FINAL REPORT

PROJECT

"NESTING ECOLOGY AND PUBLIC PARTICIPATION FOR CONSERVATION MANAGEMENT OF THE OLIVE RIDLEY SEA TURTLE (*Lepidochelys olivacea*) AT GORGONA NATIONAL PARK - COLOMBIA SEASON 2006 – 2007"

PRESENTED BY

CIMAD
CENTRO DE INVESTIGACIÓN PARA EL MANEJO AMBIENTAL Y EL DESARROLLO

SUPPORTED BY:

Libertad y Orden
República de Colombia
Ministerio de Ambiente, Vivienda y Desarrollo Territorial

CONSERVACION INTERNACIONAL COLOMBIA

The Rufford Small Grants for Nature Conservation

September 30, 2007

ACKNOWLEDGEMENTS

The Centre for Research into Environmental Management and Development CIMAD, wants to thank Gorgona National Park, its officers, voluntary rangers, the personnel of the diving station, the Henry Von Prahl Scientific Station, Héctor Montaño, Orlando Ibarbo and all those people that with their will and enthusiasm, contributed to the development of this project.

In a same way, we want to thank the financial support given by the Rufford Small Grants for Nature Conservation, without it this project would have not been possible to carry out. We want to express our gratitude to Conservation International - Colombia, for the donation of the boat Casiopea, a critical tool to continue developing our research and education activities in the Colombian Pacific.

Many thanks to the Educational Institution San José of Guapi, for opening up their doors to fulfil the activities of environmental education; as well as to the Institute of Marine Investigations José Benito Vives de Andreis (INVEMAR), the Anglo Colombiano School and the Universidad del Bosque, for the technical and logistical support offered for the development of the laboratory phase of this project.

This document should be cited: Pavía, A., Amorocho, D. and J.A. Rodríguez-Zuluaga. 2007. Nesting ecology and public participation for conservation management of Olive ridley sea turtle (*Lepidochelys olivacea*) at Gorgona National Park - Colombia. Final report presented to Rufford Small Grants for Nature Conservation. CIMAD. Cali. 38 p.

CONTENTS

FIGURES

CHARTS

GRÁPHS

SUMMARY

Monitoring of the nesting activity of Olive ridley sea turtle (*Lepidochelys olivacea*) was carried out in Palmeras Beach, Gorgona National Park (GNP), between October 8 2006 and January 12, 2007. Five nesting females were intercepted and double tagged in the front flippers. The average measurement of curve carapace length (CCL) was 65.8 cm ± 2.09. Curve carapace width (CCW) was 71.8 cm ± 5.06 and 35.4 Kg ± 4.45 of weight.

During this study 16 tracks were registered and 11 nests monitored. The average of eggs per nest was 93.1 (± 29,0) and the incubation time was 57.8 days (± 6.25). Based on 35 excavations made to *in situ* and *ex situ* nests the estimated hatching success was 82.0% (± 28.4). The emergence success was of 88.3% ± 15.3%.

A total of 42 samples (36 of tissue and 6 of blood) were collected for the genetic analysis of the Olive ridley nesting population at GNP. 47 hatchlings were sampled to determine the sexual proportion of males and females through the histological analysis of gonads. This gave as a result that 40.5% of the hatchlings were females, 38.1% males, 4.8% intersexes and the 16.7% remaining could not be determined.

INTRODUCTION

Four of the eight species of existent marine turtles have been reported in the Colombian Pacific. They are: *Lepidochelys olivacea* (Olive ridley), *Chelonia agassizii* (Black), *Dermochelys coriacea* (Leatherback) and *Eretmochelys imbricata* (Hawksbill). In spite of the research and conservation efforts and of the existent legislation in the country, some of these species are listed in the Colombian Reptiles Red Book (Castaño-Mora, 2002). All of them are also included in the Appendix I of the Convention on the International Trade of Endangered Species of Fauna and Flora (CITES).

Although abundant in the decade of the seventies in the Pacific of Colombia, Olive ridley turtle populations have been decimated in a dramatic way due to the looting of their nests and to the harvesting of females in nesting beaches, as well as to the incidental capture and direct fishing in feeding and developmental habitats and along their migration routes (Rueda, 1988; Amorocho et al., 1992; Amorocho, 2002). More recently, other pressures as climate change; pollution, introduced vegetation and the destruction of their nesting habitats by the tourism industry and front beach development, have contributed to the reduction in numbers of individuals along their distributional range (NMFS/USFWS, 1998).

Understanding the fundamental aspects of the nesting biology of marine turtles is, according to Richardson (1999), an essential element for the recovery of populations. Without this knowledge, well intentioned, but imprecise efforts, can go in detriment of the conservation purposes. This statement has motivated since 2003, the development by the Research Center for Environmental Management and Development (CIMAD) of projects targeting the conservation of these marine reptiles in Gorgona National Park (GNP). This protected area annually receives the visit of Olive ridley turtles that arrive at these beaches to nest and which importance for the conservation of this species is clear as studies on its nesting biology advance and beach surveys continue in this protected area (Mc Cormick, 1996; Amorocho et al., 2004a; Pavía et al., 2006).

Not less important it is the fact that the conservation activities carried out in the GNP, have the commitment and participation of the local communities in the area of coastal influence. They are the ones who interact directly with this marine resource and with its critical habitats, being as much part of the problem, as a fundamental part of the solution; since the survival of marine turtles largely depends on them (Marcodalvi and Thome, 1999). In consequence, for the marine turtles programs to be successful, community-based conservation should be an integral part of any process (Frazier, 1999).

The combination of scientific research and community participation for the conservation of marine turtles are the goals for which project's activities were conducted. This way we advanced in the knowledge of the nesting ecology of Olive ridley sea turtles, completing 3 years of uninterrupted assessment of this species at Palmeras Beach. This biological information has been fundamental to improve the current strategies of conservation tending to avoid the decrease of these species in the GNP. The dissemination of this scientific knowledge in the coastal communities has been crucial to call attention of local stakeholders - particularly fishermen - on the current conservation issues hampering marine turtles and to take measures to stop their dramatic decline. For this, educational chats were given at San José School, in Guapi, as well as working with fishermen in the implementation of technological and management alternatives to reduce sea turtle by-catch that has put Olive ridleys of the Colombian Pacific in risk of extinction. This report presents the results achieved by CIMAD during the 2006 - 2007 nesting season in the GNP and its area of coastal influence in the municipality of Guapi (Cauca State).

METHODOLOGY

GNP (2° 55 '-3° 00 ' N and 78° 09 '-78° 14 ' W) was declared protected area in 1984, with the purpose of protecting valuable terrestrial ecosystems of tropical rain forests and marine habitats of this island in the Colombian South Pacific (Figure 1). The Park is separated by 35 Km from Bazán (Nariño State), the nearest continental town. It has a total extension of 618.8 Km², including the terrestrial part of the island, with 13.7 Km². Its average temperature is 26°C, with a rainfall annual range between 4.164 and 8.176 mm (Garcés and De La Zerda, 1994).

Between October 8, 2006 and January 12, 2007, CIMAD carried out day and night time surveys of the nesting activity of Olive turtle in Palmeras Beach (2° 56' 38" - 2° 56' 17" N and 78° 11' 53" - 78° 12' 16" W), where nesting females end up along an approximate extension of 1.2 Km (Figure 1).

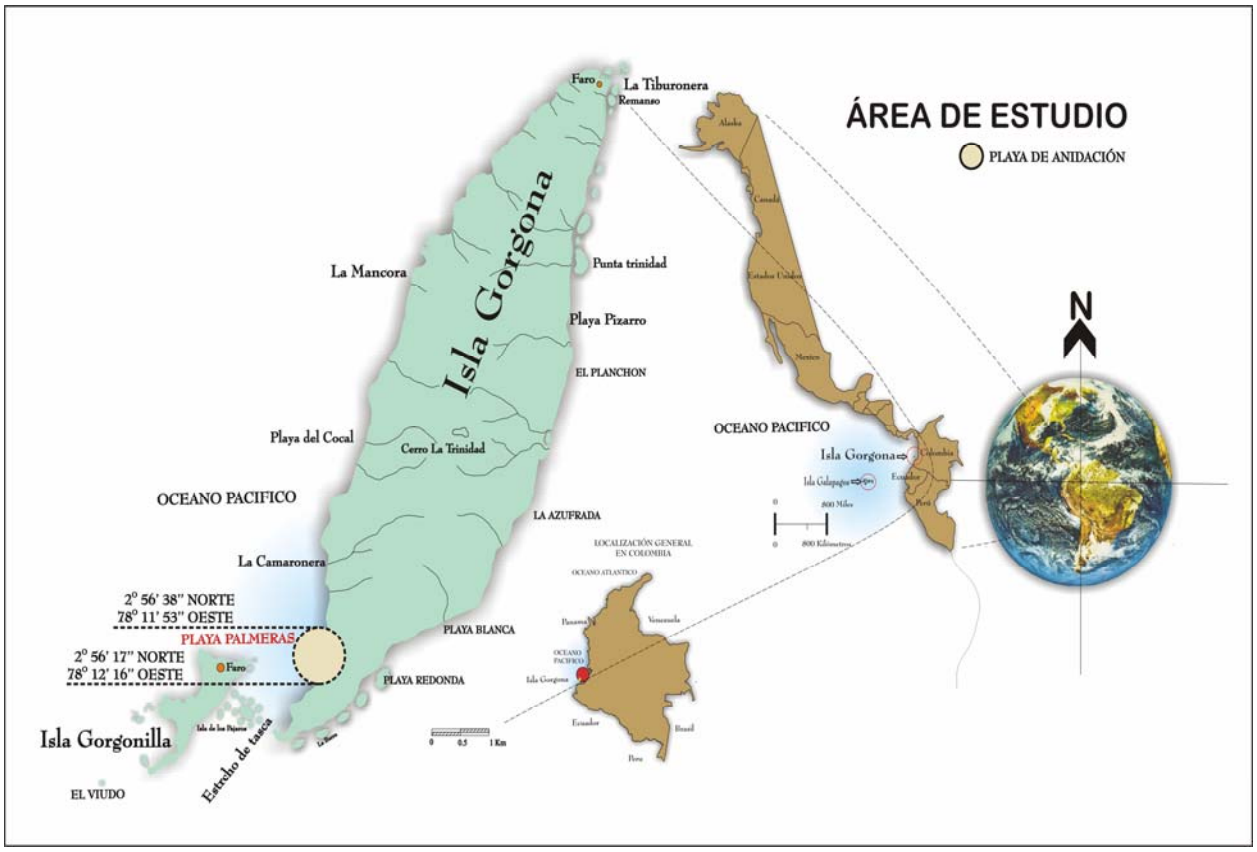


Fig. 1. Study area map, Palmeras Beach, Gorgona National Park.

