

## Distribution and abundance of marine turtles in the Socialist Republic of Viet Nam

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Received 31 August 2004; accepted in revised form 20 March 2005

**Key words:** Abundance, Conservation status, Distribution, Marine turtles, Threats, Viet Nam

**Abstract.** To establish baseline data on the distribution, abundance and threats to marine turtles in Viet Nam we conducted surveys with local fishers, community members and provincial Ministry of Fisheries staff from 17 of Viet Nam's 29 coastal provinces. These data indicate that five species of marine turtle reside in Viet Nam's waters (loggerhead, olive ridley, leatherback, green and hawksbill turtles), and four species nest on Viet Nam's beaches (all of the above except the loggerhead turtle). It is evident from these data that significant declines have occurred in both foraging and nesting populations of all five marine turtle species found in Viet Nam. The greatest current threats to marine turtle populations in Viet Nam are habitat degradation, the accidental and opportunistic of turtles capture by fishers and the direct take of nesting females and their eggs. Successful conservation efforts have been made in recent years through collaboration between international Non Government Organisations and several Vietnamese Government Ministries. Continued success of these projects and the development and implementation of marine conservation policy will depend upon building awareness among Government employees, fishers and the general public about marine turtle biology, ecology, and the need to protect them.

### Introduction

Although records of marine turtle distribution in The Socialist Republic of Viet Nam (hereafter Viet Nam) were published as early as 1777, Bourret (1941) provided the earliest assessment on the distribution of marine turtles in the Indo-China region (Dinh Hong Thanh 2002). He commented that five species of marine turtles were abundant along the entire length of the Vietnamese coast and listed four species from the Paracel Archipelago. Despite these early observations little information was recorded, and no quantitative surveys were conducted until the mid 1990s when the international Non Government Organisation (NGO) WWF, and staff from Con Dao National Park initiated an annual nesting turtle capture mark recapture project on Con Dao.

Currently, data from green turtles (*Chelonia mydas*) at Con Dao (Nguyen Thi Dao 1999), and recently initiated nesting beach surveys at Nui Chua Nature Reserve (Tran Minh Hien 2002; Tran Phong 2003) provide the only quantitative data on marine turtles in Viet Nam. In addition to this, anecdotal evidence indicates that hawksbill (*Eretmochelys imbricata*), olive ridley (*Lepidochelys olivacea*), leatherback (*Dermochelys coriacea*) and possibly loggerhead (*Caretta caretta*) turtles are also found nesting and/or residing in Viet Nam (Nguyen Thi Dao 1999; Tran Minh Hien 2002; Pham Thuoc 2003; WWF unpublished data). However, some confusion exists in Viet Nam regarding the identification of olive ridley and loggerhead turtles, and local names for these two species vary between coastal provinces. While it is likely that both species exist in Viet Nam's waters, whether either or both of these species nest in Viet Nam is yet to be resolved (Nguyen 1978; Dinh Hong Thanh 2002; Tran Minh Hien 2002; Pham Thuoc 2003).

Turtles, both marine and freshwater species, have been an important part of Vietnamese culture for centuries (Pham Thuoc 2003). Uses include placing stuffed turtles in the foundations of homes for good luck, production of turtle shell products, production of traditional medicines and food. While it is difficult to quantify the size and scale of these uses, several authors have documented a recent large-scale domestic and international trade of turtle products, which includes marine turtles (CRES 1994; Le Dien Duc and Broad 1995; TRAFFIC Southeast Asia-Indochina 2004). However, it should be noted that while international trade of marine turtle products has been illegal in Viet Nam since the Vietnamese Government became a signatory to CITES in 1994, prohibition of domestic use of marine turtles was not established until April 2002 (Decree 48/2002/ND-CP).

In order to promote the protection of marine turtles, the Vietnamese Government became a party to two regional memoranda of understanding (MoU): MoU on ASEAN Sea Turtle Conservation and Protection (ratified in 1997) and the MoU for the Protection of Marine Turtles and their habitats in the Indian Ocean Southeast Asian Region (IOSEA – ratified in 2001). Additionally, in 2002 the Vietnamese Ministry of Fisheries (MoFI), with the assistance of international NGOs, began a multi component project to develop conservation strategies for the protection, conservation and remediation of marine turtle populations and their habitats. This project included specific components addressing issues such as local and international trade, Government and public awareness-raising, a survey of current marine turtle populations, and the development of a national action plan for the protection of marine turtles. The objectives of the present paper are (1) to present the results from baseline surveys aimed to document current and historical distribution, abundance, and current threats for marine turtles and their habitats in Viet Nam and (2) to discuss these results within the context of marine turtle conservation in Viet Nam and Indochina.

## Methods

### *Choice of villages and families*

We visited 17 of the 29 coastal provinces in Viet Nam (Figures 1–5); they were selected if they had coastline deemed suitable for turtle nesting (i.e. sandy beaches or a fishing port. In each of the 17 provinces, we consulted with local Fisheries Resource Protection Department staff (FRPD is a sector of the Vietnamese Ministry of Fisheries and has officers located in each coastal province). A local FRPD staff member in each Province accompanied us to the various villages and acted as an intermediary by introducing us to the People’s Committee members and fishing families. In each village

