2008

Programa de Conservación de las Tortugas Marinas en Playa Gandoca

WIDECAST

Red para la Conservación de las Tortugas Marinas en el Gran Caribe

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RESUMEN EJECUTIVO

El proyecto de conservación de las tortugas marinas en playa Gandoca se desarrolló entre el 15 de febrero y el 15 de agosto del 2008, cubriendo los tres sectores que comprenden esta playa (A, B, C). Se utilizaron las técnicas de protección y manejo de nidos recomendada por la Resolución 055-2007-SINAC para nidos naturales, relocalizados, camuflados y enviados a vivero. Mediante dos turnos de monitoreo y tres patrullas en cada turno se cubrieron 180 noches de observación, más 150 monitoreos diurnos de confirmación. Con estas acciones de monitoreo y protección se observaron 94 diferentes hembras reproductoras, de las cuales 19 fueron declaradas como neófitas al no tener evidencia interna o externa de marcaje previo, además se registraron 35 hembras a las que se les aplicó PIT. La anidación total fue de 642 actividades de las cuales 318 fueron nidos efectivos, reconociéndose el sector B como el de mayor actividad anidatoria con 145 nidos, en promedio cada nido presentó 79 huevos normales y 33 huevos vanos, el éxito de eclosión de los nidos naturales fue de 70,3%, mientras que el éxito de eclosión para nidos relocalizados fue de 70,2% y los valores para el mismo rubro fueron de 75,7% y 54,2% para el vivero A y B respectivamente. La cifra inferior encontrada en el vivero B, manifiesta la inundación y afectación sucedida por las altas mareas y las corrientes costeras sobre este sitio de protección de nidos, aunque es importante reconocer que en concomitancia con lo establecido con la Resolución 055-2007-SINAC son solo nidos de alto riesgo de pérdida los que se mueven a los viveros, situación que permite suponer que el éxito de eclosión estimada de estos nidos antes de moverse al vivero es de 0% o valores similares; de manera tal que un valor superior al 50% representa un procentaje de importancia para la sobrevivencia de esta especie en extinción. Las hembras anidadoras de baula manifestaron un periodo de reanidación de 10 días (8 días-14 días), mientras que un largo curvo promedio de 152,3 cm (131-175 cm). Además, durante el periodo se encontraron y protegieron 28 nidos de tortuga carey y 6 nidos de tortuga verde.

Table I: Summary table of the nesting on Gandoca Beach, Costa Rica from Feb. 19th to Aug. 15th, 2008.

Total # of records of *D. coriacea* (false crawls included)	642		
# *Dermochelys coriacea* nests	318		
# *Eretmochelys imbricata* nests	28		
# *Chelonia mydas* nests	6		
# of *D. coriacea* individuals nesting	94		
# individuals tagged with MONEL No. 49	41		
# individuals PIT tagged	35		
Neophytes (external tags and PIT)	19		
Remigrants	75		
Summary for all species	*D.c.*	*E.i.*	*C.m.*
Beach sector A: Number of nests	88	4	3
Beach sector A: Number of false crawls	103	3	2
Beach sector B: Number of nests	145	4	0
Beach sector B: Number of false crawls	138	1	1
Beach sector C: Number of nests	85	10	1
Beach sector C: Number of false crawls	80	8	5
NESTING ACTIVITY	Average	Minimum	Maximum
Re-nesting interval (n=48)	10 days	8 days	14 days
BIOMETRY			
Average CCL (cm) n=227	152.6	131	174
Average CCW (cm) n=223	110.3	101	155
NEST LOGISTICS			
Average of fertile eggs/nest (n= 198)	79		
Average infertile eggs /nest (n=196)	33		
Total number of eggs counted during relocation	16918		
Average nest depth (n=146)	73 cm		
Average nest width (n=179)	40 cm		
HATCHING SUCCESS			
Hatchery A (n=39)	75.7 %		
Hatchery B (n=49)	54.2 %		
Natural nests (n=12)	70.3 %		
Nests relocated on the beach (n=58)	70.2 %		

1. INTRODUCTION

1.1 Leatherback sea turtle (*Dermochelys coriacea*)

The leatherback turtle is the largest of the world's marine turtles (Morgan, 1988) and the sole species of its family. It has a distinctive 4 cm thick rubbery textured carapace (Wood *et al.*, 1996) and is the longest, deepest diver of the air breathing reptiles. It is the most widely distributed of the marine turtles with a demographic extending from 71°N to 47°S (Pritchard and Trebbau, 1984).

Population numbers presented for sea turtles are estimates based on nesting beach monitoring reports and publications. In 1995, the leatherback population was estimated to be approximately 34 500 (± 8 300) females worldwide (Spotila *et al.*, 1996). The population estimated by the Caribbean Conservation Corporation (CCC) in 2004, was projected to be in the range of 26 000 to 43 000 individuals. Over the last two decades a > 90% decline has been reported for leatherback turtle nesting on the beaches on the Pacific coast of Costa Rica, Malaysia and Mexico (Chan and Liew, 1996; Eckert and Sarti, 1997; Reina *et al.,* 2002). The leatherback turtle has been considered endangered by the World Conservation Union since 1996 and, as a result of the population collapse in the Pacific, is on IUCN's red list classified as a critically endangered species since 2003.

The drastic decline of the leatherback population in the Pacific has been mainly attributed to egg collection, incidental capture, and long line fisheries (Chan and Liew, 1996; Eckert and Sarti, 1997; Spotila *et al.,* 2000). The natural obstacles faced by hatchlings and juvenile sea turtles are staggering, but it is the increasing threats caused by humans at juvenile and adult life stages, that can result in population decline (Musick, 1999; Tuck *et al.,* 2003). Human threats include over harvesting of eggs, hunting for the commercial use of oil and meat, commercial fishing as well as marine debris entanglement and ingestion (plastic bags are of particular concern as turtles can't distinguish them from floating jellyfish). Overdevelopment of nesting sites is an increasingly alarming problem; artificial lights discourage females from nesting and cause hatchlings to become disoriented and wander inland where they often die of dehydration or predation. Coastal armoring such as sea walls and sandbags present a physical barrier to females reaching nesting habitats as well as accelerate erosion down the beach thus diminishing the nesting area. Pollution such as oil spills, urban runoff of chemicals, fertilizers and petroleum impact the overall health of the sea turtle population as well as the food they eat.

Contrary to the collapsed leatherback population in the Pacific, it appears leatherback nesting in Caribbean Costa Rica has remained relatively stable with only a slight decline in the last

15 years (Spotila *et al.,* 2000). Regardless, threats to leatherbacks persist in the Atlantic ocean through fisheries (Chevalier and Girondot, 2000), illegal egg collection (Chacón *et al.,* 1996), and killing of nesting females (Troeng *et al.,* 2002). The inherent characteristics of turtles as a long lived, slow growing and late to mature species make them particularly vulnerable to excessive mortalities and rapid population collapse (Musick, 1999, Tuck *et al.,* 2003).

The range of the Leatherback rookery studied is believed to extend all along the Central Caribbean coast and possibly to South America however, since only a part of this area is surveyed, the true extent of the rookery is not known (Troeng *et al*., 2004). With the information available to date, the Leatherback rookery of Caribbean Central America represents one of the four largest remaining rookeries in the world (Troeng *et al*., 2004). Experience with the Pacific leatherback population shows that declines in this species can be very rapid (Spotila*,* 2004). To protect this significant Caribbean Central American rookery it is imperative that management projects be supported to stop illegal egg collection and to keep incidental captures at sea to a minimum.

The extensive migration of sea turtles means that individuals from different rookeries may share foraging grounds. Human activities in those areas can therefore affect rookeries from geographically and politically separated areas. The mortality of juveniles and adults of highly migratory species can have widespread consequences (Tuck *et al*., 2003).

Nesting for *D. coriacea* mainly takes place between March and July on the coast of Caribbean Central America, although, some nesting has been recorded as early as January and as late as August (Chacón, 1999). Once females reach sexual maturity, they return to nest on average every 2-3 years.

Leatherback turtles typically re-nest every 9-10 days for an expected total of 5-7 times a season (Boulon *et al*., 1996; Eckert, 1999). The females, in this area, generally lay 90 fertile eggs and 30 infertile eggs per clutch. Sea turtles require certain beach conditions to successfully nest. False crawls are frequent events on turtle nesting grounds and can be identified by tracks forming a half moon in the sand or turtle tracks without the presence of a body pit. False crawl can be attributable to disturbances or obstacles on the beach, or occur naturally for undetermined reasons.

Because sea turtles are migratory and solitary creatures they are not easily accessible throughout most of their life phases. Estimates of populations are still inadequate and populations dynamics are still poorly understood due to the difficulty encountered in obtaining sufficient and reliable data. Available data for survival probabilities and population dynamics are mainly obtained from females on nesting beaches. Knowledge based on long term conservation efforts is necessary to predict the effects of the preventive work being conducted, and to accumulate information to establish better management strategies. Additional research programs are needed to determine the root causes of population declines and to establish preventive measures to stop long term declines. Conservation on a global level is essential but difficult to achieve.

1.2 Hawksbill sea turtle (*Eretmochelys imbricata*)

The Hawksbill turtle is one of the smallest sea turtle species, growing to a curved carapace length (CCL) of approximately 75-88 cm and weighing 40-60 kg (Spotila, 2004). A distinguishing feature of this turtle is its narrow, sharp beak used for feeding in the corals. This species re-nests every 2-3 years for an average of 3 times per season. For centuries the Hawksbill turtle has been hunted by many cultures for its beautifully patterned shell. The long time demand and exploitation for this shell has had a profound effect on the population status and survival of this species (Eckert, 1995).

Hawksbills have been on the IUCN's red list, and considered endangered since 1982. They have been upgraded in status and classified as critically endangered since 1996. In the Caribbean, the population status has been reported to be depleted or declining in 22 of the 26 geographical areas for which information is available (Meylan, 1999). The population was estimated in 2004, by the CCC, to be between 8 000 and 15 000 nesting females worldwide. Hawksbill sea turtles are facing an extremely high risk of extinction in the immediate future.