2.1. NESTING ECOLOGY OF THE OLIVE RIDLEY SEA TURTLE IN PALMERAS BEACH

The procedures for the assessment of nesting activity, estimation of population size, blood and tissue collection for genetic analysis and sex determination of hatchlings are presented below.

The nesting assessments followed guidelines proposed by Schroeder and Murphy (1999), which establish the division by sectors of the sampling area, like an essential tool for the systematic monitoring and the comparison of data among annual seasons. For this purpose, the beach was divided into 6 sectors of 200 m each, signalled with stakes placed in the high part where the line of vegetation begins.

The beach was patrolled by the research team every night for 6 hours, between 18:00 and 05:00 hours. The sampling period varied depending on the tidal oscillation (high tides and low tides), being carried out preferably when the tide began to decrease, since turtles apparently prefer this moment to come ashore (Pavía et al. 2006). Another factor that was kept in mind was the lunar phase, since the quarters (increasing and waning), correspond to the dead tides (*quiebras*) and the moon (full and new) to the alive tides (*pujas*). The possibility of finding turtles nesting is

bigger in *quiebra* because there is more space available and less flood risk. Consequently, beach patrolling was more intensive in *quiebra* than in *puja*; when the level of the sea covered all the sectors of the beach and it was necessary to wait about two hours to renew the survey.

2.1.1. Monitoring nesting beaches

The turtles were approached during or after laying their eggs to reduce disturbance during the nesting process. Each female was tagged in the two front flippers with Monel 861s serial tags (National Band Tag Co.). The purpose of tagging individuals is to identify them during the same or the next nesting season,. This is to understand the rhythm of the reproductive cycle, as well as the nesting and migratory intervals of a given female. Gathered information was added to the database of the marine turtle mark - recapture program that CIMAD has being carrying out in feeding and nesting habitats of GNP since 2003.

13 morphologic parameters were measured from intercepted females to obtain averages of the size of nesting individuals during 2006 in GNP and to compare them with those obtained in previous years (2004 and 2005), as well as with Olive ridley colonies in other beaches of the Colombian and American Pacific. The most representative carapace standard measures were taken. Minimum curved carapace length was measured from the anterior point at the midline (nuchal scute) to the posterior tip of the supracaudals with a flexible tape. For the measures of the straight carapace length (LRC), straight carapace width (ARC) and height (h), a foot calliper was used. These measures are important to relate the corporal size with the NESTING capacity of the individuals, and also to estimate the minimum size of sexual maturity of the species (Bolten, 1999).

Additionally, and in order to confirming the phylogenetic origin of Olive ridleys that nest in Palmeras Beach, tissue of females and non viable hatchlings was collected, and preserved in buffer DMSO. These samples will be processed in the laboratory of Molecular Biology of the Humboldt Institute, where the mitochondrial DNA will be obtained following the protocols described by FitzSimmons et al.(1996; 1999). By the direct sequence of the region control D-Loop, using the PCR technique, it will be able to identify the haplotytpes that characterize the nesting population of Olive ridleys at GNP. This information will serve to update and complement results of genetic identification of the species nesting colony obtained during the 2005 season by Camacho (2006).

Fig. 2. South-western view of Palmeras Beach – Olive ridley female turtle intercepted during nigh time surveys.

2.1.2. Identification of threats, nests relocation and eggs assessment.

In spite of having the favourable conditions of a nesting beach, since direct threats of human origin do not exist, Palmeras Beach presents areas where the nesting female is limited to find an appropriate place where to lay her eggs. This is due to the abundant amount of drift wood, beach front erosion and the increase of coconut palm tree roots that invade the beach and destabilize the soil (Figure 3). As consequence, the nests are located in areas of high risk for the normal development of the eggs. For this reason, and when the circumstances allow, the nests were transferred to more secure areas of the beach previously identified making sure that they were above the high tide. The chosen places were adapted and maintained free of wooden and solid debris during nests incubation.

Figure 3. Natural threats for the reproduction of the Olive ridley sea turtle at Palmeras Beach - GNP.

Keeping in mind the above-mentioned, the eggs relocation (Figure 4) was only done when the nests were deposited in high risk areas. For example, when they were near the tide line, in areas sensible to erosion, in collapsed dunes, or close to streams, as well as in those sectors of intense

tourism activity. During nest relocation the diameter and weigh of the eggs were measured. To avoid the negative effects that could be caused by changes of temperature, humidity and development of the embryos, the eggs were placed recreating the same conditions of the original nest (depth and diameter), no more than six hours after being laid (Mortimer, 1999).

Fig.4. Relocation of high risk nests into protected areas of the Beach.

2.1.3. Eggs Incubation, size and weigh of hatchlings and sampling for genetic analysis

The transferred nests were monitored during the whole incubation period until the emergence of hatchlings. To assure the appropriate incubation, the surface around the nests was cleaned daily, removing garbage and drift wood that regularly arrive to the beach.

After 45 days of incubation, the nests were surrounded with cylinders of plastic mesh buried 45 cm, to protect emerging hatchlings from predators and to be able to count them in the moment of the appearance. Once the incubation concluded, 10 emergent hatchlings were measured for size (straight length and width of carapace, length and width of the plastron) and weighted. Additionally, tissue samples from fins, liver, heart or blood were collected from predated or dead hatchlings for genetic analysis.

Fig.5. Embryonic stages of Olive ridley hatchlings at Palmeras Beach.

2.1.4. Hatching and emergence success

The hatching success of appearance has been considered here, as the offspring numbers that leave the egg, while the emergence success, corresponds to the number of hatchlings that leave the nest. These indexes provide useful information for management that can affect the nesting populations of marine turtles at Palmeras Beach. For the evaluation of these data, the nests were excavated to count the empty shells (CV), the rotten eggs (HD), the eggs with hatchling or embryo (HCN), and the dead hatchlings (NM) inside the nest. Later on, following the methodology used by Pavía et al. (2006) for Palmeras Beach, adapted from the models used by Martínez and Páez (2001) and Chacón et al. (2007), both percentages were determined for the species according to the following formulas:

$$\text{Hatching success (\%)} = \frac{\#CV}{\#CV + \#HD + \#HCN} \times 100$$

$$\text{Emergence success (\%)} = \frac{\#CV - \#NM}{\#CV + \#HD + \#HCN} \times 100$$

Fig 6. Excavated nest, emerging hatchling of Olive ridley sea turtle

2.1.5. Sexual determination of hatchlings in Palmeras Beach

In marine turtles, the sex depends on a thermo sensitive period (PTS) that happens in the second third of the total time of incubation (Yntema and Mrosovsky, 1982). This effect that has the temperature to define the sex of the hatchling is useful in population management, as it is the need of males or females to be introduced in a decimated population. For conservation purposes, the variations of temperature can be managed assuming that the relationship between female and male is 1:1. At temperatures over 30.4° the number of females is increased, according to that registered for the species in the wild by Wibbles et al. (1998). The knowledge of the threshold of temperature PTS, is also good to evaluate the impact of the relocation techniques in the protection of threatened nests (Godfrey and Mrosovsky, 1999).

For sex determination of Olive ridley hatchlings at Palmeras Beach, the technique of sexual differentiation through gonadal histology was used. Considering the endangered status of the Olive ridley sea turtle, non viable hatchlings were collected from the nests (predated or dead). The hatchlings were preserved in 10% formalin, to extract the gonads in a laboratory in the city. This process begins with the removal of the plastron (breast) of the hatchling and with the help of a dissection microscope, the gonads are identified next to the kidneys. Both organs are extracted and then the gonads, are separated from the kidney to be fixed in 8% formalin (Figure 7).

Fig. 7. Dissected hatchlings. Details of the urogenital system of an Olive ridley hatchling.

Following the procedure used by Spotila et al. (1983), the gonads were dehydrated and embedded in paraffin to make, afterwards, traverse cuts of 10 microns thick with a rotary microtome. Then the cuts of the gonads were stained and mounted with resin in microscope slides. The gonads were observed in the microscope, differentiated and photographed. In the males the cortex is very thin, mono-stratified and they present an organized medullar region with seminiferous tubules (Figure 8). The females on the other hand, present a different and multi-stratified cortex, and a disorganized medulla, as Wibbels et al (1999) describes it and can be seen in Figure 9.