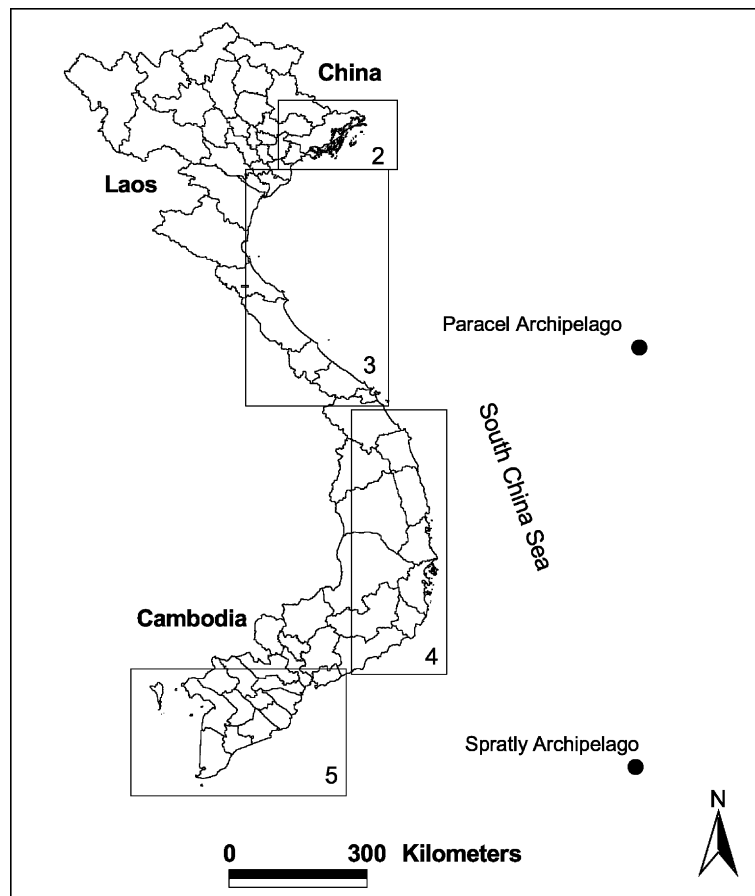


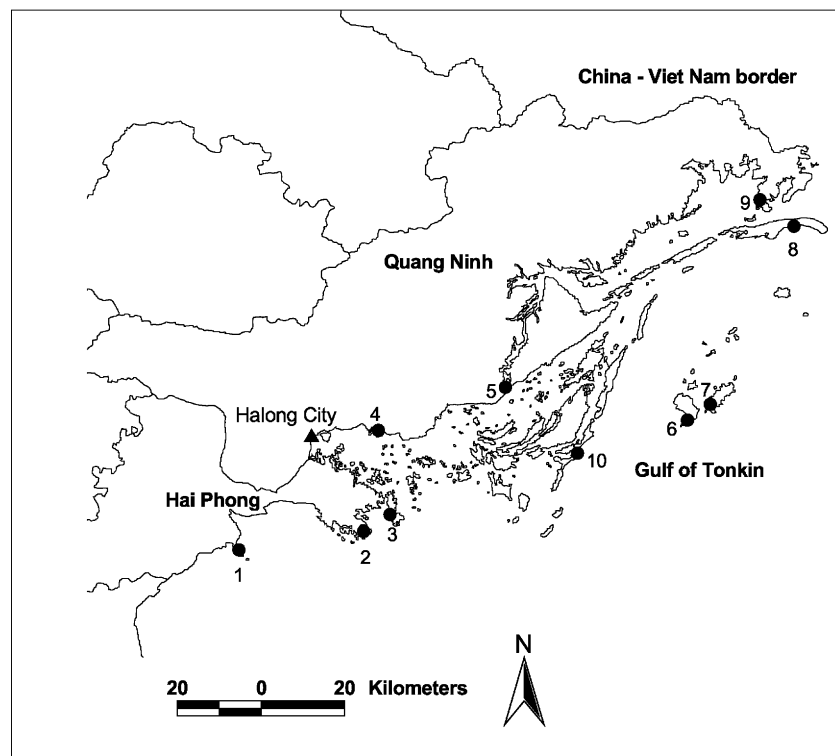
Figure 1. Regional location of the Socialist Republic of Viet Nam and offshore archipelagos.

we aimed to interview two families. To verify answers or peculiar information we spoke to as many members of each family, Peoples Committee representatives and people that worked in different fisheries sectors as possible.

### *Survey questions*

A standard questionnaire was developed and used as a basis for all interviews. Essentially, component questions were geared towards discovering;

- (a) Whether marine turtle nesting beaches exist, or existed, in the local area
- (b) What species of turtles nest, or used to nest, on these beaches
- (c) Estimates of the size of the nesting population
- (d) Whether fishers directly or indirectly catch, or used to catch, marine turtles at sea and what methods of fishing gear they use



*Figure 2.* Northern provinces of Viet Nam visited during this study; 1, Do Son; 2, Cat Ba; 3, Dau Be; 4, Ha Long City; 5, Van Don; 6, Co To Island; 7, Thanh Lan Island; 8, Vinh Thuc; 9, Tra Co; 10, Minh Chau/Quan Lan.

