Final report of the pilot project:

First genetic survey on the Magdalena's endemic fresh water turtle *Podocnemis lewyana* (Testudines, Podocnemididae) and its relation with human communities. Consequences for the species conservation

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First genetic survey on the Magdalena's endemic fresh water turtle Podocnemis lewyana (Testudines, Podocnemididae) and its relation with human communities. Consequences for the species conservation

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El proyecto en español: www.fundacionbiodiversa.org/proyectos_tortuga.html

Statements, opinions and preliminary analysis of the species-human communities section, are exclusive production and responsibility of Mario Vargas-Ramírez.

March 2006

First page photo caption:
Locality: Terraplen, Cienaga de doña Maria, Cesar, Lower Magdalena river, Colombia. 16/03/05. Juan Carlos is showing us his present. The adult female turtle, caught the previous night by his father laying its eggs on a nearby beach, was about to be killed and cooked as a lunch. The turtle found in its "owner" a little conservationist, who had a different plan for her: "Release it and let it lay the eggs". This village, located on the lower Magdalena river has a fishermen organization, committed to start a community-based conservation-initiative for *Podocnemis lewyana.*
Photo by: Mario Vargas-Ramírez.

This research is dedicated to my dearest friends Katty and Oscar.
And all the Colombian kids who are looking for a chance…

Table of contents

Figures

Tables

1. Introduction

Because of its position and particular geographic features, Colombia can be considered as a mega diverse country. Despite of the lack of biological research and incomplete fauna and flora inventories, it is well know that Colombia is among the five most biodiverse countries of the world (first in biodiversity of birds and frogs, second in vascular plants and third in reptiles). Just with the 0.7% of the world's land surface, has got 10% of the world's animal and plant biodiversity (Instituto Humboldt, 1999). Colombia has approximately 3290 species of vertebrate (mammals, birds, reptiles and amphibians), although some of these groups (fish, amphibian and some reptiles) are still poorly known. The growing number of extinction threatened species in Colombia, shows a serious process of environmental degradation related mainly to habitat loss. This phenomenon has been identified in important bio-geographic regions like Choco-Magdalena, Nor Andean and Amazon, which appear to have the highest number of threaten species (Instituto Humboldt, 1999).

In Colombia, about the 85% of the rural population- peasant, afro-Colombians and indigenous people are facing deep poverty, inequality and political instability. High percentages of these people are depending on natural resources, resources that are reaching critic of levels of depletion. Biological and cultural diversity are disappearing dramatically (WWF 2001).

The lack or incomplete biological and social base information, do not allow the creation and implementation of adequate and coherent actions towards the management of wild fauna. Ideas and possible solutions from a multidisciplinary ground, where scientific research could support socio-cultural initiatives and needs, and vice versa, must be searched.

1.1. Turtles and genetics

Turtles are one of the oldest vertebrate groups on earth. However its diversification has been very little. To date just 300 a live species are known (Iverson, 1992). This represents just the 4. 76% of the 6300 alive described reptiles' species (McNeely, 1990). Turtles are important part of the ecosystem because they play important roles in energy flow,

nutrient cycling (Moll & Moll, 2004) and are the "angular stones" in the trophic chain, establishing complex relations with many other species.

Testudinata order is after Crocodilia, the second most endangered group of the world. More than 200 species have any threat to extinction risk and the 80.7% of the species inhabit the tropical regions (Mittermier et al, 1992).

Colombia harbors 25 of the 53 species of continental turtles and tortoises found in the Neo-tropic, being one of the richest countries in Testudines of the region (Ceballos, 2002). Due mainly to habitat loss and human exploitation, fourteen of those species are threatened to some degree (Castaño-Mora, 2002) and are registered within the risk categories of the IUCN (International Union for Conservation of Nature and Natural Resources) Red List. Continental turtles and tortoises can be considered as the most endangered vertebrate group (Castaño-Mora, 2002). Colombia harbors the six species of the fresh water turtle genus Podocnemididae, and all of them are threatened (Castaño-Mora, 2002). In Colombia *P. erythrocephala* is vulnerable (VU, Castaño-Mora & Medem, 2002), *P. unifilis* and *P. expansa* are considered critically endangered (CR) in the Orinoquian region, and endangered (EN) in the Amazonian region (Castaño-Mora, 2002), *P. vogli* is near threatened (NT, Castaño-Mora, 2002), *P. sextuberculata* with data deficient (DD), but suggested threatened (Castaño-Mora, 2002) and *P. lewyana* is endangered (EN, Castaño-Mora & Medem, 2002). The problems concerning Podocnemididae turtle's conservation are both difficult and urgent (Vanzolini, 2003).

There are at least three biological reasons that make the preservation of genetic variation of wildlife populations one of the major goals of conservation biology:

- The loss of genetic variation may increase the probability of population extinction through a decline in fecundity and viability. E.g.. inbreeding depression (Frankham, et al. 2003).
- Populations with low levels of genetic variation, upon which natural selection could operates, may have reduce opportunities for future adaptation through evolutionary change (Loeschcke, 1994).
- The preservation of genetic variation may play a key roll in identifying evolutionary significant units for conservation, i.e. genetically distinct populations of management concern (Moritz, 1994). The genetic variability of populations is thought to be closely

related to the persistence of populations (Soule, 1987): the loss of genes now is the loss of new species in the future.

There is a good reason to believe that most species do not exist in stable populations, but they are subdivided into a network of interacting, locally unstable subpopulations. These so-called meta-populations constitute special problem and potentials for species conservation, because their unique ecological and genetic properties. The problem of genetic variation of species is associated with the geographic distribution of genotypes, which constitute sub species, races or ecotypes (Loeschcke, 1994).

1.1.1. Podocnemis Lewyana *(Duméril 1852).*

The Madgadelan's river turtle (Fig 1) is a middle sized, fresh water Colombian endemic turtle from the Magdalena and Sinú river basins in Colombia (Ernst & Barbour, 1989). The species has a clear sexual dimorphism. Females are bigger than males. The maximum Straight Carapace Length (SCL) registered is 50 cm in females and 36 cm in males (Gallego-García & Castaño-Mora, in press).

As diagnostic features, *P.lewyana* has got 24 marginal shields, 5 ventral shields and 8 pectoral shields. The carapace is oval and is not high (compared to other *Podocnemis* species) and the inclination from the middle to the posterior region of the carapax is more pronounced and long than the anterior region (Hurtado, 1973). Its color is gray-brown or olive-brown. *P.lewyana* is an aquatic species and only goes out of the water to lay the eggs and bask on trunks or beaches. It lives mainly in rivers, although can also be found in small tributaries and small lagoons connected to rivers. It prefers deep quiet places with abundant dead leaf and trunks on the bottom, where it can hide and have easy access to basking places. It is herbivorous, although can also eat meet in captivity (Dahl & Medem, 1964). The natural predators of adults are crocodiles (*Crocodylus acutus*) and alligators (*Caiman crocodylus*). Juveniles are predated by cat fish, alligators and otters. The eggs are eaten by lizards (e.g. *Tupinambis teguixin*), Iguanas (*Iguana iguana*), domestic dogs and pigs. Local fishing communities have used its meat and eggs for many years. Traditionally, the consumption levels are generally higher at Easter when eating turtle is an obligation more than a tradition (Castaño-Mora & Medem, 2002). This

religious festivity matches with the dry season throughout the turtle's distribution range. During this time, female turtles lay their eggs on the beaches, being easy to catch by local inhabitants. Because during Easter, the consumption of chicken and beef meat is forbidden in Colombia by catholic religion and the availability of fish is decreasing, the demand of turtle meat and eggs by small-medium urban centers has opened an opportunity of income to local poor communities through illegal trade. The hatchings are also illegally persecuted as pets (Castaño-Mora, 1986).

Although *P. lewyana* is legally protected since 1964, and is in the "National Program for The Conservation of Turtles" (Rodríguez et al., 2002), which includes an action plan for its conservation, there is little information available on the ecology and demography of this species and its relationships with human communities. Furthermore, there is not a National Park or alike in the species distribution range. These facts make Colombia the country, which must be responsible for the turtle survival, knowledge and research.

P. lewyana belongs to one of the ancient turtle linage. These species-poor clades comprise the most ancient components of the evolutionary history of turtles. Given that many of them are under extreme pressure from exploitation for food, medicine and other human activities, they deserve particular attention as conservation targets.

Due their often specific habitat requirements (Pritchard & Trebau, 1984; Ernst et al., 1994), delayed sexual maturity, juvenile mortality (Castaño-Mora et al., 2003, Paez & Bock, 1998), limited dispersal capabilities of some species and human exploitation, some fresh water turtles species (e.g. *Hydromedusa maximiliani*, Souza et al., 2002) are highly vulnerable to habitat-isolation, small population size and loss of genetic variation (Souza et al., 2002). Due to the apparently generalized low levels of genetic differentiation (see Janzen et al., 1997) and because many species are in need of conservation measures, identification of genetically distinct populations of turtles is important in guiding conservation strategy in many taxa (Janzen et al., 1997).

