Estimating the sea turtle nesting population in Terengganu 2010.

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Abstract - All four species of sea turtles in Terengganu are under severe pressure from anthropogenic impacts. Population numbers have dropped by more than 80% for Green Turtles (*Chelonia mydas*) and for the Leatherback (*Dermochelys coriacea*), Olive Ridley (*Lepidochelys olivacea*) and Hawksbill (*Eretmochelys imbricata*) turtles, nesting numbers are below 20 nests per year (Chan, 2006). Currently, nesting data is collected from official hatcheries who receive eggs from licensed turtle egg collectors. The current method underestimates the nesting population with the egg collectors preferring to sell the eggs at the market rather than to official hatcheries (DoF, 2008) and it has been suggested that only 50% of collected nests are incubated in hatcheries (Chan, 2004). Turtle track surveys which are the most commonly used tool for collecting nesting numbers on a large scale are not presently conducted on a large scale in the State of Terengganu. On the 16th June 2010 (World Sea Turtle day), which is the middle of the nesting season, a track survey commenced starting at Tanjong Jara in the south and continuing northwards to Kuala Besut. The survey lasted 10 days, covering 200km of beach and encompassing 10 islands. A total of 106 nests, 40 false nests and 60 false crawls were recorded. Using nesting numbers from tanjung tukas, (a beach within the survey area, where accurate nesting numbers have been recorded) annual numbers of turtle nests from the surveyed area were estimated to be in excess of 3095 with over 3795 nests for the whole of Terengganu. The survey estimates that double the number of nests will be laid in 2010 than were recorded in 1999. Considering an error factor of 50% (level of eggs given to hatcheries by egg collectors) in the previous population estimates the nesting numbers can be considered similar in 1999 and 2010. Unfortunately the nesting numbers in 2010 are expected to be extremely high, due to a natural cycle in sea turtle nesting regime, where some years turtles nest in high numbers and others in low numbers due to their length of migration (1-5 years). The distribution of the nests suggests the basic infrastructure for sea turtle conservation is adequate with hatcheries being present at the majority of the top 20 nesting sites. However efforts must be focused on increasing hatchery egg deposition by egg collectors. One area of concern is the 40km stretch from Merang to Bukit Keluang. WWF-Malaysia run a sea turtle hatchery in the area but numbers of nests being incubated are far lower than expected, probably because the project beinga new initiative which will take time to become established. Furthermore the highest density of turtle nests surveyed was 4.6nests/km/week. A medium density of turtle nests is considered to be above 7 nests/km/week (Canbolat, 2004) therefore it is clear to see that the nesting population of Terengganu is severely impoverished and conservation efforts must be increased before all four sea turtle species go extinct.

The following recommendations have been made;

- Repeat survey on a regular basis (weekly) to create an accurate nesting census to measure percentage of nests being incubated at official hatcheries;
- Different agencies (government, NGO's, resorts and volunteers) to be responsible for surveying different sections of beach;
- Survey the entire coastline of Terengganu;
- Ground truth survey to be conducted to account for human error;
- Increase the number of eggs being incubated – 100% for impoverished populations (Chan, 2006)
    - Ban the sale of sea turtle eggs;
    - Reduce demand for turtle eggs through education especially children;
    - Increase price paid for eggs deposited in hatcheries;
- Increase efforts for turtle conservation from Merang to Bukit Keluang;

Keywords: track survey, Terengganu, sea turtles, Setiu, population survey, egg consumption

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Introduction

Turtles evolved more than 300 million years ago, they have adapted too many environments from the dry deserts to the ocean basins. They have survived many mass extinction events including the extinction of the dinosaurs but they are now facing their biggest threat yet: man is driving them to extinction.