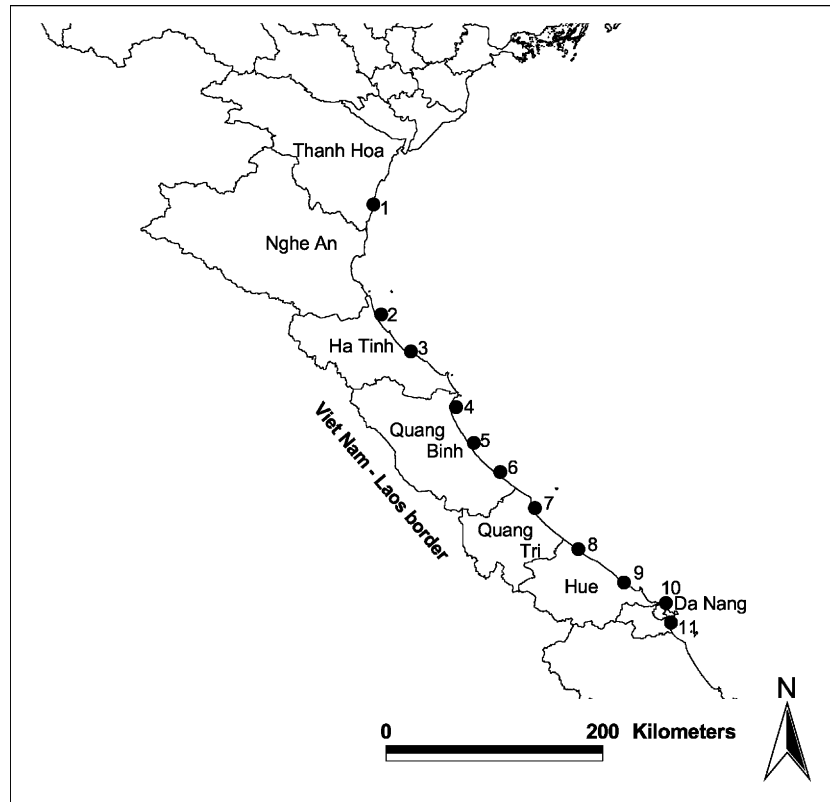


Figure 3. Northern-central provinces visited during this study; 1, Nghi Son/Hai Thanh; 2, Thach Kim; 3, Xuan Song; 4, Bao Ninh; 5, Xuan Hoa; 6, Ngu Thuy; 7, Gio Linh; 8, Phu Vang; 9, Lang Co; 10, Son Tra; 11, Dien Ban.

- (e) What species, gender, size and age class of marine turtles fishers catch or used to catch
- (f) Catch rate and mortality rate estimates (past and present)

We asked several specific questions of each of the respondents to gain confirmation of species, and the distribution or abundance of marine turtles. The remaining questions were less structured and were designed to encourage open discussion. We acknowledge that the data we received, and the conclusions we draw from them, are limited by the memory and experience of the respondents.

To confirm species identifications, a series of unlabelled photographs were shown to each respondent. This group of photographs contained several different photographs of each species at both adult and juvenile stages. As a negative control we included photographs of a species that does not occur in the South China Sea, the flatback turtle (*Natator depressus*). Most identification difficulties by respondents involved distinguishing between loggerhead and

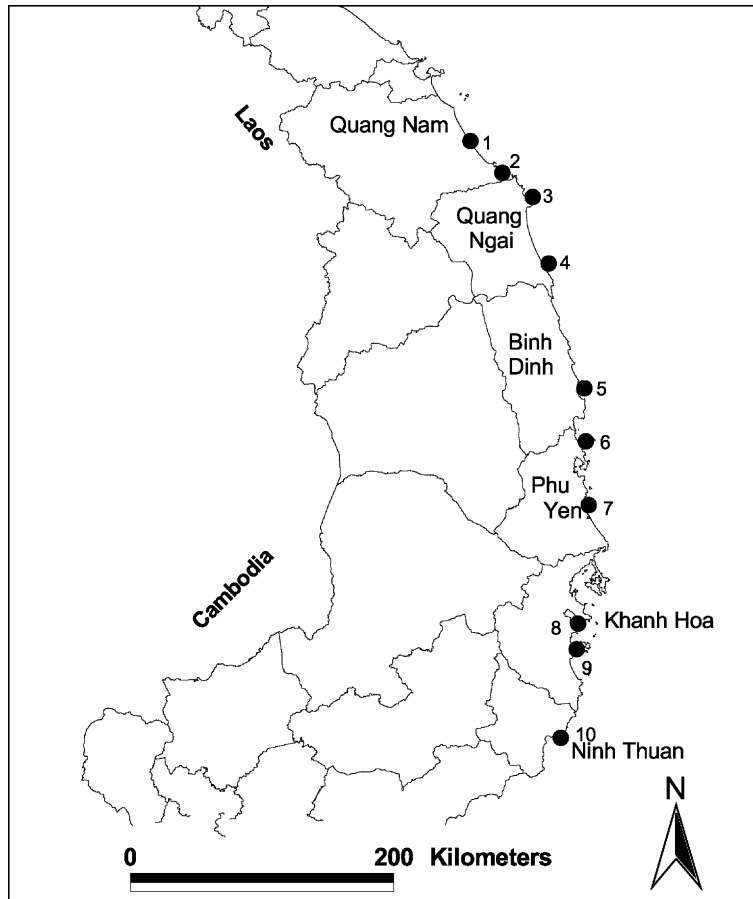


Figure 4. South-central provinces visited during this study; 1, Tam Tien; 2, Binh Thuan; 3, Duc Phong; 4, Pho Quang; 5, Ghenh Rang; 6, Xuan Hai; 7, An Phu; 8, Bai Tien/ Bai Xep; 9, Ninh Van; 10, Nui Chua.

olive ridley turtles, or between olive ridley and green turtles. However, by using the photographs and asking for specific descriptions about morphology, nesting behaviour and colour we were able to resolve most cases.