Figure 1. Adult female *Podocnemis Lewyana.*
Photo: Natalia Gallego

Conservation genetic studies for species in the genus *Podocnemis* have only been carried out in the Amazon region. Sites et al. (1999) developed specific microsatellite markers for *P. expansa*. They used six of them for evidencing metapopulation structure, insinuating gene flow within one river basin, but little gene flow between beaches in two separated river basins. They also obtained the first mitochondrial DNA data, using sequences of 354 bp of the control region mtDNA. The results were congruent with the microsatellites analyses. Valenzuela (2001), using eight *P. expansa*-specific microsatellite loci, found significant among beaches differentiation in four nesting sites within the middle Caqueta river basing, Colombia. Bock et al. (2001), researching on *P. expansa* and *P. unifilis* using allozymes, found concordant results for *P. expansa* and higher levels of genetic variability for *P. unifilis*. Here we report on the first genetic inventory on *P.lewyana* along its distribution range, using sequences of the mitochondrial gene c*ytochrome b* of 109 individuals from different populations located at several different localities along the four main river basins: Magdalena, Cauca, San Jorge and Sinú drainages (Fig 2). The Magdalena is the principal river of Colombia. It rises at the bifurcation of the Andean Cordilleras Central and Oriental, and flows northward for 1,497 km (930 miles) to the Caribbean Sea. The Cauca river is separated from Magdalena river by the Central Cordillera, and together with the San Jorge river, flow into

Magdalena river in the swampy floodplain of the northern lowlands at its lower part. The Sinú river form a separate drainage and although it is located close by San Jorge river (Magdalena drainage), there is not a direct communication between them.

It is though that the dispersion of *P. lewyana* is restricted to the rainy season, when some of the temporary water systems are connected with each other and with the main rivers (Castaño-Mora, pers.com.). However it has not been proved that individuals can go from one river basin to the other.

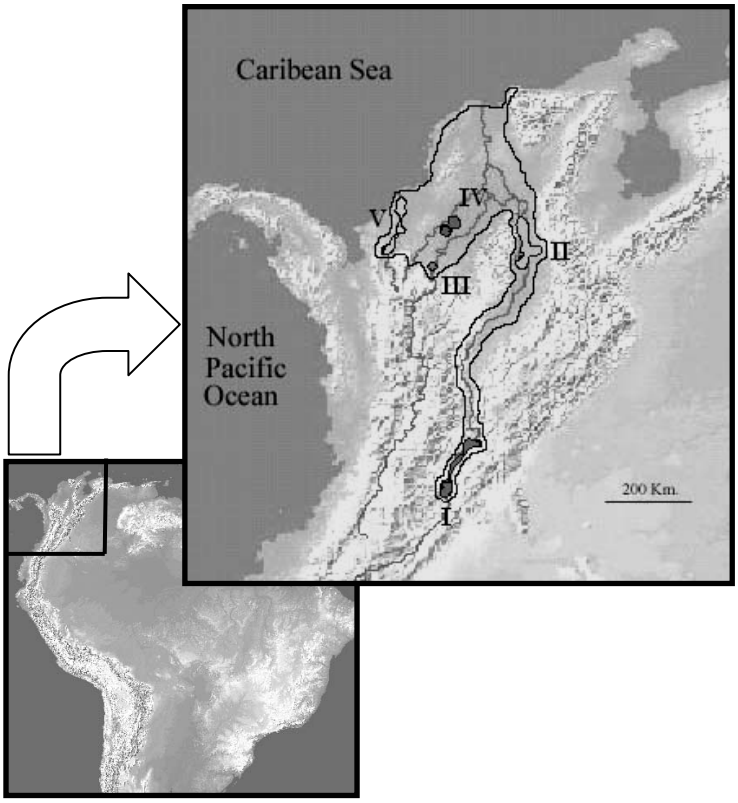

Figure 2. Map of the five regions sampled over the distribution range of *Podocnemis Lewyana.* I: Upper Magdalena River. II: Lower Magdalena River. III: Man River (lower Cauca River). IV: San Jorge River. V: Sinú River. The species' distribution range approximate area, is enclosed by black line (according to Castaño-Mora & Medem, 2002).

It is extremely important to understand the role that human communities play over wild species populations and their habitats. As a part of any conservation biology research, actions and activities involving the local communities and institutions have to be one of the main goals. We must provide the means to local people, who maintain ecologically sound practices, to play a primary role in all stages of development in the area they identify with, so they can participate and benefit directly, in a manner which is consistent

with their values, time, frames and decision-making processes. By seeking continuous local support in shaping and implementing conservation strategies, the potentials for achieving the goals of the world conservation strategy can be increased considerably (McNeely & Pitt, 1985). The current popularity of terms like "Sustainable Development and use" requires those concerned with biological conservation and natural protection to cooperate with others, in meshing environmental and biological goals, critiques and strategies with those of peace, social justice, equality and economy (Gibson, 1991; Roseland, 2000). During the past 20 years the deep and rich local knowledge system that underpin community-based renewable natural resource use and management system have been widely demonstrated, specially for agriculture, animal husbandry, forest and agro forestry, medicine, technology, and biological, physical and geographical phenomena (Ruddle, 2001). Local knowledge includes empirical and practical components that are fundamental to sustainable resources management. Local knowledge is therefore an important cultural resource that guides and sustains the operation of customary management system (Ruddle, 2001).

Local knowledge in many cases is rich and varied, and, equally clearly, the potential for applying it to the management of tropical resources is substantial. But first it has to be collected. Since research projects to record and evaluate local knowledge are rare in the third world, although the numbers are growing, there is an urgent need to stimulate low-cost data gathering. Once collected it must be verified and also blended with more technical forms of biological research, like population dynamics, population genetics and physiology, among others, before it can be put to best use. But evaluation is not easy. Objective criteria must be designed to evaluate it and to discriminate biological truths from a mass of myth. Such criteria need adapting to each distinct culture group. It is important to select the appropriate informants, as not all members of the community will be experts in all areas of ecological knowledge (Ruddle, 2001).

This pilot project aimed to start collecting and analyzing preliminary biological and social base information of the Magdalena's river turtle *Podocnemis Lewyana*, for the creation and implementation of adequate and coherent actions, towards its protection, conservation and sustainable use. The three main goals were: 1) To investigate the

genetic variability and examine the relationship among populations of *P. lewyana* from different localities widespread over its distribution range using mtDNA *cytochrome b* sequences. 2) To assess preliminarily the species' threats and its relation with human communities, at several localities over its distribution range and 3) To open a participatory scenario for the turtle's situation awareness and the identification of possible places and conditions for the creation of a community-based conservation initiative.

2. Methodology

2.1. Turtles collection

Non-invasive techniques like casting nets, snorkeling and funnel aquatic traps (Feurer, 1980, Fig 3) with green plantain as bait (Gallego-García & Castaño-Mora, in press) were used to catch the turtles. Because of part of the fieldwork matched with Easter-time, many local communities had turtles collected for consumption, which facilitated the collection of samples in several localities.

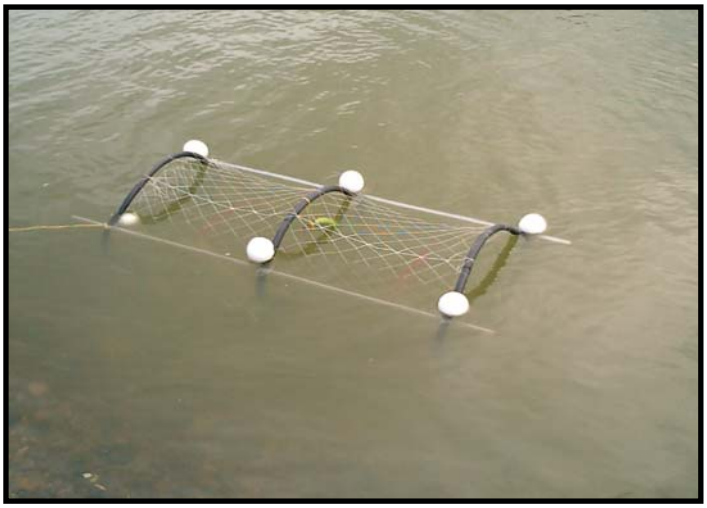

Figure 3. funnel aquatic trap (Feurer, 1980)

2.2. Genetic evaluation

A 1 ml syringe with a 6-gauge needle was used to take 50-100 μl of blood from juveniles and 100–200 μl from adults. Blood was taken from the dorsal part of the tail, from the

coccigeal dorsal vein. This method is harmless and applicable to individuals of all sizes (Vargas, pers. obs.). After collection, blood samples were immediately preserved in plastic vials containing 1 ml of Queen's lysis buffer (Seutin et al., 1991), stirred until no clots remained, and store at room temperature. Aliquots of all 109 samples were brought to the Institute for Biodiversity and Ecosystem Dynamics (IBED) of the University of Amsterdam, The Netherlands, where the laboratory work was carried out. Genomic DNA was extracted using a Qiagen DNA Tissue extraction kit (Qiagen Benelux B.V., Venlo, The Netherlands), following the manufacturer's instructions for extracting DNA from blood. Polimerase Chain Reactions (PCRs), used to amplify a fragment of the mitochondrial cytochrome *b*, were performed in a total volume of 25.25 µl containing 17. 5 µl H_2O, 2.5 µl 10X red-Taq Buffer, 1 µl $MgCl_2$ (25 mM), 2 µl dNTPs (1 mM), 1 µl of each primer (10 µM), 0.25 µl of Taq Polymerase (5 u/µl), and 1 µl of genomic DNA (approx. 60 ng) Reaction conditions were as follows: initial denaturation of DNA for 90 sec at 94 ºC; 34 cycles of 30 sec denaturing at 94 ºC, 45 sec annealing at 45 ºC, 30 sec extension at 72 ºC; and 5 min final extension at 72 ºC. Initially, we used the primers Cytb-C and CBJ10933 (Bossuyt & Milinkovitch, 2000). Based on some of the sequences obtained, we designed the degenerated primers

PodcytbF (5'-GAGGAGGATTCKCAGTAGACA-3') and

PodcytbR (5'-GTATCAGAATAGGGTCCGTG-3') using the program OLIGO 4 (MBI, Molecular Biology Insights Inc., Cascade, CO, USA). The PCR conditions to amplify the cytochrome *b* fragment with the newly designed primers were the same as above.