1.3 Green sea turtle (*Chelonia mydas*)

The Green sea turtle is named for the green color of the fat under its shell. It can be easily distinguished from the other species by the single pair of prefrontal scales between its eyes. Adults are generally 76-91 cm in length and weigh approximately 136-180 kg. Green turtles nest at intervals of 2, to 3 or more years, with wide year-to-year fluctuations in numbers of nesting females. This species nests between 3 to 5 times per season and lays an average of 115 eggs in each nest. The greatest threat to *C. mydas* is from commercial harvest of eggs and meat. Other threats are the use of green turtle parts for leather as well as incidental by-catch in commercial shrimp trawling. The Green turtle has been considered an endangered species on the IUCN's red list of threatened species since 1982 and is in danger of extinction within the foreseeable future.

The worldwide nesting females population in 2004 was estimated by the CCC to be 88 520 individuals.

The main objectives of the Widecast Gandoca Sea Turtle Conservation Project are the protection and conservation of the critically endangered *D. coriacea* sea turtles. The principal aim of this report, and the activities conducted on Gandoca Beach during the period of February 15th to August 15th, is to continue the documented existence and status of Leatherback sea turtles within the study area. Despite ongoing research and conservation efforts set up in many countries, the leatherback turtle is in serious danger of global extinction (Baillie, 1996).

The participation of the community in these endeavors is intrinsic to its function. The information gathered throughout the season helps estimate population dynamics for the south Caribbean *D. coriacea* rookery. The data collected, such as biometrics, nesting tendencies (behavioral and logistical), nest success and hatchling releases helps project future population tendencies as well as establishing and ameliorating of monitorial, conservational and research protocols.

2. MATERIALS AND METHODS

2.1 Study Site

Gandoca beach is in the jurisdiction of the Gandoca/ Manzanillo Wildlife Refuge (REGAMA), in the Talamanca region of Limón province, on the South Caribbean Coast of Costa Rica. This refuge covers 4436 hectares of marine area and 5000 hectares of protected land and includes a variety of environments such as sea grass beds, mangrove swamp and primary forest. REGAMA was established in 1985 to protect both the fauna and flora present in this rich and diverse environment, as well as the nesting beaches used by 3 species of marine turtles.

The Gandoca shore is characterized by a fine grained black sand beach, a continental platform and deep waters bordering the coastline. Strong currents and high energy waters contribute to making Gandoca Beach a very dynamic area (Chacón, 1999). Significant quantities of marine debris are periodically washed up on the shore as well as non-organic debris originating from the Sixaola River.

The Sea Turtle Conservation Program was established in 1990 for monitoring nesting activities of the Leatherback marine sea turtle, *Dermochelys coriacea* and to a lesser extent the Hawksbill (*Eretmochelys imbricata*) and Green (*Chelonia mydas*) sea turtles also nesting on Gandoca beach. Gandoca beach is 11 km long, geographically situated at 9°35'N, 82°34'W. The beach's northern limit is situated at Punta Mona and extends to the Sixaola River (southern limit) (Figure 1). The study site is marked by wooden markers every 50m, from north to south, with painted numbers ranging from 1 (Punta Mona) to 166 (Sixaola River). The area consists of 7.7 km of nesting habitat that is separated in 3 sectors: Sector A encompasses the area from the marker 1 to 36, sector B from 37-87 and sector C from 88-166.

Fig. 1. Aerial photo of Gandoca Beach.

2.2 Nesting monitoring

The Widecast Sea Turtle Conservation project on Gandoca Beach starts officially on February 15th with activities running until August 15th. All conservations and management techniques carried out this season followed the National Protocol and are enforced by Resolution 055-2007 SINAC for the conservation and research of sea turtle populations.

This season started with the replacing of damaged markers on the beach as well as a thorough beach cleaning to eliminate possible obstacles to nesting females.

2.2.1 Night patrols

Throughout the nesting season, patrols are carried out daily from 20:00-4:00, in four hour shifts, on sectors A, B and C. On the rare occasions a sector could not be patrolled at night, due to flooding or insufficient man power, morning surveys were completed between 4-6am to collect any missing information and to relocate nests if necessary. The nightly patrols started in front of the research station (marker 57) and left to be on their respective sectors as follows: 15 minutes in advance for sector A and 20 minutes in advance for sector C.

Night patrols consisted of a qualified leader accompanied by trained volunteers. All participants were dressed in black or dark clothes and carried a red light for working on the beach. Uses of lights were always kept at a minimum; restricted for emergency communication purposes between patrols or when working with the turtles required light.

When a nesting turtle was encountered during patrol, external and internal identification tags were noted or applied if necessary. Nesting activity was recorded, and eggs were relocated either to a hatchery or relocated on the beach and camouflaged or left natural and camouflaged. All turtle manipulations were conducted with the use of latex gloves. Due to the presence of another turtle patrol group on the beach Asociación de Desarrollo Integral de Gandoca (ADIG), collection of complete data was not always possible on part of sector B and on sector C. In these circumstances, minimum data was collected such as area of the beach (marker number), time as well as nesting or non-nesting activity.

2.2.2 ***Turtle Identification***

Flipper tagging was introduced as a means of monitoring individuals and cohorts for research purposes. Tagging can provide information on movements, strandings, reproductive biology, residency and growth rates (Balazs, 1999). Although external tagging, as a technique, was demonstrated to be limited with underestimations of survival due to loss of tags (McDonald *et al.,* 1996) it is still a common practice that can yield valuable information.

2.2.2.1 External tagging

External tags were checked and recorded on the rear flippers for *D. coriacea* and front flippers for *C. mydas* and *E. imbricata*. When external tags were not present the area was thoroughly cleansed with a Vanodine solution and MONEL #49 metal tags were applied using metal pliers. External tagging was carried out only when the turtle finished laying and was covering the nest. The tagging area on *D. coriacea* is located on the thin membrane between the tail and rear flippers and on the posterior edge on the second scale of the front flippers for *C. mydas* and *E. imbricata*. Tags were applied consecutively with the highest number on the right side.

Turtles front and back flippers were checked for signs of previous tagging both visually, for holes and tears, and manually for scar tissue. Nesting turtles with no PIT tag, no external tags and no sign of previous tagging were recorded as neophytes. Turtles encountered that were pitted, tagged or showing signs of previous tagging were considered re-migrants.

2.2.2.2 Internal Tagging (PITs)

Passive Integrated Transponders (PIT) tags are small inert microprocessors sealed in glass that transmit a unique identification number when activated by a low frequency radio signal which is sent by a hand held reader held at close range. Although these tags are more costly, they yield more reliable information that provides better population dynamic trends (Dutton *et al.,* 2005).

All nesting *D. coriacea* species encountered were scanned on the right and left shoulder areas while in the laying phase for a Passive Integrated Transponder (PIT) using an AVID Power Tracker IV® microchip scanner. If a PIT tag was not detected after three attempts, the area was thoroughly cleaned with Vanodine solution during the turtle's trancelike laying phase (after a minimum of 10 eggs have been laid), and a PIT tag was injected into the right shoulder using an AVID® pistol. The area was again bathed in Vanodine with applied pressure if bleeding occurred. Successful applications of PIT tags were always verified with the scanner before the new identification information was documented. PIT tags were not applied to Green or Hawksbill turtles during this study.

2.2.2.3 Tissue sampling

After the laying process, tissue samples were collected on turtles having received a new PIT tag. Tissue samples were collected using a scalpel blade (#10 or #15) from the posterior edge of the hind flipper and placed into a vial of alcohol solution labeled with project identification, turtle identification tag numbers and date. Samples did not exceed 0.5 cm in size. Vanodine solution was liberally applied with a cotton ball on the affected area before and after sampling. Tissue sample vials were kept in a cool and dark area to prevent denaturalization of the tissue.

2.2.3 Biometrics of Nesting Females

Biometric information was recorded, after the laying process, on every nesting turtle encountered during patrol. Sand was systematically brushed off the carapace to avoid inaccurate measurements. For *D. coriacea*, the curved carapace length (CCL) was measured from the top of the carapace, where the skin touches the carapace, extending along the side of the central dorsal ridge to the tip of the caudal projection. For *C. mydas* and *E. imbricata*, measurements were made along the center of the carapace to tip of the carapace. Curved carapace width (CCW) was taken along the widest area of the carapace, perpendicular to the central ridge below the front flippers for *D. coriacea,* and along the central scutes for the other two species. Measurements were conducted three times on all individuals as if the shell was undamaged and contained no malformations.

2.2.4 Relocation

Dermochelys coriacea nests were primarily left natural if laid in a safe area. If a natural nest was deemed to be at risk the first priority was to relocate on the beach in predetermined safe locations for each sector. As the objective is to keep the nests as natural as possible, relocation to hatcheries was used as a last alternative.

The person executing the egg extraction from the nest proceeded as follows:

- When the turtle's nest construction is more than half finished, sand is manually removed from the mouth of the nest to ensure easy and safe extraction of the egg bag from the nest chamber.
- When the female covers the nest mouth with a rear flipper, indicating the start of the laying process, it is time to insert the egg bag into the nest chamber. The bag is securely held around the nest's mouth so that all eggs fall into the bag.
- The last egg has been laid when the female pushes down onto the nest with her covering flipper. This is the signal to remove the egg bag from the chamber.
- To safely remove the eggs, the bag opening is twisted closed then carefully removed from the nest while avoiding contact with the peduncle.
- The bag is immediately transferred to a safe area where it is covered with wet sand to help conserve nest temperature while awaiting relocation.