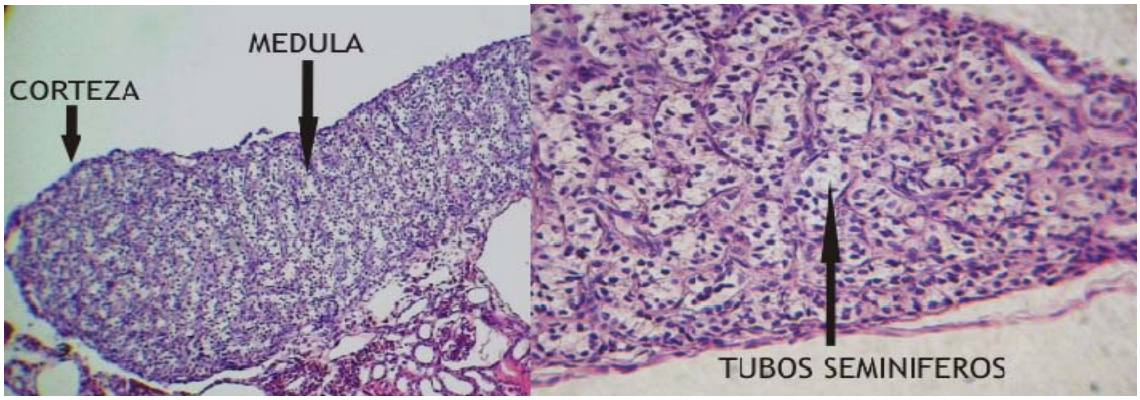


Fig 8. Gonadal structure of an Olive ridley male hatchling.(10x-40x)

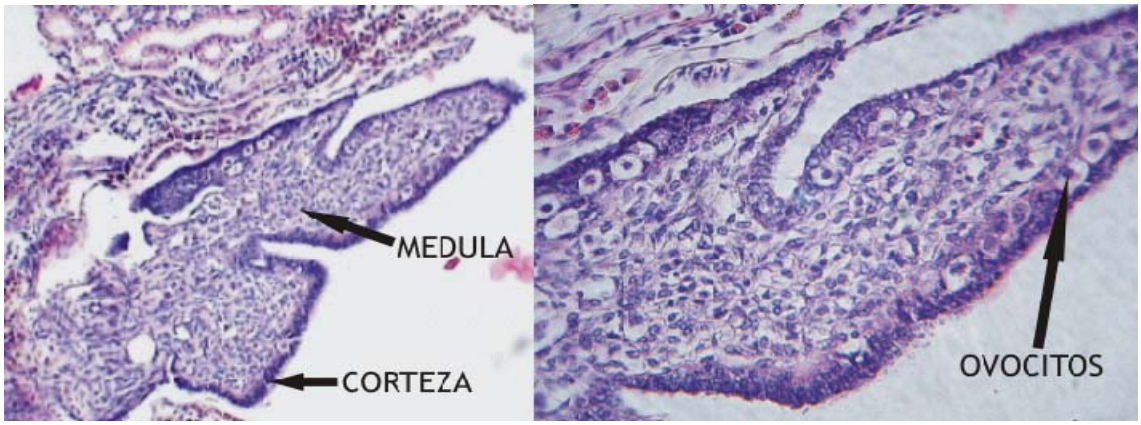


Fig 9. Gonadal structure of an Olive ridley female hatchling. (10x-40x)

2.2. PUBLIC PARTICIPATION FOR CONSERVATION MANAGEMENT OF MARINE TURTLES IN THE COLOMBIAN PACIFIC.

Through its scientific and institutional action line, CIMAD looks forward to enhance the knowledge to cope with current conservation issues that marine turtles have to face in the Colombian Pacific. For this purpose, several chats were given in Guapi (Cauca). Training workshops for conservation management and sea turtle by-catch in artisanal fisheries were also developed with 2 groups of local fishermen of the region. Fishermen get interested in the implementation of available technology for a responsible and sustainable fishing that will reduce the incidental capture of marine turtles in the Colombian Pacific (Figure 10).

2.2.1. Oral presentations given to students of San Jose School in Guapi .

These educational chats were focused on the plight of sea turtles and relevance of scientific knowledge useful to reduce current threats, as well as in the importance of preserving their critical habitats. This, to begin a process of awareness and formation of young adults in Guapi (Cauca), willing to undertake actions for an appropriate management of marine turtles and the protection of their habitats in the Colombian Pacific.

2 .2.2. Training workshops with native fishermen of Chamón.

The development of the training workshops with the local fishermen looked for firstly to know its fishing techniques and the relationship that these have with the incidental capture of marine turtles. And secondly, to introduce the use of new fishing technologies as turtle de-hookers and circle hooks. Surveys were carried out (Annex 1) with the objective of learning about the fishing gear that they use, their characteristics, their effectiveness and the influence that this gear has on marine turtles. This information is essential for the establishment of new strategies that will

help to reduce the incidental capture of marine turtles in the Colombian Pacific. This is, considering that local stakeholders are keen to implement these solutions.

Fig. 10 Students and fishermen attending educational chats and qualification workshops.

3. RESULTS

The obtained results on the nesting activity of the Olive ridley sea turtle (*Lepidochelys olivacea*) at Gorgona National Park during season 2006 , were the following:

3.1. NESTING ECOLOGY OF OLIVE RIDLEY SEA TURTLES IN PALMERAS BEACH

3.1.1. Monitoring of nesting beaches

During the time of the study, 5 turtles were intercepted, 16 tracks observed, 11 nest completely assessed and 35 excavations practiced (8 corresponding to relocated nests and 27 to nests deposited before the beginning of the monitoring). The monthly results of the nesting activity discriminated by event are shown in Chart 1. There it can be seen that, although the field phase began once the season had already started, the highest activity months were covered between September and December.

Period (2006 – 2007) / Event	October 8-31	November 1-30	December 1-31	January 1-12	Total
Intercepted Turtles	4	1	0	0	5
Traces Observed	4	11	1	0	16
Nesting Turtles	6	5	0	0	11
Excavations	5	15	14	1	35

Chart 1. Monthly nesting activity of Olive ridleys at Palmeras Beach - 2006.

The highest nesting activity (58.3%) was presented in the north area of the beach (sectors 1, 2 and 3), with 28 registered events (Figure 11). The total number of events corresponds to the sum of intercepted turtles, observed tracks and excavations practised to those nests previous to the seasonal survey (Graph 1)

