Barrios-Garrido, Héctor A. (2018) ***Socio-economic drivers affecting marine turtle conservation status: causes and consequences.*** **PhD Thesis, James Cook University.**

https://doi.org/10.25903/5be0fecec8548

Socio-economic drivers affecting marine turtle conservation status: Causes and consequences

Thesis submitted by

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June 2018

For the degree of Doctor of Philosophy

College of Science and Engineering

James Cook University

"I grow up with turtles, I would like my kids and my great grand kids to be able to enjoy the things that I enjoined as I did.
If that it is a legacy that I contributed to, I can enjoy that"
Dr. Col Limpus

"I almost died when I was 7 years old, and the turtles saved me.
My mother always said that I survived thanks to the turtle's elements that we use as medicines"
Petronila Montiel † (?? – 2017); Wayuu matriarchal community leader

Acknowledgements

Every journey in life has different phases. This thesis (and everything that involved) was a great journey, with a lot of experiences. The best part of this journey was all the connections, network, and feelings that I could experiment. So many experiences, faces, support, challenges, endeavours… In a nutshell, it was amazing! Of course, it would be impossible without the help of so many people that I would try to express on my '*not very good looking English'* in the following lines.

I want to express my most sincere and depth gratitude to my supervisor, Dr Mark Hamann, for all his support, patience, leadership, and for never saying 'we cannot do that'. Thanks for letting me put my experience into one document. This long journey was amazing for all its experiences! You changed my life, fair dinkum mate! Cheers amigo!

Thanks Dr Amy Diedrich. For all your help during my candidature, especially at the beginning when almost no one could understand my poor English. Thank you for sharing your knowledge about social sciences. Great tool for my future. As you said several times, we need more biologists doing Social Sciences, it is a fact. ¡Gracias!

I would like to thank Jordano Palmar, Segundo Palmar (Paraguaipoa), Martín Oquendo (Castilletes), Francisco "Piñita" Rodríguez, Tibisay Rodríguez (Zapara Island), José Luis González, Abraham González (Porshoure), Lerminth Torres (NGO-Mangle), Helímenes Perozo Sr., and Helímenes Perozo Jr. (MPPAmb-Costa Oriental del Lago) and Neiro Flores (San Bernardo). I am appreciative of volunteers, over many years, for providing logistical support in the field, especially those who worked in the General Ecology Laboratory. I thank all the volunteers and people who activated the RAO-Zulia (Red de Aviso Oportuno, Zulia state).

I thank all the *Putshiüs* (*Palabreros*), Piaches and Oütsüs (Wayuú caretakers) who provided key information for this research. I am particularly grateful to the fishers from Castillete, Tapuri, Wincua, Walantalao, Wayatsirá, Puerto Chugüarulú, Porshoure, Parashiou, Cuzia, Kazuzain, Caño Sagua, Paraguaipoa, Caimare Chico, Zapara Island, and San Bernardo Peninsula for their trust and assistance. All Wayuu Indigenous people who has crossed my life, thanks for all your knowledge, for believe on this *Alijüna*. I hope I could express your ideas in the best possible way, and again my gratitude. Sincerely, from this *Alijüna* who fall in love with your culture more than 20 years ago. *Anashipiia*.

I am grateful to Natalie Wildermann, María Gabriela Montiel-Villalobos, Daniela Rojas-Cañizales, Emmy Andrade, Nínive Espinoza-Rodríguez, and María Jose Petit-Rodriguez for providing logistical support in the field, and for their constructive comments and feedback during this long endeavour. Also to Pablo Barboza and Patricia Vitale (Verde Salvaje ©) for the pictures used in my thesis (Chapter 1 and 7).

I want to thank all the turtle experts who provided valuable information, especially in Chapter 2, 3 and 4. Also, my deepest gratitude to anonymous reviewers who expressed their ideas, supportive feedback, and appreciate my effort. Thank you so much.

James Cook University's staff. Those who are behind hundreds of emails, with a happy face and warms words. Especially from: College of Science and Engineering, and Graduate Research School. All the crew who were always keen to help me. Thank you so much

Debbie, Bec, Melissa, Jo, Beth, Dot, Jamie. Especial mention to Andrew Norton, who 'forced' me to backing up my thesis data files every single day. Thanks mate, I have learned.

JCU International Students staff. Oh my God! Here I am writing these short lines to express hours, days, and weeks of talks. Thank you for all your orientation, advice, and support. It is a pleasure to wear my 'JCU Alumni Pin', and proudly answer why I wear it and where I got it. Keep doing such as great work with international students. Gracias Alejo, Tom, Louise, Rob, Kat, Tristan, and Elizabeth.

My laboratory mates, such as amazing support! Thanks for all your words, emails, feedbacks, cups of coffee, cakes, and beers. Thanks – Taka, Chris, Kiki, Kay, Ruth, Justin, Shane, Annie, Coralie, Isa, Rachelita, Helene, Melanie, Mariana, Rie, Monica, Julia, Matt, Suzan, Icha, Chloe, and Hamann! Now you know how to point stuff with the 'Venezuelan style'.

I should write these following lines in Spanish, because you represent for me the connection with my roots, with my culture there Down Under. Thanks all the Latin American Student Association founder, current, and future members. The Latin crew: Chichico, Carlitos, Rieder, Oscar, Daniela, Alfonso, Ana, Ayano, Diana, Natalia, Santiago, Lucia, David, Ramiro, Ellie, Sebastian, Leynard, Mariana, Gaby, Ana, Anahis, Montse, Ñaño, Maria, Simoncito, Estefi, Nicolas, and so many other names that probably I am missing, so sorry in advance. Also, to my Venezuelan VIP club, Adriana, Helios, Alejandra, and Cesar; thanks for your understanding during the most difficult times as Venezuelans outside of our land. As Nata said, I also have faith that we will meet again in a free and recovered country.

Also, talking about Venezuela, or Maracaibo (*my city*), it is impossible not to mention our 'Townsvillian familia': Zoe, Edel, Roxanna, Enrique, Shaggy, Mari… and their extended love providers: Ana, Anita, Pichu, Patri, Jeremy, Ricardo, El Nene, Maddie, Lui, Sebas, and Rex. For being more than just friends… family. Priceless support during the hardest moments during the PhD journey. We know that we have family and love there in Townsville because you are there. Infinitamente agradecidos por todo su apoyo.

To my friends who have been included in all the acknowledgments of my third thesis (last one?). Not because it is a formalism, it is because although 14 hours in different time zone, you were there to ask 'when you are going to finish that?' I know that there is the way that you express and show your support. I have experience on that. Thank you, Pirulo, Won, Chefo, Nestor, Sarny, Fulano, Enano, Pepo, Andres, and Henry.

To my friends who believed in the project and on this way to do science, with passion. For understanding that conservation starts with communities. Thank you for all your help: Ninive, Daniela, Tibi, Jordano, Martincito, Jose Luis, Segundo, Majo, Petronila, Emmy, Teresa, Maria, Jhony, Yohendry, Piñita, Lermith, Neiro, Neirito, Helimenes, Helimenes Jr., Lisandro, Gaby, and Mabi.

To all my family distributed among Venezuela, United States, and Colombia. Especially to Ninfa, Hector, Jennyfer, Omar, Daniela, Samantha, Joel, and Staci. Also my 'new' family Jeanette, Eugen, Chris, and all my uncles, aunts, and cousins.

I want to express my gratitude to my colleagues from TOMAGE, Tortugas Marinas de Guinea Ecuatorial, who provided all their support to complete my fieldtrip in Equatorial

Guinea. Thank you Fernando Mane, Carolina Martínez, Delfina Nsongo, Jesus Mba Mba, Angela Formia, and Alejandro Fallabrino. Especially, all the Ndowe and Bengas Indigenous people from Corisco Island, Bata, Tica, and Donde in Equatorial Guinea. More outcomes will come soon my dear friends, I hope malaria will not hit back.

I thank Chloe Nash (The University of Chicago-USA) for her help in improving the English of Chapter 6.

My research was authorised by the Human Ethics Committee at JCU, under the ethics permit numbers: H5704 and H6692 and Venezuela´s Environmental Ministry (Ministerio del Poder Popular para el Ambiente, now Ecosocialims and Water Ministry) via recording data memorandum 0641, and scientific licenses 828, 886, and 1224.

My carrot, Mor, posa, morsito, Natalie… Your fundamental role as spouse, friend, partner, accomplice, and love in the deepest way. I love you Natalie Wildermann. Where will our next adventures take us? And now with Mocka, and someone else? Because this one is done.
We did it! Te amo!

All my ancestors who guided me, in some way to find this pathway to understand so many stuff that are happening in my life. Thanks God, Thanks Chinita, here I am, ready for the next journey.
The last words written on this document are these ones. Thank you everyone!
Muchas gracias a todos por su apoyo! Soy un hombre afortunado por tenerlos en mi vida.

"I am really proud of my labour as conservationists, and I always repeat it in my community: 'Always, when I release a marine turtle (Sa'wainrü), I feel like one of them, swimming free out there with the turtle in the sea"
Jordano Palmar; Wayuú clan leader, my friend, and my brother

Statement on the contribution of others

Supervision

Dr. Mark Hamann, James Cook University
Dr. Amy Diedrich, James Cook University
Dr. James Moloney, formerly of James Cook University

Research funding

International Postgraduate Research Scholarship, James Cook University,
Graduate Research School, James Cook University.

Research support

Venezuela:
Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV).
University of Zulia. Experimental Faculty of Sciences. Department of Biology.
General Ecology Laboratory. University of Zulia.
Centro de Modelado Científico (CMC). University of Zulia.

Australia:
TropWATER – The Centre for Tropical Water & Aquatic Ecosystem Research

Travel and conference assistance

School of Earth and Environmental Sciences, James Cook University,
Graduate Research School, James Cook University,
College of Marine and Environmental Sciences, James Cook University,
TropWATER – The Centre for Tropical Water & Aquatic Ecosystem Research
International Sea Turtle Society (ISTS) travel award.

Contribution of data

MSc. Nínive Espinoza-Rodríguez, (GTTM-GV): access to the historical turtle data records from the Gulf of Venezuela (GTTM-GV's database: 2000-2012).

Biol. Daniela Rojas-Cañizales, University of Zulia and GTTM-GV: access to her honours thesis database from Kazuzain, Middle Guajira.

Dr. María Gabriela Montiel-Villalobos, Instituto Venezolano de Investigaciones Científicas (IVIC): access to her doctoral thesis database from the 'Zone of Major Extraction (ZME), Upper Guajira.

Ms. Maria Jose Petit-Rodriguez, and Ms. Maria Gabriela Sandoval, University of Zulia and GTTM-GV: access to GTTM-GV's database (2013-2017).

Lic. Belen Orsini, and Biol. Veronica de Los Llanos: access to un-edited videos and interviews to Wayuú Indigenous people, recorder during the shooting of the movie "Verde Salvaje".

Statistical and analytical support

Dr. Natalie Wildermann, James Cook University

Dr. Takahiro Shimada, James Cook University

Proofreading support

Dr. Kimberly Riskas

Dr. Ruth Kamrowksi

Contributions of others by Chapter

Thesis Chapter	*Published or planned publication*	*Nature of the intellectual input of each author*
2	**Barrios-Garrido, H.**; Shimada, T.; Diedrich, A.; Hamann, M. (*in prep*). The human dimensions of the Conservation Status throughout Marine Turtle Regional Management Units (RMUs). Endangered Species Research.	HBG designed the study. HBG carried out the evaluation and data analysis. TS provided advice on analysis. AD provided guidance with socio-economic approaches. HBG wrote the chapter and TS, AD, MH helped with editing.
3	**Barrios-Garrido, H.**; Diedrich, A.; Hamann, M. (*in prep*). People using marine turtles: a socio-cultural evaluation of consumptive use throughout the world. Chelonian Conservation and Biology.	HBG designed the study, carried out the data processing and analysis. AD & MH provided guidance with the database analysis. HBG wrote the chapter and AD and MH helped with editing.
4	**Barrios-Garrido, H.**; Wildermann, N. Diedrich, A.; Hamann, M. (*in prep*). Conservation conflicts related to marine turtles: Caribbean as case study. Conservation and Society.	HBG designed the study. HBG carried out the data processing and analysis. NW provided guidance with the statistical analysis. NW, AD and MH provided guidance with the surveymonkey design and evaluation. HBG wrote the chapter and NW, AD and MH helped with editing.
5	**Barrios-Garrido, H.**; Montiel-Villalobos, 2016. Strandings of Leatherback Turtles (*Dermochelys coriacea*) along the Western and Southern Coast of the Gulf of Venezuela. Herpetological	HGB and MMV designed the study, carried out the data gathering process, HGB analysed the data and wrote the chapter. MMV helped comments and analysis. The

	Conservation and Biology 11 (1): 244-252.	publication covers the section of the chapter relating to leatherback turtles.
	Barrios-Garrido, H.; Espinoza-Rodríguez, N.; Rojas-Cañizales, D.; Montiel-Villalobos, M.G.; Petit-Rodriguez, M.J.; Wildermann, N.; Hamann, M. (*in prep*). Historical and current status of marine turtles in the Gulf of Venezuela: threats and trends. Biological Conservation.	HBG designed the study. HBG, NER, DRC, MGM, MJPR and NW conducted the fieldwork. HBG conducted the analysis and wrote the chapter. MH provided analysis advice. NER, DRC, MGM, MJPR, NW and MH helped with editing.
6	**Barrios-Garrido, H.**, Espinoza-Rodríguez, N., Rojas-Cañizales, D., Palmar, J., Wildermann, N., Montiel-Villalobos, M., & Hamann, M. 2017. Trade of marine turtles along the Southwestern Coast of the Gulf of Venezuela. Marine Biodiversity Records, 10(1), 1-12. doi: 10.1186/s41200-017-0115-0	HBG designed the study. HBG, NER, DRC, JP, NW and MGM conducted the fieldwork. HBG conducted the analysis with advice from JP, NW & MH. HBG wrote the chapter and MH helped with editing.
7	**Barrios-Garrido, H.**, Palmar, J., Wildermann, N., Rojas-Cañizales, D.; Diedrich, A., Hamann, M. (*in press*). Marine turtles presence in the traditional pharmacopoeia, cosmovision, and beliefs of Wayuú Indigenous people. Chelonian Conservation Biology.	HBG, JP and NW designed the study and conducted the fieldwork. HBG conducted the analysis and wrote the chapter. JP, NW, AD and MH provided analysis advice and assisted with editorial support.

Ethics Statement

All necessary permits required to develop this research were verified by the Human Ethics Committee at James Cook University. All the photos included on this manuscript were taken and authorised by Venezuela´s Environmental Ministry (Ministerio del Poder Popular para el Ambiente), now the Ministry of Eco-Socialism and Water, under the Venezuelan Environmental permit license numbers: 828, 886, and 1224.

The 2014 surveys were covered under a James Cook University human ethics permit. The social component of the thesis was authorised under the permits number: H5704.

Outputs produced during my PhD Candidature

Peer Reviewed Journal Articles:

Barrios-Garrido, H.; Montiel-Villalobos, 2016. Strandings of Leatherback Turtles (*Dermochelys coriacea*) along the Western and Southern Coast of the Gulf of Venezuela. *Herpetological Conservation and Biology* 11 (1): 244-252.