Malaysia is a hot spot for turtles with 18 terrestrial and freshwater species and 4 out of 7 marine species (Chan, 2004) calling Malaysia home. Marine turtles in Malaysia have declined dramatically in the last 60 years with Terengganu showing the biggest decline in Malaysia, with three out of four species being on the verge of local extinction (figures 1-4). The decline of the Leatherback turtle (*Dermochelys coriacea*) has been the most documented (Chan, 1991, 2004; Chan and Liew, 1996, 2001). Rantau Abang in the 1950's was considered the most dense leatherback rookery in the world but now nesting numbers in single figures (Chan, 1991, 2004; Chan and Liew, 1996, 2001). Just as worrying has been the decline of the Olive Ridley (*Lepidochelys olivacea*) and Hawksbill (*Eretmochelys imbricata*) turtles. The recently published Malaysia's National Plan of Action for the conservation and management sea turtles (DoF, 2008) highlighted Terengganu as the most important nesting site for the Olive Ridley turtle in Malaysia. If the Olive Ridley turtle is lost in Terengganu it can then be considered not just extinct in Terengganu but most probably in the whole of Malaysia. Another surprise is the alarmingly low nesting numbers of Hawksbill turtles within the state. Green turtles (*Chelonia mydas*) are the only marine turtle species with a significant nesting population in the state of Terengganu however their population has crashed by over 80% since the 1950's (Chan, 2006).

Sea turtle hatcheries have been run in Terengganu since the early 1960's (Chan 2004, 2006; DoF 2008) but after 50 years with continually crashing populations these measures have failed. The significant reason for this failure seems to be the inadequate number of eggs being incubated, which is rooted to the method of collection of sea turtle eggs in the state. It has been reported that less than 50% of the sea turtle eggs collected/harvested have been hatched in hatcheries (Chan, 2004), with the rest being consumed by the local human population. In 2004 the commercial harvesting of turtle eggs was limited by allocating licences for egg collection. One major flaw still remained; the sale of turtle eggs (except Leatherback turtle eggs) was never made illegal. Without making the sale of turtle eggs illegal the market continues to flourish. Legally and illegally collected eggs are being traded legally on a daily basis throughout Terengganu. The deposition of eggs into hatcheries by egg collectors is used to estimate the population status of sea turtles in Terengganu. The DoF themselves accept that 'egg collectors would rather sell the eggs at the market than give the eggs to the hatcheries' (DoF, 2008). This method for estimating nesting numbers is clearly fundamentally flawed.

There are other significant factors which have impacted the decline of sea turtles in Malaysia, however these are beyond the scope of this paper. Please refer to Chan, 2006 for a more complete overview of the status of Marine Turtles in Malaysia.

The most common technique used by turtle conservationists to estimate nesting population on a large-scale are aerial and ground track counts (Canbolat, 2004; Cape Conservation Group, 2007; Cheng et al, 2009; Handy, 2005; Laurent, 1997; Mortimer, 1988; Murphy, 1984; Rusenko et al., 2007; Sarti, et al, 1996; SCDNR, 2009; *Schroeder & Murphy, 1999;* Waller & Leong, 2007). One of the longest track surveys to be regularly conducted is along the South East coastline of the USA where Thomas Murphy started aerial counts in 1984 along the Florida and South and North Carolina beaches (SCDNR, 2009). The track surveys have also been conducted in areas where no other data has been recorded, such as Libya and Taiwan (Cheng et al, 2009; Laurent, 1997). The turtle nesting beaches in Terengganu cover 300km. The long distance and ease of access make it suitable for a track count survey because intensive data collection would not be economically viable.

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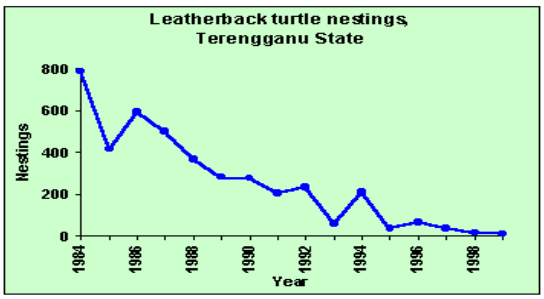

Sourced: Chan, 2009

Figure 1: Leatherback turtle nestings in the State of Terengganu

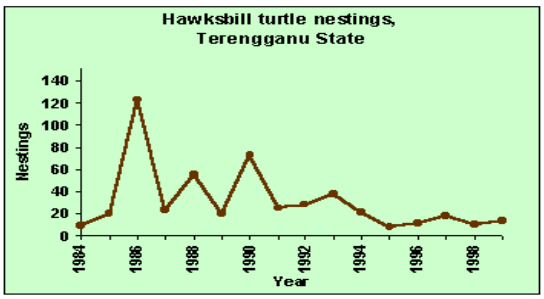

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Figure 2: Hawksbill turtle nestings in the State of Terengganu

