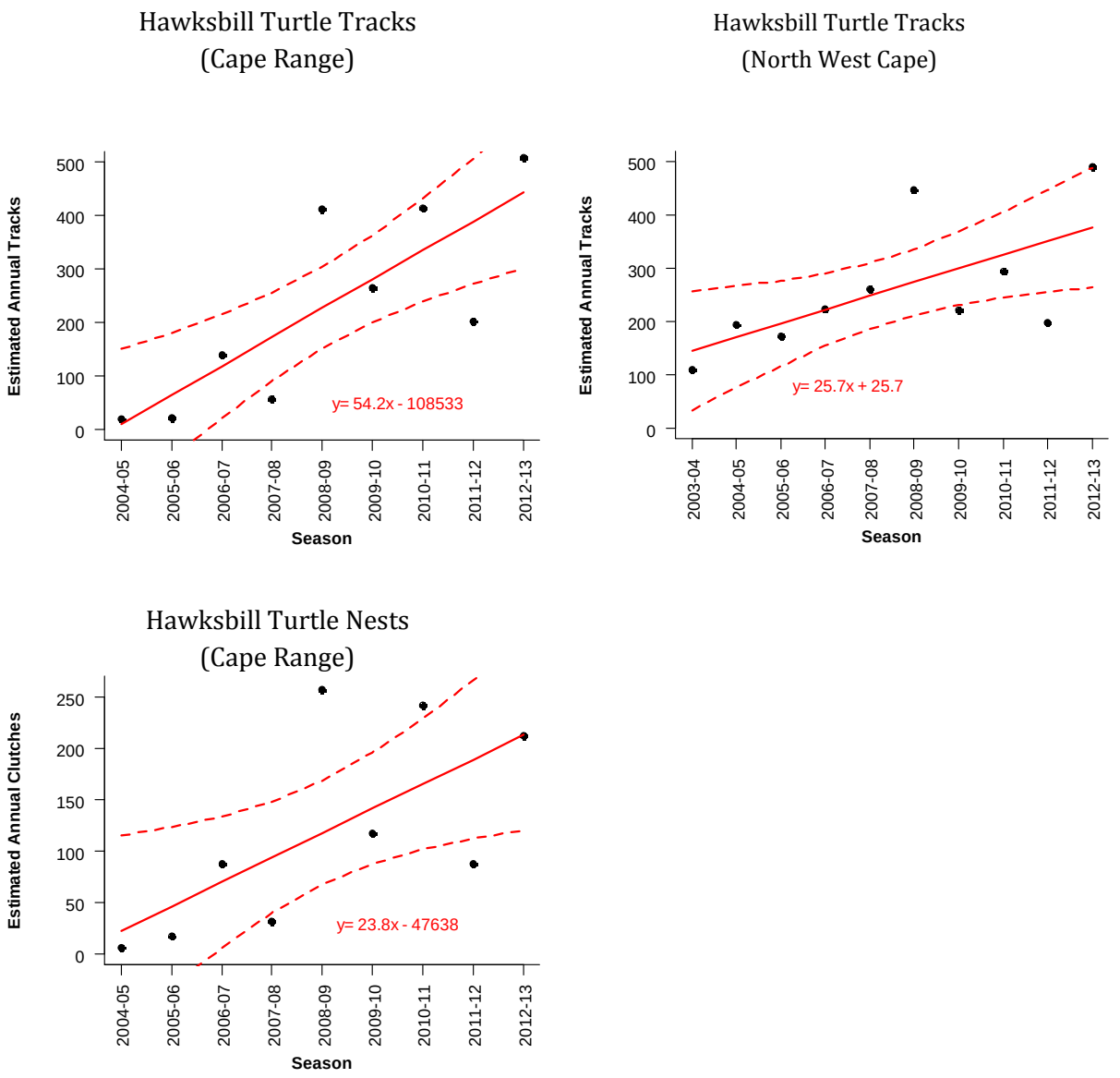


Figure 27: Linear regression between annual track counts and year for the only significant trends observed, showing positive trends for hawksbill turtle tracks at North West Cape and hawksbill turtle tracks and nests at Cape Range. Dashed line refers to 95% confidence intervals of trend line.

6.4. Nesting Success

6.4.1 Nesting Success 2012-13

For the purposes of this report, nesting success is defined as the number of suspected nests laid as a percentage of total turtle activities. It should be noted that nesting success has been calculated using visual assessment of the nest after the turtle has left the beach. The nests are identified and recorded as nests if they meet the visual characteristics which define nests, however eggs have not been observed deposited into the nest. Therefore night time observations of 30 nesting turtles needs to be undertaken to check whether eggs are deposited or not. This would give an indication of how much error exists in terms of identifying a viable nest (Whiting, 2010).

When the entire season's data is compared per species, NTP recorded a total of 585 green turtle nests and 1769 false crawls during 2012-13 season, which equates to 24.85% nesting success. Hawksbill and loggerhead turtles had the greatest nesting success rates of 39.43% and 39.48% respectively, with NTP recording 125 nests and 192 false crawls for hawksbills and 304 nests and 466 false crawls for loggerheads (Table 3).

6.4.2 Nesting Success 2002-13

6.4.2.1. Green Turtles

Green turtle nesting success has varied over the years with a spike in 2008-09 with a 37.34% success rate. In other seasons this has ranged between 24.3% – 29.9% (Figure).

Figure 28: Green turtle nesting success 2002-2013 (%) standardised by survey effort during intensive peak monitoring period.

6.4.2.2. Hawksbill Turtles

Nesting success of hawksbill turtles has varied from between 38.4-61.9% (Figure 29).

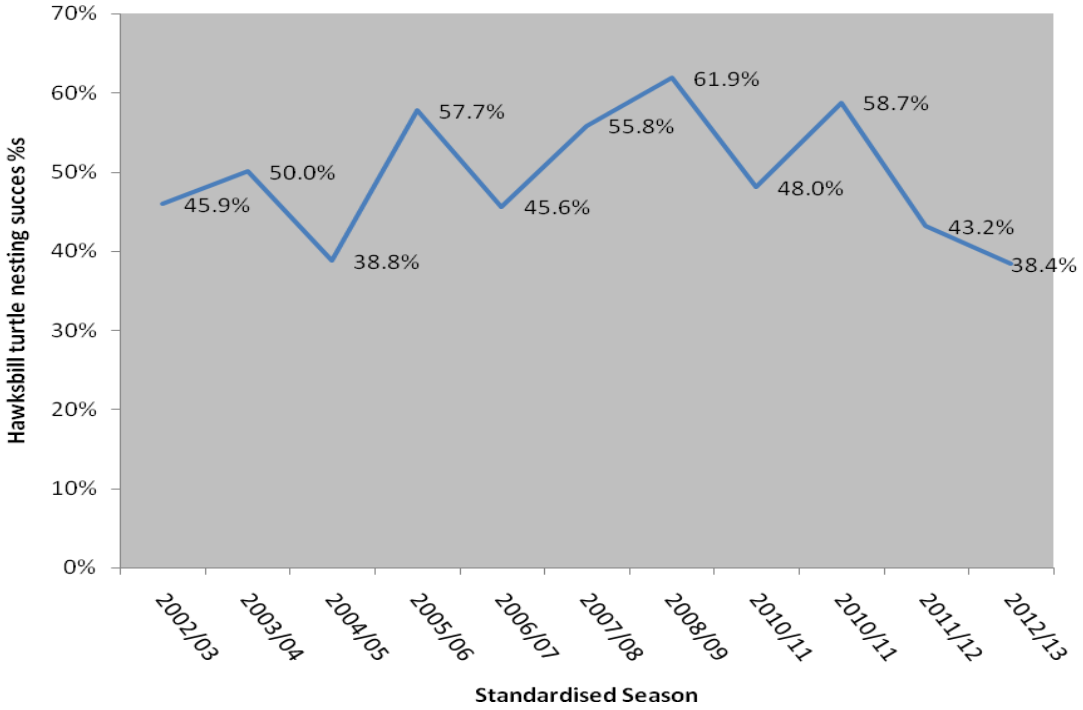


Figure 29: Hawksbill turtle nesting success 2002-13 (%) standardised by survey effort during the intensive peak monitoring period.

6.4.2.3. Loggerhead Turtles

The loggerhead turtles nesting success rate has varied from 26.9 – 59.5% (Figure 30).

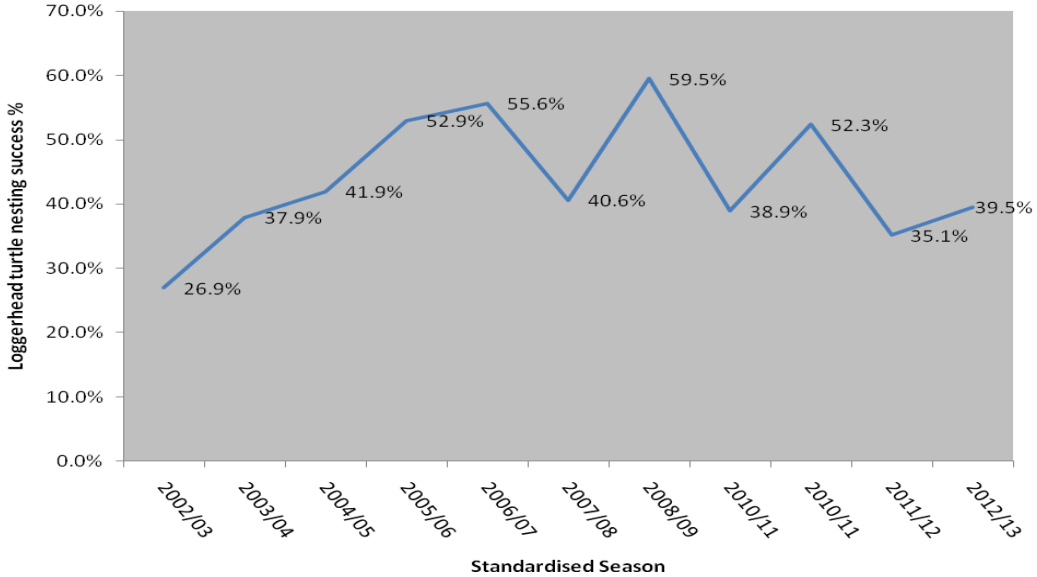


Figure 30: Loggerhead turtle nesting success 2002-12 (%) standardised by survey effort during intensive peak monitoring period

6.5. Nest Damage

6.5.1 Nest Damage 2012-13

One new nest was recorded as damaged by another turtle, one by a fox and one by a dog on the NW Cape Division. Refer to Appendix 1 and Appendix 2 for maps of sections. Note: The percentage of nest damage mentioned above is not viewed as an accurate figure since only new nests (i.e. first day of incubation period) are specifically checked for signs of damage whereas damage to old nests (i.e. day two of the incubation period until hatching) is only recorded on an incidental basis if it is encountered whilst monitoring new nests. Therefore it is likely that a proportion of damaged nests go undetected.

6.5.2 Nest Damage 2002-13

Since monitoring began in 2002 a total of 816 nests (new and old) have been recorded as damaged within the Ningaloo Region (Table 10). This equates to 1.9% of total nests recorded within the Ningaloo Region 2002-2013 (please note that survey effort within the Region varies for each NTP season, see Table 3 and Table 4 for detailed survey effort data).

Table 10: Total number of damaged nests (new and old) and cause per season NTP 2002-2013. NA indicates data no longer collected on this category.