Barrios-Garrido, H., Espinoza-Rodríguez, N., Rojas-Cañizales, D., Palmar, J., Wildermann, N., Montiel-Villalobos, M., & Hamann, M. 2017. Trade of marine turtles along the Southwestern Coast of the Gulf of Venezuela. *Marine Biodiversity Records*, 10(1), 1-12. doi: 10.1186/s41200-017-0115-0

Barrios-Garrido, H., Palmar, J., Wildermann, N., Rojas-Cañizales, D.; Diedrich, A., Hamann, M. (accepted – in press). Marine turtle's presence in the traditional pharmacopoeia, cosmovision, and beliefs of Wayuú Indigenous people. Chelonian Conservation Biology.

Other thesis outputs:

Barrios-Garrido, H.; Espinoza-Rodríguez, N.; Rojas-Cañizales, D.; Palmar, J.; Wildermann, N.; Montiel-Villalobos, M.G.; Hamann, M. 2017. Trade of marine turtles in the Gulf of Venezuela: one problem, three nations. 28th International Congress for Conservation Biology (ICCB 2017). Cartagena, Colombia. July/2017 (Oral presentation).

Barrios-Garrido, H.; Ruiz-Moreno, A.; Ramirez-Flores, O.; Wildermann, N.; Diedrich, A.; Hamann, M. 2017. Conservation conflicts related to marine turtles: Caribbean as case study. 37th International Sea Turtle Symposium, Las Vegas, USA; April/2017 (Oral presentation).

Barrios-Garrido, H.; Wildermann, N.; Diedrich, A.; Hamann, M. 2016. Socio-economic insights of marine turtle conservation status worldwide. 36th International Sea Turtle Symposium, Lima, Peru; March/2016 (Poster presentation).

Barrios-Garrido, H.; Martinez, C.; Rojas-Cañizales, D.; Mba Mba, J.; Formia, A.; Andrade, E.; Fallabrino, A.; Diedrich, A.; Hamann, M. *Hakuna Matata* and *Ayaawataa aa'u waya*: Indigenous traditions and beliefs towards marine turtles. 36th International Sea Turtle Symposium, Lima, Peru; March/2016 (Oral Presentation).

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Other outputs (peer-reviewed articles and book chapters):

Barrios-Garrido, H., Bolívar J., Benavides L., Viloria J., Dugarte F., Wildermann N. 2017. Evaluación de la pesquería de palangre artesanal y su efecto en la raya látigo (*Dasyatis guttata*) en Isla Zapara, Golfo de Venezuela. Latin American Journal of Aquatic Research, 45(2), 302-310. doi:10.3856/vol45-issue2-fulltext-6

Balladares, C., Marin, E., Espinoza-Rodríguez, N., & **Barrios-Garrido, H.** 2017. Prevalence of fibropapillomatosis on stranded sea turtles in the Venezuelan coast. Revista BioCiencias, 4(4): 1-14. Article ID 04.04.02.

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Barrios-Garrido, H.; Boher-Bentti, S. et al…, Bolaños, J. 2016. Guiana dolphin – *Sotalia guianensis* – Venezuela. Libro Rojo de la Fauna Venezolana, 4ta edición. J.P. Rodríguez, A. García-Rawlins, F. Rojas-Suarez, (Eds.) 02/2016: Provita. Fundacion Empresas Polar. (Book chapter).

Buitrago, J.; Vera, V.J.; García Cruz, M.; Montiel-Villalobos, M.G.; Rodríguez-Clark, K.M.; **Barrios-Garrido, H.**; Peñaloza, C.; Guada, H.J.; Solé, G. 2016. Green turtle - *Chelonia mydas* – Venezuela. Libro Rojo de la Fauna Venezolana, 4ta edición. J.P. Rodríguez, A. García-Rawlins, F. Rojas-Suarez, (Eds.) 02/2016: Provita. Fundación Empresas Polar. (Book chapter).

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Barrios-Garrido, H. 2017. Comercio ilegal de tortugas marinas en el Golfo de Venezuela. Latin American Meeting of Marine Turtle Specialists – RETOMALA. 37th Annual Symposium on Sea Turtle Biology and Conservation. 15-20th April. Las Vegas, USA.

Barrios-Garrido, H. 2016. Indigenous people & Marine Turtles conservation: Ndowe (Kombe & Benga) people –an African approach. African Annual Meeting (marine turtles). 36th Annual Symposium on Sea Turtle Biology and Conservation. 2nd March. Lima, Perú. (Oral presentation).

Barrios-Garrido, H. 2016. Turtle rodeo: a crucial tool to improve our understanding of feeding areas biology. Workshop of Intentional capture of marine turtles. 36th Annual Symposium on Sea Turtle Biology and Conservation. 3rd March, Lima, Perú. (Oral presentation).

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Vásquez, M.T.; Rodríguez, F.; Noriega-Perozo, C.; De Turris-Morales, K.; Vílchez, M.; Rojas-Cañizales, D.; Rodríguez-Antelo, M.A.; **Barrios-Garrido, H.**; Espinoza-Rodríguez, N. 2013. Registros de varamientos de tortuga Cardón (*Dermochelys coriacea*) en la costa sur del Golfo de Venezuela, años 2011-2013. X Congreso Venezolano de Ecología. 18-22 November. 2013. (Poster presentation).

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Thesis Abstract

Wildlife conservation is challenging. In part because we lack essential knowledge on species life-history, distribution or abundance, but also because threats are generally anthropogenic and we lack detailed understanding of the human dimensions of conservation. Numerous scholars have studied the relationship between poverty and its impact on the ecosystem condition, and the importance of environmental education and legal frameworks in successful conservation initiatives to improve enforcement and maintain relationships among traditional people and their environments. In relation to marine turtle conservation, there are significant knowledge gaps in relation to people and their role in conservation. Hence, in this thesis I evaluate human dimension aspects that affect the conservation status of marine turtles, and to improve our understanding of the relationships among human societies and wildlife conservation. To achieve my aim, I assessed four research objectives:

1) Evaluate how socio-economic drivers and legal frameworks affect the level of protection of marine turtles worldwide;
2) Identify and understand the conservation conflicts that impact marine turtle protection initiatives in the Caribbean basin;
3) Assess the historical and current demographic status of marine turtle stocks in the Gulf of Venezuela; and
4) Study the scale of use, cultural component and value of marine turtles to Wayuú Indigenous people, especially as a medicinal resource.

Human societies are closely linked to their ecological environments and the conservation capacity of a country's government plays a key role in the protection of marine turtles. In

chapter 2, I aimed to (1) evaluate the conservation capacity and enforcement within the 58 regional management units (RMUs) of the seven species of marine turtles throughout the world, using the Human Development Index (HDI) and economic levels as proxies; and (2) to predict the conservation status of 43 marine turtle RMU by merging several indices. To do this I developed a Conservation and Enforcement Capacity index (CECi) by integrating (1) the economic level of each country (defined by the United Nations); (2) the HDI (World Economic Situation and Prospects database); and (3) the risks and threats identified in the RMU framework. I then used the most recent conservation status of 15 recently IUCN assessed RMUs to predict the conservation status of the 43 RMUs without updated IUCN categorisation. I evaluated the conservation status of marine turtle RMUs in relation to the socio-economic situation of the region for each RMU. I found that using only the HDI as a proxy to assess the conservation capacity of the governments was weak. However, by using a multi-index model, I was able to predict the status of 33 of 58 RMUs, of them 57% may be of threatened conservation status due to their high CECi values.

Consumptive use of threatened species, such as marine turtles, is one of the main challenges for environmental and conservation entities. In the case of marine turtles, this use is controversial. For this reason, in Chapter 3, I evaluated how consumptive use (legal and illegal) of marine turtles occurs (regulated or not) and is distributed worldwide. After an extensive literature review, I identified and categorised the regulations associated with the consumptive use of marine turtles. Of 137 countries with a marine-facing coastline and a presence of turtles. Of them I found that legislation prevents use in 98 of them (72%), and legal use occurs in 39. Among these 39 countries, use is regulated in 33 (85%) with parameters, such as ethnicity, region, size, quotas, and special permits.

Conflicts among local, national, regional and international stakeholders (involved in marine turtle conservation) often they arise because people or groups involved come from different socio-economic backgrounds. In chapter 4, I narrow the scale of my thesis to the Caribbean region. I aim to identify and assess the conservation-based conflicts occurring in the Caribbean countries, identifying their frequency, level of severity, number of stakeholders' groups involved, the degree to which they hinder conservation goals, and potential solutions. I evaluated the presence and details of conservation conflicts provided by 72 respondents including conservation-based project leaders, researchers, and people involved in policy-based decision-making, conservation volunteers, and species experts with experience working on marine turtle conservation programs in the Caribbean. The respondents identified 136 conflicts, and I grouped them into 16 different categories. The most commonly mentioned causes of conflicts were: 1) the 'lack of enforcement by local authorities to support conservation based legislation or programs' (18%); 2) 'legal consumption of turtles by one sector of community clashing the conservation aspirations of other sectors of community (14%); and 3) 'variable enforcement of legislation to limit/prohibit use across range states of the species (10%). From the respondents, it is also apparent that illicit activities in the region are also impacting in the success of conservation based projects and programs.

In chapters 5, 6, and 7, I narrow the focus of my thesis down to a country scale and examine the current state of knowledge species distribution and threats (Chapter 5), consumptive use and trade (Chapter 6) as well as indigenous (Wayuú) perspectives (Chapter 7) in the Venezuelan territory, and its effect on the current use of marine turtles (consumptive and non-consumptive). In chapter 5, I combined data from field-based studies with survey data from community based monitoring and historical records to investigate the distribution and threats to Venezuela's marine turtles. Overall, my findings confirm that five species of marine turtle use the Gulf of Venezuela, and I provide baseline stranding trends for four of them. I evaluated 1,571 records of stranded marine turtles comprising of 82% green turtles, 8% hawksbill turtles, 5% leatherback turtles, 4% loggerhead turtles, and 1% olive ridley turtles. I found that 82% of the all turtles recorded as stranded were immature. The co-occurrence of multiple species and both immature and adult-size turtles indicates that the Gulf of Venezuela provides important habitat for year-round feeding and development.

As part of this baseline evaluation in the Gulf of Venezuela, in Chapters 6 and 7, I assessed the scale and cultural component of consumptive use of marine turtles in the region. To assess the scale and cultural component of this use, I interviewed residents and indigenous elders from the southwestern coast of the Gulf of Venezuela (Venezuelan part of the Guajira Peninsula), using a combination of in-depth and semi-structured interviews. I carried out a field and detailed market-based observations on the Guajira Peninsula to detect the sale and use of marine turtle products. I focused on three main categories of use; the type of use (e.g. traditional medicine, non-commercial cultural or commercial), the type of product, routes of trade, and the price of products. I identified types of products, routes of trade, and the prices of different products. All of the marine turtle species reported from the Gulf of Venezuela were used by people, sometimes commercially, and the prices of products varied among their type, species of origin, and the distance from the capture area to a marketplace. I obtained evidence connecting Wayuú Indigenous people's traditions and beliefs with marine turtle use, and also how up to 11 different marine turtle body parts are used for traditional medicine, and as an economic resource to sustain their communities. It is probable that illegal trade of marine turtle products is placing pressure on populations in the Gulf of Venezuela. I recommend the implementation of an inter-institutional conservation-portfolio be developed for the Peninsula to evaluate actions related to this concern.

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Chapter 1

GENERAL INTRODUCTION

Flatback hatchling turtle reaching the sea at Mon Repos beach (Queensland, Australia). Photo credit: Héctor Barrios-Garrido (2013).

1.1. Human societies and marine turtles

The history of human settlements worldwide has generally been associated with coastal environments (Frazier, 2003; Erlandson & Rick, 2010). Consequently, many of the coastal species and habitats have declined in numbers and condition (Waycott *et al.*, 2009; Gruby *et al.*, 2015).The effect of the broad-scale exploitation of marine resources by human societies has often led to species declines (Pollnac *et al.*, 2010), as has been observed in most marine turtle species (Frazier, 2003). Within human-dominated ecosystems, some species are considered to hold particular importance, either because of their value to people or for their important role in the environment (Kinan & Dalzell, 2005; Kalinkat *et al.*, 2017). Marine turtles, while not necessarily keystone species, are commonly used to evaluate the health and condition of coastal and aquatic habitats, or used as a group of flagship species to raise attention about environmental issues (Shanker, 2015).

Marine turtles are megafauna with a long life span and they are reliant on both marine and terrestrial environments during their life (Shanker, 2015). They are present year-round in tropical and subtropical marine waters around the world, with only the flatback turtle (*Natator depressus*) and the Kemp's ridley turtle (*Lepidochelys kempii*) having restricted, non-global distributions (within the Australian continental shelf and the North Atlantic – including the Gulf of Mexico – area, respectively) (Bjorndal *et al.*, 2014; Bevan *et al.*, 2016; Wildermann *et al.*, 2017). Marine turtles are considered to be an important species group for many human cultures (Frazier, 1980, 2003; Foale *et al.*, 2017), and for several decades researchers have sought to understand the links between turtles and people.

Indeed, marine turtles play critical roles of cultural and economical importance (Woodron Rudrud, 2010; Álvarez-Varas *et al.*, 2015). Some research focused on the aspects of their natural history, their ecological role and the anthropogenic pressures that marine turtle face along their life cycles (e.g. Kinan & Dalzell, 2005). Alongside this research interest, marine turtles are easily recognisable, and conservation agencies have increasingly used turtles as flagship species to advance conservation goals. Across the world there has been increases in the number of conservation programs working to mitigate threats, attempt to prevent declines, and improve the status of various marine turtle populations (Shanker, 2015; Velez-Zuazo *et al.*, 2017). However, despite increased conservation attention, there are still considerable knowledge gaps with regard to understanding how global processes may impact the functionality, interconnectivity and management of marine turtles (Hamann *et al.*, 2010; Rees *et al.*, 2016).

The marine turtle life cycle is spread over large spatial scales, spanning from nesting beaches to offshore developmental areas, feeding grounds and reproductive areas (e. g. Limpus, 2009; Meylan *et al.*, 2011). Often times critical habitat areas remain unidentified, and daily movements or migration can occur across domestic or international jurisdictional boundaries (Troëng *et al.*, 2005; Moncada *et al.*, 2010; Horrocks *et al.*, 2011; Horrocks *et al.*, 2016). Understanding migratory behaviour and the connection between habitat areas and the human communities residing in, or using these areas is important for initiating effective management arrangements. For example, in 1996, satellite tracking of a young loggerhead turtle (*Caretta caretta*) from Baja California, Mexico to Japan provided an important link between conservation projects in Japan and emerging efforts in Mexico (Nichols *et al.*, 2000). The connection between people on either side of the Pacific Ocean helped generate momentum for conservation projects in Baja California, which over time will have positive benefits for loggerhead populations in Japan (Seminoff *et al.*, 2014; Peckham *et al.*, 2017).

However, less is known about turtle population connectivity in the southern Caribbean, especially between feeding and developmental areas (Becking *et al.*, 2016). It is important to identify the associations between migratory, feeding and residency areas, because this information may provide a better perspective about the ecological role, transport of biota and nutrients, allowing improved protection measures for marine turtles and their habitats (Stringell *et al.*, 2010; Patricio *et al.*, 2011).