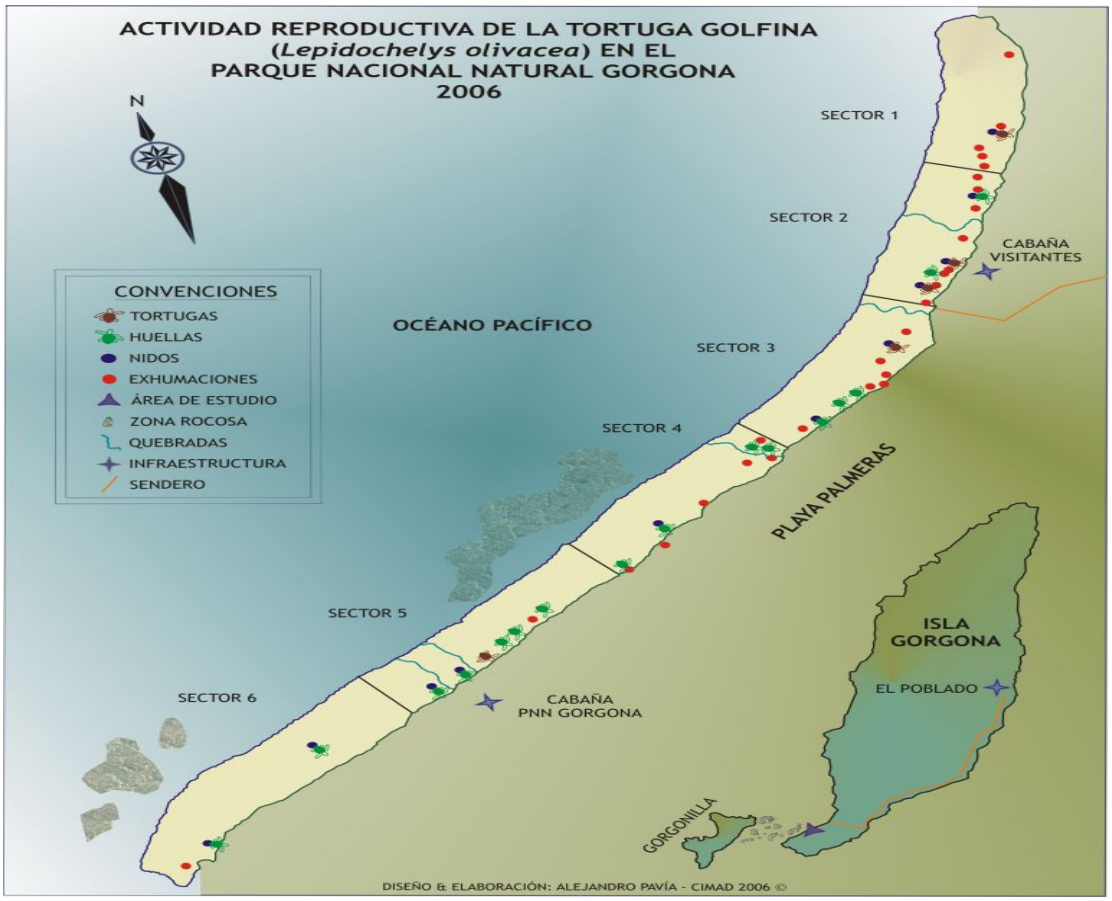
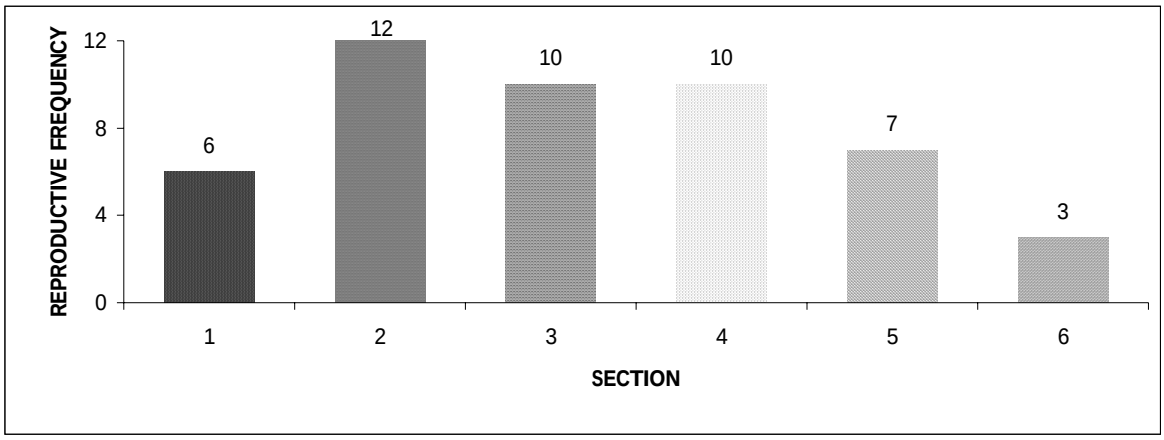
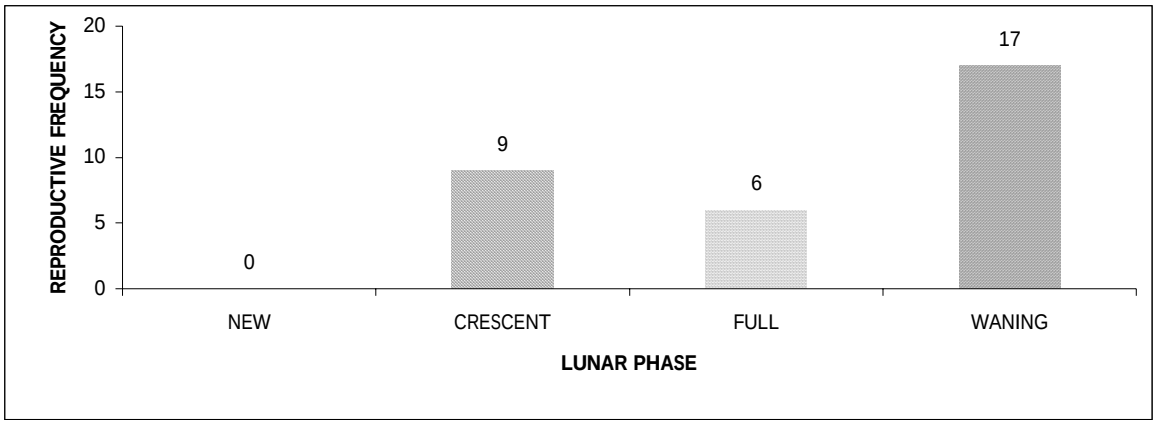


Fig. 11. Map of the of the Olive ridley nesting activity at Gorgona National Park -2006.



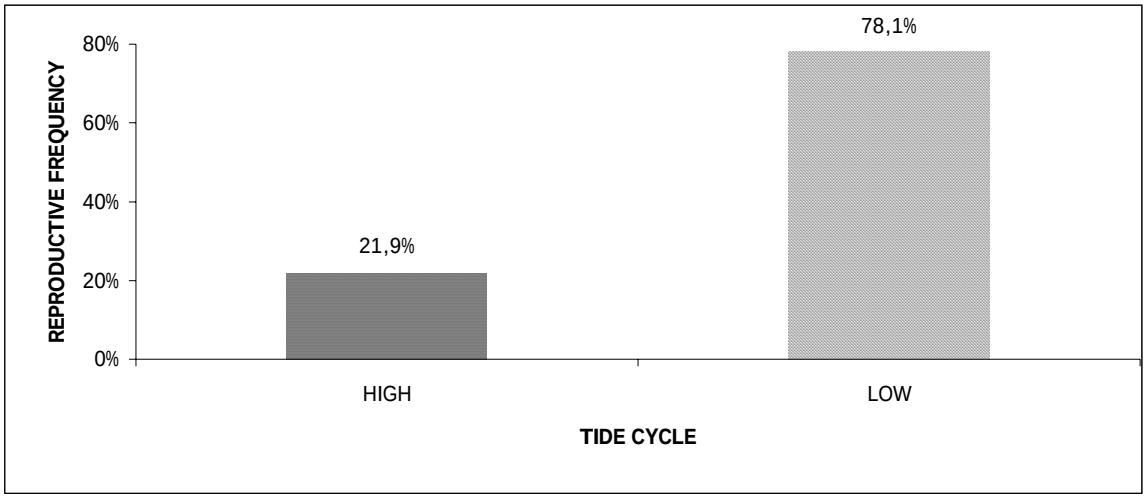
Graph 1. Record of Olive ridleys nesting activity along sectors of Palmeras Beach - 2006.

The biggest number of nesting event s (81.0% ; n=17), such as female interception and presence of tracks in the beach, took place during the moon phases of waning and growing. These phases govern the *quiebras*, being feasible; as explained previously. The remaining 19.0% (n=4) happened during the full moon, which governs the fortnight tidal cycles locally known as *pujas* (Graph 2).



Graph 2. Record of Olive ridleys NESTING activity during the moon phases.

During the 2006 season, 78.1% (n=16) of the turtles laid eggs in the beach with the tide lowering (Graph 3).



Graph 3. Record of Olive ridley nesting activity during the tidal cycles

Tags applied to nesting females and samples collected for genetic analysis are listed in Chart 2. The average of body measurements taken from marine turtles intercepted during night time surveys in Palmeras Beach are presented in Chart 3.

Applied Tags	Tissue Sample
WH 581 – 582	RTG 15
WH 583 – 584	RTG 16
WH 585 – 586	RTG 17
WH 587 – 588	RTG 18
WH 589 – 590	RTG 19

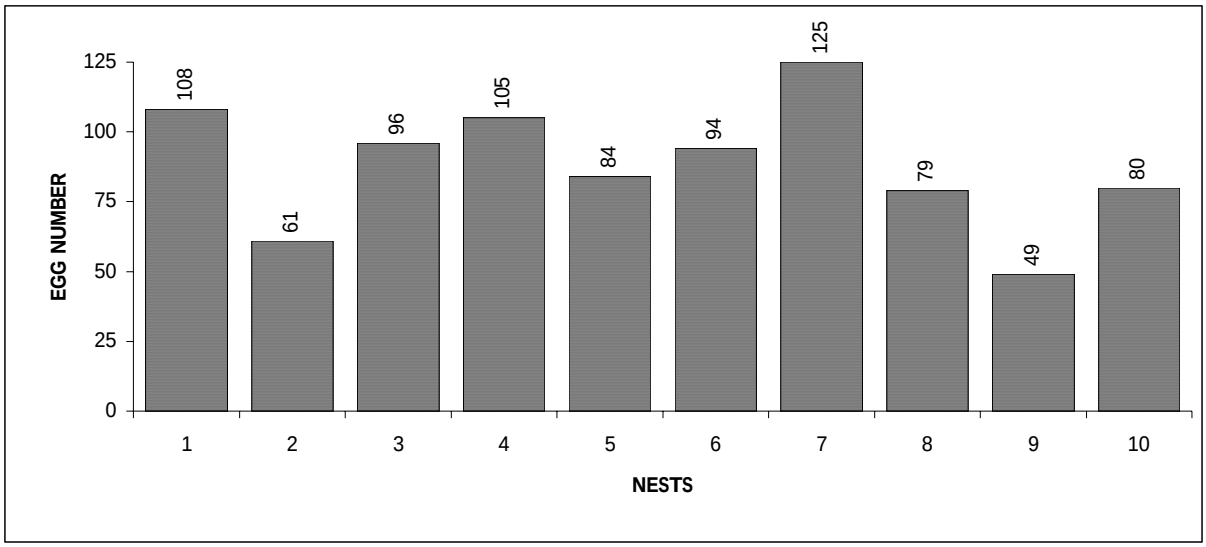
Chart 2. Applied marks and tissue samples collected from Olive ridley females – 2006

Parameter / Stadistic data	CCL (cm)	CCW (cm)	SCL (cm)	SCW (cm)	Weight (Kg)
Average	65.8	71.8	62.1	55.7	35.4
Standard Deviation	2.09	5.06	1.93	2.74	4.45
Minimum	63.0	64.4	59.8	51.8	30.0
Maximum	68.7	78.5	64.9	59.1	42.0

Chart 3. Body size of 5 Olive ridley females measured in Palmeras Beach – 2006

3.1.2. Identification of threats, nest relocation and hatching assessment

Of the 11 registered nests during or after the clutch was laid, 10 of them were relocated in the high part of the beach (*ex situ*). The remaining nest was left *in situ* because it was found six hours after the posture. The total number of eggs relocated was 881, as described in Graph 4.



