Prioritising Research-driven Management and Public Participation in Sea Turtle Conservation in Colombia

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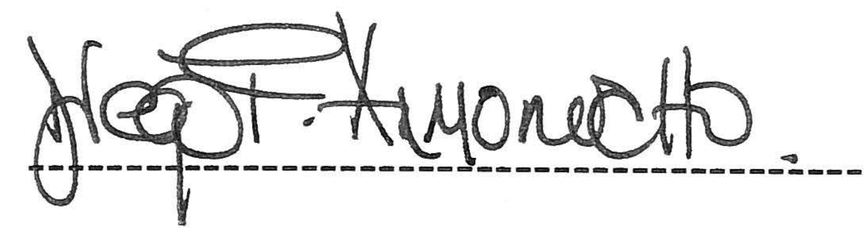
This sub-thesis is a result of my own work through consultation and research of a range of sources of information and my own experience in the field. All sources have been properly acknowledged within the following document.



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Abstract

Four endangered (*Chelonia mydas, Caretta caretta, Lepidochelys olivacea, Chelonia mydas agassizii, Dermochelys coriacea*) and one critically listed (*Eretmochelys imbricata*) species of sea turtles occur in Colombia's coastal and marine zones. Sea turtles are a natural and cultural resource of the coastal regions of Colombia, bearing both economic and traditional importance for communities along the Pacific and Atlantic coasts. Sea turtles also help maintain the productivity and balance of marine and coastal ecosystems, playing a valuable role within the food chain. In addition, marine turtles are a priority for Colombian national and international environmental policy-making processes. Yet, reliable data on short and long-term trends of sea turtle populations visiting Colombian waters and nesting on Colombian beaches is minimal and fragmented. Although Colombian law is largely participatory in nature, there is a lack of strategies to involve the public in the sea turtle research and conservation. This research paper discusses Colombia physically and naturally, covering aspects of relevance to sea turtle research and conservation. The paper also examines at the present known distribution, the major threats and the current status of sea turtles frequenting Colombian waters. The paper studies the legislative and institutional framework for sea turtle research and conservation in Colombia; identifying limitations and constraints facing government offices, NGOs and grassroots organisations mandated with and engaged in sea turtle conservation management.

In light of the above, the paper argues that the prioritisation of research-driven management and the participation of the public in research and management of the species are imperative for Colombia to increase the success of its conservation programs. Two related areas of focus for the research-driven management of sea turtles are identified for Colombia: short and long-term population trends and genetic characterization. A series of recommendations concerning these areas of focus are developed. Challenges facing Colombian sea turtle management programs, regarding the involvement and sustained participation of the public, are identified. Strategies to overcome these challenges are developed. It is intended that these recommendations for research-guided management and strategies for increased public participation contribute to the construction of an integrated and collaborative sea turtle management and conservation plan for Colombia.

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List of Acronyms

AscDNA	Anonymous single copy nuclear DNA
AWC	Widecast-Colombia Association
CEINER	Centre for Marine Research and Education
CITES	Convention in International Trade of Endangered Species
CMLU	Coastal and Marine Landscape Units
CORPAMAG	Magdalena Autonomous Regional Corporation
CORPOGUAJIRA	La Guajira Autonomous Regional Corporation
DNA	Deoxy-Ribonucleic-Acid
ECOU	Environmental Coastal and Oceanic Units
ES	Ecological Sectors
FTMSM	Sea Turtle Foundation of Santa Marta
GEF	Global Environmental Facility (World Bank)
GIS	Geographical Information System
HRC	Heart Rate Recorders
IBAMA	Brazilian Environmental Institute
ICZM	Integrated Coastal Zone Management
IGAC	Augustin Codazzi Colombian National Geographic Institute
INDERENA	Former Colombian National Resources Institute
INVEMAR	José Benito Vives de Andreis Colombian National Marine Research Institute
IUCN	World Conservation Union
LAC	Latin America and the Caribbean
mtDNA	Mitochondrial DNA
MU	Management Units
NGO	Non Governmental Organization
PCR	Polymerase Chain Reaction
Pro-TAMAR	Foundation for the TAMAR Project
RETOMAR	Colombian Sea Turtle Conservation Network
RFLP	Restriction Fragment Polymorphism
SPAW	Specially Protected Areas and Wildlife Protocol
STRAP	Sea Turtle Recovery Action Plan
TAMAR	Brazilian Sea Turtle Project
TDR	Time Depth Recorders
TERMOGUAJIRA	La Guajira Thermo-electrical Power Station
UAESPNN	National Parks System Special Administrative Unit – Ministry of the Environment - Colombia
UNIANDES	University of Los Andes
UNEP	United Nations Environment Program
US FWS	United States Fish and Wildlife Servi
US NMFS	United States National Marine Fisheries Service
WIDECAST	Wider Caribbean Sea Turtle Conservation Network

1 Introduction

Throughout history sea turtles have been associated with the cultural and socio-economic values of a diverse range of human populations in Latin America and the Caribbean (LAC) (Frazier 2001a, p. 3). These migratory navigators of the world's oceans are a natural and cultural resource of the coastal regions of Colombia, bearing both economic and traditional importance for communities along the Pacific and Atlantic (Caribbean) coasts. In addition, sea turtles help to maintain the productivity and balance of marine and coastal ecosystems; they play a valuable role within the food chain, transporting nutrients from open-ocean to coastal feeding and breeding grounds (Frazer 2001, pp. 74-5). Sea turtle conservation is also a priority for the Colombian national and international environmental policy-making processes.

Yet, reliable data on short-term and long-term trends of sea turtle populations visiting Colombian waters and nesting beaches is minimal and fragmented (Rueda *et al.* 1992 p. 2). Little is known of Colombian sea turtle population dynamics, life histories and threats (Amorocho *et al.* 1992, pp. 155-6). Research into sea turtle biology and ecology, directed by species management objectives, would contribute greatly to conservation efforts, and facilitate the policy-making and implementation process in Colombia.

Another major hurdle for sea turtle conservation in Colombia is the lack of strategies for effective and ongoing public involvement in sea turtle research and conservation. Although Colombian environmental law is largely participatory in nature, true public involvement in sea turtle research and conservation is still weak. Strategies for public involvement, tailored to the overall Colombian sea turtle conservation context, would increase the participation of local and regional communities in the research and

management of the species as well as environmental policy and planning on a broader level.

The following introductory section of the paper provides a natural and historical sketch of sea turtles and illustrates the economic, cultural, ecological and international relevance of sea turtles and their conservation to Colombian coastal communities and, in particular, to the policy-making processes.

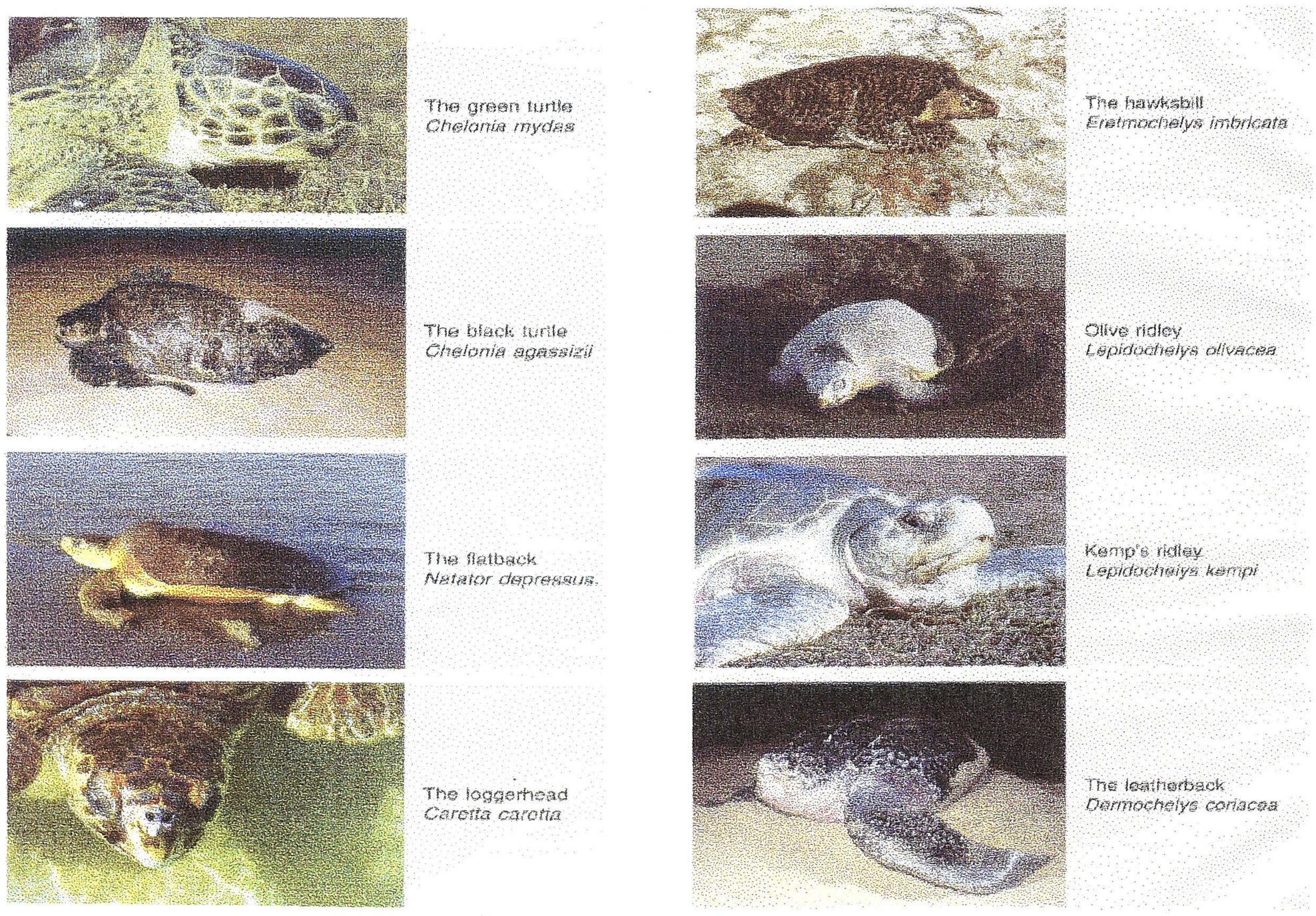
1.1 Sea turtles: a natural and historical sketch

With the exception of marine snakes, sea turtles are the only reptiles that have inhabited the world's oceans for more than 200 million years, with different species found from the Arctic Circle to Tasmania. The fossil record of sea turtles dates from the Jurassic period (Frazier 2001a, p. 3). Since that time, these long-living, late-maturating animals have experienced a low evolutionary rate (Crouse 1999, p. 195). Their morphological characteristics remain very similar to those of their early ancestors (Pritchard 1997, pp. 8). By the Cretaceous period, 150 million years ago, four marine families – the Protostegidae, the Toxochelydae, the Dermochelydae and the Chelonidae – were firmly established, the latter two surviving to the present day. The extinction of the Protostegidae and Toxochelydae families and at least 27 genera in the Chelonidae family is attributed to an elimination of overspecialised species with poor response to changing conditions (Zangerl 1980 cited in Pritchard 1997, p. 4). Thus, to a certain degree, surviving sea turtles can be considered as less specialized than their ancestors.

Seven species of sea turtles, representing the Chelonidae and Dermochelydae families, are the only living members of this large and diverse radiation of Cryptodiran turtles

(Meylan and Meylan 1999, p. 3) (Figure 1.). They are: the Green turtle (*Chelonia mydas*); the Loggerhead (*Caretta caretta*); the Flatback (*Natator depressus*); the Hawksbill (*Eretmochelys imbricata*); the Olive ridley (*Lepidochelys olivacea*); the Kemp's ridley (*Lepidochelys kempii*); and the Leatherback (*Dermochelys coriacea*). Many scientists also consider the distinctive "black" turtle from the Pacific coast of the America, sometimes referred to as *Chelonia agassizii*, as an eighth species, although its taxonomic differentiation from *Chelonia mydas* has not been conclusively demonstrated (Karl and Bowen 1999, p. 998).

Figure 1. Sea Turtles of the World



Adapted from: Lutz, P.L. and Musick, J.A (eds). 1997. *The Biology of Sea Turtles*. CRC, New York Press. pp. 20-1.

According to Pritchard and Mortimer (1999, p. 28), most of these 'living species of sea turtles' have circumglobal, subtropical and / or tropical distributions. Greens, loggerheads and hawksbills are perhaps the most confined to tropical regions, whereas leatherbacks are known to make forays into colder, sometimes polar waters. With the

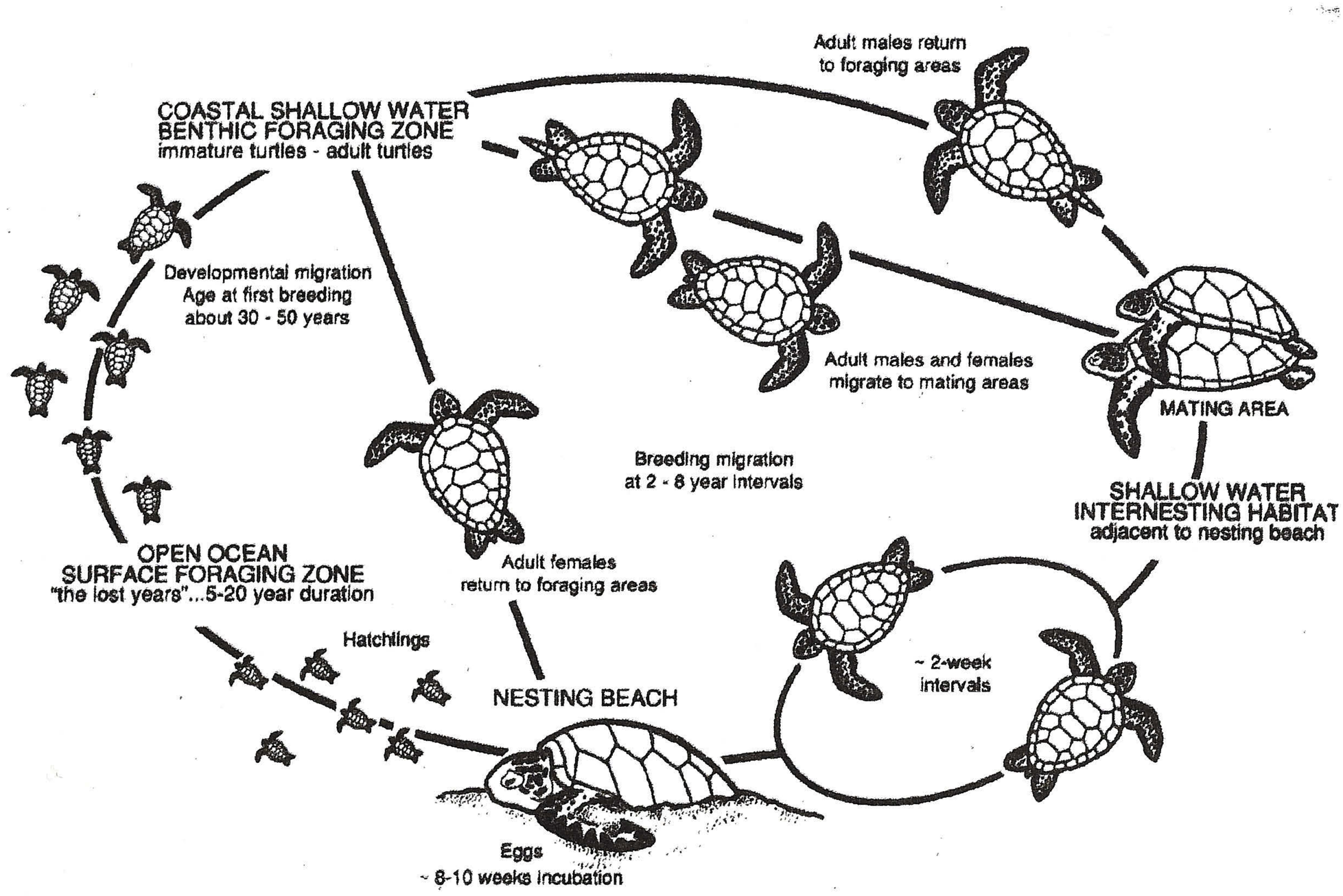
exception of Kemp's ridley and flatback turtles, all other sea turtles are widely distributed. Kemp's ridley is restricted principally to the Gulf of Mexico and the eastern coast of the United States, with some individuals found infrequently in the United Kingdom and Western Europe. The flatback turtle is endemic to the Australian continental shelf.

After an incubation period ranging from 45-60 days, all species of hatchlings emerge from the nest and make their way into the sea. During its first critical 48 hours, a sea turtle hatchling must travel from the beach to a place in the ocean where it is relatively safe from predators and where it can find food (Miller 1997, p. 69). Experiments show that in the initial stages of swimming away from the beach, hatchlings orient themselves toward the magnetic field of the Earth, and that their magnetic compasses are sensitive to inclination, rather than polarity of the planet (Lohmann 1999, pp. 1-23). This early pelagic phase of a sea turtle's life cycle, originally referred as the 'lost year', varies in duration from 1- 7 years among species and populations (Carr *et al.* 1978, p. 12).

After several years of floating around the Ocean basins, young sea turtles venture back into near-shore waters where they spend several years eating and growing (Limpus 1998, p. 2). Individual sea turtles experience slow growth, with an age of maturity ranging from 15 to 50 years or more, depending on the geographical area and species (Balazs 1982, pp. 117). Once sea turtles reach adulthood and sexual maturity, it is believed that they migrate to a new feeding ground (Carr *et al.* 1978, p. 24). It is here, in this primary feeding area, that adult turtles probably remain throughout their lives, before they are ready to make the long breeding migration of up to 3,000 Km from the feeding grounds to the nesting beaches (Limpus 1998, p. 2). During the reproductive

season, adult sea turtles travel to the vicinity of the nesting beach, where they remain for several months before mating. However, copulation is also thought to occur along the migratory corridors, breeding stations or near the nesting beach where females lay their eggs annually during each breeding season (Meylan and Meylan 1999, p. 4) (Figure 2).

Figure 2. Sea Turtles life cycle



Source: Miller, J. 1997. Reproduction in sea turtles. In: Lutz, P.L. and Musick, J.A (eds.).The Biology of Sea Turtles. CRC, New York. P.53

In many ways the survival of a marine turtle depends on it making the right responses to its environment at the right times and encountering adequate conditions along the way. This may involve its response to a light on the horizon, the successful voyage from beach to sea after birth or giving birth, the avoidance of certain bodies of water in the open ocean, its selection of a specific environment or ecosystem for feeding, or its response to cues emanating from a particular nesting beach (Owens 1997, pp. 324-30). However, so much of sea turtle natural history and ecology is poorly understood, making it difficult to assess and protect the species. In consequence, sea turtle

conservation must be sustainable over long periods of time, be carried out over vast areas, take into consideration diverse marine and terrestrial environments, and involve international cooperation. As aptly stated by Frazier (2001b, pp. 15-6), 'conservation actions must be relevant to the societies in which they are carried out, for in the end biological conservation depends on political decisions made within social and economic contexts'.

1.2 The importance of sea turtles in Colombia

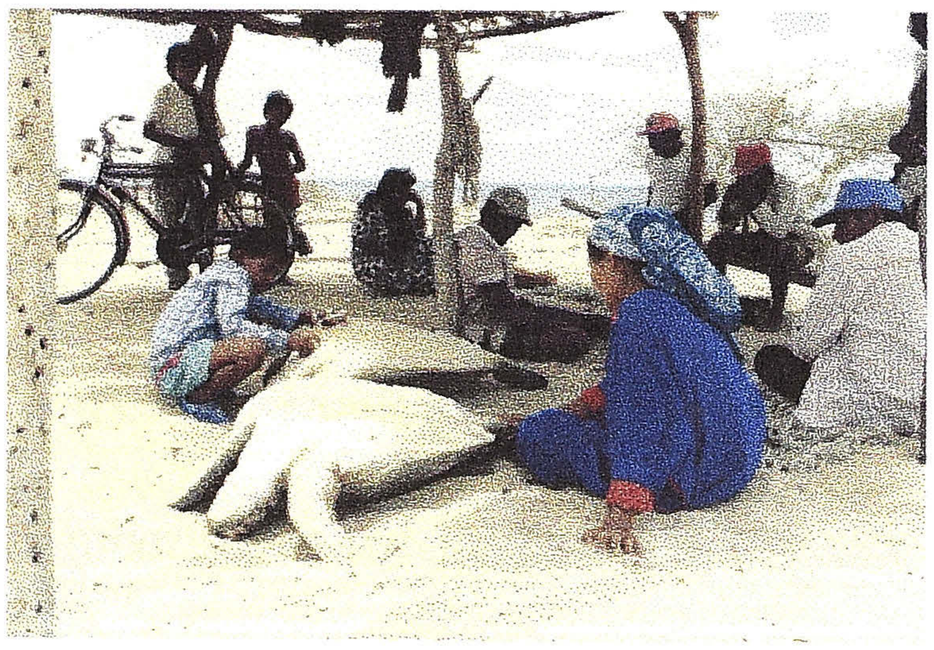
As a natural and cultural resource of coastal and insular communities of Colombia, sea turtles are depended upon for human nutrition, economic profit and as an important feature of local traditions and customs. The massive reach of trade in sea turtle products – meat, oil, bone, tortoise shell and leather – spans history and cultures. Recently, sea turtles have become important for non-consumptive uses such as tourism, education, scientific research, and activities that provide opportunities for employment and other economic benefits (Frazer 2001, p. 73).

In addition, theses reptiles serve to foster conservation processes at a broader ecosystem level. Sea turtles are model flagship species for local and international conservation due to their charismatic nature and largely unknown life cycle (Eckert 1999, p. 7). Thus, managing sea turtles adequately requires protecting coastal and marine areas, which in turn requires the integration of coastal communities that depend on the natural resources of the ecosystems in which they live.

1.2.1 The economic value of sea turtles for coastal Colombian communities

Since pre-Columbian times, indigenous groups from Colombia and LAC region, like the Caribes, the Wayuú, the Kunas, the Miskitos, the Guajiros, and the Garifunas, amongst others, have harvested sea turtles for eggs, meat, oil, skin and / or the tortoiseshell trade, they have been a vital resource for their subsistence as a people (Meylan 1999, p. 177; Chacón 2001, p. 19) (Figure 3). Sea turtle oil, meat, skin, shells and eggs were commonly traded among tribes and clans living along the Caribbean and Pacific coasts of Colombia (Parsons 1964, pp. 120-32).

Figure 3. Sea turtle harvest and egg poaching



Wayuú Sea Turtle Fishermen
Photo: Diego Amorocho 1994

Poaching eggs in the nesting beach
Photo: Luís Jiménez 2000

Sea turtles have also promoted commercial and social interactions among indigenous groups. Long migrations and re-settlement of entire human groups have occurred in pursuit of migratory turtles from their nesting beaches to foraging grounds, where a massive aggregation of sea turtles could be found (Friedemann and Arocha 1986, pp. 132-3). Stories from the Miskitos of Nicaragua, the Kunas of Panama, as well as the Caribes of the Archipelago of San Andres and Old Providence in Colombia, among the inhabitants of other Antilles islands, tell of long and distant journeys their people undertook throughout the Caribbean region in the seventeenth century searching for sea turtles (Chacón 2001, p. 19). Historical records since the era of Spanish domination in the Caribbean region confirm the consumption of sea turtle meat and eggs by the *conquistadores*, the slaves and the European navigators travelling between the 'Old World' and the 'New World' (Parsons 1972, pp. 45-60).

In the eighteenth and nineteenth centuries sea turtles were abundant, some populations numbering in the millions (Schroeder 2001, p. 126). They became the main source of income for the Afro-Caribbean people, the new ethnic group established in America as a consequence of the slave trade maintained by the Spanish and Portuguese during the conquest and colonial periods (Arocha 1996, pp. 320-3). These newcomers to the Latin American and Caribbean region based their economies and daily activities on sea turtle exploitation. Long hunting seasons carried out by Afro-Caribbean fishermen at the beginning of the nineteenth century along the Central American coast and the wider Caribbean region fostered a well-established market for meat and tortoiseshell (Chacón *et al.* 2000, pp. 4-5).

Egg poaching and small-scale sea turtle fisheries persist today in some indigenous and afro-Colombian communities. Unfortunately, social and cultural values continue to be

eroded, while the demand for eggs and meat increases in local and regional markets. Although possession of and trade in meat, eggs and other sea turtle products are prohibited under Colombian legislation (Colombia, Natural Resources Code 1996, pp. 66-73), the enforcement of these laws is not sufficient to close down this illegal trade, which has spread to all areas of the Caribbean and Pacific regions of Colombia.

Because there are inherent difficulties related to non-sustainable exploitation, it is imperative to truly involve local people who utilise sea turtles, in conjunction with other relevant stakeholders, in their conservation and management, something that has not yet occurred in Colombia.

1.2.2 The cultural value of sea turtles for coastal Colombian communities

Besides providing communities with nutritional sustenance and economic profit, sea turtles are an important component of the cultural heritage of coastal communities. Although there is no information available for Colombia, archaeological research in the Wider Caribbean associates sea turtle relics with human sites in certain localities, both continental and insular. These relics date from 1,380 BC to 1,715 AD (Molina 1981, pp. 2-5), showing that sea turtles were an important factor in cultural life in many pre-Columbian cultures.

Sea turtles are embedded in the cultural and social values of indigenous, Afro-Colombian and mestizo[1] communities. They appear in myths, tales, songs, and artistic expressions – where they play a spiritual and sometimes magical role (Correa 1999, pp. 23-4). In some cases they are the inspiration for a poem, a handicraft, or even a story

[1] Common denomination for a person derived from the interbreeding between indigenous people and Europeans since 1492.

that explains the origin of a particular geographical place. Off the central-eastern Caribbean coast between the Islands del Rosario and San Bernardo in Colombia and the San Blas Archipelago in Panama, sea turtles were not only considered an important marine resource, they were also thought to possess godlike qualities by indigenous groups inhabiting these islands. The Kuna people frequently include sea turtles in their world-renowned handmade textiles called *molas.*

Since the establishment of Afro-Colombians on the coasts and insular territories, music and oral tradition have been the main cultural assets of these ethnic groups, be they Caribbean or Pacific. *Calypso* – the music originating from the San Andres and the Old Providence Archipelago – *Currulao* of the central Caribbean and *Chrimias* of the Pacific coast, are the Afro-Colombian rhythms that often demonstrate, through lyrics or dance, the significance of sea turtles in the everyday life of these communities.

1.2.3 The importance of sea turtles for Colombian and LAC ecosystems

There is no accessible data recording how many sea turtles occurred in Colombia, or the Latin American Caribbean when Europeans arrived in the West Indies in the fifteenth century, or prior to that time. Jackson (1997, pp. s23-s33) estimates this to have been between 33 and 39 million adults and Bjorndal *et al.* (2000, pp. 269-82) calculate between 38 and 60 million adults and juveniles lived in the Wider Caribbean region during this period.

This prolific population of sea turtles has played an important role in the dynamics of the marine and coastal regional ecosystems of the Caribbean and possibly the world (Jackson 2001, pp. 633-4). Recent studies estimate between 20 and 40 percent of the total energy and organic material that a loggerhead turtle liberates on a given beach

returns to the sea in the form of hatchlings (Bouchard and Bjorndal, 2000 pp. 2305-13). The same researchers have calculated that 14,305 loggerheads nesting in 21 Km of beach in the Caribbean, must contribute 1. 6 million Kg of organic material; 365,000 Kg of lipids; 170,000 Kg of nitrogen and 15,500 Kg of phosporus – a considerable amount of energy and nutrients entering onto the nesting beach each year. As well as loggerheads, hawksbill turtles also contribute to maintaining the balance of coral reefs due to their particular feeding preference for sponges, which need to be predated or controlled, in order to ensure the survival of other organisms inhabiting this fragile ecosystem.

Sea turtles also serve as nutrient exporters on an annual basis, when mature individuals leave foraging habitats to migrate to nesting beaches or breeding grounds where they deposit substantial nutrient packets, produced from nutrients gleaned from foraging grounds (Bjorndal 1997, p. 212). Sea turtles thus help to maintain the sustainability of these ecosystems by providing tonnes of nutrients and large amounts of energy to coastal and island beaches annually. These nutrients contribute enormously to the promotion of plant growth that stabilizes the beachfront, protecting suitable nesting sites. However, the present number of sea turtles in Colombia and the wider LAC region is not sufficient to ensure the ecological sustainability of their ecosystems, nor the cultural or economic sustenance of local human populations that depend on them and their coastal and marine habitats.

Although archaeological records demonstrate that sea turtles have sustained indigenous populations for more that 1,000 years, the negative impacts of massive exploitation have been exacerbated by the introduction of new causes of mortality during the second

half of the twentieth century. As a consequence, the species' ability to maintain their numbers has weakened greatly (National Research Council 1990, p. 12).

Sea turtle populations are declining rapidly throughout the Wider Caribbean region. Persistent over-exploitation of adult females on the nesting beaches and the widespread collection of their eggs for commercial and industrial / artisanal purposes are largely responsible for the severely depleted status of sea turtle populations over the last 50 years (Lutcavage *et al.* 1997, p. 388). In addition to direct harvesting, sea turtles are often accidentally captured in active or abandoned fishing gear, resulting in the deaths of tens of thousands of turtles annually (Shaver and Teas 1999, pp. 152-3). Coral reef and sea grass degradation, oil spills, chemical waste, persistent plastic and other marine debris, high density beach-front development, and an increase in ocean-based tourism have gravely damaged or eliminated sea turtle nesting beaches and feeding grounds (Whiterington 1999, p. 179; Gibson and Smith 1999, pp. 184-8).

Population declines are further complicated by the fact that causal factors are not always entirely indigenous. Sea turtles are among the most migratory of all Caribbean fauna, thus declines in population are not necessarily the sole consequence of local activities, but may also be due to activities carried out hundreds of Km away (Smith *et al.* 1992, p. 6) (Figure 4). Thus, future action at both local and regional levels is necessary and crucial, to ensure conservation in perpetuity.

Figure 4. Green sea turtle (*Chelonia mydas*) migratory route in the Wider Caribbean region

Souce: Caribbean Conservation Corporation. Tortuguero sea turtle Tagging Project 2001 http://www.cccturtle.org/sat_zenit.htm

1.2.4 Sea turtle conservation in Colombia: a national and international policy priority

Today, six of the seven species of sea turtles that occur in the LAC region are listed in Appendix I of the Convention on International Trade in Endangered Species (CITES), and will become extinct unless causation and process are halted on reverse (Pritchard 1997, p. 16). The Flatback (*Natator depressus*) turtle endemic to the Australian Great

Barrier Reef is the exception. All six species are also listed as critically endangered or vulnerable on the IUCN (World Conservation Union) Red List (IUCN 1995, p. 1). The only species that currently appears to be increasing in numbers on a global basis is the Kemp's ridley turtle (*Lepidochelys kempii*), whose geographical distribution is confined to the Gulf of Mexico (Márquez *et al.* 1996 cited in Godfrey 1997, pp. 17-8). Despite the recent modest improvement in the Kemp's population, it is still far below the population size needed for the recovery of sea turtle species (Ross 1996 cited in Pritchard 1997, pp. 14-7).

The SPAW Protocol (1990)[2] under the Cartagena Convention (1983)[3], recently come into force in June 2000, when it was formally ratified by 9 of the 13 signatory countries, providing a regional framework for the protection of species of wild fauna and flora, and the habitats on which they depend. Under Article 10 of the SPAW Protocol the Colombian government is committed to individually or jointly carrying out recovery, management and planning to promote the survival of endangered or threatened species, and to regulate or prohibit activities having adverse effects on endangered species or their habitats. Article 11 of the SPAW Protocol declares that each signatory party shall provide total protection and recovery to the species of fauna listed in Annex II of the document. Under the SPAW Protocol, each signatory party shall ensure total protection and recovery of the species by prohibiting to the extent possible, 1) the taking and killing of listed species products and 2) the disturbance of such species, particularly during periods of breeding, incubation, aestivation, or migration, as well as other periods of biological stress (Caribbean Environment Program 1990). All four species of

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[2] Specially Protected Areas and Wildlife (SPAW) Protocol of the Cartagena Convention - signed in Kingston, Jamaica in 1990, recently came into force in **June 2000**.

[3] The Convention for the Protection and Development of the Marine Environment in the Wider Caribbean Basin, signed in Cartagena de Indias, Colombia, 1983, is the only legally binding environmental treaty for the Wider Caribbean region

sea turtles occurring in Colombian Caribbean waters are included in Annex II of the SPAW Protocol.

To address international commitments concerned with migratory and endangered species, such as sea turtles, and the habitats critical for their survival, the Colombian Ministry of the Environment has design a conservation strategy as part of the 'National Biodiversity Action Plan'. A priority within this conservation strategy is to pursue the recovery and conservation of endangered and vulnerable species of wildlife, with the input of all stakeholders at the national, regional and local levels (Humboldt Institute 1998, pp. 150-2). To achieve Colombia's self-proposed conservation goals, while also complying with the international conservation agenda, is not solely a matter of legislation or regulation, particularly as law enforcement is not efficient in developing countries. It is a matter of rethinking national policy by prioritising the strengthening of public participation and research-guided sea turtle conservation.