### Results and discussion

In total we interviewed 79 people from local Government or Peoples Committee agencies; including Government staff that worked on three offshore islands, and 234 individuals from 152 families involved in fishing or the fishing industry from 48 villages (Table 1). Data from these interviews are summarised

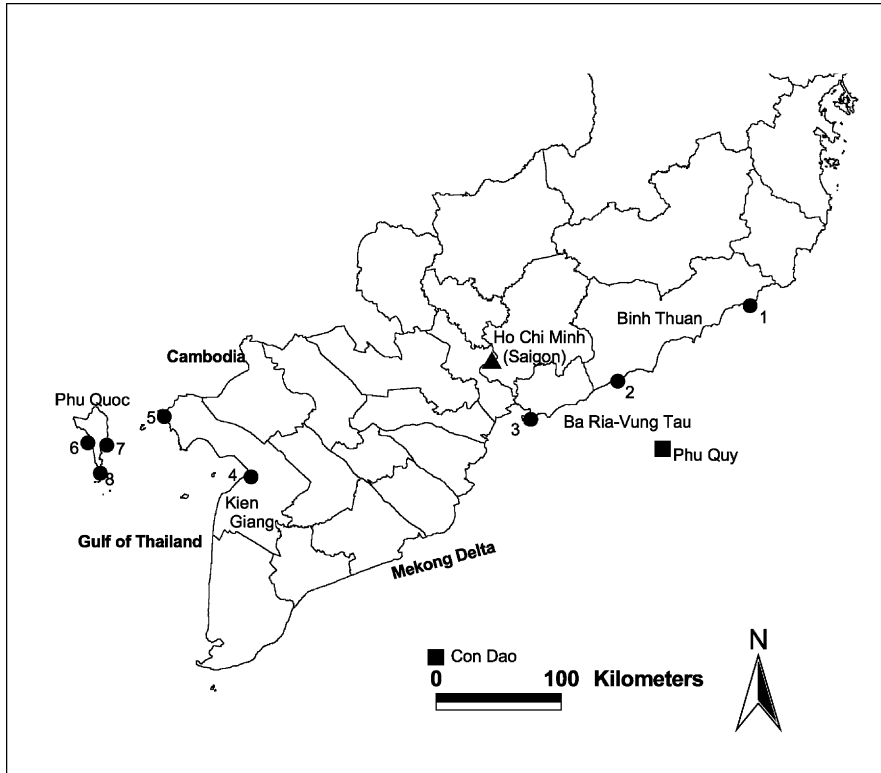


Figure 5. Southern provinces visited during this study; 1, Phuoc The; 2, Tien Thang; 3, Vung Tau; 4, Rach Gia; 5, Ha Tien; 6, Duong Dong; 7, Ham Ninh; 8, An Thoi.

discussed with regard to their relevance to Vietnamese and regional marine turtle conservation programs.

#### *Foraging turtles – capture rates in fisheries*

Documenting the presence or absence of marine turtles along sections of the Vietnamese coastline was dependent upon the principal type of fisheries that existed within the area. Our data indicate that marine turtles are widespread along the Vietnamese coastline, but not abundant; we recorded the presence of marine turtles in all 17 provinces. The average incidental catch rates per province varied from one turtle every 5 years up to 10 turtles being caught per year. However, it should be noted that the larger incidental catch rates were generally in net-based fisheries that specifically target fish species that reside in shallow water inshore habitats such as coral reefs and seagrass pastures. With regard to catch per unit effort, the largest current source of fisheries based marine turtle mortality occurs as a result of either direct harvest using specially

Table 1. Summary of villages visited and number of survey responses (\* refers to non independent responses; these responses were summarised from a group meeting in the village or Government office).

Province	Villages visited	Survey responses	Government staff responses
Hai Phong	1	4	4
Quang Ninh	8	62	11
Thanh Hoa	2	7	3
Ha Tinh	2	14	3
Quang Binh	3	6	4
Quang Tri	1	15	2*
Thua Thien Hue	2	13	5
Da Nang	2	6	3
Quang Nam	2	7	4
Quang Ngai	3	13	5
Binh Dinh	2	3	2*
Phu Yen	4	36	2*
Khanh Hoa	2	5	5 + 3 IUCN regional staff
Ninh Thuan	2	10*	5
Binh Tuan	2	6	5
– Phu Quy Island	0	0	2*
Ba Ria – Vung Tau	1	4	3
– Con Dao	0	0	2*
Kien Giang	6	23	3
– Tho Chu Island	0	0	1

designed nets, or opportunistic harvest by divers seeking other commercial species such as molluscs or crustaceans. However, it is apparent from our data that few fishers now directly target marine turtles because of dramatically lowered catch rates over the last five years. Indeed, we only found seven coastal communities in which a concerted effort is still made by at least one family to catch marine turtles.

#### *Foraging turtles – use*

The use of marine turtles by fishers was highly variable both within and between communities and generally represented one of three categories: released to the sea, eaten or sold (in part or whole). In general many Vietnamese fishers, especially those in northern Viet Nam, held superstitious beliefs that capturing a marine turtle would bring bad luck to their families. However, despite this, 25% of fishers in Quang Binh Province indicated that while their grandparents returned most turtles to the sea because of superstitious beliefs, in contemporary society most turtles would be brought back to shore and shared among the family for food.