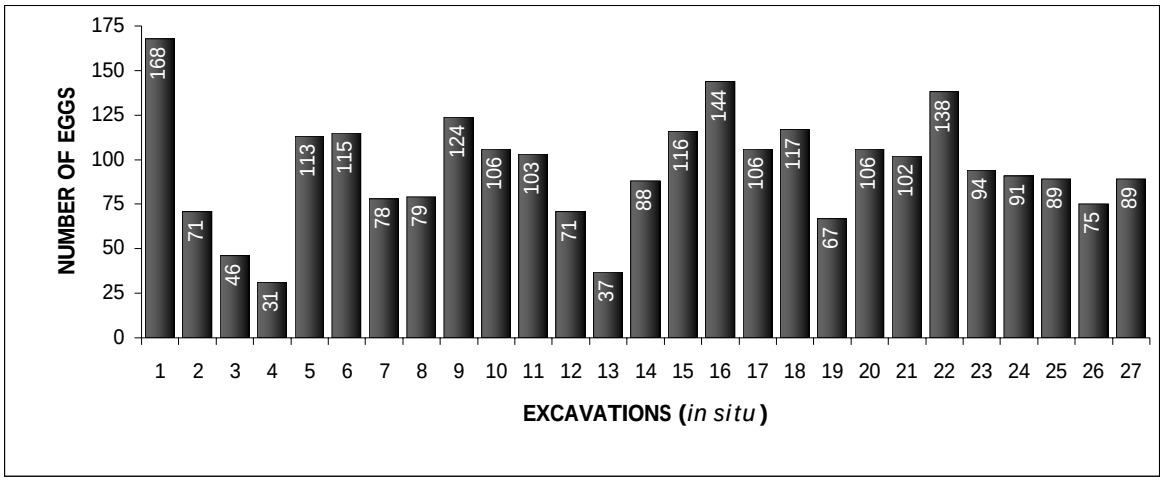
Graph 4. Number of eggs from 10 *ex situ* nests at Palmeras Beach - 2006.

The body size measurements and weight of 10 eggs randomly chosen from a total of 8 relocated nests are shown in Chart 4

Parameter / Stadistic Data	**Diameter (mm)**	**Weight (gr)**
Average	38.7	35.3
Standard Deviation	0.22	0.26
Minimum	33.0	30.0
Maximum	42.0	42.0

Chart 4. Size and weight of 80 relocated (*ex situ*) in Palmeras Beach - 2006.

Excavations were done in 27 *in situ* nests found hatched, which were deposited in previous months to the beginning of the 2006 nesting season assessment. The estimated total of these eggs was 2564 (Graph 5).



Graph 5. Number of eggs from 27 nests *in situ* assessed at Palmeras Beach -2006.

The total number of eggs deposited in Palmeras Beach in 2006 was calculated, establishing the averages of eggs per nest, for both *in situ* and *ex situ,* as presented in Chart 5.

Location / Stadistic Data	*ex situ* **(n=10)**	*in situ* **(n=27)**
Average	88.1	95.0
Standard Deviation	22.5	31.3
Minimum	49	31
Maximum	125	168

Chart 5. Average of eggs from 37 nests (*in situ* and *ex situ*) monitored at Palmeras Beach - 2006..

3.1.3. **Eggs incubation, size and weight of hatchlings, and sampling for genetic analysis**

The incubation time average of the eggs in 8 monitored nests during 2006 in Palmeras Beach, was of 57.8 days (D.E.± 6.25; Range: 44 - 65 days). The body measures (Straight carapace length, straight carapace width, plastron length, plastron width, weight) average of 94 randomly chosen hatchlings of 10 hatched nests are presented in Chart 6.

Parameter / Stadistic Data	SCL (mm)	SCW (mm)	PL (mm)	PW (mm)	Weight (gr)
Average	40.3	32.9	30.6	27.2	22.5
Standard Deviation	0.87	0.58	0.64	0.32	0.84
Minimum	37.8	30.1	28.6	24.9	18.8
Maximum	43.7	34.3	32.7	28.9	28.2

Chart 6. Measurement of 94 hatchlings at Palmeras Beach - 2006.

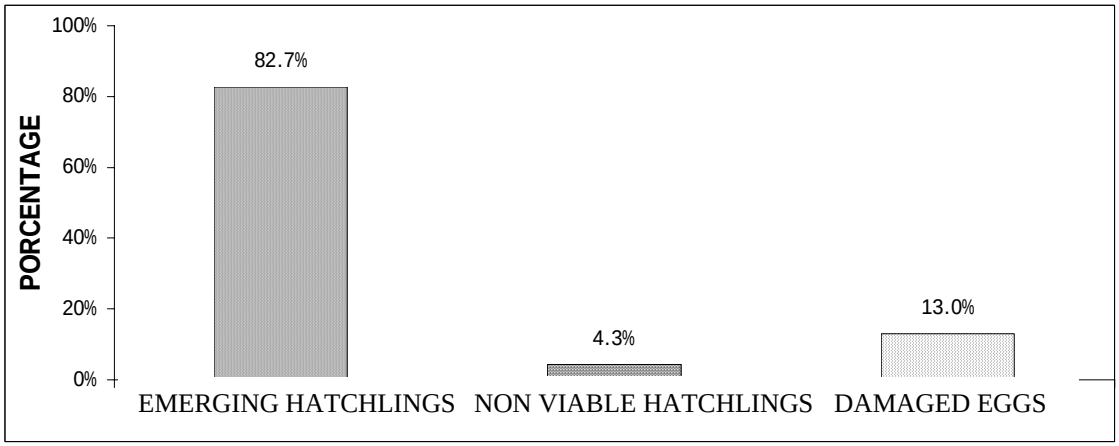
A total of 37 samples for genetic analysis (31 of tissue and 6 of blood) were collected from dead or predated hatchlings found in 20 excavated nests. The hermit crabs (*Coenobita sp*.) and ghost crabs (*Occipode sp*.), are one of the biggest natural threats that hatchlings have to overcome in Palmeras before arriving to the sea.

3.1.4. Hatching and emergence success

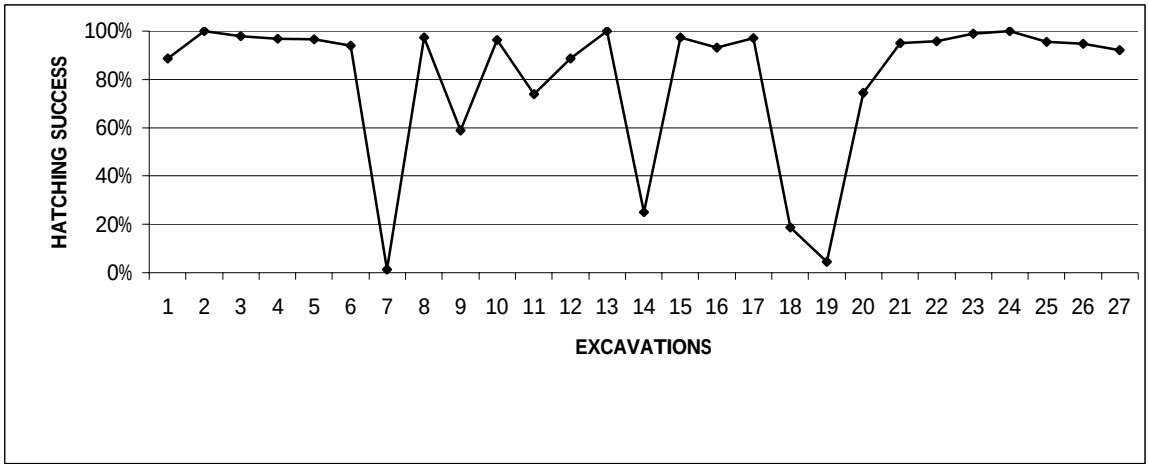
Of the 37 nests found in Palmeras Beach, 35 were excavated.10 nests relocated during the field work of which 8 were completely assessed during the incubation time and 27 corresponded to those found *in situ* before the beginning of the 2006 nesting survey. In each excavation data corresponding to emergent hatchlings, non viable hatchlings and damaged eggs was registered (Chart 7). The total percentages corresponding to the 35 excavations carried out are shown in Graph 6.