The remainder of this paper is organized into four sections, the first of which provides a physical and natural description of Colombia; defining the country biogeographically and discussing its biodiversity, protected areas, and coastal and marine zoning. The second section of the paper presents available information about sea turtle populations and conservation in Colombia. Firstly, it provides a summary of the historical distribution of sea turtles in Colombian waters and on nesting beaches, a discussion of major human-induced threats to their survival by region and subregion, and the known current status of sea turtle populations along the Caribbean and Pacific coasts. Secondly, it delineates Colombian legislation, policies and institutional framework for sea turtle conservation. And finally, based on the above discussions and data, this

section identifies and prioritises the limitations and constraints facing sea turtle conservation in Colombia today.

The paper prioritises research-guided management and increased public participation as the lines of action that would most impact on sea turtle populations and facilitate its policy-making and implementation processes. The third section of this paper aims to reconcile my own 15 years experience gained as a researcher and conservationist of sea turtles in Colombia and LAC with 'lessons learnt' from an analysis of biological and ecological research with wildlife management objectives. Recommendations will be developed regarding the directions of sea turtle biology and ecology research in Colombia. These recommendations will focus on the assessment of nesting and feeding habitats, research into hatchling sex determination and population genetics.

The last section of the paper endeavours to integrate knowledge of coastal human communities and their cultures, gained by working at the grassroots level, with the results of a review of research that has successfully initiated and maintained public participation in natural resource management elsewhere in the world. The output of this effort is the development of strategies for public involvement in sea turtle research and conservation in Colombia. These strategies will address improving data gathering and management, information dissemination, community empowerment and program assessment. It is intended that these recommendations for research-guided conservation and strategies for increased public participation contribute to the construction of an integrated and collaborative sea turtle management and conservation plan for Colombia.

2 Colombia, a physical and natural description

Colombia is located in the northwestern corner of South America (Figure 5). Its continental territory extends from latitude 12°90'40" N, at Punta Gallinas in the Department of La Guajira, to latitude 4°13'30" S, at the junction of the San Antonio River and the Amazon River, in the Department of the Amazonas. Longitudinally, Colombia extends from 66°50'40" E, at the Cocuy rock in the Department of Guainía, to 70°01'23" W, at Punta Manglares in the Department of Nariño.

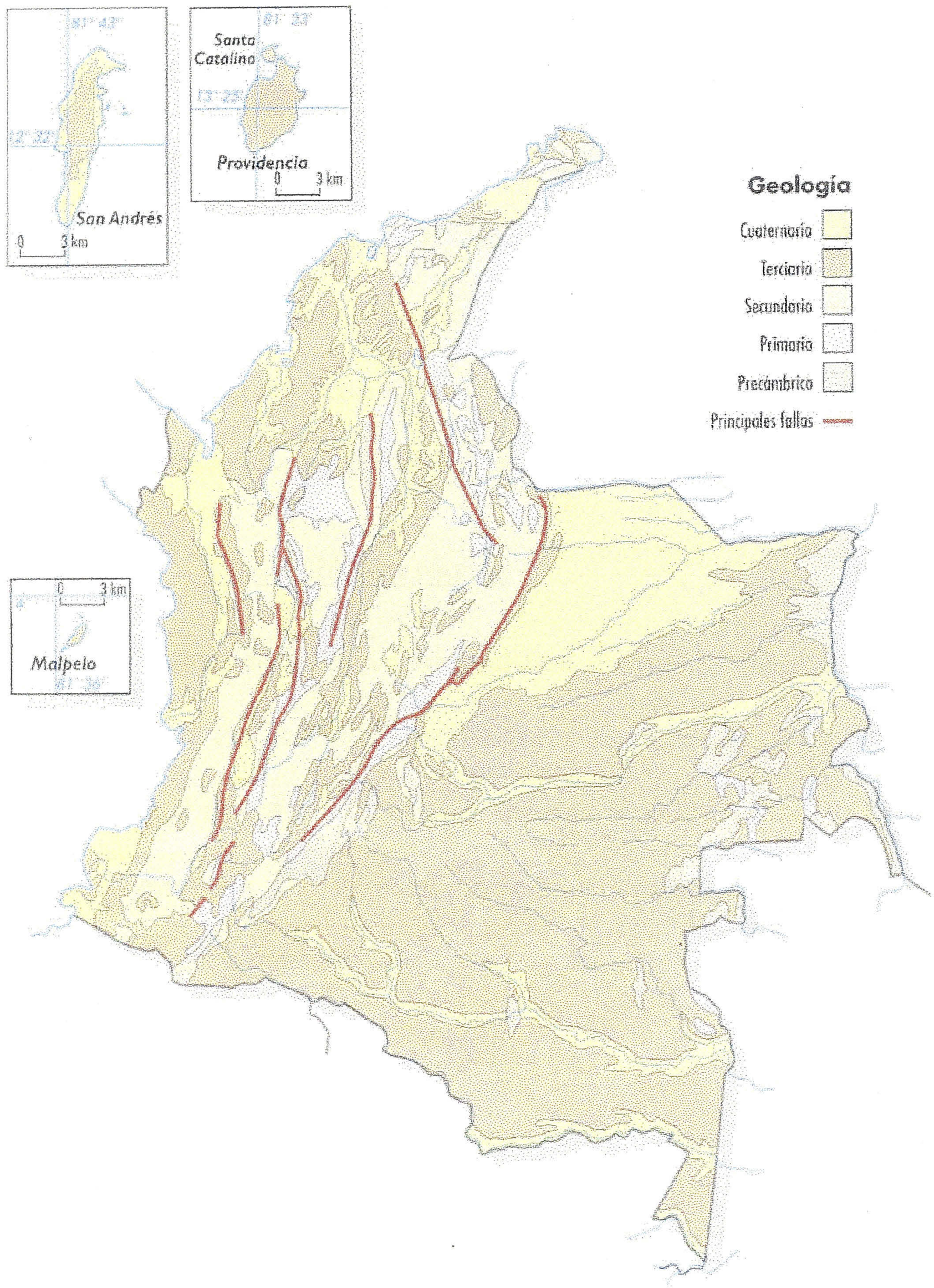
The total area of Colombia is equivalent to 0.77 percent of the world's total land – a surface of 114 million ha, that includes the Archipelago of San Andres and Old Providence in the Caribbean Sea. Other islands in the Caribbean continental shield are the coastal islands of Cartagena: Baru, Tierrabomba, and the Archipelagos of Rosario and San Bernardo. In the Pacific Ocean, Malpelo and the Gorgona and Gorgonilla islands lie near the continental shield. The terrestrial boundaries of Colombia are: in the east and northeast with Venezuela (borders 2,219 Km), in the east and southeast with Brazil (1,645 Km.), with Peru in the south (1,629 Km.), with Ecuador in the southeast (568 Km.), and in the northeast with Panama (266 Km.) (Humboldt 2001, p. 1/1)

Colombia's 'imaginary backbone' is the northern Andes mountain chain, which effectively separates the country's eastern lowland regions from the Pacific coastal lowlands in the west, and the Caribbean littoral in the northwest. A short distance from the Ecuadorian border, the Andes branch into three *cordilleras*, or ranges, running roughly parallel north-south. The Cordillera Occidental (the western Andean range) and the Cordillera Oriental (the eastern Andean range), are separated by the Cordillera Central, and by the Cauca and Magdalena river valleys, respectively (IGAC, 2001, p. 1/2) (Figure 6.).

Figure 5. Location of Colombia in South America

Source: Encarta Encyclopaedia 2000.The Americas in the Globe Microsoft

Figure 6. Colombian geomorphology



Source: Colombian Institute of Hydrology and Meteorology (IDEAM) 2002. Colombian Geographic and Morphological Patterns, http://www.ideam.gov.co/atlas/mgeomorf.htm.

1.1 The Colombian biogeographic regions

Colombia is of great geographical contrast and different ecosystems, characterized by species richness and endemism of flora and fauna. A total extension of 114 million ha – 53.2 million ha are covered with forest; 21.6 million ha with other types of vegetation, including savannahs, deserts and wetlands; 1.10 million ha represent continental waters,

snow capes and rural settlements, and some 38.4 million ha are used for agriculture and land colonization (Humboldt Institute 1998, p. 18). The Andean ranges create natural divisions of the Colombian territory into five biogeographic regions: the Andean region itself; the Pacific lowlands; the Caribbean coastal plain and the island territories (Archipelago of San Andres and Old Providence); the Eastern Llanos or plains; and the Amazonian lowlands (Hernández *et al.* 1992 cited in Andrade, 1992, p. 12). The following section provides a brief description of the Colombian Caribbean and Pacific regions where sea turtles occur (Figure 7).

2.1.1 The Caribbean region

The Caribbean coastal plain lowland was formed by material that settled beyond the waters edge in the floodplains of the lower Magdalena, Cauca, Sinú, and Atrato valleys, which spread out as they approach the sea. Near the coast the plain is grassland with seasonal droughts. But its southern section, in contact with the northern spurs of the Andes, is forested marshland affected by seasonal flooding. (UNIANDES 2002, p. 1/1) (see Figure 6).

This region includes the Islas del Rosario and San Bernardo Archipelagos that lie on the continental shelf, and the oceanic Archipelago of San Andrés and Providence under the political administration of the San Andrés and Providence Department The Caribbean region also takes in the west side of the Gulf of Urabá, an area of dense jungle and high endemism, known as the Darién Gap (Friends of the Earth 2002, p. 1/1). The Colombian Darién, which is part of the Chocó province, includes coasts in both, the Caribbean and the Pacific. This ecoregion joins the Caribbean basin with the Pacific lowlands at the border with Panama (World Resources Institute 2002 p. 1/1) (Figure 7)..

2.1.2 The Pacific region

The Pacific region is the narrowest territorial area in the American continent; it connects the north-western corner of South America with southern Central America. This region encompasses the countries of Panama, Colombia and Ecuador. In Colombia, the Pacific region drains its waters to both the Caribbean and Pacific basins (Zuluaga 1998, p. 117).

Three physiographic units integrate the Pacific region: the lowlands outlined by the *Cordillera Occidental*, the Baudó *Serrania* and the coast. The sparse human occupation of this area can be attributed to the rough landscape characterized by swamps, wetlands and mountain cliffs. Settlements in this region are concentrated mainly along the rivers and the coast. The coastline differs widely from the Caribbean or Atlantic coast of Colombia, and varies widely within the region. High coasts and cliffs dominate in the north; low coasts and plains predominate in the south. Low hills between the watersheds of the San Juan and Atrato rivers separate the Caribbean and Pacific coastal plains, west of the *Cordillera Occidental*. This lowland is made up of comparatively recent alluvial soils deposited by the San Juan River and numerous streams that drain the western slopes of the *Cordillera* (Herrera *et al*. 2002, p. 1/1).

The Colombian Pacific region is one of the wettest places in the world, receiving an average of 5,000 mm per annum. The combination of high temperatures with high humidity contributes to maintaining the biological diversity of this region, also called the Chocó province (World Rainforest Movement 2001, p. 1/1) (Figure 7).

Figure 7. Colombian Caribbean and Pacific regions

Source: Colombian Marine Research Institute (INVEMAR). 2002. Jurisdictional marine areas and coastal municipalities of Colombia.
http://invemar.impsat.net.co/images/Departamentos%20Costeros.jpg

2.2 Colombian biodiversity

Colombia is the second-richest country in the world in terms of species. The first of which is Brazil, with more species in an area seven times as large as Colombia. The 'National Biodiversity Action Plan', produced by the Alexander von Humboldt Biology

Research Institute (1998 pp. 18-23), concludes that one of every ten species of the world's flora and fauna inhabits Colombia. Flora is Colombia's largest biodiversity asset containing between 45,000 and 55,000 plant species, of which approximately one third are endemic. Colombia's orchids alone, represent close to 3,500 species, 15 % of the total world orchid species.

In the same Action Plan from the Alexander von Humboldt Institute, Colombian terrestrial vertebrates occupy third place in the world, with 2,890 species, of which 1,721 are birds, a number that constitutes 20 % of the total world bird species, and 358 mammal species, which represent 7 % of the world's total mammal species. Colombia possesses 6 % of the total number of reptile species and about 10 % of the total amphibians around the world (Humboldt 1998, pp. 18-23)

Colombia is at great risk of massive extinctions, principally caused by the destruction of habitats through deforestation and pollution. With regard to animal species, the World Conservation Union (IUCN) has identified 89 mammals, 133 birds, 20 reptiles and 8 fish as threatened species with extinction (Bailillie and Groombridge 1996).

These lists prepared by the World Conservation Union (IUCN) have been used by the Alexander von Humboldt Biodiversity Biological Research Institute[4] to update the status of Colombian fauna. The evaluation of the population status of threatened species demonstrates that the number of species at risk has increased to 11.4 percent for a total of 3,278 animals including mammals, birds, reptiles and amphibians (Humboldt

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[4]Alexander von Humboldt Biological Resources Research Institute was created by Law number 99 (1993), as one of the entities for the scientific and technical support of the Ministry of the Environment. The Institute's mission is the promotion, coordination and realization of research which contributes to the conservation and sustainable use of biodiversity in Colombia

Institute 1999, pp. 1-11). In addition, Conservation International[5] considers Colombia one of the 25 environmental 'hotspots'[6] on Earth; countries of high environmental priority where conservation, restoration and sustainable management programs to counteract the detrimental effects of human activities over ecosystems and natural resources should be developed and implemented (2001 p. 1/2). So, Colombia presents high diversity indices, its biodiversity is also highly vulnerable.

2.3 Protected Areas in Colombia

To ensure, preserve and conserve the most relevant flora, fauna, ecosystems, cultural and historical specimens, of the Colombian national biodiversity is the main goal for the National Parks System. Colombia's 47 protected areas cover more than 50 million ha, which is equivalent to 48 % of the national territory. IUCN management categories from I to V account for nearly one-quarter of the areas and cover 8.5 million ha (Caribbean Environmental Program 1996, p. 4/18).

There are nine marine and coastal national parks, three wildlife sanctuaries, one parkway and one special management area on the Pacific, Caribbean and Insular regions of Colombia. Colombia's protected areas in the Caribbean region, from northeast to northwest, are: Macuira and Flamencos Fauna and Flora Sanctuaries in the Guajira Department. The Sierra Nevada National Park, Tayrona National Park and Salamanca Parkway in the Magdalena Department. The Archipelago of Islas del Rosario and San Bernardo National Park lie offshore between the Departments of Bolivar and Cordoba,

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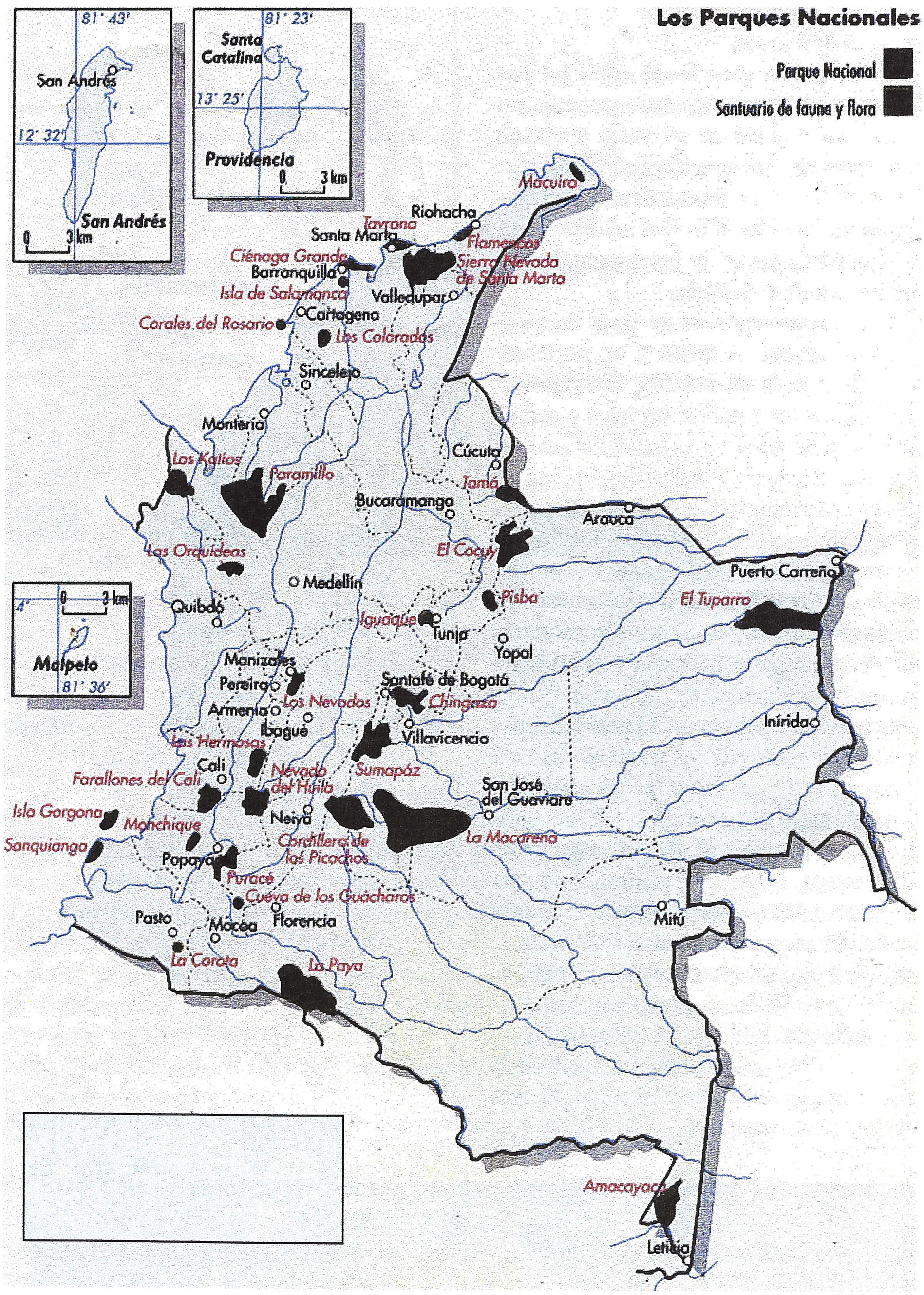
[5] Conservation International is a non-profit organization based in Washington DC, with the aim of preserving biodiversity over the world.

[6] Norman Myers conceived the Hotspot concept in 1988 as a way to designate priority areas for conservation. They are 25 Hotspots on the Earth, which are the richest and most threatened reservoirs of plant and animal life on Earth. Criteria for determining a Hotspot are endemism and degree of threat. Colombia includes two Hotspots: the Chocó-Darién Region and the Tropical Andes Mountains of South America.

and the Darién Special Management Area. In the insular Caribbean region, in the Archipelago of San Andres and Old Providence, there is the McBean Lagoon National Park. On the Pacific coast, the Utría National Park lies in the north and the Sanquianga National Park in the south. Just in front of the latter is the Gorgona Island National Park. 506 Km out to sea in a westerly direction is the Malpelo Wildlife Sanctuary (Figure 8).

Figure 8. Colombian National Protected Areas



Source: Colombian National Natural Parks Especial Administrative Unit. 2001. http://www.parquesnacionales.gov/co/areas.htm

2.4 *Colombian Coastal and Marine Zoning*

The coastal and marine zones of Colombia are natural assets with valuable ecosystems that supply environmental goods and services to human groups inhabiting both the Caribbean and Pacific littorals and islands (Pescador 2001, p. 1/1). These areas are also important in providing shelter and feeding, reproduction and nursery grounds for a large number of commercial fish and other marine species, such as sea turtles

The Biodiversity Research Program of the Colombian National Marine Research Institute, INVEMAR[7], has a mandate for the research and assessment of biodiversity found in coastal and marine zones, including protected areas. According to INVEMAR, Colombian coastal and marine zones are divided in three macro regions: the Continental Caribbean region, the Insular Caribbean region and the Continental Pacific region (Arias *et al.* 2001 p. 1/1). There are two additional regions that are concerned with Colombia's Economic Exclusive Zone: the Oceanic Caribbean region and the Oceanic Pacific region.

The three macro regions are in turn divided into eighteen 'Ecological Sectors' (ES), which are based on the coastal and oceanic characteristics of each region. Each ES is divided into 'Coastal and Marine Landscape Units' (CMLU). At present, seven ES, subdivided into eleven CMLU's, make up the Continental Caribbean region. The Insular Caribbean region comprises one ES and one CMLU, while the Pacific region is separated into nine ES, representing an equal number of CMLUs. The Oceanic

[7]Jose Benito Vives de Andreis Marine and Coastal Research Institute – INVEMAR, was created under Law 99 (1993) with the aim to carrying out basic and applied research over the marine and coastal environments of Colombia.

Caribbean and the Oceanic Pacific are each made up of one ES and one CMLU (Humboldt Institute 1998, pp. 18-22).

The Wetlands and Coastal Advisory Group[8] of the Ministry of the Environment, proposed a different zoning system for the same three macro regions in their 'National and Environmental Policy for the Sustainable Development of the Oceanic, Coastal and Insular Spaces' (2000, pp. 38-40). In this case, twelve 'Environmental Coastal and Oceanic Units' (ECOU) are defined according to landscape and ecological criteria, taking into consideration social and cultural characteristics at the local and regional levels. Five ECOUs were defined for the Continental Caribbean, one for the Insular Caribbean, and another for the Oceanic Caribbean. Four ECOUs were identified for the continental Pacific and one for the Oceanic Pacific (Colombia, Ministry of Environment 2000, pp. 3-6)

As a guide to sea turtle conservation planning, both coastal and marine zoning proposals have been integrated in one map by the Colombian Ministry of the Environment and INVEMAR (Widecast-Colombia Association 2001, pp. 6-7) (Figure 9 and Figure 10). The integration of these systems into a single framework, within which all conservation efforts exist, is necessary in order to impact positively on the threats to and decline of sea turtle populations in Colombia (Colombia, Ministry of the Environment and Widecast-Colombia Association 2001, p. 6). The following section presents the distribution of sea turtles in Colombia following this single framework for sea turtle conservation.

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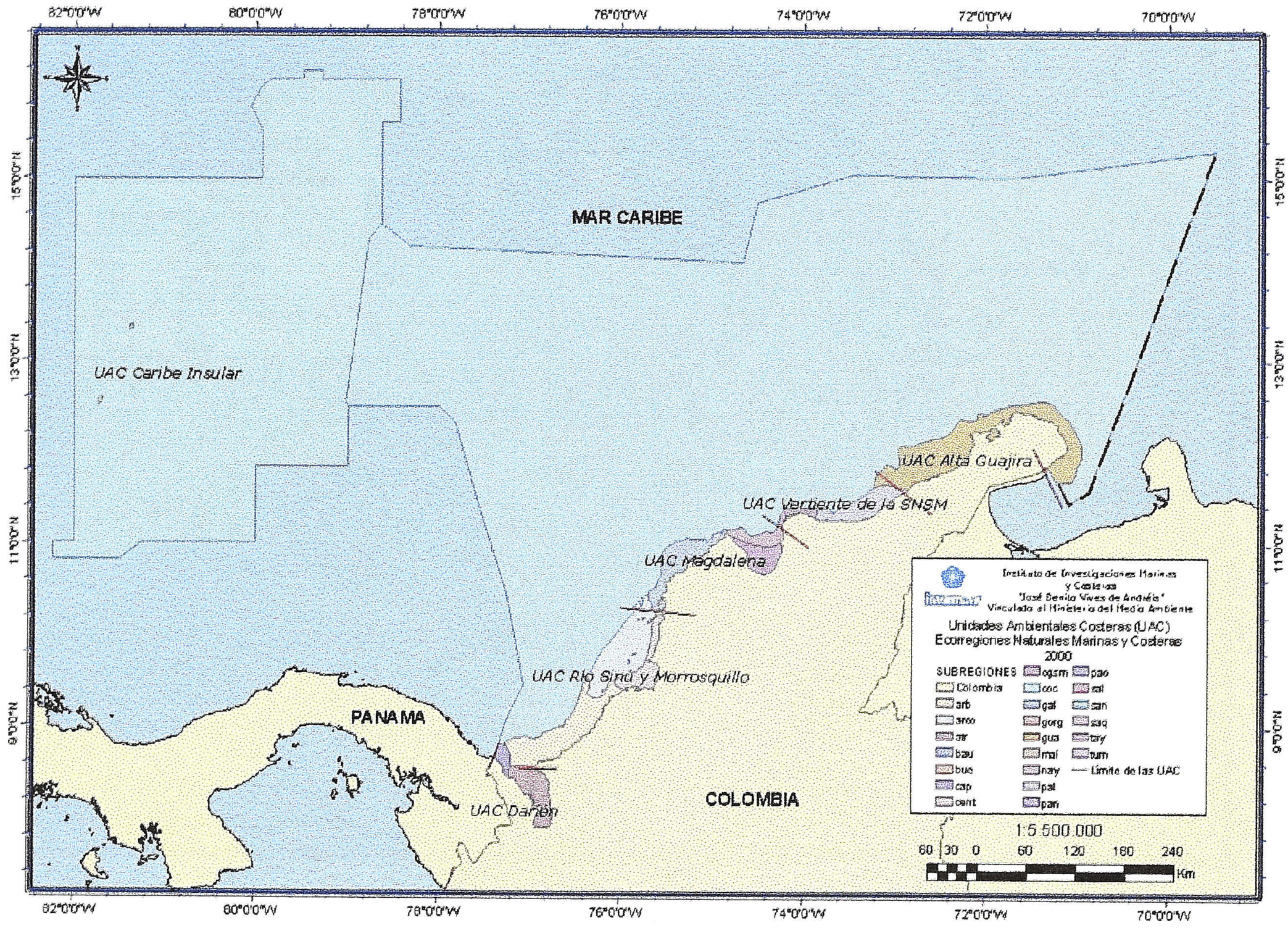
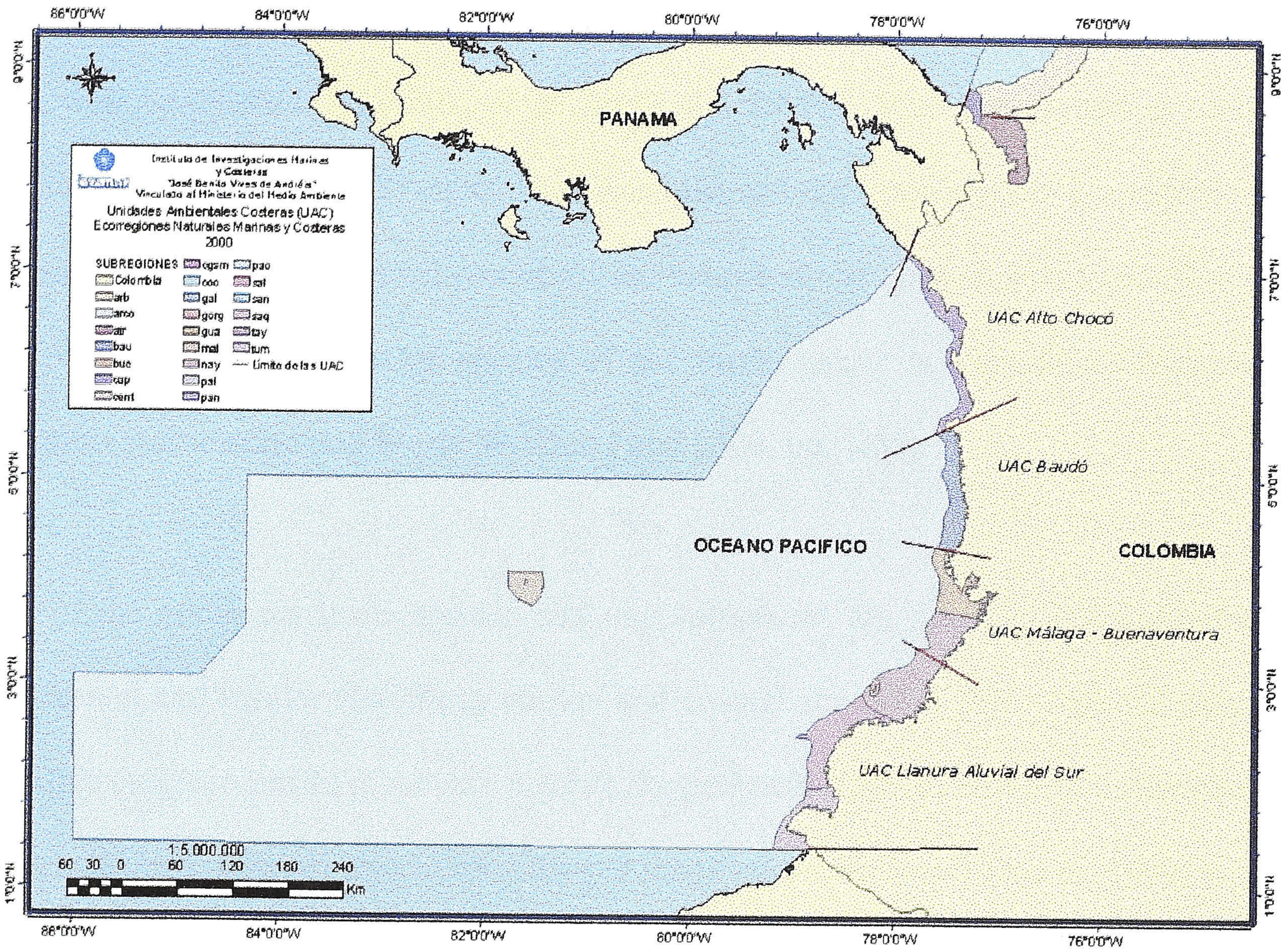
[8] The Wetlands and Coastal Advisory Group is a dependency of the General Direction of Ecosystems within the Ministry of the Environment, and produced the 'National and Environmental Policy for the Sustainable Development of the Oceanic, Coastal and Insular spaces' - December 2000.

Figure 9. Colombian Caribbean zoning



Source: Colombian Marine Research Institute (INVEMAR). 2000. Colombian Caribbean Ecoregions (ECOUs). http://invemar.impsat.net.co/images/ecorregiones1_caribe.jpg

Figure 10. Colombian Pacific Zoning



Source: Colombian Marine Research Institute (INVEMAR). 2000. Colombian Pacific Ecoregions (ECOUs). http://invemar.impsat.net.co/images/ecorregiones1_pacifico.jpg

3 Sea turtles in Colombia

This segment of the paper provides an insight into the distribution and major threats to sea turtles in their nesting and feeding grounds in the Caribbean and Pacific of Colombia. In order to conclude by identifying limitations and constraints facing government offices, NGOs and grassroots organizations mandated to and engaged in sea turtle conservation, this section discusses issues relevant to the species' current status in Colombia.

3.1 Distribution of Sea Turtles in Colombia

Colombia's shores, coastal waters and oceanic ecosystems encompass important habitats for foraging, mating, nesting and travelling sea turtles in the Caribbean and Pacific regions. With recent information and historical records available from different

governmental institutions, NGOs, universities, communities and researchers, the distribution of sea turtle species occurring in Colombia's coastal and marine zones has been well established. (Córdoba *et al.* 2000, pp. 89-99). With the exception of the flatback (*Natator depressus*) endemic to Australia and the kemp's ridley (*Lepidochelys kempii*), from which occasional recovered individuals remain insufficient to confirm its real presence, all other extant species of sea turtles occur in Colombia (Widecast-Colombia Association and World Wildlife Fund 2000, pp. 1-38).

Five of the seven sea turtle species and one subspecies are found in the Colombian Continental and Insular Caribbean marine and coastal zones For these regions, data is available on green turtles (*Chelonia mydas*), loggerheads (*Caretta caretta*), leatherbacks (*Dermochelys coriacea*) and hawksbills (*Eretmochelys imbricata*) (Rueda 1992, p. 1; Pinzón and Saldaña 1999, pp. 76-78; p.29; Amorocho 1999, p. 6). olive ridleys (*Lepidochelys olivacea*), locally called *caguama*, hawksbills (*Eretmochelys imbricata*), leatherbacks (*Dermochelys coriacea*) and Pacific green turtles (*Chelonia mydas agassizii*) are the species reported for the Colombian Pacific (Amorocho *et al.* 1992, pp. 173-5; Amorocho 1993a, pp. 1-5). Table 1. provides a summary of the distribution of sea turtles in Colombian waters and on Colombian beaches and Table 2. summarizes sea turtle distribution in coastal and maritime national parks. The information presented is not complete and needs to be reviewed under accurate nesting and feeding grounds surveys.

