Biotopic

Pilot study:

Marine Turtle Research

in the

Gamba Complex of Protected Areas
Gabon, Central Africa

2003-2004

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in coorporation with :

Kudu PROGRAM

WWF

IBONGA ACPE

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Acronyms

ASF	*Aventure Sans Frontières*
APDN	*Association des Pêcheur Artisanaux du Département de Ndougou*
CBG	*Company du Bois du Gabon*
CENAREST	*Centre National de la Recherche Scientifique et Technologique*
CITES	Convention on International Trade in Endangered Species
	CNPN National Parks Council – *Conseil National des Parcs Nationaux*
CMS	Convention of Migratory Species
CRAP	After Oil Reflection Committee *(Comité de Réflexion Après-Pétrole)*
DFC	Directorate of Wildlife and Hunting – *Direction de la Faune et de la Chasse* (MEFEPCEPN)
EU	European Union
IBONGA-ACPE	Association for Understanding and Protection of the Environment – Ibonga - *Association pour la Connaissance et la Protection de l'Environnement*
IUCN	World Conservation Union
KUDU	Protection of Marine Turtles in Western Africa
MEF(EPCEPN)	Ministry of Economic Forestry, Fisheries, Reforestation, responsible for the Environment and for the Protection of Nature – *Ministère de l'Economie Forestière, de la Pêche, du Reboisement charge de l'Environnement et de la Protection de la Nature*
NGO	Non Governmental Organization
PROTOMAC	*Protection de Turtues Marine d'Afrique Central*
PSVAP	*Programme Sectoriel de Valorisation des Aires Protégées*
SCD	Society for Conservation and Development
SFN	Société Forestière de la Nyanga
SG	Shell Gabon
SI	Smithsonian Institution
STIDUNAL	Foundation for Sustainable Nature Conservation Alusakia
STINASU	Foundation for Nature Conservation in Suriname
WCS	Wildlife Conservation Society
WWF	World Wildlife Fund

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Abstract

Gabon is the country that supports the largest nesting population in Africa of the endangered leatherback (*Dermochelys coriacea*) population. This study was conducted in the Gamba Complex in the South West of Gabon. The leatherback is the most common turtle species recorded. Less abundant but also nesting in the Gamba Complex are the olive ridley (*Lepidochelys olivacea*), green turtle (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*). In this pilot study we studied population demography and nesting ecology on these populations during the nesting season from November 2003 until mid April 2004.

Nest counts resulted in 203 nesting leatherbacks in the daily patrolled zone of 5.75 kilometer, 51 olive ridleys, 5 green turtles and 3 hawksbills. We tagged 61 leatherbacks, 9 olive ridleys, 1 green turtle and 1 hawksbill. We recaptured 16 leatherbacks, 3 of them had an unknown origin. One olive ridley was recaptured as well as one green turtle and one hawksbill. Compared to the previous nesting season (2002-2003) this indicates a decline of 66 % for the numbers of nesting leatherbacks and 28% for the number of nesting olive ridley.

Curved carapace length of the leatherback was 153.2 ± 7.6 and clutch size 64.1 ± 14.7. Besides scientifically based research we also focused on awareness raising and capacity building in Gamba. We trained 5 local villagers to become fully independent sea turtle researchers. An article was published in the national newspaper and our team was interviewed on the beach together with local students. This was broadcasted on prime time on the regional radio station. We published 2 articles in the Shell magazine, which is distributed under all Shell Employees in Gabon. In co-operation with our local counterpart *IBONGA,* local students, tourists from Gamba, Libreville and Europe were guided on the beach.

We had working sessions with turtle research teams in Mayumba and Libreville. In Mayumba one team works in collaboration with PROTOMAC the second team is lead by Aventures sans Frontières (ASF), who also have a turtle camp in Point Denis near Libreville and a camp in 'Tassi', in the extreme northern part of Loango National Park.

Lastly, we extensively exchanged ideas for long term turtle protection work in the Gamba Complex with our key partners WWF, Ibonga and PROTOMAC. This resulted in a draft project proposal of which a short resume is provided in chapter seven.

The Gamba Complex is not only an important site for sea turtles….

1 Introduction

1.1 General introduction

All seven species of sea turtles are on the IUCN Red List of threatened Animals. Four of these nest on the beaches of Gabon: leatherback (*Dermochelys coriacea*), green turtle (*Chelonia mydas*), olive ridley (*Lepidochelys olivacea*) and hawksbill (*Eretmochelys imbricata*). Gabon is one of the most important nesting areas for leatherbacks worldwide, and is considered the largest nesting site in Africa (Billes and Huijbregts 2002 in prep.). Sea turtles worldwide are threatened by a number of factors, such as egg poaching, poaching for consumption, killings through by-catch in drift nets and trawlers, habitat loss by tourism or other waterfront development, beach erosion and predation by wildlife as well as by stray dogs.

Because of the importance of the area for the leatherback turtle this study focused on this species. However, baseline data were also collected for the other species of nesting turtles. An understanding of nesting dynamics, population size and trends, local reproduction, nest ecology and threats is essential for long term management and protection of sea turtles populations.

The aim of this pilot project conducted by Biotopic, in close collaboration with WWF-NL and WWF-Gabon, Ibonga, PROTOMAC and KUDU, is to protect the sea turtles' nesting population and their habitat in Gabon by means of research in order to develop better conservation strategies, education programs, local and international collaboration, raise public awareness and build conservation capacity among the local population.

1.2 Stakeholders mapping

Key stakeholders currently actively involved in turtle protection in Gabon are:

- The Ministry of Economic Forestry, Waters, Fisheries, responsible for the Environment and for the Protection of Nature (MEFEPCEPN), through its Department in charge of Fauna and Hunting (DFC), with three of the six Wildlife Brigades of the country (two in Loango National Park - Sette Cama and Iguela Brigades - and one in Moukalaba-Doudou National Park - Mourindi Brigade), and one Fisheries Brigade in Gamba depending on the Directorate General.

- The National Parks Council (*Conseil National des Parcs Nationaux – CNPN)*, composed of representatives from the Primature, several Ministries (MEFEPCEPN, Tourism, Land-Use Planning, Plan, Scientific Research, Economy/Finances, Internal

Affairs, National Defence, Mines/Energy/Oil) and key international conservation partners. The CNPN is responsible for supervising the development of the new National Park Network. Discussions are currently taking place on creating a para-statal entity that would eventually replace the CNPN and be responsible for park management.

- The World Wildlife Fund (WWF), that has been actively involved in the Complex since 1992 and is providing overall support to governmental authorities and non-governmental local actors in park management, law enforcement, ecological monitoring and environmental education.

- The Wildlife Conservation Society (WCS), that initially focused on research, training and monitoring activities and, over the past two years, initiated with a private company, the *Société de Conservation et de Développement* (SCD), a partnership known as “Operation Loango” in the northern parts of Loango National Park.

- The Protection for Marine Turtles in West Africa (KUDU), is co-ordinating sea turtle research and protection projects in West Africa.

- Protection Of Marine Turtles in Central Africa (PROTOMAC) which works under The KUDU program.

- Ibonga, a local environmental education association - *Association pour la Connaissance et la Protection de l’Environnement – Ibonga.*

- Other key stakeholders for broader conservation and sustainable development activities in the Gamba Complex include:

- Two programs funded by the European Union: the “*Programme de Valorisation des Aires Protégées*” (EU-PSVAP) and the *CyberTracker Monitoring Program*.

- The Smithsonian Institution (SI)/Monitoring and Assessment of Biodiversity Program (MAB). SI is implementing a five-year (2001-2005) Gabon Biodiversity Program to increase the knowledge of the country’s biodiversity through research, build national capacity for continued biodiversity work and advance conservation and sustainable development through partnerships among local stakeholders, scientists and industry. This program is implemented in the Gamba Complex and supported by Shell.

- Shell Gabon and Shell Foundation through their support to the Gabon Biodiversity Program and other local initiatives.

- Local municipal and provincial authorities.
- The After Oil Reflection Committee *(Comité de Réflexion Après-Pétrole – CRAP)*, that aims to help the Gamba community to identify and implement economic development opportunities, with support from Shell Gabon and the Shell Foundation, through its Sustainable Communities Program.
- APDN, a community-based organization of local fishermen - *Association des Pêcheurs Artisanaux du Département de Ndougou* – APDN.
- In the tourism sector: Sette Cama Safaris, Ivenge Lodge, SHRLT (Gamba Vacances), SCD, Local Council's Guest Houses, Mini-Lodge.
- In the forestry sector: CBG, SFN.
- In the conservation NGO community: Conservation International.
- In the scientific national and international community: CENAREST, University Omar Bongo, Max Planck, Kyoto University, PROTOMAC, University of Wageningen and the National Herbarium.

1.3 Introduction of Biotopic

From 1995 till 2002, Biotopic has carried out sea turtle research and conservation projects in Suriname in close collaboration with STINASU (Foundation for Nature Conservation in Suriname) and STIDUNAL (Foundation for Sustainable Nature Conservation Alusakia) on a yearly basis (except for 1996). From 1995 to 1998 the project was focused on nest relocation, monitoring of nesting activities, and nest ecological research. Present activities are PIT-tagging and monitoring of nesting leatherbacks, nesting beach surveys, nest ecological research and capacity building. Collaboration with sea turtle research teams and conservation groups in the country has a high priority. Besides this project in Suriname, which was taken over by NC-IUCN in 2003, Biotopic has carried out several other projects concerning sea turtles. The foundation initiated amongst other projects, an exchange program between Benin, Costa-Rica and The Netherlands (Biotopic 2001 and Oosting 2003) concerning sea turtle research and protection in 2000 and 2001.

1.4 Objectives of the project

General

Biotopic's main objective in this projects is to conserve marine turtles. The more specific aim of this pilot study supervised by the KUDU program, during the 2003-2004 season in cooperation with WWF, Ibonga and Protomac, was to investigate the possibilities of long term conservation through a continuation of monitoring the number of sea turtles nesting on the studied site. We also focused on the possibilities of awareness raising through education and capacity building in Gamba and involvement of local stakeholders and collaboration with other organizations working on sea turtle research and protection in Gabon.

Scientific

This pilot project consisted of a continuation of the research conducted in 2003 by Billes and Huijbregts. They made a first estimation of the number of sea turtles nesting on the studied site in the season of 2002/2003. Besides, this research aimed to lay the foundation for a long term marine turtle conservation project in the area.