The PCR product was then run on a 1.5% low-melt agarose gel, stained with ethidium bromide, and visualized on a "Gel Doc" system. If positive, products were purified using QIAquick spin columns (Qiagen) prior to direct sequencing. The 10.5 µl sequencing reaction included 1 µl of template, 1.5 µl of sequencing buffer, 2 µl of 1 µM primer, 1.8 µl of ready reaction mix (Applied Biosystem), and 4.2 µl of water. The sequence reaction was included 33 cycles of 10 sec at 96 ºC, 10 sec at 50 ºC, and 4 min at 60 ºC. Sequence data collection and visualization were performed on an ABI 3100 automated sequencer at the AMC, University of Amsterdam DNA Sequencing Facility. Sequences were deposited in GenBank, accession number XXXX (to be added after manuscript acceptance).

Sequences were aligned and edited using Sequence Navigator software (Applied Biosystems). Sequences were translated into amino acid data to check for the presence of stop codons. Sequences were collapsed in haplotypes using the program Collapse version 1.2 (Posada, 1999).

2.3. Threats and relation with human communities

This is the first scanning of the human-species relationship. Several Participatory Rural Appraisal (PRA) techniques like secondary data review, direct observation, key informant interviews, semi-structured interviews, workshops, rapid field reports techniques and focal discussion groups were use to find out preliminary, the threats for the survival of the species, traditional knowledge and the human communities-turtle relationship. Although the number of carried out activities do not allow a deep analysis (qualitative or quantitative), I felt committed to write the observed situations as a first approach.

Secondary data review: The available information on the species utilization by communities over the species distribution range was gathered and confronted with the fieldwork data. Also biological and anthropological general information was consulted.

Direct observation: Direct observations were made at the visited localities. As a result of these biological and anthropological preliminary field evaluations, fieldwork reports were made.

Interviews: Following Margoluis & Salafsky (1998) methodological approach, Semi-structured interviews, Key informant interviews and Focal Group discussions were carried out. The goal of these activities was to gather preliminary information concerning the relationship among such communities and the turtle; values and practices relating to the appropriation and consumption, kinds and levels of use and start tracing out the illegal networks of trade that link fisherman, traders and consumers. Preliminary information concerning the willingness of these communities to participate in a community-based conservation-oriented initiative was also gathered.

Ecological presentations and artistic workshops: Environmental education and artistic activities focused on the awareness of the turtle's and its habitat situation and condition were performed. Preliminary information about participation, methodologies, initiatives,

experiences and ideas to be used in community-based species conservation processes were collected from these activities.

3. Results

From the 20th of November 2004 to the 17th of April of 2005, the fieldwork was carried out. The localities were chosen according to turtle population's occurrence (aiming to collect samples from the extremes of the turtle's distribution range), previous investigations, key contacts and public order and social situation. Over all, 60 localities grouped in five regions, on four river basins were registered in the frame work of this research project (table 1, figures 3 & 4). As a result, the species was confirmed in 34 localities, ten localities had reliable register, 13 localities the species was considered extinct and three localities had doubtful registry (figures 3 & 4). Blood from 130 individuals was obtained from 23 localities (table 1, Figures 3 & 4).

Table 1. General information per locality; regions, kind of registry, carried out Rapid Rural Appraisal (RRA) activities and identified prelimina threat factors. **RRA activity:** DO=Direct observation, SI= Semi-structured interview, KI= Key Informant interview, FG= Focal group discussion, EP= Educational and awareness raising presentation, PW= Painting workshop. In brackets: The number of performed events. **Threat Factors**: 1= Habitat destruction, 2= Medicinal uses and myths, 3= Traditional consumption, 4= Moderate trade of meat, 5= Moderate trade of eggs, 6= High grade trade of meat, 7= High grade trade of eggs, 8= Pet trade, 9= Non-suitable arts of fishing, 10= Dam presence (caused floods).

Region	Department	Municipality	Corregimiento o inspeccion	Place, locality		Geographic position	Registry	RRA Activity	Threath Factor
I	Tolima	Prado	Puerto del Medio	1	Río Prado	03º 45' 07" N / 74º 56' 03" W	Sampled	DO, SI (11), KI (4), FGD (1)	1,2,3,4,5,9,10
		Melgar	Cabecera Municipal	2	Río Sumapaz	04º 12' 26" N / 74º 38' 44" W	Sampled	DO, SI (4), KI (2)	1,3,4,5,8
	Cundinamarca	Girardot	Cabecera Municipal	3	Río Magdalena, Río Bogotá	04º 18' 11" N / 74º 48' 03" W	Sampled	DO, SI (6)	
II	Cesar	Terraplen	Terraplen	4	Caño Grande	07° 52' 58.2" N / 73° 44' 38.5" W	Sampled	DO, SI(7), KI(3), FGD	1,3,6,7,9
			Loma Corredor	5	Qda El Puerco	07° 52' 54" N / 73° 41' 36.2" W	Sampled	DO, SI(3)	1,3,6,7,8,9
		Aguachica	Patiño	6	Ciénaga De Doña Maria	08° 05' 19.4" N / 73° 41' 40.4" W	Extinct	DO, SI (5), KI(1)	1,3,6,7,9
		Chimichagua	Saba	7	Cienaga de Zapatosa	09° 11.4' 41.1" N / 73° 43' 55.6" W	Extinct	DO, KI(3)	1,2,3,6,7,9
				8	Río Cesar	09° 14' 06.6" N / 73° 45' 42.3" W	Extinct		
		Gamarra	Cabecera Municipal	9	Río Magdalena	08° 19' 28.8" N / 73° 44' 41.2" W	Confirmed	DO, KI(3), SI(2)	
		Pelaya	Costilla	10	Ciénaga de Sahaya	08° 44' 25.2" N / 73° 44' 2.5" W	Reliable	DO, KI(2)	
III	Antioquia	Caucasia	Hda Buenos Aires	11	Río Man	07° 52' 16.6" N / 75° 19' 38.7" W	Sampled	DO, SI (4), KI(3)	1,3,5,6,9
IV	Cordoba	Ayapel	Ayapel		Cienaga Ayapel, Cano Puerto Sorgo		Reliable	DO, KI *	1,3,6,7
			Cecilia	12	Caño Viloria	08° 30' 55.7" N / 75° 01' 45.5" W	Reliable		
			El Cedro	13	Vereda Cano Barro, Cano Barro, boca de trejos	08° 14' 8.4" N / 75° 01' 57.1" W	Sampled		
			Nariño	14	Playa Blanca, Caño Muñoz	08° 18' 11" N / 74° 59' 21" W	Reliable		
			Palotal	15	Cienaga Palotal	08° 14' 18.9" N / 75° 15' 17.6" W	Reliable		
			Popales	16	Caño Pescado	08° 14' 18.9" N / 75° 15' 17.6" W	Confirmed		
			Marralú	17	Rio San Jorge, Remolinos el Pital y la Monona	08° 14' 35" N / 74° 51' 54.1" W	Sampled		
		Buena Vista	Tierra Santa	18	Ciénaga de los Zambos	08° 14' 41.9" N / 75° 20' 24.3" W	Reliable		
				19	Hacienda La Carcajada, Río San Jorge	08° 11' 45.5" N / 75° 20' 7.5" W	Doubtful		
			Villa Fátima	20	Puerto Córdoba, Río Sanjorge	08° 04' 1.4" N / 75° 20' 7.5" W	Extinct		
		La apartada	La Balsa	21	Río San Jorge	08° 01' 49.2" N / 75° 21' 22.4" W	Extinct	DO, SI(3),	1,3,6,7,9,10
		Montelibano	Boca de Uré	22	Desembocadura del río Uré en San Jorge	07° 56' 50.2" N / 75° 31' 23.1" W	Extinct	DO,KI(2)	
			Uré	23	Cerro Matoso, Rio Uré	07° 55' 59.8" N / 75° 33' 48.6" W	Extinct		
		Puerto Libertador	Cabecera Municipal	24	El Pindo	08° 00' 4.7" N / 75° 26' 20.7" W	Extinct	DO, KI(2)	
			El brillante	25	Río San Jorge	07° 52' 16.2" N / 75° 49' 19.2" W	Extinct	DO, KI(3)	
			Pica pica viejo	26	Río San Jorge	08° 00' 57.8" N / 75° 40' 39.0" W	Extinct	DO, KI(1)	
			Puerto Carepa	27	Río San Jorge	07° 49' 19.2" N / 75° 40' 39.0" W	Extinct	DO, KI(3)	
			Torno Rojo	28	Río San Jorge	07° 57' 44.9" N / 75° 33' 16.5" W	Extinct	DO, KI(2)	
				29	Río San Pedro	07° 57' 44.8" N / 75° 34' 5.4" W	Extinct	DO, KI(1)	

Continuation table 1.