Table 1. Distribution of sea turtles in Colombia

INVEMAR Ecological Sectors (ES)	Ministry of the Environment Environmental Coastal and Oceanic Units (ECOU)		Foraging density	Nesting density	Migratory routes
San Andrés (SAN)	Insular Caribbean: San Andres & Old Providence Archipelago, Marine and oceanic territories	*Caretta caretta* *Eretmochelys imbricata* *Chelonia mydas* *(Dermochelys coriacea)*	No evidence Evidence-Low Evidence-Low	Evidence-High Evidence-High Evidence-Low	No reliable data available (Personal communications from local villagers and divers)
Guajira (GUA)	Upper Guajira: from the border with Venezuela to Rancheria River in the Department of La Guajira	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	Evidence-Low Evidence-Low No evidence Evidence-Low	Evidence-Low Evidence-Low No evidence No evidence	Evidence-High No evidence No evidence No evidence
CMLU – Rancheria River to Piedras River (PAL) Tayrona National Park area (TAY)	Northern coastal slope of the Sierra Nevada de Santa Marta National Park: from Rancheria River to Cordoba River in the Magdalena Department	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	No evidence Evidence-Low No evidence No evidence	Evidence-Low Evidence-Med Evidence-Low Evidence-Low	No evidence No evidence No evidence No evidence
CMLU – Salamanca (SAL) Galerazamba (GAL)	Magdalena River Wetlands: the Ciénaga Grande of Santa Marta and the El Dique channel system, from Cordoba River to the channel delta in the Bolivar state, includes the Islas del Rosario archipelago.	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	No evidence No evidence No evidence No evidence	No evidence Evidence-Low Evidence-Low Evidence-Low	No evidence No evidence No evidence No evidence
CENT – Tierra Bomba, Sinú River: CMLUs – Punta Barú to Sinú River Tierra Bomba to Bajo Bushner Sinú River to Punta Arenas	Sinú River estuary and Gulf of Morrosquillo: from El Dique Channel Delta to Punta Caribaná in the Department of Antioquia, includes the Archipelago of San Bernardo.	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	No evidence Evidence-Low No evidence Low evidence	No evidence Evidence-Low No evidence Low evidence	No evidence Evidence-Low No evidence No evidence

INVEMAR Ecological Sectors (ES)	Ministry of the Environment Environmental Coastal and Oceanic Units (ECOU)	Distribution of species	Foraging density	Nesting density	Migratory routes
CENT – Sinú River, Cabo Tiburón CMLUs – Punta Arenas-Acandi Acandí-Sapzurro Gulf of Urabá	Darién region: from Punta Caribaná to Cabo Tiburón along the border with Panama in the Chocó state	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	No evidence No evidence No evidence No evidence	No evidence Evidence-Med No evidence Evidence-High	No evidence Evidence-Med No evidence Evidence-Low
Open Ocean (COC)	Oceanic Caribbean: oceanic and marine Colombian territories	*Chelonia mydas* *Eretmochelys imbricata* *Caretta caretta* *Dermochelys coriacea.*	No evidence No evidence No evidence No evidence	No evidence No evidence No evidence No evidence	No evidence No evidence No evidence No evidence
North Pacific (PAN)	Upper Chocó: from the border with Panama to Cabo Corrientes in the Chocó State	*Lepidochelys olivacea* *Chelonia mydas agassizii* *Eretmochelys imbricata* *Dermochelys coriacea.*	No evidence No evidence Evidence-Low No evidence	Evidence-High No evidence Evidence-Low Evidence-Low	Evidence-Low Evidence-High No evidence No evidence
South Pacific (BAU): from the Baudó River to Docampadó River	Baudó Riverline: from Cabo Corrientes to the San Juan River Delta	*Lepidochelys olivacea* *Chelonia mydas agassizii* *Eretmochelys imbricata* *Dermochelys coriacea.*	Evidence-Low No evidence No evidence No evidence	Evidence-Med No evidence No evidence No evidence	Evidence-Low No evidence No evidence No evidence
South Pacific (BUE – Malaga Bay to Buenaventura): from San Juan River to Raposo River	Malaga - Buenaventura system: includes the San Juan del Micay River in the Department of Cauca	Non available data	Non available data	Non available data	Non available data

INVEMAR Ecological Sectors (ES)	Ministry of the Environment Environmental Coastal and Oceanic Units (ECOU)	Distribution of species	Foraging density	Nesting density	Migratory routes
South Pacific Naya (NAY): from Raposo River to Guapi River. Sanquianga (SAQ): from Sanquianga River to Isla del Morro Tumaco (TUM): from Isla del Morro to the coastal border with Ecuador Gorgona National Park (GOR)	Southern river plains: from San Juan del Micay River to Mataje River in the border with Ecuador in the Nariño state. Include the Islands of Gorgona and Gorgonilla	*Lepidochelys olivacea* *Chelonia mydas agassizii* *Eretmochelys imbricata* *Dermochelys coriacea.*	Evidence-Low Evidence-Med Evidence low No evidence	Evidence-High No evidence Evidence low Evidence-Low	Evidence-Low Evidence-High No evidence No evidence
Isla Malpelo (MAL) Open Ocean (PAO)	Oceanic Pacific: represents all the Colombian Insular and marine territories in the Pacific Ocean	*Lepidochelys olivacea* *Chelonia mydas agassizii* *Eretmochelys imbricata* *Dermochelys coriacea.*	No evidence Evidence-Low No evidence No evidence	No evidence Evidence-Low No evidence No evidence	Evidence-Low Evidence-Low No evidence No evidence

Table 2. Distribution of sea turtles in coastal and maritime national parks of Colombia

Name of protected area	IUCN & National Management Categories		Total area (ha)	Presence of sea turtle species
Caribbean Continental Region				
Flamencos	IV	FFS (D)	7,000	*E. imbricata* *C. mydas*
Sierra Nevada de Santa Marta	II	NNP (B)	383,000	*E. imbricata* *C. mydas* *C. caretta* *D. coriacea*
Tayrona	II	NNP (B)	15,000	*E. imbricata* *C. caretta* *D. coriacea* *C. mydas*
Isla de Salamanca	II	Parkway (NA)	21,000	*E. imbricata* *C. caretta* *D. coriacea*
Corales del Rosario and San Bernardo	II	NNP (B)	19,506	*E. imbricata* *C. mydas* *C. caretta* *D. coriacea*
Darién	VI	SMA (E)	500,000	*D. coriacea* *E. imbricata*
Caribbean Insular Region				
Old Providence Mc Bean Lagoon	II	NNP (B)	995	C. mydas. a *E. imbricata*
Pacific Continental Region				
Utría	II	NNP (B)	54,300	*L. olivacea* *D.coriacea* *E. imbricata*
Sanquianga	II	NNP (B)	80,00	*L.olivacea* *D. coriacea*
Pacific Insular Region				
Gorgona	II	NNP (B)	49,200	C. mydas. a *E. imbricata*
Malpelo	IV	FFS (D)	73	*C. mydas. a*

Source: Adapted from Alexander von Humboldt Institute for Biodiversity Research 1997, categories for natural protected areas modified with basis on IUCN in: Colombian Biodiversity XXI century. pp 240-1.

3.2 Anthropogenic induced threats to the survival of sea turtle populations in Colombia

Although detailed information concerning the impact of pre-Columbian harvest and consequent trade of sea turtle meat and shells is not available, there is little doubt that pressures exerted by the European *conquistadors* on sea turtle populations in the region were indeed significant. Since this period, 500 years ago, the trade in sea turtle meat and shells has been well established in most Caribbean countries (Frazier 2000, pp. 39-40).

Sea turtle evolution has demonstrated the capability of these reptiles to overcome natural catastrophes, although they remain susceptible to high intensity human activity (Pritchard 1997, p. 4.). Threats to sea turtles are broadly defined as any factor that jeopardizes the survival of these animals or impedes the recovery of their populations. Anthropogenic induced threats have been identified as the most relevant causal factors depleting sea turtle populations worldwide (US National Marine Fisheries Service and US Fish and Wildlife Service 1998, p. 14) The decline of sea turtles in Colombia is more a consequence of human activity rather than naturally-induced (erosion, accretion, driftwood, El Nino phenomenon), amongst others; the causal factors often being common across the three marine and coastal macro regions. This section will examine the major human-induced threats to sea turtle survival in the waters and on the beaches of the Colombian Pacific and Caribbean coasts.

Centuries of unregulated harvesting of sea turtle eggs, meat and shells have severely depleted the populations in nesting and feeding grounds from the Caribbean and Pacific regions. Poaching and hunting have direct adverse effects on the size of species'

populations, particularly in their nesting and feeding grounds, but these are just some of the reasons for the decline of sea turtles in Colombia. Pollution, land clearing, use of agro-chemicals, waste disposal, plastic debris, thermoelectric plants, dams, beach construction, tourism and commercial trawling are among other anthropogenic induced factors threatening sea turtles in this country (Rueda *et al.* 1992, pp. 1-2; Amorocho *et al* 1992, pp. 171-4; Amorocho 1993b, p. 8; Amorocho *et al.* 1999b, pp. 6-7; Lopez *et al.* 1998, pp. 29-30; Pinzón 1999, p. 73; Madaune 1999, p. 69)

At the same time, more than 50 years of undeclared civil war in Colombia have catastrophically eroded the social capital of indigenous and Afro-Colombian coastal communities (World Bank 1999, pp. 1-18). Individualism, mistrust, lack of property rights, and conflict over natural resources are social problems driving open access regimes along the Caribbean and Pacific coasts of Colombia (Escobar and Pedrosa 1996, p. 13-4). Poverty, high levels of impunity from policing and a lack of education and employment in local coastal communities are a few of the social and economic problems that exacerbate threats to natural resources in Colombia (Parra 2000,p. 81). These issues are steadily worsening, due to a lack of good planning and inadequate policies implemented by regional and local governments (Pedrosa 1996, pp. 65-76). The paper now explores the major human-induced threats to the survival of sea turtles in each of the coastal and marine regions of Colombia.

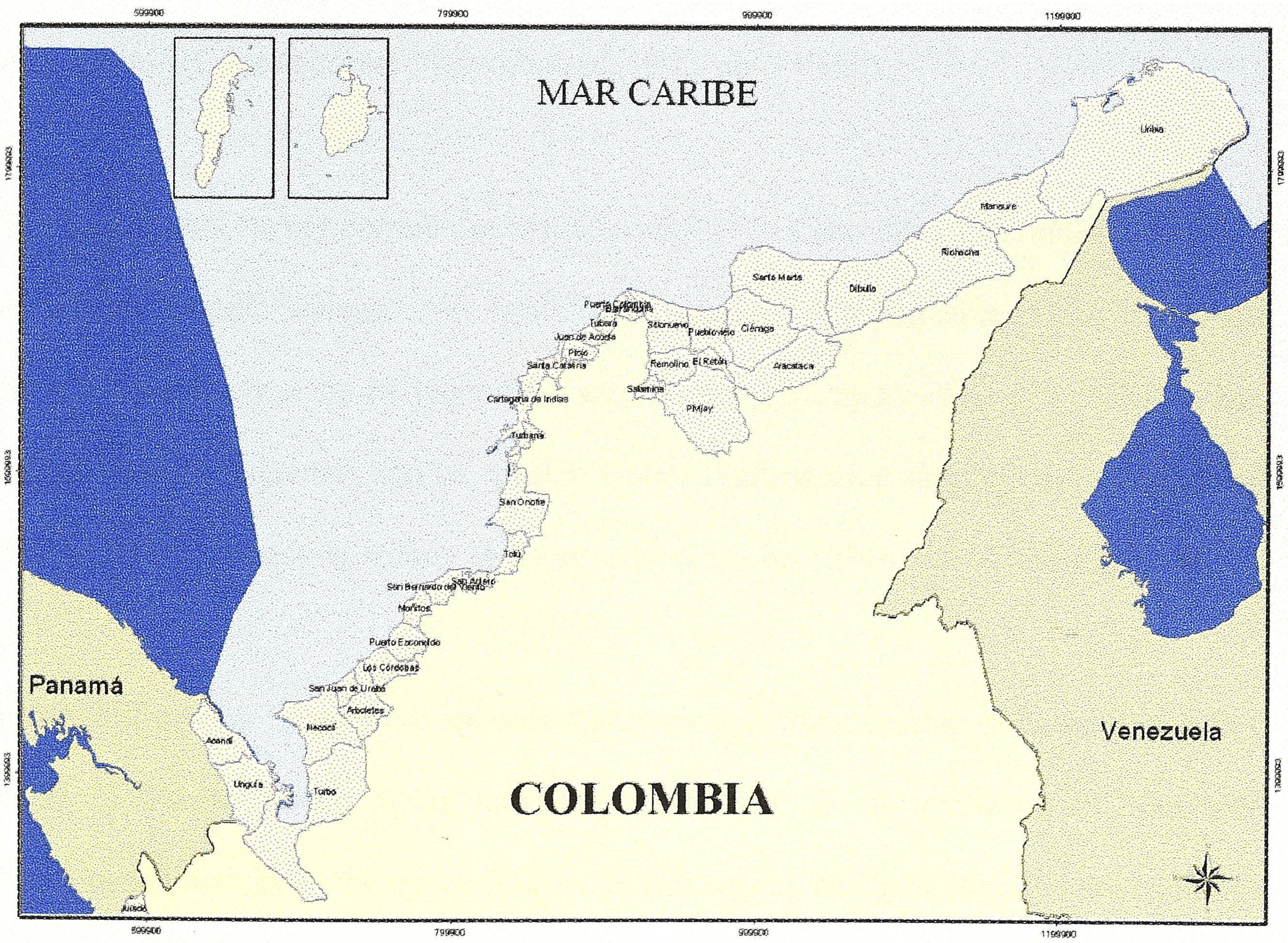
3.2.1 The Continental Caribbean region

The Colombian Caribbean coast extends over 1,600 Km from the desert of La Guajira in the east, bordering Venezuela, to the dense jungles of Darién, in the west, bordering Panama. This region includes, from northeast to northwest, the Departments of La

Guajira, Magdalena, Atlántico, Bolivar, Sucre, Cordoba, Antioquia and Chocó (Figure 11).

To better explain the risk imposed by anthropogenic induced activities, the Caribbean region is considered in four sections: the Guajira peninsula, the Central Caribbean coast, the Darién Gap and the insular San Andres and Old Providence archipelago.

Figure 11. Political division of the Continental and Insular Colombian Caribbean



Source: Colombian Marine Research Institute (INVEMAR). 2000. Caribbean (Atlantic) coastal municipalities http://invemar.impsat.net.co/images/Municipios%20Costa%20Atlantica.jpg

3.2.1.1. *The Guajira peninsula*

The Guajira peninsula is the most north-eastern Department in the country and is the land of the indigenous Wayuú people[9], the traditional inhabitants of this desert, shared by Colombia and Venezuela. In this desert region, sea turtles are captured in long nets made by fishermen of Musiche, Carrizal, Murujuy and other localities near El Cabo de La Vela, also known as the upper Guajira (Amorocho 1994b, pp. 1- 8). A rough estimate of the number of sea turtles captured on the peninsula annually is 5,000 green turtles (*Chelonia mydas*), 1,000 hawksbills (*Eretmochelys imbricata*) and 100 loggerheads (C*aretta caretta)* (Rueda *et al.* 1992, pp. 149-50).

The most recent survey carried out in the locality of El Cabo de la Vela indicates that 87 indigenous people operate 365 turtle nets annually (Corpoguajira 1997, pp. 1-4). Nonetheless, the nesting activity of this species along the upper coast of La Guajira has been poorly documented, and no specific body of information supports the existence of a well-developed nesting colony in the zone (Amorocho 1994b, p. 10) (see Figure 7).

Hawksbill nesting females are sporadically harvested while nesting on isolated beaches close to Puerto Lodo, again indicating that there is no evidence of intensive reproductive activity in the upper Guajira. In this region, hawksbill females are captured in turtle nets, although it is not known if they are migrating or permanent residents of the upper Guajira peninsula (Amorocho 1994b, pp. 11-5).

Loggerheads (*Caretta caretta*) and leatherbacks (*Dermochelys coriacea*) are

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[9] Wayuú means 'people of the desert'. Divided into 22 clans, they are widespread, dispersed across the peninsula. This group does not recognize the frontiers between Colombia and Venezuela, and move from one country to another with livestock and merchandise according to their traditions. They have classified themselves into two groups: ranchers and fishermen.

occasionally trapped in the nets of the Wayuú. However, in the majority of the cases, they are accidentally captured by shrimp trawlers fishing over the oceanic platform and close to coast in the upper Guajira. The captains and crew from the vessels sell the stranded animals, or give them away to people in the area near to El Cabo de la Vela.

Twenty years ago, in the lower Guajira peninsula, small numbers of leatherbacks (*Dermochelys coriacea*) and hawksbills (*Eretmochelys*) laid their eggs on the beaches between the towns of Camarones and Dibulla (Rivadeneira, V, local villager, 2001, pers. comm., July 2001). However, high numbers of green turtles (*Chelonia mydas*) used to occur near the town of Camarones, on the Caricari and El Ahumado beaches. Females were hunted by divers or trapped in the turtle nets of the Wayuú when leaving or approaching the nesting beaches. Today, these practices continue and sea turtle populations continue to decline despite their already very low numbers (Gutierrez and Merizalde 2001, pp. 15-6).

Arguably, the more important sea turtle nesting grounds in the lower Guajira are the beaches between Muchachitos and the village of Palomino on the border with the Magdalena department. Loggerheads are the principle nesting species, followed by hawksbill, green and leatherback turtles. Egg poaching and female hunting persist in this area, but perhaps the major threat is habitat degradation, rather than overexploitation. Beaches in this area are being naturally eroded, and beach development has considerably reduced the suitable sites for nesting activities. Sand removal, plastic rubbish, pesticides used by the regional banana industry, a thermoelectric power station and artificial lighting have further reduced the quality and

capacity of the remaining reproductive shores in Palomino (Amorocho *et al.* 1999b, pp. 6-7).

Green, hawksbill, leatherback and occasionally loggerhead adults are, in that order, the most highly prized species for the *camiones tortugueros* (turtle trucks) that operate in the Guajira department (Amorocho 1994b, pp. 16-20). These merchants dealing in illegal trade travel along the coasts and across the desert searching for turtles to buy from the Wayuú fishermen. The sea turtles are sold to restaurants and slaughterhouses in Uribia, Maicao and the department capital city, Riohacha, where street sale of meat is quite common, though illegal (Figure 12)

Figure 12. Turtle trucks in the upper Guajira

Photo: Diego Amorocho.1994

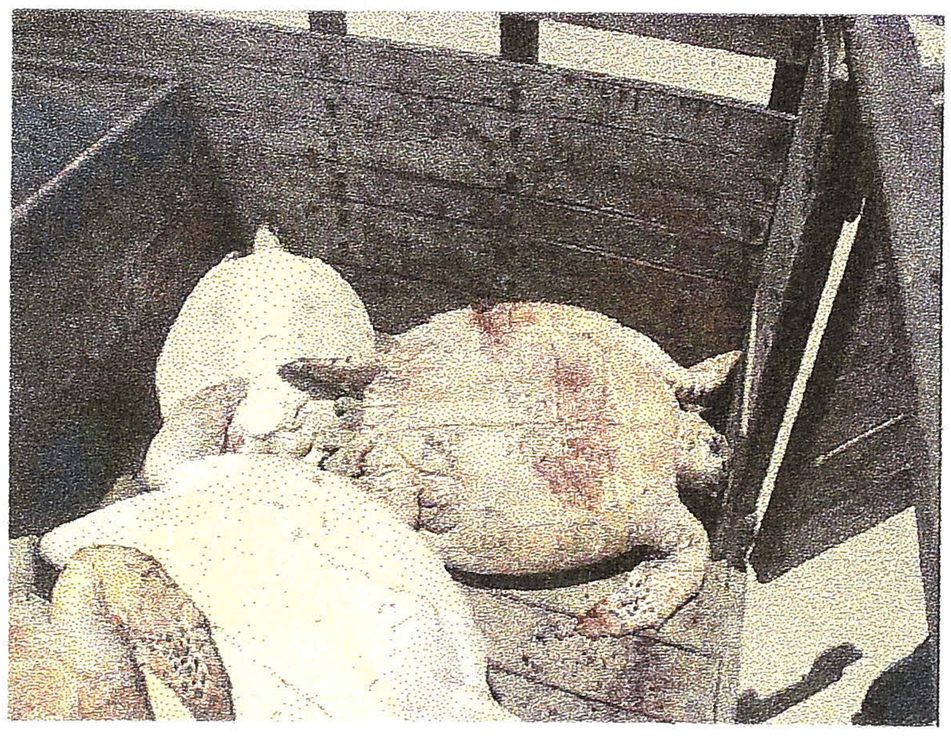

Photo: Diego Amorocho.1994

In local markets, the price for an adult green turtle can fluctuate between US $100 and US $200, depending on the size of the animal. Hawksbill turtles are the most expensive, not only because of the sweet taste of the meat, but also due to the high demand and consequent high price of the 'tortoise shell' carapace on the black market, approximately US $400 per shell. Eggs are not commonly observed on the beaches of La Guajira; any nests laid in the vicinity of Puerto Estrella, Chimare and Puerto Lodo are poached by the Wayuú for domestic consumption. Hawksbill juveniles, foraging

near the shore in their developmental habitats, are also harvested for protein (Amorocho 1994, p. 18-20).

3.2.1.2. The Central Caribbean coast

The most populated and developed urban centres along the Caribbean coast of Colombia are along the shores of the Magdalena, Atlántico and Bolivar departments (see Figure 7). Here are also the beaches, particularly in Magdalena, that have traditionally been nesting areas for loggerheads (*Caretta caretta*), leatherbacks (*Dermochelys coriacea*), hawksbills (*Eretmochelys imbricata*) and greens (*Chelonia mydas*).

Between the localities of Buritaca and Don Diego, 400-600 female loggerheads used to nest in the early 1970s (Kaufmann 1971, pp. 1-14). In the late 1980s, Munoz *et al.* (1989, pp. 9-11) reported only eight loggerhead turtle nests in the same area, calling for urgent measures to protect the species in the area. Over the last two-decades, overexploitation of females and egg poaching have severely depleted the species along the coasts of the Department of Magdalena.

Today, on the beaches of Palomino, Don Diego, Buritaca, Guachaca and Mendihuaca, no more than four loggerhead females are currently nesting between March and November (Amorocho and Pinzón 2000b, p. 9; Marrugo and Vasquez, 2001, pp. 6-10). The reduction in the number of individuals has also affected leatherbacks, hawksbills and greens occurring along the shores of the Sierra Nevada (Widecast-Colombia Association 2001, p. 9; Sánchez 2001, p.17) and Salamanca National Parks (Gutierrez and Merizalde 2001, p. 16).

Although egg and meat consumption are partially responsible for such decreases in nesting along the shores of the Magdalena Department, they are not the only causal factors making reproduction of sea turtles more difficult. Natural erosion has become a persistent problem over the last five years, and this continuous change of the morphology of the beaches has made them unsuitable for the sea turtle reproductive process (Amorocho *et al.* 1999b, p. 6).

The TERMOGUAJIRA power station located in Mingueo (La Guajira Department) is generating high levels of noise, light pollution and impacting on nesting and feeding grounds by discharging hot effluent directly into the sea. Sand mining for construction, beach protective structures, rubbish dumping, artificial lighting and vehicular traffic are some other negative impacts of human presence and occupation on the nesting areas of this region (Pinzón *et al.* 1996, pp. 1-74)

The rapid development and human occupation of former wildlife habitats combined with uncontrolled urban growth outwards from Santa Marta, Barranquilla, and Cartagena is putting increasing pressure on sea turtle habitats. Beachfront development, as a consequence of the demand for housing and profit maximization of the tourism industry, are two additional elements responsible for the loss of natural shores, sea grass beds and coral reefs that sustain sea turtle nesting and feeding populations.

In the case of the archipelagos of Islas del Rosario and San Bernardo, natural resources are being degraded and overpopulation is skyrocketing to worrying environmental proportions Tourist resorts and luxurious, celebrity beach houses are constructed

alongside small afro-Colombian and mestizo subsistence farms on the limited land in the archipelagos of Islas del Rosario and San Bernardo islands. As a consequence of the overpopulation of these islands marine resources are becoming progressively scarcer, and the health of the coral reef is at risk. Inadequate waste disposal, chemical and oil spills are also contributing to the collapse of the whole ecosystem (Amorocho and Pinzón, 2000b, p. 11).

Despite the critical ecological conditions of the threatened ecosystems in the Corales del Rosario and San Bernardo National Park, it is still possible to observe hawksbills (*Eretmochelys imbricata*) feeding on the coral reefs. Nesting females of the same species often occur in low numbers in Rosario Island and Tesoro Island (Amorocho and Pinzón, 2000b, p. 7-8). In these two islands park officers protect the nests

However, local fishermen continue hunting an unknown number of females as they move between nesting and feeding grounds within this protected area. Eggs and meat not locally consumed are sold in the market at Barú, Cartagena (Department of Bolivar), or Barranquilla (Atlántico Department) Tortoiseshell rings, bracelets and handcrafts, oil and beauty creams are other sea turtle products commonly exhibited in stores and boutiques in the main streets of the Central Caribbean department capital cities.

3.2.1.3. The Darién region

Between the Central Caribbean and the limit with Panama is an area called the Darién Gap, a lush rainforest connecting the Caribbean with the Pacific Ocean. In Colombia, the Darién Gap extends through the Gulf of Urabá in the Caribbean Sea, and in the Pacific defines the region between the Colombian borders with Panama in the north and Ecuador in the south. The entire ecoregion is known as the Chocó Biogeographic

Province, one of the globes highest biodiversity hotspots. The principal town of this area is Acandí, located near the Colombian border with Panama, on the western side of the Gulf of Urabá. It is a municipality of the Chocó Department on its Caribbean side (see Figure 7).

Acandí has high-energy[10] beaches such as Acandí itself, La Playona, and Caleta, where hundreds of leatherback turtles (*Dermochelys coriacea*) arrive each year between March and July to reproduce. This is one of the most important nesting colonies for the species in the Wider Caribbean, and the largest on both Colombian coasts. According to Pritchard *et al.* 1983 (cited in Rueda *et al.* 1992, p. 9), the high-energy characteristics of the beaches of Acandí and La Playona make them very unstable and mobile. This is a permanent threat to nests located in the zone of the shore, close to the low tide line. It is also a problem for females to find suitable places to dig their nests and lay their eggs (Madaune 1999, p. 69).

The proximity of large rivers such as the Acandí, Tolo and Arquití rivers and the dynamics of the currents have resulted in the accumulation of large volumes of driftwood on the beaches. This is a significant obstacle to the nesting females on their way to the high zone of the beach close to the vegetation, where, under natural conditions, the nests have a much greater chance of not being flooded. Similarly, the driftwood presents an obstacle to the hatchlings on their way into the ocean for the first time (Gutierrez and Hernandez 2001, p. 2).

In addition to these natural factors, leatherbacks (*Dermochelys coriacea*) and

[10] Referred to a beach of open ocean, where strong waves impact the shore line and the beach is usually steeply sloping (Pritchard *et al* 1984)

occasionally nesting hawksbills (*Eretmochelys imbricata*) are facing other threats in the Darién region, including egg consumption by local communities and wild and domestic dogs, human occupation of the beaches and commercial fishing near the shore (Madaune 2000, p. 6).

3.2.2 The Insular Caribbean region

The situation described above for the archipelagos of Islas del Rosario and San Bernardo is similar to the situation of sea turtles in the San Andrés and Old Providence archipelago (see Figure 7). As mentioned above, sea turtles on these Caribbean islands have suffered under centuries of indiscriminate exploitation on their nesting and feeding grounds. However, yet again, information about size, age and number of the animals remains uncertain for this region. The hawksbill (*Eretmochelys imbricata*) is the favourite species hunted for the meat, eggs and especially for its tortoiseshell, which is traded in the illegal markets operating in the Wider Caribbean (Meylan 1999, p. 180). Greens (*Chelonia mydas*) and loggerheads (*Caretta caretta*) are also commonly recorded on nesting beaches, particularly in the keys of Serrana, Serranilla, Albuquerque, Bolivar and Roncador north of San Andrés Island, the most density populated island in the entire Caribbean. Leatherbacks (*Dermochelys coriacea*) are observed crossing the Archipelago waters during their migrations along the Wider Caribbean (Lopez *et al.* 1998, pp. 29-30).

It is estimated that one thousand turtles of different species are captured each year on the beaches and in the waters of the San Andrés and Old Providence archipelago (Córdoba and López 1997, pp. 112-50). In contrast with the continental Caribbean, the archipelago can be affected by tropical storms and hurricanes at certain times of the year. High tides and excessive sand deposition on beaches become a major risk for the

arrival of nesting females and the emergence of hatchlings from their nests. The strength of these natural phenomena can reduce nesting site availability and possibilities for nesting females to succeed during their reproductive season.

3.2.3 The Pacific region

The Pacific coast of Colombia is delineated by 1, 300 Km of coastline. It includes the departments of Chocó, Valle del Cauca, Cauca and Nariño (see Figure 7). The main port for the Pacific Ocean is Buenaventura, two and half hours drive over the Cordillera Occidental from Cali, the most developed city in the southwest of the country. Economic, social and cultural characteristics of the people from the Pacific region are very different from those in the Caribbean region.

The history of the tropical humid forests of this region had been shaped by the cultural interactions between Embera, Katio, and Waunana indigenous groups struggling to survive in their highly biodiverse ecosystem. The Pacific region is the Colombian part of the Chocó Biogeographic province, that includes the Darién Gap shared between Panama and Colombia, and extends south through northern Ecuador. Indigenous people were the former inhabitants of this region and they are well remembered as skilled navigators before the European Conquest. During the subsequent colonial period, Afro-Colombians displaced the native population, settling along the whole Pacific coast of Colombia after being granted freedom from slavery.

The new human group learnt from the native inhabitants; adopting and developing techniques, methods and practices that allowed them to survive in the new and hostile

environment. Afro-Colombians developed friendly relationships – *compadrazgos*[11]- with the native groups (Arocha 1996, p. 322). Through a set of social interactions, familial ties and cultural arrangements, both groups have been able to coexist in the same place by defining hunting, farming and marine territories (Pardo 1996, pp. 299-300).

Since that time, Afro-Colombians have dominated the littoral and the lowlands of the Pacific coast. Their territories are recognized through collective entitlements, a process enforced by Law 70[12] (Burke 1995, pp. 1-2). Colombia has recognized the Embera and Waunana indigenous territories in the Pacific as autonomous entities under the category of *Resguardos*[13]. This land devolution to indigenous people does not include the tenure of historically coastal territories more recently occupied by Afro-Colombians (Ulloa *et al*. p. 143-5)

Fishing, logging and agriculture have long been the main economic activities carried out by Afro-Colombians on the Pacific of Colombia. In contrast to the high diversity of flora and terrestrial fauna, low species diversity and large number of individuals per species, typify the fish diversity of the region. Fisheries and a range of local activities derived from the exploitation of marine resources are the main economic force behind

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[11] Intercultural relationships established between Chocó indigenous groups and Afro-Colombians in the Pacific region. It refers to the situation in which a person from one group takes care of the child from a person of the other group. The relationship established between the indigenous father and a black godfather is called *compadrazgo*.

[12] Law 70 recognizes black communities as an ethnic group and defines the titling of collective land rights to whole afro-Colombian communities in the Pacific coast. The law gives land rights to communities, but excludes community control over natural resources, subsoils, National Park area, zones of military importance, and urban areas.

[13]It is a form of legal land tenancy by indigenous groups. *Resguardos* are mechanisms by which the Department integrates indigenous societies into the national context. They are the government's acknowledgement of ethnicity and provide for a degree of autonomy. Spaces that often do not correspond to the real territory are required for carrying out social, economic and spiritual activities of a community (Ulloa *et al.* 1996, pp. 73-81).

development in the Pacific. Approximately 80 percent of Colombia's fish production comes from the sea and mostly from the Pacific Ocean, where 99 tonnes of sea product per annum are produced, in contrast with the 15 tonnes produced in the Caribbean each year (Humboldt Institute 1998, p. 24)

Considering that Colombian seas and coasts are half of the total country's territory, the fisheries sector has enormous opportunities to increase and develop in the Pacific. However, past and current national and regional development policies have been poorly implemented in the region, with minimal opportunities to reduce poverty, social inequity conditions and provide employment. In consequence, indigenous, Afro-Colombians and a variety of more recent immigrants, continue struggling to exist within this fragile environment, almost as they did 500 years ago.

Sea turtles have been an important and vital resource for the subsistence of local communities settled all along the Pacific coast, particularly when no fish or meat is available in the village markets. Sea turtle meat and eggs are part of the coastal Afro-Colombians diet. There is an extra high demand for the eggs and meat during the nesting season. Each year, between July and November, the beaches of the Utría National Park in the northern Pacific and Sanquianga National Park in the south, near the border with Ecuador, are visited by olive ridleys (*Lepidochelys olivacea*), the most abundant nesting species in the Colombian Pacific.