The scientific objectives of the present study were following the protocol used in Suriname (Hilterman & Goverse 2002-2004).

- Determine the number of species of marine turtles nesting on 5.75 kilometers of beach in the Gamba Complex;
- Determine the number of nests the turtles produce;
- Identify internesting intervals, remigration rates and beach fidelity of the populations, by tagging nesting females;
- Determine nest success for *in situ* nests;
- Obtain biometric data on nesting turtles;
- Investigate nesting habitat quality and the threats facing adult turtles, hatchlings and eggs.

Social

The objectives of this project were not only to focus on scientific research, but equally important were local development, capacity building, education, international and local collaboration and identifying alternative ways of income for the local population e.g. through ecotourism. In collaboration with the local NGO *Ibonga* we aimed to investigate the possibilities for education and collaboration with local students. This pilot study enabled us to meet counterparts on turtle biology in Gabon, to exchange research techniques, and to discuss data analysis and interpretation.

International collaboration is realized trough cooperation with WWF Gabon and the KUDU program. Meetings with local partners will enable data sharing and further collaboration.

Long term objectives

- Have the research camp function as Turtle Information Centre and provide guided tours. Local development can benefit from the presence of a research team by giving guided tours on the beach, anti poaching patrols, conducting research.
- Continue training of 'local population' to monitor and manage marine turtles research and conservation.
- Continue and intensify environmental education in cooperation with NGO Ibonga through adoption of nests/hatcheries, environmental education on schools.
- Investigate local (illegal) marine turtle egg market.
- Expand presence on the beach by constructing and using a second field camp resulting in more daily and weekly patrols and involving Ministry of "Eaux et Forêts" to enable law enforcement.
- Improve the collection and analyse data through innovative CyberTracker data collection and analysis technology.

1.5 Sea turtles in Western/Central Africa

According to Fretey, in Western Africa, the leatherback (*Dermochelys coriacea*) is very widely spread and its reproduction sites goes from Mauritania to Angola. The leatherback nests on the coasts of all countries in Central Africa and 3 juveniles (17 to 21 cm) have been observed as far as south of the island of Principe.

Green turtles (*Chelonia mydas*) show the same distribution pattern as the leatherback, from Mauritania to Angola. The nesting of green turtles has been reported on all countries along the Central African coasts with favourite sites on the islands of Bioko and Sao Tome and Principe. Immature turtles often swim in the coastal waters of Cameroon, Equatorial Guinea, Sao Tome & Principe and Gabon. Sea grasses in the Corisco Bay, on the border between Equatorial Guinea and Gabon, constitute a very important feeding zone for adult green turtles.

The northern limit of distribution of the olive ridley (*Lepidochelys olivacea*) seems to be situated between Mauritania and Cape Verde and the southern limit near Angola. The olive ridley can nest in practically every country from Guinea-Bissau to Angola. The olive ridley nests on all Central African beaches, even on islands (Bioko and Sao Tome), which is rather unusual for this species. The Cameroon estuary is thought to be a feeding and growing zone for this species.

The northern limit of the distribution of the hawksbill (*Eretmochelys imbricata*) seems to be situated between Mauritania and Cape Verde and the southern limit near Congo. The hawksbill would apparently only occasionally nest on the island beaches of Bijagos, Bioko, Sao Tome and Principe, Equatorial Guinea and in Gabon. Juveniles can be seen in the waters of Equatorial Guinea (island and continental part) in the Sao

Tome and Principe Archipelago, Gabon, Cameroon and Congo. Nesting is still to be confirmed in Cameroon and Congo.

The loggerhead (*Caretta caretta*) is mainly seen in the northern part of West Africa and only sporadically appears south of Cape Verde.
The nesting of the loggerhead in Central Africa has not yet been confirmed. Mating has been observed in the Sao Tome waters and fishermen sometimes catch adult loggerheads of both sexes.

The species which is most rarely seen on the Western African coasts is the kemp's ridley (*Lepidochelys kempii*), since it has only sporadically been seen in northern waters and has not been seen nesting in the region.

1.6 Protection

Sea turtles have been exploited by men since prehistoric times. Local extinctions have already taken place in all oceanic basins. Today, this group is so much threatened that no population can be considered to be safe. Marine chelonians have been the victims of direct exploitation for centuries, today they are also endangered by industrial fisheries, the deterioration and loss of their habitat, and pollution. All species of sea turtles have been listed in Annex 1 of the CITES (forbidding international trade to and from signatory countries) and Annex 1 (except the flatback turtle *Natator depressus*) and 2 of the CMS (strict conservation of the species and necessary agreement on international co-operation). All sea turtles, except *Natator depressus*, are listed on the red list of IUCN as "Endangered" (*C. mydas, L. olivacea, C. caretta*) or "Critically endangered" (*D. coriacea, L. kempii, E. imbricata*).

Central Africa is no exception, sea turtles are victims of many threats. Females are killed for their meat, their eggs are collected and their shell is used in local craft industries. In certain areas, traditional sea turtle fishing exists. Other threats are by-catch and severe habitat alterations or deteriorations caused by industrial fisheries and pollutions, artificial lights preventing the nesting of turtles on certain sites or the running aground of logs barring turtles' way on the beaches, and the possible impacts of oil production. Even though the latter are very little known in Central Africa and difficult to estimate, it is worth mentioning that laboratory research has shown how sea turtles can be greatly affected by petroleum (Billes and Huijbregts 2002 in prep.). Oil on the skin can also affect respiration and salt gland functions.

The presence of sea turtles in Gabon has first been mentioned by Duméril (1860) in his report on reptiles in Western Africa. But it was Fretey who, in 1984, told the scientific community about the existing nesting sites of the leatherback south of Libreville. Since, the importance of Gabon's beaches for the nesting of leatherbacks and three other species (olive ridley, green turtle and hawksbill) has been shown on several occasions. However, no beaches in the Gamba Complex of the Protected Areas had then been the site of a steady monitoring during a nesting season (Billes and Huijbregts 2002 in prep.).

1.7 Research area - The Gamba Complex

Gabon's littoral, which spreads on nearly 9,500 km has very rocky parts but consists mainly of long sandy beaches. This is also the case in the Gamba Complex of Protected Areas, it's is situated in the south-western part of Gabon along the Atlantic coast and extends over a total area of 12,000 km². It contains a mosaic of habitats including seashores, mangroves, coastal forest, swamp forest, equatorial rainforest, semi-montane forest, savannas, rivers, lagoons and swamps. Because of currents and the obliquity of the swell to the shore, the aspects of the beaches often vary and the mouths of the lagoons tend to move northwards. As for the smaller lagoons, they communicate with the sea through much narrower channels, opening and closing according to the rate of the rivers flowing into them or the power of the tides and waves. The conservation value of the Complex has been recognized since 1962 through the protection of eight different areas. Two of the 13 recently created National Parks in Gabon are now located in the Complex: Loango National Park (1,500 km²) in the Northwest, and Moukalaba-Doudou National Park (5,000 km²) in the eastern part.

The Complex is considered as one of the best-preserved landscapes of its kind in Central Africa. It is now part of the "Gamba-Conkouati" trans-boundary forest

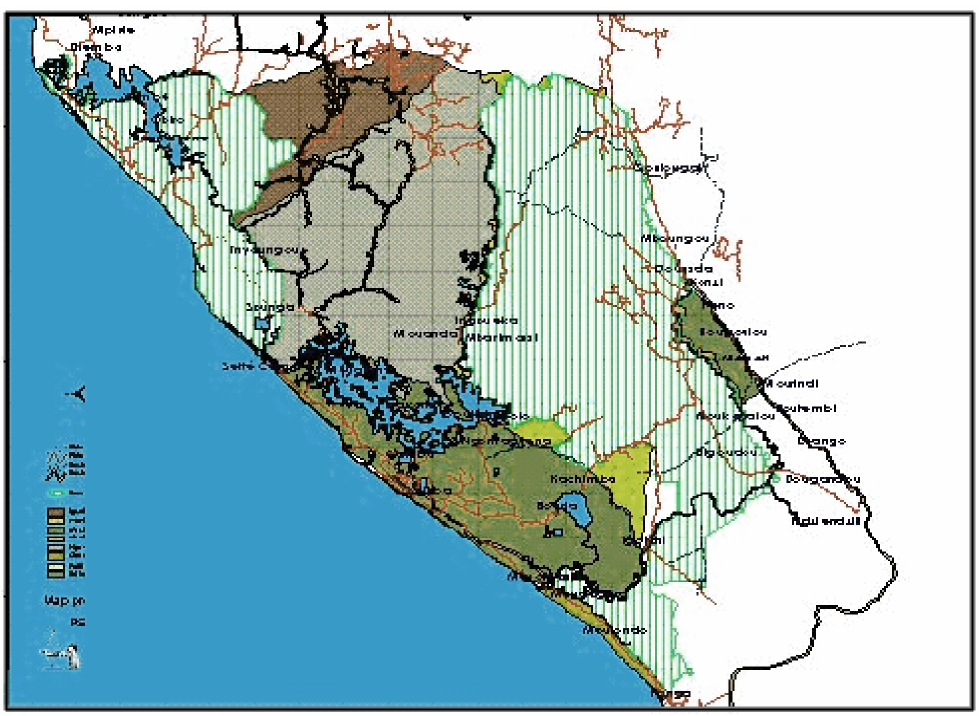

Figure 1.1: The Gamba Complex

as one of the 11 key landscapes that form the focus of the Congo Basin Forest Partnership (CBFP) launched during the World Summit on Sustainable Development in September 2002.

Some 9,500 people live within the Gamba Complex. About 7,500 people reside in Gamba town, which is located in the heart of the Complex, and their presence is mostly linked to the oil industry. Oil and gas exploration and production concessions are located in the reserves between the two parks and off shore. A large oil export terminal, operated by Shell Gabon, is located on the coast near Gamba town. Some 30 small villages and settlements with populations ranging from 15 to 350 people are located within and around the Complex. The main towns around the Complex are Tchibanga, Mandji, Moabi, Mayumba and Omboué.