Location / Excavation results	*ex situ* **(n=8)**	*in situ* **(n=27)**	**Total (n=35)**
Emerging Hatchlings	674	2068	2742
Non viable Hatchlings	19	124	143
Damaged Eggs	59	372	431
Total Excavated Eggs	752	2564	3316

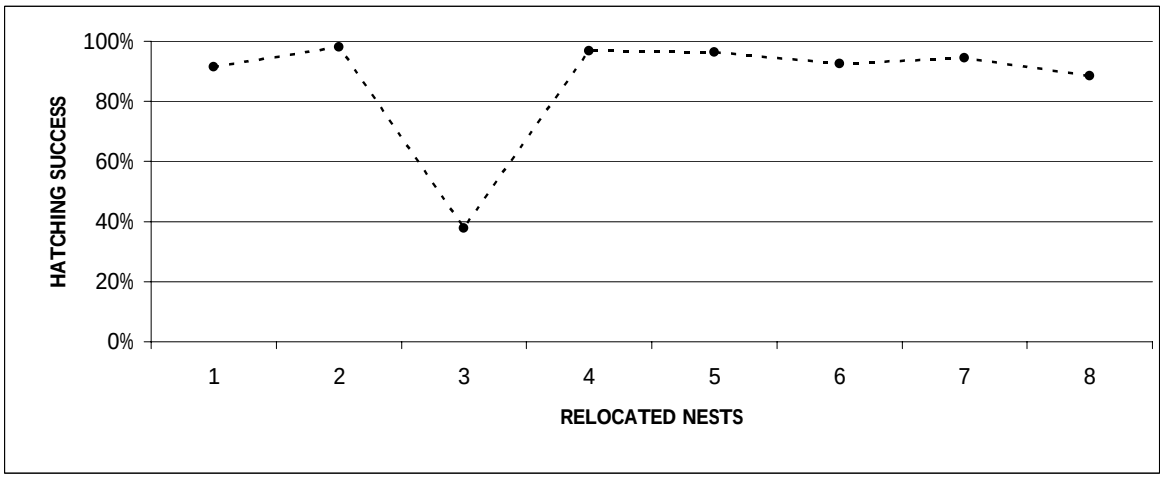
Chart 7. Results from 35 nest excavated in Palmeras Beach – 2006



Graph.6. Total percentages obtained during the excavations carried out at Palmeras.

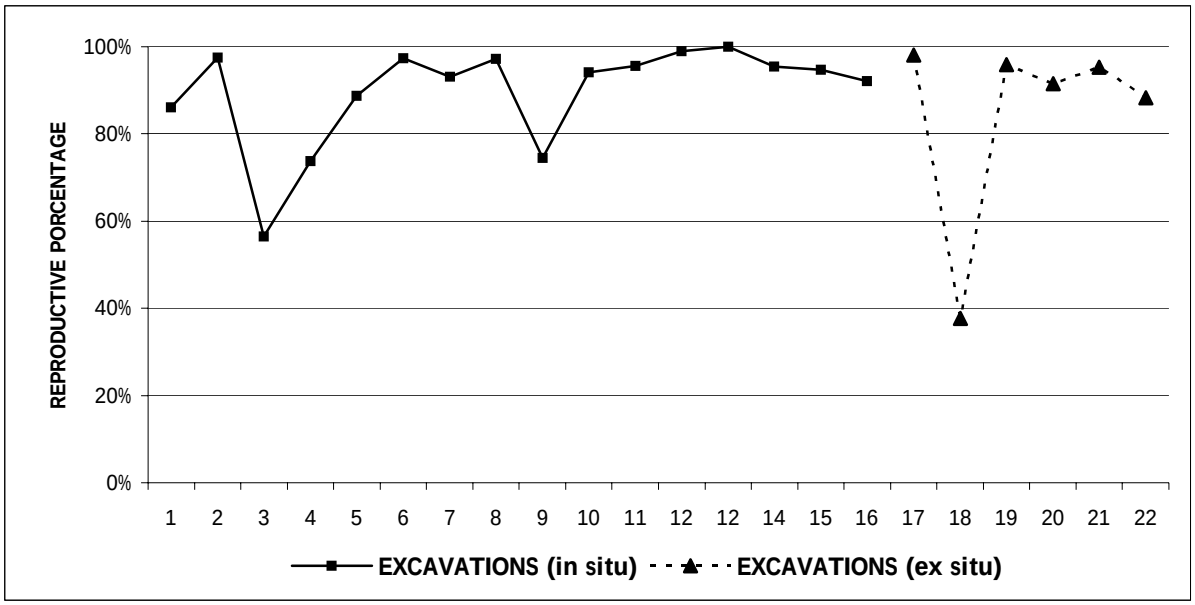


Graph.7. Hatching success of excavations carried out to nests *in situ* (n=27).



Graph 8. Hatching success of excavations carried out to nests *ex situ* (n=8).

The emergence success of 88.3% (D.E ± 15.3%; Range: 37.7% - 100%) was determined using the data of 22 of the 35 nests assessed throughout the entire incubation period Graph 9 show the values of emergence success obtained from each of the nests. Only up to 16 of the 27 *in situ* nests were completely assessed and the emergence success was 89.7% (D.E ± 11.8%; Range: 56.5%-100%). In 6 of the 8 *ex situ* evaluated nests the result was 84,4% (D.E ± 23.2%; Range: 37.7%-98.1%).



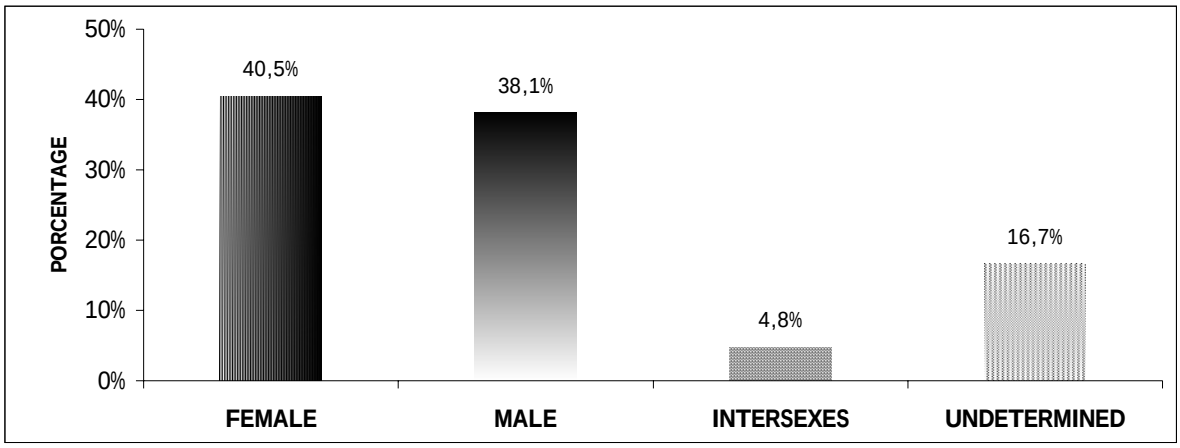
Graph 9. Emergence success of 22 nests monitored at Palmeras Beach - 2006.

3.1.5. Sexual determination of hatchlings in Palmeras Beach

From 12 out of the total of nests monitored in Palmeras Beach (n=37), 47 Olive ridley turtle hatchlings were selected randomly for sexual determination. It was possible to extract gonads from 42 of them. The gonads of the remaining 5 hatchlings could not be dissected properly .

In the slides obtained from the cuts after the tint, the presence of a multi-stratified cortex and follicles were observed in 17 individuals, typical characteristic of the females. The appearance of seminiferous tubules and the lack of the characteristic cortex in the males, was observed in 16 of the 42 cuts. In two of the slides it was not possible to complete the identification. There were regions that showed an alternation between a well developed cortex and medullar tubes along the gonad, being considered as inter-sexes. In 7 slides the sex could not be determined. This, due to the fact that there were no traces of gonads because the tubes or the surface of the epithelium were poorly developed, or because the extraction process was not appropriate done.

The final results of the sexual proportions found in the hatchlings collected in Palmeras Beach, are presented in Graph 10.



Graph 10. Gonadal characterization of the collected hatchlings.

3.2. PUBLIC PARTICIPATION FOR THE CONSERVATION MANAGEMENT OF MARINE TURTLES IN THE COLOMBIAN PACIFIC.

3.2.1. Oral presentations to students of San Jose School in Guapi (Cauca State).

15 oral presentations were given to over 300 high school students among grades 9 to11 from San Jose School, in Guapi. In these chats the knowledge that students have about marine turtles was measured, being clear that they were not very familiar with the topic, and the few information that they have, is gotten from the television.

On the other hand, all mentioned to have consumed meat and/or turtle eggs in some moment of their life. Although it is not a usual part of their diet, it is considered a luxurious plate which consumption is occasional. Knowing this fact, they were explained of the magnitude of the current problem of conservation of marine turtles, due to the growing impact of natural and anthropogenic factors responsible for the current global extinction that these animals face.

9 books about Neotropical Marine Turtles, of the Series of Field Notebooks published by Conservation International – Colombia and 150 flyers allusive to the protection of marine turtles in the Colombian Pacific were distributed among teachers of this Institution. The distribution of this educational material, seeks to motivate the students of the educational institutions of Guapi, to undertake urgent actions towards the conservation of these marine reptiles in their region.

3.2.2. Training workshops with local fishermen of Guapi and Chamón.

The surveys carried out in Guapi indicated that the traditional fishhook "J" (size 7 - 8) is the only one that the fishermen use. In spite of knowing the "circular" fishhook and to prefer it for its effectiveness and durability, it is difficult to acquire it in the market and when it is gotten, it turns out to be more expensive than the traditional one. The gathered data shows that in average each fisherman uses a total of 835 fishhooks per spinel, distributed along 3541 line meters. It was determined that the fishing task has a duration average of 3 days, in which 2 throws of 24 hours each are made, and approximately 50K. of mainly wreck fish (Serranidae), hake (Ophidiidae) and snapper (Lutjanidae) are caught.

All those interviewed affirmed that they occasionally capture marine turtles during the long line fishing activities; being the Olive ridley turtle the most hooked. Some mentioned that when the turtles are caught alive, they release them, although generally turtles end up being part of their meals.