Hawksbills (*Eretmochelys imbricata*) and leatherback (*Dermochelys coriacea*) females are occasional visitors to remote and isolated beaches, while the Pacific green or black turtle *(Chelonia mydas agassizii*), a subspecies of the Atlantic green turtle, is confined

to the foraging and developmental grounds surrounding the Gorgona Island (Rueda 1988, p. 184; Sánchez and Quiroga 2000, pp. 1-11). This unconfirmed subspecies has also has been observed travelling from foraging grounds in the Ecuadorian Islands of Galapagos to nesting areas in the peninsula of Yucatán in Mexico. Meanwhile, the occurrence of 'Tortuga', a generic denomination for *Caretta caretta,* has not been established yet (Amorocho *et al.* 1992, p. 174)

There is no doubt that sea turtles are under high risk in the Pacific coast and islands (Gorgona, Gorgonilla and Malpelo), but, once again, egg poaching and female overexploitation on the nesting beaches are not the only threats sea turtles face. The shrimping and fishing industries were largely responsible for the mortality of sea turtles, particularly olive ridleys (*Lepidochelys olivacea*) and black turtles (*Chelonia mydas agassizii*) during the late 1980s. Duque-Goodman (1988, pp. 351-2) calculates that 8,321 turtles are captured each year by the Colombian fleet operating in the Pacific. The compulsory use of Turtle Excluder Devices[14] (TEDs) in response to the commercial sanctions imposed by the US government, have contributed to reducing incidental sea turtle capture in the Colombian waters. However, some vessels still avoid using TEDs or remove them because there are few official controls once out at sea. Other marine menaces like plastic debris, oil spills, chemical disposal, logging and land clearance are also severely affecting the quality of nesting beaches and feeding grounds in the Pacific of Colombia.

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[14] A Turtle Excluder Device (TED) is a fishing gear device which is inserted in an existing trawl and functions as an escape hatch to allow turtles which are caught up in a trawl net to be released, without at the same time releasing a significant amount of intended catch. A 1989 amendment to the U.S. *Endangered Species Act* requires the U.S. government to negotiate with other countries for agreements promoting the conservation of sea turtles and, in particular, mandating the use of TEDs by their fleets if they may endanger sea turtles species protected by U.S. legislation. Trade sanctions will apply to those nations that do not fulfil the compulsory use of TEDs

3.3 Current status of sea turtles in Colombia

In Colombia the depletion of sea turtles in the last three decades has been a direct consequence of the historical over-harvesting of the species by local communities and the fishing industry (Rueda *et al.* 1992, p. 1; Amorocho *et al.* 1992, pp. 155-6). In 1985, all five species of sea turtles occurring in Colombia were declared 'endangered' by the former Natural Resources Institute (INDERENA), and included in the list of reptiles under threat of extinction (Andrade *et al.* 1992, p. 37). More recently, a review of the status of sea turtles for Colombia based on the new categories proposed by IUCN in the Red Data Book (Humboldt, 1999, pp. 1-4), lists *Chelonia mydas*, *Caretta caretta*, *Dermochelys coriacea* and *Lepidochelys olivacea* as 'endangered' species and *Eretmochelys imbricata* as 'critically endangered' (Rueda 1998, p. 1/2).

Indeed, it is important to continue assessing the criteria used to establish the current status of sea turtles in Colombia, because sea turtles are slow maturing long-lived animals and changes in population size need to be evaluated over significant periods of time. At least two generations are recommended to have an accurate approximation of the population dynamics and their short and long term trends (Abreu-Grobois 2001, p. 112).

The following graphs were developed from information from governmental sources and a range of NGOs fostering sea turtle conservation in Colombia[15] (see Annex 1. for

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[15] Information used to develop the tables and graphics were provided by the Colombian Ministry of the Environment, the National Parks System Special Administrative Un t (UAESPNN), Widecast- Colombia Association, CEINER, Darien Foundation, Natura Foundation, Sea Turtle Foundation of Santa Marta, Jorge Tadeo Lozano University, Popayán University Foundation, University of Atlántico, communities of Cabo de La Vela, Palomino, Don Diego, Buritaca and Acandí, Mulatos and El Valle, on the Caribbean and Pacific coasts. The information was obtained from conference proceedings, government plans, research and conservation project reports, undergraduate thesis and personal field notes.

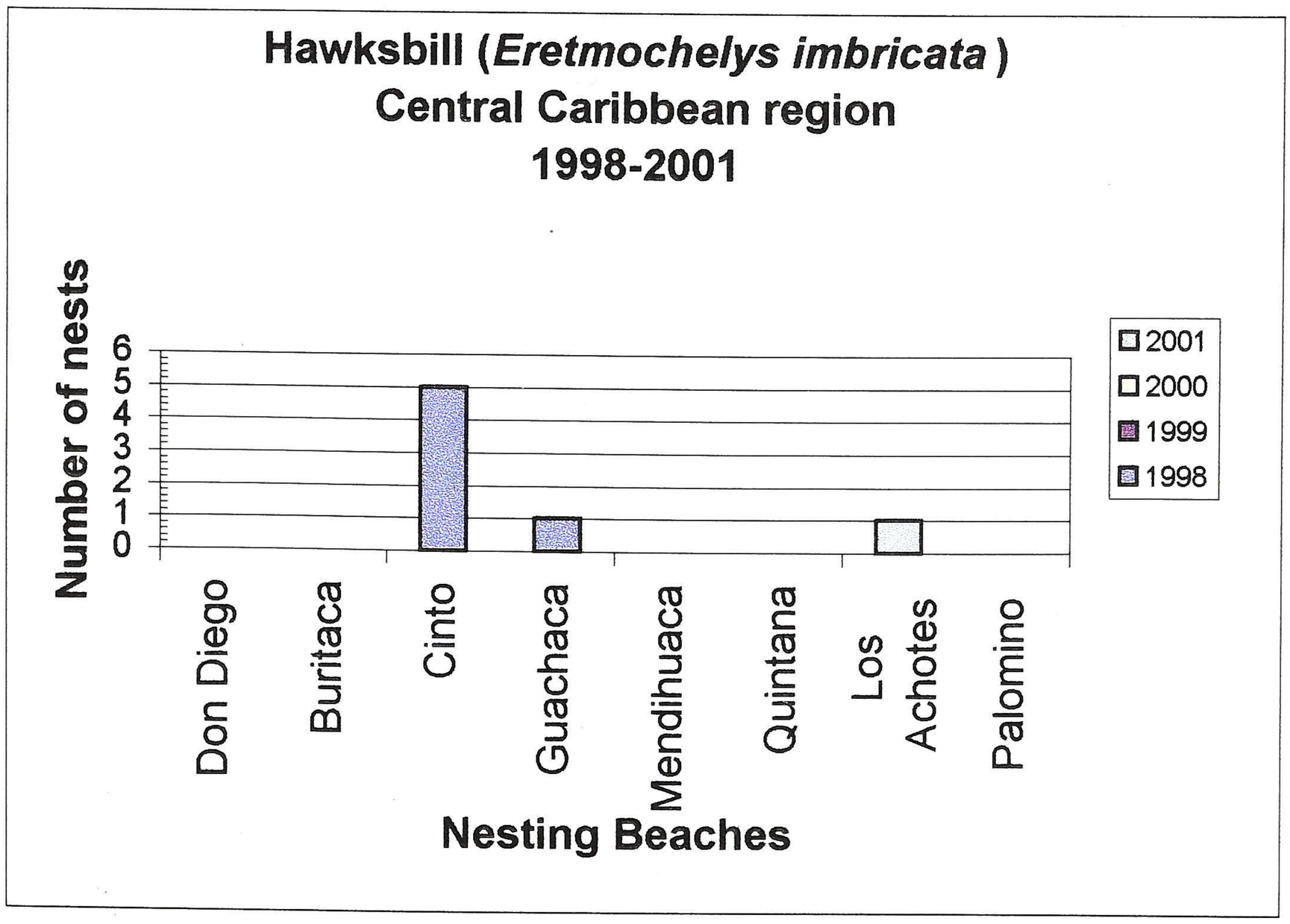
complete data). Unfortunately, the information is fragmented and at times ambiguous. However, it does provide a very good perspective on the perturbing current status of all five species of sea turtles occurring on the nesting beaches of Colombia. The graphs illustrate the nesting activities of the species occurring in each of the regions in which sea turtles have been monitored over the last eight years.

3.3.1 Central Caribbean region

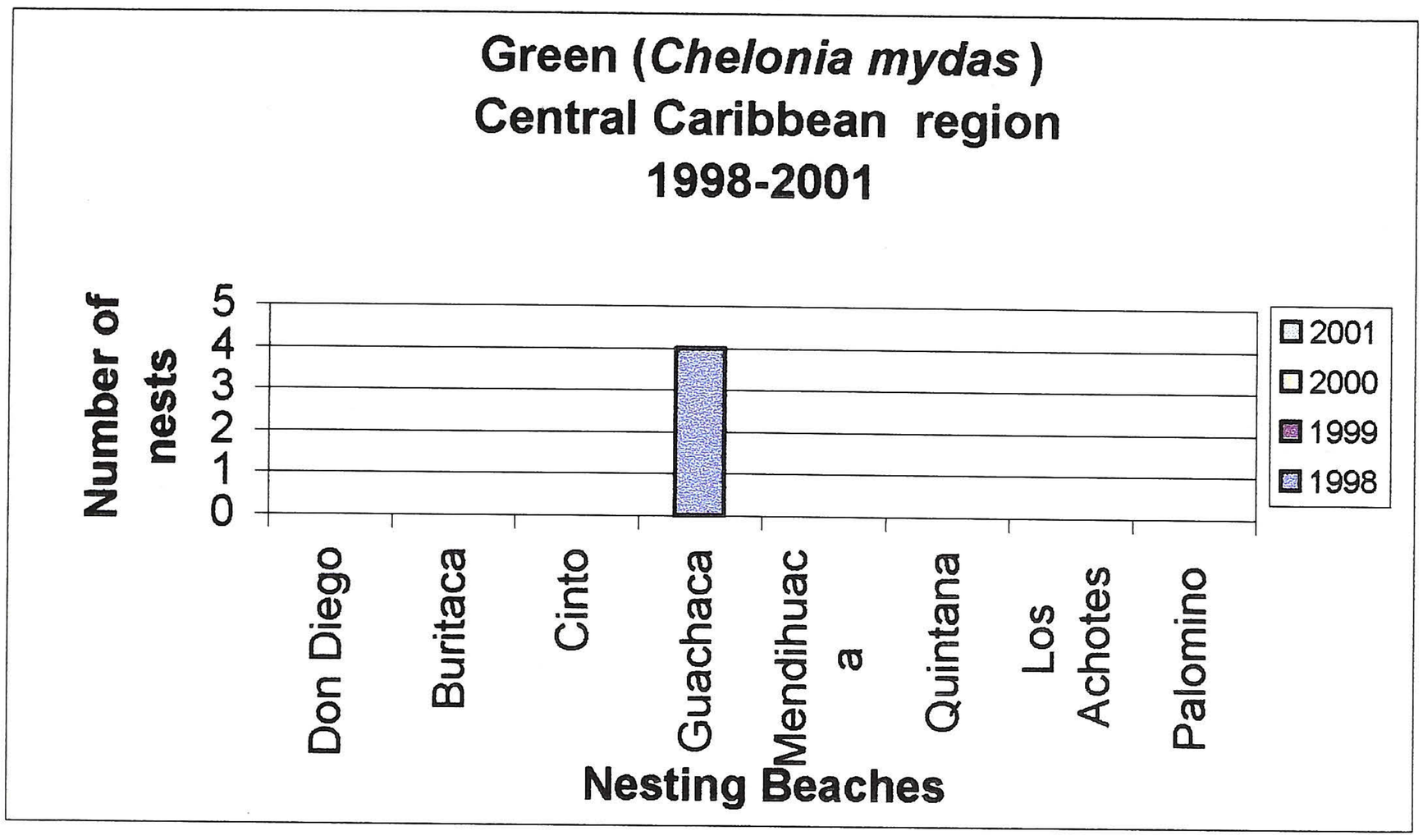
The nesting activity for *Eretmochelys imbricata, Chelonia mydas*, *Caretta caretta* and *Dermochelys coriacea* along the shores of the Central Caribbean coast between 1998 and 2001 is presented in Graphs 1-4. Graphs 5 to 8 illustrate the trends of nesting populations between 1999 and 2001 for *Chelonia mydas* and *Caretta caretta,* respectively.

Graph 9 provides information on the nesting activity of *Eretmochelys imbricata* in the Islas del Rosario and San Bernardo National Park.

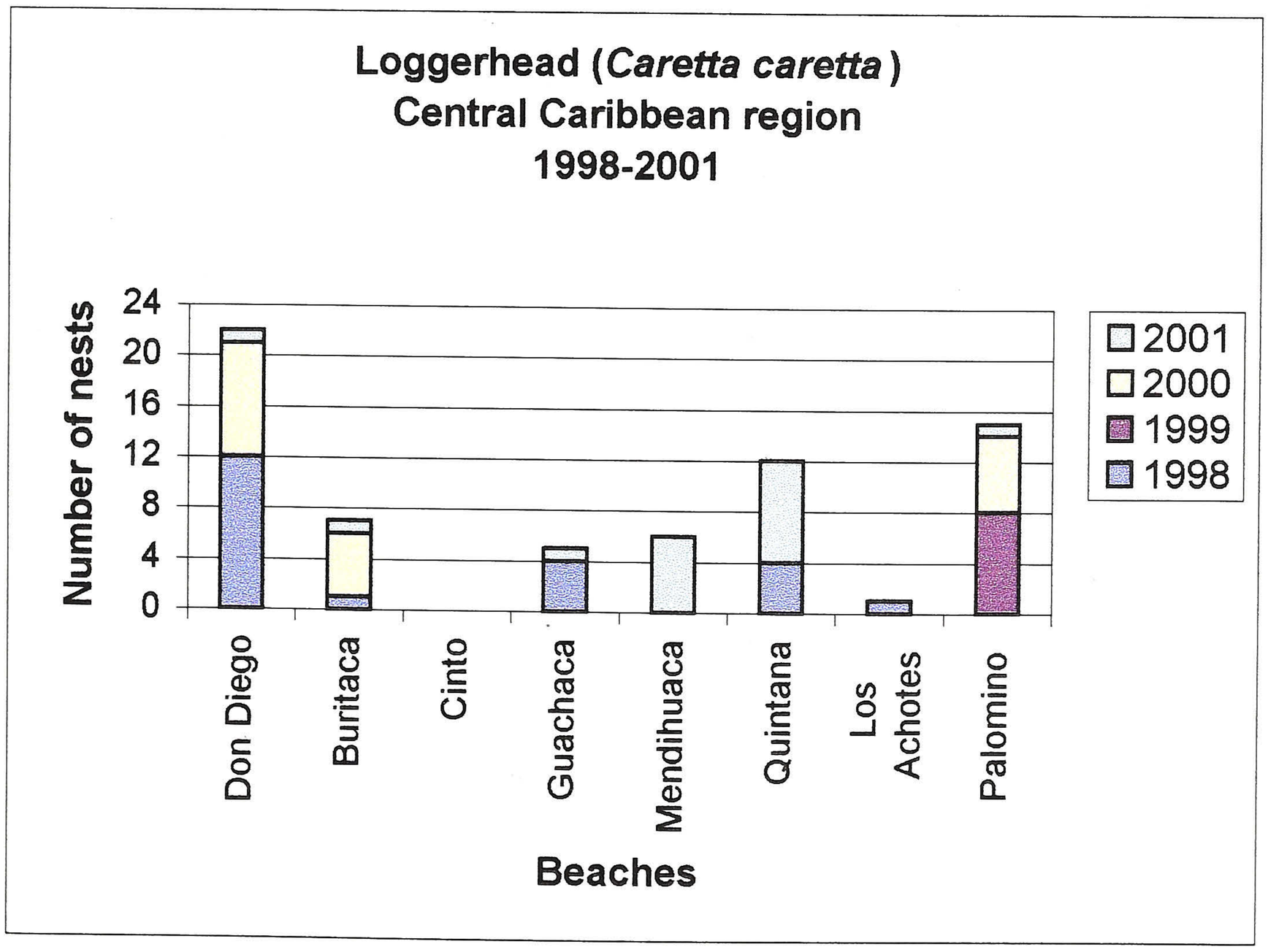
Graph 1. Nesting activities of hawksbill turtles (*Eretmochelys imbricata*) on the beaches of the Central Caribbean region (1998-2001)



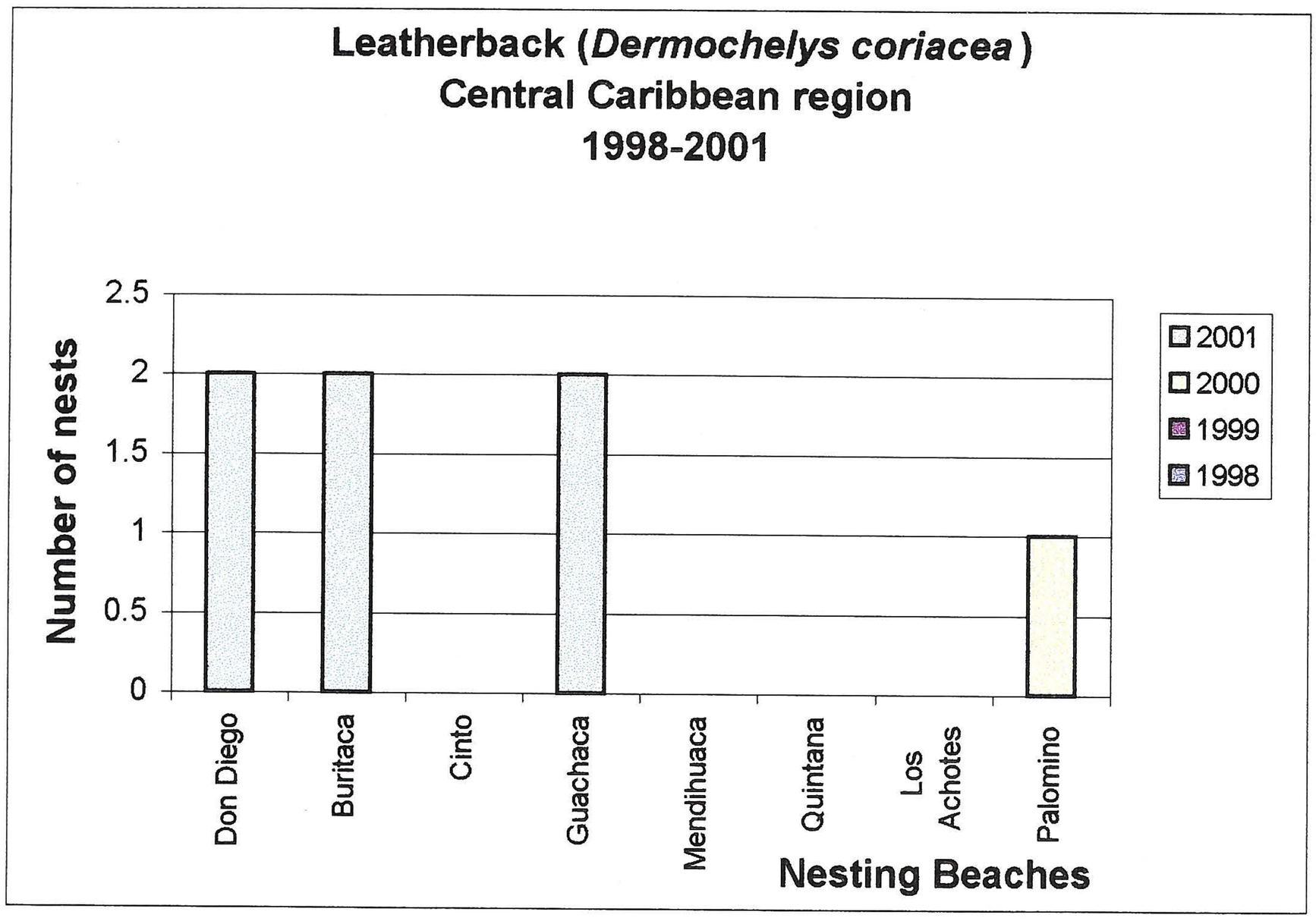
Graph 2. Nesting activity of green turtles (*Chelonia mydas*) on the beaches of the Central Caribbean region (1998-2001)



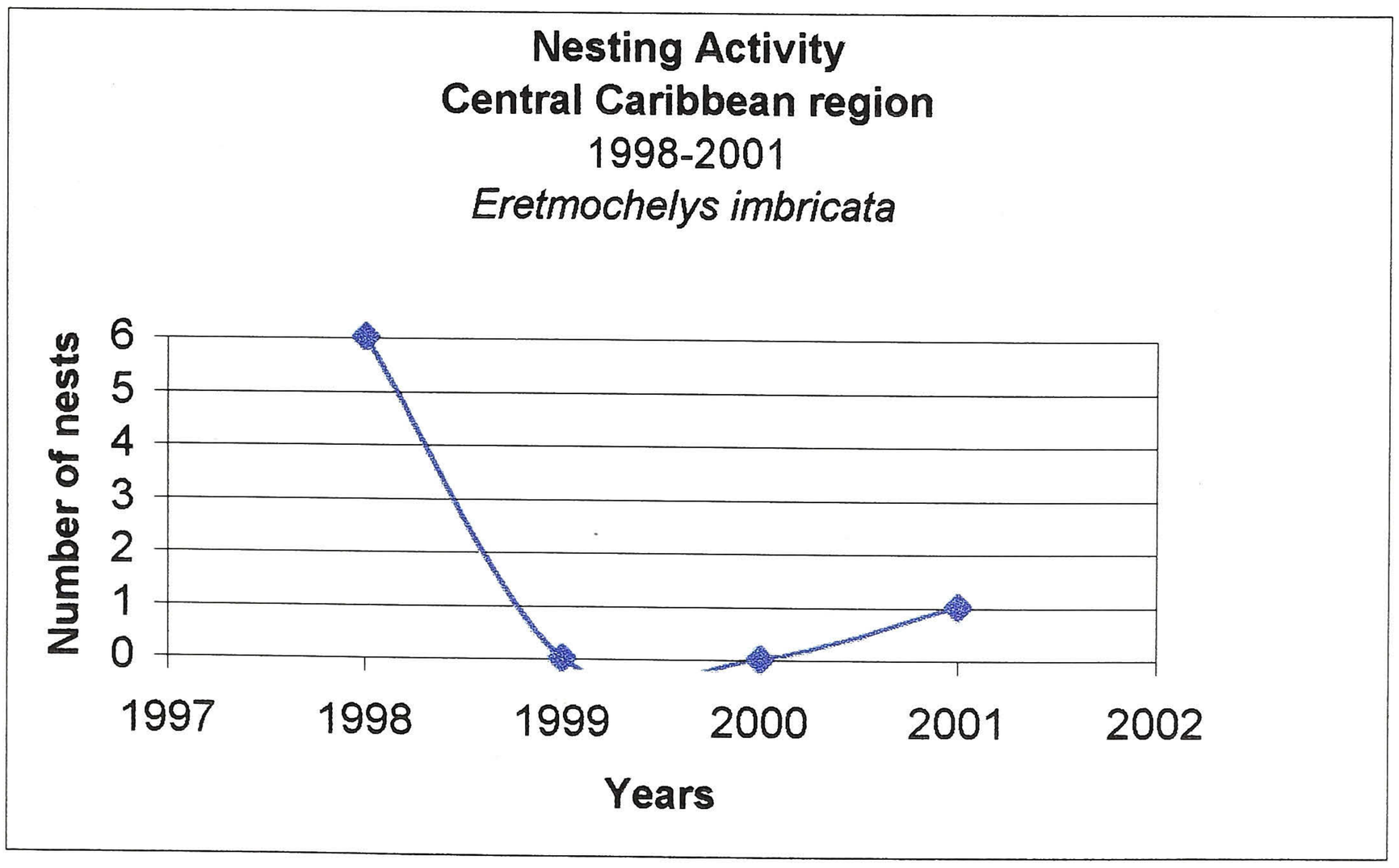
Graph 3. Nesting activity of loggerhead turtles (*Caretta caretta*) on the beaches of the Central Caribbean region (1998-2001)



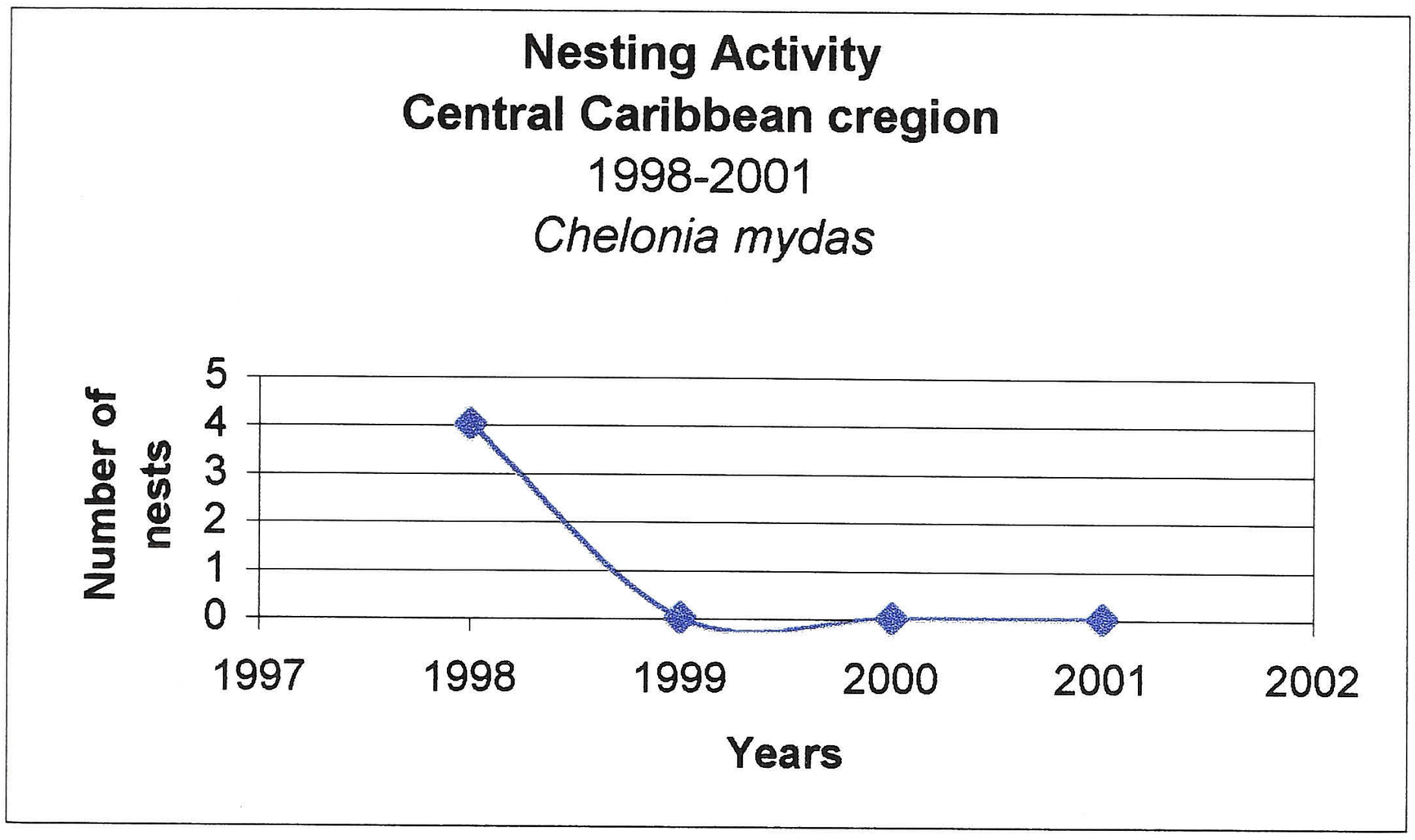
Graph 4. Nesting activity of leatherback turtles (*Dermochelys coriacea*) on the beaches of the Central Caribbean region (1998-2001)



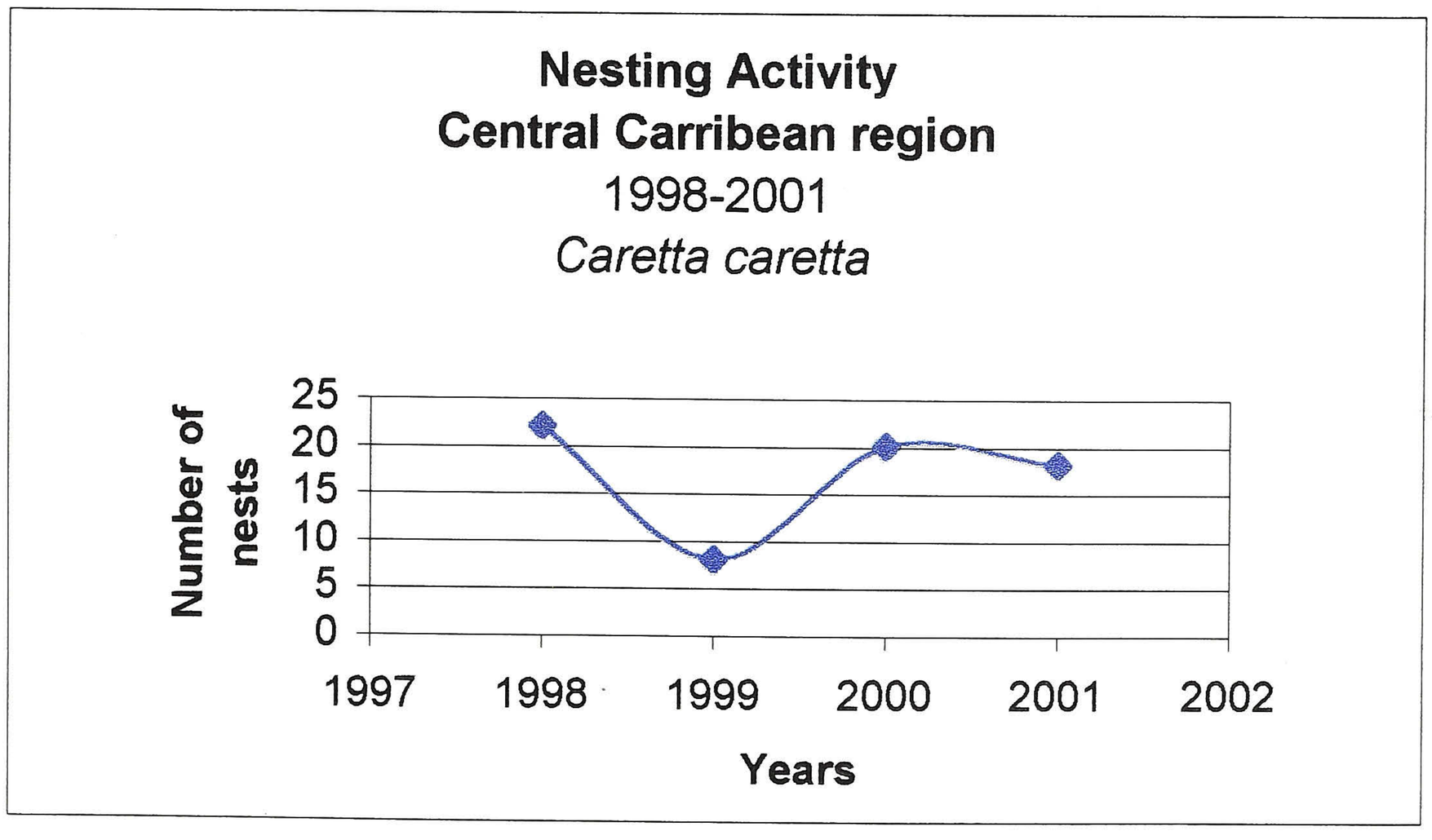
Graph 5. Hawksbill turtle (*Eretmochelys imbricata*) nesting trends in the Central Caribbean region (1998-2001)



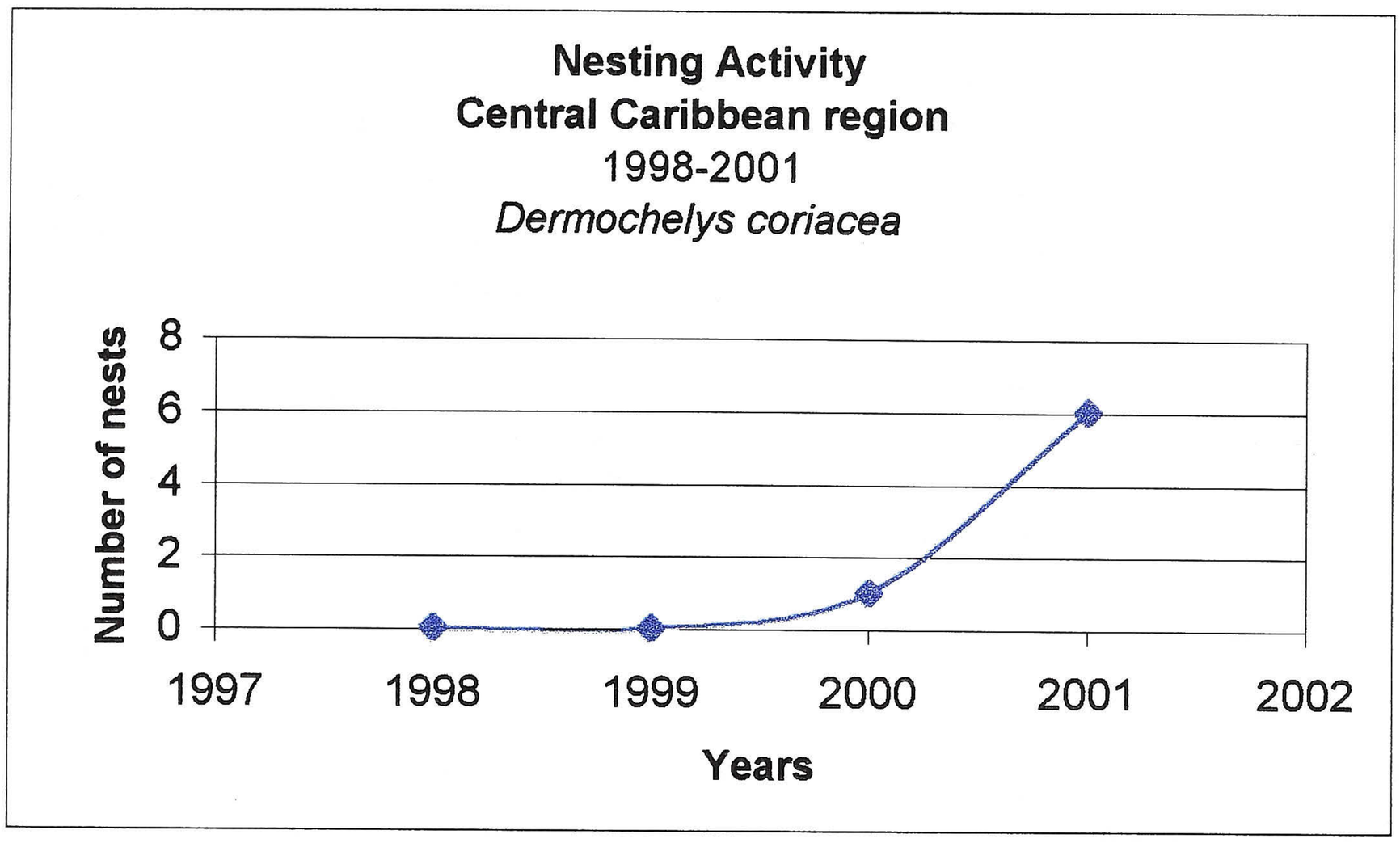
Graph 6. Green turtle (*Chelonia mydas*) nesting trends in the Central Caribbean region (1998-2001)