	Cause of Nest (new and old) Damage										
Season	**Unknown**	**Dog**	**Fox**	**Ghost Crab**	**Goanna**	**Human**	**Seagull**	**Tide**	**Another Turtle**	**Vehicle**	**Total**
2002-2003	14	0	58	14	3	9	2	2	3	0	**105**
2003-2004	53	0	95	4	2	11	2	4	2	0	**173**
2004-2005	10	0	26	2	1	1	0	2	1	2	**45**
2005-2006	0	0	4	12	0	0	2	2	4	1	**25**
2006-2007	5	5	30	22	1	0	0	1	13	0	**77**
2007-2008	9	9	13	96	4	2	3	9	13	0	**158**
2008-2009	31	7	57	1	0	0	0	0	1	0	**97**
2009-2010	15	2	15	2	4	1	0	0	0	0	**39**
2010-2011	14	2	2	3	0	1	0	6	0	0	**28**
2011-2012	12	2	3	NA	NA	NA	NA	7	42	NA	**66**
2012-2013	**0**	**0**	**1**	**1**	**0**	**0**	**0**	**0**	**1**	**0**	**3**
Total	**163**	**28**	**304**	**156**	**15**	**25**	**9**	**33**	**80**	**3**	**816**

6.5.3 Predation of nests by foxes and dogs

Since 2002, damage by foxes and dogs has accounted for 40.6% of the total damaged nests recorded. Nest predation by foxes and dogs has remained below 5% for all recorded nests. When the NTP was commenced, discussions were held on the possible sustainable level of fox/dog predation to turtle nests, with the consideration of advice provided by C. Limpus (pers com). It was concluded that a desirable maximum threshold of 5% would be adequate to monitor a measure of the success of fox baiting regimes. However, this threshold is not indicative of the acceptable total level of predation, as the cumulative effects of mortality of hatchlings, juvenile and adult turtles would need to be considered in order to assess a truly sustainable level of predation for the whole turtle population.

The highest record of fox and dog predation since monitoring began is 4.4% of total nests in 2003-04 and was primarily within the Five Mile subsection. As this subsection is a significant green turtle rookery, fox control measures were introduced by DEC in 2004-05 (Halkyard, 2008). As a result of this initiative, fox and dog predation has declined significantly in subsequent seasons and has maintained a very low level (less than 1.5%) due to continued fox baiting at key rookeries.

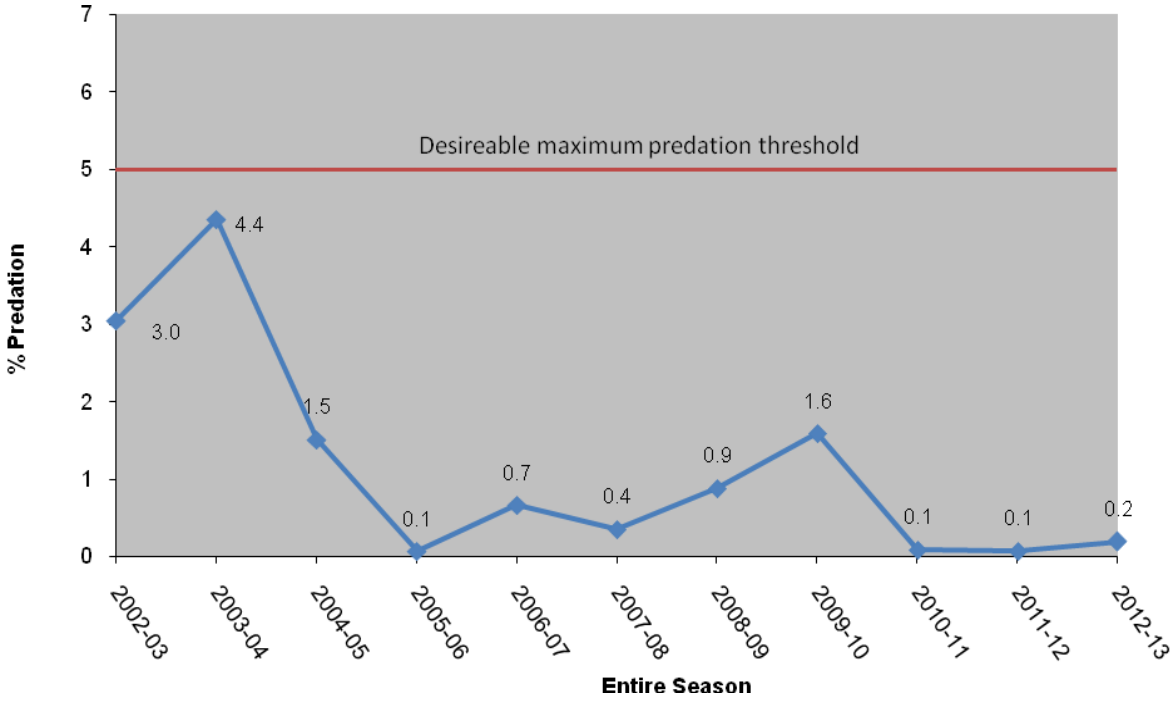


Figure 3125: Fox and dog predation as a percentage of total nests per season, NTP 2002-13. Note: data from 2009-10 season onwards includes NW Cape and Cape Range Divisions only, other seasons include an additional two divisions.

6.6. Turtle Rescues

There were no records of turtle rescues carried out during the 2012-13 NTP season.
However NTP volunteers have rescued a total of 226 stranded marine turtles from 2002-2012. The number of turtles rescued has fluctuated over the seasons (Figure 32), which to a degree is influenced by the level of turtle activity for the season (i.e. higher activity levels mean more turtles present on the beaches, which can also result in more turtle rescues being required).

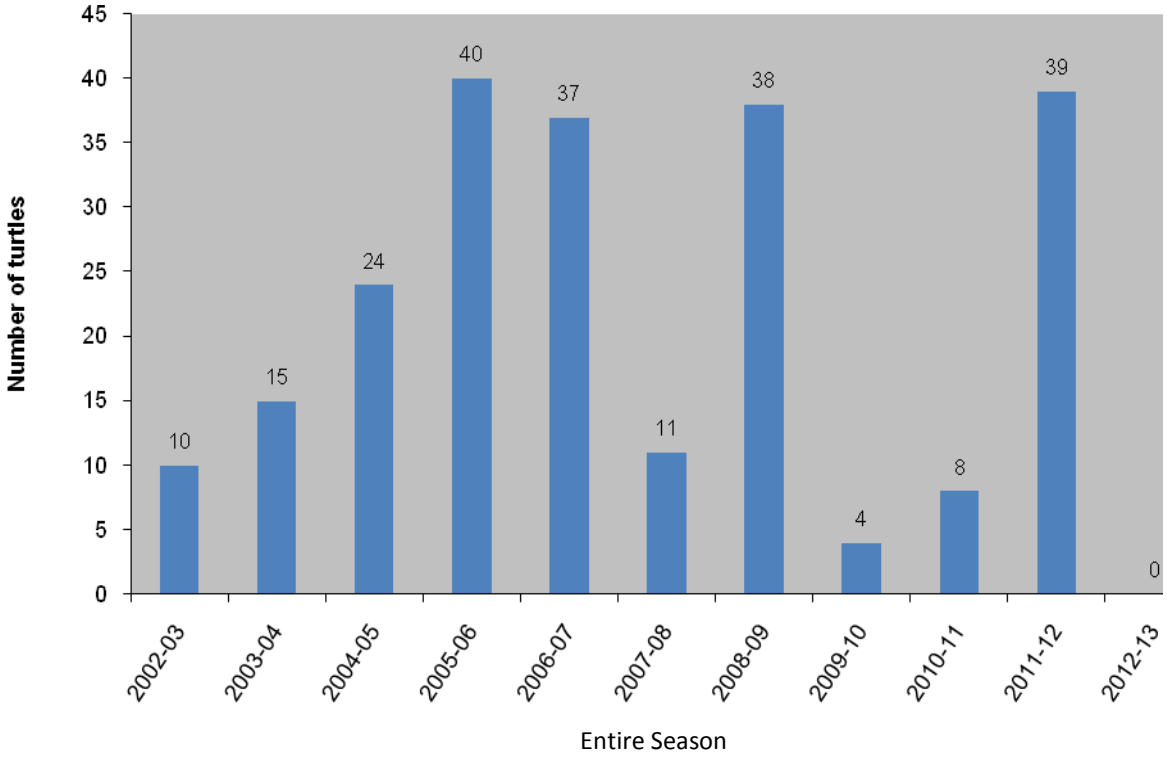


Figure 32: The number of turtles rescued in each NTP season, 2002-13. Note: from 2009-10 season data includes NW Cape and Cape Range Divisions only, other seasons include an additional two divisions.

6.7 Turtle Mortalities

6.7.1. Turtle Mortalities 2012-13

Eight mortalities were recorded during the 2012-13 season, compared to 36 in 2012-2013 (Table 11). Detailed mortality reports can be obtained from DEC Exmouth District.

Table 11: The location, species and number of deceased turtles recorded in the Ningaloo Region 2012-13.

Division	Subsection	Species	Maturity	Sex	Number
NW Cape	Mildura Wreck to NW Car park	Green	adult	male	1
NW Cape	Surf Beach- Hunters	Green	juvenile	female	1
NW Cape	Jacobsz-Wobiri	Green	juvenile	unknown	1
NW Cape	Five Mile to Trisel	Green	adult	female	1
NW Cape	Brookes-Graveyards	Loggerhead	adult	female	1
NW Cape	Brookes-Graveyards	Green	adult	male	1
NW Cape	Brookes-Graveyards	Loggerhead	adult	unknown	1
NW Cape	Graveyards to Burrows	Green	adult	unknown	1
Total					8

6.7.2. Turtle Mortalities 2002-13

Turtle mortalities have only been recorded as part of NTP since 2007-08. This number has fluctuated greatly over the seasons, with the highest number of deceased turtles in 2011-12.

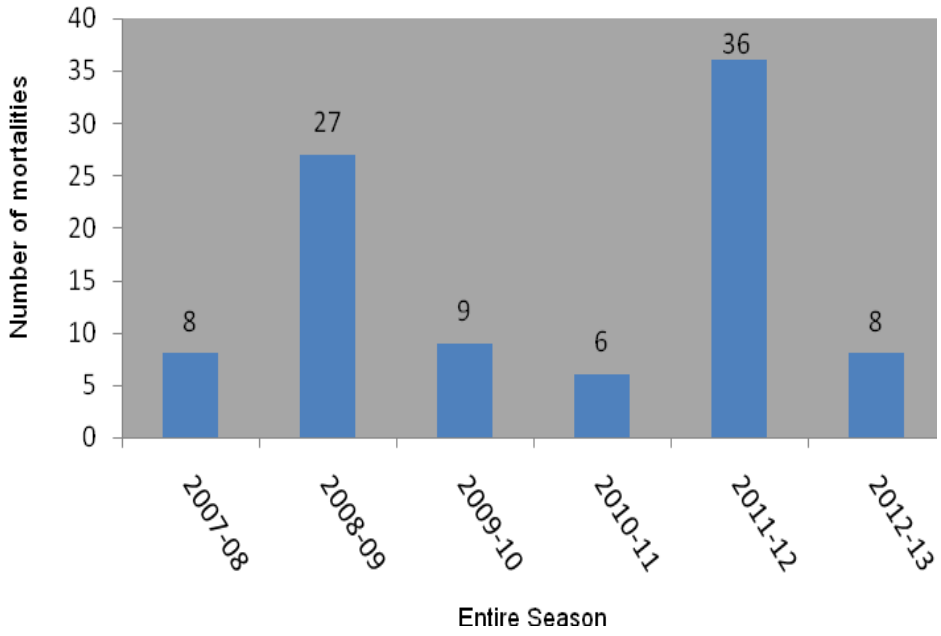


Figure 33: The number of turles mortalities 2007-12 (2002-06 data not available).

6.8. Weather Events 2012-13

One cyclonic event affected the program during 2012-13. Cyclone Narelle (a Category 5 system) which stayed off the coast but led to the cancellation of the last three days (11th, 12th & 13th January) of intensive peak monitoring at Bungelup and two days (12th & 13th January) along the NW Cape.

This cyclone activity produced large storm surges well past the high tide mark up along the base of the dunes in some sections within both the NW Cape and Cape Range Divisions. Large amounts of sand were eroded and underlying rocks exposed. This changed the structure of the beaches and left few areas suitable for nesting. As a result, the northern sections of the NW Cape Division were devoid of any nesting activity in the days following the cyclones. From general observations a large number of nests were observed to be destroyed, having been inundated by the tide which left eggs exposed or washed away.

6.9. Tagged Turtle Re-sightings 2012-13

No tagged Turtles were recorded as being sighted in 2012-13 season.