The commercial use of marine turtles was centred among the central and southern provinces, and each person interviewed in this study indicated that the scale of this use had diminished considerably over the last 5 to 10 years



because fewer turtles were caught. We did find green turtle meat for sale at both a market at Ha Tien and at a restaurant on Phu Quoc, and hawksbill turtle were widely available in shops in many major coastal Vietnamese towns and cities. Indeed, TRAFFIC report that during 2002 approximately 28,000 individual items made from hawksbill turtle were for sale in Viet Nam (TRAFFIC Southeast Asia-Indochina 2004). However, in this report TRAFFIC provide no data on the turnover of these hawksbill shell items in stores. Hence there is no data from which to draw conclusions about supply rates. Although previous authors noted a presence of commercial turtle ranches, our data, and those collected by TRAFFIC Southeast Asia-Indochina (2004) indicate that these operations have been discontinued. However, in Ha Long Bay we found two locations where both green and hawksbill turtles were being kept in holding pens adjacent to floating seafood restaurants as a sight for tourists. The cost quoted to buy the turtle for food or to be released into the sea was in the order of \$100USD. In general the data we collected on the capture and use of marine turtles in Viet Nam paralleled those collected in recent trade surveys (see TRAFFIC Southeast Asia-Indochina 2004).

#### *Species summaries for Viet Nam*

##### *Loggerhead turtle (Caretta caretta)*

Nguyen Thi Dao (1999) suggested that (1) loggerhead turtles were once the most numerous species of marine turtle in Viet Nam, (2) a hybrid clutch of loggerhead and green turtles were found at Con Dao, and (3) olive ridley turtles are not present in Viet Nam. In contrast, our data indicate that;

1. Loggerhead turtles do not currently nest along the coast, and if there was historical nesting it has not occurred since the 1960s.
2. Viet Nam has nesting and foraging populations of Olive Ridley turtles (see below).
3. The 'hybrid' hatchling pictured in Nguyen Thi Dao (1999) has five costal scales (both left and right), consistent with loggerhead turtles. However, abnormal scale counts occur relatively frequently in hatchling marine turtles of other species (e.g. Hewavisenthi and Kotogma 1989; Mast 1989; Guinea 1990; Schäuble et al. in press) and so it would not be considered unusual for olive ridley turtle hatchlings to have five, rather than six, costal scales.

Data we collected from survey respondents indicate that sightings and accidental captures of loggerhead turtles are rare, and captures and/or sightings have only occurred in (1) the waters around Co To and Thanh Lan Islands (Quang Ninh Province) or (2) the coastal waters of the south-central provinces Quang Ngai to Ninh Thuan. Indeed, only three (of six) of the fishers that we spoke with at Co To/Thanh Lan, five (of 13) in Quang Ngai and two (of five) in Khanh Hoa and had accidentally caught a loggerhead turtle while fishing and none were caught in the after 2001. In each case captured turtles were taken back to the village and shared for food. Aside from these capture data a

sub-adult sized loggerhead turtle was caught after it was stranded by low tide in a shallow reef area within the Nui Chua Nature Reserve by reserve staff in 2002; this turtle was released to the sea.

Limited data makes it difficult to determine whether numbers of loggerhead turtles residing in Viet Nam's waters have changed or remained stable over time. However, large declines in the two Pacific Ocean breeding populations have occurred (Limpus and Couper 1994; Suganuma 2002). This coupled with the recapture of a female loggerhead in Viet Nam that was originally tagged while nesting in Japan (Sadoyama et al. 1996), suggest that foraging populations in the Vietnamese region are linked to the wider region and are likely to have suffered at least some level of decline.

*Leatherback turtle (Dermochelys coriacea)*

It is our conclusion that historically (gt 30 years ago), nesting by leatherback turtles would have been relatively common along the central coast beaches of Viet Nam. Extrapolating from our survey findings, gained predominantly through speaking with elder fishers, we estimate that three decades ago the annual nesting population was in the order of 500 females per year spread throughout the central provinces from Quang Binh south to Binh Thuan. In particular, three elderly fishermen in Quang Ngai (Binh Son district) and two elderly fishermen in Binh Thuan (Bai Xep commune) said that prior to 1960s between 10–20 and 20 leatherback females nested per night during June–August. It now appears that the annual leatherback turtle nesting population in Viet Nam is fewer than 10 nests per year and those nests are mostly laid along beaches of Quang Ngai and Binh Dinh Provinces. The major impacts on the leatherback turtles in Viet Nam have been (1) coastal and offshore fisheries such as gill nets and bottom trawling and (2) the harvest of eggs along most of the leatherback's nesting range.

Our data indicate that current catch rates of leatherback turtles in gill nets and bottom trawlers is one turtle every 2 years per province in the six central Vietnamese provinces of Ha Tinh, Quang Tri, Thua Thien Hue, Quang Ngai, Binh Dinh, and Khanh Hoa. Moreover, based on evidence from overseas fisheries (McCracken 2000), and because there are approximately 12000 long line vessels operating in Viet Nam's exclusive economic zone (Asia Development Bank 1999), long line fishing may pose a serious, and as yet unquantified, threat to leatherback turtles in Viet Nam and the broader Southeast Asian region. This potential impact warrants investigation.

While the difficulties associated with searching for turtles along long open beaches at night prevented many nesting leatherback turtles from being eaten, each respondent in the provinces of Quang Ngai and Binh Dinh that recalled leatherback turtle nesting also told us that close to 100% of the eggs laid would have been, and still were, collected for food by people residing in villages adjacent to the beach. We found no evidence that a commercial trade in leatherback turtle eggs existed at any time in Viet Nam. Reasons provided why female turtles were not targeted for food were that clutches of eggs were easier

to find because fishers would patrol the beaches by boat in the morning while they were out setting gill nets close to shore.