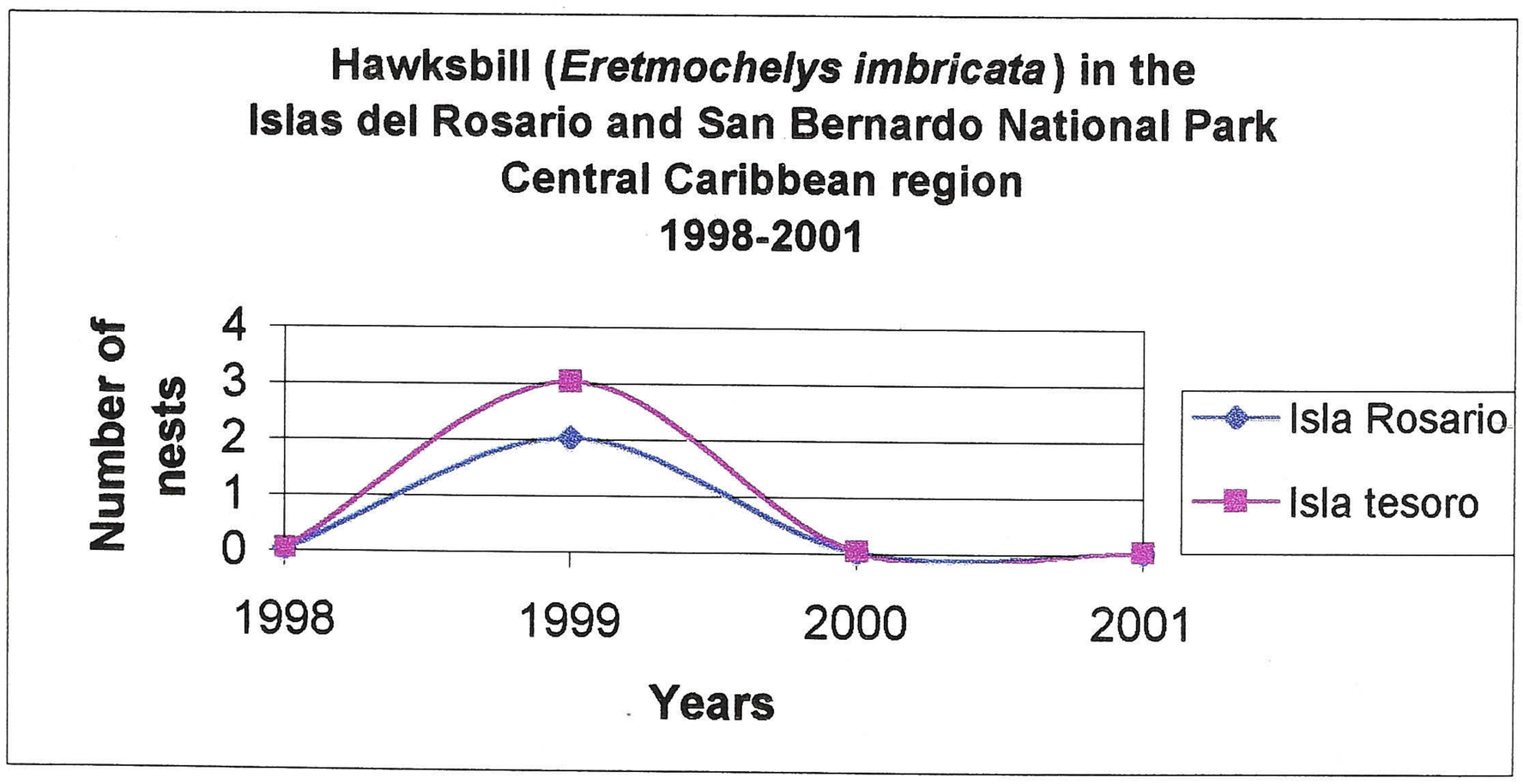
Graph 7. Loggerhead turtle (*Caretta caretta*) nesting trends in the Central Caribbean region (1998-2001)



Graph. 8. Leatherback turtle (*Dermochelys coriacea*) nesting trends in the Central Caribbean region (1998-2001)



Graph 9. Nesting activity of hawksbill (*Eretmochelys imbricata*) in the Islas del Rosario and San Bernardo National Park. (1998-2001)

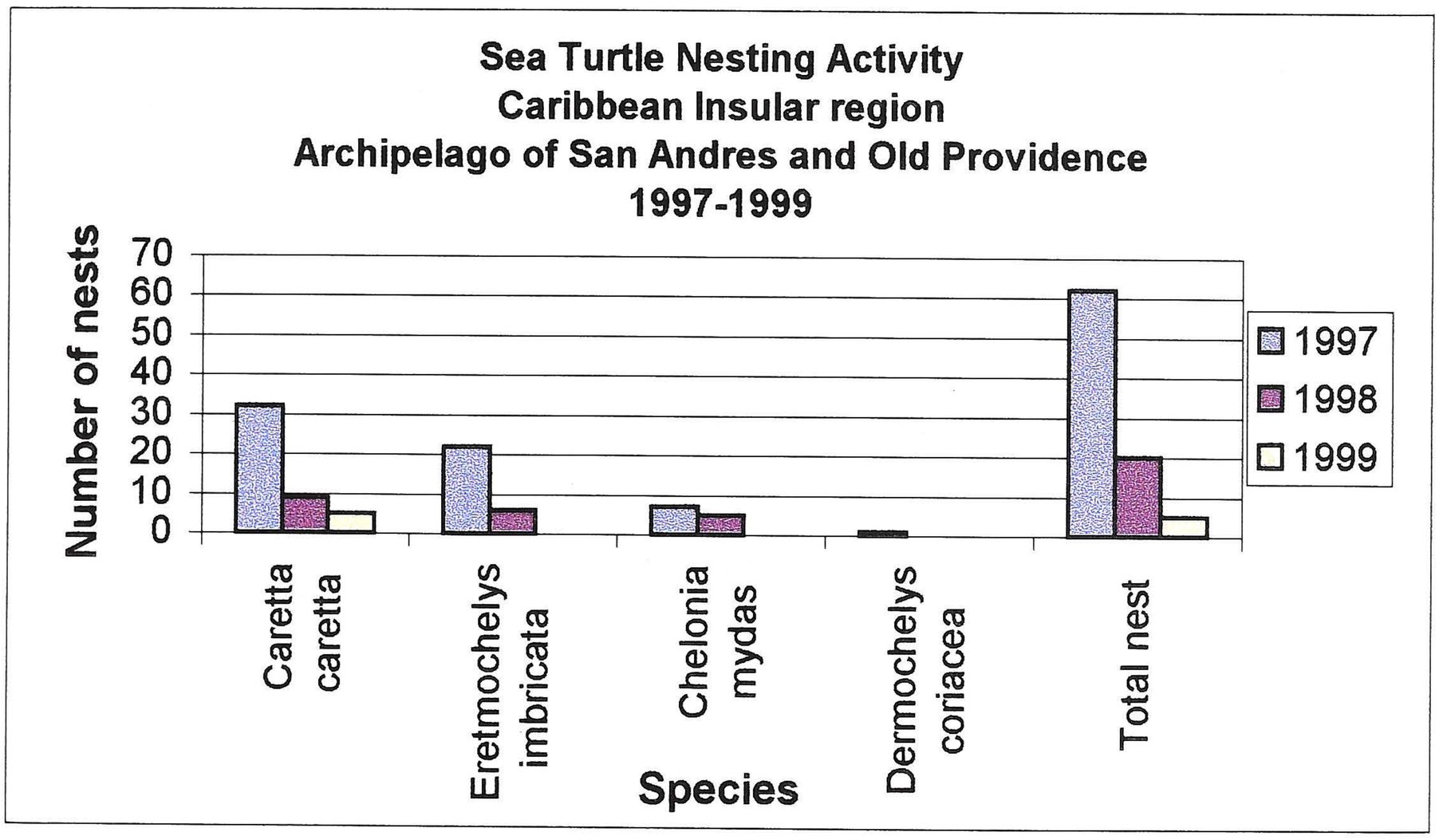


3.3.2 Insular Caribbean region

Nesting activity for *Caretta caretta*, *Eretmochelys imbricata*, *Chelonia mydas* and *Dermochelys coriacea* is presented in Graph 10. Information from the Archipelago of San Andres and Old Providence is scarce due to the logistical constraints for sea turtle surveys in these remote islands of the Colombian Caribbean. The most complete data

was collected during the 1997-nesting season in this region (Córdoba and López 1997, pp. 80-150).

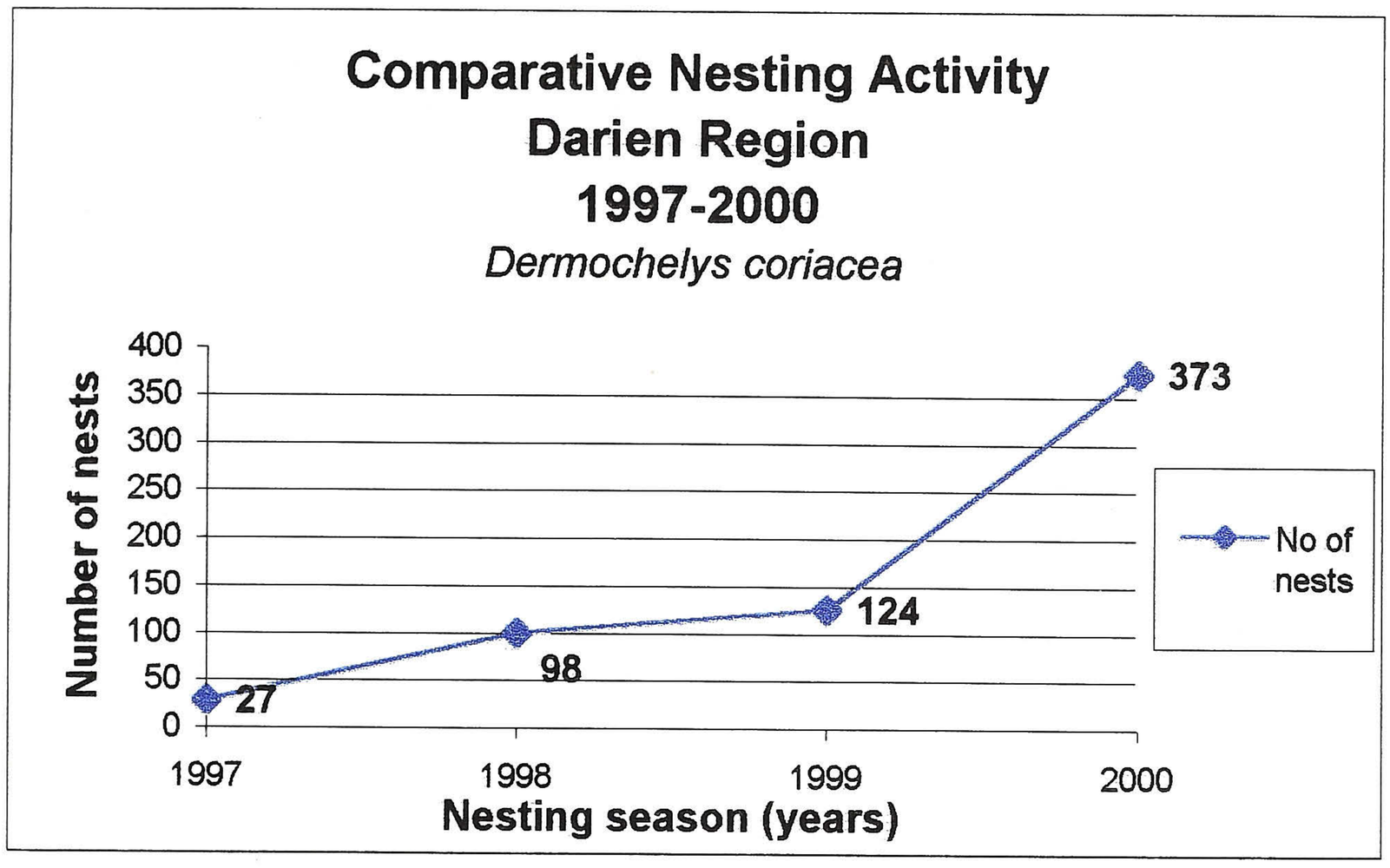
Graph 10. Nesting activity of loggerhead (*Caretta caretta*), hawksbill (*Eretmochelys imbricata*), green (Chelonia mydas) and leatherback (Dermochelys coriacea) turtles in the Archipelago of San Andres and Old Providence (1997-1999)



3.3.3 Darién region

Information for *Dermochelys coriacea* in the Darién region corresponding to four nesting seasons (1997-2000) is presented in Graph 11. As can be seen discerned from the graph and data at hand, survey accuracy has increased over the years.

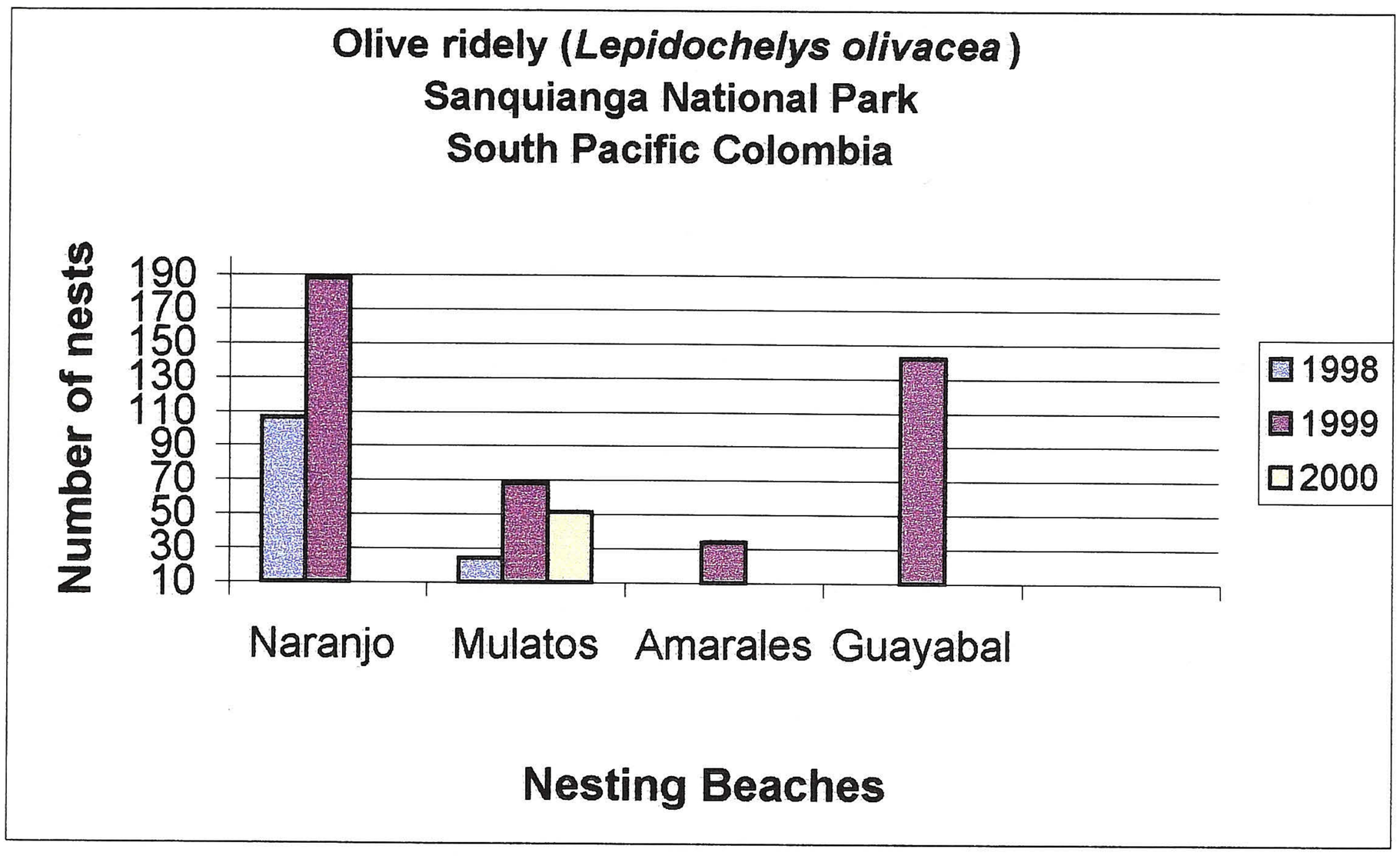
Graph 11. Nesting activity of leatherback (*Dermochelys coriacea*) turtles in the Darién region (1997-200)



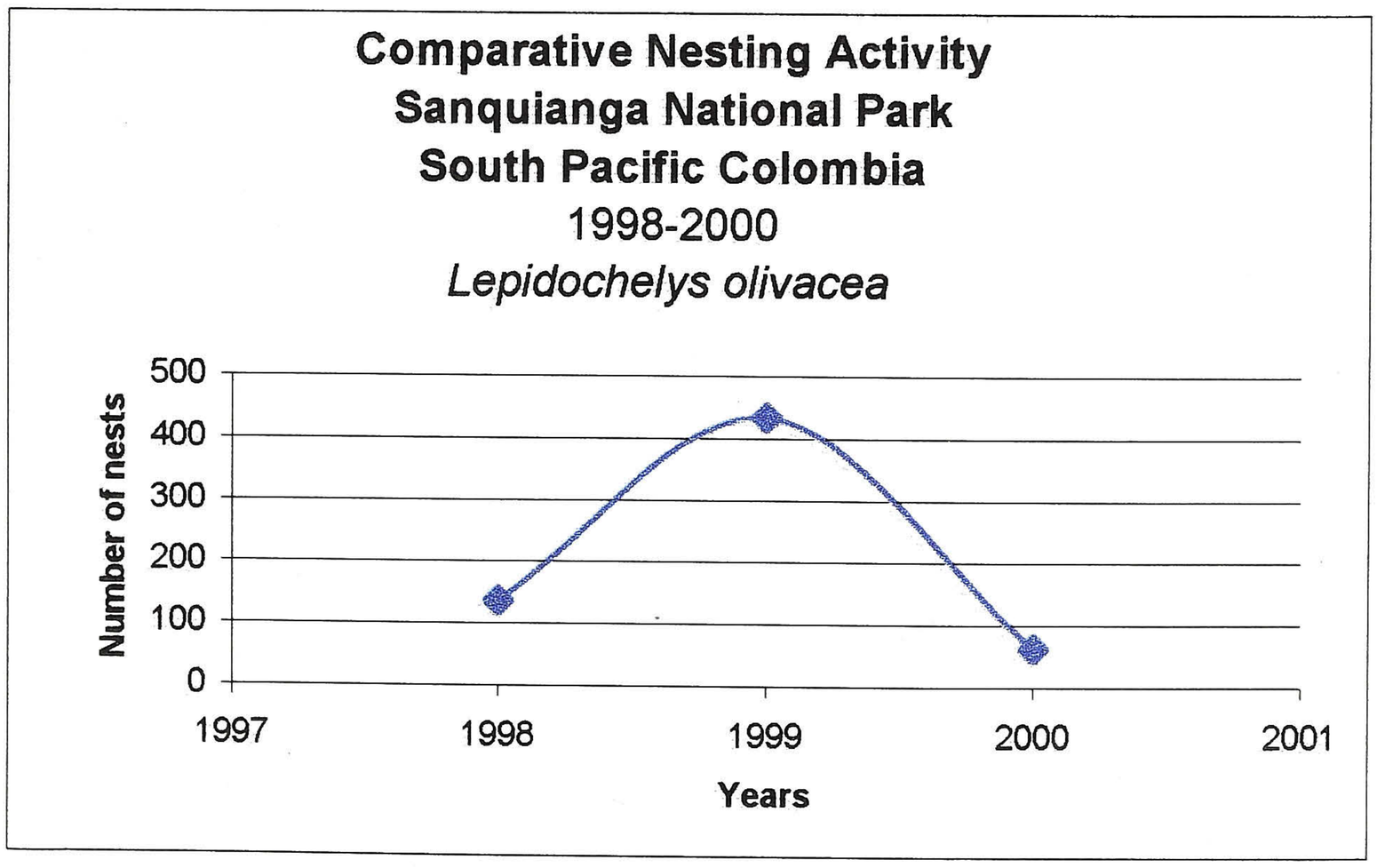
3.3.4 Pacific Continental region

Graph 12 illustrates the nesting activity of *Lepidochelys olivacea* among different nesting beaches included within the Sanquianga National Park in the southern Pacific coast of Colombia. Graph 13 shows the nesting trend for the same species over three years. Graph 14 illustrates the nesting activity for *Lepidochelys olivacea* in the northern Pacific coast of Colombia over seven nesting seasons. The information from the south and north pacific is integrated in Graph 15, providing a rough trend for the species' nesting activity between 1991 and 2000.

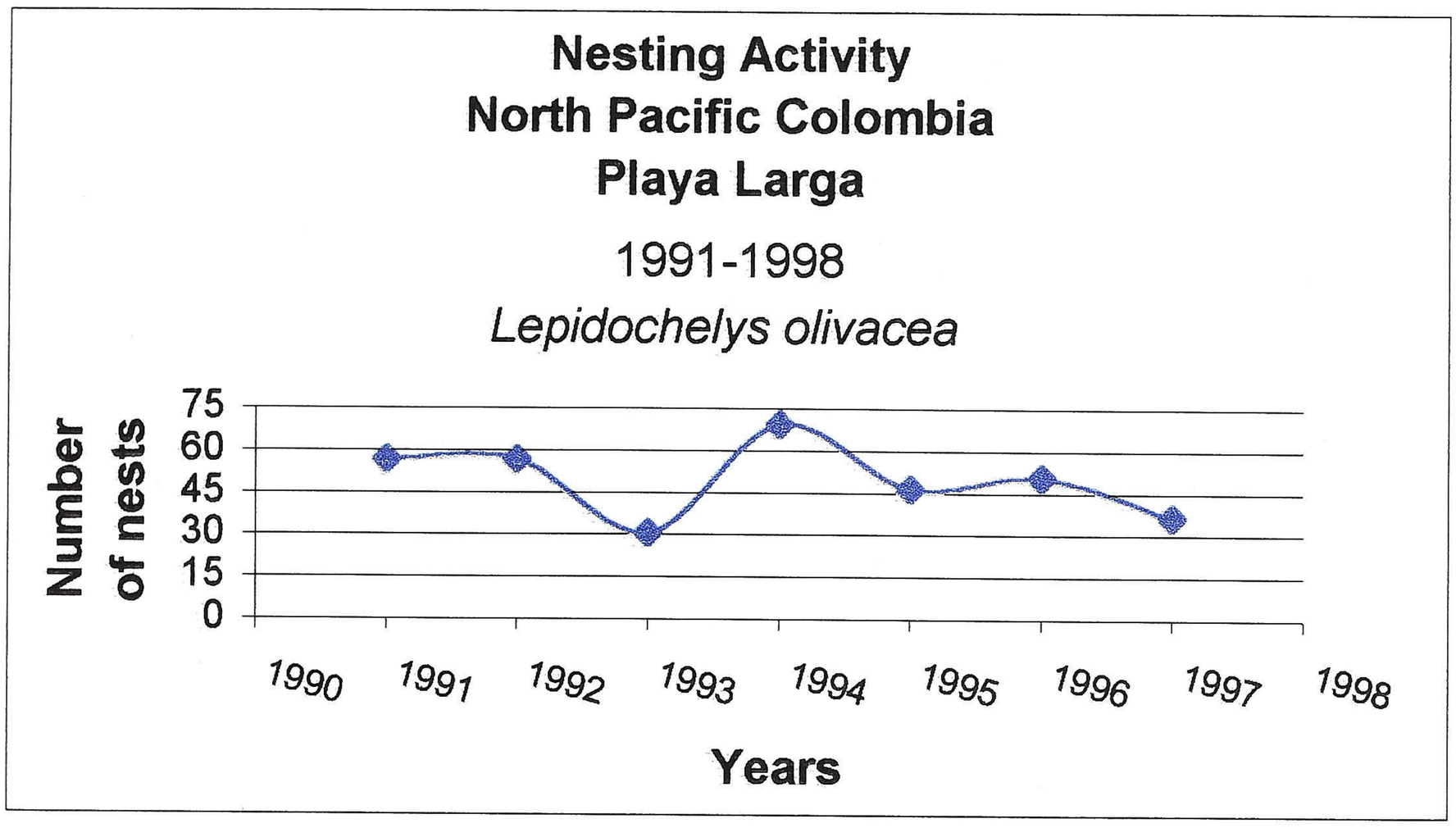
Graph 12. Nesting activity of olive ridley turtle (*Lepidochelys olivacea*) in the beaches of the Sanquianga National Park, South Pacific of Colombia (1997-2000).



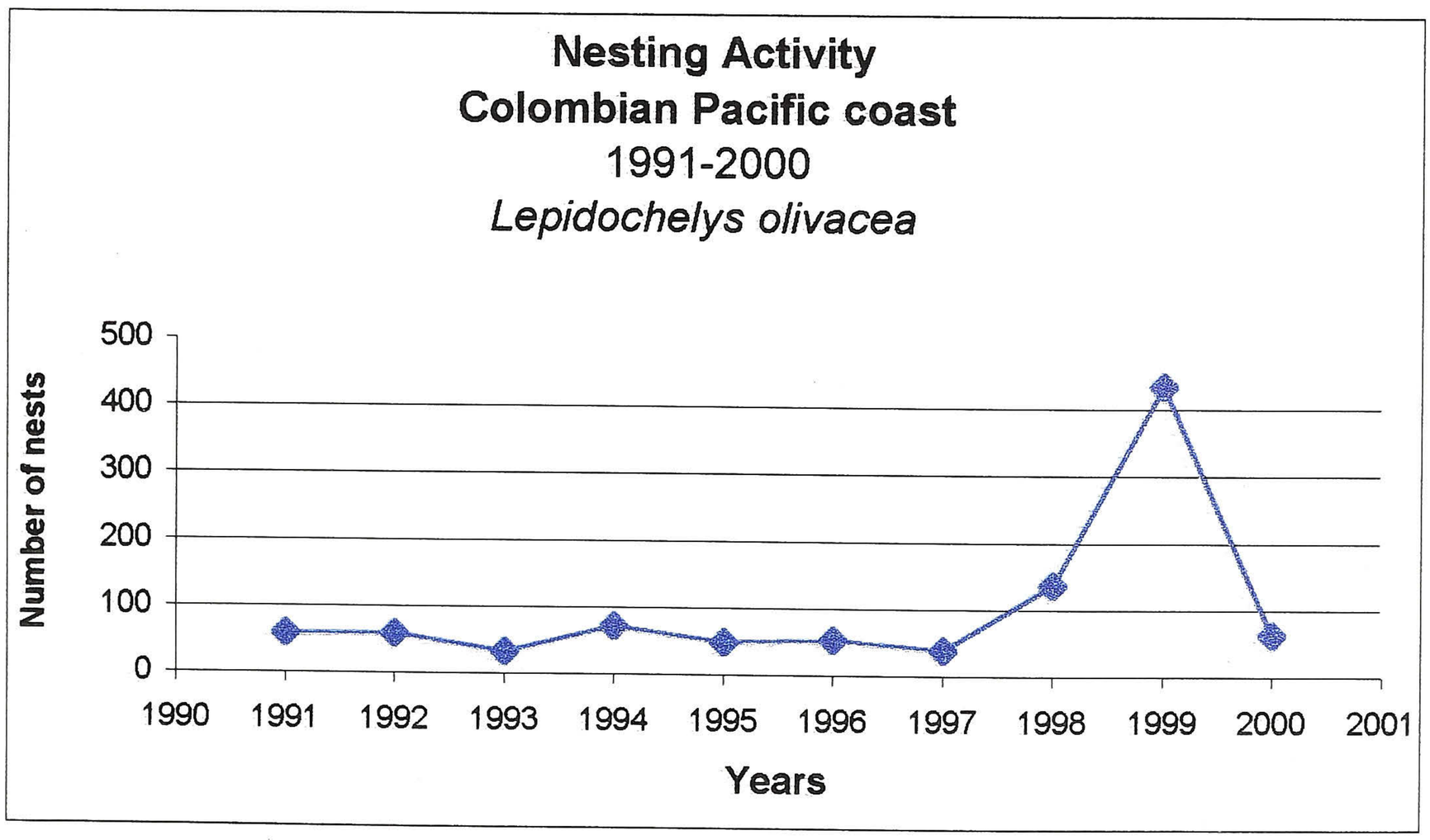
Graph 13. Olive ridley turtle (*Lepidochelys olivacea*) nesting trends in the Sanquianga National Park, South Pacific of Colombia (1998-2000)



Graph 14. Nesting activity of olive ridley turtle (*Lepidochelys olivacea*) in Playa Larga beach, North Pacific of Colombia (1991-1998).



Graph 15. Olive ridley turtle (*Lepidochelys olivacea*) nesting trends in the Pacific of Colombia (1991-2000)



3.3.5 Pacific insular region

Nesting activity in the Gorgona Island National Park is not a common phenomenon. However, within the coastal and marine perimeter of this protected area are the more important feeding and development habitats for *Chelonia mydas agassizii,*

Eretmochelys imbricata and *Lepidochelys olivacea*. These species were monitored around the island between October 1999 and March 2000 and are presented in Table 3 (Sánchez and Quiroga. 2000, p. 29).

Table 3. Foraging activity of sea turtles in the Gorgona National Park

Sea turtles foraging activity in the Gorgona National Park located in the Colombian Insular South Pacific (October 1999 – March 2000)			
Sector	**No. Individuals**	**Total No. Individuals per specie**	
North (1)	18	62	*C. mydas. a*
Centre (2)	38	5	*L. olivacea*
South (3)	44	4	*E. imbricata*
Total	100	29	*Unidentified*

Source: Sánchez and Quiroga. 2000. Habits and foraging behaviour of sea turtles in the Gorgona National Park, Colombian Pacific. pp. 105

3.4 Colombian legislation, policies and institutional framework with regard to sea turtle conservation

As in the case of sea turtle conservation in Colombia, environmental legislation in less developed countries can often be contradictory and ambiguous, causing governmental confusion and public controversy (Reichart 1999, p. 221). Marine turtles live most of their lives in the sea, although females do periodically throughout their life cycle come out of the ocean to nest on sandy beaches. The Latin American and Caribbean region commonly experiences administrative complications when sea turtles, regarded as a fisheries resource when in the ocean, leave the ocean to nest on the sandy beaches and then are also considered wildlife (Sybesma 2001, pp. 139-42)

'Colombian environmental management, in agreement with the National Constitution, is decentralized, democratic and participatory' (Colombia, National Environmental System 1993, p. 7). This is one of the guiding principles behind the creation of the Ministry of the Environment and The Colombian National Environmental System (*Sistema Nacional Ambiental – SINA*) under Law 99 in 1993.

3.4.1 The Ministry of The Environment

The Ministry of the Environment is in charge of the design and implementation of national policies concerned with the Colombian environment and natural resources. It is also responsible for the environmental planning in all Colombian terrestrial, coastal and marine territories. The Ministry of the Environment defines the norms and regulations related to exploitation, conservation and the recovery of natural resources to prevent environmental degradation within the country. The Ministry's administrative structure includes, among other dependencies, the *SINA*[16] Planning and Coordination Office, The National Parks System Special Administrative Unit, which is responsible for 46 protected areas within the country, and the Ecosystems General Direction Office, which is in charge of the development of policies related to terrestrial and aquatic ecosystems.