7.0 SUMMARY OF 2012-13 SEASON: OBJECTIVES AND ACHIEVEMENTS

7.1 Objectives

The Ningaloo Turtle Program has four primary objectives - these are outlined below.

7.1.1. Objective 1: Determine the abundance of nests on specific sections of beach over specified times for each species

7.1.1.1. Nesting Abundance

Nesting abundance for the 2012-13 season was relatively low when compared to the last ten seasons. This season's results are not however indicative of a decrease in population, as marine turtle populations fluctuate considerably between years (Broderick et al. 2001).

7.1.1.2. Nesting Trends

There were no significant trends in track counts or nest counts for green or loggerhead turtles, nesting either at the North West Cape or at Cape Range (Table 9). There was a significant positive trend in hawksbill track counts at North West Cape and Cape Range and hawksbill turtle nest counts at Cape Range but not North West Cape (Table 9, Figure 27). Linear regression models showed an overall fractional increase in hawksbill turtle track counts of 1.59 and 41.24 times at North West Cape and Cape Range respectively. The increase in nest counts of hawksbill turtles at Cape Range was 8.38 times.

Although the increase in hawksbill turtle nesting seems encouraging, this may still be artefact of a relatively short monitoring period or an error in track identification. As it may be difficult to distinguish between hawksbill and loggerhead turtle tracks, verifying track identification through observing turtles would be desirable to increase confidence in the apparent trend.

Further analysis of nesting trends should be completed every few years to continue the long term analysis of nesting trends.

7.1.1.3. Nesting Success

A total of 1023 nests and 2439 false crawls from green, hawskbill and loggerhead turtles were recorded by volunteers during the 2012-13 season. Volunteers recorded 585 nests and 1769 false crawls for green turtles, which equates to 24.9% nesting success. The loggerhead turtle had the greatest nesting success rate of 39.5% with NTP recording 304 nests and 466 false crawls. The hawksbill turtle was responsible for 125 nests and 192 false crawls, which resulted in a nesting success rate of 39.4% (Table 3).

Note: Nesting success is calculated as a percentage of suspected nests over total turtle activity. In the 2012-13 season this was calculated using a visual assessment of the nest after the turtle

had left the beach. It is known that a margin of error exists when using this method as the eggs are not seen to be laid (Whiting, 2010). For nesting success to be quantifiable, night time studies of egg laying turtles should be conducted in conjunction with the current track counts and post-nesting observations, which would enable more accurate estimates of hatchling success and annual number of nesting turtles (Whiting, 2010). During the 2012-13 season the nesting success of Loggerhead turtles was monitored during night time studies within the Cape Range Division, which involved the verification of the presence of eggs through observations of egg-laying turtles. The results of this study will be published in a separate report.

7.1.2. Objective 2: Identify the significance of nesting beaches per species.

7.1.2.1. Nesting Locations

At the commencement of the program, significant nesting locations along the Ningaloo Coastline were identified. NTP data from 2002-13 indicates that the turtle nesting locations that were originally identified remain important within the Region:

- The NW Cape Division is an important breeding ground for green turtles while also supporting loggerhead and hawksbill turtles in smaller numbers.
- The Cape Range Division which contains the Bungelup Section is an important rookery for loggerhead turtles and also supports a smaller number of green and hawksbill turtles.
- Gnaraloo Bay also contains a significant loggerhead rookery. (The Gnaraloo Turtle Conservation Program (GTCP) has adapted the NTP monitoring procedures to collect nesting abundance and nest disturbance data. 2011-12 data is to be provided to the NTP for comparison).

7.1.3. Objective 3: Establish the level of disturbance on nests

7.1.3.1. Nest Disturbance

Since monitoring began in 2002, 816 nests (1.9%) have been disturbed by various natural and unnatural factors. In the 2012-13 season there were three records of nest disturbance, which is 0.3% of nests recorded within the Cape Range and NW Cape Divisions. Note: The percentage of nest disturbance mentioned above is not viewed as an accurate figure since only new nests (i.e. first day of incubation period) are specifically checked for signs of disturbance, whereas disturbance to old nests (i.e. day two of the incubation period until hatching) is only recorded on an incidental basis if it is encountered whilst monitoring new nests. Therefore it is likely that a proportion of damaged nests go undetected.

7.1.3.2. The level of predation on turtle nests by the European red fox (Vulpes vulpes)

Foxes have been present along the beaches of the Ningaloo Coastline since the 1960's and are known to predate on turtle nests and hatchlings (Limpus 2002; Dean 2003; McKinna Jones 2005). Consequently, the implementation of fox control is a key management strategy under the Ningaloo Marine Park Management Plan 2005-2015 for the conservation of marine turtles. This includes the controlled distribution of 1080 poison (sodium fluoro acetate) in the form of dried meat baits placed at key rookeries where the risks to the general public are deemed to be low.

The aim is to reduce the number of foxes within the area thereby reducing the number of nests predated on by foxes and increasing nesting success. Nest disturbance data collected by the NTP assists DEC to target fox control in areas of high nest predation.

Since monitoring began in 2002, fox and dog predation of total recorded nests has remained below 5% for all recorded nests. When the NTP was commenced, discussions were held on the possible sustainable level of fox/dog predation to turtle nests, with the consideration of advice provided by C. Limpus (pers. com). It was concluded that a desirable maximum threshold of 5% would be adequate to monitor a measure of the success of fox baiting regimes. However, this threshold is not indicative of the acceptable total level of predation, as the cumulative effects of mortality of hatchlings, juvenile and adult turtles would need to be considered in order to assess a truly sustainable level of predation for the whole turtle population.

During 2012-13 there were two records of foxes and dogs damaging nests. Current methods of identifying fox and dog predation cannot be used as an effective indicator of fox and dog presence as it may be possible that the actual level of nest predation is higher than that observed given that:

- Predation on a nest is only recorded from the night before.
- Volunteers are not highly trained in identifying predation of nests and may not be accurately recording nest predation, as effectively identifying predation requires experience.
- The period of time NTP monitoring is conducted may not be the optimal time to be accurately gaining predation information. During the 2003-04 NTP season fox predation along the Five Mile Beach Subsection (NW Cape Division) was at its highest during March (McKinna-Jones 2005). This is consistent with findings by researcher Sabrina Trocini, indicating that much of this nest predation occurs towards the end of the incubation period (Trocini, S et al 2009), which is largely outside of the NTP monitoring season. McKinna Jones (2005) also found that during the emergent phase nests were predominantly predated by foxes.
- S. Trocini et al (2009) also found that levels of nest predation at Bungelup were much higher than those observed through the NTP. During the 2007-08 nesting season, 83.3% of nests showed signs of partial or total predation. Over 60% of the monitored nests showed signs of predation by ghost crabs while foxes and perenties were responsible for 20% and 16.7% respectively (Trocini, S et al 2009). During NTP monitoring, new nests are checked for signs of predation but a large proportion of 'old' nests are not checked for predation (predation on old nests is only recorded on an incidental basis if it is encountered during the monitoring of the new nests), therefore there is a high likelihood of not seeing predated nests and hence underestimating predation levels. It must also be noted that NTP methods do not include recording ghost crab predation, therefore this will account for some of the difference in observed predation levels between the NTP and Trocini.
- It is known that foxes are still present at the turtle rookeries from track observations recorded during NTP monitoring, bait uptake monitoring, and from remote camera footage (DEC 2011). It may be likely that foxes are predating a higher level of turtle nests than suggested in this report and/or consuming hatchlings.

7.1.3.3. Ghost crabs: natural predators of marine turtle eggs

The level of predation by ghost crabs and the impact on nest success are not known and is not a component of this monitoring. Determining ghost crab predation by visual assessment of a nest alone is prone to uncertainty, as the presence of a ghost crab hole into the egg chamber does not necessarily indicate that ghost crabs predated the nest, nor does it give an indication if predation *has* occurred how many eggs within a clutch were depredated. For this season crab damage to a nest was not recorded as a cause of nest damage. Ghost crabs are natural predators within the area and research is required to determine the dynamics of ghost crab predation on nesting turtle populations at Ningaloo over space and time. For further studies on ghost crab predation on the Ningaloo Coast please contact the Gnaraloo Turtle Conservation Program.

7.1.4. Objective 4: Determine the impact of human interaction on nesting success of each species

7.1.4.1. Human Interaction with Nesting Turtles

In the past, NTP recorded a measure of possible human disturbance to turtle nests through observations of human prints within 5m of nests. This was shown to be minimal (0.6%), however the data did not include visual observations of visitors interacting with turtles, which meant disturbance during the other stages of nesting would not be measured. The presence of people on nesting beaches are likely to cause disturbance to nesting females and hatchlings if they do not follow appropriate interaction protocols (Waayers 2003; Johnson et al. 1996; Lorne & Salmon 2007). Disturbance by humans can lead to the female abandoning her nesting attempt prior to the laying of eggs and returning to the ocean, resulting in a failed nesting attempt. The NTP now only records specific damage to nests by humans, rather than just the presence of human prints in the vicinity of a nest. Further research into visual assessments of turtle-visitor interactions is required to determine the level of impact on new nests within the Ningaloo Region and subsequent impact on local turtle populations.

The development of the DEC Jurabi Turtle Centre (JTC) program in 2008-09 was supported by Woodside Energy Ltd and Mitsui Ltd (2009-11) through the Community Partnerships Program. The program operates along the NW Cape and provides a supervised interaction experience with nesting turtles using trained turtle tour guides, giving visitors an opportunity to observe turtles nesting in their natural environment and contribute to turtle conservation within the Region. DEC encourages visitors to participate in a guided experience with JTC staff but those wishing to observe nesting turtles independently are requested to abide by DEC's Turtle Watcher's Code of Conduct (available online at the DEC and NTP websites).

7.2. Achievements NTP 2002-13

- Training of 3 additional DEC staff members in order to provide assistance in future years.
- Ongoing distribution of the NTP monitoring field guide and monitoring training videos to community turtle projects worldwide.
- Continual support for marine turtle monitoring programs throughout Western Australia.
- Continual collection of nesting data to assist with the implementation of visitor management strategies such as beach accesses and 4WD vehicle restrictions.
- Continual collection of nest distribution data to assist government agencies in future tourism development planning.
- Continual collection of nesting habitat locations to improve Oil Spill Contingency Atlas (OSRA) information and support potential oil spill response planning.
- Continual collection of nesting habitat encroachment data to assist in the removal of existing car parks within the Jurabi Coastal Park.

In the coming years the program will continue to collect data on nesting female turtles within the Ningaloo Region which will assist in the long term prediction tends in turtle populations. This will assist management in identifying turtle population recovery targets within the Region.

8.0 Key Program Recommendations

8.1 Volunteer Participation

- Build capacity among the local Exmouth community and promote local program participation through more personalised communication with volunteers.
- Improve the level of interaction between external volunteers and local volunteers and the NTPSC throughout the program.
- Continue to charge volunteer participation fee to external volunteers in order to recoup program costs.

8.2 Occupational Health and Safety

- Update job safety analyses (JSA's) and maintain occupational health and safety standards and vigilance.
- Consider a full manual license and senior first aid certificate as prerequisites for all external volunteers. These qualifications are currently only required by the NTP Team Leaders and Coordinator.

8.3 Field Data Collection

- Emphasise to volunteers the importance of accurate data collection and data entry. Ensure volunteers fill in data sheets accurately, cross-check data sheets on a daily basis and maintain daily communication with the volunteer coordinator regarding any data collection or entry issues.
- Continue to ensure volunteer accuracy in track, nest and predation identification by carrying out concurrent cross-checks of beach surveys and data collection.
- Continue to improve monitoring techniques and data collection methods with all trainers and volunteers prior to the start of the monitoring. This will provide consistent methodology and accurate data collection.
- Continue to provide additional volunteer training on species-specific track identification – especially how to distinguish between loggerhead and hawksbill turtle tracks. Utilise Bungelup research station and adjacent loggerhead rookery during training to expand knowledge base of loggerhead track identification.
- Continue to encourage volunteers to use their own digital cameras (rather than the supplied disposable cameras) to take photos of turtle tracks, deceased and stranded turtles for quicker identification and more cost effective reporting.
- Consolidate monitoring folder content into a more practical field folder.