Due to the distance between the sectors in Gandoca, nests must remain in their respective sectors, thus controlling the distance the eggs are transported and the amount of time they are outside the nest environment. For relocating nests, natural nest depth and width were recorded for nest replication. Nests relocated on the beach were camouflaged and data was collected on the new location. A metal tag indicating the nests date, egg count and nesting female's identification numbers was placed approximately 10-15 cm from the surface for accurate nest identification during exhumations. Nests relocated to the hatchery quadrants were also replicated using the natural nest's measurements and were protected with a mesh basket sunk 10 cm into the sand around the perimeter of the nest. Thermocouples, for temperature measurements, were placed in randomly predetermined nest quadrants.

Every encountered *C. mydas* and *E. imbricata* nests were relocated to the hatchery to ensure a safe incubating environment and to ensure complete data collection on the nests.

2.3 Hatcheries

2.3.1 Hatchery construction

Two hatcheries were erected for the 2008 season, one in sector A and one in sector B. Sites determined to be safe, with low inundation risks, were selected with the assistance of local workers as well as with the use of previous year's experience and data, under the Rapid Ecological Assessment methodology. To begin the construction of the hatchery sand was sieved 1 m deep to rid the area of roots, wood and other materials that could affect the success of the nests. Both hatcheries were comprised of a mesh wall sunk 10 cm into the sand, as well as a barrier of sand bags and a ditch covering the whole front area of the hatchery. A grid was created, with the help of some string tied to the mesh walls, each square measuring 50x50 cm. A total of 275 quadrants were created in Hatchery A, covering an area of 106.4m^2.

Quadrants in this hatchery were identified from A1 to K25; as a quadrant is skipped between each nest, the total capacity of this hatchery was 137 nests. Hatchery B covered an area of 128.2m^2 with quadrants ranging from A1 to L29. The capacity of this hatchery was 174 nests. Both hatcheries included a dark mesh cover over 50 % of their total area to create a shaded environment.

2.3.2 Hatchery data collection

The hatchery environment provides an area with added protection and superior conditions as well as a means of collecting practical data which can then be used to extrapolate population dynamics information. Throughout the incubation period (55-75 days), data were collected on the ambient environment of the nests such as temperature (to estimate sex ratios of hatchlings), rainfall and air temperature. Nest temperature (° C) data were thus collected every 6 hours from nests randomly chosen to contain thermocouples using an Omega® HH501AJK Type K thermocouple reader. Rainfall was recorded (ml), using a plastic rain gauge, daily at 6:00 am. Incoming *D. coriacea* eggs from patrols were relocated into the next available hatchery quadrant starting from the front (A1). Nests from *E. Imbricata* and *C. mydas* were relocated to the back rows to replicate the natural nesting environment of these species

Added responsibilities on hatchery shifts consisted of cleaning the area of crabs as well as watching for ant infestations and the presence of flies in the canastas. Disinfected boots were worn at all times in the hatchery and a maximum of three people were permitted at a time in the enclosed area to prevent sand compaction. Hatcheries were monitored 24 hours a day in six hour shifts, and expected nests were monitored every 30 minutes for emerging hatchlings.

2.3.3 Reproductive Success

2.3.3.1 Hatchling Measurements

Biometrics and weights were collected from 15 hatchlings, chosen at random, using a 15 cm calibrator and Pesola ® 100g scale. Hatchlings were placed into a plastic cup to be weighed. For hatchling measurements, straight carapace length and width were obtained with the use of a caliper, following the same methodologies as those of nesting female turtles. Health conditions of emerged individuals are recorded as well as the weather conditions at time of emergence. Hatchlings are released no less than 5 meters from the sea, above the high tide line, after 5 pm or when conditions are deemed optimal during the day, i.e. cloud cover and cool temperatures. Hatchlings are released no more than twenty at a time in different areas along the beach with the intention of limiting predator adaptation to hatchling presence and thus increasing the chance of survival.

2.3.3.2 Exhumations

Exhumations were performed on hatched nests 2 days after the bulk of the hatchlings have emerged. They were performed on natural, relocated and hatchery nests to collect data on the overall condition of the nests. During exhumations, all open shells were counted and all unopened eggs were carefully opened to study content. Distinction was made between the different stages of development within the egg as well as pipped hatchlings. The different stages of development were distinguished as follows:

Stage I: the embryo fills 0 to 25% of the amniotic cavity of the egg.

Stage II: the embryo fills 26 to 50% of the amniotic cavity of the egg.

Stage III: the embryo fills 51 to 75% of the amniotic cavity of the egg.

Stage IV: the embryo fills 76 to 100% of the amniotic cavity of the egg.

Information was also collected on egg content such as the presence of larva, fungus, insects etc. From the data collected, hatching success rates as well as emergence success rates of the nests were calculated.

# Shells = number of empty shells
UH = Unhatched eggs: including stage 1, 2 and 3 development.
UHT = Unhatched at term: including stage 4 development and pipped eggs.
P = Predated: including larva, bacteria and crabs.

$$\text{Hatching Success: } \frac{\#\text{ Shells}}{\#\text{ Shells} + UH + UHT + P}$$

$$\text{Emergence Success: } \frac{\#\text{ Shells} - \text{Living and dead hatchlings in nest}}{\#\text{ Shells} + UH + UHT + P}$$

2.4 ADIG

Due to a permit change requested by ADIG and issued by MINAET, no beach activities were permitted from marker 61 in sector B to the end of sector C from April 14th to May 5th. Following the International Protocol, morning surveys were thus conducted to effectively count the total number of nests it the area. However, data such as identification information and turtle biometrics are absent. In consequence, Hatchery B, situated between markers 63-64, was also closed during this period of time. Nests already in the hatchery at this time could remain and data could be collected from thermocouples however, no new nests could be relocated in this hatchery.

2.5 Daily surveys

Starting in May, morning surveys were also conducted on Playita, a small beach north of Punta Mona, to monitor the occasional Hawksbill or Green nesting. When a Hawksbill nest was present on Playita, night patrols were scheduled on this beach and carried out for the turtle's expected re-nesting (12-17 days later). Nests found on this beach were systematically relocated to Sector A as there is no area safe from erosion on Playita. There is also a high rate of poaching in this area.

Morning surveys were also conducted starting near the end of April, when hatching of the first nests were expected. These surveys consisted of finding nests and cleaning the adjacent area of obstructions liable to hinder hatchlings successfully reaching the sea, counting hatchling tracks if present and marking hatched nests for exhumation purposes.

3 RESULTS AND DISCUSSIONS

This year's season started on February 15th and the first data records on nesting females were collected on February 19th. A suitable location was determined for the hatchery B location and construction was started on March 7th. The hatchery was finished by March 20th and received its first nest on March 22nd. Despite the low numbers of volunteers, construction was completed quickly owing to the proximity of this hatchery to the town. Building activities were generally carried out in the morning and in the afternoon. Construction of the hatchery on sector A started on March 25th, was finished on April 19th but did not received its first nest until the 30th as the sand was dry and nests had a tendency to collapse. Nests were thus relocated outside the hatchery with mesh baskets and thermocouples where deemed appropriate.

3.1 Nesting season

Tendencies recorded for the 2008 Gandoca sea turtle nesting season show a distinct high phase in April as well as a second, lesser peak in May (Fig. 2). These findings concur with nesting peaks previously recorded for Gandoca beach during the months of April and May (Chacón and Eckert, 2007). In comparison with last year's results, June appears to have been less active this year with a proportionally lower nesting frequency.

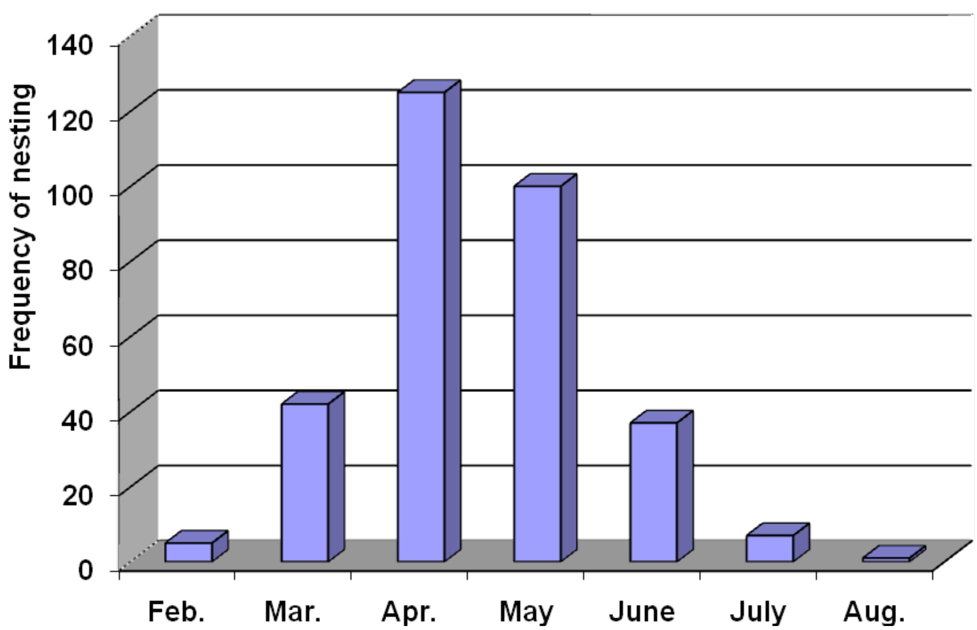

Fig 2: Time series of nesting frequency of *D. coriacea* per sector on Gandoca beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

The magnitude of nesting recorded for the Gandoca 2008 season was below average, but with a significative increase of nesting in the other side of Sixaola river mouth on Panama. A total of 318 nests have been recorded for *D. coriacea* on Gandoca Beach this year (Figure 3). Leatherback nesting recorded for Gandoca since the year 2000 ranges between 430 and 1400 nests, for a complete season, with the exception of 250 nests in 2004. However, when considering the total nesting for the season, nesting on Sixaola Beach, Panama, must be taken into account as this nesting area is actually a continuation of Gandoca Beach. It is possible that the reduced nesting recorded on Gandoca Beach is attributable to the increase in disturbances (activity and light) present on the beach this season. These disturbances started mid-April with the presence of ADIG patrol groups on the beach. The lack of experience, lack of qualified personnel as well as the competitiveness of this second group resulted in an increase of light usage, people and disturbances on the beach as well as numerous breaches in turtle protocols.