To advance towards sustainable development in Colombia, the Ministry works jointly with other institutions that integrate the *SINA*, such as research institutes, the Autonomous Regional Corporations and the Urban Environmental Units. These institutions provide technical support for decision-making and collaborate in the policy implementation process of the Ministry. Thus *SINA* is a comprehensive legal and institutional framework through which the Ministry of the Environment can integrate government at regional and national levels and civil society in the implementation of the country's environmental policies (Colombia, Ministry of the Environment 2002, p. 1/1).

3.4.2 Colombia's environmental policy and institutional framework

Colombia's environmental policy establishes programs for the preservation of strategic ecosystems, the improvement and management of water resources, the restoration of

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[16] The National Environmental System consists of sets of rules, norms, activities, resources, programs and institutions that allow the appliance of the environmental principles contained within Law 99/1993

marine and coastal systems, the expansion of protected forest areas and cleaner technology for industrial production (Colombia, Ministry of the Environment 2002, p. 1/1). Important instruments to adjust, update and create new environmental policies were developed after the creation of the Ministry of the Environment in 1993. These new policies are based on participatory democratic principles; they emphasise dialogue and consensus among stakeholders and recognise the right of ethnic groups and the public to participate in the policy-making process (Colombia, Ministry of the Environment 2002, pp. 1-3). The policy attempts to put an end to the violations of the traditional and cultural rights of the many different human populations living within Colombian territorial bounds. Current policies like 'National Parks with and for the People'[17], 'The Wildlife Management Policy'[18], and the 'Coastal, Marine and Oceanic Spaces Policy'[19] are examples of the new participatory trend that, in theory, favours better environmental management in Colombia.

Although well intentioned and representative, these policies have not been effectively applied to wildlife conservation. The current legislation on wildlife is not widely known or disseminated, nor is it adapted to change and innovation within the administrative system, to new initiatives for scientific investigation or technological development. It is acknowledged by the Ministry of the Environment, in the report on the 'Strategic Lines of Action for Wildlife Policy Development in Colombia' (1997, p. 16), that the nature of environmental legislation in Colombia is largely unknown and static. This is

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[17] Social participation policy promoting changes in natural protected areas management based on cultural, environmental and economic local contexts.Published by the Colombian National Parks System, in 2001.
[18] Guidelines for a Colombian wildlife management policy.Published by the National Environmental System and the Ministry of the Environment, 1997a.
[19]National policy for the management and conservation of the coastal zones, marine territories, and oceanic spaces of Colombia.Published by the National Environmental System and the Ministry of the Environment, 2001.

attributed to inadequate planning and management. The same report acknowledged that this lack of planning and management directly contributes to the increase in natural resource over-exploitation and habitat degradation by local coastal communities

Significant advances have taken place recently with the commitment of the Ministry of the Environment and other institutions of *SINA* to address the decline of sea turtles in Colombian waters and coasts. For instance, the National Parks System has dedicated technical and logistic resources to information acquisition, community involvement and law enforcement in the coastal and marine Parks where sea turtle nesting or feeding occurs. The Autonomous Regional Corporations have developed nesting surveys and workshops in those areas of their jurisdiction – not including the National Parks System – in which reproductive or foraging sea turtle activities take place. The Marine Research Institute, INVEMAR, has begun to develop of a comprehensive survey of the current status of sea turtles in the Caribbean during 2002 (Díaz, J.M. Director Natural Resources INVEMAR, pers. comm., January 29/2002).

All these efforts contribute to and strengthen the 'Colombian Strategic Plan for the Recovery of Endangered Wildlife Species' and the 'National Program for the Evaluation and Conservation of Marine and Continental Turtles' (Colombia, Ministry of the Environment-Widecast-Colombia Association 2001, p. 4). The latter Program includes the development of the 'Sea Turtle Management and Conservation Action Plan', one of Colombia's obligations under the SPAW protocol, protecting migratory wildlife species in Latin America and the Caribbean region.

3.5 *Significant sea turtle conservation efforts in Colombia*

In the last ten years significant contributions to the conservation of sea turtle have been made in Colombia. Before this time, research and beach protection were only promoted if they were within the personal interest of government officers or international/national wildlife scientists.

3.5.1 Non-government organisations

Since 1990, a wave of NGO and government conservationists have become engaged in carrying out sea turtle conservation programs on both the Caribbean and Pacific coasts. Marine turtle conservation activities to date are nesting beach surveys and community capacity and skill building. Many of programs have failed due to isolation and the lack of coordination of activities, many involving duplication and wasted efforts (Colombia, Ministry of the Environment 1997, p. 16). It is, however, impossible to overlook the valuable achievements of the sea turtle conservation programs being carried out in the country. Arguably, the most active NGOs promoting sea turtle conservation in the Caribbean and Pacific of Colombia are:

a) The Darién Foundation, a local NGO encouraging the conservation of leatherbacks (*Dermochelys coriacea*), active in the Darién region since 1993. Each year during the nesting season, beach patrolling, nest relocation, female tagging and cultural community activities, involving local stakeholders, are carried out by the Darién Foundation in the Gulf of Urabá in the Colombian Caribbean.

b) The Centre for Marine Research and Education – CEINER – in the Islas del Rosario National Park (central Caribbean), in coordination with the National Park officers, relocate to protected beaches the nests of hawksbill's

(*Eretmochelys imbricata*) that are found between July and September each year in the islands of Rosario, Cachimba and Tesoro. Hatchlings have been retained in tanks within CEINER for educational purposes and after one or two years they are released into the sea. CEINER researchers are currently conducting research on the composition of the diet of the species in captivity. Educational and recreational activities that include marine wildlife trials and show are offered to tourists who visit this oceanographic centre.

c) The Sea Turtle Foundation of Santa Marta (FTMSM) is a regional NGO promoting conservation activities in the region of the Magdalena Department, on the central Caribbean coast of Colombia. FTMSM is primarily concerned with hawksbills (*Eretmochelys imbricata*) and loggerheads (*Caretta caretta*) research and conservation. Beach patrolling, nest relocation and training courses, are some of the activities conducted by this organization since 1997.

d) From 1991 to now, the Natura Foundation, a national NGO with headquarters in Bogotá, has operated a sea turtle conservation program in La Cuevita Beach (also called Playa Larga) in the north Pacific coast of the country. Olive ridley (*Lepidochelys olivacea*) nesting activity has been assessed in this nesting area throughout the last nine years. Female tagging and measurement, nest relocation into beach-protected hatcheries, and capacity building for sustainable development in local communities are some of the activities carried out by this organization in the highly biodiverse coastal buffer zone of the Utría National Park.

3.5.2 Wider Caribbean network

To assist Caribbean governments collaboratively develop their national Sea Turtle Recovery Plan (STRAP), required under the SPAW protocol, is one of the two main

objectives of The Wider Caribbean Sea Turtle Conservation Network (WIDECAST), an autonomous international NGO partially supported by the Caribbean Environment Program of UNEP[20]. WIDECAST's second objective is to promote regional capability to implement scientifically sound sea turtle programs by developing a technical understanding of sea turtle biology and management among local institutions and individuals in the Wider Caribbean region (Figure 13) To promote such a capability, WIDECAST's mission is implemented by resident Country Coordinators who network, collect information and draft, with the assistance of regional sea turtle researchers and conservationists, locally appropriate sea turtle management recommendations. WIDECAST also provides for and assists in the development of educational materials, as well as supporting technical workshops on sea turtle biology and conservation (Winter and Eckert 1994, p. 1)

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[20] The United Nations Program promoting regional cooperation for the protection and development of the marine environment of the Wider Caribbean region

Figure 13. The Wider Caribbean Region

Source: The United Nations Environment Program. The Wider Caribbean Region
http://www.gpa.unep.org/seas/workshop/widercaribb.gif

The primary output to be developed for each of the 39 Wider Caribbean nations being assisted by WIDECAST is a Sea Turtle Recovery Action Plan (STRAP). The STRAP of each of these countries is envisioned to summarize the known distribution of sea turtles, discuss the major causes of mortality, evaluate the effectiveness of existing conservation legislation, examine the present and historical role of sea turtles in local culture and economy, and prioritise implementing measures for stock recovery (Smith *et al.* 1992, pp. 17-20). In addition, the envisioned direct involvement in the development of the Action Plan of resident conservationists, enforcement officers, policy-makers, fishermen, teachers, and other individual and collective members of the public will create an informed advocacy body behind the implementation of the policy. Each STRAP, following a standard format, is a blueprint for national action and harmonized regional action that is promoted by the UNEP Caribbean Environment Program.

The WIDECAST Colombian Country Coordination has managed sea turtle research and conservation projects in Colombia since 1996. It has also established cooperative agreements with the National Parks System Special Administrative Unit [21] (UAESPNN) to provide training, technical support, educational materials and other tools needed to bring communities within national parks and their buffer zones into focus with regard to the long-term protection of sea turtles and their habitats (Widecast-Colombia Association 2000, p. 105).

In 2000, a local branch of WIDECAST was established by the Country Coordination office under the name of Asociación WIDECAST-Colombia (AWC). Over the last two years, AWC has negotiated agreements with the Colombian Ministry of the Environment[22], the departments Autonomous Regional Corporations[23], regional NGOs[24] and regional universities[25], to advance a national STRAP customized to local needs, culture and regulatory systems. This STRAP will be a part of the 'National Program for the Management and Conservation of Marine and Continental Turtles in Colombia', which significantly includes the Pacific coast and islands. This is the fourth draft of a

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[21] The UAESPNN was created under Law 99 (1993), as one of the dependences from the Ministry of the Environment in charge of preservation and conservation of the Colombian natural protected areas. Agreement was signed by Directors of UAESPNN and WIDECAST in June 2000, defining collaborative activities for the research and conservation of sea turtles an their habitats in the protected areas of the Caribbean and Pacific of Colombia

[22] An agreement between AWC and MMA was signed in January 2001. It defines the framework for institutional collaboration in the elaboration and implementation of the STRAP as well as the National Sea Turtle Management and Conservation Plan that includes the Pacific coast and islands.

[23] There are Autonomous Regional Corporations throughout the country, responsible for resource regulation and policy implementation in their regions. Agreements were signed with the Autonomous Regional Department Corporations of Magdalena (CORPAMAG) and La Guajira (CORPOGUAJIRA) in 1999 and 2001, respectively

[24] Agreements among AWC, the Sea Turtle Foundation of Santa Marta and Prosierra Nevada Foundation signed in January 2001

[25] AWC staff supervise several undergraduate students from universities of the Caribbean and Pacific coasts of Colombia. A recent agreement between AWC and the University of La Guajira was signed in August 2001.

participatory Colombian Sea Turtle Management and Conservation Action Plan (Amorocho 2000, p. 96).

Institutional integration has been encouraged by WIDECAST since 1998, linking government policies and international agreements with projects and people working on the ground. Through the Colombian Sea Turtle Network – *RETOMAR* – government, NGOs and communities are devoting efforts to the construction and further implementation of the STRAP and the National Sea Turtle Management and Conservation Plan (Figure 14).

At this stage in the paper, it can be said that there still exists a need to develop a Colombian vision for sea turtle research and conservation that extends beyond the local and national to the regional and international, and that is aimed at improving the policy-making process both locally and nationally. The identification of the main factors affecting the achievement of the conservation program objectives is a likely first step in this process. The next section of this paper will identify and discuss the critical limitations and constraints to the effective implementation of sea turtle conservation programs in Colombia.

Figure 14. Colombian workshops for the development of the National Sea Turtle Recovery Action Plan (STRAP)

Photo: Diego Amorocho - 2000

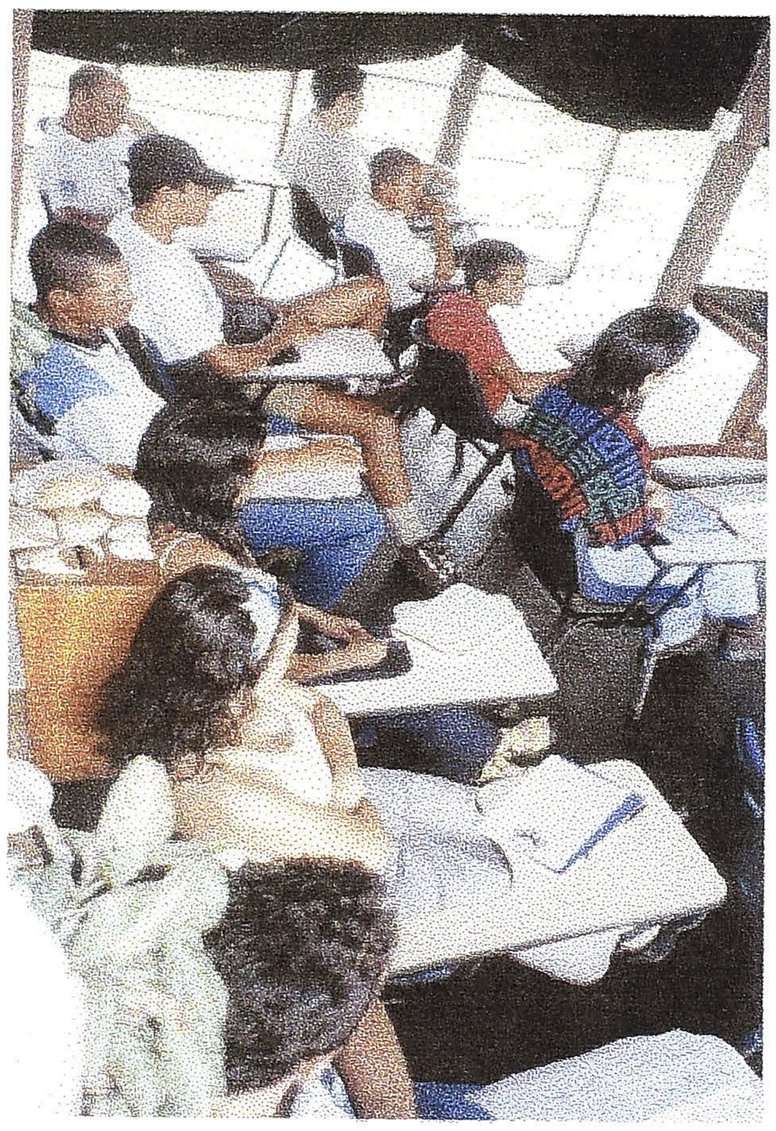

Photo: José Antonio Riascos - 2000

3.6 Limitations and constraints facing sea turtle conservation in Colombia

There is a range of limitations and constraints facing sea turtle conservation initiatives in Colombia. The most critical are identified by this paper as poor institutional coordination for policy implementation, lack of resources, poor research planning and weak public participation.

3.6.1 Poor institutional coordination for policy implementation

Colombian governmental agencies with varied, yet at times overlapping and at times competing mandates, are involved in the conservation of sea turtles. Complexities exist as to which agency is responsible for what aspects of the research and management of marine turtles and their critical habitats.

Much of the administrative responsibility for sea turtle research and conservation is shared between two or more government agencies or institutes, depending on the region. Instead of this increasing the attention and support provided by the governmental agencies, sea turtles have often been neglected – each agency considering them the responsibility of the other (Reichart 1999, p. 221). The jurisdictional frontiers between the Colombian Environment Ministry's' dependencies, research institutes and autonomous regional corporations relevant to sea turtle conservation within the National Environmental System (*SINA*), therefore remain unclear.

Another institutional policy and planning issue contributes to the decline of sea turtles and other species of wildlife in Colombia, the lack of coordinated regional and national policies and priorities to address conservation goals (Humboldt 1998, p. 71) The benefits of an equitable and more socially-oriented policy can be seen if the mechanisms for its implementation are realistic. As stated by Reichart (1999, p. 223), the involvement of stakeholders in the design and enforcement of the conservation law is essential, and must be honestly and openly conducted. The three spheres of government (local, regional and national) are coordinating the involvement of all stakeholders through a 'bottom –up' approach in the policy-making and implementation process (Frazier 1999a, p. 16). To date this has not been achieved in Colombia.

3.6.2 Lack of funding

A feature common to all organizations working on sea turtle conservation is that activities are carried out through an enormous commitment from individuals, but with very limited budgets (Frazier 2000, p. 4). Lack of trained personnel, camp facilities, research equipment, vehicles and lab materials, are some of the common constraints to field teams monitoring nesting beaches each season on the coasts of Colombia. Financial uncertainty is a strong limitation affecting the performance of most conservation programs. There is no one formula to follow to achieve the financial sustainability of a conservation project.

One way to partially overcome the funding issue is to integrate a regional conservation initiative into an existing intergovernmental agenda. This means, for instance, that sea turtles can be considered within a project submitted by the Colombian government to the Global Environmental Facility (GEF) of the World Bank for funding. A bi-national or transnational project for 'marine protected areas' or 'oceanic waters quality', using GEF categories, should be encouraged by Colombia to improve national and regional sea turtle conservation management.

There are other fundraising strategies that have been tested with success by other projects around the world and whose 'lessons learnt' can be applied in Colombia. Brazil is a good example: Projeto TAMAR is a federal governmental program, created in 1980 by IBAMA (Brazilian Institute for the Environment), with the mandate to protect sea turtles along the extensive Brazilian coasts. In the beginning the program was also affiliated with and assisted by several national non-governmental organizations (NGOs). However, when the program matured in scope the many alliances had over

time become unmanageable. In response, the Pro-TAMAR Foundation was created in 1988 to conduct fund-raising and co-administer Projeto TAMAR with the Brazilian government. The government funds 40% of TAMAR and the Pro-TAMAR Foundation funds the remaining 60% percent. The non-governmental funds comes from the manufacture and sale of TAMAR products (T-shirts, embroidery, handcrafts) as well as from Brazilian private and public organizations, and two major international aid agencies: the European Economic Union and the Interamerican Bank for Development (Marcovaldi and Marcovaldi 1999, pp. 39-40).

Whatever the fundraising strategy decided upon, it needs to consider the social and economic context in which the given project is carried out (Marcovaldi and Thomé, 1999 pp. 165-7). Some non-consumptive uses of the species such as small local businesses, ecotourism and other green businesses, need to be identified and encouraged by stakeholders involved in sea turtle conservation and sustainable use in Colombia (Amorocho 2000, pp. 62-3)

3.6.3 Research planning

One of the consequences of working with little funding in Colombia is that some research generates data that is not comparable from year to year. These research gaps are currently reducing the effects of or preventing effective sea turtle conservation programs because they do not provide sufficient scientific knowledge to manage the species. In addition, non-standardized methodologies, inaccurate data gathering, limited dissemination of research results and inconsistent monitoring activities are issues that contribute to the duplication of efforts and the loss of collaborative and coordinated opportunities. Although research and inquiry should be encouraged, the mere accumulation of information is insufficient to meet the needs of a competent

conservation program (Eckert 1999, p. 7). Moreover, for the success of a sea turtle conservation program, every effort must be made to improve data management (Eckert 1999, p. 7). Section four of this paper addresses in detail the issue of research-driven management of sea turtles in Colombia, identifying crucial directions research should take in order to effectively guide the conservation of sea turtles in Colombian waters and on Colombian beaches.

3.6.4 Public participation

In Colombia not all stakeholders are identified and involved in sea turtle research and conservation in coastal and marine zones (Rueda *et al.* 1992, p. 150; Amorocho 1999, pp. 6-7; Amorocho 2000, p. 91-3). The failure to effectively involve the public makes it difficult to achieve the overall goal of sea turtle conservation programs, which, according to Eckert, is to promote the long term survival of sea turtle populations, including the sustained recovery of depleted stocks and the safeguarding of their critical habitats, integrated with the well being of rural communities (1999, p .6). In general rural people are those most in direct contact with sea turtles and their habitats, however, as seen in the introduction, the entire Colombian society has reason to be concerned about the conservation of sea turtles, as well as the health of their coastal areas and oceans. Section five of this research paper addresses this constraint to effective sea turtle conservation in Colombia, and identifies strategies to involve the public and improve public participation processes for better environmental policy-making and sea turtle conservation programs.

4 Prioritising research-driven management in sea turtle conservation in Colombia

There is little doubt that research is highly relevant to effective environmental policy-making and wildlife management and conservation (IUCN 1995, p.6; Humboldt 1998, p.68; INVEMAR 2002, p. 1/1; Bass 1999, p.195; Bowen *et al.* 1996, p. 570; Marcovaldi and Laurent 1996, p. 55; Frazier 2001b, p. 1/1; Witzell 1998, p. 3; Meylan 1999, p. 193; Garduno *et al.* 1999, p. 292). Congdon and Dunham argue that the worth of a research project is not determined by the quantity of data obtained, but by the way in which the data complements previous research and contributes to the understanding of broader biological issues or general problems in the management and conservation of biodiversity (1999, p. 87). In a similar vein, Eckert contends that research is required to both 'define the extent of the conservation challenge' and 'evaluate the effectiveness of a potential intervention or management response' (1999, p. 7). Wildlife management and interventions should be carried out based on appropriate research and should respond constructively to a defined threat.

Supported by an extensive literature review and 15 years experience working in sea turtle research and conservation in Colombia, the following section identifies two related areas of focus for the research-directed management of sea turtles in Colombia – short and long-term population trends and genetic characterization. The paper justifies the decision to focus on population trends, discusses the research into population trends that has been carried out in Colombia to date, and recommends research directions on feeding and nesting grounds, essential for the advancement of Colombia's sea turtle conservation agenda. Genetic characterization of nesting and feeding populations is an indispensable tool in the conservation management of sea turtles globally. This paper

discusses how genetic tools can improve identification of nesting and feeding populations, as well as decision-making for sea turtle conservation in Colombia

4.1 Short and long-term population trends

Although estimating short and long-term trends for migratory species is difficult, population dynamics need to be addressed in order to understand the current status of the animals (Abreu-Grobois 2001, p. 107). The accuracy and the quality of data gathered through research into sea turtle populations' short-term (two to three decades) and long-term trends (over one hundred years) is crucial for their management (Murphy and Noon 1991, pp. 773-4; Meylan 2001, p. 8). Documenting population increases, decreases or constancy, and gauging change and the rate of change are issues of significance to be considered while monitoring trends in sea turtles (Congdon *et al.* 1993, pp. 826-7). Due to the characteristic life history of marine turtles, decades of dedicated, persistent and systematic research on nesting, development and feeding grounds is required to obtain basic information for conservation management (Eckert 1999, p. 6).

The assessment of population trends is complicated by the fact that a single female nests several times within a breeding season, follows a non-annual schedule with intervals varying in length, and is reproductively active for decades (FitzSimmons *et al.* 1995, pp. 2-4). Limited access to reproductive males and all non-reproductive segments of the population makes it difficult to estimate population size (Frazier 2001a, p. 15). In addition, extensive life generational periods, due to late maturation and the long lives of sea turtles, are a constraint that need to be considered when estimating trends (Frazier 2001a, p. 21; Crouse 1999, pp. 195-6; Musick 1999, pp. .61-2). Therefore, long-term

monitoring is essential to document true population change in sea turtles (Meylan 2001, p. 4).

Given that the environments in which these marine reptiles live are dynamic and unpredictable in time and space, the challenge to establish a foundation of knowledge adequate to understand complex interrelationships and make meaningful predictions is significant (Frazier 2001b, p .4). In addition, much of the data on the population dynamics of sea turtles can only found in 'grey literature', which is scientifically unreviewed (Lutcavage *et al.* 1997, p. 388). As a result, both scientists and conservationists are obliged to deal with fragmented knowledge, of varying reliability, in their attempts to understand and manage sea turtles.

Much of the 'grey literature' is not readily available to policy-makers and wildlife managers, particularly in the case of migratory species like sea turtles. In Colombia, large amounts of information, some of which is critical for decision-making in both scientific and conservation initiatives, is only obtainable in reports, meeting minutes and workshop proceedings produced by government offices, conservation organizations or university departments. This lack of information and understanding leads to generalisations being made at various levels; attempts are made to fill in gaps between 'fragments' of information and produce an overall sketch of the biology of the species (Frazier 2001a, p. 4). Therefore, to improve knowledge about sea turtles in Colombia and develop more accurate management practices, population trends in nesting grounds must be addressed

4.1.1 Researching sea turtle population trends in nesting grounds

An understanding of reproduction and nesting biology is therefore essential to inform for the recovery and management of sea turtle stocks (Meylan 1999, p. 189; Richardson 1999, p. 9; Schroeder and Murphy 1999, p. 45; Marcovaldi et al. 1999, pp. 301-7; Santos *et al.* 2000, pp. 8-11; Miranda 1998,p.206; Blair *et al.* 1998, p.178). Without this knowledge, well-intentioned yet ill-informed conservation efforts can be detrimental to sea turtle populations (Richardson 1999, p. 9; Yakup *et al.* 1998, p. 199). The negative impact of some such 'conservation' programs is seen through the manifestation of two problems. The first, a management problem, is concerned with the relocation of nests to artificial hatcheries and the effects of hatchlings sex determination due to temperature modification between the natural and artificial nests (Mrosovsky and Yntema 1998, pp. 271-80; Godfrey *et al.* 1999, p. 1465).

A second possible negative impact of ill-informed conservation programs is the situation where a country like Colombia supports the down listing of hawksbill (*Eretmochelys imbricata*) sea turtles, proposed by Cuba, from Appendix I to Appendix II of the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES). Based on no scientific evidence of healthy or recovered nesting populations in the waters and on the beaches of Colombia (Meylan 1999, pp. 189-90), how can the country approve the exploitation and trade of this critically endangered species in other localities within the Wider Caribbean? Effective long-term monitoring is thus essential in documenting true population dynamics in nesting areas and can be used ultimately to reverse negative impacts such as those presented above.

In Colombia, as in other countries around the world, most sea turtle research has been

carried out on nesting beaches, which is a comparatively easier task for scientists than studying population trends in feeding grounds, and because what occurs on nesting beaches is crucial to the survival of the species (Schroeder and Murphy 1999, p. 45; Schroeder 2001, p. 126).

Although studies undertaken to date in the Caribbean and Pacific of Colombia have contributed significantly to identifying where the major species nesting colonies occur and to providing information on certain aspects of their reproductive biology (as has been shown in previous sections and graphs of this paper), this body of research as a whole has overlooked sea turtle population trends. Moreover, the methodologies used for data gathering in nesting grounds each reproductive season are usually inconsistent with those employed the following season.

Gaps in information are common for all Colombian regions in which sea turtle conservation activities are carried out, as Tables 1. and 2. illustrate. This is a critical issue for sea turtle research and conservation - the lack of standardized methodologies adds a bias to the biological information, reducing confidence in studies that compare species populations in time and space within a particular nesting area (Abreu-Grobois 2001, p. 106). Arguably, nesting beaches provide basic data for demographic models such as nesting female population, reproduction parameters and remigration intervals (Richardson 1999, p. 10). In consequence, it is crucial for Colombia to begin to fill the gaps in knowledge in population trends, standardizing methodologies for a better understanding of sea turtles and their management on Caribbean and Pacific nesting beaches.

Even though it is considered one of the more problematic areas of marine turtle biology, research must be directed toward estimating the size of the species' nesting populations - highly significant according to Frazier (2001a, p. 19). Furthermore, it is vital to determine the exact nature of the sea turtle 'population', as only a proportion of the adult population reproduces each year (Bowen and Karl 1997, p. 45). The following section emphasizes research conducted to estimate population size, evaluate demographic processes and effectively determine the current status of sea turtles in Colombia.

4.1.1.1. Measuring nesting population size

Because sea turtles are mobile creatures and difficult to census on land, the most commonly used method for monitoring population trends is to count the number of nests per season at the nesting grounds rather than the number of individuals coming out of the ocean to nest (Meylan 1999, p. 177). This method proves useful as conservation programs do not usually tag female sea turtles, making it impossible to distinguish females nesting several times during the same season (Meylan 2001, p. 4). Thus to estimate population size and demographic parameters, nesting grounds must be assessed by the number of nests on the beach as an indicator of the number of females nesting in a year during the reproductive season (Gerodette and Taylor 1999, p. 67).

Alvarado and Murphy (1999, p. 116) proposed an indirect method for estimating the number of nesting females per year from the total number of nests recorded during the same time period. That is, the number of nests constructed annually can be related to the number of female turtles nesting each season. The total number of nests is divided by the clutch frequency, defined as the average number of nests laid per female per year (Garduno-Andrade *et al.* 1999, p. 288). Clutch frequency varies somewhat from year to year, as well as geographically. Once the value is established for a particular species and

place, based on data collected at a monitored study site where nocturnal coverage includes a comprehensive tagging program (Meylan 1999, pp. 190-3), then estimates of population size can be obtained for sites where only nest counts are available. For example, during the 2001 nesting season for *Caretta caretta* on the Central Caribbean coast of Colombia, 18 nests were identified within 21 Km and the average clutch frequency for this species is known to be at least three nests each season (US NMFS-US FWS 1998, p. 14). Hence, the number of nesting females can be estimated at six (18 divided by 3 is equal to 6 females) for this particular year.

4.1.1.2. Estimating total population size

For the purposes of conservation management, according to Meylan (2001, p. 177), the number of nesting females can be related to total population size (though not precisely) if appropriate data for populations like sex ratio and population structure are known. However, it is important to keep in mind that the high variability of nest counts makes trend estimation difficult. Often the data is too variable to detect a trend with statistical significance and sample error can result in incorrect assessments (Heppell *et al.* 2001, p. 14). To help resolve this problem, Gerodette (1993, pp. 515-6) developed a computer program to determine how many years of nesting surveys are required to detect a trend[26]. This program also identifies the rate of change of these population trends, as well as the probability of detecting a trend given a measured amount of variance in the data available.

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[26] Tim Gerodette and John Brandon from the US National Marine Fisheries Service developed TRENDS. TRENDS is a program designed to carry out an analysis of linear regression, particularly in the context of monitoring populations in wildlife studies. TRENDS summarizes the analysis in 5 parameters: duration of study, rate of change, precision of estimates alpha (type 1 error rate), and power (1-beta, where beta is the type 2 error rate). The value of any one of these can be estimated if the other 4 are specified. The relationships among these is affected by several other parameters, such as whether the change is linear or exponential, whether the change is positive or negative, whether the statistical test is one-or two-sided, and how the precision of the estimates depends on abundance. The software can be down loaded from the Internet from http://mmdshare.ucsd.edu/trends.html.

To convert the number of nesting females per annual season to the total number of reproductively active females in the population at large, the average remigratory interval (inter-seasonal nesting periodicity) must be known. To determine the remigratory interval nocturnal surveys must include the tagging of nesting females for periods exceeding one decade with accurate estimates of tag loss (Richardson 1999, p. 9). This is essential to obtain data over many reproductive seasons for robust estimates of remigratory behaviour (Alvarado and Murphy 1999, p. 117) It is, however, necessary to understand that the act of tagging is not a valid scientific or conservation measure in itself (Witzell 1998, p. 3), and that tagging programs need to take into consideration the real benefits of this tracking method for sea turtle management (Mrosovsky and Shettleworth 1998, pp. 11-5). In conclusion, the presence or absence of each female on the nesting beach and her absolute number of clutches laid are pieces of vital information for improving nesting population assessment.

Colombian sea turtle conservation is constrained by the few and discontinuous seasons in which sea turtle tagging has been conducted, and by the unreliability of the data that has been collected (Amorocho and Pinzón 2000a, pp. 1-38). In consequence, it is a priority for reproductive studies in Colombia to design and support long-term monitoring programs spanning at least a decade. As this will require teams of trained personnel over several years, the capacity and technical knowledge for database management and computer analysis must be developed to provide the most accurate information available for sea turtle conservation. In order to achieve credible results, rates of tag loss should be measured, tag records must be error free, and tagging databases should be accessible to any sea turtle research program (Witzell 1998, p. 2; Richardson 1999, p. 10).

Colombian sea turtle researchers should be cautious when interpreting nesting beach survey data collected over a relatively short time. Yearly fluctuations between nesting seasons (remigration intervals) are common in sea turtles and should be thoughtfully reviewed and considered rather than immediately construed as absolute indications of the health or status of the population (Schroeder and Murphy 1999, p. 53). According to Richardson (1999, p. 10) a management priority for sea turtle conservation is to identify beaches with high reproductive activity, and there estimate nest clutch size and hatchling success rates, identifying the likely causes of low hatch rates and mortality. Assessment of these demographic parameters can provide reliable information for a comprehensive estimation of population size at large. Therefore, the real value of future nesting beach surveys in Colombia lies in establishing a standardized, repeatable and statistically rigorous long-term record of nesting activity for monitor species populations along both the Pacific and Caribbean coasts.