The training workshops that have been carried out until now are the initial steps of an awareness process focused on the reduction of sea turtle by-catch in the Colombian Pacific. The first part of this process has been the compilation of information to design strategies for the local fishermen to begin the use of new fishing technologies in an organized way. The next step is to give them the tools for this means (use of de-hookers and circle hooks), promoting the voluntary substitution of traditional J hooks in the fishing long lines and qualifying fishermen in their use. The last step is to make an evaluation of the process to adjust the strategies outlined initially, so that the objective, which is the contribution to the protection of marine turtles that frequent the American Pacific, is achieved.

4. DISCUSSION

4.1. NESTING ECOLOGY OF THE OLIVE RIDLEY SEA TURTLE IN PALMERAS BEACH

4.1.1. Monitoring of nesting beaches

The preference of marine turtles for certain sectors of Palmeras Beach during the nesting activity corresponding to 2006 season, is similar to the tendency reported in the same beach in 2005, when the percentage of events in the same sectors (1, 2 and 3) was of 74.4% (n=32). This implies the need to consider these aspects for conservation decision making. Therefore, the places of the beach where the biggest activity of nesting females takes place, require to be free of solid debris, drift wood and tourism activities, to make sure that Olive ridley turtles can fulfil their natural NESTING function (Cornelius, 1976).

Additionally, it is observed that 78,1% of the females prefer to nest when the tide is lowering, this allows them to have more time to find an appropriate place to lay their eggs. This behaviour is consequent with the one observed by McCormick (1996) who affirms that the

biggest number of turtles in the beach (64.3%) occurred with the low tide. The same thing reported Pavía et al. (2006) in 2005, when 74,5% of the events took place in the same circumstances.

The nesting females measured in Palmeras Beach through the years (McCormick, 1996; Amorocho et al., 2004a; Pavía et al., 2006), have average sizes of curve carapace length (CCL) and width (CCW) that do not show significant differences among annual seasons, with ranges of CCL among 60.5 - 70 cm and of 60 - 80 cm for the CCW. Similar results were obtained in the Colombian Pacific by Amorocho et al. (2004) in Sanquianga National Park (Average CCL = 69.1 cm; D.E ± 3.96; Range: 64.5-75 cm and Average CCW = 68.9 cm; D.E ± 3.51; Range: 61-72.5 cm). The average measure of CCL obtained in 2006 is within the range reported for the species (60-70 cm) in studies carried out in the East Pacific (NMFS/USFWS, 1998).

4.1.2. Identification of threats, nests relocation and hatching assessment

The nesting beaches are considered world wide as the foremost critical habitats for the reproduction of marine turtles, besides being indispensable for the survival of their populations (Witherington, 1999). Therefore, as the UAESPNN underlines (2004), the degradation of these habitats in the GNP, facilitates an increase the risk for the Olive ridley nesting population to annually decline in number of individuals.

Previous evaluations (Amorocho et al 2004a; Pavía et al., 2006) have demonstrated alterations in the sea turtle nesting habitats at Palmeras Beach, particularly by natural and mand induced factors, such as the introduction of coconut palm trees. In consequence, the only option available at the moment is the relocation of nests, which is considered the last management technique to ensure the protection of eggs for marine turtles conservation (Mortimer, 1999).

During the relocation, the eggs were measured to compare them with the results of other beaches where Olive ridley sea turtles are known to nest in the Colombian Pacific. The averages obtained for Gorgona by McCormick (1996) and Pavía et al. (2006) did not present significantl differences. They both fall within; the ranges of 32.1-44.7 mm of diameter and of 30-38 gr of weight established for the species in the U.S. Recovery Plan for Pacific Populations of the Olive Ridley Turtle (1998).

Additionally, it was observed that the obtained average of 93.9 eggs per nest (n=70) during the last three seasons (2004 - 2006) at Palmeras Beach, is higher than that of 92 (n=14) reported for Gorgona in 1994 and 1995 by McCormick (1996). In the same way it is larger than the 82,9 eggs per nest (n=43) obtained by Amorocho et al. (2004a) in Sanquianga National Park. However, this number is low if it is compared with La Cuevita beach in Chocó (north

Pacific of Colombia), where Martínez and Páez (2001) estimated an average of 102 eggs per nest (n=365). This average of eggs is also lower than the 105.3 eggs per nest (n=1120) reported by Márquez (1990) in Pacific of Mexico..

4.1.3. Eggs incubation, size and weight of hatchlings, and sampling for genetic analysis

The incubation process of the Olive ridley turtle eggs is of approximately 50 to 60 days (NMFS/USFWS, 1998). This period varies depending on factors like the environmental temperature, relative humidity, and type of sand where the nest is located (Hughes and Richard, 1974). The incubation time during the 2006 – 2007 season in Palmeras Beach was 57.8 days (D.E ± 6.25; Range: 44-65 days). Shorter than the period of 62.3 days registered in 2005 by Pavía et al. (2006) and 59.9 days reported in 1995 by McCormick (1996). Comparatively speaking, the times obtained in Gorgona are longer than the ones registered in other beaches of the Colombian Pacific. In La Cuevita Beach, the incubation time ranges from 49 to 52.2 days (Amorocho, 1998; Martínez and Páez, 2001). However, incubation time for 2006 season at Palmeras beach is within the range estimated worldwide for the species.

The body size measurements taken to the hatchlings in Palmeras Beach, indicate that the CCL stays inside the species' range (34.7 - 44.6 mm); while the weight was above the NMFS/USFWS (1998) established range of 12.0 - 22.3 gr. These differences are not significant, but they should be kept in mind, since according to Miller (1999), the changes of these measures among annual seasons, indicates the existence of difficulties that can limit the normal development of the embryo during the incubation process.

4.1.4. Hatching and emergence success

Considering the obtained results, it can be said that neither the manipulation, nor the transfer of the eggs, affected the hatching success. Additionally, the methodology of relocation of nests used in Palmeras Beach during 2006, shows a higher percentage of hatching success (82%), compared with the 66.7% and 61.3% obtained by Amorocho (1998) in La Cuevita Beach during 1994 and 1995, respectively. It was also bigger than the 71.4% estimated later on in the same beach by Martínez and Páez (2001).

It was possible to observe that the low percentages of hatching success presented in some clutches were due to the fact that certain nests were affected by some of the natural threats that exist in Palmeras Beach, like: the floods, the invasion of coconut palm tree roots and the erosion of the beach. The monitoring of the annual variations of hatching and emergence success among nesting seasons is critical to understand the sustainability of the Olive ridley sea turtle nesting population in Palmeras Beach, since the variations in number of hatched and emergent hatchlings are associated to the quality and conditions of the beaches as nesting habitats (Chacón et al., 2007).

4.1.5. Sexual determination of hatchlings in Palmeras Beach

There was not a high difference among the obtained percentages of sexual differentiation of 40.5% for females and 38.1% for males. This approaches to the relationship 1:1, defined as ideal for the conservation of the populations of marine turtles. This highlights the effectiveness of the relocation techniques used in Palmeras Beach during this season. This suggests that care must be taken when eggs are relocated into beach protected nurseries, which was not the case of Palmeras, because it could commit the viability of the species favouring the production of a particular sex. This findings contrast with the proportion of 3 males for a female obtained by Martínez and Páez (2001) in the nursery of La Cuevita in northern Colombian Pacific coast.

5. CONCLUSIONS

• The Olive ridley sea turtle (*Lepidocheys olivacea*) is the predominant species nesting at Palmeras beach in Gorgona National Park.

• Marine turtles prefer to nests in more suitable sectors 1, 2 and 3, located to the north of the beach, in which they concentrate 58.3% of the nesting activity during 2006.

• The average body size of nesting females (CCL = 65.8 cm) in Gorgona National Park felt within the 60 to 70 cm established for the species in the tropical east Pacific.

• Natural threats are the main responsible for the reduction of hatching success. This is why the relocation of nests into safely places in the beach, has proven to be an important management tool to increase the number of hatchlings reaching the sea.

• The mean incubation time of 57.8 days was close to the top of the range (50 to 60 days) estimated for the species. This due to the high rainfall registered in the area during the sampling season.

• The species hatching success of 82.0% in 2006 at Palmeras Beach was higher than those reported in previous studies carried out in the Colombian Pacific. This emphasise the role of Gorgona as a critical protected area in the east Pacific for the conservation of the Olive ridley sea turtle.

• The sexual proportions of 1 male per female obtained in Palmeras Beach, are appropriately adjusted to 1:1 to maintain the sexual proportion of marine turtle populations in their natural environment.

• The education and training activities developed in the municipality of Guapi, were the beginning of a process that seeks to merge environmental education and the implementation

of new fishing techniques, to reduce the incidental capture as a viable alternative for the conservation management of marine turtles in the Colombian Pacific.

6. RECOMMENDATIONS

• The monitoring in nesting areas of the Gorgona National Park should be continued to enhance knowledge for better management of Olive ridley sea turtle populations that breed in Palmeras Beach.

•There should be permanent support from the Park officers and Rangers for the development of the monitoring activities in order to intensify the hours of night surveys with two groups of people.

• Maintaining the beach free of plastic debris and drift wood is a priority during the annual season to guarantee the normal nesting of Olive ridley sea turtles in the Gorgona National Park.

• During the nesting season the tourism activities in Palmeras Beach should be controlled to avoid disturbance of turtles and their nests. A protected beach nursery should be considered if tourism increases in the next two years.

• Beach development and construction of infrastructure in Palmeras should not be allowed because these would dramatically affect the nesting behaviour of Olive ridleys putting in risk the breeding colony at Palmeras Beach.

• The environmental education activities carried out in the Park and in the municipality of Guapi, should continue. It is important, to increase the knowledge and call attention of the local inhabitants about the current situation of endangered Olive ridleys in the Colombian Pacific and how to get engage in their protection.