*Olive Ridley turtle (Lepidochelys olivacea)*

According to Bourret (1941) olive ridley turtles were the most common species nesting in Viet Nam. Similarly, it is our conclusion that olive ridley turtles were once commonly found nesting along most of the outer islands of Bai Tu Long Bay (Quang Ninh Province) and along the beaches of the central coast of Viet Nam (Ha Tinh through to Phu Yen). Although it is difficult to place a figure on historical or current nesting population sizes; based on results from interviews conducted in these provinces we estimate that at least several hundred females nested along the Viet Nam coast each year during the 1970s and 1980s.

While our data indicate very low density and low frequency nesting was recorded from beaches in Ha Tinh, Thua Tien Hue, Quan Nam, Binh Dinh and Phu Yen, we found that the main nesting sites for this species are now confined to; Quan Lan Island in Quang Ninh Province (less than 10 nests per year), Son Tra Peninsula in Da Nang City (less than 10 females per year) and scattered along the sandy coastline of Quan Binh Province (less than 20 nests per year). On Son Tra Peninsula we visited Bai Tre beach (16 deg 05'991 N and 108 deg 16'939 E) on the 21 July 2002 and found 15 recent olive ridley tracks and 10 old body pits. Following up on this trip the provincial staff from MoFI in Da Nang City conducted daily or weekly surveys of all beaches on Son Tra Peninsula between September 2003 and March 2004 and these surveys did not record any nests or turtles, although it is likely that these surveys missed the optimal nesting period in this location (June/July).

The largest threats to olive ridley turtles in Viet Nam have been, and still are (1) their incidental capture in fishing gear, particularly bottom trawl nets and gill nets and (2) the harvest of eggs along most of their nesting range. Of particular concern is that in at least five Provinces (Ha Tinh, Thua Tien Hue, Quang Ngai, Binh Dinh and Phu Yen) captures of females with either large vitellogenic follicles in the ovary and/or oviducal eggs during are relatively common. This suggests that these females are being caught during courtship or in their inter-nesting period. Similar to leatherback turtles, each of the respondents that reported olive ridley nesting along the Viet Nam coast indicated that close to 100% of eggs would have been, and still were collected for consumption by people residing in villages adjacent to the beach. We found no evidence that a commercial trade has existed at any time in olive ridley eggs.

*Hawksbill turtle (Eretmochelys imbricata)*

In the early 20th century hawksbill turtles were regarded as relatively common along the entire Vietnamese coastline (Bourret 1941). Since then, several authors have conducted surveys of the hawksbill turtle trade in Viet Nam; each has concluded that widespread and large-scale commercial trade exists and has probably done so for decades (This study; Baird 1993; Le Dien Duc and Broad 1995; TRAFFIC Southeast Asia-Indochina 2004). This commercial trade has

largely been unmonitored and unregulated, and little information exists from which to estimate historical nesting or foraging population sizes for hawksbill turtles. However, our data indicate that for several decades local fishers routinely caught nesting hawksbill turtles and collected their eggs from beaches in Ha Long Bay (Dau Be [three beaches], Ba Hoa and Gio Cung). Indeed, prior to 1980 fishers were able to collect around 10 clutches per night on each of the beaches and the collection of nesting turtles was large enough to support regular (approximately annual) shipments of around 200 stuffed turtles per occasion to national and/or international markets. These beaches are now semi-settled by fishing families that reside on board their boats and turtle nesting is rare. In the late 1980s there were attempts by local fishers to establish a headstart program at Ang Tham, a natural, shallow sea-water crater in Ha Long Bay, to rear hawksbill hatchlings to supply a commercial market. This project reared 150 hatchlings for 3–4 years before the project was abandoned because the turtles kept escaping.

Additionally, although data are limited, it is likely that scattered hawksbill nesting occurs on the islands in the Gulf of Thailand offshore from the southern Viet Nam Province of Kien Giang (this study) and on the islands in the Spratly Archipelago (Chu The Cuong et al. in press). In Kien Giang Province (bordering Cambodia) turtle rearing facilities operated throughout the 1970s and 1980s. Eggs for these facilities were sourced from Vietnamese and Cambodian islands in the Gulf of Thailand such as Tho Chu, Phu Quoc, Hong Ong and Hong Ba (this study, but also see CRES 1994 and TRAFFIC Southeast Asia-Indochina 2004). While it remains unknown how many of these turtle rearing facilities operated or how many turtles they raised, one respondent in our study was a former employee at a facility at Hon Mat. He indicated that this facility reared in the order of a 1000 hatchlings each year throughout the 1980s, and there were three or four other facilities of a similar size within the district. They all ceased operation in the early 1990s (this study; TRAFFIC Southeast Asia-Indochina 2004). Few data are available from the Spratly Archipelago, however recent surveys by Vietnamese and Chinese researchers indicate that current nesting is low, perhaps 10s of nests per year (Cheng 2000; Chu The Cuong et al. in press); there are no indications of historical trends in these islands. Overall, our data indicate that large scale declines in nesting numbers have occurred in Viet Nam for this species and current nesting is limited to less than 10 clutches per year in both the Gulf of Tonkin and Spratly Archipelago and negligible in Gulf of Thailand.

Aside from the impacts of egg collection and hunting of nesting turtles, data from our survey and those collected during trade surveys (see TRAFFIC Southeast Asia-Indochina 2004) indicate that Vietnamese populations of hawksbills have been exposed to both direct harvest and accidental capture over the last three decades. This combined take of hawksbill turtles has mainly occurred in provinces that have offshore islands and/or coral/rocky reef systems, in particular; Quang Ninh and Hai Phong on the north coast, Da Nang City to Binh Thuan on the central coast and Kien Giang on the south coast.