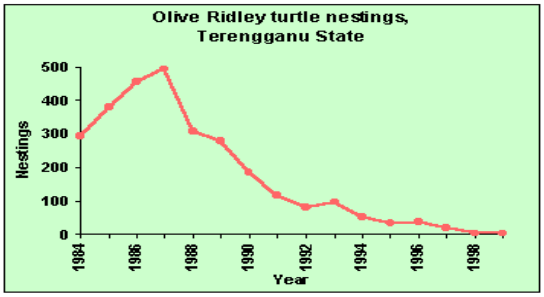

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Figure 3: Olive Ridley turtle nestings in the State of Terengganu

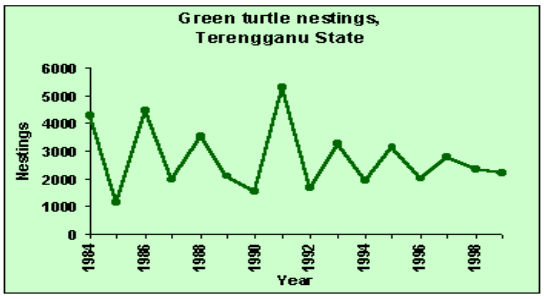

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Figure 4: Green turtle nestings in the State of Terengganu

Methodology

The track survey was conducted between 16th and 25th June 2010 during the peak sea turtle nesting season. The beach was surveyed between Tanjong Jara and Kuala Besut, including the islands of Tenggol, Kapas, Gemia, Bidong, Gemok, Pinang, Redang, Lang Tengah and Pulau Perhentian Besar and Kecil (figure 5). For ease of calculations the mainland beaches were split into sections of 5km and islands (figure 5). The surveys were conducted between 6am - 10am and 2pm - 6pm each day, each session covered approximately 10km, and each section of beach was surveyed only once. Walking along the high tide mark the team recorded all turtle tracks they encountered. Upon finding a track the team first identified the emerging and exiting tracks and then analysed the body pit for signs of nesting. If a fill-in area was present the track was considered to be a nest. For tracks with a body pit but no fill-in a false nest was recorded and if a track with no body pit was found this was recorded as a false crawl. At the point where the turtle turned back to the sea a dGPS recording was taken and the width of the track was recorded. The width of the track helps identify the species of turtle. Table 1 presents the width of track made by the four species of turtle thought to nest in Terengganu. The methodology follows that recommended by the Ningaloo Turtle Program which is considered the global standard set by the World sea turtle conservation committee for further information please refer to their field guide (Cape Conservation Group, 2007).

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Species	Track Width (cm)
Leatherback	>130cm
Green	80 – 144cm
Hawksbill	60-80cm
Olive Ridley	<70cm

Table 1: track width estimates for the four species of turtles

Track longevity is dependent on the weather and human activity. Experiments were conducted in 1987 on the longevity of tracks under different weather conditions which suggests tracks last for between 4 and 14 days with the mean being 7 days (Hirth & Ogren, 1987). Due to the variable longevity of turtle tracks when a lot of body pits and no tracks were encountered, especially in areas of high human activity, the body pits were recorded (presence of eggs cannot be confirmed). Furthermore the assumption was made that the high winds and rain of the monsoon season from November to February flattens all body pits (Hirth & Ogren, 1987) so any body-pits seen were assumed from the 2010 season. Information on the existence of body pits and no tracks was important for identifying areas where very few individuals nested or for turtles whose nesting season is slightly different for example the Olive Ridley nesting season is from February to May (DoF, 2008).

For each segment of beach and island the nesting density, relative importance and annual nestings were calculated. Various studies suggest a density of >4nests/km/day (>28nests/km/week) can be considered high density, 28>nests/km/week>7 medium and <7nests/km/week as low (Canbolat, 2004).

The Relative Importance - percentage of nests in each zone dependant on the total number of nests surveyed. The Relative Importance will be used to rank the zones in importance for turtle nestings (Canbolat, 2004; Laurent, 1997).

The annual nests for each zone were estimated using a nesting curve from confirmed nesting numbers from data collected from Tanjung Tukas, Pulau Perhentian Besar. Data on the relative percentage of nests per week from Tanjung Tukas for the years 2006 to 2009 was used to estimate the mean percentage of nests in a season to be laid during the week of the survey (figure 6). The percentage for the week the survey was conducted is 8.5% and this was used to estimate the annual number of nests for each section, and then for the surveyed area. This methodology was used previously to estimate the turtle population in Libya (Laurent, 1997).