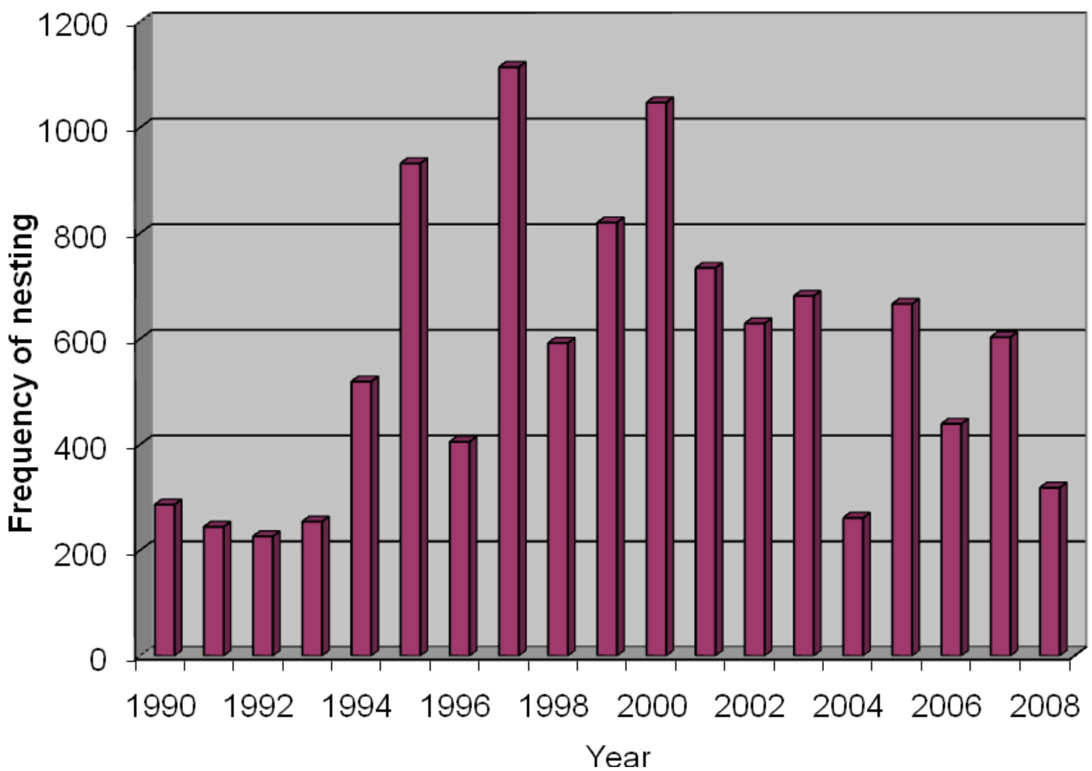

Fig. 3: Seasonal frequency of nesting of *Dermochelys coriacea* on Gandoca Beach, Costa Rica, from 1990 to 2008.

3.1.1 Nest distribution

3.1.1.1 Beach sectors

Nesting tendency between sectors on Gandoca beach shows a moderate inclination for sector B with 45% of the total nests on this section of the beach, following is sector A with 28%, and last, sector C with 27% of total nests (Fig. 4). Nesting preference varies throughout the season, particularly in response to the condition of the different sectors of the beach. Gandoca beach has a highly dynamic coastline attributed to a narrow continental shelf, strong southern currents and deep water near the coast (Chacón and Eckert, 2007). The beach is prone to high levels of erosion that is intermittently pronounced in various areas at certain times. The presence of narrowed stretches of beach, ledges and sharp inclinations can discourage nesting in particular areas. However; the conditions are sporadic and unsuitable areas can convert to adequate conditions rapidly.

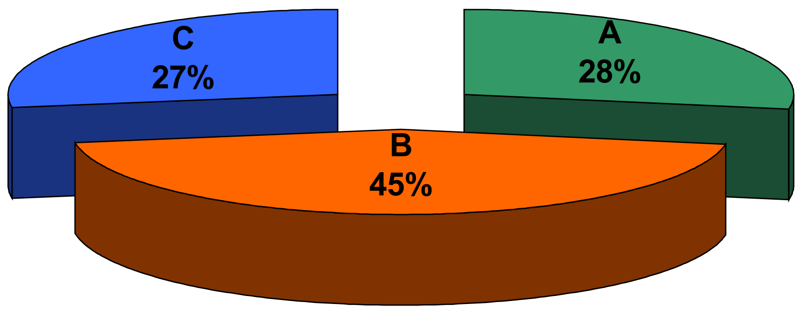

Fig. 4: Percentage of nesting activity of *D. coriacea* per sector on Gandoca beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

Some areas of the beach remain more stable and present less of a threat of erosion than others throughout the season. These locations often translate to areas of high density nesting (Fig. 5). Determination of these high density nesting sites helps in patrol logistics, concentration of efforts, as well as establishing suitable hatchery locations throughout the years (Chacón and Eckert, 2007). Nesting tendencies within sector A this year showed distinct concentrations of nesting between markers 31-35. In sector B, the nesting was concentrated in the area of markers 51-56 and to a lesser extent between markers 61-65. However, there were moderately high levels of nesting throughout areas of sector B thus supporting the overall higher nest count detected on this sector of the beach. A high nesting area was also identified between markers 91-95 on sector C. The lower nesting activity recorded past marker 120 can be attributed in part to the high quantity of marine debris washed in by the tides on this end of the beach. The first 750 m of sector A and the last 1 km of sector B also present low nesting rates. The highly compacted sand in these areas may be responsible for the low levels recorded. The high and low density nesting areas recorded this year generally coincide with those established between 1994 and 1999 (Chacón, 1999) as well as last year's findings. The areas presenting amplified lows in comparison to previous years can be explained by high levels of erosion for long periods of time, sometimes reaching to the vegetation.

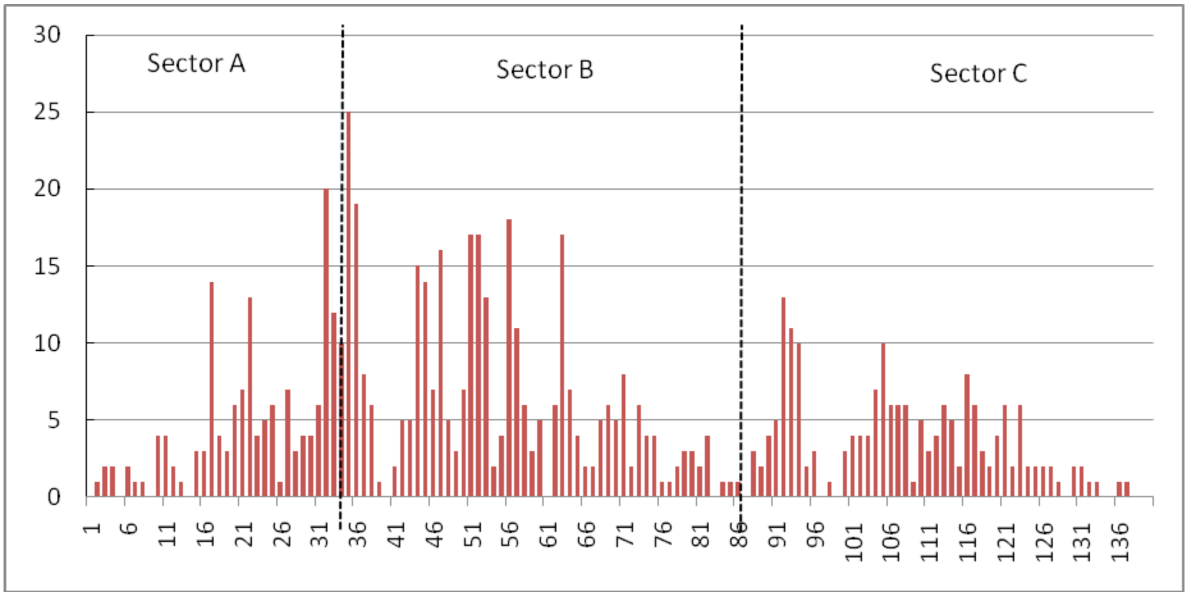

Fig. 5: Natural distribution of *D. coriacea* nests along Gandoca Beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

High levels of false crawls generally occurred in the same areas where high levels of nestings were recorded. It is probable the high activity areas are coupled with favorable in-water topography and currents.

3.1.1.2 Nest relocation sites

The 2008 season was marked by very high tides and high levels of beach erosion, particularly on sector A at the beginning of the season and on sector B near the end. When tides were high, sections of the beach all but disappeared when the water reached directly to the vegetation. These environmental conditions are responsible for lower density nesting in certain areas at different periods of the season.

Because of the dynamics of Gandoca beach, what appears to be a good nesting location does not necessarily translate to a suitable incubation area for nests. Predetermined suitable locations for natural nests or for relocation must be confirmed as safe and stable environments for the entire incubation period. With the expertise of the locals and data compiled from previous years, appropriate sites for natural and relocated nests were determined and modified accordingly throughout the season to ensure the safe development of all nests. However, despite careful planning, unpredictable events invariably occur and continuous adaptation to arising conditions is essential.

3.1.1.3 Nests Final Destination

The majority of the nests this season have been relocated on the beach (36%) to these predetermined stable areas (Fig. 6). Although leaving nests natural is the preferred choice, oftentimes nest relocation is necessary. Due to this fact, nest relocation is the most viable option. Twenty-three percent of the nests to date have been relocated to hatcheries A and B and 19% have been left natural. Six percent of nests have been left natural and camouflaged.