Marine turtles generally have high fidelity to particular nesting and foraging areas (Bowen *et al.*, 2007; Pajuelo *et al.*, 2016), and although they sometimes have ontogenetic shifts in foraging sites, their biologically important sites commonly remain crucial during their life cycle (Shimada *et al.*, 2014). Indeed, marine turtles remain in foraging areas for decades and use key habitats as developmental zones (Seminoff *et al.*, 2003; Chaloupka & Limpus, 2005), and even if the turtles are intentionally displaced from humans as a management strategy, they will return to their home areas (Shimada *et al.*, 2016). Hence, a main element that is still underestimated, and not well understood, is the importance of space-based protection of foraging grounds for mixed aggregations of marine turtles, especially in the southern Caribbean. A key component of space-based protection is understanding the behaviour, movement, the effects of displacement and the use of migratory corridors (Baudouin *et al.*, 2015); these are still not known for some marine turtle feeding areas (Rees *et al.*, 2016).

During their migrations, marine turtles can pass through several aquatic habitats with different management arrangements. For example, marine turtles may have nesting habitat that is fully protected by legislation in one country, but they may migrate across coastal or oceanic waters to foraging habitats in a different country where the protection is limited, and/or the enforcement of existing legislation is lacking in one or more of these other habitats

(Horrocks *et al.*, 2011; Baudouin *et al.*, 2015). This issue is most noticeable in regions such as the Mediterranean, South-east Asia, and the Caribbean. These regions support globally important marine turtle stocks, and turtles from these stocks are regularly reported to nest in one country and migrate to another. Hence, effective conservation in these regions requires international cooperation, which is difficult to achieve, because these areas have a high density of smaller countries with large EEZs. One area it has work is the Turtle Islands Heritage Protected Area (TIHPA), which is an international agreement between Malaysia and the Philippines (http://whc.unesco.org/en/tentativelists/6008/) established to manage a shared turtle population. Conservation efforts in these regions are starting to show signs of success (Jin *et al.*, 2010; Nabangchang-Srisawalak *et al.*, 2016).

1.2. Human dimensions of marine turtle conservation

Human dimensions (of natural resources in general) is a reference to the social attitudes, processes, and behaviours related to how humans protect, enhance, and use biodiversity and its elements (Manfredo & Dayer, 2004; Broussard Allred *et al.*, 2010). Finding a balance between the varying perspectives, beliefs and socio-economic realities that occur within and among countries, and the maintenance of bio-ecological systems or wildlife populations remains challenging (Reid *et al.*, 2016). This challenge often occurs because there are real or perceived conflicts in the objectives of different levels of governance or stakeholder groups and consequently it becomes difficult to balance conservation and socio-economic realities (Wilkie *et al.*, 2016). In Africa, for example, the capacity to protect terrestrial megafauna has been studied by relating conservation success to human population density (Balmford *et al.*, 2001), and by balancing pastoral livelihoods and wildlife conservation (Reid *et al.*, 2016). Reid *et al.* (2016) found that regions of remarkable conservation significance in Africa are likely to coincide with areas of dense human settlement; hence, the role of people'(s') values (collective or individual) are crucial to establish confidence among stakeholders (i.e. researcher-community-policymaker teams) in order to minimise potential conflicts that can affect biodiversity.

However, finding the balance between human realities and conservation objectives are still challenging for researchers and managers because there are complex socio-ecological circumstances that the projects have to contend with. For example, most of the world's marine turtle populations have been exposed at some point in time to consumptive use, and in some areas of the world use continues (Humber *et al.*, 2014). The task of managing the use occurs because in a single country the reasons turtles are consumed differ within and between communities. Hence, there is become a particular challenge of protecting a threatened species that is used, for traditional purposes and/or commerce by local community members while other sectors of the community strive to prevent or manage the use, or a different community derives benefit from taking divers to see them alive (e.g. Chen *et al.* (2009); Valverde *et al.* (2012); Kondo *et al.* (2017)). Understanding the reasons why groups of people use turtles, and why people value turtles, is thus an important component of conservation.

There is a need for research studies that aim to increase general understanding of the cultural values of indigenous people, or people residing in coastal communities in relation to the environment and how their views can be incorporated into conservation (Weiss *et al.*, 2013). Doing this may improve our understanding of what kind of changes have occurred in the human- environment relationships among different groups of people, this understanding will aid the design of socially, economically and environmentally balanced conservation strategies in the future. Such strategies are clearly needed to prevent further declines in environmental resources such as marine turtles.

1.3. The Caribbean basin as key habitat for marine turtles

The Caribbean basin is located in the Atlantic Ocean (tropical region of the Western Hemisphere). It is delimited by Mexico, Central America (from the west), Panama, Colombia, and Venezuela at the south, by the Lesser Antilles at the east, and Greater Antilles at the north. The Caribbean basin covers about 2,754,000 km^2 and represents one of the biggest seas in the planet (Miloslavich *et al.*, 2010).

Four species of marine turtle nest on Caribbean beaches, and two more species reside in the Caribbean. The species breeding in the Caribbean basin include the green turtle (*Chelonia mydas*), hawksbill turtle (*Eretmochelys imbricata*), loggerhead turtle (*C. caretta*) and leatherback turtle (*Dermochelys coriacea*) (Dow Piniak & Eckert, 2011; Amorocho *et al.*, 2016) and the two species that do not regularly nest in the Caribbean are the two species of ridley – olive ridley (*Lepidochelys olivacea*) and Kemp's ridley (*L. kempii*). Seven regional management units (RMUs) have been described for the species occurring in the Caribbean basin (Wallace *et al.*, 2010): two RMUs for *C. mydas* (rmu47, southern Caribbean; and rmu50, northwestern Atlantic), and one RMU for each of the other five species found in the Caribbean (rmu10, western Atlantic for *E. imbricata*; rmu25, northern Atlantic for *C. caretta*; rmu51, northern Atlantic for *D. coriacea*; rmu02, western Atlantic for *L. olivacea*; and rmu58, northwestern Atlantic for *L. kempii*) (Table 1.1).

The presence and abundance of marine turtles in the Caribbean basin is habitat dependent. For example, green turtles are relatively common where seagrass is present (e.g. *Thalassia testudinum*, *Syringodium filiforme*, and *Halodule wrightii*) (Bjorndal *et al.*, 2000a; Labrada-Martagón *et al.*, 2017), hawksbill turtles are generally associated with coral reef habitats

(Carricart-Ganivet, 2014; Strindberg *et al.*, 2016), and leatherback turtles are specialist hydrozoan feeders, so they are primarily found in the open, deeper, pelagic waters (James *et al.*, 2005). However, loggerhead turtles are considered opportunistic carnivores and do not tend to have specific habitats, and have been found to reside in sandy benthic environments, deeper pelagic waters, neritic habitats or those close to mangrove forests (Bjorndal *et al.*, 2000b). The distribution of olive and Kemp's ridley turtles are less well known, but are most commonly associated with deeper habitats (NMFS & USFWS, 2007; Petitet & Bugoni, 2017).

The distribution, abundance and seasonality of prey items all influence the presence of marine turtle species in the Caribbean basin (Bjorndal *et al.*, 2000a; Pajuelo *et al.*, 2016). These factors are likely also to be related to displacement and movements of marine turtles along Caribbean coastal areas (Meylan *et al.*, 2011). Also, in many areas of the world the turtles' body condition and growth rates are affected by local variation in water temperature or the quantity/quality of food sources (Bjorndal *et al.*, 2000a; Wallace & Saba, 2009; Bjorndal *et al.*, 2016; Rossi *et al.*, 2016; Bjorndal *et al.*, 2017). Indeed, several authors claim that it is important to monitor the health of marine turtles in relation to environmental predictors. Doing this will enable evaluation and prediction to be made about how the degree to which changes in the environments they use may influence their growth, breeding rates, and site fidelity (Labrada-Martagón *et al.*, 2010; Limpus *et al.*, 2012). This is a particularly large knowledge gap for many foraging areas in the Caribbean.

Table 1.1. Caribbean RMUs: status and trends of marine turtles in the seven RMUs present in Caribbean waters.

Turtle (Scientific name)	**Oceanic basin**	**Index nesting beaches (rookeries)**	**Regional Management Unit code**	**Current Population Trend**	**Confidence (L-Low, M-Medium, H-High)**	**Reference**
Green (*Chelonia mydas*)	southern Caribbean	Tortuguero, Costa Rica index beaches, Florida, USA El Cuyo, Yucatan & Isla Holbox, Quintana Roo-Mexico	rmu47	Increasing	H	Seminoff *et al.* (2015)
	northwestern Atlantic	Aves Island, Venezuela Galibi Reserve, Suriname Isla Trindade, Atol Das Rocas, Brazil	rmu50	Stable	M	García-Cruz *et al.* (2015); Seminoff *et al.* (2015)
Loggerhead (*Caretta caretta*)	northern Atlantic	86 within Florida, USA Quintana Roo, Mexico	rmu25	Increasing	H	Ceriani and Meylan (2015)
Hawksbill (*Eretmochelys imbricata*)	western Atlantic	Jumby Bay, Antigua, Barbados, Doce Leguas Cays, Cuba Yucatan Peninsula, Mexico Mona Island, Puerto Rico US Virgin Islands	rmu10	Decreasing	M	Mortimer and Donnelly (2008)
Leatherback (*Dermochelys coriacea*)	northwestern Atlantic	Among 19 index beaches in several countries	rmu51	Increasing	H	Tiwari *et al.* (2013)
Olive ridley (*Lepidochelys olivacea*)	western Atlantic	28 index sites	rmu02	Decreasing	M	Abreu-Grobois and Plotkin (2008)
Kemp's ridley (*Lepidochelys kempii*)	northwestern Atlantic	Rancho Nuevo, Mexico Padre Island, USA	rmu58	Increasing	H	Bevan *et al.* (2016)

1.4. Anthropogenic threats to marine turtles in the Caribbean basin

The impact of human activities on the condition of marine areas in the Caribbean basin has been assessed at a regional scale (Fleming, 2001; Amorocho *et al.*, 2016). The Caribbean basin is considered socially and economically to be a developing region, where the majority of the countries experience exploitation of natural resources, and have a dependence on extractive commodities (Fleming, 2001; Forster *et al.*, 2011). Due to the developing economies in the majority of the countries in the area, the consumptive use of marine turtles frequently occurs (Santidrián Tomillo *et al.*, 2008; Campbell, 2014). Indeed, in some remote regions, marine turtles are the main source of protein for people (Roe Hulse, 2005; Cawthorn & Hoffman, 2016). Although there is some anecdotal evidence contained in national reports, grey literature or regional assessments, there is generally a lack of information about the quantity, size and species of marine turtles taken, and the degree to which they are impacted by other human activities in the Caribbean basin each year (Lagueux *et al.*, 2014, 2017).

In some Caribbean coastal communities, especially isolated settlements, the consumptive use of marine turtles occurs primarily for subsistence (Roe Hulse, 2005; Robles, 2008). In contrast to this, some authors assert that subsistence use provides an opportunity for marine turtle products to be traded or sold in commercial markets, often illegally (Rueda-Almonacid *et al.*, 1992). Indeed, commercial and/or illegal markets have occurred (Horrocks *et al.*, 2011; Humber *et al.*, 2014; Horrocks *et al.*, 2016). These conflicts and variation in people’s perspectives towards marine turtle use and conservation have led to tensions among human groups (Meylan & Donnelly, 1999; Broderick *et al.*, 2006; Seminoff & Shanker, 2008). Overall, different perspectives towards the consumptive use of marine turtles appear in the literature, such as differences in opinion for (a) traditional and non-commercial, (b) traditional and commercial, and (c) non-traditional and commercial (Balazs, 1983; Bell *et al.*, 2006; Matsuzawa, 2009; IOSEA, 2014; Poonian *et al.*, 2016). Hence, identifying and understanding different approaches towards the consumptive use, or other threats (e. g. by-catch impact), is important for not only informing the decision-making process, but improving acceptance among people about management-based decisions. In the Caribbean the existence and importance of the traditional, or local component of consumptive use carried out by communities is not well understood. Some researchers have described the traditional fishery of marine turtles that occurs among indigenous communities in the Caribbean (e.g. Thorbjarnarson *et al.*, 2000a; Campbell, 2003), but our understanding on traditional use component in the use of marine turtles remains low. Therefore, new evidence about this topic is examined in chapters 6 and 7 of this thesis, where a pertinent example of the illegal consumptive use (traditional and commercial) that may impact marine turtle populations occurs in Venezuela, specifically in the Gulf of Venezuela is presented. Here I used the definition of the term "Traditional Use" described previously by Berkes (1993), who defined it as 'a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed out by generations by cultural transmission, about the use of natural resources (and all the elements of their environment)'.

1.5. The Gulf of Venezuela as a key feeding ground in the Caribbean

The Gulf of Venezuela is located in the western region of the country, it consists of a shallow (~50 meters) embayment with an area of ~16,800 kms^2 (Zeigler, 1964; Morán *et al.*, 2014; Barrios-Garrido *et al.*, 2016b). The Gulf of Venezuela connects Maracaibo Lake with the Caribbean Sea, and it is the most northern of Venezuela's four aquatic interconnected environments (Rodríguez, 2000; Barrios-Garrido *et al.*, 2016a). Alongside Tablazo Bay, Maracaibo Strait and Maracaibo Lake, it forms the Maracaibo Lake System (MLS) (Rodríguez, 2000; Medina & Barboza, 2003; Barrios-Garrido *et al.*, 2016a). The Gulf of Venezuela is the only exclusively marine habitat of the Maracaibo Lake System, with a mean salinity between 25 and 37 ppt (Rodríguez, 2000; Espinoza-Rodriguez *et al.*, 2011). In addition, the Gulf of Venezuela is known to support marine upwelling (Rueda-Roa & Muller-Karger, 2013) that are associated with important habitat areas for coastal dolphins (mainly Guiana dolphin, *Sotalia guianensis*) (Barrios-Garrido *et al.*, 2016a), seabirds (García *et al.*, 2008; Espinoza-Rodríguez *et al.*, 2015), manatees (Montiel-Villalobos & Barrios-Garrido, 2005), sharks (Tavares & Sánchez, 2012) and marine turtles (Parra, 2002; Barrios-Garrido, 2003; Montiel-Villalobos *et al.*, 2010; Montiel-Villalobos, 2012; Barrios-Garrido & Montiel-Villalobos, 2016). The Gulf of Venezuela supports large aggregations of marine turtles, which are exposed to intense hunting by artisanal fisheries in the area (Montiel-Villalobos, 2012; Rojas-Cañizales, 2015; Barrios-Garrido *et al.*, 2017b).