The wildlife in the area is abundant and high densities of large mammals such as forest elephant, forest buffalo, red river hog, gorilla and chimpanzee have been recorded. Twelve species of forest antelope are present as well as nine species of primates (e.g. white collared mangabeys). Hippopotami and manatee are also present. The avifauna is represented by many spectacular species such as pelicans, ibises, hornbills, turacos and bee-eaters. A total of 470 bird species have been recorded, of which 80% are breeding residents. The widespread distribution of a variety of aquatic habitats favours the occurrence of all three African crocodile species as well as fresh water turtles, manatee and hippopotamus. Offshore, marine mammals such as dolphins and whales are regularly sighted, and the coastal waters are a breeding ground for important populations of Humpback whales.

1.8 Study site

The chosen study site was a 5.75-km-long beach situated near the airport of Gamba, between the terminal of Shell and a place known as 'Pont Dick'. On the largest part of the site, the sandy stretch is quite narrow with a rather steep incline (>10%). At the back of the beach, grassy lands spread onwards 20 to 30 m, with low plants completely covering the substratum. Then, littoral thickets or low but also marshy forests grow before the lagoon areas bordering the shore. The northwestern part of the site (near the oil terminal) is the only area that differs from the rest with a wider stretch of sand which spreads up to the side edge of the lagoon.

This beach has been chosen in 2002 by the WWF team as the first study zone for different reasons. First, local people had told that sea turtles often came here to nest. Secondly, its closeness to Gamba town makes it an easy target for poaching (both eggs as adult female turtles). The presence of a research team might prevent this. The proximity to Gamba town also offers an easy possibility to show sea turtles to tourists, visitors and the local community. Finally, the terminal of Shell being situated at the northwestern end of the project area could favour the study of the possible impact of the oil activities in the Complex on sea turtles.

2 Project activities

2.1 Population identification

Tag return data are essential to understand the demography and reproductive ecology of marine turtles. Monel tags (style 49) are used to identify all species of marine turtles. Monel tags are cheap and easy to apply and can be used for all species of marine turtles. These visible tags make it also possible for non-scientists to identify turtles such as fishermen, or people on local markets. We also used the Passive Integrated Transponder (PIT) tagging method but exclusively for the leatherbacks.

2.2 PIT tagging leatherbacks

PIT tagging is essential to any leatherback tagging program in order to allow accurate population size assessments, because of the high loss rates of conventional flipper tags occurring with leatherbacks (McDonald and Dutton 1994 and 1996, Paladino 1999 in Hilterman *et al* 2003). It is believed that, in contrast to the use of flipper tags with leatherbacks, PIT tags are a more permanent way of marking. Data from Spotila (1998) indicated a tag loss of less than 5% for AVID tags. This may, however, be due to inexperience by users or use of cheaper pocket readers that are less reliable for deeper placed tags in leatherbacks (McDonald and Dutton 1996, Paladino 1999 in Hilterman *et al* 2003). PIT tagging is a very suitable tool to perform much needed studies such as the delimitation of the leatherback population in the Guianas and to estimate of population size and trends. If carried out long enough, it will yield information on (changes in) population size, the fraction of first time nesters (recruitment), remigration rates and intervals, mortality at sea, and internesting frequency and intervals (McDonald and Dutton 1996, Spotila 1998, Steyermark *et al.* 1996 in Hilterman *et al* 2003). PIT tagging with TROVAN tags in the Guianas started on a large scale in 1998 in French Guiana (Chevalier and Girondot 1999 in Hilterman *et al* 2003), but some leatherbacks had already been PIT tagged in French Guiana in 1995/96 (Girondot and Fretey 1996 in Hilterman *et al* 2003). PIT tags were introduced in Gabon at Pointe Pontgara beach in 1998 and in 1999 in Mayumba (pers. comm. ASF and Billes 2000), but their budget did not allow them to use PIT tags after 1999.

2.3 Biometric measurements

Sea turtles on nesting beaches are measured to:

- be able to relate body size to reproductive output;
- determine minimum size at sexual maturity;

- monitor nesting female size for a particular rookery.

The size-frequency distribution of a population is an important parameter of that population's demographic structure (Bolten 1999, Zug and Parham 1996 in Hilterman 2003). We measured curved carapace length (CCL) and width (CCW) for nesting leatherbacks.

2.4 Reproductive success and nest ecology

A study on reproductive output of leatherbacks was carried out on the nesting beach in an effort to determine some of the basic parameters of the leatherback population, such as clutch size, hatch success, fate of eggs and survival and failure of nests. With this knowledge, net output of hatchlings on each of the important nesting beaches can be assessed (Eckert 1999). Fluctuations and structural changes in yearly nest numbers may be explained by nest survival, hatch rates, and sex ratio production (*e.g.* predominantly males for a couple of years) in the past (Eckert 1999, Chevalier *et al.* 1999).

Leatherbacks often nest in the open sand area below the spring tide line (STL), as part of a 'bet hedging' or 'scatter nesting' strategy. Nest scattering or dispersal on the beach as leatherbacks do, spreads possible risks (Mrosovsky 1983, Eckert 1987, Tucker 1990). In contrast to green turtle eggs and hatchlings, leatherback eggs and hatchlings are easily damaged or killed by roots of beach vegetation (eggs are ruptured and dehydrated, hatchlings get entangled) (pers. obs., Whitmore and Dutton 1985). This may be another reason why leatherbacks generally nest in the open sand area, as is also the case in Gabon.

3 Methods

3.1 Monitoring nesting activities

From November 2003 till March 2004 a group of at least 5 people was present in the study site. Every night two teams of each two persons patrolled 5.75 km of beach in search of nesting marine turtles. The time of research was related to high tide. The teams started their shifts two hours before high tide until two hours after high tide, according to experience gained in Suriname (Hilterman, 2001). Female leatherbacks were identified and marked by a double tagging with Monel tags (style 49) pinned on the skin-fold joining the hind leg to the tail. Hard-shelled turtles, (Cheloniids) were identified and marked by a double tagging with the same tags fixed on the forelegs. From December onwards we introduced the PIT tag (Trovan ID100 and scanner LID500, both EID Aalten B.V., Aalten, The Netherlands). These tags were additionally to the Monel tags and only used on leatherback turtles.

3.2 Nest counts

Every day at dawn, nesting tracks were systematically counted. Only tracks from the night before were taken into account. The number of tracks for each species, with and without the laying of eggs was then recorded. These tracks included the tracks that were already recorded at night during identification

3.3 Biometric measurements

Biometry was conducted on each female sea turtle encountered. For the leatherback, the curved carapace length was measured along the median ridge from the nuchal notch to the tip. For the hard-shelled turtles, the curved carapace length was measured in the middle of the shell from the nuchal, at the junction of the shell and the skin, to the hind notch situated between the two supra-caudal scutes. The curved carapace width was measured at the widest part of the shell, the tape stretching out from one crest to the other for the leatherback.

3.4 Nest ecology

Nests were marked with two sticks just behind the nest when a female was encountered during the nightly patrol just before or during the creation of a nest, or whilst laying its eggs. The following morning, the marked nests were opened to verify our nightly observation. A tag with date and species was placed next to the eggs and the nest was gently closed again. Triangulation was used to mark the nest properly, by placing three sticks on the edge of the vegetation and record the exact distance of each stick to the nest.

When the hatchlings had emerged, the nests were excavated. Hatched, non hatched eggs, small yolkless eggs and non-emerged hatchlings (dead and alive) were counted. All non-hatched eggs were opened and the developmental stage of the embryo was determined:

Non-hatched eggs were divided into the following categories (according to Hilterman 2001):

- Undeveloped eggs: no embryo or blood spot visible, a clear distinction between egg white and yolk.
- Early embryo: blood spot to early embryo of about 3 mm with eyes. No body pigmentation present.
- Mid embryo: all embryos with body pigmentation with the size of approximately 3 mm to full term.
- Late embryo: full term embryo, ready to hatch but dead.
- Unidentified rotten: the egg content was rotten, identification in one of the above categories was impossible).

3.5 CyberTracker technology

To collect data the 'CyberTracker' was used. The CyberTracker (www.cybertracker.org / Cape Town, South Africa) is a field computer ('visor') designed to be quick and easy to use in the field, even by non-literate users. Scientists and conservationists benefit from the icon interface enabling significantly faster data collection than text interfaces or written methods. So it is a user-friendly interface developed for PalmOS handheld computers allowing field workers to record hundreds of detailed observations per day. The handheld computer is linked to a GPS. The CyberTracker software also allowed us to design and edit a database, customise screen sequences using the Screen Writer feature, gather data with the CyberTracker field computer, view data with the CyberTracker Geographic Information System.

3.6 Additional research

Every morning and night, during the patrols, the team also collected any other significant data, particularly recording occasional strandings, poaching activities and turtle carcasses left on the beach. Apart from daily observations on the 5.75 km of beach, a 60 km stretch of beach was additionally patrolled ranging from several kilometers south to as far north of the study site as possible for tracks once a week using a quad.

4 Results

4.1. Species composition

Through the nightly patrols, a detailed insight in the marine turtle species composition in the Gamba complex was obtained. Overall, leatherbacks (*D. coriacea*) and olive ridleys (*L. olivacea*) regularly used the beach as a nesting ground whereas the site was only rarely visited by green turtles (*C. mydas*) and hawksbills (*E. imbricata*) (Table 4.1).

Between November 2003 and March 2004 a total of 203 leatherbacks females nested on the patrolled 5.75 km strip of beach (Table 4.1). We succeeded in tagging 61 leatherbacks with a Monel tag of which 38 were also given a PIT tag (which unfortunately arrived a while after the start of the nesting season due to logistic problems). We recorded a total number of 77 tag records, including within season recaptures. A total of 16 leatherbacks were recaptured. Thirteen of the recaptures were tagged this season by our team on the beach of Pont Dick, 3 of them had an unknown origin. So a total of *at least* 64 leatherback individuals came to nest on the beach of Pont Dick.

	DC	***LO***	***CM***	***EI***
Number Monel tagged (*PIT*)	61(*38*)	9	1	1
Number of Monel recaptures (*PIT*)	16(*4*)	1	1	1
Nest count (*false crawl*)	203(*10*)	51(*5*)	5(*3*)	3(*0*)

Table 4.1 Number of tagged turtles, number of recaptures and nest count per species. DC = Dermochelys coriacea; LO = Lepidochelys olivacea; CM = Chelonia mydas; EI = Eretmochelys imbricata.