8.4 Organisation and Procedures

- Build on collaborations between Australian Universities and the Program.
- Continue to involve NTPSC members and DEC staff in day to day management during the intensive peak monitoring period.

8.5 Data Management

- Upgrade the Microsoft Access database to ensure currency and functionality.
- Continue to carry out intermittent checks of GPS settings and waypoints during the season as they can be accidentally changed by volunteers.
- Reinforce the importance of accurate data entry to those volunteers entering the data: ensure data is entered on a *daily* basis in accordance with a data entry roster.
- Continue to ensure data entry by volunteers is supervised by a Team Leader or Coordinator.
- Provide the Team Leaders with access to the database password (previously only the Volunteer Coordinator had access), and additional database training, so any data entry issues or mistakes can be rectified quickly and at the time of entry.
- Continue with ensuring backup copies of the 'live' database are saved at least once a week to ensure data security.
- Provide comprehensive data entry training.
- Ensure regular checking of the database by the Volunteer Coordinator.

8.6 Volunteer Education, Information and Communication

- Continue to encourage local participation in social activities prearranged for external volunteers for more social interaction and opportunities for knowledge exchange between the two groups of volunteers.
- Continue with relevant turtle presentations to external and local volunteers to stimulate interest.
- Continue to provide volunteers presentations from DEC staff to educate on a range of Departmental activities.
- Encourage local volunteers to give presentations to external volunteers on topics of relevant expertise or interest.
- Consider to invite local Indigenous council members (Coral Coast Park Council) to provide information of Indigenous history in the area.
- Continue to deliver program progress updates to all volunteers throughout the season.

8.7 Survey Effort and Nesting Abundance

- Continue to monitor turtle activity within the NW Cape and Cape Range Divisions.
- Continue with opportunistic monitoring by DEC staff within the Bundera/Ningaloo and Coral Bay Divisions.
- Conduct further track surveys to assess if turtle rookeries have moved and subsequently if we are monitoring in the most important areas. In particular, the southern end of Cape Range National Park.
- Continue with current length of the NTP survey period (five week intensive peak period monitoring including one week of training and four weeks of monitoring with intermittent weekend monitoring outside of this period).
- Maintain the intensive peak period monitoring between mid-December to mid-January, and adjust if peak season shifts are detected

- Consider further studies to determine nesting success for a sample of turtles using night time monitoring to gather data for trend refinement during analyses.
- Ensure intermittent weekend track counts outside of the intensive peak monitoring period are only counting the tracks from the previous night's nesting.

8.8 Training

- Expand trainer and assessor capacity prior to the arrival of the external volunteers. Provide more encouragement to new local volunteers to work towards this.
- Continue to ensure a minimum of two seasons experience as a prerequisite to train volunteers in monitoring techniques to ensure accurate and consistent methods.
- Encourage all DEC staff with adequate NTP experience to be trained as NTP trainers, this will also help to reduce the workload of the other key trainers and reduce the reliance on external sources.
- Ensure a trainer refresher meeting is held prior to commencement of monitoring training. This will improve consistency in training information and techniques.
- Maintain development of field staff to ensure accurate identification of tracks during training week and throughout the program.
- Update the 6th edition of the "Turtle Monitoring Field Guide" to reflect any adaptations that may have occurred in recent years (last updated in November 2007).
- Continue to provide volunteers with the 6th edition of the "Turtle Monitoring Field Guide" (on loan) in volunteer induction packs and encourage frequent use of the Field Guide, especially during the training week. Encourage all volunteers to become familiar with the glossary of terms (in Appendix 1). E.g. costal scales, prefrontal scales and false crawl definitions.
- Provide volunteers a night time JTC tour during training week to promote a better understanding of the nesting process.
- Utilise Bungelup research station during training to improve loggerhead turtle track identification.
- Consider using the Navy Pier beach during training to improve hawksbill turtle track identification.
- Continue to ensure smaller training and assessment groups where possible. Ideally a maximum of four volunteers per trainer/assessor.
- Continue to provide training on turtle rescues.
- Train the Gnaraloo Turtle Conservation Program (GTCP) manager in NTP methodologies to enable the GTCP to train their own volunteers in-house each season.

8.9 Predation Control

- Continue with the current DEC fox control program within the four divisions - NW Cape, Cape Range, Bundera/Ningaloo and Coral Bay. This will assist in maintaining the current low level of fox predation on nests within the Ningaloo Region.

- Ensure fox control within Cape Range Division (Bungelup Section) is adequate to maintain predation levels at less than 5 Percent of recorded nests.
- Further investigate the impacts of fox, dog and ghost crab predation on nesting success within the Ningaloo Region.
- Continue to report opportunistic cat, dingo and fox sightings to DEC Feral Control Officer.
- Report evidence of human damage to nests to DEC Wildlife Officer to enable immediate action to be taken and prevent further occurrences.

8.10 Turtles Rescues

- Continue to conduct turtle rescues as required when it is feasible.
- Provide volunteers with training in turtle rescue techniques.
- Notify the DEC Wildlife Officer of areas with considerable numbers of turtle strandings and mortalities.
- Continue to collect data on stranded turtles and mortalities

8.11 General Recommendations

- Continue to investigate future funding opportunities for the program to ensure the longevity and sustainability of the program.
- Review and update the NTP overarching goals and objectives to reflect the progression of the program and changes which have occurred since the commencement of the program in 2002.
- Develop the NTP in conjunction with the DEC state turtle coordinator's recommendations, taking into consideration threats and adaptations required.
- Continue to record tagged turtles observed on beaches, maintain local tagging registers and provide data to state turtle coordinator.

9.0 ACKNOWLEDGEMENTS

Cape Conservation Group Inc., World Wildlife Fund-Australia and the Department of Environment and Conservation for their initial collaborative partnership.

Roland Mau, Susie Bedford and David Waayers, for the 2001-2002 NTP pilot program.

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

Cape Conservation Group Inc., in particular Susie Bedford, Suzie Lalor and Jutta Wildforster, for their continued passion, support and partnership.

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Team Leaders- Sara Rathborne, Katie Ashford and Howard Foster

Local Exmouth Volunteers- Susie Bedford, Suzie Lalor, Jutta Wildforster, Barb Dickson, Kasi Palmer, Dallas Godson, Maggie Wright, Mary Bullock, Chaile Eager , Dani Rob, Lyn Irvine, Robert & Sue Chapman, Bev Wilson, Jason Harnvey, Zoe Eves, Kerrilyn Aherne, Anna Williams, Niki Mouzourides, Cass Pickel, Pam Stevens, Yvonne Turbett, Sally Graham, Jen Thompson, Colin Valentine, Jemma & Lindy Cross, Jack Hine.

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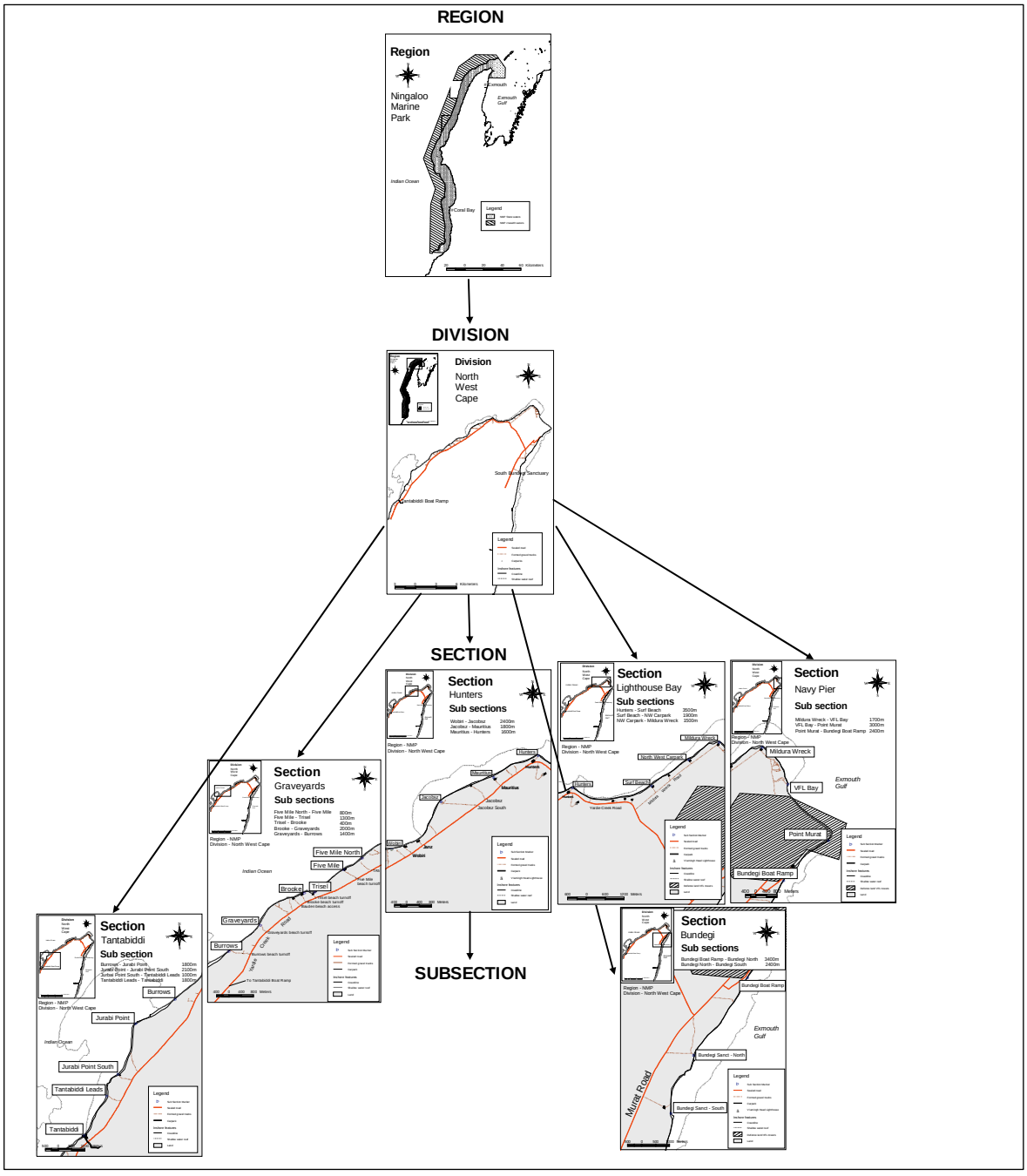
11.0 Appendix