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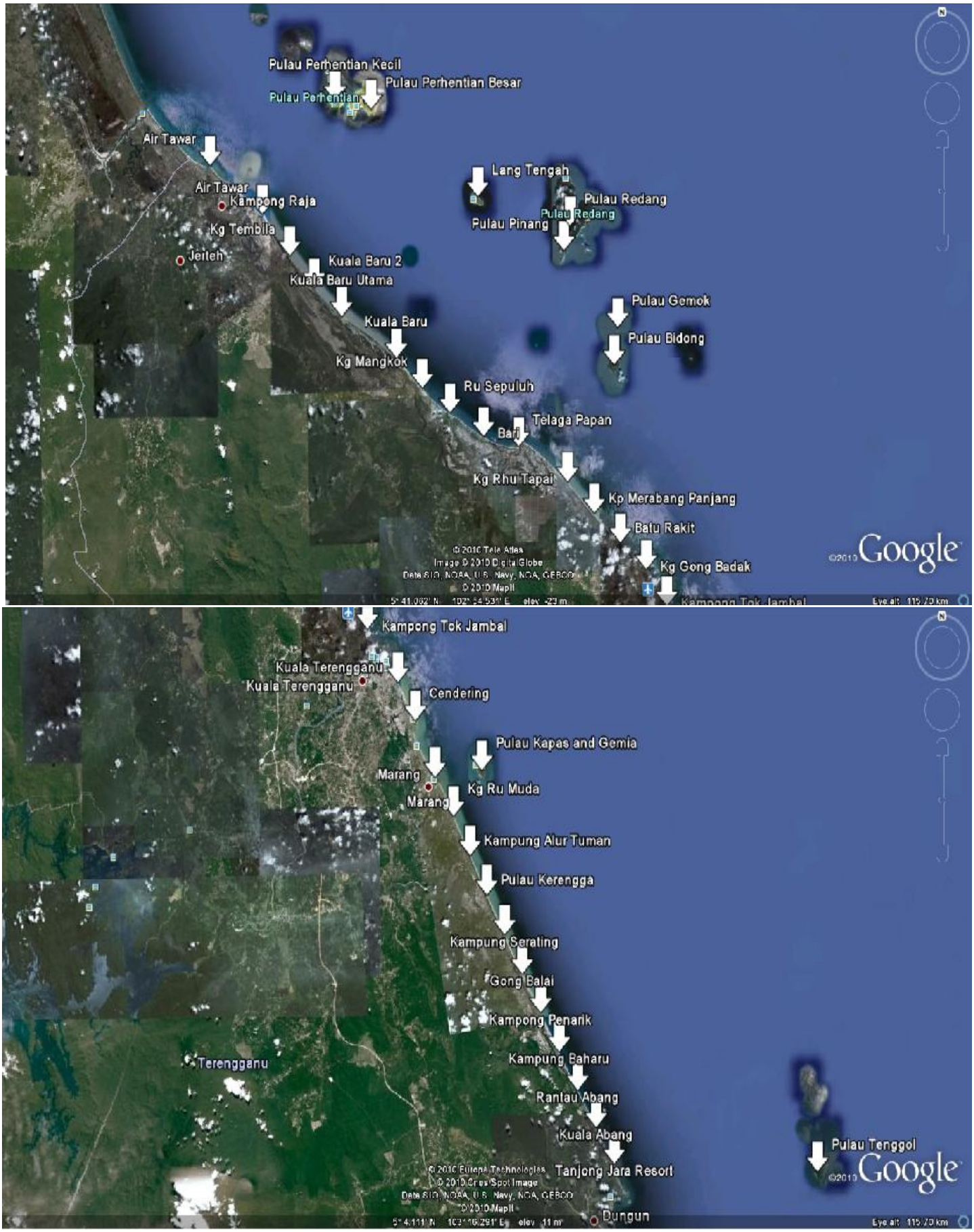

Figure 5 – Survey area.