Although data on historical catch rates are not available, over 80% of fishers we interviewed from these provinces indicated that catch rates of hawksbill turtles were regular 10–20 years ago, and had declined significantly in recent years. Indeed, one family that made their living from catching and selling hawksbill turtles in the late 1970s mentioned that they were able to catch around 200 turtles per 2 months fishing trip to the islands and reefs in the Gulf of Thailand. Now, fishing in the same region, they only catch one or two per year opportunistically as they dive for crustaceans. Moreover, we found no families that continue to target hawksbill turtles and the majority of hawksbill turtles caught are opportunistic captures by divers that target commercially important crustaceans and molluscs. Although our data indicate that the combined annual take of hawksbill turtles from the waters off the southern coast of Viet Nam and the Gulf of Thailand could be in the order of a hundred turtles per year, sightings and captures in the northern waters are rare. For example, one of us (CTC) has accumulated 100 h SCUBA diving on coral reefs in northern Viet Nam as part of regional coral reef check and has not seen a turtle.

Regionally, apart from the rookeries in the turtle islands of Sabah (Malaysia), most Southeast Asian populations of hawksbill turtles continue to decline (Meylan and Donnelly 1999). Hence, because legislation prohibiting the domestic commercial trade of hawksbill turtles was not established until 2002, and given the volume of hawksbill turtle products for sale in Viet Nam in 2002, it is likely that the Vietnamese hawksbill turtle population(s) have undergone declines as well.

Although there have been no economic surveys of the trade in hawksbill turtles in Viet Nam, our data and previously published trade surveys indicate that the hawksbill turtle trade could have been an important sector of the economy in some coastal communities, especially those in the Ha Long Bay, Nha Trang, Phu Yen and Kien Giang (this study; TRAFFIC Southeast Asia-Indochina 2004). Even today, with highly reduced catch rates, opportunistic capture of a hawksbill turtle can mean a significant injection of cash into household income. Indeed, the price for a fresh hawksbill turtle when sold to the market or middlemen is in the order of 100,000VND (~\$6 USD) per 10 cm of shell length (this study; TRAFFIC Southeast Asia-Indochina 2004). Hence a medium sized hawksbill turtle (~50 cm shell length) can yield a monetary value well exceeding the minimum monthly salary of a Vietnamese Government employee [290,000 VND] (as per Government decree No 03/2003/ND-CP effective February 2003).

The commercial use of hawksbill turtles in Viet Nam is an issue warranting urgent attention if local and regional population(s) are to be managed effectively. To address this problem in 2002 the Vietnamese Government developed and implemented legislation to prohibit or control the domestic use of marine turtles, they have worked cooperatively with donor agencies and International NGO groups to address these issues. Central to this have been a series of education and awareness activities and publication of leaflets that target

fishers, traders, enforcement agencies and tourists. While these initiatives are still in their early days they have the support of Government Ministries and the general public and will aid in the development of national management policies.

*Green turtle (Chelonia mydas)*

In the early 20th century, green turtles were regarded as relatively common along the entire Vietnamese coastline (Bourret 1941). Likewise, our data indicate that nesting by this species occurs in several areas along the coast. We estimate that prior to the mid 1960s:

1. Approximately 100 females nested each year on islands in the Gulf of Tonkin (Co To Island, Bach Long Vi, Quan Lan, Minh Chau, Son Hoa and Dau Trui)
2. Approximately 500 females nested each year along the mainland beaches and near-shore islands of south-central Viet Nam (Quang Nam to Ninh Thuan).
3. Tens of females nested each year on islands in the Gulf of Thailand (although we have no data from the islands on the Cambodian side of the Gulf)

Based on our survey data we estimate that aside from Con Dao, breeding populations of green turtles in Viet Nam have declined significantly; most likely to current levels of around 10 nests per year in both the Gulf of Tonkin (Minh Chau and Quan Lam Islands) and south-central Viet Nam (mainly at Nui Chua in Ninh Thuan Province) and rare nesting occurs on islands within the Gulf of Thailand. In addition, limited data that indicates that green turtles breed on offshore islands such as the Spratly Archipelagos (see Chu The Cuong et al. in press), however, at this location we do not have sufficient information to estimate the size of the nesting population or comment on their stability. Despite the lack of data for these locations staff from Con Dao National Park have monitored the green turtle nesting population since 1995. At this location the numbers of green turtles nesting each year has remained relatively stable for the last eight years (mean number of annual nesting turtles 1995–2003 = 239; range 117–291) (WWF unpublished data and Nguyen Thi Dao 1999).

Given that molecular data from green turtle populations in other areas of South East Asia and the South Pacific region indicate that green turtle rookeries separated by more than a few hundred kilometres usually differ genetically, and these genetically different populations should be regarded as separate management units (Moritz et al. 2001). It is possible that genetically distinctive breeding populations may exist in Vietnam's south, north and offshore archipelagos (Spratly and/or Paracel). In addition to this widespread distribution of nesting green turtles in Viet Nam; a turtle originally tagged while nesting at Con Dao was caught by fishers in Cambodia (Con Dao National Park unpublished data), and there are published accounts of green turtles nesting on the Chinese owned islands in the Paracel and Spratly Archipelagos (Cheng

2000). Hence, Viet Nam may share management responsibility for green turtles with neighbouring countries.