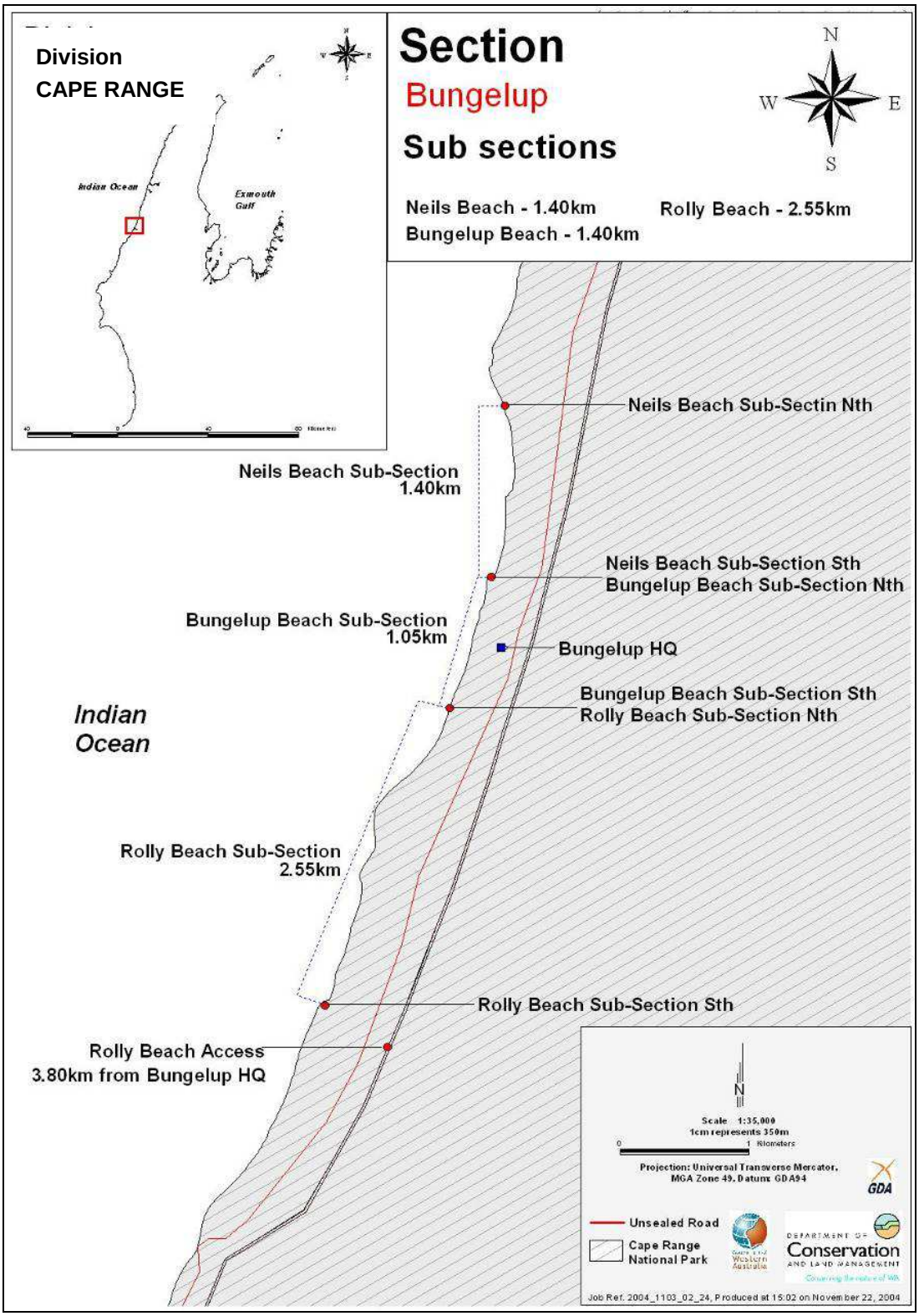
Appendix 1: Zoning of the NW Cape Division.



Location and distance of each subsection within NW 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

Appendix 2: Zoning of the Cape Range Division.

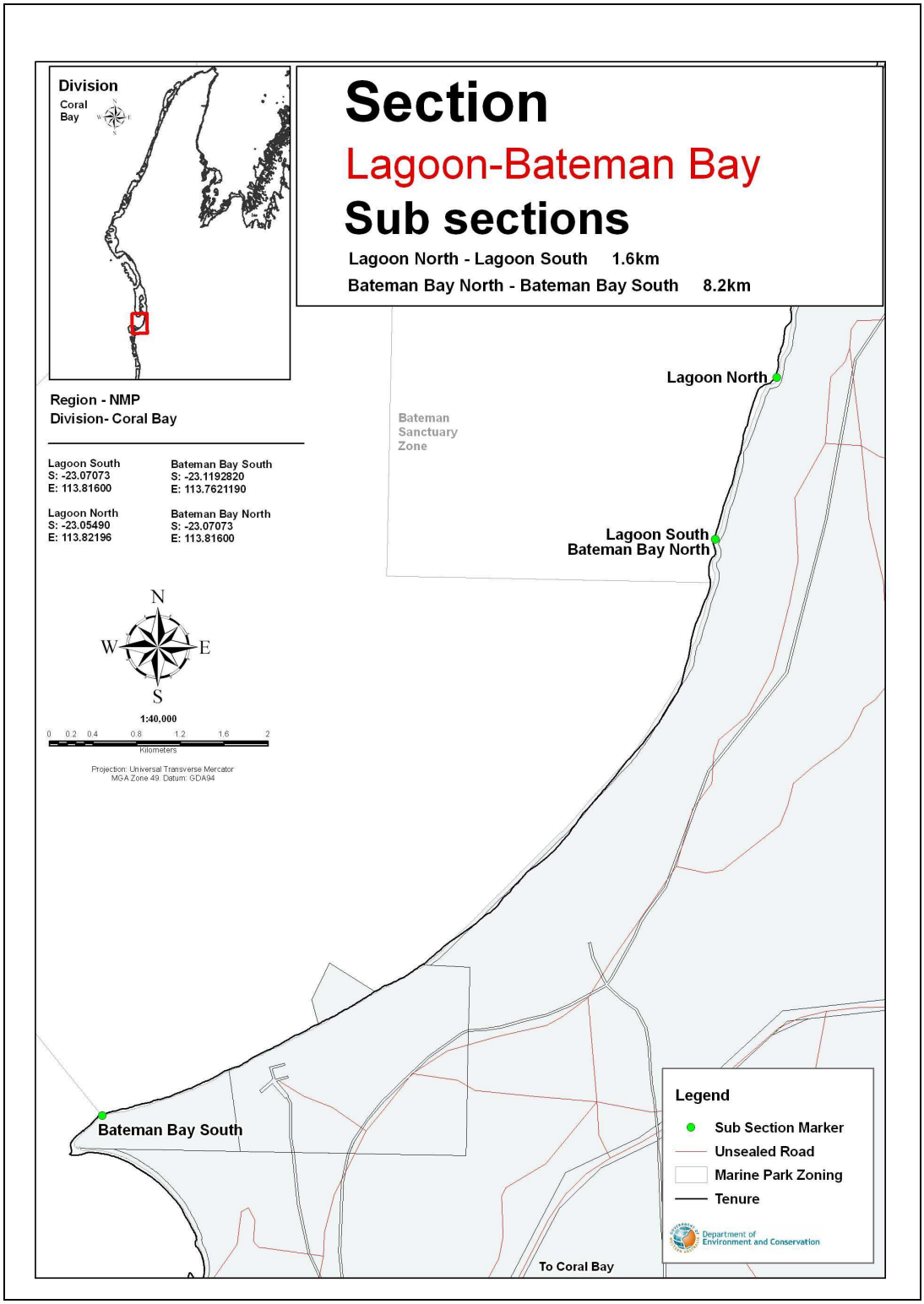


Location and distance of each subsection within Cape Range Division.

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

Appendix 3: Coral Bay Division

Location of subsection within the Lagoon-Bateman Bay Section (Coral Bay Division), (Lagoon South - Lagoon North; Batemans South – Batemans North).



Location and distance of each subsection within the Coral Bay Division.

Subsection	Location of northern totem	Location of southern totem	Distance (m)
Batemans South - Batemans North	23.07073 S; 113.81600 E	23.11928 S; 113.76211 E	8200
Batemans North – Lagoon North	23.05490 S; 113.82196 E	23.07073 S; 113.81600 E	1500

Appendix 4: NTP Data Sheet 2012- 13

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

Date		Recorder	
Start subsection		Finish subsection	
Start time		Finish time	
Equipment Details		Radio No	
GPS No		Camera No	

TABLE A: FALSE CRAWLS TALLY				
	Green	Loggerhead	Hawksbill	Unknown
Total				

Prints in subsection?	
Fox	Y / N
Dog	Y / N

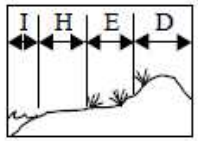


TABLE B: NESTS

New (N) / Old* (O) Nest?	Species Type G/L/H/U	GPS Position (in decimal degrees) (Datum WGS84) latitude (S)	longitude (E)	Nest Position I/H/E/D	Is Nest Damaged? Y/ N	Damage Cause? A/D/F/G/H/Ti	Photo Frame No.	Any Other Observations? (e.g. Diggings, Egg shells, Hatchlings, Turtle)
Comments:								

Cause of Damage Key: A= Another turtle, D= Dog, F= Fox, G= Goanna, H= Human, Ti= Tide

** Only record old nest data if it has been disturbed.* **~Please complete and return even if no nests are recorded!** 311011

Appendix 5: Tagged Turtle Re-sightings Datasheet

West Australian Turtle Research – Nesting Turtles

DEPARTMENT OF Conservation AND LAND MANAGEMENT Conserving the nature of WA

TAGGED TURTLE RESIGHTINGS

Locality: _____ Date: _____ Observer: _____

Tag Left	Tag Right	Time	Turtle Activity	~~Nest~~ Location	~~Egg~~ Count	Turtle Species

Tag Position:

- Please record tag information for both left and right flippers. If single tagged put 'NIL' in the column as needed.

Turtle Activity Key:

A = resting at waters edge
B = leaving water
C = climbing beach slope
D = moving over bare sand
E = digging body pit
F = excavating egg chamber
G = laying eggs
H = covering eggs (filling in)
I = returning to water

Nest Location Key:

A = above high water mark
B = at high water mark
C = below high water mark
D = edge of Spinifex
E = in Spinifex

Appendix 6: Marine Turtle Stranding and Mortality Datasheet

MARINE TURTLE STRANDING AND MORTALITY DATASHEET – Pilbara Region

Please record the following information for all sick, injured or dead marine turtles and send it to the nearest Department of Environment and Conservation office (see overleaf for addresses).

DATE: _____ **(DD/MM/YYYY)** **TIME:** _____ **(24 hour)**

LOCATION: _____

Latitude: _____ ° _____ **S**

Longitude: _____ ° _____ **E**

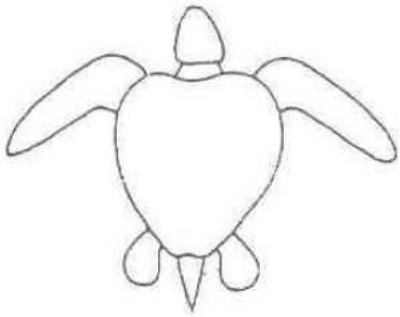
STATUS: ☐ Alive **Condition/Behaviour:** _____

☐ Dead **The following coding can be used to code beach washed carcasses:**

☐ Live but subsequently died
☐ Carcass in good condition (fresh/edible)
☐ Carcass fair (decomposed but organs intact)
☐ Carcass poor (advanced decomposition)
☐ Mummified carcass (skin holding bones)
☐ Disarticulated bones (no soft tissue remaining)

SPECIES (see key overleaf):
☐ Green
☐ Loggerhead
☐ Flatback
☐ Hawksbill
☐ Olive Ridley
☐ Leatherback
☐ Unknown

DISTINGUISHING FEATURES: (please also indicate on diagram)
☐ Obvious damage/injuries
☐ Missing limbs
☐ Barnacles
☐ Algal growth on carapace
☐ Tagging scars



TAG NUMBERS: Left flipper _____
Right flipper _____

MEASUREMENTS:

Curved Carapace Length:	_____ mm	☐ Measured	☐ Estimated
Curved Carapace Width:	_____ mm	☐ Measured	☐ Estimated
Tail Length (from Carapace):	_____ mm	☐ Measured	☐ Estimated
Maximum Head Width:	_____ mm	☐ Measured	☐ Estimated