4.1.1.3. Monitoring nests and hatchling success

Monitoring nesting sites includes management of eggs, whereas the best conservation response is to leave sea turtle eggs *in situ* (Miller 1997, p. 70). Unfortunately, in many parts of the world and Colombia is not a exception, egg depredation by people or domestic animals is so intense that hatchling mortality approaches 100% and nest protection *in situ* is largely impossible. Relocation of marine turtle eggs to protected hatcheries is a common conservation practice used to reduce embryo and hatchling mortality and increase hatchling recruitment (Morreale *et al.* 1982, pp 1245-7). Nonetheless, the use of open-air hatcheries has been criticized since it may inadvertently bias the sex ratios of the hatchlings emerging from the hatchery due to changes in the incubation temperature (Mrosovsky and Yntema 1980, pp. 271; Blanck and Sawyer 1981, pp. 163-5). Moreover, as I will look at in more detail in the following

section, population modelling suggests that the conservation of eggs and hatchlings without concurrent conservation of the older life stages may be of limited value (IUCN 1995, p. 2).

Sea turtles hatcheries are especially important as conservation tools in Colombia, since nest predation by humans and introduced animals is the major source of mortality for sea turtles in the Caribbean and Pacific nesting grounds. However, it has been noticed by various studies worldwide that this management practice can be detrimental to hatchling success as well as sex determination as mentioned earlier (Miller 1997, pp. 69-70; Carretero and Trejo 1998, p. 184; Mortimer 1999, p. 175; Naro-Maciel *et al.* 1999 p. 407)(see Annex 2). The use of hatcheries in Colombia needs to be viewed as an interim measure; implemented only when the chances of sea turtle survival are otherwise very low (Godfrey *et al.* 1999, p. 1471). It is crucial to evaluate the possible repercussions of nest relocation over wildlife populations, as a management practice for sea turtle conservation in Colombia. The effects of nest relocation and egg manipulation are issues that have to be considered for a better estimation of species population size (Mrosovsky 2000, p. 7). Thus, information on natural sex ratios is needed, both to guide conservation programs and hatchery practices and to facilitate understanding of the population structure of sea turtles (Marcovaldi *et al.* 1997, p. 756).

Following this line of thinking, alternative options to protect nests from poachers and animal predation should be explored first, in order to reduce the manipulative intervention of eggs. As suggested by Boulon (1999, p. 169), the presence of researchers or surveillance personnel, such as law enforcement officers, survey volunteers and community environmental activists on nesting beaches, can reduce or

even eliminate a variety of threats. Local community involvement is crucial to achieve this purpose (Frazier, 1999a, pp. 16-7; Reichart 1999, p. 221; Vieitas *et al.* 1999, p. 127; Marcovaldi 1999, p. 18; Amorocho 2000, p. 62). Later in section five of this paper, strategies for involving the community in the research and conservation of sea turtles and their habitats are argued and presented.

The reduction of threats negatively impacting on sea turtle eggs and hatchlings on nesting beaches, as well as the protection of the nesting sites, make up just one side of the process required to ensure the long term survival of marine turtles. Sea turtles spend the majority of their lives at sea, and little is known about what they do after they leave the nesting beach (Frazier 2001b, p. 4). Therefore, it is important to concentrate research efforts in feeding areas where sea turtles occur for long periods (Horrocks 2001, p. 132).

4.1.2 Researching sea turtle population trends in feeding grounds

It is from foraging areas that sea turtles obtain the energy for yolk deposition (hence embryonic hatchling and post-hatchling survival) and migration (Bjorndal 1982 cited in Miller 1997, p. 70). Feeding grounds play an important role in the structure and function of ecosystems and, as they have traditionally been little studied, should receive high priority (Bjorndal 1999, p. 12). The importance of feeding areas for sea turtle management conservation is little known in Colombia. The uneven distribution of research efforts has biased research toward nesting beaches (Bjorndal 1999, pp. 126-34). With the exception of one undergraduate thesis study on the feeding behaviour of *Chelonia mydas agassizzi* conducted in the Gorgona National Park on the southern Pacific coast of Colombia (Sánchez and Quiroga 2001, pp. 1-5), no other serious studies have been carried out in Colombian feeding areas. Most of the available information on

sea turtles in feeding areas consists of observations or comments made by local villagers or divers, regarding the presence of a species in coral reefs or seagrass beds (Amorocho *et al.* 1992, pp. 170-1).

The emphasis of conservation programs in nesting beach activities has caused a lacuna in our knowledge of these reptiles in their feeding grounds (Bjorndal 1999, p. 12). As a result, the popular forms of intervention conservation including egg hatcheries, 'head starting'[27] (Ross, 1999, p. 197) and predator control are not meaningfully addressing the threats to a target sea turtle population in foraging areas (Eckert 1999, p. 7). The major threats to sea turtles in feeding grounds are incidental or intentional capture by industrial or artisanal fisheries (Horrocks 2001, p. 136). Thus, the mitigation of threats to adult sea turtles in the feeding grounds is a critical factor in the conservation of sea turtle populations (Eckert 1995, p. 1-3).

The next section of this paper provides five recommendations to guide the conservation management of sea turtles in Colombian feeding grounds.

4.1.2.1. Identify sea turtle populations and their critical feeding grounds

As highlighted by Bjorndal (1999 p .13), identification of sea turtle populations through their life cycle is an area of research that deserves special attention. However, marine turtles are difficult to observe in foraging habitat, and for this reason, several components of their life history critical for conservation management remain unknown

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[27] Head starting is a conservation practice that consists of rearing sea turtle hatchlings in captivity for nine months to a year. Once the young turtles have reached a size more able to survive predation, they are released onto their natal beaches. http://www.bagheera.com/inthewild/van_anim_turtle.htm

(Bowen *et al.* 1996, pp. 566). Most marine turtles undertake complex developmental migrations that carry them through a number of habitat types and many different jurisdictions (Bass 1999, p. 198). It is not generally known which nesting area contributes to a particular feeding area (Limpus 1992, p. 489-450; Limpus *et al.* 1992, pp. 185-6) and this gap hampers a complete understanding of marine turtle life history in Colombia.

Another priority closely related to the elucidation of distribution and population abundance, is the identification of critical habitats - other than nesting beaches - that must be protected to ensure that minimum habitat requirements for known or estimated sea turtle populations (Bjorndal 1999, p. 13) are suitable

Identifying and assessing potential feeding grounds is fundamental to the success of any sea turtle conservation or management program (Bowen *et al.* 1996, pp. 566-7). Studying sea turtles in the water is much more difficult and expensive than studying them on land. However, an increasing number of published studies illustrate a variety of proven methods that can be adopted in Colombia, such as those proposed by Erhart and Ogren (1999, pp. 61-4), Limpus (1992, pp. 489-506) and Collazo *et al.* (1992, pp. 293-300).

Diez and Ottenwlader (1999, pp. 41-3) describe a rapid assessment approach that includes a set of techniques from interviews to preliminary surveys and follow-up procedures that can be employed by sea turtle researchers in Colombia to identify and characterise feeding habitats. In-water studies, like capture-recapture and diet composition, can provide an insight into the species distribution, abundance, size,

classes and behaviour of sea turtles in marine and coastal feeding areas (Bjorndal 1999, p. 12-3).

4.1.2.2. Ensure the protection of feeding grounds

Awareness of the impact of human activities on feeding habitats is clearly a high priority for the management and conservation of sea turtles (Carrillo *et al.* 1999, p. 277-8; Horrocks 2001, p. 133-6; Bjorndal 1999, pp. 13-4). Sea turtles are good indicators of the health and richness of marine and coastal ecosystems (Bjorndal 1997, pp. 212-3; Bouchard and Bjorndal 2000, pp. 2305-7; Jackson *et al.* 2001, p. 634) The priority in Colombia is to develop predictive methods that employ reliable data to respond to some of the unanswered questions about the complex interaction between sea turtles and their feeding grounds. Studies need to go beyond the descriptive level and evaluate the regulatory mechanisms that control demographic parameters. Such studies must examine the roles of nutrition, physiology and behaviour in the regulation of sea turtles' growth and reproduction Bjorndal *et al.* 2000, pp. 269-270; Seminoff 2000, pp. 1-24). In understanding the regulation of productivity, it is possible to predict how sea turtles populations will respond to climatic or anthropogenic disturbances to their environment, amongst others (Miller 1997, pp. 70-1).

4.1.2.3. Better implementation of legislation and policies

Adoption of measures to strengthening law enforcement and reduction of human impacts - like direct harvest or habitat degradation through water pollution, tourism, or shipping - should be encouraged by national and regional environmental authorities, as well as by NGOs working on the ground (Andrade 2001, pp. 93-100; Eckert, 1999, p. 7-8: Reichart 1999, p. 223). Such measures should be designed to reconcile sea turtle ecology with the local, regional and national land planning objectives developed by the

Colombian Ministry of the Environment. Sea turtles and their habitats need to be considered within the integrated coastal zone management initiatives promoted by the Colombian government.

4.1.2.4. Better networking and data management

Although the implementation of survey techniques and legislation requires human and financial resources that are often limited in Colombia, networking can avoid and overcome logistic restrictions, while creating a mechanism for the regular diffusion of information to wildlife managers (d'Auvergne 2001, pp. 121-5; Marcovaldi and Marcovaldi 1999, pp. 39-40). The national research institutes, the Autonomous Regional Corporations, the National Parks System, the Navy, NGOs and local fishermen should be able to jointly devote resources and efforts to carry out sea turtle surveys in coastal and marine feeding grounds.

Following this line of argument, an urgent priority is to develop a computer-based information system of updated information relevant for conservation management of sea turtles. With the use of Geographical Information Systems (GIS) and data sets it is possible to improve predictions regarding future impacts of large development projects, intensified land use and habitat fragmentation in certain habitats critical for the survival of sea turtles (Encalada *et al.* 2001, pp. 9-10). In addition, with the assistance of computer mapping programs and scientific databases, it is possible to know where turtles migrate, what routes they travel and how fast they generally swim (Blamires *et al.* 2001, pp. 9-11). Such maps will also contribute to the determination of the habitat characteristics at the turtles' location. As more information is made available, managers in National Parks, Autonomous Regional Corporations and conservation NGOs will be

able to refine their institutional priorities, as well as to implement specific habitat protection measures to safeguard important foraging grounds and migratory corridors.

4.1.2.5. Track sea turtles in nesting and feeding grounds

Beyond the protection of feeding grounds there are other habitats used by the turtles that also require protection, such as mating areas, developing areas, internesting areas and migration routes (Bjorndal 1999, p. 13; Eckert 1999, pp. 88-93). A clear lack of knowledge of migratory routes and developmental and feeding grounds continues to hamper sea turtle management and conservation. The complex migrations of sea turtles lead to unknowable distribution patterns, with sea turtles from various nesting populations intermingling in feeding grounds (Bjorndal 1999, p. 13; Bowen *et al.* 1996, p. 570). This characteristic significantly increases the difficulties of developing effective management plans for sea turtle populations.

Researchers use several methods to determine where sea turtles move. One of the simplest is tagging their front or rear flippers with metal or plastic tags. Each tag includes a code number and an address to which to return the tag if it is found (Balazs 1999, p. 101). More recently, data acquisition systems for monitoring behaviour and physiology have been developed with the use of microprocessor technologies, including a range of methods such as: VHF and sonic telemetry; satellite transmitters and linked data recorders; hybrid and advanced telemetry systems; geolocation tags; time depth recorders (TDR); and heart rate counters (HRC) (Eckert 1999, pp. 88-92).

Although these methods have contributed to the assessment of sea turtle populations, they are still not sufficient to monitor the extensive migrations of hatchlings, juveniles and adults between mating, nesting and feeding habitats. These migrations are indeed

difficult to track, especially because their movements are largely submerged and encompass vast tracts of open ocean. In many cases, wildlife managers know the location of nesting areas and feeding areas, but do not know which nesting populations use which feeding areas (Bowen *et al.* 1994, p. 1826). This information is vital in assessing the impact of coastal and oceanic fisheries on endangered nesting populations.

The extensive migrations made by most species' juveniles and breeding adults highlight the need to identify those feeding habitats that support specific breeding populations and to assess proportions of different breeding populations present in a particular foraging ground or harvest (FitzSimmons *et al.* 1999, p. 72) An explanation of how genetic tools can be employed to identify nesting and feeding populations to improve sea turtle conservation management in Colombia is presented in the next section of this paper.

4.2 Genetic characterization of sea turtles in nesting and feeding grounds

As can be concluded from the previous sections of this paper, sea turtle biology and ecology are poorly understood, making it difficult to assess and protect these endangered species (Frazier 2001b, p. 15; Richardson 1999, p. 11; Bjorndal 1999, p. 14). Nevertheless, over the last decade, genetic techniques have begun to shed some light on the natural history of sea turtles. These genetic techniques can have conservation applications for wildlife management (Bowen *et al* 1993, p. 5574; Bowen 1994, p.1826; Dutton and Balazs 1995, pp. 9-10; FitzSimmons *et al* 1997, p. 8916; Bowen *et al.* 1998, p. 187; Encalada *et al.* 1999, pp. 8-10; Richardson 1999, p. 10). Advances in molecular biology have made it possible for scientists to reveal detailed

information about population size, structure, breeding systems and individual identity of sea turtles (Bowen and Avise 1995, p. 195-6; FitzSimmons *et al.* 1999, p. 72) With the genetic characterization of sea turtle populations, 'range states' that share sea turtles at different stages of their life cycle will be able to establish integrated regional approaches that ensure the sustainable use of the populations[28] (Bowen and Avise 1995, p. 217; Meylan and Meylan 1999, p .4; Bowen 1999, p. 11).

This section will draw attention to the molecular contributions of DNA assays for wildlife management, demonstrating how these tools can be used to fill lacunae in the natural history and evolution of sea turtles. Following this, the paper illustrates how conservation genetics can contribute to identification of feeding and nesting sea turtle stocks that are vulnerable to human disturbance. Finally, this section will highlight the relevance and implications of genetic markers in the improvement of regional and national conservation programs concerned with the fate of these long distance migratory species.

Before preceding, it is important to explain what a genetic marker is and identify its implications for conservation management.

4.2.1 The molecular genetic toolbox

Twenty years ago direct sequencing of DNA was relatively difficult and beyond the resources available to researchers of sea turtle natural history. To cope with this

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[28]. In the language of international conservation, 'range states' are nations impacted by the consumption of natural resources at a remote location. The 1982 United Nations Convention on the Law of the High Seas recognizes that nations which host the developmental habitat for a species hold exclusive fishing rights for these animals in the open ocean (Dixon and McCorquodale, 2000, p.415). For the case of sea turtles, countries that host nesting and developmental habitats have some level of jurisdiction over fisheries affecting 'their' turtles.

constraint, scientists employed a simple method to survey gene sequences by using DNA cutting enzymes. Restriction endonucleases, which cut DNA at the specific 4-5, or 6 – base sequences, became an alternative to analysing restriction fragment length polymorphisms (RFLPs) in sea turtles (FitzSimmons *et al.* 1999, p. 73; Norman *et al.* p.3 67).

The challenge for early molecular and genetic analysis was in comparing the same homologous piece of DNA from each sampled individual. Considering that the nuclear genome consists of tens of thousands of genes, identifying the same gene from a range of individuals was a huge challenge. The problem was solved working with the extra nuclear mitochondrial genome (mtDNA). In vertebrates, the mitochondrial DNA has an adequate size to assay with restriction endonucleases and search for sequence divergences (Avise 1995, p. 686).

In addition, mitochondrial DNA in turtles is passed from the mother to her offspring and from her female offspring to the next generation. For this reason, variants are typically called haplotypes and when several haplotypes are present among populations, information is received about the structure of female lineages (FitzSimmons *et al.* 1997, p. 1844). With this gender-specific information, behaviours such as female nest site fidelity in sea turtles have been elucidated (FitzSimmons *et al.* 1999, p. 73).

Another powerful molecular genetic tool used in recent years is the polymerase chain reaction (PCR) (FitzSimmons *et al.* 1999, p. 72). From only a few starting molecules it is possible to synthesize millions of copies of a particular segment of DNA (Bowen and Karl 1997, p. 31; Bass *et al.* 1996, pp. 322-3). As a result, mitochondrial or nuclear

genomes can now be efficiently amplified and characterized. A single drop of blood or a small piece of tissue can be used to sample large numbers of individuals from natural populations without causing sea turtles any harm (Bowen and Karl 1997, p. 31; Dutton *et al.* 1999, p. 399; Dutton and Balaz 1995, p. 9; Mrosovsky 2000, p. 5).

One of the fastest evolving segments of the mtDNA molecule is the control region, referred to sometimes as the D-loop (Bowen and Karl 1997, p. 31). This region is the site of the origin for replication of the mtDNA molecule, and its relatively rapid rate of mutation allows fine-scale resolution of population (FitzSimmons *et al.* 1999, p. 72). For this reason, the control region sequencing has become the most accurate method for population definition with mtDNA, as it is the recognized segment for choice of nesting beach (Bowen *et al.* 1992, p. 866; Lahanas *et al.* 1994, pp. 63-5).

The nuclear DNA is inherited from both parents, thus studies using nuclear markers provide information about gene diversity among populations as influenced by both females and males (FitzSimmons *et al.* p. 73). The nuclear DNA segments that are appropriate for sea turtle population studies include anonymous single copy nuclear DNA (ascnDNA) (Karl *et al.* 1992, p. 165), minisatellites (Peare 1996, pp. 87-9) and microsatellites (FitzSimmons *et al.* 1997, p. 1843).

Minisatellite and microsatellite techniques, popularly known as DNA fingerprinting, have also been used to assess pedigrees and the possibility of multiple paternities in sea turtle nests (Bowen *et al.* 1994, p. 1822). These nDNA molecular genetic markers are valuable tools in identifying gene flow within populations and in determining the influence of sexual selection on the evolution of mating systems in sea turtles

(FitzSimmons *et al.* 1997, p. 8915-6; FitzSimmons 1998, p. 75-6). The advantage of microsatellites over restriction fragment length polymorphisms (RFLPs) is that the mutation rate for microsatellites is relatively high, which increases the ability to track coalescence events and detect population–specific alleles (FitzSimmons *et al.* 1997, p. 1844)

Studies of several species of sea turtles are currently underway in many countries around the world and many of the gaps are being bridged as research programs in five continents have begun to apply molecular genetic assays to different aspects of sea turtle biology (Bowen and Karl 1997, p. 30).

4.2.2 Application of molecular genetic markers to the conservation management of sea turtles

Sea turtles, as other species of migratory animals with wide distributions, are composed of several distinct demographic units. The isolation between these Management Units[29] (MU) (also known as stocks, rookeries, or populations) is the result of a low gene flow among reproductive units that follow well-established migratory routes within the species biogeographical range (Bowen 1999, p. 20; Bowen 1999, p. 13; Abreu-Grobois 2001, p. 106).

Therefore, the migratory nature of sea turtles presents researchers with a number of challenges, in particular, the capacity to adequately assess different individuals at different life stages in all their distributional habitats (Horrocks 2001, pp. 132-3). Some

[29] Management Units are demographic sub-units identified by using genetic techniques. The isolation in time and space (annually nesting season) between nesting MUs, is a consequence of low gene flow among nesting females within a particular nesting beach.

frequently asked questions are – How to know where the nesting and feeding habitats are? How do the turtles behave while there? What is the route that a turtle takes to migrate back and forth? These are questions sea turtle biologists need to answer in order to clarify the species distribution and make decisions for their conservation management.

Population stocks are considered by biologists to be the fundamental units of wildlife management and are a prominent concern of wildlife managers. In the case of sea turtles, stocks are defined primarily by the homing behaviour of adults, for example, the strong site fidelity observed in nesting females under the 'natal homing' hypothesis, which states that mature females return to nest on their natal beach (Lahanas *et al.* 1994, p. 57). This characteristic behaviour of sea turtles has been confirmed with the use of genetic markers, that have demonstrate that most nesting rookeries are distinct populations (Bowen and Avise 1995, p. 196).

The exact geographic limits of nesting populations are still being resolved, but the corresponding conservation principle is not controversial: each nesting rookery is an isolated reproductive population. Hence, sea turtle nesting rookeries are genetically distinct and therefore must be treated as independent 'management units' (Abreu-Grobois 2001, p. 106). This principle is an accepted standard for regional management guidelines around the world; if a nesting rookery is depleted by human or natural factors it will not be replenished by turtles arriving from other nesting areas (Bowen and Avise 1995, p. 229).

The discovery of population genetic distinctions among sea turtle nesting rookeries

opened the possibility that genetic markers could be used to identify turtles on distant feeding grounds. This type of analysis depends on 'maximum likelihood algorithms'[30] (Pella 1987, pp. 250-5) and was originally applied to mixed stocks of salmon in the Eastern Pacific (Grant *et al.* 1980, pp. 1240-2). This investigation, known as 'mixed stock analysis' has been applied by researchers worldwide to several sea turtle species, and it is particularly effective when the conservation concern is a fishery in the open ocean, which is beyond the jurisdiction of any individual nation. Mixed stock analysis of genetic markers can determine which populations of sea turtles are impacted by harvest on the high seas; this information has important applications under the United Nations *Law of the High Seas* (Bowen and Avise 1995, p. 217; Bolten *et al.* 1998, p. 6).

The geographic distribution of genetic markers has also been used to evaluate sea turtle stocks that are subjected to international trade. Recently, mixed stock analysis has been accepted by the IUCN as a valid method to evaluate international trade restrictions under the CITES treaty (Bowen 1999, pp. 12-3; Bass 1999, p. 196). Finally, genetic markers have been used to identify turtle species in markets and restaurants. DNA sequence assays can reveal the species of origin, and in some cases, the location of origin for harvested wildlife. Indeed, wildlife management agencies are actively developing genetic markers to detect illegal turtle products in the market place (Roman *et al.* 1999, p. 137; FitzSimmons *et al.* 1999, p. 72).

There is no doubt that in the future, largely complete genetic inventories of nesting populations for each species are likely to be compiled. These inventories will represent

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[30] Qualitative (rather than precise) indicators are used to estimate contributions from multiple nesting locations to the foraging ground composition. There are appropriate for general hypothesis testing (Bass 1999, p.197)

a milestone in conservation genetics of sea turtles. According to Bowen (1997, pp. 45-6), the advantages of genetic sea turtle surveys can be summarized in three points:

1. Global phylogenetic surveys of sea turtles have proven valuable tools for forensic identification. The DNA from meat, bone or shell can be used to identify the species and region of origin. For example, using mtDNA a green turtle recovered from a cargo vessel in the Port of San Francisco (California – USA), was determined to be from a nesting rookery in the southern or eastern Atlantic (Encalada *et al.* 1996, p. 479). Federal agencies in the United States, Australia, the Caribbean and elsewhere are developing DNA sequence databases to monitor turtles and other wildlife appearing in domestic markets (Baker *et al.* 1996, pp. 671-685; Bowen 1999, p. 13).
2. The definition of management units for this group of threatened and endangered migratory species based on mtDNA demonstrates that nesting populations within ocean basins are effectively independent from one another (Abreu-Grobois 2001, p. 106). This genetic data constitutes strong evidence of a barrier to female dispersal between nesting populations, and could be used to assess specific nesting colonies in their feeding ground under the 'natal homing' hypothesis (Bowen 1999, p. 20).
3. With mtDNA analyses of maternally inherited genetic markers and bi-parentally inherited markers nDNA, a large amount of information about population size, structure and sex-specific dispersal (gene flow) can be obtained (Karl *et al.* 1992, p. 163; FitzSimmons *et al.* 1997, pp. 8912-3). In addition, genetic markers for mixed stock assessments and other indirect and direct methods, that is, tagging and telemetry, can identify the source of turtles in feeding areas vulnerable to human disturbance.

This issue is critical for wildlife managers and conservationists at the geopolitical regional and transnational scales, because during the course of its life cycle, an individual sea turtle will pass through the territories of several nations. This means that agreements need to be developed at regional and international levels on how to protect, manage and utilise sea turtles (Eckert 1999, p. 7; Trono and Salm 1999, p. 224). The challenge is to make the best use of these multilateral accords, encouraging full compliance by all parties with the measures involved.

4.2.3 Recommendations for genetic characterization of 'Colombian' sea turtles

At the II International Seminar and Workshop on Sea Turtle Biology and Conservation held in Santa Marta, Colombia in August of 1999, Bowen proposed three priorities for genetic conservation needs of 'Colombian' sea turtles. Firstly, Bowen suggests establishing DNA sequence inventories of nesting colonies (1999, p. 14), which would benefit Colombia as turtles can then be detected on distant feeding grounds, which may be adversely affected by human activities. The second priority discussed by Bowen (1999, p. 14) is to conduct surveys of feeding habitats in Colombian waters, especially those being impacted by fisheries, to determine which populations feed in Colombian waters, and which fisheries may negatively impact Colombian nesting colonies. Thirdly, Bowen (1999, p. 14) suggests surveys of commercial markets may be useful, to determine the origin of turtle products.

Thus, genetic surveys are crucial for sea turtle conservation in Colombia; action beyond that of nesting beach and feeding ground protection is required to prevent the extinction of sea turtle populations. The ever-increasing human activity in coastal regions infinitely threatens sea turtles. As stated by Bowen (1999, p. 14), policy makers and

wildlife managers need to be aware of these menaces sea turtles face away from their nesting beaches, and genetic markers can provide guidance in answering questions.

As populations are the fundamental units of species management, the use of DNA (mt DNA) would allow the nesting populations of sea turtles in the Caribbean to be managed as demographically independent units, as suggested by Bowen *et al.* (1992, pp. 865-81). For this purpose, genetic tools appear able to solve questions involving population structure. The fate of Colombian sea turtle hatchlings is unknown, and their demographic information concerning breeding and feeding grounds will be valuable to determine if these animals inhabit which ocean's regional rookeries, or belong to an isolated reproductive population.

For conservation issues mtDNA will provide a scientific basis for rookery or population management strategies. If the sea turtle populations in Colombia are depleted by natural factors, mtDNA data will indicate whether this population will be replenished by recruits from other rookeries, or whether the Colombian nesting population must recover in isolation (Bowen, B.W., Professor at University of Florida, 1999, pers. comm. August 25).

Once nesting populations are genetically defined, rookery specific mtDNA markers can be used to resolve the demographic composition of feeding grounds (Bowen *et al.* 1992, pp. 865-81). Tagging data indicates that many nesting populations overlap on the feeding grounds. Using genetic markers as mtDNA tags should identify whether sea turtle populations nesting on Colombian beaches are harvested elsewhere. This approach is very important for conservation applications.

At this stage in the paper's argument it is important to point out that wildlife

management and biological conservation are as much about managing people as managing wildlife; in the end they are largely politics, not science (Frazier 1999a, p. 15). Marine turtles have existed for centuries, and continue to do so, inhabiting the world's oceans regardless of protected areas, decrees or national and international law. The conservation problem is created with the ever-increasing involvement of people in the functioning of coastal ecosystems in the form of overexploitation, habitat degradation and other threats that demand conservation intervention.

The involvement of the public is crucial to the establishment and implementation of a fair and effective sea turtle conservation program (Marcovaldi and Thomé 1999 pp. 165-8). The lack of participation of all the parties that were either involved in the program development or stood to gain or lose from a project outcome is crucial for environmental conservation (Sankovski 2000, p. 18; Reichart 1999, p. 222). It is a basic necessity that stakeholders in sea turtle conservation, as well as those who benefit from the use of sea turtles, be stewards of their ecosystems and natural resources (Marcovaldi and Thomé 1999, p. 166-7).

Section five emphasizes the role of public participation as a democratic tool for policy-making. This section identifies and discusses some of the limitations that affect public participation in sea turtle conservation management. Finally, it will suggest recommendations that might improve the participatory processes for sea turtle conservation in Colombia.

5 Prioritising public involvement and sustained participation in sea turtle conservation in Colombia

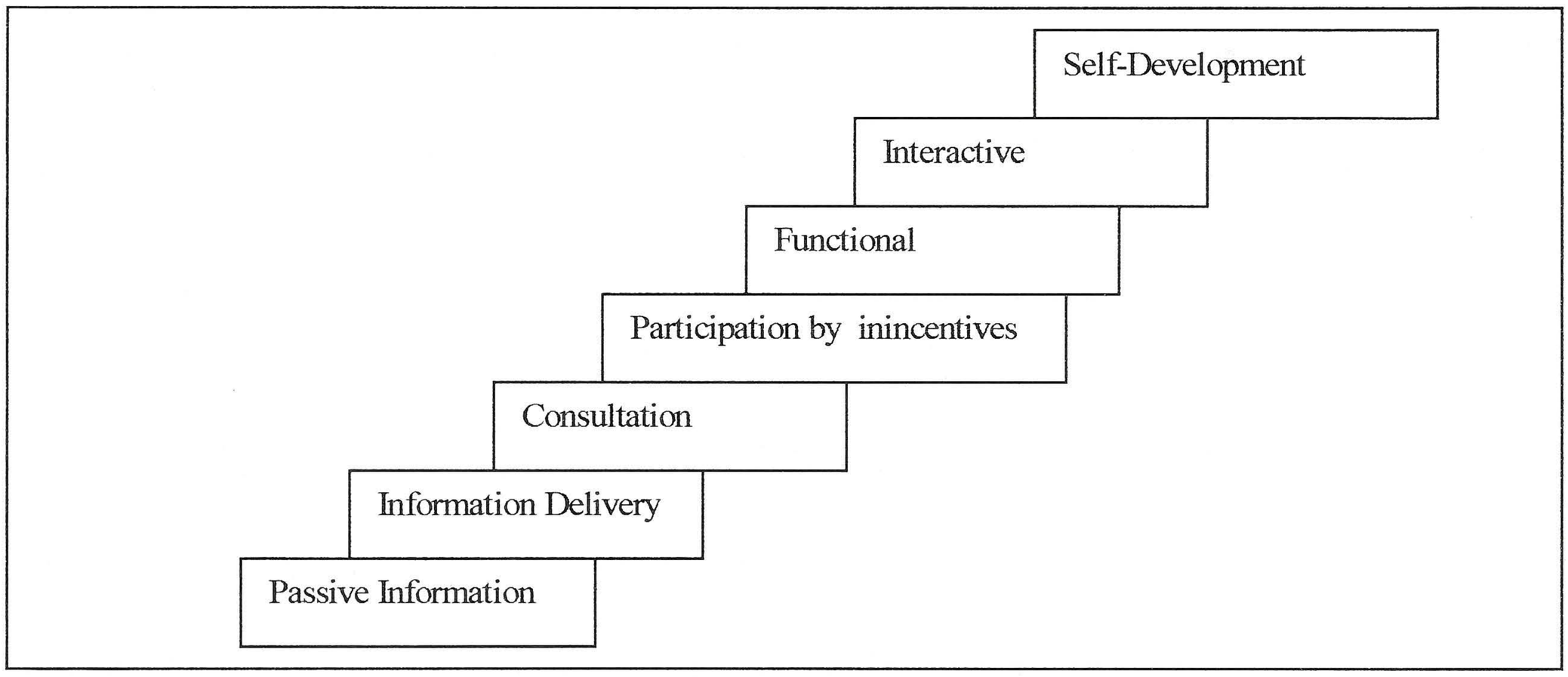
At this stage of the paper, it is important to consider the public as being among a nation's greatest resources for developing and implementing environmental laws, policies and conservation programs. Local people know the country's natural attributes more intimately than a government officer, a politician or, even, a researcher (Bandaratillake 1992, pp. 16-9; Baker *et al.* 2001, pp. 3-19). Today it is widely accepted that the involvement of the public is necessary for establishing and implementing a fair and effective environmental conservation program (Sayer 1991, p. 22; Marcovaldi and Thomé 1999, p. 165; Selener 1997, p. 271; Carr 2002, p. 8).

Public participation is conceptualised by many as the involvement of the public in the decision-making process, with the intention to influence the choice or choices being made (Bickerstaff 2001, p. 432). This definition is consistent with the well known 'ladder of citizen participation' conceptualised by Arnstein (1969, p. 216-24). Arnstein's ladder begins with two levels of 'non-participation', where 'manipulation' and 'therapy' are used by some decision-makers as substitutes for true participation; next on the ladder are three rungs of 'tokenism' that allow people of the lower socio-economic classes to hear and have a voice, but not necessarily be heard. The higher three levels of the Arnstein's model are called 'degrees of citizen power', where partnerships are formed, power is delegated and the public controls decision-making.

Other conceptualisations of public participation are based on the assumption that it is a dynamic process, adaptable to the range of different issues confronting natural resource management and conservation. The 'bottom-up' model (illustrated in Figure 15)

developed by Geilfus (1997, p.3), also using the idea of a ladder of participation, follows a community's progress, from holding a passive attitude toward participation through to a community's ability to self-develop, that is, when local groups make their own decisions with no external intervention.

Figure 15. Participation ladder



Source: 80 tools for participatory development (Geilfus 1997, p.1)

Public participation is also understood to be a mechanism to improve the decision-making process, by enhancing the capability of different stakeholders to cope with current and future environmental problems and underlying challenges related to biodiversity loss (Zwiep 1994, p. 1/4). This section of the paper will discuss the role of the public in decision-making about and implementation of sea turtle conservation programs. The section deals in turn with conservation planning – the legislation and institutional framework relevant to sea turtle survival – and conservation management – the reduction of threats facing sea turtles in Colombian waters or on Colombian beaches. The paper then goes on to identify the limitations to effective public participation in sea turtle conservation management in Colombia. Finally, it presents strategies to overcome these limitations.