Region	Department	Municipality	Corregimiento o inspeccion		Place, locality	Geographic position	Registry	RRA Activity	Threath Factor
V	Cordoba	Tierra Alta	Frasquillo	30	Río Verde	07° 47' 50.4" N / 76° 22' 26.3" W	Doubtful	DO	1,3,5,6,10
			Bonito viento	31	Ciénaga de Juan León	08° 11' 04.9" N / 75° 55' 21.9" W	Doubtful	DO	
		Valencia	Barú	32	Hacienda los Rosales, Río Sinú	08° 17' 25.2" N / 76° 03' 20.0" W	Confirmed	DO, SI (14), KI (9), FGD (1)	
			Carrizola	33	Río Sinú	08° 09' 42.9" N / 76° 06' 12" W	Sampled		
			Manzanares	34	Río Sinú	08° 13' 08.6" N / 76° 04' 31.7" W	Reliable		
			Volador	35	Río Sinú	08° 19' 13.3" N / 76° 03' 59.2" W	Sampled		
			Río Nuevo	36	Hacienda No te Canses	08° 13' 08.6" N / 76° 03' 45.5" W	Sampled		
				37	Río Sinú	08° 15' 19.8" N / 76° 04' 10.1" W	Sampled		
		Montería	Tres piedras	38	Quebrada Flores	08° 26' 07.4" N / 75° 58' 02.2" W	Sampled	DO, SI (9), KI (4), FGD (1)	1,3,4,5,10
				39	Caño Betancí	08° 27' 26.9" N / 75° 57' 36.2" W	Sampled		
			Tres Palmas	40	Río Sinú	08° 30.2' 35" N / 75° 58' 29" W	Sampled		
				41	Caño Betancí	08° 27' 46.9" N / 75° 57' 36.8" W	Reliable		
			Las Palomas	42	Río Sinú	08° 22' 59.1" N / 76° 01' 19.7" W	Confirmed		
			Guateque	43	Río Sinú	08° 36' 23.3" N / 75° 57' 58" W	Confirmed	DO	
				44	Río Sinú	08° 38' 24.4" N / 75° 55' 32.7" W	Confirmed	DO	
			San Isidro	45	Río Sinú	08° 34' 47.3" N / 75° 58' 04.9" W	Confirmed	DO	
			Santa Isabel	46	Río Sinú	08° 32' 17.4" N / 75° 58' 47.8" W	Confirmed	DO	
			Jaraquiel	47	Río Sinú	08° 41' 37.7" N / 75° 56' 58.3" W	Sampled	DO, EP, PW, SI (11), KI (4), FGD (1)	
			Guasimal	48	Río Sinú	08° 21' 20.8" N / 76° 02' 30.3" W	Confirmed	DO, SI(3).KI(1)	
			Cabecera Municipal	49	Río Sinú	08° 44' 36.5" N / 75° 55' 14.6" W	Sampled	DO, SI(4)	
		Lorica	San Nicolás de Bari	50	Caño Viejo, Río Sinú	09° 14' 44.3" N / 75° 52' 15.2" W	Sampled	DO, EP, PW, SI (5), KI (2), FGD (1)	1,3,5,6,10
			San Nicolás de Bari	51	San Nicolás de Bari	09° 14' 44.3" N / 75° 52' 15.2" W	Sampled	DO, EP, PW, SI (6), KI (3), FGD (1)	
			Cotocá Arriba	52	Río Sinú	09° 07' 23.2" N / 75° 50' 24.7" W	Sampled	DO	
			Remolino	53	La Ganga, Río Sinú	09° 012' 13.2" N / 75° 49' 21.3" W	Sampled	DO, SI(3)	
			La doctrina	54	Río Sinú, Vuelta Juan de Alba	09° 015' 52.8" N / 75° 54' 02.6" W	Sampled	DO, SI(2), KI(2)	
			Mata de Caña	55	Río Sinú	09° 05' 50.1" N / 75° 50' 34.2" W	Confirmed	DO	
			La Palma	56	Río Sinú	09° 12' 39.2" N / 75° 49' 30.2" W	Confirmed	DO	
			Los Monos	57	Caño El Guamal	09° 15' 6.2" N / 75° 47' 29" W	Reliable	DO	
			La Peinada		El Tamarindo		Reliable	DO	
			Palo de Agua	58	Río Sinú	09° 10' 20.1" N / 75° 50' 1.1" W	Sampled	DO	
			San Sebastian		Caño Aguas Prietas		Sampled	DO	

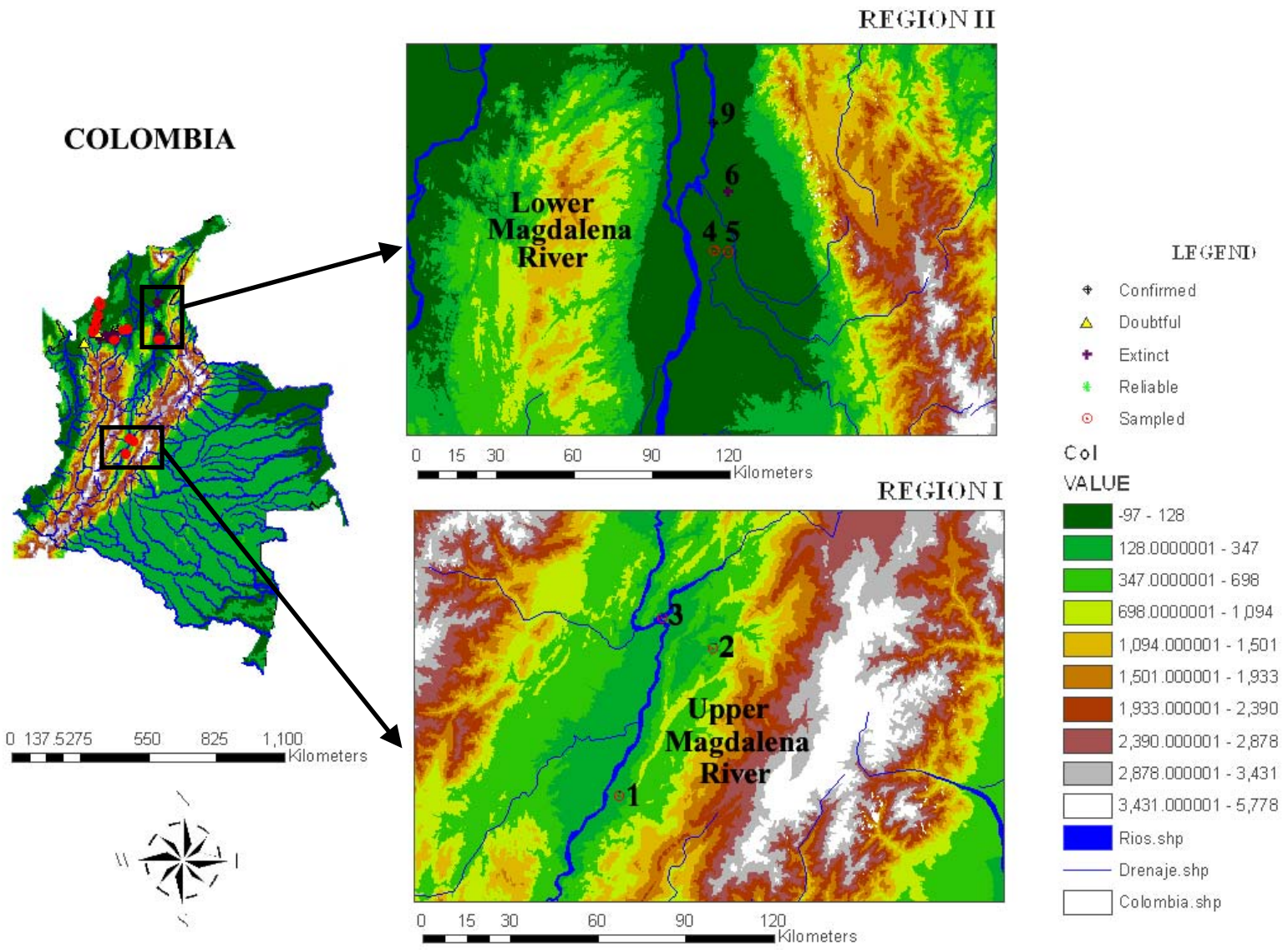

Figure 4. Location and registry of the visited localities in Regions I and II.