SEX: ☐ Male ☐ Female ☐ Unknown

MATURITY: ☐ Juvenile ☐ Adult ☐ Unknown

PHOTOGRAPHS* (see overleaf): _____

SECURITY/DISPOSAL/RELEASE of turtle: _____

NOTES: _____

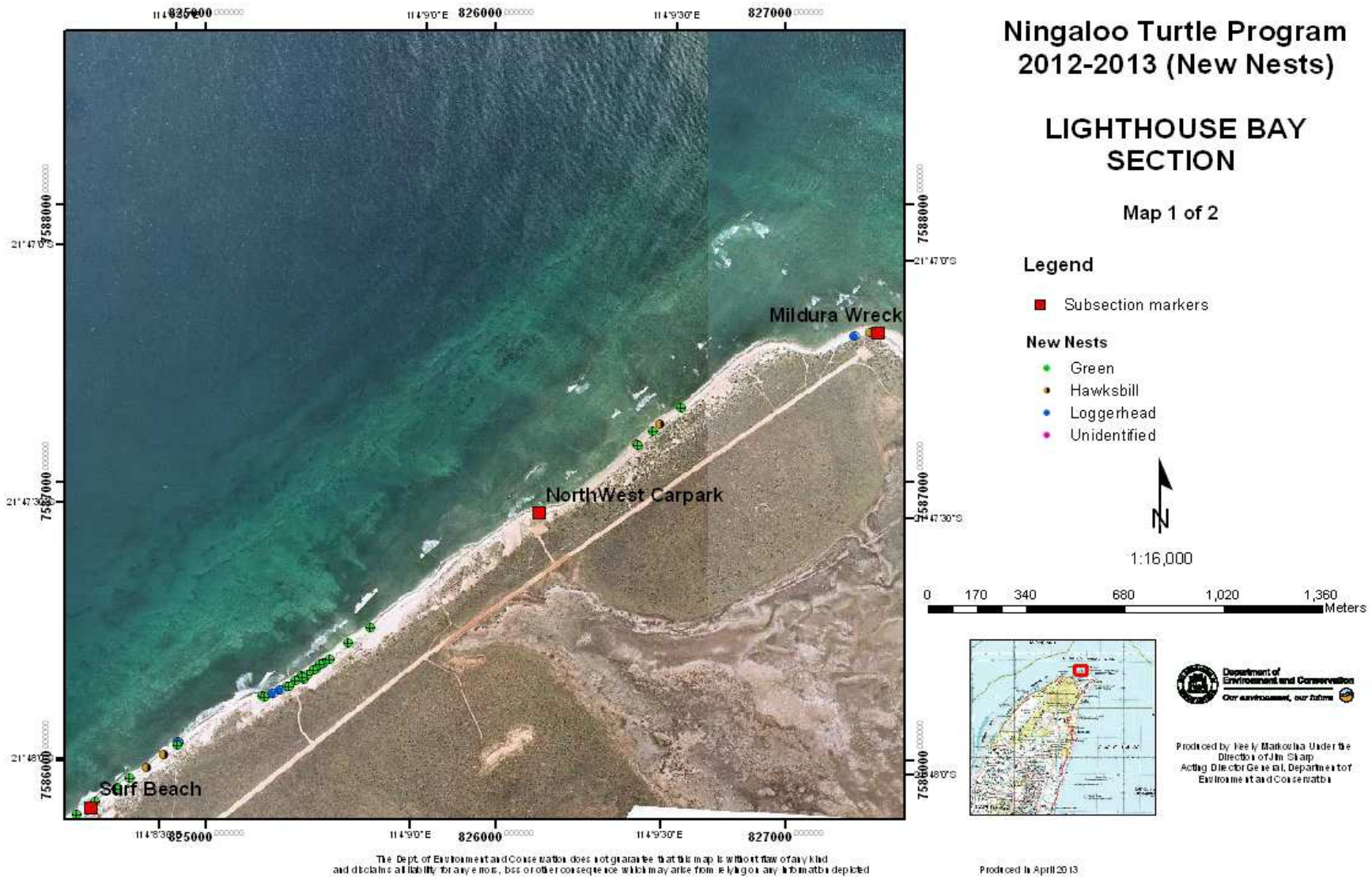
_____

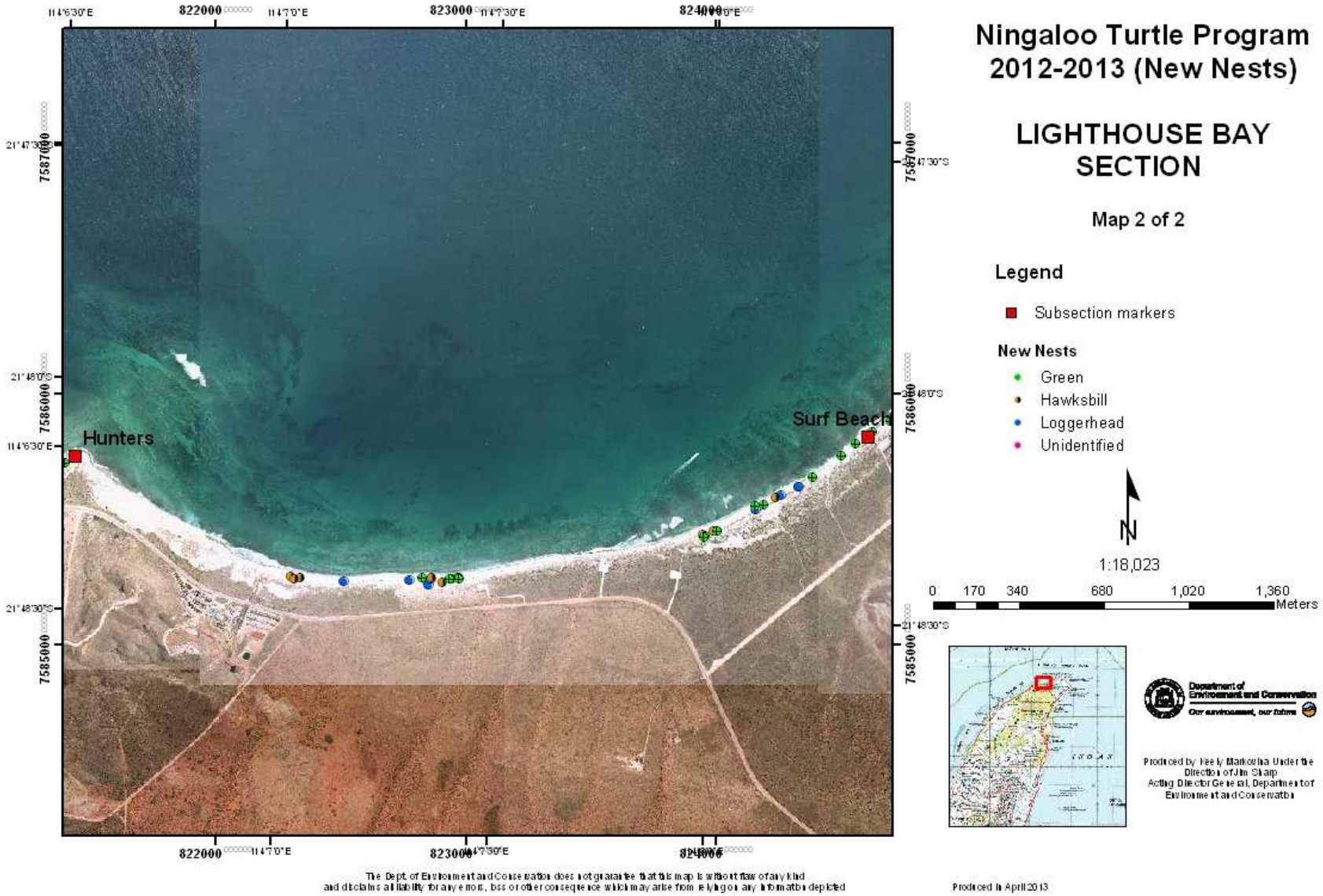
CONTACT DETAILS:

Name: _____ Phone number: _____

Address: _____ Email: _____

Appendix 7: Lighthouse Bay Section - Location of New Nests (NTP 2012-13) Map 1 & 2




Ningaloo Turtle Program
2012-2013 (New Nests)
LIGHTHOUSE BAY
SECTION
Map 2 of 2
Legend
Subsection markers
New Nests
Green
Hawksbill
Loggerhead
Unidentified
Hunters
Surf Beach
N
1:18,023
0 170 340 680 1,020 1,360
Meters
114°6'30"E
822000
114°7'0"E
823000
114°7'30"E
824000
21°47'30"S
7587000
21°48'0"S
7586000
21°48'30"S
7585000
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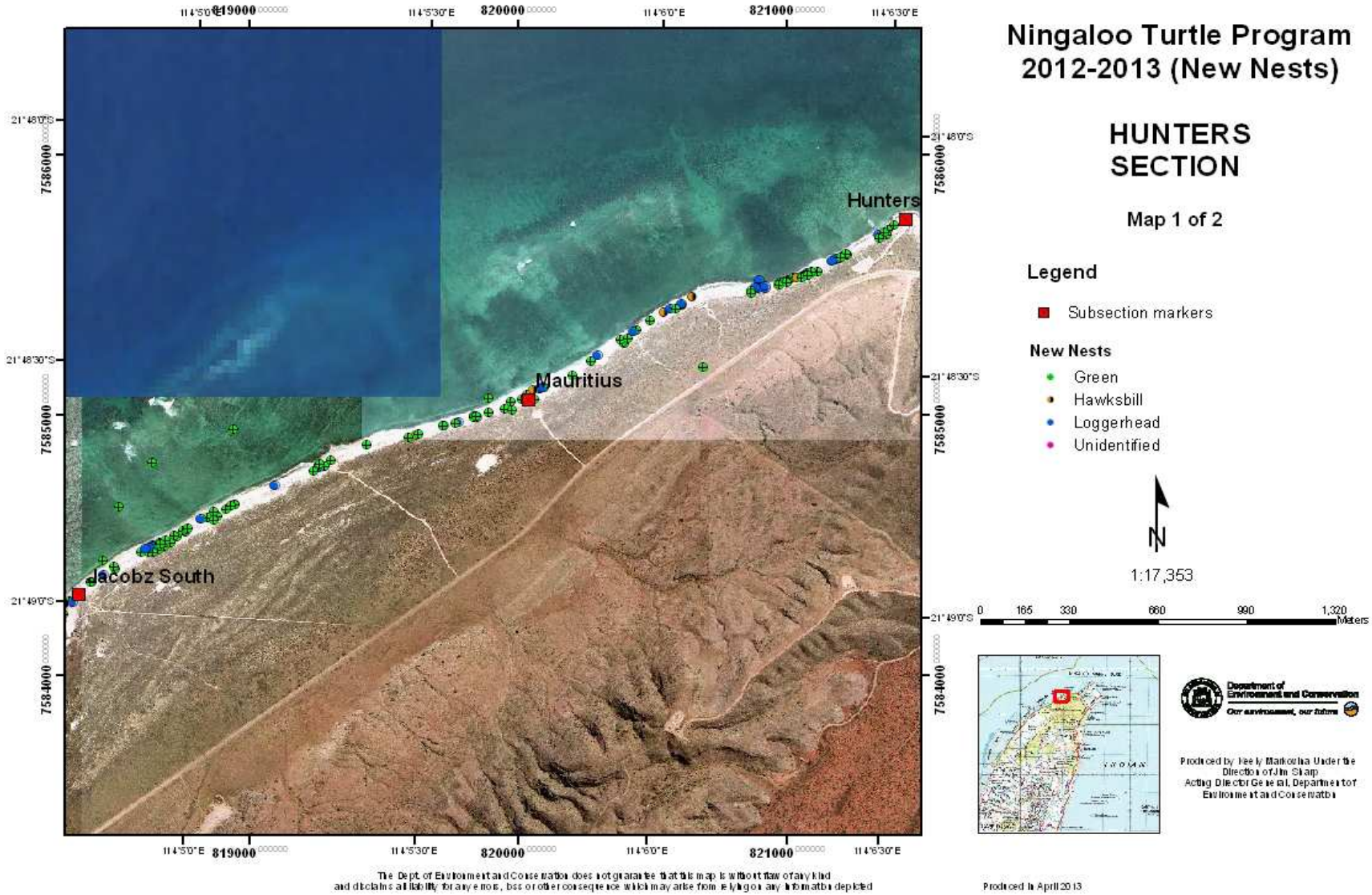
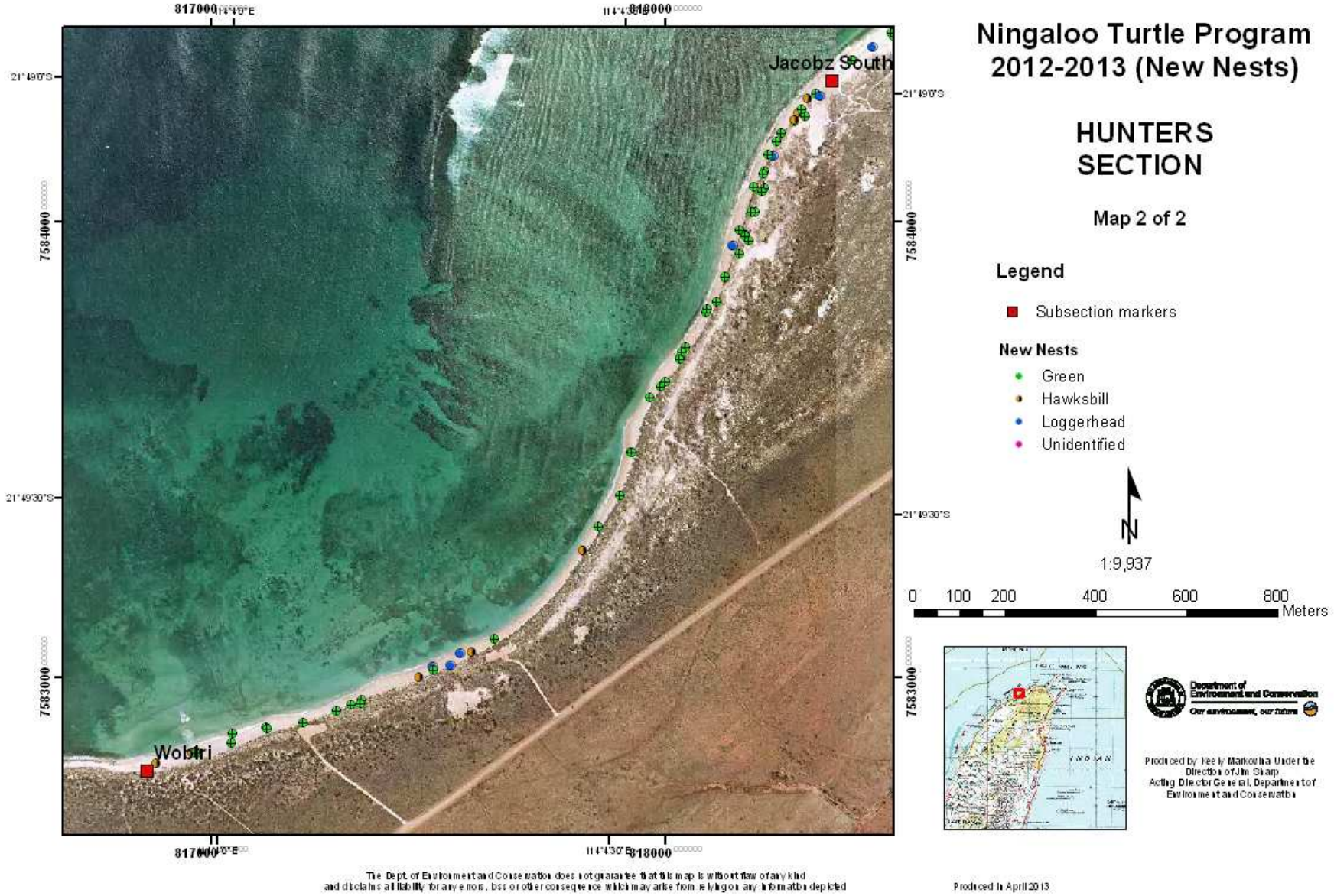
Produced in April 2013