While there have been no management programs established on beaches in the Gulf of Tonkin, Government and NGO funded marine turtle management projects have been running since 1995 at Con Dao National Park and since 2000 at Nui Chua in Ninh Thuan. Hence, most turtle nests laid on beaches within Con Dao National Park and Nui Chua are currently protected from human collection (WWF unpublished data) and egg collection remains a major threat to nesting populations in the Gulf of Tonkin. Collectively along the coast of Viet Nam the largest mortality of green turtles occurs from incidental capture in gill nets set around key habitat areas (coral reefs and seagrass pastures) and opportunistic take by divers targeting commercial species such as crustaceans and molluscs. Similar to hawksbill turtles these threats are most pronounced in waters of the southern provinces. While fishers that operated within the inshore coastal seagrass areas of the Gulf of Thailand indicated that it was not worth fishing for turtles because they were now very rare, individual fishers operating around reef areas or offshore islands in the same region reported current catch rates up to 20 turtles per year. At least some of these turtles are from the Con Dao breeding population because in 2002 FRPD staff on Phu Quy reported the capture and consumption of two tagged turtles that were caught by gill nets set offshore of Phu Quy Island. Both of these turtles were tagged while nesting on Con Dao (Con Dao National Park unpublished data). Studies to address post-nesting and inter-nesting movements and recruitment are warranted to assess the stability of the Vietnamese green turtle populations.

#### *Threat mitigation*

It is evident from our data, and those presented by other authors (referenced above), that there have been immense and widespread anthropogenic impacts on marine turtle populations and their habitats in the Indo-China region. The main threats include widespread direct and indirect fishing based mortality, direct harvest for the production of turtle products, the collection of eggs, and habitat loss or alteration. While Pham Thuoc (2003) indicates that historically turtles held cultural significance to people in Viet Nam, less than 10 of the fishers we spoke to listed cultural aspects as a reason for direct capture or keeping accidentally caught turtles, and these were references to hawksbill turtles only. Instead they were driven by (1) the economic benefits that result from selling the product or (2) the nutritional and social benefit that result from sharing the turtle meat throughout the fisher's family. Viet Nam is a developing country, and many coastal communes struggle to stay above the poverty line (Asia Development Bank 1999). Hence any conservation efforts must focus on remediation of economic concerns at a community level. Indeed, it has only been in recent years that these threats have been addressed by

Government or conservation agencies, and the 'use' of marine turtle products has only been illegal since April 2002.

Aside from the fisheries based mortality and the collection of marine turtles for food or shell products (that we have reported), habitat loss is perhaps the largest threat to marine turtles in Viet Nam and the Indo-China region. Both coral reefs and seagrass pastures are widespread throughout the near-shore regions of Viet Nam's coast and offshore islands and their distribution, abundance and taxonomy have been widely investigated (Nguyen Huy Yet 1999; Vo Si Tuan 2002; Nguyen Van Tien et al. 2002). It is noteworthy that both habitats have been widely exploited over the last three decades for the collection of fisheries products and development of coastal infrastructure and recent surveys have indicated that destructive fishing is a problem for coral reefs in 21 of 29 provinces (Asia Development Bank 1999; Wilkinson 2002; DeVantier 2003). These problems are currently being addressed through the development of marine protected areas such as Hon Mun and Cu Lao Cham and legislation outlawing destructive fishing techniques.

#### *Conservation efforts*

While marine conservation programs are relatively new in Viet Nam, the Ministry of Fisheries and NGO groups have been instrumental in accepting the immediacy of the situation and developing proactive programs to assist the conservation of marine turtles and their habitats. Since 2001 the Government of Viet Nam have; signed the IOSEA MoU, developed an action plan for the management of marine turtles until 2010 (Ministry of Fisheries 2004), supported the development and release of an education package for school children, and run several workshops to raise community awareness about marine turtle conservation, turtle trade and management issues. Clearly, these are the first steps in a long process that aims to protect and restore marine turtle populations and their habitats in Viet Nam; the success of this project will ultimately depend on the continued cooperation and participation of all stakeholder groups.

#### **Acknowledgements**

This study was undertaken as part of a Royal Danish Embassy funded project to develop a Marine Turtle Management Strategy for the Government of Viet Nam. We would like to thank the following people and organisations for participating in various aspects of the survey including; providing permits, participating in field surveys, and translating survey data; Viet Nam Ministry of Fisheries, WWF-Indochina, TRAFFIC Southeast Asia-Indochina, Mr Dong Ngoc Son (Quang Ninh), Mr Nguyen Quy Thac (Hai Phong), Mr Dinh Tien Hung (Thang Hoa), Mr Nguyen Van Hoa (Ha Tinh), Mr Hoang Duc



Hien (Quang Binh), Mr Nguyen Dang Suong (Quang Tri), Mr Ngo Dung (Thua Tien Hue), Mr Dang Duy Hai (Da Nang), Mr Ngo Van Dinh (Quan Nam), Mr Nguyen Van Muoi (Quang Ngai), Mr Nguyen Duy Lam (Binh Dinh), Mr Nguyen Van Do and Mr Pham Van An (Phu Yen), Mr Nguyen Nhu Dao (Khanh Hoa), Mr Pham Van Xiem (Nui Chua Reserve), Mr Giao Nguyen Tuong (Nui Chua), Mr Nguyen Quach Truong Thanh (Ninh Thuan), Mr Nguyen Anh Tuan (Ba Ria – Vung Tua), Mr Tran Ngoc An and Mr Nguyen Minh Xo (Binh Thuan), Mr Pham Ngoc Tuan and Mr Le Van Lam (Kien Giang), Mr Nguyen Linh Ngoc (Phu Quoc), Nick Cox, Julie Thomson-Delaney, Mr Nguyen Tri Man, Chloe Schäuble, Chris Gow, Nick Pilcher. This assistance is gratefully acknowledged.

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