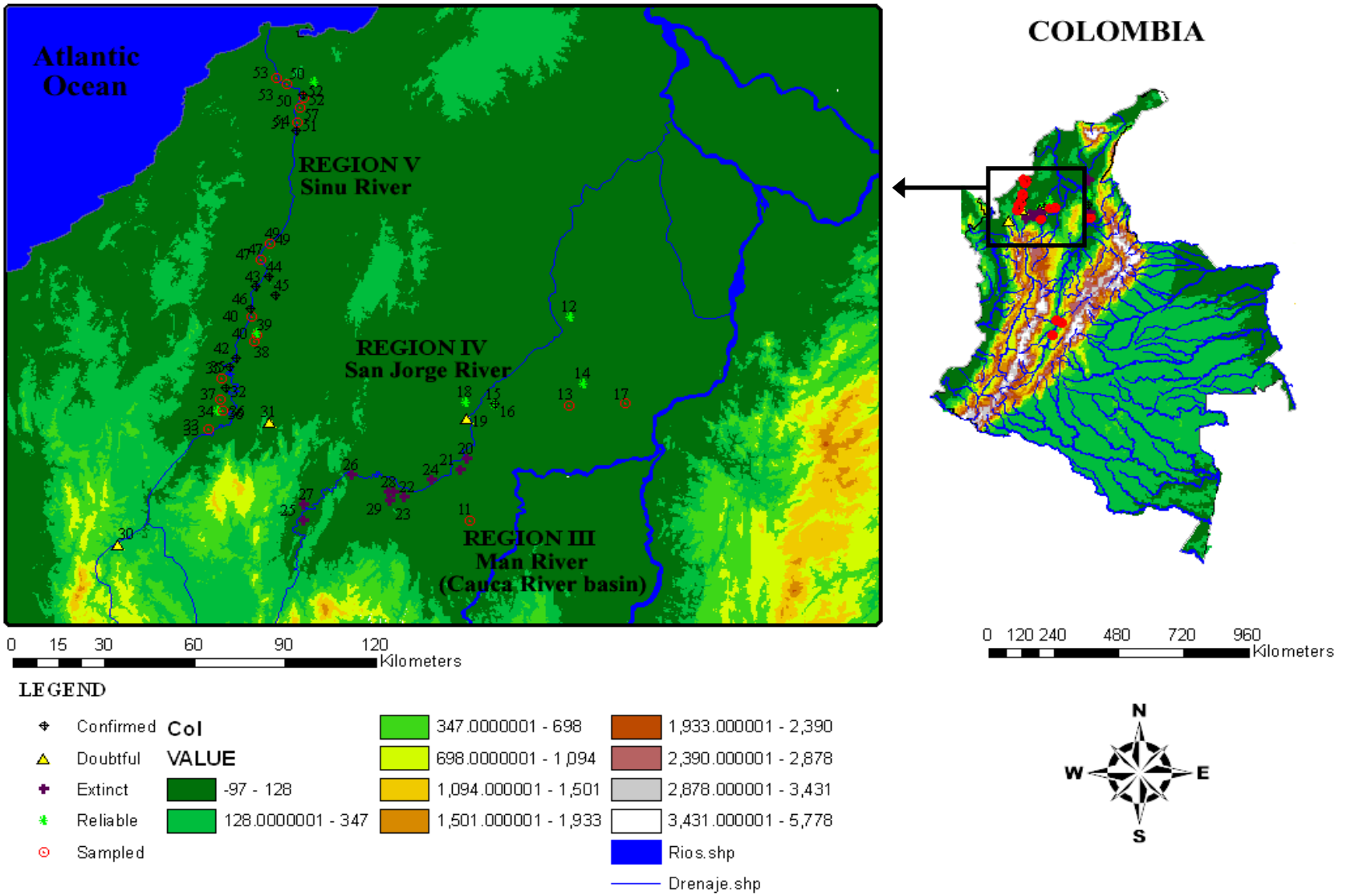

Figure 5. Location and registry of the visited localities in Regions III, IV and V.

3.1 Genetic evaluation

Blood samples were used from 109 individuals from 26 localities (grouped in five regions) in the Magdalena, Cauca, San Jorge and Sinú river basins. We caught n= 27 individuals for the upper Magdalena river, n= 21 individuals for the lower Magdalena river, n= 4 individuals for the Cauca river, n= 9 individuals for the San Jorge river and n= 48 individuals for the Sinú river.

We obtained a total of 490 bp of the cytochrome *b* mtDNA gene sequence from 109 turtles. No indels or stop codons were detected. In the 490-nucleotide sequence there was only one polymorphic site, a single-nucleotide, silent substitution (transversion) at position 12. The two haplotypes were designated H1-H2 (Fig. 6).

```
H1: GAGGAGGATTCGCAGTAGACAACGCCACACTCACTCGATTCTTTACATTCCATTTCCTAACCCCATTCATCA
H2: .............................T..................................................................................... ...

    TCGCAGGCTTAACAATAATTCACCTCTTATTCCTTCACGAAACAGGATCAAACAACCCCACTGGGTTAAACT
    ..... .....

    CAAACACCGATAAAATTCCATTCCATCCATACTTTACATACAAAGACATCCTAGGAATCATGATCCTAATAA
    ..... .....

    TATACCTCCTAACCCTATCTATACTTTTACCCAACCTCCTATCAGACCCCGAAAATTTCACACCCGCAAATC
    ..... .....

    CCCTTGTCACTCCACCACACATCAAACCAGAGTGATACTTCCTCTTTGCATACGCTATCCTACGATCAATCC
    ..... .....

   CAAACAAACTAGGAGGTGTTTTAGCCCTCTTCTTATCAATCGCAATCCTCATCCTTATCCCTACACTTCACAC
   ..... .....

    CTCTAAACAACGAACCCTTTCATACCGTCCTATTTCACGGACCCTATTCTGATAC
    .....
```

Figure 6. The two different identified haplotypes with indicates the polymorphic site in position 12.

Haplotype H1 was most common with 81 specimens out of the 109 sampled (74%). Different regions had different haplotype frequencies. Region III presented the highest frequency of H1 (100%) because only four individuals (belonging to H1) were collected. Among the regions where both haplotypes were found, the highest frequency was found in region V (91.7%), followed by region II (76.2%), region IV (55.6%) and region I (48.2%). The regions with the highest frequencies of haplotype H2 were I (51.8%) and

IV (44.4%), followed by Region II (23.8%) and region V (8.3%). In the region III, H2 was not found (Fig 7).

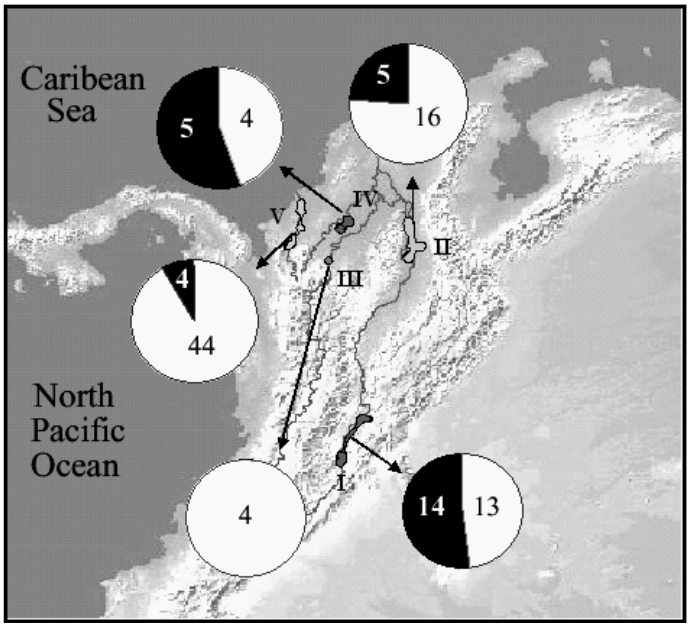

Figure 7. Absolute numbers indicating number of individuals sharing haplotypes, H1 (white) and H2 (black), per region at the cytochrome b gene.

3.2. Threats and relation with human communities.

We collected preliminary information about threats, the relationship between the turtle and human communities and traditional local knowledge from, 74 semi-structured interviews, 51 key informant interviews, 13 ecological presentations, 13 focal discussion groups, 12 painting workshops, informant chats and direct observation (table 1). Due to the short time we spend at the communities, we did not carry out a representative number of activities that could allow us to carry out a deep analysis. However, the preliminary diagnostic of the threats and human utilization per region, are just some comments based on the gathered data, taken at the particular visited localities through the previously mentioned activities. These interpretations were not intended to neither describe a completely known situation, nor to denounce anything about them. Further research should be carried out.

The pilot research has given the conceptual basis, survey concepts and instrument, response scale for the further research.

Preliminary, we identified ten threat factors that are affecting the survival of the populations at the visited localities.

1) Habitat destruction: Refers to direct evidence of deforestation, pollution and destruction of the habitats; rivers, water sources and terrestrial habitats.

2) Medicinal uses and myths: Refers to the utilization of turtles for traditional medical purposes, religious/spiritual uses and mythical believes.

3) Traditional consumption: Refers to the utilization of individuals and eggs for family consumption. Non-commerce activities were involved.

4) Moderate trade (meat) Refers to the commerce of meat in a moderate scale. Commerce mainly inside the community and near by communities.

5) Moderate trade (eggs): Refers to the commerce of eggs in a moderate scale. Commerce mainly inside the community and near by communities.

6) High grade trade (meat): Refers to the commerce of meat in high scales. The turtles are hardly ever used at the locality but instead they are sent to middle-large urban centres.

7) High grade trade (eggs): Refers to the commerce of eggs in high scales. The turtles are hardly ever used at the locality but instead they are sent to middle-large urban centres.

8) Pet trade: Refers to the establishment of commerce of juveniles to be kept as pets:

9) Non-suitable arts of fishing: Use of non-suitable arts of fishing.

10) Caused floods (dam presence): Floods caused by the dynamics of the dams in an electricity generation process.

Figure 8. Participatory Rural Appraisal (PRA) activities: **A**: Ecological and awareness rising presentations. **B**: Focal Discussion Groups with students. **C**: Focal Discussion Groups with fishermen. **D** & **E**: Key informant activities and interviews. **F**: Painting workshop at local schools. **Photos**: Mario Vargas-Ramírez, Natalia Gallego & Olga V Castaño-Mora.