Appendix 8: Hunters Section - Location of New Nests (NTP 2012-13) Map 1 & 2.




Ningaloo Turtle Program
2012-2013 (New Nests)
HUNTERS
SECTION
Map 2 of 2
Legend
Subsection markers
New Nests
Green
Hawksbill
Loggerhead
Unidentified
N
1:9,937
0 100 200 400 600 800
Meters
Jacobz South
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817000
818000
758400
758300
21°49'0"S
21°49'30"S
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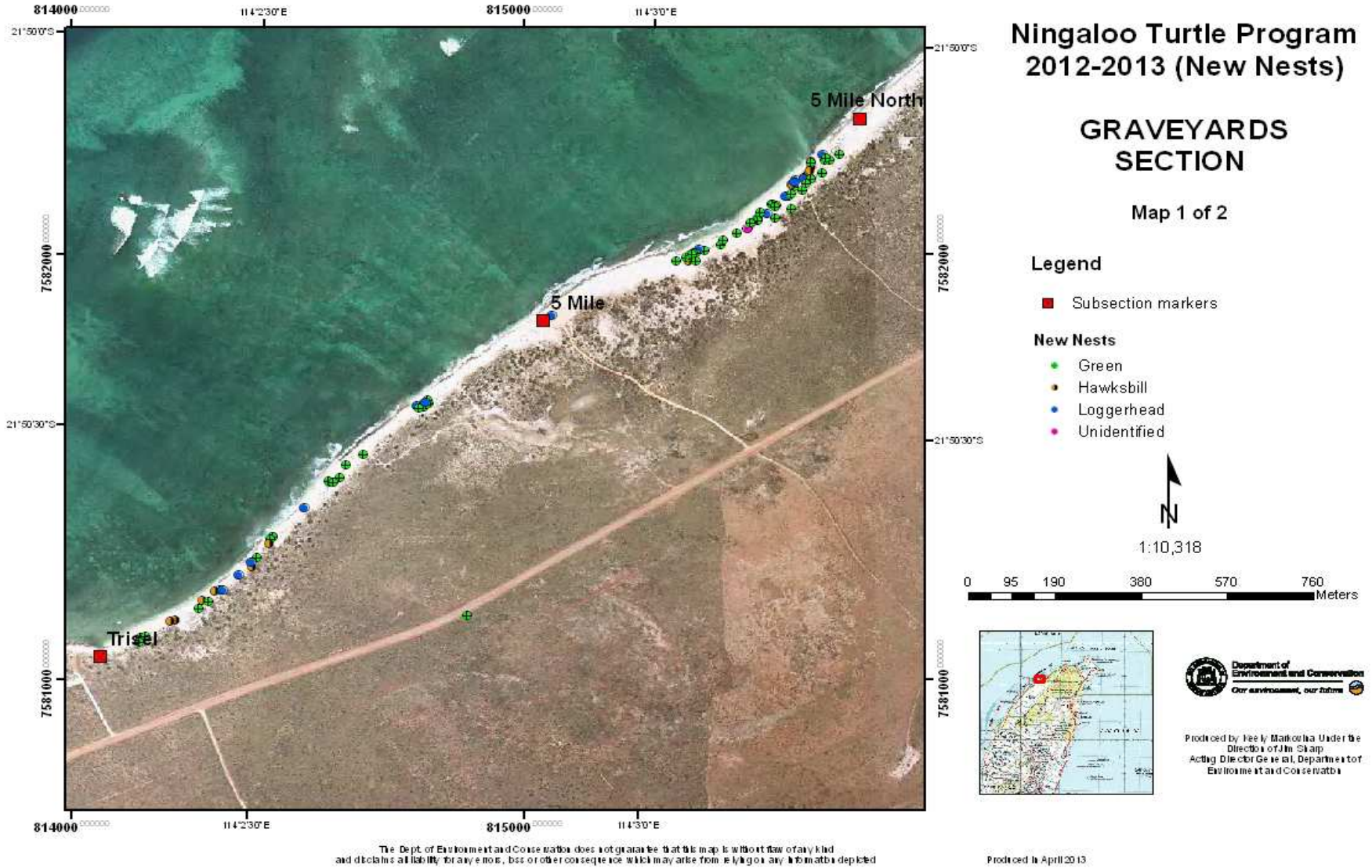
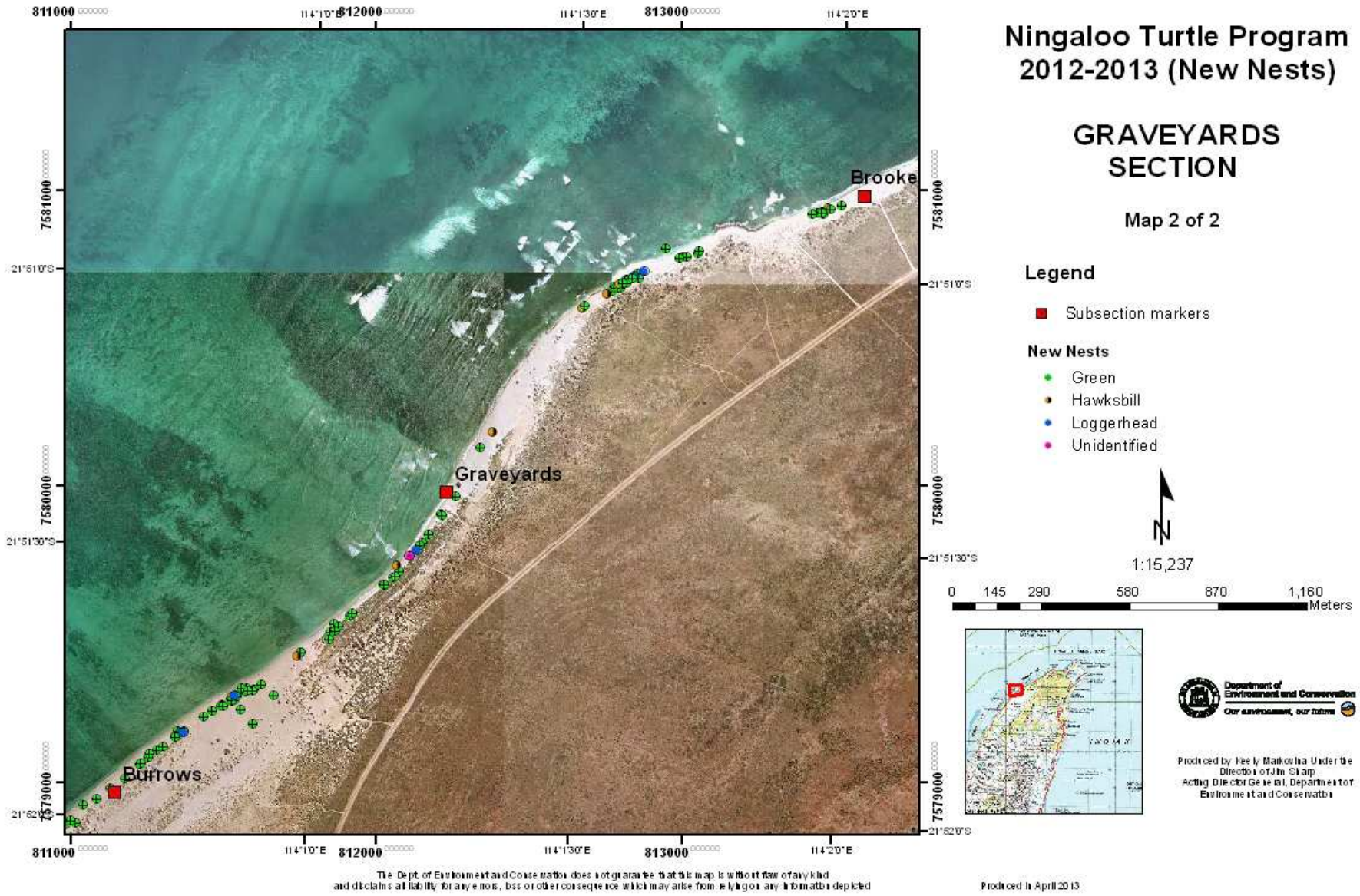
Appendix 9: Graveyards Section - Location of New Nests (NTP 2012-13) Map 1 & 2.