The environmental conditions in the Gulf of Venezuela are crucial for maintaining habitats used by the marine turtles (Montiel-Villalobos, 2012). Is for this reason that the Gulf of Venezuela is considered by multiple authors as the most important feeding area for marine turtles in the country (Guada & Vera, 1995; Guada & Sole, 2000). Also, the upwelling currents in the area historically supported industrial fisheries, such as shrimp trawling and these may had affected marine turtle populations because they did not use bycatch excluder devices properly (Pirela *et al.*, 2008). However, this fishery was banned by the development of a national official gazette ruling in 2009 for all the Venezuelan waters (Venezuela, 2009), leaving artisanal fisheries as the main fisheries operating in the Gulf of Venezuela. This management decision was criticised by the industrial trawler owners but supported by the artisanal fishers. Other industrial fisheries still occur in the country, but they are mainly located in the eastern side of the Venezuelan Caribbean and Atlantic coast (such as the industrial tuna fishery), and not in the Gulf of Venezuela. It is currently not known whether the removal of the shrimp fisheries from the Gulf of Venezuela has had a positive impact on marine turtles.

1.6. Trade and use of marine turtles

Legal or illegal trade of marine turtles occurs in several regions of the world (e.g. Barr, 2001; IOSEA, 2014; Migraine, 2015). The trade occurs at different levels (local, national, regional and international), hence the national and multi-national protection initiatives such as legislation and regulations are required. International trade is regulated under the Convention on International Trade in Endangered Species (CITES), which highly restricts all international trade for all marine turtle species and ensures that trade does not affect their survival. One notable exception is maintenance of traditional-based trade between Indigenous people of Australia and Papua New Guinea under the Torres Strait Treaty (1985). Within countries, most governments aim to regulate, control and evaluate the level and sustainability of in-country marine turtle trade and some governments have developed a permit-based or quota system for traditional hunting (Bell *et al.*, 2006; Brikke, 2010; Poonian *et al.*, 2016; Alexander *et al.*, 2017). However, even with these management systems in place, managing use is challenging because it can be problematic differentiating between legal and illegal use in a regulated market and between traditional and commercial use (Humber *et al.*, 2014; Miskelly, 2016; Poonian *et al.*, 2016). If indeed, the Government distinguishes between traditional and commercial use, then the Government enforcement agencies will need a regulatory system that can distinguish between them.

Marine turtles are a key component in many traditional cultures (Campbell, 2003). Currently, the Wayuú people are considered the most populous indigenous group inhabiting Venezuela, and their connection to marine turtles, evident through ancient customs, is discussed in a general sense in the literature (Parra *et al.*, 2000). For generations, Wayuú people have used marine turtles in their daily lives, such as food, medicine and as talismans (Parra *et al.*, 2000). Understanding the degree to which turtles are used for consumption, either for commerce or tradition, in combination with improved knowledge of marine turtle population sizes, would make a significant contribution towards the development of management incentives for the protection of marine turtles in Venezuela, and all the southern Caribbean region.

1.7. Thesis outline

1.7.1. Research aims and objectives

The overall aims of my thesis were to evaluate human dimension aspects that affect the conservation status of marine turtles, and to improve our understanding of the relationships among human societies and wildlife conservation. I assessed that through evaluating socio-economic aspects and legal frameworks that involved marine turtles.

The structure of the thesis is represented in Figure 1.1. I assessed my aim through four research objectives:

1) Evaluate how socio-economic drivers and legal frameworks affect the level of protection of marine turtles worldwide;
2) Identify and understand the conservation conflicts that impact marine turtle protection initiatives in the Caribbean basin;
3) Assess the historical and current demographic status of marine turtle stocks in the Gulf of Venezuela; and
4) Study the scale of use, cultural component and value of marine turtles to Wayuú Indigenous people, especially as a medicinal resource.

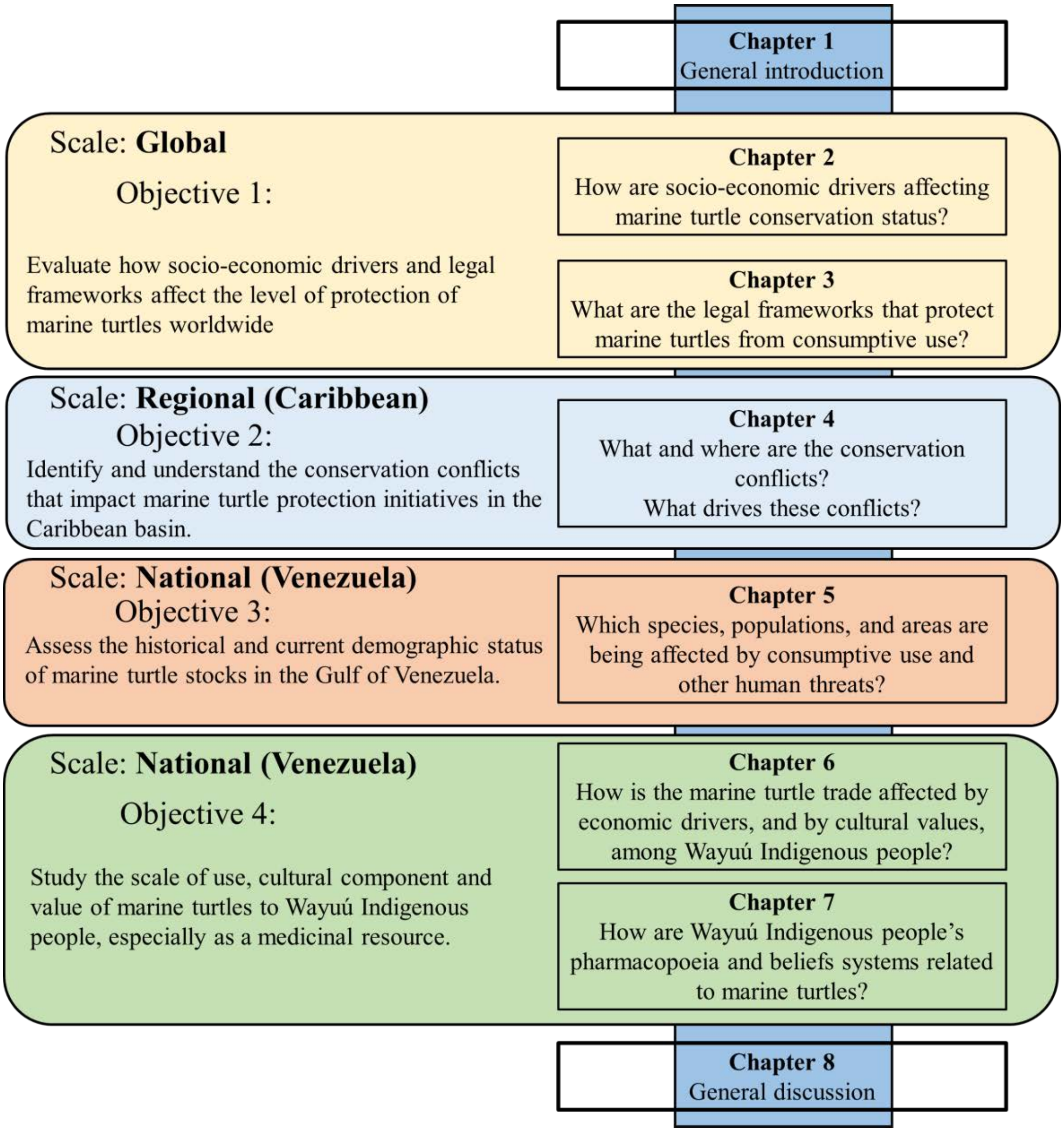


Figure 1.1 Schematic diagram of thesis structure.

In **Chapter 1**, I provide a general introduction to the context, concepts and rationale of my thesis. In particular, the concepts related to human dimensions of conservation (socio-economic indices, economy, and protection status) as they relate to marine turtles. I also explain the challenge of protecting marine turtles at regional scales. Furthermore, I aim to develop a general perspective about the baseline, trends and status information of the marine turtles in the Gulf of Venezuela and to highlight the barriers that are hampering the protection of marine turtles the Gulf of Venezuela. Especially as they relate to Wayuú Indigenous people and their cultural relationship with marine turtles.

Chapter 2 aims to evaluate how the socio-economic drivers, such as the Human Development Index (HDI) and national economic indicators, may influence the conservation of marine turtle species worldwide. Here, I aim to develop a proxy index to classify conservation status. The index is based on national socio-economic indicators coupled with the Regional Management Units (RMU) framework, which is used by the Marine Turtles Specialist Group (MTSG) of the International Union for Conservation of Nature (IUCN). I then use the proxy index to predict the conservation status of the species and RMUs that do not have a recently updated IUCN status. I aim to submit this chapter as a manuscript to *Endangered Species Research*.

Chapter 3 aims to understand the legal frameworks that protect marine turtles across the world. This chapter includes an extensive revision of more than 300 documents on the legislation, conservation and status of marine turtles in 152 countries. I found variation in the legal status of marine turtles among countries, and different uses by governments of regulations to prevent, or manage, the consumptive use of marine turtles. Overall, the consumptive use of marine turtles occurs in 37 countries and may be considered legal, under certain regulations. I aim to submit this chapter as a manuscript to *Chelonian Conservation and Biology*.

In **Chapter 4**, I narrow the focus of the thesis and assess the conservation conflicts that affect the marine turtle-based initiatives along the Caribbean basin. Here, I used a cross-sectional social model to gather data from experts in marine turtle conservation in countries of the

Caribbean basin. My data affirm that conflicts related to conservation are common and may affect marine turtle based initiatives in different ways. Respondents offered a list of different potential solutions to tackle these conflicts. The aim of most of the potential solutions was to minimise the clashes that occur among local, national and regional stakeholders. I aim to submit this chapter as a manuscript to *Ocean and Coastal Management*.

In **Chapter 5**, I provide the first baseline data of marine turtle strandings in the Gulf of Venezuela. To achieve this, I undertook a comprehensive evaluation of marine turtle stocks in the Gulf of Venezuela. Here, I compiled and analysed multiple sources of data (e.g. reports, grey literature, theses, national documents, legislation and conference proceedings), which in total included more than 56 years of data (1966-2017).

Associated publication:

> **Barrios-Garrido, H.,** & Montiel-Villalobos, M. G. 2016. Strandings of Leatherback turtles (*Dermochelys coriacea*) along the western and southern coast of the Gulf of Venezuela. *Herpetological Conservation and Biology*, 11(1), 244-252.

I aim to submit the remainder of information from Chapter 5 to *Biological Conservation.*

Chapter 6 aims to assess the scale and cultural component of consumptive use of marine turtles carried out by Wayuú Indigenous people. It covers several aspects related to the trade and consumptive use of marine turtle products in the Venezuelan portion of the Guajira Peninsula, among the Wayuú Indigenous people. I used market-based observations, semi-structured interviews, and participant observation to evaluate the trade, and focused my findings on three main topics: type of product used, routes of trade (i.e. local, national and international), and the value of the products. Here, I found that marine turtles are used by local inhabitants, and although there is an essential cultural component to the use, marine turtles are also used as an economic resource. I found that four of the five species of marine turtles present in the Gulf of Venezuela are being used on a commercial basis, mainly by Wayuú Indigenous people. I described the trade routes which occurred within Venezuelan territory (mainly Zulia state) and found the commercial use of marine turtles in the neighbouring states of Mérida and Táchira in Venezuela, and in two localities in Colombia: Maicao and Riohacha (Guajira department).

Associated publication:

> **Barrios-Garrido, H.,** Espinoza-Rodríguez, N., Rojas-Cañizales, D., Palmar, J., Wildermann, N., Montiel-Villalobos, M., & Hamann, M. 2017. Trade of marine turtles along the southwestern coast of the Gulf of Venezuela. *Marine Biodiversity Records*, 10(1), 1-12. doi: 10.1186/s41200-017-0115-0.

In **Chapter 7**, I evaluated the value of marine turtles to Wayuú Indigenous people, with a particular emphasis on their value as pharmacopoeia. I used an open-ended question-based survey to collate information from Wayuú healers and caretakers about the different customary practices which involve the use of marine turtles, such as medicine, rites, beliefs and cultural system. Also, I compiled information on the Wayuú people's cosmovision and ancestral customs. My findings may help to inform decision makers about which aspects of Wayuú marine turtle consumption are considered to be traditional, and therefore worthy of protection. Merging socio-cultural data gathered here and the legal framework which regulates the use of marine turtles in Venezuelan waters, it should be possible to create the basis for further discussions among stakeholders in the country.

Associated publication:

> **Barrios-Garrido, H.;** Palmar, J.; Wildermann, N.; Rojas-Cañizales, D.; Diedrich, A.; Hamann, M. (*accepted-in press*). Marine turtle presence in the traditional pharmacopoeia, cosmovision, and beliefs of Wayuú Indigenous people. *Chelonian Conservation and Biology*.

Finally, in **Chapter 8**, I summarise the primary results of my preceding data chapters within the context of how socio-economic indices may be used to evaluate and predict the conservation status of threatened species, and the different legal frameworks that protect and regulate the consumptive use of marine turtles. Then, I include key ideas about how consumptive use can generate conflicts among stakeholders resulting from their different perspectives towards the need to protect marine turtles. The chapter summarises the thesis data to provide information of strandings, human impact, and bio-ecological characteristics of the marine turtle stocks that reside in the Gulf of Venezuela. Extensive use of marine turtles by Wayuú Indigenous people was documented, and I describe how part of this use is culturally-based and marine turtles remain an essential part of the customs of Wayuú people; however, the commercial component may not be sustainable and requires management. Finally, I provide a list of recommendations to inform decision makers how they may use the information from my thesis to improve the Venezuelan legal framework that protects marine turtles and their habitat.

Chapter 2

PEOPLE AND MARINE TURTLES: HUMAN DIMENSION AND GLOBAL CONSERVATION STATUS

Wayuú children looking at a juvenile green turtle in the Guajira Peninsula, Venezuela.
Photo credit: Natalie Wildermann (2012)

ABSTRACT

Human societies are closely linked to their ecological environments. Countries with healthy, educated and economically prosperous populations often have wildlife populations in better condition. However, in many of these developed countries people have already decimated their wildlife in the name of economic progress. In contrast, countries with depressed economies, lower literacy and numeracy rates, and lower health conditions relative to developed nations tend to have natural environments in poorer condition. In the latter type of country, these socio-economic factors also compromise government's capacity to protect and regulate its natural environment. Moreover, the conservation capacity of the government plays a key role in the protection of marine turtles. This chapter has two aims: (1) to combine data from the Human Development Index (HDI), Economy, and the regional management units (RMU) assessment database to develop a proxy to enable prediction of the conservation status of marine turtle RMUs, and (2) to evaluate the conservation capacity and enforcement within the 58 (RMUs) of the seven species of marine turtles throughout the world. I used the RMU framework (risk and threats scores) provided by Wallace *et al.*, (2010) and integrated it with socio-economic indices. I developed a Conservation and Enforcement Capacity index (CECi) by integrating the following indices: (1) the economic level of each country (defined by the United Nations); (2) the HDI (World Economic Situation and Prospects database); and (3) the risks and threats identified in the RMU framework proposed by Wallace *et al.*, (2011). I then used the most recent conservation status of 15 RMUs recently assessed by IUCN to predict the conservation status of the 43 RMUs without updated IUCN categorisation. Median values of HDI by RMU were calculated and mapped. CECi values ranged from 0 to 1, where lower values represent a better capacity for implementation of conservation initiatives. I evaluated the conservation status of marine turtle RMUs in relation to the socio-economic situation of the region for each RMU. I found that using only the HDI as a proxy to assess the conservation capacity of the governments was weak. However, using my multi-index model, I was able to predict the status of 33 of 58 RMUs, of them 57% may be of threatened conservation status due to their high CECi values. Further research is needed to improve my assessment; however, it is a step towards a better understanding of a socio-economic aspect which may impact the conservation status of marine turtles.