The olive ridley turtle is less abundant than the leatherback in the Gamba Complex. A total of 51 olive ridley nests were found during the early morning patrols. We tagged 9 olive ridley turtles with a Monel tag and recorded one recapture of this species. Furthermore, five green turtle nests and three nests made by hawksbills were counted during the monitoring period. For both species we succeeded in tagging one individual with Monel tags and both individuals were recaptured during this pilot study.

4.2 Nest counts

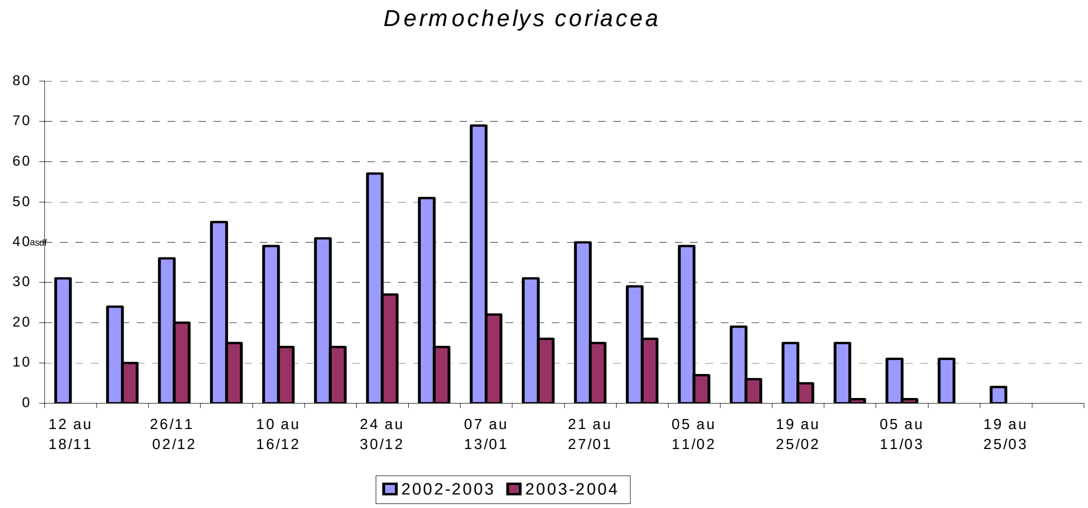

Figure 4.1: Cmparison of observed total number of leatherback (Dermochelys coriacea) nests per week at Pont Dick, Gabon during seasons 2002-2003 & 2003-2004

Figure 4.1 shows the number of leatherback nests in the study site per week during this research period compared to the results of the year before. The numbers shown are the sum of the daily nest counts of one week. As shown in Table 4.1, a total of 203 leatherback nest were counted whereas in the nesting season 2002-2003 a total of 607 nests were counted, indicating a 66 % decline in observed leatherback nests between the two successive nesting seasons.

The occurrence of new nests per week throughout the 2003-2004 nesting season shows a similar distribution compared to the previous season despite the lower numbers of leatherback nests. The highest number of nests were formed in the period between the end of December and the beginning of January. The nesting season of 2004 finished at the end of February, roughly one month before the end of the nesting season in 2003.

The nesting season of the olive ridley started earlier in the season 2003-2004 than that of the leatherback, similar to the observations in 2002-2003. The highest numbers of nesting females in 2003-2004 were observed in the period between the end of November and the beginning of December (Fig. 4.2), comparable to the observations in 2002-2003. A total of 51 nests of the olive ridley were found, whereas during the monitoring period in 2002-2003, 71 nests were observed in the same area, indicating a decline of 28 %. The daily counts this nesting season were started one week later though, compared to the previous year. With the peak of the nesting period during November/December, presumably a significant percentage of the breeding population of the olive ridley had already visited the beach before the start of this monitorings' period.

During this campaign we further identified 5 green turtles and 3 hawksbills nests. Both species were not recorded in the nesting season of 2002-2003. All 5 green turtle nests were observed within the last week of December and the first week of February, while the nests of the hawksbill were found in the last week of December and the two first weeks of 2004.

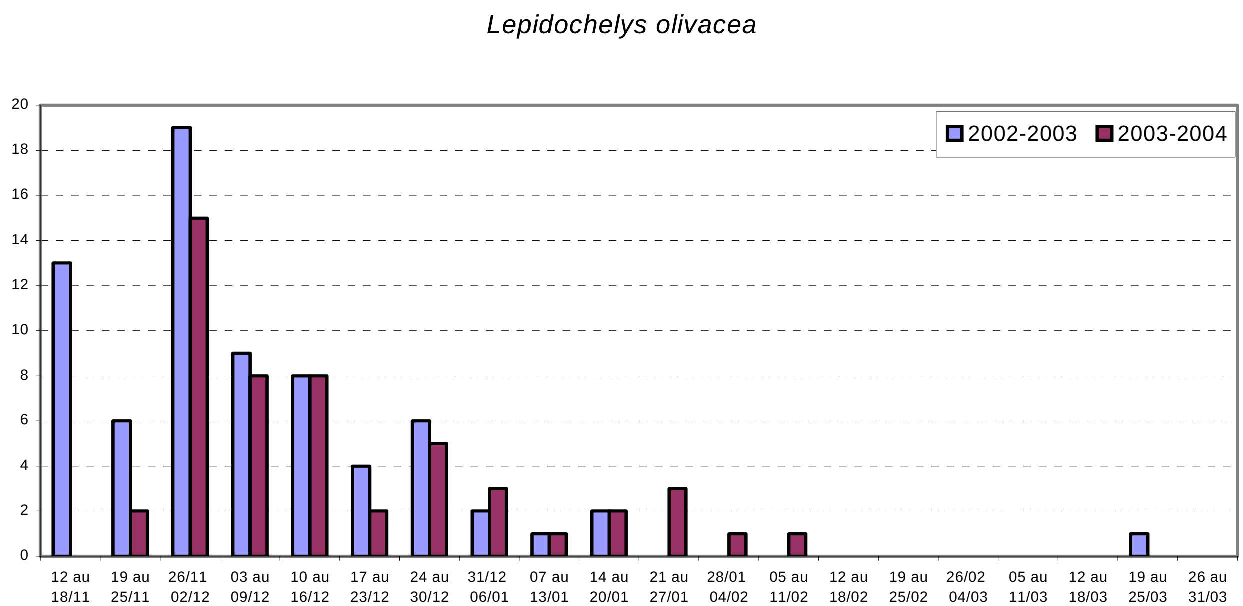

Figure 4.2: Comparison of observed total number of olive ridley (Lepidochelys olivacea) nests per week at Pont Dick, Gabon during seasons 2002-2003 & 2003-2004

The internesting intervals for tagged and recaptured leatherbacks are shown in Figure 4.3. Estimating the exact internesting interval for the leatherback with only 13 recaptures can not be considered to be a reliable parameter though. Two 'peaks' can be seen around 10 and 20 days. Mean observed internesting period in 2002 in Suriname was 10.13 days (Hilterman and Goverse, 2002). Longer internesting periods then this average number can be explained by the fact that turtles were not encountered on their previous return(s) or formed nests outside the research area. None of the recaptured leatherbacks were observed more than 2 times in this research. The fraction of 'one-time nesters' was found to be 83 %.

The recaptured olive ridley had an internesting period of 16 days, the hawksbill 17 days and the green turtle only 1 night. Internesting periods of less then 4 days are considered to be false crawls (Table 4.1).

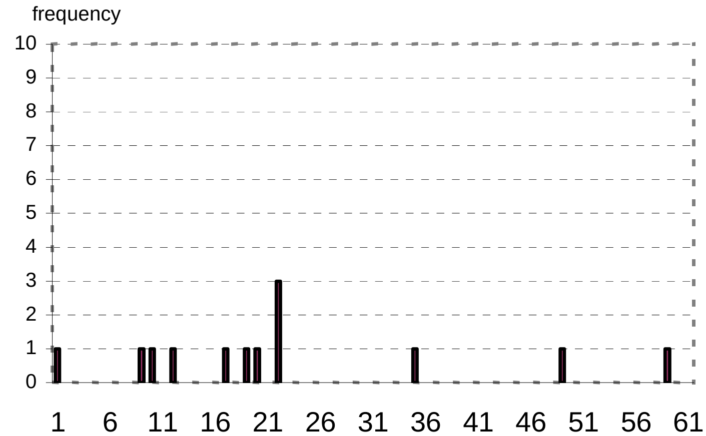

Figure 4.3: Observed internesting (n=13) periods (in days) for tagged leatherbacks at Pont Dick, Gabon 2003-2004.

4.3 Measurements of body size

The Curved Carapace Length (CCL) and Curved Carapace Width (CCW) were measured for all nesting turtles on Pont Dick (Table 4.2). Figure 4.4 shows the size distribution of the CCL of the leatherback population at Pont Dick.

Table 4.3 gives an overview of the carapace length of nesting leatherback females in different regions and years. Although the sample size at Pont Dick is much smaller than those used in the other studies, the results of this population in Gabon were highly comparable.

Sea turtle	CCL	SD	n	min	max	CCW	SD	n	min	max
D. coriacea	153.2	7.6	73	135	170	111.8	5.6	73	100	126
L. olivacea	64.6	2.6	10	65	74	65.9	2.5	10	67	75
C. mydas	100.0	0	2	100	100	85.5	3.5	2	83	88
E. imbricata	85	--	1	--	--	74.5	--	1	--	--

Table 4.2: Mean Curved Carapace Length (CCL) and Curved Carapace Width (CCW) with standard deviation (SD) for 4 sea turtle species found at Pont Dick, Gabon 2003-2004 (n = number of tagged individuals).

Measuring carapace length

Country	Beach	Source	Year	CCL	n	min	max	CCW	n	min	max
Gabon	Pont Dick	This report	2003-2004	153.2	73	135	170	111.8	73	100	126
Gabon	Mayumba	Billes	1999-2000	150.9	902	130	179	108.4	902	86	124
Fr.Guyana	Yalimapo	Fretey	1978	154.6	1341	135	192	87.3	1341	70	120
Suriname	Babunsanti	Hilterman Goverse	2002	154.9	1542	135	177.5	113	603	99.5	130
Suriname	Babunsanti	Hilterman Goverse	2001	154.2	2307	131	182.5	113	876	97	139

Table 4.3: Observed mean curved carapace length (CCL) and mean curved carapace width (CCW) of leatherback populations from different countries and sampling periods (n = number of measured individuals).