Ningaloo Turtle Program
2012-2013 (New Nests)
GRAVEYARDS
SECTION
Map 2 of 2
Legend
Subsection markers
New Nests
Green
Hawksbill
Loggerhead
Unidentified
Brooke
Graveyards
Burrows
811000
812000
813000
7581000
7580000
7579000
21°51'0"S
21°51'30"S
21°52'0"S
114°1'0"E
114°1'30"E
114°2'0"E
N
1:15,237
0 145 290 580 870 1,160
Meters
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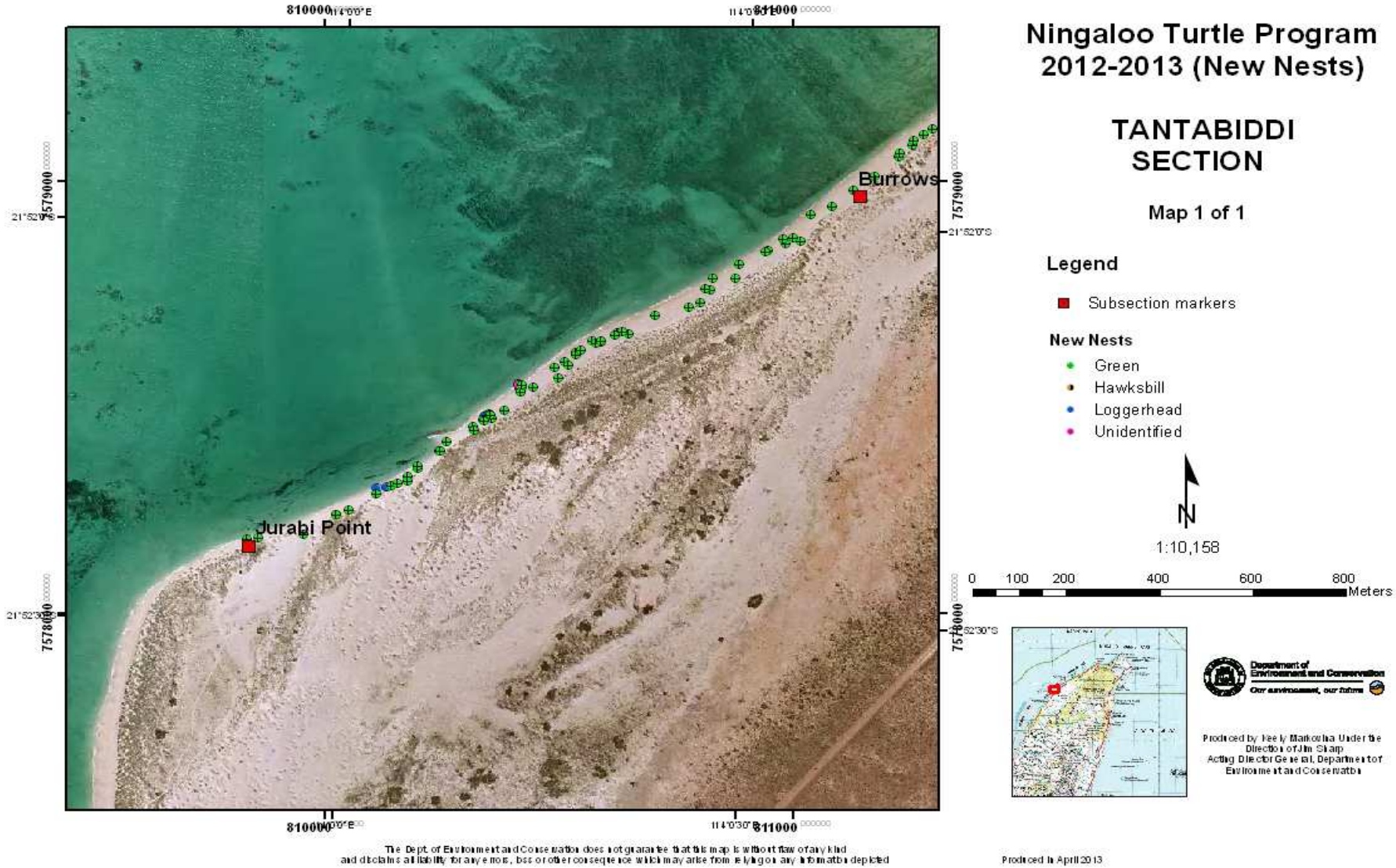
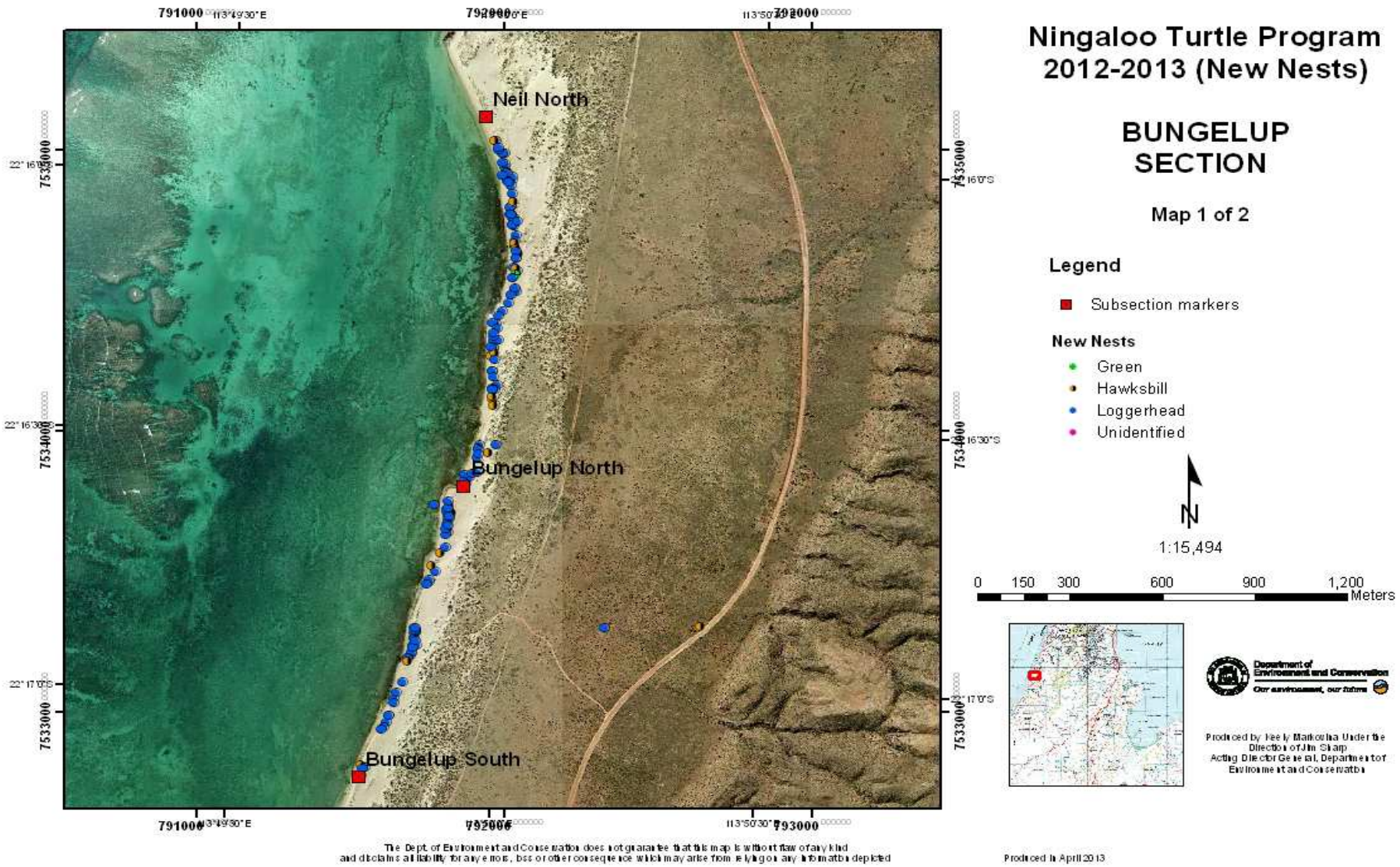
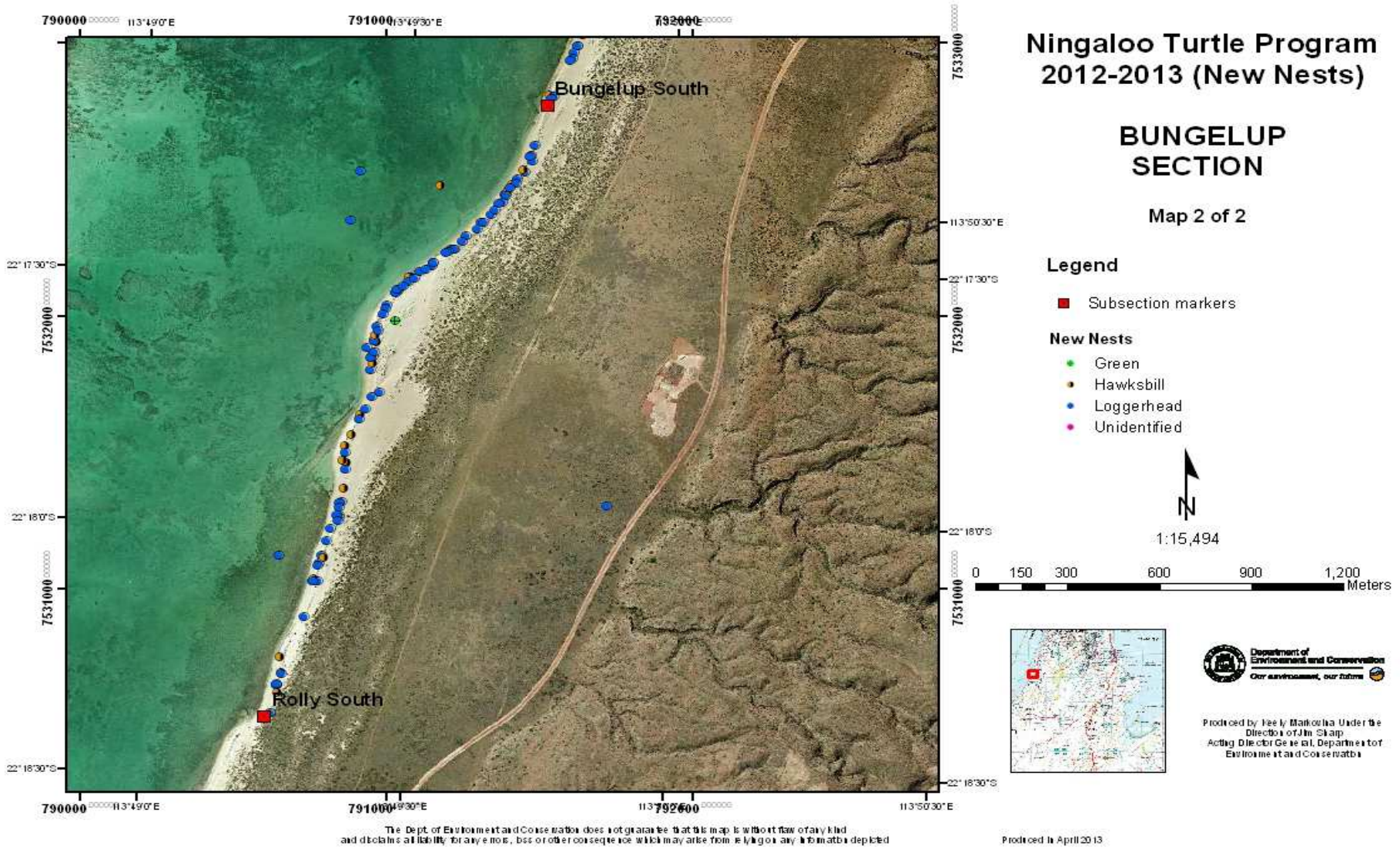
Appendix 10: Tantabiddi Section - Location of New Nests (NTP 2012-13) Map 1.



Appendix 11: Bungelup Section - Location of New Nests (NTP 2012-13) Map 1 & 2.




Ningaloo Turtle Program
2012-2013 (New Nests)
BUNGELUP SECTION
Map 2 of 2
Legend
Subsection markers
New Nests
Green
Hawksbill
Loggerhead
Unidentified
N
1:15,494
0 150 300 600 900 1,200
Meters
Bungelup South
Rolly South
790000
791000
792000
7533000
7532000
7531000
113°49'0"E
113°49'30"E
113°50'30"E
22°17'30"S
22°18'0"S
22°18'30"S
Department of Environment and Conservation
Our environment, our future
Produced by Neely Markovina Under the Direction of Jim Sharp
Acting Director General, Department of Environment and Conservation
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