3.2.1. Preliminary diagnostic of the threats and human utilization per region.

3.2.1.1. Region I: Upper Magdalena river.

Identified threat factors (1,2,3,4,5,8,9,10. Tab 1)

Puerto del Medio (locality 1), is a small fishing village (34 families live there) located on the Prado river (affluent of Magdalena). The village depends entirely of the river's resources. Turtles are important for consumption, medical purposes and as pets. They are consumed in Eastern mainly, although we detect several families that kept individuals alive, to be consumed latter on when the availability of food decreases. The common way to catch turtles is during the day. Individuals are detected when are breathing and the fishermen (who normally are fishing) approach the boat to the place and throw a net called "Atarraya" over the turtle. Immediately, the fisherman dives to get the turtle from the bottom. Although fishing with nets that cross from one side of the river to the other one is forbidden, it was a common practice. Turtles are also trapped in this way, and many times juveniles that are not used for consumption drown down when get twinkled.

According with the healer of the village, the consumption of turtle gives longevity and strength; "The person who eats turtle frequently will have along and healthy life". He also had very precise traditional medical prescriptions that are actually using: "helps women to recover after pregnancy. If they present uterus problems, nine adult turtles should be found, cooked and the vapour from the boiling water should be taken by the woman. The turtles cannot be consumed". He also assured that the fat of the turtle helps with skin problems, fading scars, helping with eyes diseases, fertilization problems and as a powerful aphrodisiac.

There is a Dam located some kilometers up stream Pto del Medio. Although during the sampling time we did not see any flooding, according to the interviewed fishermen, when Prado Dam releases water flow during the dry season, beaches which are already expose submerge. They assure that hundreds of eggs drown. The Puerto del Medio fishermen association, showed interest by the research and participated actively.

Girardot (locality 3), is a medium sized city, well recognized tourist center, where people from Bogotá (capital city of Colombia) take vacation. It is located on the Magdalena river. Consumption of turtles and eggs was identified in several poor communities

outskirt of the city. It is unknown if there is a high commerce of meat and eggs. A well-established pet commerce was identified at the market place instead. At the local market, juveniles are sold for between 2500 to 10000 pesos each depending on the size (1 to 4 dollars). According to a pet seller, tourist asks for the small turtles to be kept in aquariums. Fishermen bring the turtles to the market under the fish. Also a sale by a shopping center was identifying. They supplied them to residential holiday complexes as a decoration for artificial lakes. It is unknown the way that pollution could affect *P. lewyana* populations. I have identified a population 13 kilometres up Bogotá river (at the outfall into Magdalena River) in extremely high polluted area. This population seemed to be abundant, possibly for the fact that there is not human pressure over the population.

3.2.1.2. Region II: Lower Magdalena river basin.

Identified threat factors (1,3,6,7,8,9. Tab 1)

Terraplen and Caño Grande (locality 4), evidenced an extreme process of habitat destruction. We could see that land owners, were destroying the forest and Cienagas in order to "clean" for pastures. Local consumption and commerce of meat and eggs was identified; the consumption and commercialization activities increase during Eastern. There is the believed that eggs are highly aphrodisiac and are sold by 700 pesos each (0.60 dollar cents). The local community through the fishermen, association has established conversations with the regional governmental organization (Corpocesar) and is planning the first steps of a community-based natural resources conservation initiative. According to locals, the species was abundant just five years ago, but the high exploitation of turtles and eggs, plus habitat destruction and water pollution have affected the local turtle populations. There is a high understanding by the locals about the turtle and its habitat situation; they are motivated to start a conservation initiative. Corpocesar (local governmental environmental corporation) is willing to fully support such initiative; this is one of the localities where it is worth to start and support local conservation. In Lebrija river (Magdalena affluent) there were several important nesting beaches.

Gamarra (locality 9), is a medium size town, located on the Magdalena river. This locality also evidenced an extreme habitat destruction and river pollution. The high demand of turtle meat and eggs by medium-big urban centers like Bucaramanga, Ocaña (Norte de Santander), Santa Marta and Cartagena, has establish a high illegal commerce

of them. At this locality a chain of such commerce was preliminary identified. There are people specialized on the capture, transport and commercialization of turtles, also belonging to different species (e.g. *Trachemys scripta callirostris*). Adult individuals are sold alive for between 10 and 25 thousand pesos (4 to 13 dollars). Eggs are more expensive than hen's and are sold for between 700 a 1000 pesos each (30 to 50 cents of dollar). According to the key informants, during the dry season, there are groups of people who are specialized in collecting turtles and eggs from the beaches. In several places we could see small turtles kept as pets. When we were investigating about the illegal exploitation, we ha information from a key informant about a cargo of more than 70 turtles that were about to be sent to Bucaramanga, where there is a high demand of turtle meat and eggs in Eastern. We were not allowed to see the turtles. This information needs confirmation. The interviewed people said that they do not belong to any fishermen association, because they do not represent the people's intersets.

Patiño (locality 6), is a small village located on the shore of the Cienaga de Doña Maria. According to locals, the Cienaga is gradually filling up by sediment, which comes from the erosion caused by deforestation. Rich cattle breeders are replacing the forest beside the water body for pastures. They also said, that the lack of rules on fishing activities and the extreme pollution, have almost exterminated the fish and turtles. They assured that some years ago, the turtles used to lay their eggs on the Cienaga beaches. Those turtles are not coming anymore; "the turtles have disappear since approximately six years ago". We did not identified a community organization in this locality.

Costilla, Cienaga de Sahaya (locality 10), is a small fishermen village where although habitat destruction was also evident, it was not as extreme as the previous localities. Local consumption of meat and eggs was identified, but there was not evidence of commerce. It is probable that this situation has to do with the availability of fish. The local fishermen organization has clear rules concerning the exploitation of fish (capture size, art of fishing, fishing times etc.). The organization really works for the benefit of the community.

Chimichagua (locality 7 and 8), is a small-medium town on the shore of the Cienaga de Zapatoza. The Cienaga evidenced extreme habitat destruction and pollution. Key informant told us that due to the demand of meat in Eastern, and the difficulties to bring a

live individual to the middle-large urban centers, meat is paid by weight and not per individuals. In this situation, even small turtles are killed in order to put some extra grams of meat. Traders set an extra bottom underneath the container in which the fish is brought to the cities and can carry as many as 20 kilos of turtle meat. It is extremely necessary to support the locals towards the creation of a community organization and start an educational program as a first step.

3.2.1.3. Region III: Man river, affluent of Cauca river.

Identified threat factors (1,3,5,6,9. Tab 1)

Although the Man River (locality 11), still harbors many species of the original wild fauna, nowadays is under an extreme process of intervention. The gallery forest has been almost exterminated by cattle breeders and it was evident an over-fishing by locals who also destroy the aquatic environment, in search of cat fish and turtles. At this locality turtles are caught for local consumption and commercialization. Local villagers catch them in the dry season and keep for Eastern mainly. According to the interviews, the population was much more abundant five years ago. Ten years ago, they assure it was possible to catch turtles all over the year. The believed that the presence of crocodiles and the abundance of turtles are related, is widespread allover the area. In fact we identified several places where they said were crocodiles. This places where deep pools and were not used neither to fish nor to catch turtles by locals. An illegal trade of crocodiles (*Crocodylus acutus*) was also identified. Individuals are sold for 50.000 pesos (25 dollars) to rich farmers of the area, who keep them as pets in artificial pools. After is known that a crocodile from a certain area has been removed, an intense process of exploitation of the site starts.

We identified a high illegal trade of individuals. We got information from locals and saw evidence that few days before we arrived to the locality, a group of people who did not belong to the region, arrived with nets and traps. They were catching turtles for several days, setting the traps and nets from one side to the other of the river and scaring the turtles from up river. Locals assure they caught more than 300 individuals of sorted sizes. They (locals) did not act because they were afraid of being involved in troubles with illegal armed groups that are found in the region (see further comment about oppression factor).

Despite local inhabitants at the visited localities, are conscious that the resource is in extreme depletion and they will run out of it soon, we could not see any interest to participate in any process related to the sustainable use and conservation. In fact the river flows through private land and the local villagers have not got any decision power over the river.

3.2.1.4. Region IV: San Jorge River

Identified threat factors (1,3,6,7,9. Tab 1)

Not even one individual was registered in the upper or middle part of the river (fig 4); however local communities commented that 20 years ago it was common to find turtles in these regions. Few individuals were identified in the middle-lower part of the river. The river is still poorly known concerning turtle populations. According to local inhabitants, there were several factors which determined the extinction of the species at the upper part (localities 18 to 29): First of all, the destruction of the original forest located on the sides of the river and up river by cattle breeders and wood traders. It causes an intensive erosive process that threw a lot of sediments into the river, filling it up. According to the collected information, turtles were easily to catch by fishermen. "There was a time when individuals of the species and their eggs were caught exaggeratedly". This, plus the extreme water pollution product of miner activities, could have been the reasons that brought the species to a local extinction. It is also probable that some individuals moved to a part of the river with better conditions. Nowadays the upper and middle part of the San Jorge river is shallow and turbid, not appropriate for the species which prefers deep and quiet places. Another explanation that local people gave was that the turtles disappeared because the crocodile (*Crocodylus acutus*) was exterminated. They said that crocodiles make areas in the river appropriate for turtles (keeping deep pools into the river) when they dig their caves. Such caves are used by turtles. Furthermore, the presences of crocodiles intimidate local fishermen and hunters. There was also information about a landslide that occurred in March of 1997. It is believed that after such a natural event, the population of turtles could not recover. This phenomena could had also incremented the amount of sediment into the river.