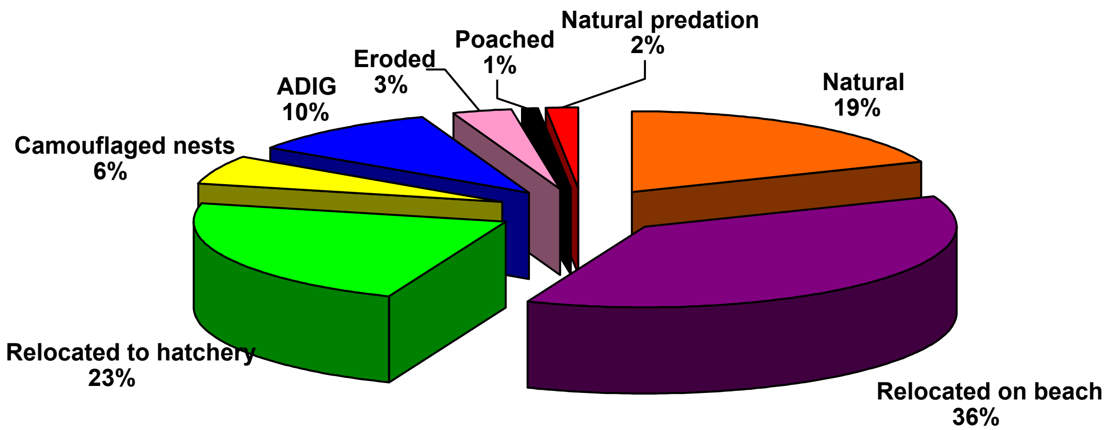

Fig. 6: Final destination of *Dermochelys coriacea* nests on Gandoca Beach, Costa Rica, from Feb. 19th to Aug 15th, 2008.

The turtle patrol group ADIG on Gandoca Beach, conducting patrols on a part of sector B and on sector C as of April 14th, took possession of 10 % of the nests this season. These are nests for which we have confirmation but for which final destination in unknown.

3.1.1.4 Nest natural distribution

Dermochelys coriacea generally lays its nests in the area above the tide line on the beach whereas a smaller percentage nests lower then the tide line and only a small percentage are laid on the berm, next to the vegetation (Chacón *et al*., 1996, Chacón and Eckert, 2007). The data reflects these tendencies with only 5% of the natural nests to date laid high on the beach next to the vegetation (Fig. 7). The bulk of the nests on Gandoca beach this season have been laid between the tide line and the berm (64%) expressed in this study as the high tide area. The low tide area, below the tide line, holds 31% of the nests laid to date. All nests deposited in the low tide areas are relocated to higher ground to prevent inundation by seawater and/or loss due to erosion. The percentage of nests laid in high risk areas, in and of itself justifies the presence of the patrols on the beach.

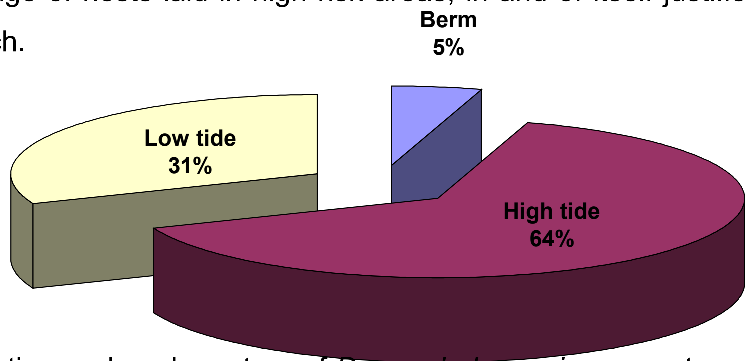

Fig. 7: Natural distribution on beach sectors of *Dermochelys coriacea* nests on Gandoca Beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

3.2 Time distribution

Nesting activities this season were concentrated between the hours of 21:00 and 1:00 with very slight differences between hours and no discernable trend (Fig. 8). The nesting hours previously recorded for Gandoca Beach (1990 to 2007), present similar results with a trend that reaches a peak between 24:00 and 1:00 (Chacón and Arancibia, 2007). This year however, peak activity was attained earlier in the evening and maintained until 1:00, with no specific peak hour distinguishable.

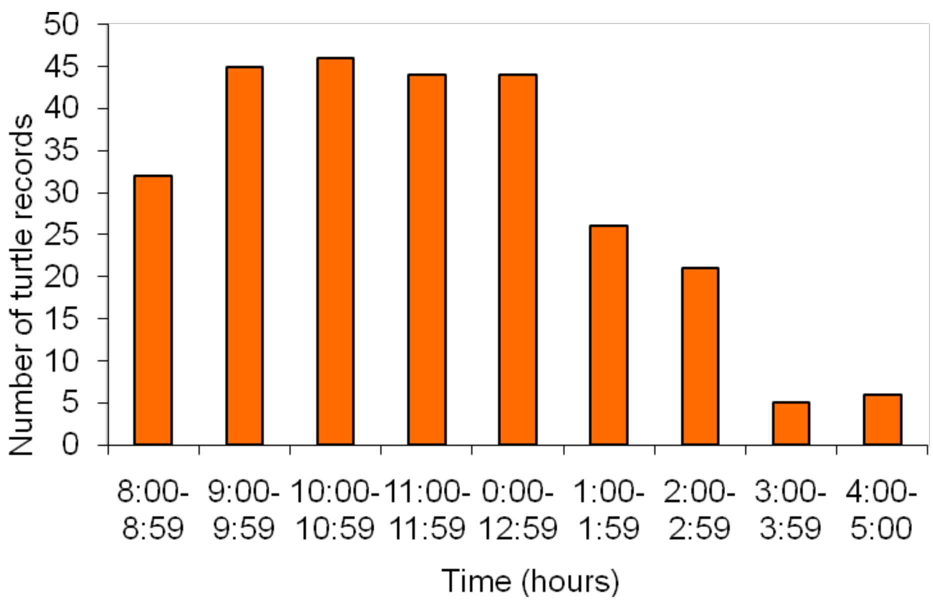

Fig. 8: Time distribution (hours) of *D. coriacea* encounters during night patrols on Gandoca beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

3.3 Re-nesting

The majority of individual turtles encountered on Gandoca Beach have only been encountered once (27.4%, Fig. 9). Re-nesting occurred to varying degrees. In general, the same turtle nested five times or less in the patrolled area with fewer individuals nesting 6 times or more. On average, turtles nested 3.5 times during the study period. However, these numbers are conservative as the extent of nesting area between the south Caribbean of Costa Rica and North Caribbean of Panamá covers more than 40 Km of coastline, and data from the other beaches is not included in this report.. The data is further biased by the unavailability of the data collected by ADIG this season. It is thus impossible to ascertain the true re-nesting tendency on Gandoca Beach, as 10% of the total nesters encountered in the area are not accounted for in the presented data.

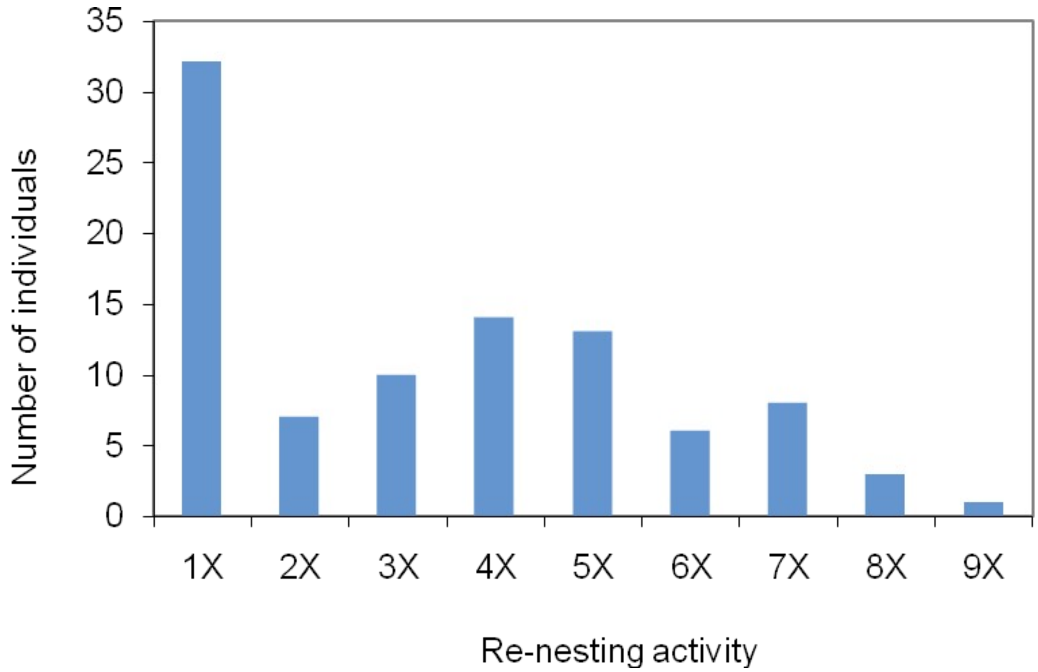

Fig 9: Re-nesting activity of *D. coriacea* individuals on Gandoca Beach, Costa Rica and Sixaola Beach, Panama, from Feb. 19th to Aug. 15th, 2008.

3.4 Reproductive success

3.4.1 Nest Logistics

Of the relocated nests, the total amount of eggs individually counted this season is 15 564 and the total estimated amount, including natural and camouflaged, is 24 807 eggs. The average clutch size counted 79 fertile eggs to 33 infertile, nest depth and width averaged 7 cm and 40 cm respectively.

3.4.2 Incubation time

Incubation time for nests this season ranged from 50 to 76 days with an average of 62.8 days ± 4.7 S.D. Average incubation days for hatchery A (62.5 days ± 3.6 S.D.) and hatchery B (61.1 days ± 0.1 S.D.) differed slightly but were not significantly different (T-test: $p=0.13$). The slightly longer incubation time recorded for hatchery A could be attributable to the added quantity of shade cover owing to the trees situated behind this hatchery.