Key Words: Human Development Index (HDI), economy, enforcement, conservation status, conservation capacity, marine turtles.

2.1 INTRODUCTION

Many of the world's natural environments and species are declining due to direct and indirect anthropogenic modification of landscapes (Halpern *et al.*, 2008; Newbold *et al.*, 2015). Consequently, there are significant global social-economic and governance challenges related to species and habitat conservation (Hoffmann *et al.*, 2010). Although depletions do not generally occur across the range of species or across all similar habitats, the declining status of different marine ecosystems and species is receiving increased attention (Cheung *et al.*, 2013). Some examples of these declines include, seagrass (Waycott *et al.*, 2009), coral reef habitats (Gardner *et al.*, 2003) and marine biodiversity (Worm *et al.*, 2006; Hooper *et al.*, 2012; Selig *et al.*, 2014) as well as reduction of commercial or threatened species (Stevens *et al.*, 2000; Purcell *et al.*, 2013; Cosentino & Fisher, 2016). Furthermore, it is becoming more apparent that declines are significant prevalent in economically depressed regions within developing and impoverished nations (Agarwala *et al.*, 2014; Ripple *et al.*, 2016).

The ability of national governments to develop, fund, implement and enforce conservation policy is key to the potential success of conservation strategies (e.g. Rands *et al.* (2010); Mazaris *et al.* (2017)). These challenges are often most noticeable in developing nations (Adams *et al.*, 2004; Kusters *et al.*, 2006), and the challenges of balancing conservation with the preservation of livelihoods in developing nations is well described in the literature (Sanderson & Redford, 2003). In essence, conservation programs are highly influenced by the social and cultural context of the species or habitat, the socio-economic background of stakeholders and governments, the strength and clarity of a country's environmental governance framework and the relationships between them (Mehta & Heinen, 2001; Salafsky *et al.*, 2001; Dowie, 2009; Carver & Sullivan, 2017). Thus, well-researched and coordinated conservation frameworks with tangible, achievable targets and goals often reflect local people's knowledge, perspectives and aspirations as well as those of government (Webb, 2002; Marcovaldi *et al.*, 2005; Kondo *et al.*, 2017; Shaffer *et al.*, 2017).

The challenges to habitat and biodiversity conservation are particularly relevant to groups of threatened migratory species, especially those that move across political boundaries (Baum *et al.*, 2003). Example of this are the marine turtles, which are a widely-distributed group of seven migratory species found across the world's tropical and sub-tropical regions (Hamann *et al.*, 2006a; Woodron Rudrud, 2010; Senko *et al.*, 2011; Martins *et al.*, 2015). The species vary in status across the world, and each is conservation dependent (Wallace *et al.*, 2011b; IUCN, 2014). One approach to understand and quantify the degree to which the condition and status of each species varies across the world is the Regional Management Unit (RMU) concept (after Wallace *et al.,* 2010). This concept separates each of the species into ecologically relevant units (termed RMUs) and then integrates all available information for each RMU to create a conservation priority portfolio for each. This enables comparison of the condition among the RMUs (see details in Wallace *et al*., 2010). Slightly modified versions of the RMU designations were subsequently used by the IUCN Red List group to assess the status of loggerhead and leatherback turtles, and a similar classification was designed and used by the United States Government (Distinct Population Segments – DPS) to assess green turtles (Seminoff *et al.*, 2015).

Understanding the social and economic differences among countries and regions is an essential aspect of world's marine turtle conservation and management (Hamann *et al.*, 2010; Rees *et al.*, 2016), especially because marine turtles are migratory species and often move across political boundaries (Campbell *et al.*, 2009; Lascelles *et al.*, 2014). Thus, strategies aimed at protecting them would ideally consider their biological attributes, such as longevity, delayed maturity, migratory behaviour, habitat use (Mazaris *et al.*, 2014) and the human dimensions associated with threats and threat management (Campbell, 2002a; Meletis & Campbell, 2007; Pont *et al.*, 2015; Naeem *et al.*, 2016). The creation of strategies which consider the turtles' social, cultural and economic value may be difficult to develop, or might take longer to implement given the complexity of the situation, but the conservation rewards could be greater (e. g. Kondo *et al.*, 2017). This most likely occurs because conservation gains in one area may be affected by losses in other countries throughout the same region (Chapters 3 and 4).

Alongside natural and human induced mortality, the level of economic and development growth of countries, and their political stability, may also influence the conservation of migratory species at national and regional scales (Rodríguez, 2000; Greiner, 2012; Watkin Lui *et al.*, 2016a). The status of a marine turtle population (or management unit – MU) could be negatively impacted by activities such as consumption or use, or positively impacted through implementation of robust protection initiatives. The ability of national governments to reduce threats and implement conservation strategies is likely to be influenced by their ability to introduce and enforce measures that change people's attitudes and behaviour, and consequently reduce threats (Senko *et al.*, 2011; Rinkus *et al.*, 2017). For migratory species, this could also mean that other countries have complementary measures in place. Hence, the status of marine turtle populations are connected to the human populations by regional variation in social, cultural and economic factors. Moreover, several researchers affirm that the capacity of governments to enforce and apply management measures is related to countries level of economic development (Buitrago *et al.*, 2008; Keane *et al.*, 2008; Agarwala *et al.*, 2014), as it is commonly measured using the Human Development Index (HDI) score

(Kusters *et al.*, 2006; Marsh *et al.*, 2011; Jain & Jain, 2013; Purcell *et al.*, 2013), and the economic level, such as a develop or developing economy (Lindsey *et al.*, 2017; Arétouyap *et al.*, 2018). Further, there is increasing evidence demonstrating the importance of considering local communities in conservation and protection initiatives (Hope, 2002; Reid *et al.*, 2016). Understanding how these social and economic factors vary across the range of a migratory species such as marine turtles can inform future conservation initiatives.

Marine turtles make a useful case study to examine broad-scale variation in conservation status and investigate how conservation status could be linked to the degree of economic and social development in countries. For this reason, I aimed (1) to combine several indices: the Human Development Index (HDI), economic index, and the natural risks and anthropogenic threats scores from the RMU framework, and use them as proxies for potential capacity for conservation, having as product the Conservation and Enforcement Capacity index (CECi). This enabled me to assess the conservation capacity and enforcement ability within the 58 RMUs for the world's seven marine turtle species, and (2) to apply the novel and here designed Conservation and Enforcement Capacity index (CECi) to predict the conservation status of 43 RMUs without updated IUCN status.

2.2 METHODS

2.2.1. Data compiled

Previous research has linked the conservation and enforcement capacity of a country to its rank on the HDI (Marsh *et al.*, 2011; Jain & Jain, 2013; Purcell *et al.*, 2013; Iddrisu & Bhattacharyya, 2015). The HDI integrates data from several databases, such as the World Bank and the International Monetary Fund (economic data), the World Health Organisation (health data), the International Union for Conservation of Nature (IUCN) and Yale Centre for Environmental Law and Policy (environmental data), among others. The HDI is calculated for most of the world's countries. The index, which ranges from 0-1, with low being less than 0.55 and Very High being more than 0.80, is used to evaluate a number of social issues (such as environmental sustainability, human security and rights, and gender equity), and explores the link between these elements with human demographic and environmental attributes such as lifespan, water access, access to financial resources and education (UNDP, 2011).

At a national level, conservation initiatives are likely to be influenced by the level of development achieved by the country. This situation could arise because if a country's inhabitants have limited access to, or lower levels of, standard education, or low average per capita incomes, then they would need to obtain special benefits or concessions from the government through its social programs. If these allowances are not provided by governments, in such cases, people may rely more on natural resources to satisfy their basic necessities (Adams *et al.*, 2004; Jain & Jain, 2013; Leisher *et al.*, 2013; Wilkie *et al.*, 2016). Hence, economic conditions are likely to be a key factor in developing effective conservation initiatives by local, national and regional government entities (Rodríguez, 2000; Hope, 2002; Bräutigam & Eckert, 2006; Carver & Sullivan, 2017). Thus, "developing" or "least developed" countries may face challenges when they have to implement initiatives or legislation that seek to boost economic development, and wellbeing of people while also preserving natural environments (Buitrago *et al.*, 2008; Redo *et al.*, 2012).

Previous research has designated large-scale management units for each of the world's marine turtle species. The management units have been used by the IUCN, Regional Management Units – Wallace *et al.* (2010), to assess the conservation status of loggerhead

(Casale & Tucker, 2015) and leatherback turtles (Wallace *et al.*, 2013b), and a similar designation was used by the US Government, as Distinct Population Segments (DPS) to assess green and loggerhead turtles (NOAA & USFWS, 2010; Seminoff *et al.*, 2015). Wallace *et al.,* (2011a) also calculated an index to create a conservation priority portfolio approach in order to compare the condition of each of the RMUs. To achieve this, they collated empirical data and used it to score each RMU across two indices: (1) a risks index (which includes population size, recent trends, long-term trends, rookery vulnerability and genetic diversity), and (2) a threats index (which includes fisheries bycatch, take, coastal development, pollution and pathogens, and climate change) (see details in Wallace *et al.,* 2011a).

Each of the seven marine turtle species has also been assessed under the IUCN Red List framework (http://www.iucnredlist.org). Until 2008, species were all assessed at a global level and this approach generated concern among marine turtle experts who believed that a global status did not accurately reflect regional variability in status. Following the assignment of RMUs (Wallace *et al.*, 2010) and DPSs (NOAA & USFWS, 2010; NOAA, 2012; Seminoff *et al.*, 2015), the IUCN began to allow the assessment of marine turtle species at regional geographic units. To date, the assessments of two species, loggerhead (*Caretta caretta*) and leatherback turtles (*Dermochelys coriacea*), have been completed by the IUCN and the others five species of marine turtle are pending (*Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys olivacea*, *Lepidochelys kempii*, and *Natator depressus*) (as of November 2017). Having the conservation status updated by the IUCN is crucial for many countries because a significant portion of government environmental entities use the IUCN Red List to prioritise the use of economic resources for conservation programs (Campbell, 2012).

2.2.2. Socio-economic index

To develop a socio-economic index to evaluate conservation and enforcement capacity among nations within the area of each marine turtle management unit (i.e. Conservation and Enforcement Capacity index – CECi), I combined the RMU framework with two social indices: HDI and a global economic index (socio-economic index). To achieve this, I downloaded the 2014 HDI values for each of the 137 countries with a maritime boundary and regular presence of marine turtles (see chapter 3 for details). The data for the HDI were extracted from the United Nations database, and categorised following the UN categories: very high, high, medium, and low (see details at www.hdr.undp.org) (Table 2.1).

The economic data was obtained per country and its regional context using the "aggregation methodology" provided by World Economic Situation and Prospects (WESP) database, where values were calculated based on the economic growth over ten years in each country (see details in: United Nations, 2014, and Nielsen, 2011). I categorised each country as being either part of a developed region (including G7[1] and non-G7[2] countries); an emerging region (BRICS[3] group, MINT[4] group, and G20+); a developing region or a least developed region (see details at http://www.un.org). I then calculated the HDI and economic values for each country within each RMU.

Because the social and economic indices evaluated are calculated for each country, and the RMU framework relates to groups of countries (i.e. each RMU spans the coast or Exclusive

[1] G7: countries with the largest economies in the world (Canada, France, Germany, Italy, Japan, United Kingdom, United States of America).
[2] Other developed countries as defined by the UN, which are not part of the G7 group.
[3] Acronym used to identify: Brazil, Russia, India, China, and South Africa as economic group.
[4] Acronym used to identify: Mexico, Indonesia, Nigeria, and Turkey.

Economic Zone – EEZ of more than one country) (Campbell *et al.*, 2009), I made the following adjustments. For the economic index, I used the proportion of developing and least developed countries within each RMU. In the case of the HDI (social index), I used the ratio of medium and low HDI values within each RMU (see Table 2.1 for the examples). I used these categories because previous research affirms that countries with those categories have problems with conservation enforcement and tend to focus more on non-environmental priorities, due to their socio-economic hierarchies (Khan *et al.*, 2009; Redo *et al.*, 2012; Purcell *et al.*, 2013).

Using the HDI, economic (taken from the UN reports), risks and threats values (taken from RMU framework), I calculated the Conservation and Enforcement Capacity index (CECi) for each RMU, as shown below:

$$CECi = \frac{RI + TI + DLD\ proportion + ML\_HDI\ proportion}{4}$$

Where, RI= Risk Index divided by 3; TI= Threat Index divided by 3; DLD proportion= Developing and Least Developed countries proportion; ML_HDI proportion= Medium and Low Human Development Index proportion. RI and TI were divided by 3 due to they were standardised to 0-1 scale for the prediction calculations (See details in Table 2.1).

To predict the IUCN conservation status of the RMUs for species without an existing regional status assessment (i.e. *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys kempii, Lepidochelys olivacea*, and *Natator depressus*), I obtained the IUCN regional assessment results for the loggerhead and leatherback turtles RMUs from the www.iucnredlist.org web page. Then I classified each of these RMUs as either threatened[5]

[5] There were no RMUs classified as vulnerable.

(includes categories of 'near threatened', 'vulnerable' 'endangered', and 'critically endangered') or least concern. I used these two options to represent a simplified IUCN status as: (a) threatened – TH; or (b) least concern – LC) (Table 2.2).

I used logistic regression with a probit link function to model the simplified IUCN status (as threatened or least concern) for *C. caretta* and *D. coriacea* in 15 RMUs (n=10 for *C. caretta* and n=5 for *D. coriacea*[6]). The explanatory variables were either RMU index, socio-economic index (the economic index and the social index combined), or CECi. I evaluated the models using the R package DHARMa (Hartig, 2016). The residuals were generated using simulated data from the fitted models to check the model assumptions. The models were also tested for the goodness of the fit using a one-sample Kolmogorov-Smirnov test. The three models were then compared using Akaike information criterion corrected for small sample size (AICc) using the R package MuMIn (Barton, 2015). Models within two AICc units were considered to have similar explanatory power (Burnham & Anderson, 2002). I used the selected model to predict the IUCN status of the other marine turtle species (i.e. *Chelonia mydas*, *Eretmochelys imbricata*, *Lepidochelys kempii, Lepidochelys olivacea*, and *Natator depressus*) for each RMU.

Because positive trends in population (e.g. Mazaris *et al.*, 2017) estimates are likely connected to the conservation capacity activities developed on land (i.e. nesting habitats) and in water (e.g. feeding grounds and migration routes), then I used the main outcomes from Mazaris *et al.* (2017), who evaluated the trends of published population sizes among several

[6] I did not use the leatherback turtle RMUs categorised as Data Deficient (rmu53, Atlantic Southeast and rmu57, Indian Northwest) due to the lack of data.

RMUs. Their findings were included and merged on Table 2.4 and Table 2.5, in order to compare and provide further details about the conservation status of those species.