5.1 *The role of the public in conservation management*

In many conservation programs the role of the public is scarcely recognized and less often developed; it is a relatively new phenomenon in the decision-making process (Zwiep 1994, p. 1/2). The recent decade saw a plethora of national and international environmental projects and initiatives that failed to reach their goals due to the lack of participation of all the parties that were either directly involved in the project development or stood to gain or lose from the project outcome (Sankovski 2000, p. 18).

Today, there is an acceptance of the public as a valued partner in the environmental protection process. The cooperation between citizens (civil society) and their government (state) is crucial to the success of any conservation management program (Sybesma 2001, p. 140). If the right of people to participate in environmental decision-making really exists, there will need to be guarantees that local communities can exercise this right effectively in both policy planning and conservation management.

5.1.1 Public involvement and sustained participation in sea turtle conservation planning in Colombia

The Colombian National Constitution provides citizens with participatory rights, legally giving the public an active role in the decision and policy-making processes (Colombia, National Environmental System 1993, pp. 5-222; Murgueitio 1997, pp. 11-6). The current environmental policies, as mentioned earlier in the paper, have provisions for people to participate through different mechanisms in the conservation and management of biodiversity within marine and coastal zones (Frazier 1999a, pp. 17; Marcovaldi and Marcovaldi 1999, pp. 39-40; Colombia, Ministry of the Environment 2000, pp. 1-93; Coelho *et al.* 2000, pp. 133-4; Smith 2001, pp. 68-73). Nevertheless, the effort to

involve the public in the decision-making process does not always provide communities or individuals with a defined role in the determination of an environmental policy. This is a common issue in both developed and developing countries, where public participation is no more than a way to transform people into a reliable instrument to achieve that government's administrative goals (Stec 1994, p. 3/4). To avoid this sort of 'tokenism' it is important to reduce the power of government officers to manipulate situations (Martinotti 1999, p. 175) and encourage true public participation, as is also emphasised by Sager:

> ... the force driving levels of consensus and quality in decision-making, and the process by which alternatives are put on the agenda and the procedures for dealing with the items on the final agenda, are significant determinants of the outcome (Sager 2001, p. 769).

In consequence, public participation needs to be guided by a manipulation-free process and an intense interaction between authorities, experts and citizens and, more than anything else, truly collaborative planning and democratic delegation of power and shared leadership (Ploger 2001, p. 220; Bickerstaff 2001, p. 434; Vlachos 1993 cited in Ferraz de Abreu 1996, p. 1/2). However, this situation is not easy to reach and maintain due to the fact that most environmental issues revolve around conflict between groups of people. This is particularly important in the area of natural resource management where the impact of policies depends, in large part, on the performance or reaction of people not under the direct control of any policy maker (Browman 1994, p. 1/12). Methods of informal public participation commonly used by citizens as a way to pressure the government - demonstrations, letters to politicians, protest meetings, and establishing of organizations, or even violent revolutions - largely show that public participation can be very effective in decision and policy-making.

When aiming to involve a community in environmental decision, it is important to set objectives that guide the process. There are a range of public involvement and continued participation objectives that must be achieved for a successful participatory endeavour. Conacher and Conacher (2000, p. 273) propose objectives such as: to increase public awareness of environmental problems and issues; to mutually educated the governors and the governed; to reduce suspicion in the decision-making processes; to seek greater transparency and accountability; to reduce conflict between different interests, and to seek a consensus among stakeholders. There are also diverse ways of achieving these objectives, as identified by Selener (1997, pp. 39-42); the identification of problems, the importance of local values for ideas and in solving problems, and conflict resolution to strengthen community participation in decision-making.

The government, in turn, has profound responsibilities to help the community frame and articulate its demands. This is a difficult task. Governments can employ paternalistic approaches, telling the people what they want and avoiding adaptation by reshaping society instead (Davis 2001, p. 220). Therefore, a real dialogue in which government and community share some understanding of each other's capacities is critical to improve public participation in sea turtle conservation planning. But, what happens when the people lose confidence in the capacity of the representative institutions or government agencies to meet their needs, as has happened in Colombia? A reply to this question regarding participatory environmental management will be possible given once government officers and conservation managers have identified the reasons for the decline of faith in democratic and participatory systems in Colombia.

Social capital is defined by the World Bank (1999, p. 16), as 'the rules, norms, obligations, reciprocity and trust embedded in social relations, social structures, and

societies' institutional arrangements which enable its members to achieve their individual and community objectives'. Thus, a decline in faith in the democratic and participatory systems in Colombia amounts to a loss of social capital. Social capital is widely recognized to contribute greatly to sustainable development; the size and density of social networks and institutions, as well as the nature of interpersonal interactions, significantly affects the efficiency and sustainability of any development process (Pearce and Barbier 2000, pp. 96-8). There is an undeniable need to rebuild the notion of community through greater public participation in Colombia; making possible 'civic engagement', where people are connected with the life of their communities and the politics of their nation (Gibson and Bishop 1996, pp. 1-3). Having social capital means to have the networks, the information and a comprehensive understanding of civic life (Davis 2000, p. 222).

Any open policy-making process involves a broad range of stakeholders, a condition that is both the goal of the process and a potential source of confusion and dissatisfaction for 'participants' who have little access or contact with the government or who are not accustomed to public participation opportunities (Glicken 2000 pp. 306-8). The call for participation formulates two main questions. Firstly, how is participation best structured to emphasise conflict resolution, marginalised groups and networking. Secondly, who should participate at the regional and local levels? Ostrom (1987, pp. 250-265; 1999, pp. 1-2) recommend focusing on institutions, conceptualised as sets of formal and informal rules that shape human interactions with others, and with nature, rather than in the concept of community (Agrawal and Gibson 1999, p. 637). Conversely, as is highlighted by Rosenberg and Korsmo (2001, p.286), this approach can leave NGOs outside of the participatory process since they consist of a range of

groups, some operating at the local grassroots level, and others with connections to national governments. Other social researchers have suggested involving specific local populations, such as poor villagers interacting on a subsistence basis with natural resources, who are often blamed for the environmental degradation (Stonich 1998, p. 28-30; Faust 2001, p. 153-4)

In developing countries such as Colombia, it is important to consider the political and economic forces of elite groups and the coercion and intimidation exerted over poor rural communities by guerrilla-styled rebels and armed paramilitary groups that operate within the country (Escobedo 1998, pp. 37-58; Garcia 1998, pp. 93-113). Also of importance for the government in Colombia is how to rebuild social capital and cope with violence generating mistrust at the community level.

The challenge is to create meaningful participation mechanisms that promote social capital. To achieve this goal in Colombia, it is necessary to devote efforts to finding ways in which people would feel more confident to participate in decision and policy-making; expanding the reach of true democracy (Sager 2001, pp. 629-47; Diduck 1999, pp. 85-97). This does not imply that the government merely has to respond to the community demands or expectations, rather it is more about encouraging active citizenship so people can develop greater control over their lives and their natural resources. The challenge facing the Colombian Ministry of the Environment, its agencies and institutions, and national, regional and local conservation NGOs, is to involve the public in the political system, in ways that would strengthen the participatory process for sea turtle conservation planning in the Caribbean and Pacific coasts.

5.1.2 Community involvement in sea turtle conservation management

Community participation in conservation is one of the nine strategies promoted by the IUCN 'Global Strategy for the Conservation of Sea Turtles' (1995, p. 14). Today, one of the greatest and most complex challenges to the long term conservation of sea turtles is changing historically important habits of coastal communities in which natural resource use is a vital source of income and essential to their survival (Marcovaldi and Thomé 1999, p. 165; Chacón *et al.* 2000, p. 19; Frazier 1999a, pp. 15-8; Amorocho 2000, pp. 62-3).

Generally, the lack of public involvement leads to a shortage of local support for conservation activities, which is detrimental to the survival of endangered species (Sayer 1991, pp. 21-3; Imbach and Godoy 1992, p. 20; Sankovski 2000, pp. 17-8; Tisdell and Zhu 1995, pp. 110-6). There are strong reasons to believe that the overexploitation of sea turtles and the destruction of their habitats in Colombia will continue, if the local communities are not convinced of the benefits provided by current research and conservation programs. If local communities do not really become engaged with the goals of the conservation programs a probable result would be an unsustainable sea turtle conservation plan (Eckert 1999, p. 8).

The experience gained by the Brazilian Sea Turtle Conservation Programme (Projeto TAMAR), over twenty years of activities, demonstrates that the protection of endangered species is only possible if local conditions are acceptable to the people, and if their individual and communal survival is assured (Marcovaldi 1999, p. 18; Vieitas *et al.* 1999, pp. 127-8). In addition, Projeto TAMAR recognised the cultural, social and economic issues driving sea turtle exploitation, a necessary step in successful

conservation programs (Marcovaldi and Thomé 1999, p. 165). To evaluate and propose effective environmental management and development alternatives it is necessary to investigate and learn about the livelihood of local villages.

Before proposing a project, it is crucial to integrate the community into the implementation of the conservation program (Selener 1997, pp. 11-2). If the community is involved in the entire decision making process, their concerns may be met early on in the planning process when changes may be easier to make, rather than late in the process when even small changes may cost both time and money (Lane 1997, p. 10). In addition, this will enable the community to understand, discuss and accept the purpose and objectives of the conservation program. The involvement of the community in the latter stages of the project will surely delay the participatory process and generate mistrust, misunderstanding and rejection (Sankovski 2000, p. 18; Pierce and Wadley 1996, p. 12). At the same time, it is essential that project coordinators and facilitators be realistic and honest in regard to the duration and outcomes resulting from each particular project. Stakeholders from all arenas must be aware of the time factor; community-based conservation is rarely appropriate for the short-term resolution of sea turtle decline (Frazier 1999a, pp. 15-6).

Change from current patterns of resource use to a sustainable and equitable use is both a complex and difficult challenge (Diduck 1999, pp. 85-91; Eriksen 1995,p. 79). To deal with such a long-term goal, project officers and facilitators must develop an understanding of lifestyles, religious perceptions, as well as health and education problems burdening local communities (Pearson and Sullivan 1995, p. 309; Marcovaldi and Thomé 1999, p. 165). Living with the local communities and sharing their

difficulties will enable facilitators to learn about the real factors threatening sea turtles, and should be considered within any sea turtle conservation program. With this on ground knowledge, project officers can identify new sources of income for local communities based on ecologically sustainable initiatives (Castro and Nielsen 2001, p. 237; Smyth 2001, pp. 72-3; Coelho *et al.* 2000, pp. 133-5). This will improve not only the performance of a conservation program, but also the management and the protection of marine and coastal ecosystems as a whole (Marcovaldi 1999, p. 18).

Indeed, contemporary coastal communities, their cultures and traditions, are dynamic and evolve over time and in response to changes (Frazier p. 2001c, p. 2/3). Local communities live in constant contact with markets and have adapted their cultural structures accordingly (Faust 2001, p.165), something that commonly results in increased competition over natural resources and a modern day version of the 'tragedy of the commons' (Hardin and Baden 1997, p. 20; Coop and Brunckhorst 1999, pp. 70-1).

The above situation is worsened by massive community displacements caused by the violence of illicit armed groups operating in coastal areas of Colombia. As a consequence of human displacements, the lack of respect of property rights and 'open access regimes', the risk of natural resource over exploitation increases. These cultural, political and legal obstacles to natural resource conservation make it difficult for local communities to negotiate management arrangements with the governments (Castro and Nielsen, 2001, p. 235). Thus conflict resolution for sea turtle conservation is a way to initiate negotiations among stakeholders moving communities from conflict to collaboration (Oviedo 1999, pp. 163-84; Bush and Opp 1999, pp. 185-200). The

establishment of agreements and commitment around sea turtles and the protection of their important nesting and feeding areas should be a common goal in conflict areas.

To reduce the threat of violence that can drive overexploitation of natural resources, and is currently undermining cultural structures and eroding social capital, the community must be aware that in order to improve the quality of their lives they must become involved in the decision-making process and be and active part of the solution (Pierce and Wadley 1992, pp. 2-13). Whilst, project officers and facilitators must develop an understanding of traditional ecological knowledge and support local decision-making, as well as other environmental initiatives originating from communities (Dwyer 1994, pp. 91-96; Selener 1997, p. 265-6)

To summarize, Berkes and Folke (1998, pp. 1-25) and Frazier (1999a, p. 16) emphasise the need for awareness that the well being of the environment is intimately related to the socio-economic status of human communities and their needs. This implies that the community involvement process requires facilitators who show respect for the structures of local social capital, working through local leaders, organizers and other principal actors. Changes must be promoted based on the cultural roots of the communities giving them recognition and identity through sense of self in place (Cantrill and Senecah 2001, pp. 189-91). Nevertheless, is it is critical to distinguish true leaders that represents community interests, from those pursuing personal or political ends.

These issues call attention to the presence challenges to public involvement and sustained participation in sea turtle conservation management. The following section

will focus on three of the, arguably, more critical challenges facing community involvement in sea turtle conservation in Colombia.

5.2 Challenges facing sustained public participation in sea turtle conservation in Colombia

The most common challenges identified across LAC countries are poor information and public dissemination, lack of training and education, low representativeness, and scarce financial resources (Brownman and Roberts 1994, p. 2/12). This section will focus attention on information and public dissemination, representativeness and funding in relation to sea turtle management. These three challenges significantly influence community involvement in sea turtle management in the areas where the species occur along both coasts of Colombia. The subsequent section provides some recommendations to succeed in the challenges facing public participation in sea turtle conservation management.

5.2.1 Appropriate information gathering and dissemination

The need for full and timely information, in order for public participation to be effective highlights one of the pitfalls in the development of participatory processes for environmental conservation in LAC (Stec 2001, p. 2/3). However, strategies for environmental information and dissemination are rarely assessed by governments and NGOs working in conservation management (Allen 1997, pp. 629-43). Consequently, good information and appropriate dissemination has been recognized as a trigger for change. It is being argued that if people and organizations better understand how their decisions and actions impact on the environment they may well change their behaviour in positive ways (Moxen and McCulloch 1994, pp. 9-19).

It is important to distinguish at this point between the role of the citizen as a provider of information and social values, and the role of the citizen as a decision maker (Cortner 2001, p. 3/3). Both are important to improve the performance of any conservation program and to develop communication channels among stakeholders. Without communication there is no definition of problems, expression of interests, evaluation of alternative solutions, or enforcement of a decision (Ferraz de Abreu 2001, p. 1/1) which is the purpose of public participation. In reference to this, public participation needs to be more than public awareness, which implies one-way information transfer and alerting communities about issues. Instead, public involvement should be a two-way communication process that engages community members to the exchange of information through dialogue (Vlachos 1993, cited in Ferraz de Abreu, 1996, p. 1/2). The advantages of this approach in the long run will be a better informed, educated, and more cooperative public; as Torgenson (1986, cited in Ferraz de Abreu, 2001 p. 1/1) declares: 'one must develop not only knowledge of society but knowledge in society'.

Bear (1994 cited in Glicken 2000, p. 307) proposes the use of new kinds of information in environmental decision-making, enabling a shift from the traditional model of consultation toward a consensual type in which 'every affected group participates'. One of the greatest problems with participatory processes in environmental conservation is the exclusion of key groups from the dialogue. In many cases, this exclusion is inadvertent; in some cases deliberate (Glicken 2000, p. 308). Despite the benefits of public participation for sea turtle conservation management in Colombia, the identification to what extent communities are represented in the participatory processes and how well their voices are heard in the implementation conservation programs is of critical concern.

If this is the purpose of public participation, then, it is important to ensure that all affected individuals or communities receive adequate information in a timely and meaningful manner. The flow of information in two directions will allow communication among stakeholders with different interests in sea turtle or other environmental issues. Considering that different types of information need to go beyond dissemination and public awareness campaigns (Rosenberg and Korsmo 2001, pp .283-300), it is crucial to develop a well-established information baseline for a better consultation process and stakeholders' feedback.

In order to improve decision-making and community participation in sea turtle conservation management in Colombia, there are some research questions that need to be answered. It is necessary to study and investigate how well organizations know what is the key information they must disseminate? How easy is it for the communities to access sources of information? And, by which method can feedback and information assessment be conducted jointly with the communities? In answering these questions research needs to be undertaken in four key areas, as proposed by Moxen and Culloch (1999, pp. 160-1):

1. The availability and efficacy of information sources.
2. The ability of organizations to access and disseminate critical information.
3. The advantages of networking with respect to accessing environmental information.
4. The extent and effectiveness with which disseminating organizations monitor information delivery systems.

5.2.2 Community involvement and representativeness

The problem of representativeness of stakeholders is a challenge in participatory processes for environmental decision-making. This is usually the case for minorities and marginalized groups such as women, youths, peasants, lower castes and indigenous groups that are often excluded, particularly from participatory processes in developing countries (Buckingham-Hatfield 1999, pp. 121-5). As is highlighted by Frazier (1999a, p. 16), indigenous and Afro-Caribbean groups in LAC have largely experienced apprehension about getting involved in a participatory process. This circumstance and the matter of representativeness are discussed in the following section.

Traditional methods of participation were primarily reactive, involving the formulation of plans and proposals before public involvement, with this often viewed as a means of legitimising decisions (Bickerstaff and Walker 2001, p. 433). The practical challenges identified by Bickerstaff and Walker (2001, p. 444) includes poor turnouts to events and meetings, poor response to questionnaires and consultation documents, and general difficulties in engendering participation, particularly amongst the wider public. In addition, on occasion the public is reluctant to use the legal public participation mechanisms, even when such mechanisms are provided (Stec 1994, p. 3/3).

Underpinning this issue, the way stakeholders are identified and represented in management regimes does not necessarily ensure adequate local participation (Castro and Nielsen 2001, p. 236). The general tendency is to identify local stakeholders in very specific and narrow terms as product-centred resource user groups. The concern with this approach often ends up in resource allocation rather than resource management *per se* (Faust 2001 pp. 162) The main problem with this perception according to Faust

(2001, p. 163) is that the community is viewed as user rather than an actor, and this makes conservation difficult, particularly in the case of endangered species. In fact, this poses high risk for indigenous groups willing to deal with natural resources management (Carter 1993, pp. 1-3; Cruikshank 1998, pp. 45-70). Usually indigenous or minorities groups consider the environment in terms of holistic living landscapes and when defined in terms of resource users, they are divorced from their wider ecological and social contexts (Icamina 2001, pp. 115-67)

A huge body of literature highlights the propensity for decision-makers to overlook or misinterpret indigenous and other locals' perspectives (Howitt 1989, pp. 155-167; Chase 1990, pp. 11-25; Gibson and Bishop 1996, pp. 1-3; Baker *et al.* 2001, pp. 247-55). This raises two important issues. The first, highlighted by Lane (1997, p. 310), refers to the traditional cultural perspectives of indigenous people that differentiate them from other local residents in terms of being involved in planning. Under this consideration, the participation of both, indigenous and Afro-Colombian groups in sea turtle conservation is essential. Otherwise, the cultural perspectives of these human groups should be ignored in planning and management.

The second issue mentioned by Lane, relates to the capacity of indigenous people to participate effectively in planning processes (1997, p. 310). Language and cultural barriers, geographical isolation, illiteracy, lack of resources and insecurity, are some of the factors inhibiting the efficacy of indigenous or Afro-Colombian groups participation in planning conservation. These factors are common across other countries, as have been acknowledged by different authors (Ross 1992, pp .47-76; Dale and Lane 1994, pp. 253-67).

For good representation of indigenous, Afro-Colombians, and other minority groups it is critical to directly involve a range of local groups with traditional links to the coastal areas. By doing this, special attention needs to be paid to the diverse and localized social environment to avoid well organized regionally-focused groups from dominating less-organised and locally oriented groups, with particular traditional and historical roots as suggested by Lane (997, p. 317).

To involve indigenous and Afro-Colombian groups in sea turtle conservation planning and management is fundamental for the cultural bases of social and territorial organizations, as well access to financial resources offered by national or international donors. Failure to incorporate both conditions into the design of the conservation program will ensure the under-representation of some groups and the dominance of others (Lane 1997, p. 320; Carr 2002, p. 121)

The third limitation is related to financial resources constraints. This is a common issue to most of sea turtle conservation programs carried out in developing countries. The paper moves now to describe the financial constraints related to public participation and the fragile sustainability of sea turtle conservation programs in Colombia. Based on other experiences in LAC, the following section will provide ideas on how to overcome this limitation.

5.2.3 Financial resources to seek and support community involvement

Two aspects deserve special attention in this section. The first concern is access to funding for stimulate the participatory process in local communities and improve environmental decision-making. The second concern is lies with the strengthening of financial resources for sea turtle conservation management in Colombia.

The countries with some degree or advanced legal framework for public participation have often discussed its effectiveness. As mentioned by Zwiep (1994, p. 2/12), the arguments against a system of public participation are nearly the same everywhere: it is too expensive and it delays the decision-making process. In addition, public participation for environmental conservation cannot be effective without some fundamental *prerequisites*: information resources, financial resources, education and training (Browman and Roberts 1994, p. 2/12). On the other hand, a legally sound system of public participation presents advantages for the government – the quality of the decision making process proves to be better and the decisions that are made, more harmonic (Glicken 2000, p. 306).

If there is an established legal system for public participation, it implies a human and financial commitment from the official side to facilitate the activities of organizations and/or individual citizens necessary to carry out the process. (Zwiep 2001, p. 1/2) The limited budget of government environmental agencies makes difficult to ensure the participatory process in Colombia (Biocolombia 2000, p. 11-3). The NGOs have been playing an important role in raising funds to support the government's policies, but they inevitably run up against the lack of funds and the financial instability involved in biodiversity conservation (Caribbean Environment Program 1996, p. 3/18). Therefore, networking appears to be an option under financial restrictions.

Partnerships among government agencies, NGOs and local communities, through organization and cooperation, are means that need to be considered and improved for funding community involvement in sea turtle conservation (Sybesma 2001, pp. 140-1). In this way fragmentation of knowledge, energy and funds can be prevented. An

understanding of environmental issues is not only the responsibility of the government; the citizens and their organizations must also be part of the solution (Ransom and Ettenger 2001, pp. 219-20).

Therefore, an integrated strategy to identify and access available sources of funds is required in Colombia for effective public participation in sea turtle conservation management. This strategy must include sea turtles into larger projects presented by the government to multinational aid agencies; the development of multi-species proposals with other groups of endangered or endemic species; and the setting up of small-scale businesses as economic alternatives administered by communities or NGOs (Winter and Eckert, 1994, p. 25-6).

The Colombian undeclared war imposes restrictions to researchers and conservationists working on the ground. Beyond the security conditions in which sea turtle conservation programs operate in Colombia, international or national donor agencies are reducing support to conservation projects in high-risk countries. They do not want to be blamed for casualties and prefer to avoid this type of responsibility. Most, if not all of the suitable nesting beaches for sea turtles in Colombia coincide with the zones of war. Therefore, funding for activities in sea turtle conservation in Colombia are challenged through the need for innovative fundraising techniques.

Fundraising in sea turtle conservation needs to move towards ecological marketing or green business rather than depending exclusively on donations to non-profit projects. Clearly, donor agencies must be partners in environmental business producing monetary benefits. This condition is particular attractive when communities, government and

NGOs get involved and committed, with the common stake of ensuring sea turtles' survival.

The Brazilian TAMAR project is an excellent model to adapt for the sustainability of the Colombian sea turtle conservation programs. Taking advantage of the non-consumptive uses of sea turtles, TAMAR has combined ecological marketing with community involvement and conservation management. The ecological marketing of TAMAR is based on the local production of goods and services inspired by the conservation of endangered species like sea turtles (Vieitas and Marcovaldi 1997, p. 607; Marcovaldi and Marcovaldi 1999, pp. 38-9; Vieitas *et al.* 1999 pp. 127-8). Besides the small business chain created by TAMAR, which includes the sale of T-shirts, handicrafts, innovative fishing alternatives, tourist ventures and adoption campaigns, there is a strong relationship among communities and the project due to reinvestment of funds in fostering local jobs and social benefits like health and education (Marcovaldi 1999, pp. 18-19).

Therefore, sustainability for sea turtle conservation programs is possible to be achieved. Nevertheless, it is a difficult task that requires broad participation and strong commitment from local, regional, national and international stakeholders. As stated by Marcovaldi (1999, p.19), isolated conservation programs without public support will turn fragile and vulnerable if they do not involve different sectors of society, ranging from fishermen to ministers. In recognition of the cultural, socio-economic and nutritional significance of sea turtles, community-based can be an alternative for conservation management in Colombia. To be conducted properly, it would need to

preserve the integrity of the local communities and ensure the long-term survival of sea turtles, an essential component of the Colombian coastal cultures, identities and lives.

6 Conclusion

In order to increase success and efficiency of long-term sea turtle conservation programs in Colombia, lines of action must be prioritised. The prioritisation and integration of directed research for conservation management and policy planning ends, and the sustained involvement of the people living in the coastal zones can bring Colombia closer to sustainability.

6.1 Directed research for sea turtle conservation management ends

Marine turtle research in Colombia is hampered by uncoordinated and fragmented information gathering and data analysis, and the ineffective dissemination of results for conservation management. The majority of sea turtle research carried out in the Colombia coastal and marine regions has overlooked the most important issues related to long-term population trends for sea turtle conservation. Much of the available information is inconsistent and incomparable between nesting years on the same beach. In addition, low input into data analysis leads to inadequate decision making for conservation research and sea turtles management.

Without conducting genetic analyses it will be impossible for Colombia to determine to which nesting population a given marine turtle belongs, and thus for wildlife managers to know which nesting populations use which feeding areas. This is due to the fact that individuals from separate nesting beaches mix in feeding grounds and the open ocean. Genetic identification of Management Units (MU) and well-developed tagging programs managing standardized, accurate and appropriate information through an accessible data base, are the first priorities for long term assessment of sea turtle nesting populations status in Colombia

Little is known about sea turtles and their feeding habitats along the Colombian coasts and in Colombian waters. Therefore, efforts must be devoted to assess population trends in these areas. Surveys in feeding grounds must be the second priority for sea turtle research in Colombia. Critical feeding grounds must be identified and protected. Tagging, measurement of species individuals, diet composition and ecological studies should be conducted in acknowledged feeding areas. Telemetry and underwater techniques need to be employed to track individuals when leaving the feeding grounds. Geographical Information Systems (GIS) are essential for monitoring habitat alterations and sea turtles behaviour on a long time scale.

Although open beach hatcheries in Colombia have been a traditional conservation measure to protect nests, the benefits are still controversially established. The current practice of relocation can be imposing bias in sex determination and at the same time, reducing the hatchling success rates from those found in nature. It is important to concentrate efforts in changing social behaviour rather than in establishing more beach hatcheries. As far as most nests remain in their natural habitat, the closer wildlife managers will be to accomplishing true conservation.

6.2 Policy planning and sustained community involvement for sea turtle conservation management

Poor coordination among local, regional and national governments and the omission of crucial stakeholders from the planning process, are challenging the appropriate design and enforcement of participatory policies in Colombia. Public awareness, information dissemination and community involvement need to be strengthen at the local and regional levels. Strategies including incentives and alternative sustainable practices

should be identified and fostered to encourage community involvement in the decision making process for policy planning and conservation management. A combination of 'top-down' and 'bottom-up' approaches must be considered for improving public participation in sea turtle conservation in Colombia. Giving the community a certain degree of control over natural resources management will contribute to enhance the participatory process. Assessment and evaluation of the planning process should be carried out periodically by external facilitators, with experience in conflict resolution and community based management

The roles of Integrated Coastal Zone Management (ICZM) and Land Planning process are critical to ensure the protection of sea turtles habitats and control the negative impacts of human environmental threats. Effective planning must be closely coordinated between the three levels of the Colombian government through the legal participatory mechanisms provided by the National Constitution. Specifically, regulations can be included in the goals of the ICZM and Land Planning processes, focusing on protection or mitigation measures that ensure the quality of nesting and foraging grounds for sea turtles. To conserve migratory species the national planning process should complement a broader international perspective.

Due to the complex life cycle of sea turtles, which includes long distance migrations, there are international issues such as: local harvest, pollution, coastal and open sea fisheries, that make effective conservation management difficult. The collection of sea turtle eggs in Colombia will affect the future of this resource in other Caribbean or Latin American countries, and vice versa. Thus, national policies and conservation measures need to be harmonised with international law and cooperative regional agreements, in

order to guarantee the protection of sea turtles and their vital habitats in their entire distributional range.

6.3 Sustainable use and sea turtle conservation management

Sea turtles populations are declining dramatically in the Colombian coastal and marine zones, as a result of over exploitation of adult nesting females and egg poaching. Artisanal and industrial fisheries have also been largely responsible for the decrease in numbers of sea turtles while they are in coastal or pelagic waters. Contemporary Colombian coastal communities are loosing social capital through alterations in their cultural patterns and adaptive natural resource management. Indigenous and Afro-Colombians traditional practices are inadequate to ensure the survival of endangered sea turtles. The acculturation process and rejection of traditional knowledge and values are jeopardizing the fabric of these human societies. Thus, the challenge for current conservation programs in Colombia is to integrate culturally acceptable practices that protect sea turtles and provide benefits to local communities. There is no way these coastal communities can continue to exploit sea turtles and their eggs as it they have since the Spanish conquest.

Developing sustainable activities that are also culturally informed is a priority to reduce the decline of sea turtle populations in Colombian waters. There are many issues, both social and ecological that need to be considered before the identification and implementation of an economic alternative. This means that communities require advice and reliable information in order to suggest alternatives that would contribute to fulfil their basic needs. It also means a greater degree of empowerment of and control by the community in natural resources management

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Annex 1. Summary of the known distribution of sea turtles along the Colombian Pacific and Caribbean Coasts

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Region	Especie	Location / Nesting Beach	Number of nests recorded / year					Total nests
			1997	1998	1999	2000	2001	
Central Caribbean Coast	Loggerhead *Caretta Caretta*	Don Diego		12		9	1	22
		Buritaca		1		5	1	7
		Guachaca		4			1	5
		Mendihuaca					6	6
		Quintana		4			8	12
		Los Achotes		1				1
		Palomino			8	6	1	15
		Total		22	8	20	18	68
	Leatherback *Dermochelys coriacea*	Don Diego					2	2
		Buritaca					2	2
		Guachaca					2	2
		Palomino				1		1
		Total				1	6	7
	Green *Chelonia mydas*	Guachaca		4				4
		Total						
	Hawksbill *Eretmochelys imbricata*	Cinto		5				5
		Guachaca		1				1
		Los Achotes					1	1
		Total		6			1	7
Insular Central Caribbean Region	Hawksbill *Eretmochelys imbricata*	Isla Rosario			2			2
		Isla Tesoro			3			3
		Total			5			5
San Andrés Archipelago	Loggerhead *Caretta Caretta*		32	9	5			46
	Leatherback *Dermochelys coriacea*		1					1
	Green *Chelonia mydas*		7	5				12
	Hawksbill *Eretmochelys imbricata*		22	6				28
	Total							

Annex 2. Nesting activity, intervention type and hatchling success in the Darién Region

Region	Especie	Location / Nesting Beach	Number of nests recorded / year					Total nests
			1997	1998	1999	2000	2001	
Darien Region (Acandí - Playona)	Leatherback *Dermochelys coriacea*		27	98	124	373		622
	Total							
Southern Pacific Coast - Sanquianga National Park	Olive ridley *Lepidochelys olivacea*	Naranjo		106	188			294
		Mulatos		24	68	51		143
		Amarales		0	34	10		44
		Guayabal		4	142	0		146
		Total		134	432	61		627

Region	Especie	Location / Nesting Beach	Number of nests recorded / year							Total nests
			1991	1992	1993	1994	1995	1996	1997	
Northern Pacific	Olive ridley *Lepidochelys olivacea*	Playa Larga	56	56	30	69	46	50	36	343
		Total	56	56	30	69	46	50	36	343

Annex 2. Nesting activity, intervention type and hatchling success in the Darién Region.

Nesting season	Nesting Beach	No. of nests	No. of eggs	Type of incubation	Released hatchlings	Hatchling success
1997	Acandi-Playona	27	1,722	Hatchery	298	17.30%
1998	Acandi-Playona	88	4,661	Hatchery	1,219	26.80%
1998	Acandi-Playona	10	647	in situ	432	66.70%
1999	Acandi-Playona	90	7,308	in situ	1,597	21.80%
1999	Acandi-Playona	34	769	Beach relocation	206	2.82%
2000	Acandi-Playona	68	6,895	In situ	10,516	72.25%
2000	Acandi-Playona	305	19,237	Hatchery	4,666	63.13%
TOTAL		**622**	**41,239**		**18,934**	

Notes:

1. The above data has been collated from numerous sources including project reports, proceedings,conference proceedings, government plans, research and conservation project reports, undergraduate thesis and personal field notes produced by a range of organisations, namely: the Colombian Ministry of the Environment, the National Parks System Special Administrative Unit (UAESPNN), Widecast- Colombia Association, CEINER, Darien Foundation, Natura Foundation, Sea Turtle Foundation of Santa Marta, Jorge Tadeo Lozano University, Popayán University Foundation, University of Atlántico, communities of Cabo de La Vela, Palomino, Don Diego, Buritaca and Acandí, Mulatos and El Valle, on the Caribbean and Pacific coasts.
2. Empty cells in the above tables represent an invitation for the provision of recorded data or, in its absence, they represent gaps in sea turtle research in Colombian.