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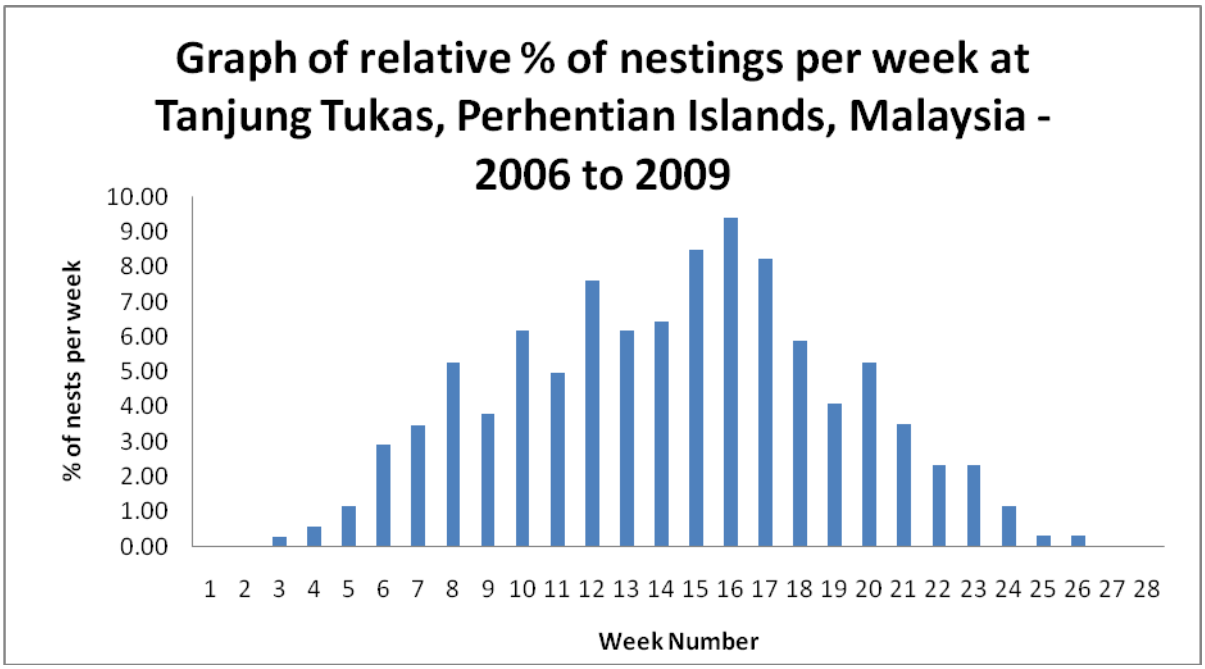

Figure 6– Relative % of confirmed sea turtle nestings per week from data collected from 2006 til 2009 at Tanjung Tukas.

Results

A total of 106 nests, 40 false nests and 60 false crawls were collected during the survey. The data was input into Google Earth and grouped into the 5km sections and islands as shown in Figure 5. To enable easier analysis the data was tabulated and weekly densities of false crawls, false nests and nests per km per week were calculated. The density of nests ranged from 4.6 nests/week/km in Bari to 0 between Kampong Penarik (near Rantau Abang) to Kampong Alur Tuman. According to previous studies, they rate high turtle nesting density to be >4/nests/day/km, medium 4<nests/day/km<1 and low below 1nest/day/km. even the highest density of turtle nestings surveyed in this study is considered low. However it is important to consider the higher density beaches on the islands of Bidong, Redang and Perhentian were not surveyed due to difficulties regarding permissions to survey the beaches.

The Relative Importance Index highlights Bari and Kuala Baru Utama as being the most important beaches which were surveyed. Through the survey it has been shown that Bari and Kuala Baru Utama are more important than the famous Ranatu Abang and Kuala Abang. The apparent extinction of sea turtle nestings on the beaches between Kg Baharu to Marang is surprising. The beach between Kg Baharu to Marang had been suspected to be an area of turtle nesting activity due to restricted access to the beach due to the Marang River. Accounts from local villagers suggest that the area previously had a lot of turtle nestings, but in the past 5 years nestings have been almost zero. The villagers blamed the use of Ray nets, which ensnare the turtles drowning them, for the declines in nesting female turtles. Ray nets were encountered close to the beach in this area during the survey which may support the villagers claims. Another issue that requires investigation is the question of whether any of the eggs laid in this area from the 1960's - 1990's were incubated in hatcheries? And if so where were the hatcheries located? Moving sea turtle eggs from one beach to another to incubate would result in the released hatchlings returning to the beach were the hatchery was, not where their mother laid them. If the eggs were either eaten by humans or moved to hatcheries on other beaches this could result in a seemingly undisturbed beach suitable for sea turtle nesting welcoming no more nesting turtles.