Differences in incubation time varied significantly according to shade and sun treatments (63.9 days ± 3.3 S.D. and 60.1 days ± 4.2 S.D. respectively; T-test: $p<0.01$). Nests in the shady part of the hatchery took longer to hatch than eggs located in the sunny area. Higher nest temperatures recorded for the sunny area of the hatcheries support these findings (Fig. 10). Nests relocated in the sun presented an average temperature of 30.7 ˚C ± 1.4 S.D. Shaded nests averaged 29.4˚C ± 1.2 S.D., with an average difference of 1.3 ˚C between the treatments.

Mrosovsky *et al*. (1984), determined that the pivotal temperature for sex determination of the Leatherback was 29.5 ˚C, we can thus assume that the nests relocated in the sun produced a majority of females this season.

Nest temperatures between treatments varied similarly throughout the months. Rainfall this season remained fairly constant between months and thus cannot be used to explain the highs and lows recorded for nest temperatures (Table II). The month of July recorded the second highest rainfall recorded for the season and the highest nest temperatures. This inconsistency may have come about due to the main concentration of the rain falling during the night hours while day temperatures remained high. Total rainfall for the season, between 28/3/08 and 2/8/08 was 1130.25 mm, the lowest accumulation recorded since 2003.

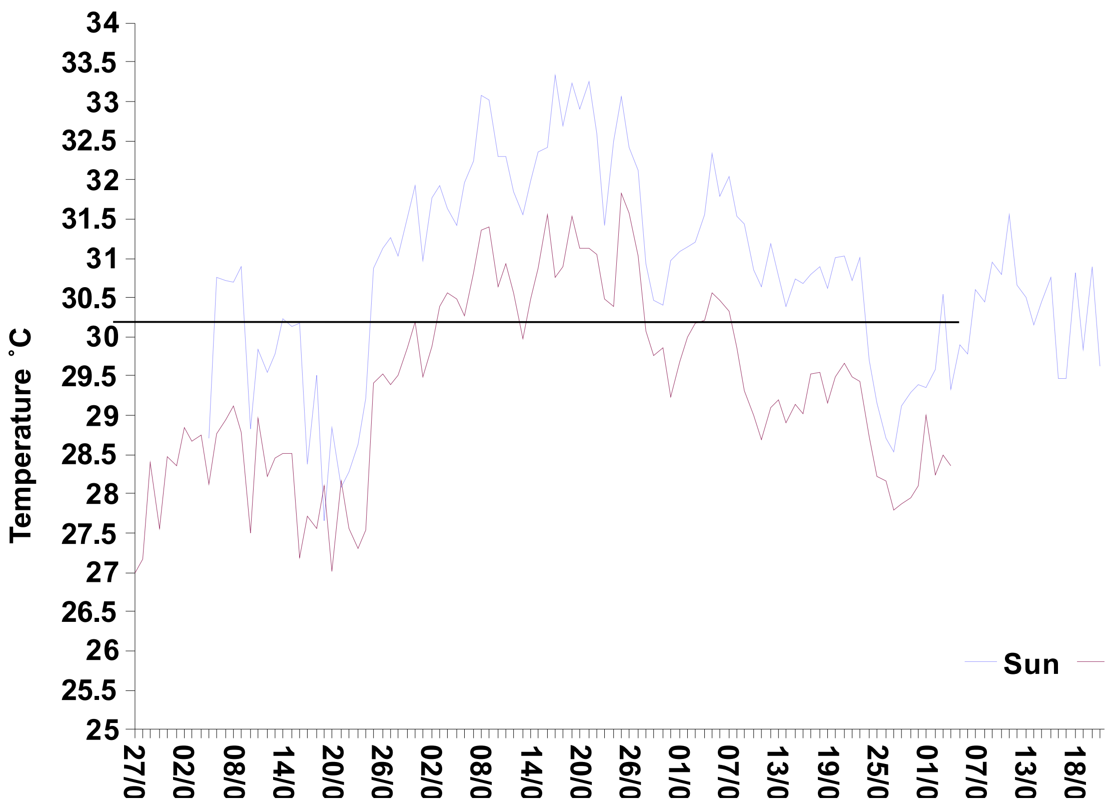

Fig. 10: In-nest temperature of shade and sun treatments of relocated nests on Gandoca beach, Costa Rica, from Feb. 15th to Aug. 15th, 2008.

Table II: Accumulated rainfall (mm) on Gandoca Beach, Costa Rica, during the 2003 to 2008 seasons.

Season	April	May	June	July	Total
2008	185.15	297.6	218.5	344.5	1130.25
2007	153.1	315.3	160.4	625.7	1254.4
2006	344.9	251.3	494.5	477	1567.7
2005	372.7	228	381	246	1227.7
2004	202.7	1204	543.7	477.1	2427.5
2003	280	572	270	1100	2222

3.4.3 Hatchling biometrics

Hatchling biometrics were not affected by the different nest treatments ($p>0.05$). The average weight, length and width of the hatchlings released this year were of 5 g ± 0.5 S.D., 5.9

cm ± 0.46 S.D. and 4.1 cm ± 0.5 S.D. respectively. These data are comparable with previous data collected from nests on Gandoca beach in past years (Chacón *et al.*, 1996; Chacón, 1999).

3.4.4 Hatchery B relocation

The last nests to be relocated in the hatcheries arrived on June 9th for hatchery B and June 12th for hatchery A. On June 27th, hatchery B was lost to a storm and all nests were relocated to a safe area on the beach (marker 48) to finish their incubation period. Canastas were added to the nests at the new relocation site as well as the rain gauge and air thermometer. Thermocouples were not transferred to the new site. See institutional report of this situation in appendix I.

A comparison performed between nests having finished their incubation period in Hatchery B and those having undergone a second relocation reveal a non-significant difference among hatching successes ($P=0.198$). One nest appears to have suffered as a result of the relocation to marker 48. This nest was the last relocated to the hatchery, and was moved during a critical stage of its development (after 17 days of incubation). Despite the care taken during relocation, this nest probably suffered adverse affects and presented a 0.01% hatching success. For more details on the hatchery B relocation see the report (Appendix I).

The day after relocating hatchery B, nests left between markers 43 and 47 were also relocated due to high levels of beach erosion. These nests were brought to marker 48, one of the few suitable areas at that time. Three percent of the nests were confirmed eroded during this season. It is however, likely that this amount is slightly underestimated due to height of the currents this season.

3.4.5 Hatching success

A total of 159 nests have been exhumed this season representing 50% of the total. Most eggs opened during exhumations presented no distinguishable fetus (Fig. 11). In fact, 68% of the un-hatched eggs were completely undeveloped. In relation to these results, findings also show that the dominant problem in healthy nest development on Gandoca Beach is the growth of fungus. Out of the total number of undeveloped or underdeveloped eggs opened this season 67% held the presence of fungus and/or bacteria. Stage 2, 3, 4 and pipped eggs were present to a much lesser extent. In these instances, larva, crab and insects were usually detectable.

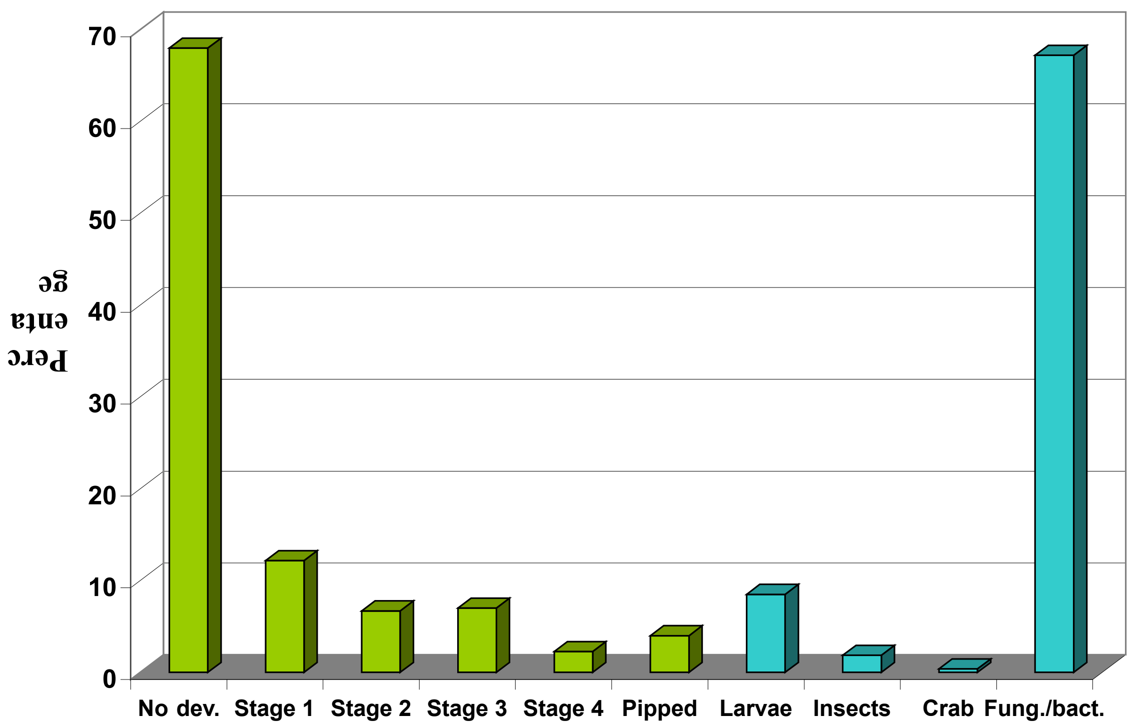

Fig. 11: Percentage of non developed, stages 1,2,3,4 development and pipped eggs and egg predation percentages, Gandoca Beach, Costa Rica, 2008.

Based on the shell count of the exhumation data 7967 hatchlings were released from Gandoca beach to date. An estimation, based on averaged egg count of nests and hatching success rates, approximates the release of 16 714 hatchlings in total for this season.