• To extend the training workshops and facilitate fishermen to use new gear and techniques that reduces sea turtle by-catch without hampering the commercial targeted species.

7. BIBLIOGRAPHY

Amorocho, D.F., H. Rubio y W. Díaz. 1992. Observaciones sobre el estado actual de las tortugas marinas en el Pacífico colombiano. Contribución al conocimiento de las tortugas marinas de Colombia. J. Rodríguez y H. Sánchez. Bogotá, Biblioteca Andrés Posada Arango, No 4:155–179 pp.

Amorocho, Diego. 1998. Biología reproductiva de la tortuga Golfina (*Lepidochelys olivacea*) en Playa Larga, Chocó. Pp. 345-349. In: Instituto de Investigación de Recursos Biológicos Alexander Von Humboldt. Informe Nacional sobre el Estado de la Biodiversidad 1997 - Colombia. Editado por María Elfi Chávez & Natalia Arango. Santa Fe de Bogotá: Instituto Humboldt, PNUMA, Ministerio del Medio Ambiente, 1998. 3 Vol.

Amorocho, D. 2002. Prioritizing research-driven management and public participation in sea turtle conservation in Colombia. Masters Thesis, School of Resources, Environment and Society. Australian National University. ACT – Canberra. Australia. 143 p.

Amorocho D.F., L.A. Merizalde y J.A. Riascos (Eds). 2004. Investigación – Acción para la conservación de las tortugas marinas en el Pacífico colombiano. Creando capacidad técnica para el manejo y conservación de la tortuga Caguama del Pacífico (*Lepidochelys olivacea*) 2003 – 2004. Informe final. CIMAD. 38 p.

Amorocho D.F., L.A. Merizalde y J.A. Riascos (Eds). 2004a. Biología reproductiva de las tortugas marinas en el Parque Nacional Natural Gorgona. CIMAD. Noviembre 30 del 2004. Informe final. 35 p.

Bolten, A.B. 1999. Techniques for Measuring Sea Turtles. p. 110-114. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Camacho, L. 2006. Caracterización genética de la colonia reproductiva de la tortuga marina golfina (*Lepidochelys olivacea*, Eschscholtz 1829) en Playa Palmeras - Parque Nacional Natural Gorgona, Pacífico colombiano. Universidad del Cauca. Facultad de Ciencias Naturales, Exactas y de la Educación. Programa de Biología. Énfasis en Zoología. Popayán. 77p.

Castaño – Mora, O.V. (Ed). 2002. Libro rojo de reptiles de Colombia. Libros rojos de especies amenazadas de Colombia. Instituto de Ciencias Naturales – Universidad Nacional de Colombia, Ministerio del Ambiente, Conservación Internacional – Colombia. Bogotá, Colombia.

Chacón, D., Sánchez, J., Calvo, J. y J. Ash. 2007. Manual para el manejo y la conservación de las tortugas marinas en Costa Rica; con énfasis en la operación de proyectos en playa y viveros. Sistema Nacional de Áreas de Conservación (SINAC), Ministerio de Ambiente y Energía (MINAE). Gobierno de Costa Rica. San José. 103 p.

Cornelius, S.E. 1976. Marine turtle nesting activity at Playa Naranjo, Costa Rica. Brenesia 8:1-27 pp.

FitzSimmons, N., Moritz, C., Limpus, C.J., Miller, J.D., Parmenter, C.J and R. Prince. 1996. Comparative genetic structure of green, loggerhead, and flatback populations in Australia based on variable mtDNA and nDNA regions: p.25. In: Bowen, B.W. and W. N. Witzell (Eds). Proceedings of the International Symposium on Sea Turtle Conservation Genetics. NOAA Technical memorandum NMFS-SEFSC-396. 173 p.

FitzSimmons, N., C. Moritz and B. Bowen. 1999. Population Identification. p. 72-79. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Frazier, J.G. 1999. Community-Based Conservation. p. 15-18. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Garcés, D. y De la Zerda, S. 1994. Gran libro de los Parques Nacionales de Colombia. Intermedio editores, Circulo de lectores. Santafe de Bogotá, Colombia. 156 – 159 pp.

Godfrey, M. and N. Mrosovsky. 1999. Estimating Hatchling Sex Ratios. p. 136-138. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Hughes, D.A., and J.D. Richard. 1974. The nesting of the Pacific ridley turtle *Lepidochelys olivacea* on Playa Nancite, Costa Rica. Marine Biology 24:97-107.

Marcovaldi, M. A., and Thome, J.C. 1999. Reducing Threats to Turtles. p. 165-168. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Márquez M., R. 1990. Sea turtles of the world. An annotated and illustrated catalogue of sea turtle species known to date. FAO Species Catalog, FAO Fisheries Synopsis 11(125):81 pp.

Martínez, L.M. y Páez, V.P. 2000. Ecología de la anidación de la tortuga Golfina (*Lepidochelys olivacea*) en la Playa de La Cuevita, Costa Pacífica Chocoana, Colombia, en 1998. *Actual Biol* (73):131-143.

Mc Cormick, C. 1996. Contribución al conocimiento de la Ecología y Biología Reproductiva de las Tortugas Marinas en la Isla Gorgona, Trabajo de grado, Dpto. de Biología, Facultad de Ciencias, Universidad del Valle, Santiago de Cali.

Miller, J.D. 1999. Determining Clutch Size and Hatching Success. p. 124-129. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Mortimer, J.A. 1999. Reducing Threats to Eggs and Hatchlings: Hatcheries. p. 175-178. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

National Marine Fisheries Service and U.S. Fish and Wildlife Service. 1998. Recovery Plan for U.S. Pacific Populations of the Olive Ridley Turtle (*Lepidochelys olivacea*). National Marine Fisheries Service, Silver Spring, MD. 52 p.

Pavía, A., Rodríguez-Zuluaga, J.A., Amorocho, D.F. 2006. Biología reproductiva de la tortuga Golfina del Pacífico (*Lepidochelys olivacea*) en el Parque Nacional Natural Gorgona –Colombia. Informe final presentado a National Fish and Wildlife Foundation (NFWF). CIMAD, Cali, Colombia. 34 p.

Richardson, J. I. 1999. Priorities for Studies of Reproduction and Nest Biology. p. 9-11. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Rueda, J. 1988. Notas sobre la anidación de Tortugas Marinas en el Pacífico colombiano. Revista Trianea. Bogotá, Biblioteca Andrés Posada Arango. No 1:79-86 pp.

Schroeder, S. and Murphy, S. 1999. Population Surveys (ground and aerial) on Nesting Beaches. p. 45-55. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Spotila, J.R., E.A. Standora, and S.J. Morreale. 1983. Methodology for the study of temperature related phenomena affecting sea turtle eggs. U.S. Fish and Wildlife Service, Albuquerque, New Mexico No. 11:51pp.

UAESPNN. 2004. Plan Básico de Manejo Parque Nacional Natural Gorgona 2005-2009. Dirección Territorial Suroccidente. Cali. 229 p.

WIbbels, T., Rostal, D., Byles, R. 1998. High pivotal temperature in the sex determination of the Olive Ridley sea turtle, *Lepidochelys olivacea*, from Playa Nancite, Costa Rica. *Copeia* 1998:1086-1088.

Wibbels, T., Z. Marie, H. Starr and B. Phillips. 1999. Female-biased Sex Ratios of Hatchling Hawksbill Sea Turtles from Caribbean Nesting Beach. Journal of Herpetology. 33(1):142-144.

Witherington, B.E. 1999. Reducing Threats to Nesting Habitat. p. 179-183. In: Eckert, K. L., Bjorndal, K. A., Abreu-Grobois, F. A. and M. Donelly (Eds). Research and Management Techniques for the Conservation of Sea Turtles. Blanchard, IUCN/SSC Marine Turtle Specialist Group. No.4:235 pp.

Yntema, C.L. and Mrosovsky, N. 1982. Critical periods and pivotal temperatures for sexual differentiation in loggerhead sea turtles. Can. J. Zool. 60:1012-1016.

ANNEXES

Annex 1. Survey format used in the workshops with local fishermen.

"Reduction of the incidental capture of marine turtles with the use of circle hooks"

No. of survey ____ _____ Dates

Name of the interviewer _____

Name of fisherman _____

Sidewalk or community _____ City_____

If your fishing gear is longline, please answer:

1. Do you use traditional fishhook, type "J?"Yes ____ No ____

2. Do you know the circle or curve fishhook ? Yes ____ No _____ have you used It? Yes _____ No ____

3. How many fishhooks do you possess in this fishing gear? _____ What number? _____ (Differentiate the fishhook type)

4. What longitude does it have? _____ meters-fathoms (mark the measure unit)

5. How long does it take since you leave port until you arrive? _____

6. How many launches do you do during that task? _____ How much do they last? _____

7. The capture average (kg) during each task is _____ being the main species (objective) of capture _____ and using as bait _____

8. Have you captured turtles? Yes _____ No ____

9. How many turtles captured by task? _____

10. With what name do you know that turtle? _____ What size? _____

11. Is the capture of turtles given especially in some time of the year? _____ Which _____

If your fishing gear is not longline, but occasionally you have captured turtles, with what type of gear have you made it? _____

Please of the previous survey answer questions number

4. _____

5. _____

6. _____

7. _____

8. _____

9. _____

10. _____

11. _____

When you catch a turtle, you _____ release it _____ sell It _____ consume It

THANK YOU!!