2.2.3. Considerations for the Conservation and Enforcement Capacity index (CECi)

The RMU index (0-1) is the averaged value of the standardised risks and threats indices for each RMU. The socio-economic index (0-1) is the averaged value of the economic level (mean value among all the countries or territories where the RMU span), and HDI (social index). The CECi (0-1) is the averaged value of the RMU indices (i.e. risks and threats, scaled to 0-3, but standardised to 0-1) and socio-economic index (HDI and economy indices merged). In order to identify the countries within the areas of each RMU, I mapped and merged the RMU shapefiles and the countries EEZ, using ESRI ArcMap 10.2 (Redlands, California, USA). Note that I used all the national territories within a country as part of each country, and the CECi ranges from zero to one, where higher numbers correspond to threatened status, and lower numbers are more likely to be considered as least concern.

Table 2.1. Summary of the information sources used to develop the Conservation and Enforcement Capacity index (CECi).

Framework	Data sources	Range	Indicators involved	Categories	Reference
RMUs	Risk	1 – 3 [1]	Population size Recent trend Long-term trend Rookery vulnerability Diversity	High Medium Low	Wallace *et al.*, 2011
	Threats	1 – 3 [1]	Fisheries bycatch Take Coastal development Pollution Climate change	High Medium Low	Wallace *et al.*, 2011
Socio-economic index	Economic index	0 – 1	Aggregate data (sums or weighted) Multi-year (means) growth rate (10 – 15 years) Exchange-rate conversions Gross Domestic Product (GDP) in USD	Developed countries: G7 and non-G7 country members Emerging countries: BRICS group, MINT group, and G20+ Developing countries Least developed	WESP, 2014
	Human Development Index	0 – 1	Life expectancy at birth (years) Mean years of schooling (years) Expected years of schooling (years) Gross National Income (GNI) per capita (constant 2005 PPP[2] USD)	Very high (1 – 0.800) High (0.799 – 0.700) Medium (0.699 – 0.550) Low (0.549 – 0)	UNDP, 2011

[1] These values were standardised to 0-1 scale for the prediction calculations.
[2] Purchasing Power Parity (terms) a day/year, where the International Poverty Line is 1.25 USD per day.

Table 2.2. Economic index (Developing and Least Developed Economies), Human Development Index (HDI) proportion (Low and Medium categories), and real examples by Regional Management Unit (RMU).

Data associated with Regional Management Unit					**Number of countries**	**Economy Index**	**HDI**	**CECi value**
Species	RMU code	Geographic location	Risk index	Threats index		Developing and Least Developed Economy proportion	Low and Medium HDI proportion	
L. olivacea	Rmu02	West Atl	0.533	0.667	8	0.625	0.125	0.488
	Rmu08	West Ind	0.900	1.000	30	0.714	0.500	0.779
E. imbricata	Rmu11	East Atl	0.722	1.000	20	0.950	0.950	0.906
	Rmu19	N-Central Pac	0.917	0.333	1	0.000	0.000	0.313
C. mydas	Rmu45	East Atl	0.627	1.000	23	0.957	1.000	0.896
	Rmu49	S-West Atl	0.467	0.556	3	0.000	0.000	0.256
L. kempii	Rmu58	N-West Atl	0.800	0.556	2	0.000	0.000	0.339
N. depressus	Rmu59	S-East Ind	0.600	0.889	3	0.333	0.667	0.622
	Rmu60	S-West Pac	0.733	0.667	3	0.333	0.667	0.600

2.3. RESULTS

2.3.1. Conservation and Enforcement Capacity index (CECi)

Within the 58 RMUs, the CECi values ranged from 0.256 (rmu49, *Chelonia mydas* in the South-West Atlantic – Brazil-Uruguay-Argentina), to 0.906 (rmu11, *Eretmochelys imbricata* in the East Atlantic – West Africa). Among the models with three different explanatory variables (RMU index; Socio-economic index; CECi), the simplified IUCN status (Least Concern or Threatened) was best predicted when CECi was used (Table 3). For the best-fit mode, the CECi values had significant relevance to the predictions made for the IUCN scores for *C. caretta* and *D. coriacea* ($z = 2.13$, $p < 0.05$).

I used the best-fit model to classify the conservation status of each RMU. If the CECi value is higher than 0.59 there is more than a 50% probability that the RMU status will be designated as threatened, and if the CECi < 0.59 there is less than a 50% probability the RMU status will be least concern (Figure 2.1).

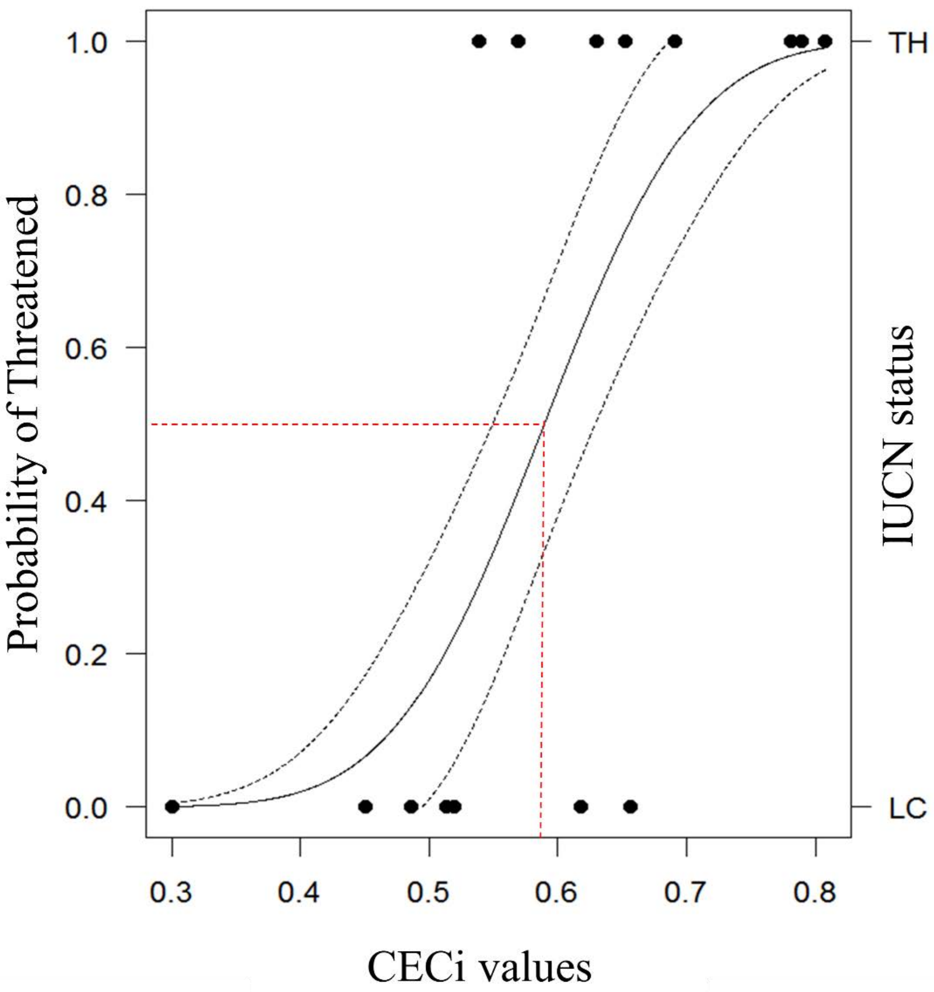


Figure 2.1 The probability of each RMU to be classified as threatened under the IUCN status in relation to the combined (CECi values), based on logistic regression for 15 RMUs for loggerhead and leatherback turtles. The solid line is the model fit with the dashed lines denoting one standard error. Dots are the current IUCN status in relation to the CECi values. TH is threatened and LC is least concern. Red dot lines denote the convergence between the 50% of probability that the RMU status will be designated as threatened (Y axis), and the CECi value= 0.59 (X axis).

Table 2.3. Model ranking based on AICc values. RMU index (0-1) is the averaged value of the standardised risks and threats indices for each RMU. Socio-economic index (0-1) is the averaged value of the economic index and HDI. CECi (0-1) is the averaged value of the RMU index and socio-economic index.

Model	*AICc*
Status ~ RMU index	23.68
Status ~ Socio-economic index	19.28
Status ~ CECi	17.23

2.3.2. HDI and economic values: Socio-economic index

My results indicate that marine turtles reside in countries that encompass the entire spectra of HDI values (i.e. low, medium, high and very high) and economic scores (i.e. least developed, developing, emerging, developed) (Table 4). The median HDI values for RMUs ranged from 0.495 to 0.754 for *L. olivacea*, from 0.486 to 0.914 for *E. imbricata*, from 0.486 to 0.812 for *C. caretta*, from 0.495 to 0.914 for *C. mydas*, and from 0.515 to 0.747 for *D. coriacea*. I included *L. kempii* and *N. depressus* in my evaluation; however, because their distribution spans one and two RMUs, respectively, no further analysis was carried out.

It is important to consider that only five RMUs (i.e. rmu14 and rmu19 for *E. imbricata*, rmu26 for *C. caretta*, rmu35 for *C. mydas*, and rmu58 for *L. kempii*) have a median HDI value higher than 0.800, which is considered by the UNDP (2011) as very high. According to my predictions, these five RMUs were categorised as least concern. Four of these five RMUs have a restricted distribution within one or two countries (Table 2.4).

Furthermore, the DLD proportion of countries that were categorised as Developing and Least Developed in each RMU, varied among RMUs. The values calculated ranged from 0.000 (meaning that no countries in the RMU were Developing or Least Developed; seven RMUs) up to 1.000 (meaning that all countries in the RMU were considered as developing or least developed; one RMU). Seven RMUs did not have any countries categorised as developing economies or least developed (i.e. rmu14 and rmu19 for *E. imbricata*, rmu24 for *C. caretta*, rmu35, rmu37 and rmu49 for *C. mydas*, and rmu58 for *L. kempii*). In addition, these seven RMUs have no more than three countries in their range.

2.3.3. RMUs predictions by species

Based on my analysis with the CECi, I found that 13 of the 15 predictions for RMUs matched the current status provided by the IUCN. I also found that six marine turtle species in 33 RMUs (out of 58 RMUs: 57%) could be threatened. The two RMUs where my predictions and the IUCN Red List status did not match were *C. caretta* in the North-West Indian Ocean (rmu27) and *D. coriacea* in the West Pacific (rmu56). In both cases my model predicted least concern status, yet the status provided by IUCN was critically endangered, which falls under the threatened category under my CECi designation. Although rare, these were important discrepancies.

Six out of eight (75%) *L. olivacea* RMUs were predicted to be threatened, and this species had the highest proportion of RMUs categorised as threatened (Table 2.4a). For *L. olivacea* only the RMUs from the West Atlantic and East Pacific were categorised as least concern, and their index nesting beaches are believed to be stable or increasing (da Silva *et al.*, 2007; Eguchi *et al.*, 2007; NMFS & USFWS, 2007; Kelle *et al.*, 2009). The remainder of the olive ridley RMUs were considered by CECi to be threatened, in particular rmu05 and rmu07 from the North-East Indian Ocean. My categorisation of these two RMUs agrees with the previous assessment that considered them to be two of the 11 most threatened RMUs on the planet (Wallace *et al.*, 2011a) (Table 2.5).

The third-highest proportion of threatened RMUs are represented by *E. imbricata*, with 69% (9 out of 13 RMUs) of RMUs predicted by my model to be threatened (Table 2.4b). Of these nine RMUs, five are listed among the 11 most threatened RMUs proposed by Wallace *et al.* (2011a). These five most-susceptible RMUs have a CECi value higher than 0.700; hence my predictions indicate that there is a high probability that these RMUs would be formally categorised in future IUCN assessments as threatened.

According to my results, *C. caretta* has 50% of its 10 RMUs with high CECi values and could be classed as threatened. Further, my data and IUCN Red List categorisations matched in eight of the 10 (Table 2.4c). The two differences were: rmu32 in the North-East Indian Ocean, which I classed as least concern and the IUCN classed as critically endangered; and rmu29 in the South-East Indian Ocean, which I classed as threatened and the IUCN classed as near threatened.

The proposed model predicted 6 out of 17 *C. mydas* RMUs (35%) are designated as threatened (Table 4d). This marine turtle species has the lowest proportion of RMUs predicted to be threatened. However, the West Atlantic RMU (rmu45) has the second highest CECi score, overall, and the highest in all the Atlantic Ocean. On the other hand, 65% of the green turtle RMUs were classed as least concern based on the CECi, with mean and median values (0.544 and 0.562 respectively) in the least concern range (CECi < 0.59).

D. coriacea has six of eight RMUs (75%) categorised as threatened (Table 4e). The West Pacific RMU (rmu56) came out as 'least concern' in my model but it is assessed as 'threatened' by the IUCN. Additionally, my model using the CECi could evaluate and designate the two RMUs which were considered to be data deficient by the IUCN.

Table 2.4. Conservation and Enforcement Capacity index (CECi) by species within Regional Management Units (RMUs). All the values are between 0 and 1. Risk and threats values were extracted from Wallace *et al.* (2011a). HDI Category uses the data from UNDP (2011). Economic proportion includes the ratio of countries categorised as Developing and Least Developed countries. HDI proportion includes the ratio of countries categorised as Medium and Low HDI. * denotes RMU with arribada behaviour. A) *Lepidochelys olivacea*; B) *Eretmochelys imbricata*; C) *Caretta caretta*; D) *Chelonia mydas*; E) *Dermochelys coriacea*; F) *Lepidochelys kempii*; G) *Natator depressus*. For *C. caretta* and *D. coriacea*, I included a column with the Current IUCN status (last updated October 2016). Predicted conservation status were termed either Threatened “TH” or Least Concern “LC”. Coloured lines: blue = increasing, and red = decreasing according to Mazaris *et al.* (2017).