Resorts, Marine Parks and DoF staff were asked about turtle nesting activity on the islands of Tenggol, Kapas,

Pinang, Lang Tengah and Perhentian (big and small) this is because high human activity had covered the sea turtle tracks. The data collected through verbal communication were recorded for the current season, and for the past few years. The data collected from the islands is consistent with the trend that nesting numbers in 2010 are high. The only exception to this is the island of Tenggol whose nestings have declined from 17 in 2008 to just 3 in 2009 and a predicted level of 4 in 2010.

The graph of nesting percentage in weeks (figure 6.), demonstrates that upto and including week 15, 57.30% of the seasons total number of nests would have been laid. Using this figure we estimated the season total for the islands. Using the same graph we calculated that in week 15 8.5% of the nests would have been laid. Making the assumptions that the tracks we surveyed were an average of 7 days old and the nesting season follows the same pattern as Tanjung Tukahs we calculated estimates of the total nesting number for 2010 for each section. The results for both the islands and the mainland were then combined. Using past nesting numbers we estimated nesting numbers for the beaches we did not survey within the survey area. The estimated number of nests from the surveyed beaches was just over 1855 (figure 7). When we combined the beaches that we did not survey with the survey data the annual nesting number increased to 3095. Finally the survey area did not include the more discontinuous beaches south of Dungun where some significant sea turtle nestings are known to occur. If we include nesting estimates for the beaches at Ma'Dearah, Dungun, Paka and Cukai we have an estimate nesting number of just under 3800 nests for 2010.

Considering that only 50% of nests are deposited into hatcheries and thus recorded (Chan, 2004), the number of nests in 1999 and 2010 can be considered similar. However this portrays false hope of a stable population as 2010, as has been confirmed by this study, can be considered a naturally high nesting season.

The most important nesting beaches in the area between Tanjong Jara and Kuala Besut can be seen in Figure 8. The two most important beaches are on the island of Redang with the 3rd and 5th most important stretches being between Telaga Papan and Kuala Baru Utama near the Setiu River. The coverage of conservation projects can be considered adequate, if in this impoverished population egg protection approaches 100% (Chan, 2006). Efforts should be focused on encouraging more egg collectors to sell eggs to the hatcheries rather than at the market. More hatcheries in the Telaga Papan – Kuala Baru Utama area, particularly Bari, would reduce the travelling burden on egg collectors to deposit eggs into the hatchery, increasing the likelihood of them taking the eggs to the hatchery. An increase in egg price paid by hatcheries should also be considered, to encourage more eggs to be sold to hatcheries. The resorts in Redang in the bays of Tekuk Dalam, Long beach and Mutiara should be encouraged to assist sea turtle conservation by managing their own hatcheries which could become attractions for tourists. However resorts operating headstart programs at Gemia and Lang Tengah should be encouraged to follow guidelines set out in the DoF Standard Operational Procedures (SOP) and release hatchlings directly after they hatch.

	Annual nests	individual mothers
Surveyed beaches	1855.83	371.46
TJR to KB	3095.83	619.46
All Terengganu	3795.83	759.46

Fig 7 predicted annual nesting numbers

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Area	Annual nests	Relative Importance	Ranking	Conservation agent
Mat kepit	500.00	16.15	1	DoF
Chagar Hutang	400.00	12.92	2	UMT
Bari	270.59	8.74	3	egg collectors / WWF
Pinang	266.67	8.61	4	Marine Parks
Kuala Baru Utama	211.76	6.84	5	egg collectors / WWF
Kuala Abang	200.00	6.46	6	DoF
Perhentian Besar (Not surveyed Pinang Seribu	163.16	5.27	7	DoF / HOPE
Rantau Abang	117.65	3.80	8	Dof
Kuala Baru 2	117.65	3.80	8	egg collectors / WWF
Redang (Mutiara, long beach, Teluk Dalam)	105.88	3.42	10	NEEDS PROTECTING
Other redang beach	100.00	3.23	11	DoF
pinang seribu	100.00	3.23	11	DoF
Perhentian Kecil (not surveyed Penglime ABu0	87.72	2.83	13	DoF
Ru Sepuluh	58.82	1.90	14	egg collectors / WWF
Penglime Abu	50.00	1.62	15	DoF
Kuala Baru	50.00	1.62	15	egg collectors / WWF
Kapas/Gemia	49.12	1.59	17	Headstart - Resort
Tanjong Jara	47.06	1.52	18	???
Bidong (not umt beach)	47.06	1.52	18	???
Bidong (UMT)	40.00	1.29	20	UMT
Lang Tengah	38.60	1.25	21	Headstart - Resort
Telaga Papan	23.53	0.76	22	egg collectors / WWF
Kg Baharu	23.53	0.76	22	DoF
Gemok	11.76	0.38	24	
kg Pulau Kerengga	11.76	0.38	24	
Tenggol	3.51	0.11	26	Resorts
Kg Mangkok	0.00	0.00		egg collectors / WWF
Kuala Baru	Not surveyed			egg collectors / WWF