In general, hatchling success on Gandoca Beach was high this season and did not vary greatly between treatments (Table II; p=0.67). Data was tested for homogeneity of variance and subsequently tested for differences between treatments. Results of an ANOVA performed on different nest treatments (natural, relocated and relocated to hatchery) yielded no significant differences in hatching success. Although hatchery nests generally provide better hatching rates than nests relocated on the beach and nests left natural, the lowest successes observed this season were recorded for Hatchery B (Table III, Fig. 12). This season, exhumation results revealed that low hatching successes were generally associated with the presence of fungus in the nests. The nests relocated in and around hatchery B demonstrated higher levels of fungus than in any other area on Gandoca Beach. This hatchery was located near the entrance of the beach, in a high traffic area, used by both people and animals. It is not recommended that this area be used again as a hatchery site, or as a relocation site due to its susceptibility to fungus. The same observations were made in front of markers 56-57. This area on the beach coincides with the entrance to the biological station; it is also an area of high traffic as well as a popular site for nest relocation during turtle seasons. This season, the abundance of fungus observed in the nests has proved this site less than optimal in comparison with other sites. This may be due to contamination resulting from over usage of the area for nest relocation, it is thus suggested that this area is given 2-3 years without nests to allow the area to cleanse itself.

Table III: ANOVA table for hatching success of nests relocated to Hatchery, relocated on the beach and nest left natural, Gandoca Beach, 2008.

Source	Sum of Squares	Df	Mean Square	F-Ratio	P-Value
Between groups	501.57	2	250.78	40.00%	0.67
Within groups	111221	178	624.84		
Total (Corr.)	111723	180			

Table IV: Hatching success percentages for Natural, Relocated, Hatchery A and Hatchery B nests, Gandoca Beach, 2008.

	Natural	Relocated	Hatchery A	Hatchery B
Count	12	74	45	50
Average	70.35	70.44	77.36	54.75
S.D.	14.89	23.67	19.68	26.31
Coeff. of variation	21.16%	33.61%	25.44%	48.06%
Minimum	46.3	0	0	0
Maximum	92.1	100	100	97.02

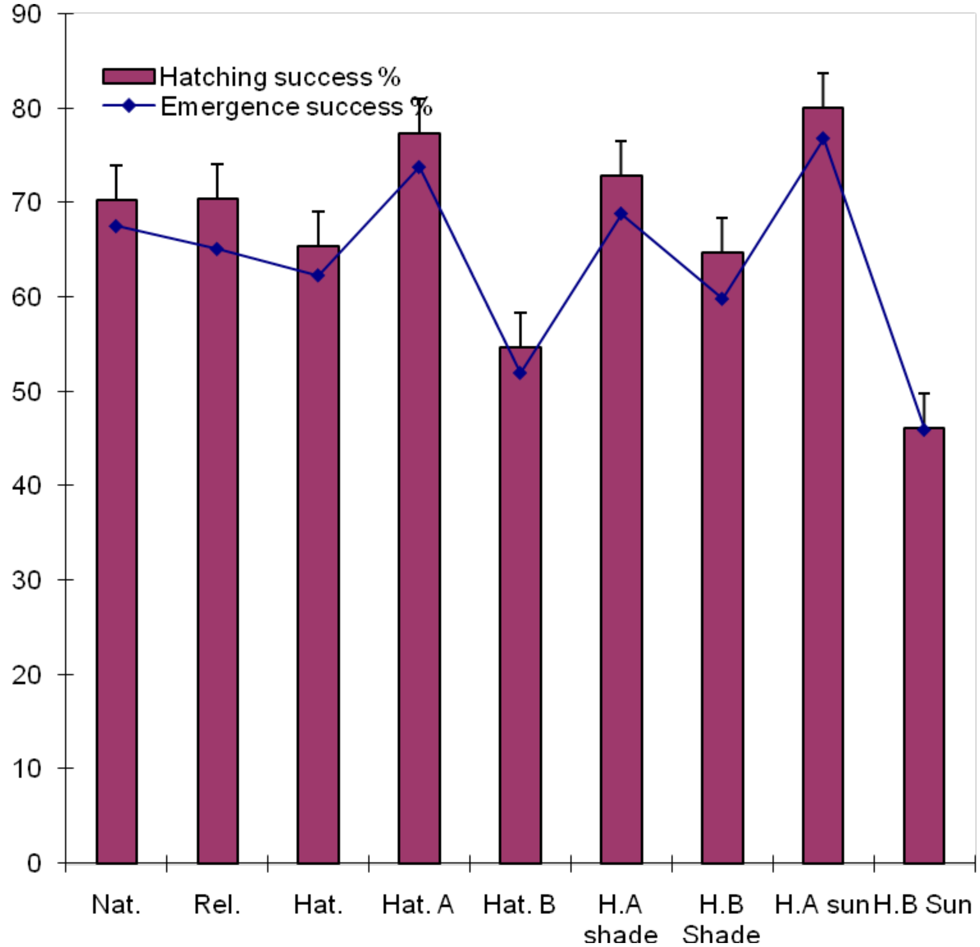

Fig. 12: Hatching success rates and emergence success rates of *Dermochelys coriacea* between different nest treatments, Gandoca Beach, Costa Rica, 2008.

Comparison of hatching rates between the three sectors also show diminished percentages for sector B in comparison with the other sectors (Fig. 13). Data presented for sector C are not robust due to the small amount of exhumations performed in this sector. Problems arose in locating hatched nests on which to perform exhumations. This situation on sector C lends credibility to the rumor that egg poaching and trafficking was more important this season than in previous years. Sector C is particularly susceptible to poaching and trafficking groups owing to its distance from the village as well as the many exits, via lagoon, available in this area. Furthermore, the presence of two conservation groups on the beach this year created a great deal of confusion, particularly in this area.

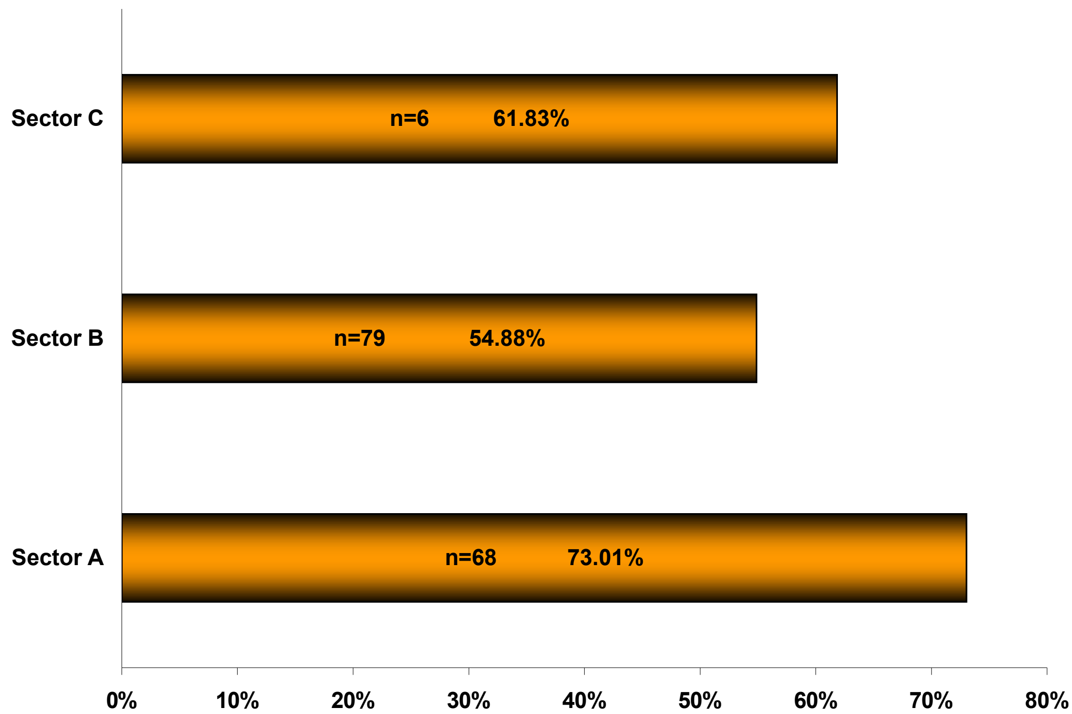

Fig. 13: Percentage of hatching success for nests left natural, relocated and relocated to hatcheries on Sectors A, B and C of Gandoca beach for *Dermochelys coriacea*, Costa Rica, 2008.

3.5 Internal and External tagging

Since the beginning of the season 94 individuals have come to nest on Gandoca beach, 75 of which have been re-migrants and 19 neophytes. Of these turtles, 41 individuals have been tagged with external tags and 35 have been PIT tagged during this season by the project staff. The list of identification tags effectively applied is detailed in Table IV. The use of external tags is contradictory as, over time, the usefulness of this technique was demonstrated to be limited and unreliable with gross underestimations of survival due to loss of tags (McDonald and Dutton, 1996). Although the use of external tags is not entirely reliable, it remains indispensable in areas where most projects do not have funds for more advanced equipment, and provides information on movements, strandings, reproductive biology, residency and growth rates (Balazs, 1999).

Table V: Pit series numbers and tag numbers applied to *D. coriacea* on Gandoca Beach, Costa Rica, during the 2008 nesting season.