A)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	HDI		Economic proportion	HDI proportion	CECi value	Predicted conservation status
					Median	Category				
rmu01_Lo	East Pacific	0.633	0.889	13	0.711	High	0.615	0.385	0.631	TH
rmu02_Lo	West Atlantic	0.533	0.667	8	0.754	High	0.625	0.125	0.488	LC
rmu03_Lo	West Pacific	0.556	0.667	32	0.719	High	0.690	0.483	0.599	TH
rmu04_Lo	North-East Indian	0.767	0.889	2	0.668	Medium	0.500	0.500	0.664	TH
rmu05_Lo	East Atlantic	0.500	0.778	23	0.495	Low	0.864	0.909	0.763	TH
rmu07_Lo	North-East Indian*	0.733	0.889	2	0.668	Medium	0.500	0.500	0.656	TH
rmu08_Lo	West Indian	0.900	1.000	30	0.722	High	0.714	0.500	0.779	TH
rmu09_Lo	East Pacific*	0.533	0.444	13	0.711	High	0.615	0.385	0.494	LC
Mean values		**0.644**	**0.778**		**0.681**		**0.640**	**0.473**	**0.634**	
Median values		**0.594**	**0.833**		**0.711**		**0.620**	**0.491**	**0.643**	

B)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECi value	Predicted conservation status
					Median	Category				
rmu10_Ei	West Atlantic	0.533	0.833	29	0.750	High	0.793	0.172	0.583	LC
rmu11_Ei	East Atlantic	0.722	1.000	20	0.486	Low	0.950	0.950	0.906	TH
rmu12_Ei	South-West Pacific	0.633	0.556	4	0.588	Medium	0.500	0.750	0.610	TH
rmu13_Ei	East Pacific	0.833	0.889	11	0.711	High	0.727	0.364	0.703	TH
rmu14_Ei	South-East Indian	0.556	0.444	2	0.808	Very High	0.000	0.500	0.375	LC
rmu15_Ei	South-West Atlantic	0.767	0.667	5	0.674	Medium	0.800	0.600	0.708	TH
rmu16_Ei	North-East Indian	0.792	0.778	4	0.572	Medium	0.750	0.750	0.767	TH
rmu17_Ei	North-West Indian	0.444	0.667	18	0.722	High	0.700	0.500	0.578	LC
rmu18_Ei	South-West Indian	0.600	0.611	12	0.678	Medium	0.692	0.583	0.622	TH
rmu19_Ei	North-Central Pacific	0.917	0.333	1	0.914	Very High	0.000	0.000	0.313	LC
rmu20_Ei	South-Central Pacific	0.767	0.667	9	0.705	High	0.900	0.444	0.694	TH
rmu21_Ei	West-Central Pacific	0.767	0.667	5	0.684	Medium	0.800	0.600	0.708	TH
rmu22_Ei	West Pacific	0.733	0.889	13	0.719	High	0.462	0.462	0.636	TH
Mean values		**0.700**	**0.690**		**0.690**		**0.620**	**0.510**	**0.630**	
Median values		**0.733**	**0.667**		**0.705**		**0.727**	**0.500**	**0.636**	

C)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECi value	Predicted conservation status	IUCN current status
					Median	Category					
rmu23_Cc	North-East Atlantic	0.722	0.890	11	0.486	Low	0.818	0.800	0.808	TH	EN
rmu24_Cc	South-West Atlantic	0.533	0.667	3	0.790	High	0.000	0.000	0.300	LC	LC
rmu25_Cc	North-West Atlantic	0.600	0.667	37	0.753	High	0.622	0.167	0.514	LC	LC
rmu26_Cc	Mediterranean	0.600	0.889	24	0.812	Very High	0.458	0.130	0.519	LC	LC
rmu27_Cc	North-West Indian	0.444	0.556	19	0.745	High	0.684	0.471	0.539	LC	CR
rmu28_Cc	South-West Indian	0.700	0.500	11	0.580	Medium	0.727	0.700	0.657	TH	NT
rmu29_Cc	South-East Indian	0.667	0.556	4	0.652	Medium	0.500	0.750	0.618	TH	NT
rmu30_Cc	South Pacific	0.767	0.667	16	0.724	High	0.688	0.400	0.630	TH	CR
rmu31_Cc	North Pacific	0.733	0.889	10	0.756	High	0.100	0.222	0.486	LC	LC
rmu32_Cc	North-East Indian	0.722	1.000	5	0.586	Medium	0.600	0.800	0.781	TH	CR
Mean values		**0.649**	**0.728**		**0.688**		**0.520**	**0.444**	**0.585**		
Median values		**0.683**	**0.667**		**0.735**		**0.611**	**0.435**	**0.578**		

D)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECi value	Predicted conservation status
					Median	Category				
rmu34_Cm	East Pacific	0.600	0.611	13	0.737	High	0.615	0.308	0.534	LC
rmu35_Cm	North-Central Pacific	0.833	0.333	1	0.914	Very High	0.000	0.000	0.292	LC
rmu36_Cm	South-Central Pacific	0.500	0.500	8	0.715	High	1.000	0.375	0.594	TH
rmu37_Cm	North-West Pacific	0.700	0.556	3	0.719	High	0.000	0.000	0.314	LC
rmu38_Cm	West-Central Pacific	0.556	0.500	7	0.672	Medium	0.714	0.667	0.609	TH
rmu39_Cm	South-West Pacific	0.333	0.776	4	0.784	High	0.500	0.500	0.528	LC
rmu40_Cm	South-East Indian	0.443	0.556	4	0.652	Medium	0.500	0.750	0.562	LC
rmu41_Cm	West Pacific	0.567	0.889	8	0.702	High	0.375	0.500	0.583	LC
rmu42_Cm	North-East Indian	0.583	0.889	7	0.684	Medium	0.429	0.571	0.618	TH
rmu43_Cm	North-West Indian	0.333	0.667	21	0.745	High	0.714	0.474	0.547	LC
rmu44_Cm	South-West Indian	0.467	0.667	13	0.641	Medium	0.692	0.583	0.602	TH
rmu45_Cm	East Atlantic	0.627	1.000	23	0.495	Low	0.957	1.000	0.896	TH
rmu46_Cm	Central Atlantic	0.567	0.667	20	0.495	Low	0.850	0.850	0.733	TH
rmu47_Cm	Caribbean Atlantic	0.750	0.556	17	0.744	High	0.765	0.118	0.547	LC
rmu48_Cm	Mediterranean	0.667	0.889	11	0.784	High	0.545	0.182	0.571	LC
rmu49_Cm	South-West Atlantic	0.467	0.556	3	0.790	High	0.000	0.000	0.256	LC
rmu50_Cm	North-West Atlantic	0.333	0.722	18	0.756	High	0.556	0.222	0.458	LC
Mean values		**0.549**	**0.667**		**0.708**		**0.542**	**0.418**	**0.544**	
Median values		**0.567**	**0.667**		**0.719**		**0.556**	**0.474**	**0.562**	

E)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECi value	Predicted conservation status	IUCN current status
					Median	Category					
rmu51_Dc	North-West Atlantic	0.333	0.556	72	0.747	High	0.611	0.300	0.450	LC	LC
rmu52_Dc	South-West Atlantic	0.867	0.667	24	0.515	Low	0.792	0.833	0.790	TH	CR
rmu53_Dc	South-East Atlantic	0.583	0.556	24	0.515	Low	0.792	0.833	0.691	TH[7]	DD
rmu54_Dc	South-West Indian	0.867	0.444	11	0.535	Low	0.727	0.727	0.691	TH	CR
rmu55_Dc	East Pacific	0.833	0.776	13	0.737	High	0.692	0.308	0.653	TH	CR
rmu56_Dc	West Pacific	0.733	0.556	32	0.721	High	0.594	0.393	0.569	LC	CR
rmu57_Dc	North-East Indian	0.833	0.667	7	0.684	Medium	0.571	0.571	0.661	TH[8]	DD
Mean values		**0.721**	**0.603**		**0.636**		**0.683**	**0.567**	**0.643**		
Median values		**0.833**	**0.556**		**0.684**		**0.692**	**0.571**	**0.661**		

[7] Predicted status although the IUCN current status was considered Data Deficient.
[8] Predicted status although the IUCN current status was considered Data Deficient.

F)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECI value	Predicted conservation status
					Median	Category				
rmu58_Lk	North-West Atlantic	0.800	0.556	2	0.835	Very High	0.000	0.000	0.339	LC

G)

RMU ID	Geographic location (ocean basin)	Risk value	Threat value	Total sovereign states	H D I		Economic proportion	HDI proportion	CECi value	Predicted conservation status
					Median	Category				
rmu59_Nd	South-East Indian	0.600	0.889	3	0.684	Medium	0.333	0.667	0.622	TH
rmu60_Nd	South-West Pacific	0.733	0.667	3	0.684	Medium	0.333	0.667	0.600	TH
Mean values		**0.667**	**0.778**		**0.684**		**0.333**	**0.667**	**0.611**	
Median values		**0.667**	**0.778**		**0.684**		**0.333**	**0.667**	**0.611**	

Table 2.5 The world's most threatened RMUs: according to highest CECi values; plus, the Wallace et al., (2011a)'s evaluation and outcomes; and IUCN actual status. IUCN status acronyms: CR = critically endangered; EN = endangered; VU = vulnerable; NT = near threatened; LC = least concern. √= cited as 'most threatened by Wallace et al., 2011a; X= not cited as 'most threatened' by Wallace et al.2011. Coloured lines: blue = increasing, and red = decreasing according to Mazaris *et al.* (2017).

Species	RMU ID	Ocean basin	CECi values	This research	Wallace et al, 2011	IUCN actual status (year)
E. imbricata	rmu11	East Atlantic	0.906	TH	√	CR (2008)
C. mydas	rmu45	East Atlantic	0.896	TH	X	EN (2004)
C. caretta	rmu23	North-East Atlantic	0.808	TH	√	EN (2015)
D. coriacea	rmu52	South-West Atlantic	0.790	TH	X	CR (2013)
C. caretta	rmu32	North-East Indian	0.781	TH	√	CR (2015)
L. olivacea	rmu08	West Indian	0.779	TH	√	VU (2008)
E. imbricata	rmu16	North-East Indian	0.767	TH	√	CR (2008)
L. olivacea	rmu05	East Atlantic	0.763	TH	X	VU (2008)
C. mydas	rmu46	Central Atlantic	0.733	TH	X	EN (2004)
E. imbricata	rmu21	West-Central Pacific	0.708	TH	X	CR (2008)
E. imbricata	rmu15	South-West Pacific	0.708	TH	X	CR (2008)
E. imbricata	rmu13	East Pacific	0.703	TH	√	CR (2008)
L. olivacea	rmu04	North-East Indian	0.664	TH	√	VU (2008)
L. olivacea	rmu07	North-East Indian	0.656	TH	√	VU (2008)
E. imbricata	rmu22	West Pacific	0.636	TH	√	CR (2008)
C caretta	rmu31	North Pacific	0.486*	LC	√	LC (2015)
D. coriacea	rmu55	East Pacific	0.653	TH	√	CR (2013)

*The only RMU considered to be Least Concern according to my results on this table. It is considered by the IUCN new assessment as Least Concern as well.

2.4. DISCUSSION

I developed and tested the Conservation and Enforcement Capacity index (CECi) as a new proxy to aid future evaluation of conservation status for marine turtles. The CECi value for each RMU provides a conservation perspective, which includes socio-economic aspects that are likely to influence marine turtle conservation. My results indicate that more than half of the RMUs worldwide could be considered to be threatened. Indeed, some of the RMUs I assessed showed high risk values when using data from Wallace *et al.*, (2011), but my analysis predicted them to be of least concern status, because there are low anthropogenic threats and more developed economies for the countries within their RMUs (e.g. *Lepidochelys kempii* – although, unforeseen situations such as the Gulf of Mexico Deepwater Horizon oil spill puts RMUs of *L. kempii* in high risk. Thus, developed economies are not immune to exposing turtles to higher threats to RMUs). On the other hand, the implications of human impacts on marine turtle populations (e.g. bycatch, take and pollution) are evident in RMUs which may have low natural risk values and high threat values, but are combined with higher levels of poverty and lower levels of regional development, such as rmu44 of *C. mydas* from south-West Indian. Furthermore, in regions such as West Africa (East Atlantic Ocean), and the Bay of Bengal (North-East Indian Ocean) there are likely to be considerable conservation challenges because my data suggest that all RMUs in these regions could be considered threatened (e. g. Thorbjarnarson *et al.*, 2000b; Shanker & Pilcher, 2003; Weir *et al.*, 2007; Tomás *et al.*, 2010; Marco *et al.*, 2012; Hancock *et al.*, 2016).

C. mydas' RMUs have the widest range of CECi values (ΔCI= 0.640), including the second highest overall CECi value (rmu45 in the East Atlantic) and the lowest CECi value overall (rmu49 in the South-West Atlantic). Also, green turtles have the lowest proportion of threatened RMUs, with six and eleven categorised as threatened and least concern, respectively. It is worthy to note that the RMU with the lowest CECi value is located in the South-West Atlantic, with nesting in Brazil and foraging and migratory turtles occurring in southern Brazil, Uruguay and Argentina. Despite its status, a recent study has highlighted the impact that plastic pollution may be having on the health of this green turtle population in one of its most important feeding areas, the Rio de la Plata estuary, between Uruguay and Argentina (González Carman *et al.*, 2014). Hence, a future initiative into developing proxies could be to collect and map the expert opinion or published data to refine the threats index, including plastic pollution.

For *D. coriacea*, I predicted the conservation status for all RMUs and compared my results with the conservation status determined by the data-driven IUCN Red List process. I found five out of seven RMUs to be threatened and only one RMU status differed from the IUCN Red List assessment. My model assigned rmu56 (West Pacific) as least concern and the IUCN Red List classed it as critically endangered. This difference is likely to occur because in my assessment, the species' geographic distribution includes countries with very high HDI values and strong economies, such as Australia, Canada, Japan, France and the United States of America. However, the IUCN Red List assessment is based on the declines in nesting females at key rookeries in Malaysia, Indonesia and Papua New Guinea (Spotila *et al.*, 2000; Shanker & Pilcher, 2003; Wallace *et al.*, 2013b). These nesting populations are declining due to threats impacting on hatchling production (e.g. nest predation, erosion and consumption) and offshore impacts (e.g. fisheries bycatch and consumption of plastic pollution) (Wallace *et al.*, 2013a). Protection of this stock will likely require a coordinated, multi-country conservation approach. These stocks may benefit from a Convention on the Conservation of

Migratory Species of Wild Animals (CMS) supported single-species action plan, as per the South Pacific Ocean loggerhead[10].

Only two of my predictions and current IUCN conservation status did not match (for rmu27, *C. caretta* in the North-West Indian Ocean; and rmu56, *D. coriacea* in the West Pacific). In both cases my model predicted a status of least concern, but the IUCN current status is critically endangered. This difference could be explained by the high HDI values and low proportion of low economic status within the countries in both RMUs. Also, this variance may occur due to the high impact of artisanal and high seas fisheries, plus the IUU (illegal, unreported and unregulated) fishing activities that occur in both areas, especially in the recent past ~30 years (e. g. Alfaro-Shigueto *et al.*, 2011; Wallace *et al.*, 2013b; Casale & Tucker, 2015; Abdulqader *et al.*, 2017). Part of this mismatch may also be related to the availability of empirical data on the various threats to each stock and how availability of this data may change over time. This is an aspect that could be improved for future exercises, which must strive to incorporate the most recent data on threats for each RMU. Both RMUs could serve as examples of the need to leverage international capacity and funding to boost local-scale or nation-wide conservation initiatives.

Lepidochelys kempii's RMU is considered by my model to be least concern. The CECi value of the rmu58, North-West Atlantic (more specifically in the Gulf of Mexico) was calculated at 0.339. *L. kempii* distribution throughout the waters of the USA, coupled with US government initiatives to manage nesting locations and threats such as bycatch, could provide adequate conditions for maintenance and recovery. However, the impacts of events such as

[10] Available at: http://www.cms.int/en/document/single-species-action-plan-loggerhead-turtle-south-pacific-ocean

the 2010 Deepwater Horizon oil spill in the Gulf of Mexico are believed to have impacted the species, and these impacts are yet to be seen in terms of changes to adult recruitment or nesting numbers (Putman *et al.*, 2015; Reich *et al.*, 2017).