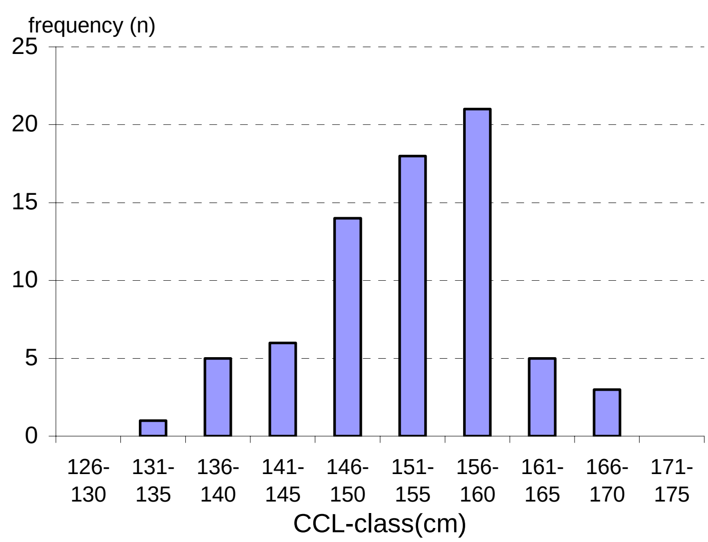

Figure 4.4: Size frequency distribution of tagged leatherbacks at Pont Dick,Gabon 2003-2004.

4.4 Nest ecology

Mean clutch size (yolked-eggs), or number of eggs, per nests of leatherbacks at Pont Dick was 64.1 ± 14.7 (n=10), the number of yolkless or false eggs per nest was 28.6 ± 12.8. Billes (1999) found a clutch size of 77.8 ± 20.4 normal eggs and 31.3 ± 14.8 false eggs at Mayumba beach in Gabon. Mean clutch size in Suriname estimated by Hilterman (2001) on three several beaches varied between 84.3 ± 17.9 and 92 ± 21.1. For the other three sea turtle species found on Pont Dick no nest ecology research was done because of the low nest numbers.

Incubation period is only known for three leatherback nests in the present study. Incubation period is defined as the number of days between the laying of egg and hatchling emergence on the beach surface. Incubation time is correlated to both nest and sand temperature. Mean incubation period for natural leatherback nests was 66.7 ± 1.1 days. Hilterman (2001) found a incubation period of 61.1 ± 2.1 days at Samsambo and 65.5 ± 3.1 days at Metapica in Suriname.

Hatching success for natural nests (non-marked) was 87 % (n=10) as shown in Figure 4.5. From the non-hatched eggs the largest part (6.8 %) were undeveloped eggs, embryonic mortality was scarce (5.0 %).

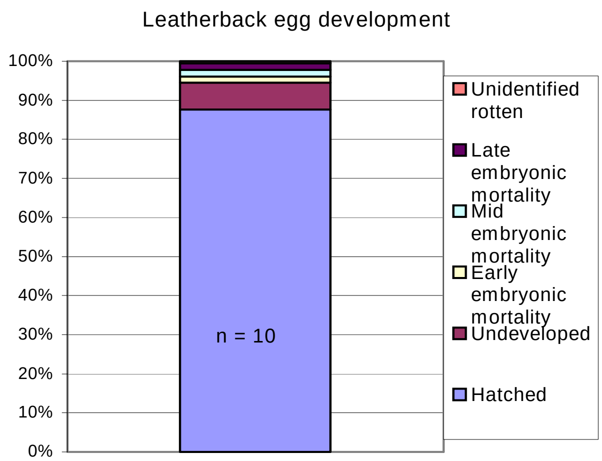

Figure 4.5: Egg development of natural nests at Pont Dick, Gabon 2003-2004.

4.5 Threats

Egg poaching was not recorded in our daily patrolled zone. Outside the daily patrolled zone however, we have found evidence for egg poaching activities. Especially the zone north of the camp and close to the terminal of Shell was visited regularly by poachers. This zone is near the village of Gamba and can be reached on foot by villagers. Eggs are not for sale openly on the market, but several interviews with villagers made clear that leatherback eggs can be bought on demand. We were told that four eggs were sold for 200 CFA, or 0.30 Euro.

Killing sea turtles for consumption was probably not very common in this region. One killed leatherback was found during this research period outside the research area, the scene clearly demonstrated that it had been killed and butchered for its meat.

On the southern part of the research zone, dozens of logs had accumulated per 100 meter stretched beach. A dead leatherback was found stuck in between logs on the beach on two occasions. Apparently these individuals were not able to find their way back to the sea after laying their eggs, and with their bodies half on the log and their flippers in the air they could not release themselves and died.

The southern part of the research zone is littered was dozens of logs, Adolphe is observing a stranded leatherback on a log.

In front of Pont Dick fish trawlers were often observed at a distance of less than about 500 meters, but no clear fishery related injuries such as fresh cuts from machetes or fishing lines were found on the nesting turtles. We never found stranded dead leatherbacks on the beach. Two handicapped leatherbacks were observed during our nightly patrols; one nesting leatherback was observed with only one hind flipper, another individual had a paralysed right hind flipper and was not able to dig a nest pit but there was no indication that this symptom was fishery related.

Gabon is a country with a lot of oil reserves, several big oil companies like TotalFinaElf and Shell are present, both on shore and off shore. In the sea in front of Mayumba in the South of Gabon, close to the border of Congo Brazzaville, there are at least 10 oil platforms at sea. These off shore platforms have enormous flares to burn excess gas, which are causing light pollution at night and disorientating marine turtles. Artificial lights attract sea turtles at night. Normally hatchlings and adults orient themselves using the clear “whiteness” of the waves of the ocean. Artificial lights may confuse them and as a result they may crawl towards the light, which is often not in the direction of the sea.

Our camp was located 2 kilometers south of the Shell Oil terminal from Gamba. Its flare is situated about 400 meters from the beach. Additionally, the Shell Gabon operated oil terminal is artificially lighted and situated 200 meters north from the end of our daily patrolled zone.

Oil tankers are loaded offshore of Pont Dick, a fish trawler and the lights of an oil platform at Mayumaba(r)

On one occasion 100% of hatchlings of a nest situated at about 400 meters from the lighted dam of Shell were lost. All hatchlings crawled towards this lighted dam in a route parallel to the sea, unable to find the 'safe' sea. As a result they were all eaten by crabs and other natural predators on the beach. Traces in the sand made clear that some hatchlings had been crawling almost 50 meters on the beach looking for the artificial lights before a predator found them. We observed several adult leatherbacks who could not find a way back to the ocean after nesting. Attracted by the burner of the terminal, these individuals entered the lagoon after crawling on the beach for more than 100 meters.

On two occasions during this 4 months' campaign, reasonable amounts of oil where found on the beach in our daily patrolled zone. The many activities at sea involved with the oil industry make it likely that these are not rarely occurring events. Furthermore, it is difficult to find the source of the pollution. Did someone make a mistake with charging the oil tankers, did they clean the oil pipelines after filling the tankers, did a fishing ship dump some oil or was it directly from the oil platforms scattered in the sea? Mr. Bos from the department of Health Safety and Environment of Shell Gabon explained us that Shell is able to locate the source of the pollution by fingerprinting the oil. Comparing this component pattern with their own oil it is possible to exclude or confirm any direct relationship. According Mr. Bos Shell feels responsible for the pollution around their terminal in Gamba so they will try to clean it after every event of pollution. Notwithstanding if the oil is theirs. In the beginning of February a team of Shell has been cleaning the beach for several days.

A team of Shell Gamba is trying to clean the beach of Pont Dick after a pollution with oil(r).

5 Discussion

5.1 Population dynamics

The results from the Monel en PIT taggings showed that at least 64 leatherback have nested at Pont Dick during the 2003-2004 nesting season, as these turtles were identified. However, incomplete beach coverage and the high-percentage of one-time nesters indicate that the actual size of the nesting population at Pont Dick is very likely to be larger.

We estimated that the minimum number of individual leatherback females that nested in 2003-2004 at Pont Dick was 168. This was be calculated roughly by dividing the number of observed individuals (64) by the number of tag records (77) times the number of nest counts (203). The high percentage of one-time nesters can be explained by the fact that the beaches of the Gamba complex are part of the long and still mainly untouched beaches all along the coast of Gabon. This makes it more difficult to recapture the tagged turtles with small scale monitoring as used in the present study. Although we patrolled on the beach from 2 hours before high tide until 2 hours after high tide we have indications that we missed high proportions of nesting leatherbacks in some weeks. Leatherbacks in the Gamba complex appear to be less bound to high tides to enter the beach for egg laying as the leatherbacks in Suriname and French Guyana. This unexpected fairly random nesting behaviour of the leatherback should be taken into account in future research setups.

The decline of the nesting olive ridley population (28%) can partly be explained by the fact that this pilot study started one week later then last year, presumably we missed a high proportion of the breeding population in this week. The rather large decline (66%) in nesting leatherbacks in the nesting season of 2003-2004 at Pont Dick compared to previous years however, was confirmed by the results of other major nesting sites of leatherbacks along the Atlantic coast of Africa. At Pointe Pongara close to Libreville, the local researchers noticed an even larger decline for the leatherback population than observed in this study (ASF, pers. comm.) and also in Mayumba they are facing a major declines in nesting attempts (A. Billes, pers. comm.). According to Fretey, the number of nesting females during the 2003-2004 nesting season was also lower in Sao Tomé, Cameroon and Congo Brazzaville. Fretey was not worried by this phenomenon and stated that this could be part of a natural reproduction cycle of the leatherbacks in this region. Similar situations were also noticed in a 30 years research program in French Guyana (Fretey, pers. comm.).

Possible explanations could also be sought in changing availability of food sources due to changes in the large golf streams (comparable to or related to El Niño effects). Still the observations of sharp decline of nesting females are a point of concern and discussion for the West African leatherback population. The African population suffered from high egg poaching and turtle killing for consumption activities in the past (CMS/Fretey 2001) and those activities are still going on as we showed in the pilot study, although hopefully on a smaller scale. The poaching of leatherback eggs in French Guyana and Suriname is rare and meat from leatherbacks is not eaten by the local population as they do in West Africa. Comparisons between population dynamics of these two populations have therefore an increased uncertainty. The leatherback population in Suriname and French Guyana showed an increase during the past decades. During the nineteen-sixties no more then 200-300 came to nest in Suriname (Schultz 1980) while 30,000 nests were estimated in 2001 (Hilterman and Goverse, 2002).