It is possible that many of the mentioned factors were crucial in its extinction.

3.2.1.5. Region V: Sinú river

Identified threat factors (1,3,4,5,6,10. Tab 1)

Gallego 2004, identified four broad factors which affect populations of *P.lewyana* in the Sinu river basin; 1) exploitation and consumption 2) Dam presence (water levels) 3) Sand extraction from the nesting beaches and 5) Extensive cattle breeding.

Although nowadays at Sinú river, the turtle consumption and utilization is not as important as it was in the past (Dahl & Medem, 1964), the species is highly used. Because the availability of individuals has decrease, the difficulty to catch it and the fact that there are other species; *Trachemys scripta* and *Rhinoclemmys melanosterna*, which meat are considered of better quality, some communities have lost interest by *P. Lewyana*. However, the species all over Sinú river is under extreme exploitation.

At the upper Sinú river (localities 30 to 37), high habitat destruction was evidenced. Nowadays the upper Sinú river is almost running through pastures for cattle and plantations. At the visited localities, few patches of gallery forest were identified. The forest destruction is causing high degree of erosion. The river is eroding the land and throwing a great amount of sediments into the river.

We did not identify different uses for the turtle rather than consumption. Turtles are caught mainly during the dry season, at night, when females go out to lay their eggs. Some individuals are kept by traders (who are local fishermen) in small places called "Chiqueros" (Fig. 9: B,D) until Eastern when they are sold for between 15000 to 35000 pesos (8 to 13 dollars each), depending on the size and the buyer. Eggs are also consumed. It is relatively easy to track the nests making easy to collect them.

The middle Sinú river (localities 38 to 49), is more human populated than the upper part. Extreme habitat destruction and river pollution was also identified. Some of these deeply poor communities presented a precarious situation. They lack of basic services and human rights: No health, clean water, food, education, social security and freedom of speech (it is a paramilitary area). We had information of children dying from disease related to gastric and respiratory infections. Due to the fact that these communities do not have land at all, they depend only on the natural resources; resources that are decreasing dramatically. High exploitation of turtles and eggs were identified. The local consumption is high and there is a high external commerce as well. We could see

fishermen selling turtles at the main road that goes to the Caribbean coast of Colombia. In these localities, we identified groups of very skilled turtle catchers; locals who have a life time experience in turtle capture and commerce. They dive in the dry season and use nets to catch them. According to the key informant interviews, the turtle population in the Sinu rivers and Caño Betanci has diminish dramatically; they assured that "Even five years ago, during the dry season was possible to catch more than 15 turtles in a day, nowadays this is not imaginable".

The lower portion of the Sinú river (localities 50 to 58), evidenced an extreme degree of pollution. The natural habitat has almost completely disappeared and the human population is high. Due to the same problems described for the middle Sinú, the pressure over the river is enormous. Local consumption and high commerce were identified. Also locals specialized on turtle and eggs catching and commercialization were identified. High sand exploitation of the beaches was also common. During the fieldwork at Sinú river we could see how several times in three months the water level went over dry beaches which had been used by nesting females of *P.lewyana*. It was evident that thousands of eggs drowned.

The whole Sinú river, has evidenced a deep and complicated social, political and environmental situation.

Figure 9. Illegal commerce of turtles: A & C: Local villagers specialized in the capture and commercialization of turtles B & D: Turtles kept by traders in small places called "Chiqueros". **Photos**: Mario Vargas-Ramírez.

3.2.2. Ecological presentations, awareness raising activities and artistic workshops:

This first stage of the project had a great impact on the communities, local government, conservation agencies and researchers. Because the project implied intensive contact with local people; villagers, students, fishermen, members of local organizations, authorities etc. who were interviewed, employed as guides, drivers, assistants, participants of the educational activities etc; there were many opportunities to exchange points of view, knowledge and feelings. Also discussion on the relevance of biodiversity conservation, the role of the community in these kind of processes, improvement opportunities etc; thus increasing the overall awareness on this issue and incentive natural conservation ideas and attitudes. It was also easy for us, to get involved in those communities' struggling to survive. But this first impact can easily fade away if a follow up with concrete goals is not carried out.

The ecological and awareness raising presentations and painting workshops at local schools and communitarian organizations left important outcomes which are important for the creation of a further educational program for the protection, conservation and sustainable use of the species (fig. 10).

Figure 10. A & B : Ecological presentations and awareness raising activities. C-F: Painting workshops. **Photos**: Natalia Gallego & Mario Vargas-Ramírez

According to the evaluation of the activities outcomes, we can point out that:

1) The participants understood that the conservation of the species, its habitat and natural resources should be a priority. Not only due to the benefits that they can get from them, but because we are part of the same natural environment. The activities started the creation and understanding of values (e.g. intrinsic value) and attitudes towards these issues.
2) Participants learnt about the turtle and habitat situation and the important role that turtles play as a part of the aquatic ecosystem.
3) They share ecological traditional knowledge about the turtle, identified several populations that are under exploitation and risk and understood that ideas and potential solutions should also come from their attitudes and willigness to participate. It was evident that many communities identify the nowadays species and environmental situation and are willing to participate actively creating concrete actions towards their protection, conservation and sustainable use and management.

3.2.3. Productive alternatives

As a part of the communities' cultural-traditional expressions, almost in every single visited locality, we could evidence several activities, which are potential productive alternatives. These activities should be evaluated and included into a community based conservation-initiatives for the communities economic improvement, cultural recognition and environmental management and sustainability. Amongst many others we identified; chicken, turkey and fish breeding (Fig. 11: A & B), pottery (Fig 11: C & D), different kind of handicrafts (Fig. 11: E- I), traditional food and ecotourism.


A


B


C


D


E


F

Figure 11. Productive alternatives. A: Artificial fisheries, B: Chicken breeding, C & D: Pottery, E-I: Different kind of handicrafts. **Photos**: Mario Vargas-Ramírez.

4. Discussion

Turtle eggs and meat have been used as an important food resource for humans for at least the last 20,000 years (Moll & Moll, 2004). Moreover, turtles are also highly required for medicinal use in some part of the world (in particular in Asia) and collected for the pet trade (Moll & Moll, 2004). These factors, together with habitat alteration and introduced species contribute to the shrink of a large number of turtle species in the world (Moll & Moll, 2004). The analysis of the genetic diversity within and among species can help in turtle conservation (Moll & Moll, 2004). Genetics has for example been used in turtle conservation to evaluate the genetic variability within and among populations (e.g., Janzen et al., 1997; Schwartz & Karl, 2006; Souza et al., 2002), to recognize the

existence of cryptic species (e.g. Russello et al., 2005) and to reveal migratory pattern (e.g. in marine turtles, Bowen & Avise, 1996)

Among others, the use of mitochondrial genes has been widely used in turtles for phylogenetic, phylogeographic and population genetics studies (e.g. Barth et al., 2004; Bowen et al., 1993; Parham et al., 2006; Spinks & Shaffer, 2005). Chiari et al. (2005), using the cytochrome *b* marker, recovered three distinct genetic subspecies in the tortoise species *Pyxis arachnoides* in agreement with their geographic separation and carapace differences. Examination of intra-specific genetic variation in the Western Pond Turtle, *Clemmys marmorata*, has shown low levels of among and within-populations divergence (Janzen et al., 1997). However, even in this latter case, the cytochrome *b* marker used was able to provide some indication of genetic differentiation between northern and southern populations. Considering the slower rate of molecular evolution of the mitochondrial DNA in turtle when compared to other taxa (Avise et al., 1992, but see also Seddon et al., 1998 and Weisrock & Janzen, 2000), even small genetic differentiation in mitochondrial markers can be informative in detecting geographic or historical splits. In fact, Fritz et al. (2005) even with a maximum of 1% sequence divergence in the cytochrome *b* marker were able to observe differentiation between populations of *Mauremys leprosa* north and south of the Atlas Mountains.

In *P. lewyana*, the first scanning of its genetic variability based on the cytochrome *b* marker over the distribution range of the species evidenced low mitochondrial differentiation among populations. Only two different haplotypes have been detected and no geographic population sub-structure could be associated with them. Both haplotypes have been found in all population but one, even if with different frequencies. This result suggests that the species can be considered uniform, without any cryptic variation or genetically differentiated population associated with different river drainages, as we could have expected. This result could either indicate relatively high gene flow among river basins or slow differentiation since the population's separation time. However, although apparently is not something common, local people move individuals from one place to another (Vargas, pers.obs.), and have probably moved individuals for many years, since *P. lewyana* surely had been used since pre-hispanic times, as happened with *P. expansa* and *P. unifilis* (Rodriguez et al., 2002). Furthermore when local governmental

and wild fauna conservation organizations confiscate individuals from illegal trade mainly, they release them with out knowing the places where they were caught.

It could be a serious mistake to manage populations in different environments as a single unit, simply because no molecular differentiation among them has been detected, especially if morphological, behavioral and physiological characteristics in which the populations might be adaptively differentiated have not been investigated (Landweber & Dobson, 1999).