Fig 8: Ratings of zones starting with the most important turtle nesting beaches.

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Discussion

Sea turtle populations in Terengganu are in five main areas – Redang, Perhentian, Ma' Daerah, Setiu and Rantau Abang. The infrastructure and coverage for the protection of nesting sea turtles and their eggs is adequate, however the method of collection of eggs needs to be urgently addressed. The surveyed beaches can be considered low in nesting density and thus the turtle population in Terengganu can be considered impoverished. Therefore the DoF and relevant conservation agencies involved should seek to protect 100% of the eggs laid throughout these areas. There are a number of strategies to increase the number of eggs deposited into the hatcheries including: making it illegal to sell eggs at market, education to decrease demand, increasing the price paid per egg at hatcheries and/or operate more hatcheries to reduce travelling for the egg collectors.

The present/current survey has been a success but should be more thorough and used to identify how many nests are being protected, however manpower becomes a problem. Track surveys are conducted in many countries by using volunteers who survey a section of beach on a regular basis, for example in Western Australia (Cape Conservation Group, 2007). The annual nesting figures calculated in this survey cannot be considered accurate and can only be used as an estimate for the nesting population of marine turtles in Terengganu. The main flaws of the current survey are that it was only conducted once, made assumptions that nesting effort follows the same pattern as Tanjung Tukas, didn't include accurate data for major nesting beaches such as Chagar Hutang and Mat Kepit and no ground truthing was conducted to account for human error in identifying true nests. By sharing workloads between different agencies weekly reporting on the number of false crawls, false nests and nests can be collected to build a more accurate estimate of the nesting population, which can be used to estimate the percentage of eggs incubated in hatcheries.

The survey has highlighted the significant importance of the area of beach from Telaga Papan to Bukit Keluang, an area covering just under 40km. This area is also thought to be the nesting location for Olive Ridley Turtles (DoF, 2008) which are on the brink of extinction not just in Terengganu but throughout Malaysia. WWF are running a conservation project in this area but the project is relatively new. In 2009 the number of nests incubated in the hatchery was in single figures however 2010 has seen a promising increase. At the heart of this area around the Setiu river, Penarik and Kg Mangkok significant development has been proposed, including a very large fish farm, tourist resorts and even the creation of a new river mouth. These developments at the heart of this important turtle nesting area would cause significant environmental damage and would ultimately affect the sea turtle nesting population, probably resulting in the extinction of Olive Ridley turtles not just locally but ultimately the entire Malaysian population.

Below are recommendations for future surveys;-

- Repeat survey on a regular basis (weekly);
- Survey the entire coastline of Terengganu;
- Differentiate between fresh and old tracks;
- Different agencies (government, NGO's, resorts and volunteers) to be responsible for surveying sections of beach;
- Ground truthing to be conducted to account for human error;

Recommendations for sea turtle conservation in Terengganu

- Increase the number of eggs being incubated – target 100%
  - Ban the sale of sea turtle eggs;
  - Reduce demand for turtle eggs through education especially children;
  - Increase price paid for eggs deposited in hatcheries;
- Regular track surveys to collect accurate nest numbers which can be used to calculate the percentage of eggs being incubated;
- Ensure all agencies conducting turtle conservation follow the DoF SOP;
- Increase efforts for turtle conservation from Telaga Papan to Bukit Keluang;

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- Oppose detrimental developments in and around the Setiu River and coastline;
- Protect sub-adult and adult lifestages of nesting turtles;

It is only with accurate nesting population data, which is made public, that turtle conservation in Terengganu can have the spring board to jump up and become a global player in sea turtle conservation! The infrastructure is in place, now the agencies need to work together for the common goal of saving the turtles of Terengganu.

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