To determine whether the decline in nesting leatherbacks in Gabon in the nesting season of 2003-2004 is temporally or definitive, ongoing monitoring studies in the upcoming nesting seasons are of high necessity. With increasing fishing activities in the Atlantic Ocean and poaching activities still going on, the leatherback population will be facing many possible threats in Gabon. While the leatherback population in Suriname increased spectacular, the olive ridley population has gone almost extinct in Suriname, from 3300 nests in Galibi (one of the several nesting beaches in Suriname) in 1967 (Schultz, 1980), down to at least 109 nests in the total of Suriname's nesting area (Hiltermans, 2000). The olive ridley has been under high egg poaching pressure by the local communities. This example shows how vulnerable and fragile a nesting sea turtle population can be under continuing egg-poaching activities. The results of the West African sea turtle research programs in the upcoming years will be highly important to validate Fretey's (hopeful) statement both for the South American population in Suriname, French Guyana and Trinidad and the West African populations. Closer co-operation between research teams and sharing of data and experience will provide important extra tools to improve the knowledge on the Atlantic leatherback population.

5.2 Nest success

Hatched nests were excavated immediately after hatching in order to prevent the numerous crabs on the beach to 'plunder' the remains of the nests. As soon as the juveniles in nest were hatching, crabs entered the nests chamber to predate on the remaining hatchlings and the unhatched eggs. In a very recently hatched nest, 4 killed hatchlings were found, 3 living hatchlings and a total of 19 crabs.

A total of 13 hatchlings predated by crabs were found in a total of 10 nest chambers. We may assume that crabs predate much higher numbers of hatchlings.

Once emerged on the beach surface, the hatchlings encountered several other predators besides the crabs, like Mongoose (*Atilax paludinosus*), Monitor Lizard (*Varanus niloticus)*, Civet (*Viverra civetta*) and Genette (*Genetta tigrina*). Traces on the beach and around hatched nests are demonstrated that all these were present and predated on the hatchlings. Besides crabs the Monitor lizard is also capable to find the nest, to excavate the nest and to predate on the eggs.

The hatch rates of natural (unmarked) nests on Pont Dick where the spring tide inundated almost the entire beach width cannot be considered representative to all nests formed by leatherbacks. Unfortunately most of the marked sticks were irretrievable by the team, probably because of vandalism (visitors taking the marking sticks away), or because of tides and wind. Due to the low numbers of marked nests we did not succeed in using results from the marked nests. A better solution for successful nest retrieval will hopefully be applied next year, using a metal detector. Therefore, to estimate hatching success we excavated those nests where we saw tracks of emerging hatchlings. With this method, hatchling nests with few hatchlings were easily overlooked, because they left fewer tracks in the sand. Hatchling traces were easily washed away by waves while wind transported sand made the traces invisible. This resulted in a bias towards finding nests with a high emergence success and thus a higher visibility of the traces. To monitor hatch rates and nest survival rates a random marked-nests study as started this year has to be improved and enlarged.

Although the number of excavated nests was low (n=10), and the problems mentioned above, this research gives an indication of remarkable high hatching rates of successful nests. In the next years, percentage of un-hatched nests must become clear with the marked nest study. Beach erosion will be a major factor of nest loss. Logs on the beach are influencing the currents and waves on the beach, which results in high beach erosion around these logs. On the highly dynamic coast, logs are transported northwards by the current and are thus influencing the beach erosion on several locations. The slope of the beach is often changed by beach erosion as well, resulting in sudden level change resulting in high ridges on the beach. It is highly likely that complete nests are washed away by the sea because of erosion. Especially the shallow nests from olive ridleys and hawksbills are under a high risk.

Another factor for erosion in the study area, which often results in total nest loss, are the outlets of the swamps directly into the sea. After heavy rains, a spontaneous outlet to the sea can be created from the swamps directly located behind the beach. These outlets are highly dynamic and are closed by sand transport when the water pressure of the swamps is weakened.

Results of beach erosion and the result of a small outlet of swamps direct in the ocean.

6 Conclusions

Nest counts at Pont Dick made clear that the leatherback is the most common sea turtle in the Gamba Complex followed by the olive ridley. Nesting green turtles and hawksbills are scarce but observed.

The nesting season 2003-2004 in Gabon and neighbouring African countries is characterised by a large decrease in nesting leatherbacks. From observations in our study site, Pont Dick in the Gamba Complex, we estimated that the number of nests decreased 66% compared to the nesting season of 2002-2003. It is yet unclear if this is a temporary decrease and thus part of a natural reproducing cycle in West Africa or that the African leatherback population is in critical danger.

No direct evidence was found for a similar reduction of the olive ridley population at our study site when compared to results from the previous monitoring season.

Hatch success of successful leatherback nests at Pont Dick was high (83%), but for a more accurate and representative result an improved randomly marked *in situ* study has to be carried out. Mean curved carapace length and width of the leatherbacks at Pont Dick were comparable with other leatherback populations world wide.

Trawlers are fishing in front of the nesting beaches at Pont Dick but no fishery-related injuries or deaths were observed. Further studies are needed to qualify the dangers for turtles by fisheries.

7 Next steps

7.1 Objectives and Activities

The next step of the marine turtle monitoring program in the Gamba/Sette Cama/Southern Loango National Park area is to link community research-based turtle monitoring to education, while providing sustainable development opportunities through the implementation of an innovative marine turtle research-based eco-tourism product. In the longer term, the goal is to set up a Marine Turtle Research and Monitoring Station in the Gamba Complex, in collaboration with WWF Gabon and Protomac. This Station would not only guarantee better long-term knowledge and protection of marine turtle populations, but also contribute to sustainable conservation-related employment while contributing to diversification of the eco-tourism potential in the Complex.

The program is being implemented on a small-scale basis by our existing team of four locally recruited researchers, who received initial supplementary training from Biotopic. Following the recruitment and training of four additional rangers, two teams of totally eight rangers will then work under Biotopic's direct technical field supervision for a period of three years.

After three years, a Gabonese research team should be in charge of the marine turtle monitoring in the Gamba Complex, coordinated by Biotopic. Income will partly be generated through eco-tourism and by continuous funding through international nature conservation programs. An educational program in co-operation with Ibonga, and the Dutch company ‘de Praktijk’ and other organizations will then ensure awareness raising. Biotopic will implement data exchange, leading to an overall view on marine turtle populations, migration and beach quality in Gabon. Activities can be regarded as the implementation of the Abidjan Memorandum on sea turtle protection along the Atlantic coastline of Africa. The KUDU Program describes the outlines for this implementation.

The following activities will be implemented:

a. Set up two semi-permanent research stations (protection and local development);
b. Scientific research (population dynamics, nest ecology, biometry, threats);
c. Collect and analyze data through the innovative Cyber Tracker technology;
d. Reinforce protection;
e. Implementation of an Education Program in Holland, Gabon and Suriname;
f. Develop an eco-tourism product;
g. Adoption Program (raise awareness in Europe, alternative funding);
h. Active part in Trans-Atlantic Migration Program.

a. Set up two research stations

The impermanent character of the field camp used in the former two seasons, consisting of tents and a plastic tarpaulin, will change into a more permanent one, though at the same costs. Eight traditional huts will be constructed using only traditional materials (wood, leaves and bark). These traditional huts will create better living conditions (small tents in the tropics are too hot), are aesthetically better, and create work for locals and show traditional building techniques.

The second Camp will be located 15 kilometers of Sette Cama, north of Gamba. This will be a similar camp.

b. Scientific research

The program will monitor trends in turtle abundance and distribution as well as the causes of seasonal variations.

The objectives of the research are:

- Determine the number of marine turtles nesting in the Gamba complex, the number of nests they produce, and trends of this population (e.g. clutch frequency, internesting intervals, remigration rates and beach fidelity), by means of a large scale-tagging project;
- Determine nest survival and hatch success for *in situ* turtle nests;
- Determine the sex ratio of hatchlings, based on prevalent sand temperatures;
- Obtain biometric data on nesting sea turtles and hatchlings;
- Qualify and quantify the threats facing adult turtles, hatchlings and eggs with a special focus on fisheries related injuries;
- To educate and train local students and counterparts in sea turtle biology on research techniques, data analyses and interpretation.
- Dutch and Gabonese students (in co-operation with the University of Amsterdam) will be part of the research teams and under supervision of the field co-ordinator.

c. CyberTracker

One of WWF's and its partners' main focus in the Gamba Complex is to support the setting up and operation of a centralised GIS Data Center for the Gamba Conkouati Landscape to be based in Gamba. In this context, a partnership was established with the CyberTracker Monitoring Program. A GIS expert of this Program is now based in Gamba to provide technical assistance in tailoring the technology to the needs of the various projects and activities in the Complex, including the great ape program and the marine turtle program. Two thematic visors have been tested by the 2003-2004 monitoring team. The sequences are currently being refined, and the final version will be developed at the beginning of October 2004. The team of rangers will then be enlarged with four new recruits and further trained and equipped with additional visors, to ensure that the data collection and analysis process is fully operational and that the information is integrated into the Data Center.

d. Reinforce protection

In the Congo Basin, the experience shows that one of the best ways to assure effective and long-term surveillance in protected areas is to ensure that highly motivated ecological monitoring teams are 'filling' the area with 'conservation eyes and ears'. Through the Marine Turtle monitoring program, two teams of four people will be present on two different stretches of beach on a day-to-day basis, and they will be able to collect and report information on human presence and poaching activities.

e. Education

An environmental education program focusing on marine turtles and international exchange will be implemented in co-operation with Ibonga and 'de Praktijk' (Dutch nature and science education company). Educational material will be produced together with local partners to fit the local needs. This program also includes an educational hatchery, which enables school classes to have their own nests and see the hatchlings. To begin with educational material which is successfully used in Suriname will be used in Gabon after translation.

f. Eco-tourism

In general, tourists coming to visit tropical forest environments are very interested to acquire knowledge about the ecosystem they are discovering. The program will therefore develop a product where tourists are invited to join the monitoring teams and assist them in data collection on the beach.