As a part of the idea to start looking for scenarios where a Community-based conservation initiative that could be a medium-long term goal, we tried to understand in a preliminary way, the socio-political situation of different visited communities, and try to recognize factors that are determinant to measure the willingness of communities towards participatory activities. I based this preliminary assessment on the social research methodology of Zanetell & Knuth, (2004) about willingness of the communities towards Community Based Natural Resource Management (CBNRM).

a) Dependence on the resource: As a generalized situation, the only source of food and economic income for many of the communities are natural resources. Thousand of hectares a long the Magdalena, Sinú and San Jorge rivers, belong to rich cattle breeders, who forbid the utilization of the resources inside their properties. Local people, who are normally very poor peasants and aborigines, use what they can get from the rivers and surrounding habitats (swamps, gallery forest, etc). Fish and turtle population are decreasing dramatically. Because turtles are difficult to catch in the rainy season, the communities depend on them as a source of food and income mainly during the dry season.

b) Perception and level of concern about the state of the resource: Many communities understand that turtles will disappear in a short-term. Local inhabitants have seen the populations of turtle decreasing and disappearing from many places. Although as a generalized idea, the turtle populations are in troubles and are "not as abundant as it used to be years ago, and every year is more difficult to find turtles and nests", we identified three main perceptions. A) In some places although people know turtle's situation is extreme, they feel there is nothing to do about it. People understand that the solution depends on many actors, and they believe is extremely difficult to coordinate efforts.

There is an important degree of consciousness in those communities. B) In some other localities, villagers believe that they will never run out of turtles, and their lives will not change that much if the species disappears. The communities that have this perception, are mainly recent inhabitants of the regions, coming from other regions due mainly for violence; their situation is extremely precarious. C) Some communities are aware of the species situation, and believe that the solution does not depend on them. They assure that the definitive solution must come from the local and national government, and the role the community should play in solving it, is not that important. Although protection, conservation and sustainable utilization are not a widespread idea, only in three localities; Puerto del Medio, Tolima (Region I), Terraplen, Cesar (Region II) and Caño Viejo, Cordoba (Region V), people clearly understand that the sustainability depends also on them, in cooperation with local and national governmental and non-governmental institutions. At these localities, there are community associations which are taking incipient measures in this sense. Those communities are the potential places where a Community Based Natural Resource Management should be implemented and supported.

c) Locus of authority. Although it was evident that in many localities, local corporations (local environmental governmental bodies) are willing to deal with the natural resources situation and take some actions, such actions are in many cases weak, wrongly address, mean to solve such situations temporarily and focused in tackling the consequences and not the causes of such social and environmental problems.

d) Oppression factor: This new factor influences directly the way that communities are seeing, feeling and behaving towards the utilization and management of natural resources. The majority of the visited localities have or have been under the influence of armed groups; especially right-wing paramilitary forces. The impact and the influence that they have created on the communities has changed the relationship between nature and human communities. In regions like Sinú river, people had to adapt to the conditions that the armed groups believe are convenient. Such groups set up rules concerning the management and utilization of natural resources, based on their own interests. In the majority of the identified cases, the new "rules" were completely different to the traditional way that communities had utilized and managed their natural resources. In many localities fishing and hunting are forbidden; paramilitary warned and threatened

local villagers and sometimes punished them in extreme ways. I could see and feel that in many localities, the communities stop seeing their natural resources as their "own" and started to believe that they belong to "somebody else". When the groups withdraw, in some cases the generalized attitude was "to exploit the resources as much as we can", because they did not know when "the same or another armed group" could come, set up new rules and restrict the use of them. In some localities, local community leaders where executed because they disagreed with the armed groups illogic requests. In other localities, people from somewhere else, exploit heavily fish and turtles and when they can not get any more individuals, just left. The communities cannot control the situation, they feel the natural resources belonging to their land, is not theirs anymore. They are afraid of being dealing with paramilitary, Army or Guerrilla groups. The causes, consequences and real affect of such a factor have to be deeply study.

I would also like to make some comments about two habitat destruction factors, which are greatly affecting the turtle populations and its habitat. These factors are; caused floods by dams and habitat pollution. Once more, I will comment them in a very superficial and preliminary way; further research on the real magnitude, causes and consequences of them are needed and should be carried out in a short term. a) Caused floods (Dams precence): Two localities presented hydroelectric dams (Pto del Medio in region I and Sinú river, Region V). Nowadays at these two places, the rising of nesting beaches is not depending on natural rainy cycles (dry or wet) but on the need of electric generation. During the dry season, the water levels used to be low and the nesting beaches always above the water level. Nowadays, the water level covers the nesting beaches and it is believed that thousand of eggs die (Gallego & Castaño, in press, pers. obs.). This factor, changes completely the rivers dynamics and therefore affects the organisms which depend on it. For fresh water turtles, the situation is really dramatic. This situation was reported by Gallego 2004 at the Sinu river basin, but nothing was known about the problem at Prado river. The private companies that are causing are not willing to know or do anything about it (Vargas, per.com.). In the field work carried out at the Sinu river (region V) we could see how seven times in three months the water lever undercover dry beaches which had been used by nesting females. It is evident that thousands of eggs are drowning down in such flooding events. B) Habitat pollution: High grade of pollution

associated to urban and agricultural activities was observed in several localities (table 1). In many cases, several medium urban centres were identifies located on the shore or near by the rivers and in many of them, domestic and industrial wasted go into with out any previous treatment. In several regions, evidence of high agricultural activity was also identified. Plantations like watermelon and tomatoes which demand great amount of pesticides were observed at the shores of the rivers.

5. General recommendations

Based on these preliminary results, the main conclusion is that the situation of *Podocnemis lewyana* throughout its distribution range is critical. The main factors that are serious threat the survival of many of the identified populations on the Magdalena and Sinú river basins, are related to environmental depletion and human utilization. Ideas and possible standard solutions from a multidisciplinary ground, where scientific research could support social economic and politic initiatives and needs (and the other way around) should be searched. This ideas and possible standard solutions should fulfil sustainability requirements of natural resources (species and habitats diversity) and based on the identification and use of traditional knowledge and methods, towards the increment of communities cultural, political and ecological recognition.

In 2002, the Colombian government through its Ministry of Environment developed the "National program for the conservation of Sea and Continental turtles and tortoises of Colombia" as a technical document. This document is the first analysis and diagnosis of information concerning natural history and biology of Colombian turtles and the identification of causes which threat their survival. It also includes a formulation of necessary actions in order to minimize these factors and increment populations to optimums levels, framed into sustainable development. In Colombia, theoretically actions designed to protect biodiversity are general and hardly ever developed locally. Although many of them incorporate the participation of local communities and view traditional knowledge as an important part of the solutions, in practice their application affect negatively socio-cultural practices, local livelihoods and economic interest.

The central Colombian government through the regional corporations, which have influence on the Magdalena and Sinú river basins, should give a high priority to the

conservation of the water sources and the protection, recovery, management and sustainable use of their resources. It is necessary to: 1) assess the policies aimed at Colombia biodiversity and more specifically, endangered species and the communities that use them 2) develop new tools and design a scenarios for community-based conservation-oriented initiatives that could bring economical benefits, political and social recognition to those communities, 3) be strict on the application of the legislation in order to stop habitat destruction and illegal commercialization of fauna and flora, 4) control the use of chemical pollutants like pesticides, herbicides, served waters and garbage, 5) create protected areas, 6) finance biological and social research on endangered species.

5.1. Recommendations for the conservation and sustainable use of Podocnemis lewyana

It is a high priority to carry on with the research on population genetics, ecology and etno-zoology of *Podocnemis lewyana* through out its distribution range (Magdalena and Sinú river basins). Environmental and social governmental and non-governmental institutions should prioritize participative biological and social research towards the creation of a management plan for the protection, conservation and sustainable use of the turtle, its habitat and economic, political and social improvement of the communities at the regions. It is also important to support initiatives, which include educational and awareness raising activities, with the goal of designing an educational program as a part of such management plan. The assessment biological and social factors for a community-based conservation initiative and natural resource management process feasibility should be the first step. Based on the development of new tools (e.g. educational program) and the design of a proper participatory scenario, the chance of achieving biological and cultural diversity conservation will increase. It is crucial to carry on with the assessment of the relationship among the communities and the turtle; values and practices relating to the appropriation and consumption, the willingness of the communities to participate in a community-based conservation-oriented initiative, and to understand kinds and levels of use, quantification of them and trace out the illegal networks of commerce that link fisherman, traders, consumers and user's characterization. It is also important to carry on with the collection of biological information of the populations throughout the species distribution range; natural history, distribution, reproductive ecology and an estimation of population dynamics.

In order to assess the hypothesis of a high gene flow or slow differentiation since the population's separation time, more ecological data on the species dispersal during rainy and mating seasons are needed. Moreover, further molecular studies using more rapid evolving markers (e.g. mtDNA control region or microsatellites) and more molecular technique as the AFLP analysis, would help to study the genetic variation among and within this species, to detect possible migration patterns or different sex dispersal and to clarify the genetic diversity within this species.

Final remark: Every year, local environmental governmental organizations all over the turtle distribution range deal with great amount of turtles that confiscate from local dealers, fishermen and tourist (mainly in Eastern time). According to the preliminary outcomes and until more detailed and confident results can be available, it seems prudent that at least these individuals will not be released in a different river basin.

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