NEW PIT	New right Tag	New left Tag	Neophytes		
131929765A	VA7252	*VC0580*	126521572A	VA0693	VA6664
132121691A	VA7039	*VA6131*	131714127A	VA7046	VA7045
132127573A	VA7255	*VA6215*	131952186A	VA7217	VA7067
132135465A	VA7262	*VA0623*	132129133A	VA7257	VA7261
132138180A	V1830	V1831	132131515A	VA7274	VA7265
132149216A	VA7042	VA7041	132135216A	VA7264	VA7263
132153364A	VA7226	*VA7045*	132137240A	VA7268	VA7285
132163090A	VA7228	*VA2037*	132163095A	VA7223	VA7222
132167522A	VA7283	VA7282	132175165A	VA7280	VA7281
132209644A	VA7289	VA7288	132228533A	VA7208	VA7105
132214613A	VA7027	VA7026	132229467A	VA7276	VA7277
132229345A	VA7260	VA7273	132231296A	VA7012	VA7011
132233126A	VA6371	VA6370	132259160A	VA7225	VA7224
132275280A	VA7221	VA7220	132259292A	VA0581	VA0580
132312183A	VA6794	VA6793	132279515A	VA7032	VA7031
132323644A	VA7029	*VA7030*	132316526A	VA7296	VA7297
132336525A	VA7038	VA7037	132317097A	VA7044	VA7043
132338124A	VA6663	*VA0519*	No PIT	VA7017	VA7016
	VA2684	VA6957	No PIT	VA7079	VA7078
	61265	VA0485			
	VA2462	VA7279			
	VA7038	*VA7037*			

* Tags in italic= previously applied tags

3.5 **Physical condition of turtles (Scars, injuries, evidence of previous tagging)**

The physical condition of observed nesting females this season revealed that 95% of the individuals presented, to various degrees, some sign of previous injuries to its flippers. Twenty-three individuals had damage to their carapace, 8 to the head and neck area and 3 revealed a cut peduncle. Nine individuals were observed to have a mutilated flipper that, in all probability, affects the turtle's maneuverability.

Twenty-two different marks due to lost tags were observed, 6 of which were encountered on the front flippers. In 59% of the cases when a tag was lost, a hole was left in the flipper. In 2 individuals the residual damage did not permit re-tagging. This season, 9 individuals were encountered with damage due to tagging such as scar tissue, infection or overgrown skin. In most of these cases the problem appears to be due to bad tagging, in particular tagging too close to the tail.

Table VI: Physical condition, assessed visually, of nesting *D. coriacea* turtles encountered during the 2008 nesting season on Gandoca Beach, 2008.

Identified injuries	Number of individuals
Right front flipper	16
Left front flipper	18
Both front flippers	33
Front flipper mutilation (more than ¼)	3
Right back flipper	14
Left back flipper	20
Both back flippers	37
Back flippers mutilation (more than ¼)	6
Peduncle	3
Damaged carapace	23
Head and neck	8
Presence of barnacles	10
Fresh injuries	1
Evidence of previous tagging	
Holes	13
Scars	5
Cuts	4
Damage due to tagging (infection, scar tissue, overgrown skin)	9

3.7 Turtle biometrics

The averaged CCL and CCW of the encountered nesting turtles this season were 152.6 cm (range: 131-174 cm) and 110.3 cm (range: 101-155 cm) respectively. Although slightly lower, averaged biometric values obtained this year are comparable to those previously recorded on Gandoca Beach between 1990 and 1997 (CCL: 154.7 cm; CCW: 112.8 cm; Chacón, 1999). Data recorded for CCL and CCW during the 2007 season more closely resembled this year's results (152.8 cm and 111.9 cm respectively; Chacón and Arancibia, 2007).

3.8 ***Eretmochelys imbricata* and *Chelonia mydas***

Eretmochelys imbricata and *Chelonia mydas* also nest, to some extent, on Gandoca Beach. The first nest of *E. imbricata* was laid on May 2nd and of *C. mydas* on May 13th. It is assumed that their nesting will continue until October or November as is normal for these species. Opposite to the low season recorded for the Leatherback species, *E. imbricata* presented higher than normal activity on Gandoca Beach this season. A total of 28 nests have been recorded to date for this species, 10 of which have been laid on Playita. In total, five nests were relocated to hatcheries, 11 relocated on the beach, 2 were left natural and 7 were taken by ADIG. One *E. imbricata* nest has been poached this season on Playita Beach and a second was only half-poached as the patrol interrupted the poacher. The quantity of nests laid on this little beach and the poaching activity in the area underlines the importance of patrols at this site. A total of 6 *C. mydas* nests have been laid on Gandoca Beach; 2 were relocated to hatcheries, one was relocated on the beach and one was taken by ADIG. Two nests laid on Playita were poached during the night. A total of 18 % of *E. imbricata* and *C. mydas* nests have been poached to date this season. It is assumed that more nests will be poached now that the patrols are stopped for the season and there is no presence on the beach to discourage these actions.

Hatching success for *E. imbricata* and *C. mydas* were 87.39% (n=5) and 86.35% (n=2) respectively. Described in Table VI are the external tags effectively applied to the two species during the season.

Table VII: External tags applied to *E. imbricata* and *C. mydas* on Gandoca Beach, Costa Rica, during the 2008 nesting season.

E. imbricata	**VA7004**	**VA7003**
	VA7022	*VA7003*
	VA7056	**VA7055**
	VA7066	**VA7065**
C. mydas	**VA7052**	**VA7270**
	VA0812	**VA0811**

3.9 ADIG

With the presence of ADIG, the added quantity of people present on sectors B and C of the beach during the nesting season had a negative effect on the overall nesting on the beach. Added human activity, over usage of light and a total disregard for rules of patrolling had a noticeable effect. For example, mandatory use of red filtered lights, dark clothing and maximum patrol participants per sector were completely disregarded by ADIG. Furthermore, basic working protocols such as not walking in front of a turtle, or not flashing lights directly in a turtle's eyes were not heeded. Nests were transported between beach sectors, in direct violation of the work protocol issued by MINAET. The established protocols help insure minimum disturbances to the natural nesting process and to the nesting turtles. Disregard for these established norms potentially lead to alterations in turtle's nesting behaviour that may lead to added false crawls and diminished nesting in these high disturbance areas of the beach.

The interactions on the beach between the two patrols were not friendly. Procedure shifted towards a first come policy that brought about further breaches in patrol protocol. Direct, physical interference from the ADIG group barred turtle access to the Widecast patrols. There was a distinct atmosphere of competition that shifted the priority from turtle conservation to getting to the turtles before the other group. ADIG's behavior also brought about fears for personal safety on the beach that were felt by the international volunteers participating in the project.

Unless ADIG agrees to work in partnership with Widecast on the beach and to share in the collected information, neither group will be in possession of the complete data for the area. It is thus not recommended that permits be granted to both parties for the upcoming 2009 season as one group is sufficient to patrol in full the three sectors of Gandoca Beach. Should the permit be issued to ADIG for the 2009 season, it is highly recommended that local authorities take active interest in the suspected increased poaching in the area reported since the arrival of this other group on the beach.

4. RECOMMENDATIONS

Due to the extreme dynamics of Gandoca beach, it is recommended that added attention be paid to erosion patterns to correctly identify high risk areas. Furthermore, erosions due to the overflowing of inland bodies of water during the rainy season present recurring patterns that can easily be documented. Details of which would greatly support future selections of hatchery and relocation sites on Gandoca Beach. In addition, intensity of coastal erosion should be documented throughout the years on Gandoca Beach for future trend analyses.

After the loss of hatchery B this season, it is important to carefully consider the most stable areas for next season's hatchery location in this sector. Should the erosion pattern witnessed this year repeat itself, it is not advised to construct the hatchery anywhere between the entrance to the beach and the mouth of the lagoon (markers 62-89). The most stable areas of beach in sector B this season appeared to be found between markers 48-52 and 40-43. The more stable of these two choices is at markers 48-52, however, this location is in proximity to a farm.

It is also advised that areas around markers 64, near the entrance of the beach, and markers 56-57 not be used as relocation sites for the next few season in response to the high incidence of fungus in the nests this season.

External tagging remains a controversial issue and is already discontinued in many areas. Although internal tags have been recognized as being more effective and reliable (McDonald and Dutton, 1996), many projects in Latin America do not possess the means for obtaining the necessary equipment. Until such a time as nearly all turtle projects are in possession of PIT scanners at the least, the use of external tags is still worthwhile. Although, in a small number of cases, some harm does occur due to tagging. These occurrences are uncommon and appear to be mainly due to application of the tag in the muscle tissue instead of the thin tissue found between the flipper and the tail. It is thus advised that a standard training guide be developed and used to ensure proper training be given to anyone applying external tags. In time, external tags will surely be replaced completely by internal tags. However, it will eliminate a wealth of information currently obtained worldwide. Such as: fishermen and patrons' reports on captures or fatalities, call-in's on lost tags, etc.

Problems in obtaining constant, reliable in-nest temperature readings this season were frequent. The main problem lies with the temperature readers which are not weatherproof and thus present difficulties during rainy periods. Furthermore, the thermocouples, on occasion, were not precise showing improbable variations between readings. It is thus recommended that new equipment be considered for the collecting of temperature data in the nests. With reliable temperature data, concerned nests could be studied carefully to determine more precise sex ratios.

The situation in Gandoca this year suggests that attention should be brought to the presence of renewed poaching activity in the area. Accordingly, benefit would be gained by a greater presence of MINAET on the beach. Presence is necessary to ensure the regulations and protocols applied to the turtle nesting beach be respected. There is also some concern as to the illegal activities on Gandoca Beach once the leatherback season is finished and the patrols are no longer active. The Hawksbills and Greens nesting on Gandoca and Playita Beaches are vulnerable to poachers owing to the seclusion of the area.

Recommendations also need to be made concerning the two permits granted this season on Gandoca Beach. Should the situation repeat itself next season, the presence of MINAE, during all nightly patrols, would be necessary to ascertain both teams have equal opportunity to work with encountered turtles on the beach.

The continued research and monitoring of sea turtle activities is indispensable so that the population can be monitored and conservation efforts can be focused where they are most needed. For example: studying population status (population size), re-nesting and re-migration intervals, beach fidelity, hatch rates, threats to eggs and hatchlings and adult turtle sources of mortality. This information is essential for effective management and future recovery of sea turtle populations. To further the cause, an essential conservation strategy is to promote greater public awareness and support for sea turtle conservation worldwide. The Widecast project in Gandoca will continue its conservation efforts towards these aims.

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Appendix 1: Binational team during February training.

Appendix 2: Hatchery in sector B

Appendix 3: Females returning to the Caribbean Sea.

Appendix 4: Baby leatherbacks just before released.