Initially, this will mainly be developed with the tourists hosted by Sette Cama Safaris, a small local family-owned tourist lodge located in Sette Cama village. This lodge is currently the best example in Gabon of involving local people in nature-based tourism development and it is expected that this new product will contribute directly and indirectly to increased revenues for local communities. Tourists and researchers will be able to informally interact and exchange information and experiences. The EU funded PSVAP ('*Valorisation des Aires Protégées*') is positive towards our initiatives and will help providing tourists in the future. Also Serge Mkombe, a local tourist operator reacted positive towards our ideas and is willing to provide tourists.

Employees from Shell and their friends and family have already visited our camp frequently last year and are likely to continue in the following years, especially if more facilities and information can be provided in the research camp(s).

Dutch tour operators are also being approached to be involved in eco-tourism, and this already resulted in a positive reaction of "Summum reizen".

g. Adoption Program

The Marine Turtle Adoption Program for Gabon involves individuals and companies in turtle conservation. This project allows people and companies to adopt a tagged turtle for € 50,- or more that can be followed on the website (www.biotopic.org). Individual and company involvement is an important aspect to raise general awareness and long term fundraising for Marine turtles.

h. Trans-Atlantic Migration Program

Biotopic will also be integrated in the project submitted by WWF to the CMS Small Grant Program: *"Movements of Atlantic leatherback turtles - steps toward by-catch reduction and trans-oceanic cooperation for conservation"*.

This project will set up the platform for the compilation and dissemination of travel route information about the trans-oceanic movements of leatherback turtles, for the subsequent design of measures to reduce by-catch mortality in Atlantic fisheries. For this project ARGOS transmitters will be mounted on leatherback turtles on the different continents and GPS data will be collected and collectively presented on the Internet. This project includes: WWF – Latin America & the Caribbean Program (LAC), CID/Karumbé – Proyecto Tortugas Marinas del Uruguay, WWF – France Guyana's Program, Centre d´Ecologie et Physiologie Energétique CEPE, Caribbean Conservation Corporation, UICN-France, WWF-Gabon, Bureau régional du Programme KUDU, Ibonga and Biotopic. Biotopic will co-ordinate the migration data for Gabon.

7.2 Partnerships

Biotopic will be working closely with WWF-NL and WWF Gabon, Ibonga PROTOMAC, KUDU Program, De Praktijk (Dutch nature and science education company) and The University of Amsterdam.

The Principal Technical Advisor of the WWF Gamba Project (Bas Huijbregts) will ensure logistical support. Technical support will come from Jacques Fretey of the KUDU Program and Alexis Billes of PROTOMAC.

The university of Amsterdam will provide students and so some financial backstopping for the Program.

Technical support to Cyber Tracker data collection development and data analysis will be carried out by the GIS expert of the WWF/Cyber Tracker Gamba Data Center, Annabelle Honorez and the WWF data base manager.

7.3 Sustainability

Given the thirteen national Parks the president appointed in 2002 and the enormous biodiversity in Gabon, tourism will be an important factor for Gabon's economy in the future. The Gamba Complex is the biodiversity hotspot in Gabon and will play a very important part in nature conservation and (eco-) tourism. Experience has shown that the leatherback turtle is an impressive animal that can easily be approached and therefore serves as a flagship species for turtle conservation and tourism. The positive results of Ibonga's (environmental) education inspired us and provides a solid foundation for a larger education program involving field trips and international exchange. As marine turtle research is just starting in West Africa, scientific data are needed to take the proper conservation measures. Biotopic's and PROTOMAC's experience combined, together with the technical assistance and local expertise from WWF, provides a solid base for scientifically sound research.

7.4 Conclusion

This program is a natural follow-up of previous years of work on Marine Turtles in the Gamba Complex. The partnership with PROTOMAC/KUDU will provide the overall scientific backstopping needed, whereas data collection system development, GIS and data analyses expertise will be provided by Biotopic. This program will form a sound long-term monitoring program in the Complex and provide all government and non-government actors in the Complex with a continuously updated tool allowing for the best conservation-related management-decisions.

8 Acknowledgements

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Bas & Martijn

9 References

Billes, A., Moundemba, J-B. & Gontier, S. (2000). Campagne Nyamu 1999-2000, rapport de fin de saison. PROTOMAC/ECOFAC, mimeogr., 77 pp.

Billes, A., Huijbregts, B. (2003) Nidification des tortues marines dans le complexe d'aires protegees de Gamba: premier suivi d'une plage de ponte. In prep.

Biotopic, Project Sea Turtle Protection Across Frontiers. Technical report 16, Biotopic Foundation, Amsterdam, The Netherlands.

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

Duméril, A. (1860). Reptiles et poissons de l'Afrique Occidentale. Etude précédée de considerations générales sur leur distribution géographique. Arch. Mus. Nat. Hist. Nat. Paris, 10: 137-268.

Fretey, J. (2001). Biogeography and Conservation of Marine Turtles of the Atlantic Coast of Africa / Biogéographie et conservation des tortues marines de la côte atlantique de l'Afrique. CMS Technical Series Publication N° 6, UNEP/CMS Secretariat, Bonn, Germany, 429 pp.

Chevalier, J., and M. Girondot, 1999. Status of Marine Turtles in French Guiana. *Manuscript*, 7p.

Eckert, K.L., 1987. Environmental Unpredictability and Leatherback Sea Turtle (*Dermochelys coriacea*) Nest Loss. Herpetologica 43(3):315-323.

Fretey, J., and A. Billes, 2000. Les Plages du Sud Gabon: Derniere Grande Zone de Reproduction de la Planete Pour la Tortue Lute? NDIVA Complément Écosystèmes Marins Canopee 17:1-4.

Girondot, M., and J. Fretey, 1996. Leatherback Turtles, *Dermochelys coriacea*, Nesting in French Guiana, 1978-1995. Chelonian Conservation and Biology 2(2):204-208.

Hilterman, M.L., 2001. The Sea Turtles of Suriname. 2000. Guianas Forests & Environmental Conservation Project (CFECP). Technical Report World Wildlife Fund for Nature (WWF)/Biotopic Foundation Amsterdam, 63p.

Hilterman, M.L., and E. Goverse, 2002. Aspects of Nesting and Nest Success of the Leatherback Turtle (*Dermochelys coriacea*) in Suriname, 2001. Guianas Forests and Enviromental Conservation Project (CFECP). Technical Report, World Wildlife Fund Guianas/Biotopic Foundation, Amsterdam, The Netherlands, 34p.

Hilterman, M.L., and E. Goverse, 2003. Aspects of Nesting and Nest Success of the Leatherback Turtle (*Dermochelys coriacea*) in Suriname, 2002. Guianas Forests and Enviromental Conservation Project (CFECP). Technical Report, World Wildlife Fund Guianas/Biotopic Foundation, Amsterdam, The Netherlands, 31p.

McDonald, D., and P. Dutton, 1994. Tag Retention in Leatherback Sea Turtles (*Dermochelys coriacea*) at the Sandy Point, St. Croix, U.S. V.I. In: B.A. Schroeder, and B.E. Witherington (Editors), 1994. Proceedings of the Thirteenth Annual Symposium on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-341, 281p., pp.253.

McDonald, D., and P. Dutton, 1996. Photoidentification of Leatherback Sea Turtles (*Dermochelys coriacea*) at the Sandy Point National Wildlife Refuge, St. Croix, U.S. V.I. In: J.A. Keinath, D.E. Barnard, J.A. Musick, and B.A. Bell, 1996. Proceedings of the Fifteenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFSC-387. 355p., pp.200.

Mrosovsky, N., 1983. Ecology and Nest-site Selection of Leatherback Turtles *Dermochelys coriacea*. Biological Conservation 26(1):47-56.

Oosting, B., 2003. Sea Turtle Protection Across Frontiers, a project between The Netherlands, Benin and Costa Rica, "South-South Cooperation". Report No 25 Biotopic Foundation Amsterdam, The Netherlands

Paladino, F., 1999. Leatherback Turtle Workgroup at the 19th Annual Symposium. Marine Turtle Newsletter 86:10-11.

Schulz, J.P., 1980. Zeeschildpadden die in Suriname Leggen. Natuurgids Serie B, No. 5, Stichting Natuurbehoud Suriname (STINASU). Vaco-press Grafische Industrie N.V. Paramaribo, Suriname. 113p.Spotila, J.R., A.E. Dunham, A.J. Leslie, A.C. Steyermark, P.T. Plotkin, and F.V. Paladino, 1996. Worldwide Population Decline of *Dermochelys coriacea*: Are Leatherback Turtles Going Extinct? Chelonian Conservation and Biology 2(2):209-222.

Steyermark, A.C., K. Williams, and J.R. Spotila, F.V. Paladino, D.C. Rostal, S.J. Morreale, M.T. Koberg, and R. Arauz, 1996. Nesting Leatherback Turtles at Las Baulas National Park, Costa Rica. Chelonian Conservation and Biology 2(2):173-183.

Tucker, A.D., 1990. A Test of Scatter-nesting Hypothesis at a Seasonally Stable Leatherback Rookery. In: T.H. Richardson, J.I. Richardson, and M. Donnelly (Editors), 1990. Proceedings of the Tenth Annual Workshop on Sea Turtle Biology and Conservation. NOAA Technical Memorandum NMFS-SEFC-278, 286p., pp.11-14.

Zug, G.R., and J.F. Parham, 1996. Age and Growth in Leatherback Turtles, *Dermochelys coriacea* (Testudines: Dermochelyidae): a Skeletochronological Analysis. Chelonian Conservation and Biology 2(2):244-249.

Appendix I

List of Monel and PIT tag codes used at Pont Dick in the nesting season from November 2003 until March 2004.

List of abbreviation:

DC	=	*Dermochelys coriaceae*
LO	=	*Lepidochelys olivacea*
CM	=	*Chelonia mydas*
EI	=	*Eretmochelys imbricata*
LHF	=	Left hind flipper
LFF	=	Feft front flipper
RHF	=	Right hind flipper
RFF	=	Right front flipper
CCL	=	Curved carapace length
CCW	=	Curved carapace width
ICT	=	Head with

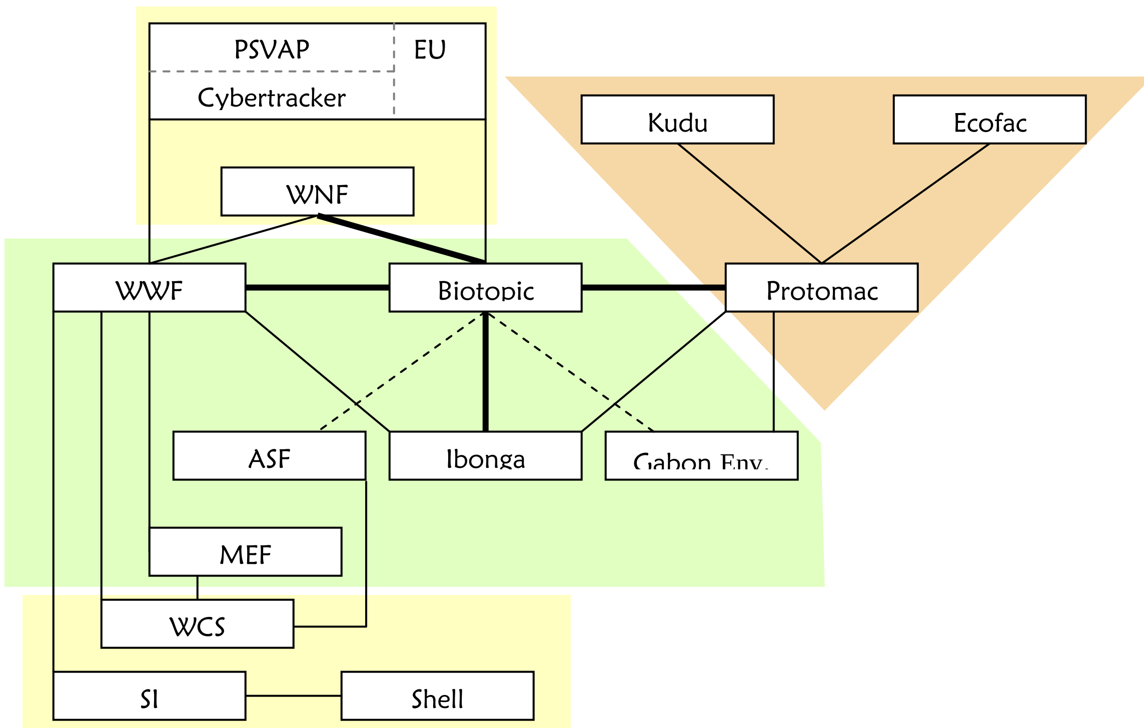
DATE	Spec.	Monel tag	Monel tag	Monel Relecture		PIT-code	PIT Rel.	CCL	CCW	ICT
		LHF	RHF	LHF	RHF					
25-26 Dec	DC	12648	12649	X	X			152	112	
19-20 Feb	DC	ASF11942	ASF11943	X	X	064D 6DD8		--	--	
7-8 Dec	DC	ECO12201	ECO12202					135	105	
18-19 Feb	DC	ECO12218	ECO12219	X	X	064D 6B23	X	151	110	39
19-20 Jan	DC	ECO13616	ECO13615	X	X	064D BD5O	X	162	114	39
19-20 Jan	DC	ECO13619	ECO13620					155	110	39
21-22 Feb	DC	ECO13619	ECO13620	X	X	064D F2A7		154	110	43
19-20 Jan	DC	ECO13621	ECO13622					148	104	38
12-13 Feb	DC	ECO13649	ECO13650			064D 3267		145	107	40
2-3 Feb	DC	ECO13651	ECO13652			0648 5810		157	114	39
2-3 Feb	DC	ECO13653	ECO13654			064D 8A57		151	119	41
9-10 Feb	DC	ECO13655	ECO13700			064E 08D6		160	114	42
10-11 Feb	DC	ECO13656	ECO13657			064E 048C		155	107	39
17-18 Jan	DC	ECO13678	ECO13679			064D EOC1		146	108	39
19-20 Jan	DC	ECO13681	ECO13682			064E 048D		156	116	40
24-25 Jan	DC	ECO13688	ECO13689			064E OFAO		152	114	
28-29 Jan	DC	ECO13690	ECO13691			064D F57C		148	107	39
1-2 Feb	DC	ECO13692	ECO13693			064D BE4F		140	103	
3-4 Feb	DC	ECO13694	ECO13695			064E 05DF		152	116	39
8-9 Feb	DC	ECO13696	ECO13697			064D FC33		152	113	39
12-13 Dec	DC	ECO12203	ECO12205					145	105	
15-16 Dec	DC	ECO12206	ECO12207					160	110	
2-3 Jan	DC	ECO12206	ECO12207	X	X	064D E1FG		159	117	40
15-16 Dec	DC	ECO12209	ECO12208					157	118	
15-16 Dec	DC	ECO12210	ECO12211					170	120	
21-22 Dec	DC	ECO12213	ECO12212					160	114	32
6-7 Jan	DC	ECO12213	ECO12212	X	X	064E 6943		160	117	42
26-27 Dec	DC	ECO12215	ECO12214					155	110	39

1-2 Jan	DC	ECO12216	ECO12217			064D EF48		163	120	
2-3 Jan	DC	ECO12218	ECO12219			064D 6B23		149	111	41
5-6 Jan	DC	ECO12220	ECO12221					140	110	39
16-17 Jan	DC	ECO12220	ECO12221	X	X	064D 9A6B		140	110	39
7-8 Jan	DC	ECO12222	ECO12223			064E B5FF		147	102	
8-9 Jan	DC	ECO12224	ECO12225			064D BCOC		--	--	
4-5 Dec	DC	ECO12226	ECO12227					145	101	
25-26 Dec	DC	ECO12226	ECO12227	X	X			141	102	39
25-26 Dec	DC	ECO12228	ECO12229					152	108	45
2-3 Dec	DC	ECO12231	ECO12230					164	122	
2-3 Dec	DC	ECO12232	ASF6095		X			155	113	
1-2 Dec	DC	ECO12234	ECO12235					148	100	
30-1 Dec	DC	ECO12236	ECO12242					160	119	
27-28 Jan	DC	ECO12236	ECO12242	X	X	064E 057C		159	118	
24-25 Nov	DC	ECO12240	ECO12239					159	119	
15-16 Dec	DC	ECO12240	ECO12239	X	X			155	119	
20-21 Nov	DC	ECO12241	ECO12244					166	126	
31-1 Jan	DC	ECO12241	ECO12244	X	X			--	--	
1-2 Dec	DC	ECO12251	ECO12252					151	109	
3-4 Dec	DC	ECO12253	ECO12254					162	114	
7-8 Dec	DC	ECO12256	ECO12255					160	117	
7-8 Dec	DC	ECO12257	ECO12258					153	114	
8-9 Dec	DC	ECO12259	ECO12260					150	107	
29-30 Dec	DC	ECO12259	ECO12260	X	X			154	112	39
8-9 Dec	DC	ECO12261	ECO12263					148	108	
17-18 Dec	DC	ECO12264	ECO12265					150	108	39
6-7 Dec	DC	ECO12267	ECO12266					155	105	
5-6 Dec	DC	ECO12268	ECO12269					160	117	
3-4 Dec	DC	ECO12270	ECO12271					146	102	
23-24 Nov	DC	ECO12273	ECO12275					141	106	
19-20 Nov	DC	ECO12290	ECO12293					159	119	
23-24 Nov	DC	ECO12294	ECO12295					159	111	
17-18 Dec	DC	ECO13601	ECO13602					157	120	39
28-29 Dec	DC	ECO13603	ECO13604			064D EAA8		160	116	39
16-17 Jan	DC	ECO13603	ECO13604	X	X	064D EAA8	X	160	116	39
29-30 Dec	DC	ECO13606	ECO13605					160	115	39
7-8 Jan	DC	ECO13605	ECO13606	X	X	064D E9DE		156	115	40
30-31 Dec	DC	ECO13607	ECO13608			064D D7BF		155	110	39
29-30 Dec	DC	ECO13610	ECO13609					157	116	39
1-2 Jan	DC	ECO13611	ECO13612			064D 2257		139	108	
1-2 Jan	DC	ECO13613	ECO13614					--	--	
11-12 Jan	DC	ECO13616	ECO13615			064D BD5O		165	115	39
16-17 Jan	DC	ECO13617	ECO13618			064E OD92		168	118	41
29-30 Jan	DC	ECO13625	ECO13623			064D 9428		140	107	38
17-18 Jan	DC	ECO13676	ECO13677			064D AE96		150	109	39
20-21 Jan	DC	ECO13683	ECO13684			064E ED97		144	108	
20-21 Jan	DC	ECO13683	ECO13684	X	X	064E ED97	X	--	--	
21-22 Jan	DC	ECO13686	---			064D B8D8		146	112	
21-22 Jan	DC	ECO13687	ECO13685			064D E1D8		149	108	
10-11 Jan	DC	ECO13698	ECO13699			064D D9E3		149	106	37

DATE	Species	Monel tag left	Monel tag	Monel Relecture		CCL	CCW	ICT
		LFF	RFF	RFF	LFF			
29-30 Dec	CM	KUD10707	KUD10708			100	83	26
30-31 Dec	CM	KUD10707	KUD10708	X	X	100	88	
27-28 Dec	EI	KUD10781	KUD10782			85	74,5	24
13-14 Jan	EI	KUD10781	KUD10782	X	X			
10-11 Dec	LO	KUD10701	KUD10706			68	70	
21-22 Nov	LO	KUD10702	KUD10703			70	73	
23-24 Nov	LO	KUD10705	KUD10703			65	67	
19-20 Nov	LO	KUD10777	KUD10776			71	72	
12-13 Dec	LO	KUD10778	KUD10779			70	75	
15-16 Jan	LO	KUD10778	KUD10779	X	X	70	75	
29-30 Nov	LO	KUD10796	KUD10795			70	72	
2-3 Dec	LO	KUD10798	KUD10797			69	70	
30-31 Dec	LO	KUD10709	KUD10710			74	70	23
30-31 Dec	LO	KUD10711	KUD10712			74	71	22

Appendix II

Schematic overview of the organizations directly and indirectly involved in the project from Biotopic's point of view:



Direct financial link with Biotopic

Formal contact between various organisations

Informal contact with Biotopic

Organisations directly involved on a national scale (Gabon)

Organisations involved in regional (West) African programs

Organisations not necessarily involved in Gabon or Africa