C. caretta from the South-West Atlantic (rmu24) has the second-lowest value of CECi, which means that its predicted status was catalogued as least concern. This RMU appears well protected on its nesting beaches by national programs in Brazil (Marcovaldi *et al.*, 2005; Chapman & Seminoff, 2016) and by international initiatives among Brazil, Uruguay, and Argentina (IAC, 2013a). However, recent published data urge more effort to understand the migration patterns between the high seas and coastal areas and the behaviour of turtles in coastal waters because the effect of plastic ingestion is likely to be problematic for the RMU (Giffoni *et al.*, 2014). The other eight RMUs predicted to be least concern (by CECi values) are also believed to have experienced significant increases (Mazaris *et al.*, 2017; Table 4), which may infer successful conservation outcomes.

There are four RMUs catalogued as threatened by CECi with upwards population trends, which implies that a degree of, successful conservation is occurring. Three RMUs (i.e. rmu05, *L. olivacea*; rmu55, *D. coriacea*; rmu60, *N. depressus*) were considered to be threatened according to their CECi values and had downward population trends (Mazaris *et al.*, 2017). These RMUs likely require protection to minimise further decline. Finally, two RMUs showed CECi values greater than 0.59 and although they were categorised as least concern they have downward population trends implying they may need continued conservation strategies.

Among the world's most threatened RMUs (Table 5), when I compared my results with those of Mazaris *et al.* (2017), I found that two of the RMUs have upward trends (rmu46 *C. mydas*, and rmu07 *L. olivacea*), one located in Central Atlantic and another in North-East Indian Ocean, respectively, which may drive a recovery of their RMU status and population size. On the other hand, two of the RMUs (rmu05 and rmu55, East Atlantic and East Pacific respectively) are under a high risk of extinction, because of their high CECi values and the downward trend of the population size. On these four cases the role of the governments to improve the status of these RMUs is vital (Chapter 3 and 4), further evaluations will be required to evaluate if these positive and negative trends are constant throughout years.

Some authors recommend the use of different indices to determine the status of threatened species, especially species of conservation concern (Jain & Jain, 2013; Lindsey *et al.*, 2017). However, due to several pertinent gaps in information, particularly in data availability for developing and least-developed countries, I decided to use the HDI and economic index because these are more commonly used in the scientific literature, and for the HDI, it has been used to evaluate the level of wellbeing of countries (Kusters *et al.*, 2006; Jain & Jain, 2013). The use of proxies combining risks, threats and socio-economic data to evaluate the status of threatened species is useful because it allows for rapid and cost-effective initial analysis that can aid the prioritisation of conservation planning (Agarwala *et al.*, 2014). Hence, to predict the conservation status of RMUs without an updated IUCN status is essential.

Also, using CECi, protection agencies can prioritise limited resources and improve the understanding of the general status of other species, especially if they are exploited by humans. For instance in sea cucumber fisheries, the trends, level of exploitation, enforcement and future management measures were evaluated using similar proxies (Purcell *et al.*, 2013). My results may be used to improve decision-making on limited funding models or by NGOs to prioritise areas or species for conservation initiatives and partnerships. Furthermore, it may be implemented with other migratory marine species such as sharks, whales, dolphins, dugongs and sea birds.

Chapter 3

PEOPLE USING MARINE TURTLES: A SOCIO-CULTURAL EVALUATION OF CONSUMPTIVE USE THROUGHOUT THE WORLD

Street stall in Guatemala offering illegally-harvested marine turtle eggs for sale.

Photo credit: Elga Sanchez (2014)

ABSTRACT

Management of legal and illegal consumptive use of threatened wildlife species is a key challenge for governments and conservation practitioners. In particular, it is a key challenge for sustaining or improving the conservation status of marine turtles because consumptive use is one of the primary hazards facing some marine turtle species and populations. Indeed, in some countries where consumptive use is allowed there are resulting tensions between stakeholders over opposing views on consumption. This chapter aims to (1) evaluate how the consumptive legal and illegal use of marine turtles is distributed and regulated worldwide, and (2) assess how this use is related to the presence of indigenous people. I carried out an extensive literature review (>300 documents), to determine the extent of legal (both regulated and un-regulated) and illegal use of marine turtles globally. I also categorised special regulations associated with the use of marine turtles. I then evaluated what proportion of this regulated use was related to the presence of indigenous people. I coded all the gathered information using a logical matrix. Of 152 countries with marine areas, 137 have a regular presence of marine turtles in their waters. Within those 137 countries (and their overseas territories), illegal use occurred in 98 countries and legal use occurred in 39. I found that the legal use was regulated in 33 of the 39 countries where it occurs and I discuss different conservation alternatives to address the issue in different areas of the world. The recognition of the indigenous people's presence within their territories is a key factor in developing further strategies to protect marine turtles, as well as considering the traditions, beliefs, cultural values, and ancient customs of the indigenous people.

Key Words: marine turtles, IUCN status, indigenous people, consumptive use, aquatic bushmeat, traditional use.

3.1 INTRODUCTION

One of the primary conservation challenges of the past 50 years has been trying to identify, quantify, minimise, and/or regulate the consumptive use of wild fauna, especially species of conservation concern (Campbell, 2002a; Mancini & Koch, 2009). Much of the literature on this issue centres on the bushmeat trade, trophy hunting, and sustainable use of aquatic fauna such as cetaceans, sirenians, turtles, and crocodiles (Montiel-Villalobos & Barrios-Garrido, 2005; Cosentino & Fisher, 2016; Prideaux, 2016; Wilkie *et al.*, 2016) (Chapter 6). However, information regarding the cultural values of consumptive use of wild fauna is still lacking (Woodron Rudrud, 2010; Rees *et al.*, 2016) (Chapter 7) and this knowledge would be useful to improve local, culturally-based conservation initiatives (Alexander *et al.*, 2017).

Hundreds of threatened, or potentially threatened, terrestrial and aquatic species are negatively impacted by consumptive use, especially in the world's developing regions (i.e. Asia, Latin America, and Africa) (Sunderlin *et al.*, 2005; Costello & Scott Baker, 2011; Cosentino & Fisher, 2016; Ordaz-Németh *et al.*, 2017). When flagship species with high public recognition are involved, and if management intervention involves reducing or eliminating the consumptive use, such incentives can result in increased tensions between stakeholder groups that hold opposing values or beliefs (Balmford *et al.*, 2001; Pont *et al.*, 2015). This is largely because addressing conservation and livelihood goals at the same time is challenging (Haalboom & Campbell, 2012; van Vliet *et al.*, 2016). The issue is particularly evident in areas where the consumptive use is a key element of cash- or trade-based economies (Van Vliet *et al.*, 2015; van Vliet *et al.*, 2016; Rogan *et al.*, 2017) (Chapter 6). For example, in the small-scale fisheries of Turks and Caicos (a United Kingdom overseas territory in the Caribbean), the use of iconic species (e.g. queen conch, and spiny lobster) is considered by several authors to be fisheries in need of conservation efforts (Richardson *et al.*, 2009; Stringell *et al.*, 2013).

Marine turtles occur across most of the world's tropical and sub-tropical oceans (Limpus, 2009). Turtles have been used for consumption for thousands of years by indigenous and other ancient cultures (Olijdam, 2001; Antczak *et al.*, 2007; Brikke, 2010), and broad scale (legal or illegal) commercial use has only occurred for hundreds of years (Mancini & Koch, 2009; Nada & Casale, 2011). While it is clear that commercial use of turtles in the past has brought some populations down to very low levels (Bell *et al.*, 2006; Alfaro-Shigueto *et al.*, 2011), or caused local extinctions (e.g. Malaysian leatherbacks) (Spotila *et al.*, 2000), some populations were able to sustain large levels of take and some depleted populations are recovering (Balazs & Chaloupka, 2006; Chaloupka *et al.*, 2008; García-Cruz *et al.*, 2015; Mazaris *et al.*, 2017).

Although marine turtles were once hunted across many regions of the world and supported large domestic and international markets for food, bekko, and trade (Campbell, 2003; Frazier, 2003), all species are now listed as species of conservation concern by the IUCN (2014). Indeed, in the last 50 years, there has been a switch; where marine turtles were once largely used as an economic commodity, now they are often used as a conservation flagship species and are widely protected by international regulations and national legislation (Kinan & Dalzell, 2005; Frazier, 2009). However, despite increased awareness of marine turtle conservation, turtles are still used legally as a commercial or non-commercial food source in at least 42 countries and overseas territories (Humber et al., 2014), and there has been academic debate about the sustainability and legal framework of this use (Campbell, 2002b; Lagueux *et al.*, 2014) (Chapter 6).

3.1.1 Indigenous territories and marine turtle habitats

The mega-biodiverse areas of the world often coincide with the traditional territories owned by indigenous people (Balmford *et al.*, 2001). Indeed, indigenous-owned land areas include 22% of the world's surface, and the majority of these are located within the tropics (Sobrevila, 2008). Further, a considerable proportion of indigenous groups' territories (especially within the Americas, Africa, and Asia) overlap with marine turtle habitats, including feeding grounds, migratory corridors, and nesting beaches (Hyndman, 1993; Roe Hulse, 2005; Poonian *et al.*, 2016) (Chapter 5). Importantly, these habitats often coincide with areas where the indigenous people live in depressed economic conditions (IWGIA, 2013, 2014, 2015, 2016) (Chapter 6), and where marine turtles both are a valuable food source as well as culturally iconic species (Woodron Rudrud, 2010; Hancock *et al.*, 2016) (Chapter 7).

Inter-disciplinary research examining social, geographic, and cultural values related to marine turtles and their conservation is increasing in the literature (Frazier, 2009; Alexander *et al.*, 2017). Indeed, global-scale studies can provide a better idea about critical regions for conservation, and the tools that could be developed to manage threats such as consumptive use. For these reasons, I aimed to examine available information from each country regarding consumptive use (traditional, commercial, legal, and illegal) of marine turtles, and the legal frameworks within countries regarding the consumptive use for traditional purposes or subsistence. I then classified these regulations with respect to the legal situation of use in order to compare how different governments address the management of marine turtle consumption.

3.2 METHODS

To understand patterns of marine turtle use, I assessed published data for each country and scored each document according to whether marine turtles occurred in each countries jurisdiction: regular year-round occurrence, irregular occurrence, or no published records of marine turtles (generally high latitude countries). For each country where marine turtles were present – including their overseas territories – I recorded whether or not the consumptive use of turtles in the nation was legal. I did this by collating information from the national government website, research and technical reports, and published academic papers on marine turtle status and trends. All documents were available online (> 300 sources of information including Acts of Legislation Government policy documents, scientific papers, graduate student theses, and technical reports).

I categorised patterns of consumptive use of all marine turtle species using published accounts of legal and illegal use. The countries with legal use had their use further categorised as "regulated" or "non-regulated". In order to do this, I considered the specific regulations stipulated within the legal framework of each country; for example, restrictions related to (1) species allowed/protected, (2) whether special permits are required, (3) regulations (protection or allowance) by region, territory, or habitat, (4) seasonal closures, (5) presence of regulations allowing certain ethnic groups to use turtles, (6) quotas on use, and (7) other (regulated by size or weight of the animal hunted). These regulations were not mutually exclusive in my final outcomes. All this information was complemented, when necessary, with in-country expert opinion by email (52 experts were contacted and 38 provided information). An expert on marine turtles was defined as a person holding membership with the IUCN – Marine Turtle Specialist Group (MTSG).

It is worth noting that some countries have a legal framework which allows the regulated use of marine turtles under certain circumstances (under special permits and conditions, and with management plans involved), but there are published accounts of the illegal use of marine turtle species occurring in the country (i.e. under different conditions and breaking the law). For example, in Costa Rica the use of eggs from olive ridley turtles (*Lepidochelys olivacea)* during *arribadas* at Ostional beach on the Pacific coast is legal under certain conditions[11] (Campbell, 1998; Valverde *et al.*, 2012; IAC, 2015), but any consumptive use of marine turtle species along the Caribbean coast of this country is considered illegal as has been reported on by several authors (Troëng *et al.*, 2004; Santidrián Tomillo *et al.*, 2008). For this reason, in order to simplify my analysis, these countries were categorised as allowing regulated use.

I used a series of databases (Google Scholar, ISI Web of Knowledge, Scopus, CIA World Fact Book, and the United Nations) and documents from the International Working Group for Indigenous Affairs (IWGIA), the C169 Indigenous and Tribal Peoples Convention (ILO, 1989), and the 2007 United Nations Declaration on the Rights of Indigenous Peoples (UN, 2008) to obtain literature relating to indigenous presence and recognition (CIA, 2014). I used the following keywords to collect information on the use of marine turtles: “marine [sea] turtles” + “traditional use”, “consumptive use”, “legal use”, “lethal use”, “illegal use”, “legal consumption”, “fishing”, “legal fishing”, “illegal fishing”, “illegal trade”, “legal trade”, “people” and “indigenous people”. Although the term “use” has been used to describe non-lethal (such as ecotourism) and lethal activities, I only used lethal consumptive use of turtles and/or their eggs in this paper (Garland & Carthy, 2010; Garland, 2011).

[11] Community agreements established with the National Protected Areas System assessed and supervised by University of Costa Rica.

The literature was used to identify the presence of indigenous people and their level of recognition by their own Government (Figure 1); each nation was categorised as having: a) *full recognition of indigenous people* (country with indigenous people within its territory, has national recognition of indigenous people, and is party to the IOL, or country that voted “yes” during the United Nations General Assembly UNGA 2007); b) *recognition of just national indigenous people* (country that recognises its own native peoples, but did not vote ‘yes’ during the United Nations General Assembly-2007 regarding indigenous peoples (these countries voted ‘no’, ‘abstention’ or were not present during the United Nations General Assembly-2007); c) *recognition of just foreign indigenous people* (country that voted ‘yes’ during the United Nations General Assembly in 2007); d) *non-recognition of their own indigenous people but recognise foreign indigenous* (countries that have indigenous groups but do not formally recognise them, and these countries also voted ‘no’, ‘abstention’, or were not present during the United Nations General Assembly-2007; or e) *non-recognition indigenous people at any level*.

“Indigenous” is a commonly-used term; however, its definition is highly variable (Dove, 2006; UNPFII, 2009). To identify which nations with indigenous people, I used the United Nations definition from 1986 and self-identification as key factors. I define indigenous as “tribal peoples in distinguished lands or territories, whose social, cultural and economic conditions have a historical self-described continuity with pre-invasion and pre-colonial societies” (International Labour Organization, 1989; United Nations, 2008). When conducting literature searches, I considered the following terms as also referring to indigenous people: “tribal”, “aboriginals”, “First Nations”, “Traditional Custodians”, “Traditional Owners”, “natives”, or “indigenous”. Using the IWGIA database I found 56 countries with indigenous people, plus 15 countries where published information stated that those countries have indigenous people with self-identification.

In order to examine marine turtle use in relation to indigenous and non-indigenous people, I compiled and mapped the following data for each nation: presence (regular or irregular) or absence of marine turtles; the traditional uses of the turtles; and the presence or absence of legislation regarding legal protection of marine turtles, which could include regulated or non-regulated use (Hamann *et al.*, 2006b; Lagueux *et al.*, 2014; Poonian *et al.*, 2016). Patterns of use were compared with the national government or NGO reports of illegal use of marine turtle by regions and/or country.

Using a logical matrix (examples in Table 1), I extracted, collated, and coded the information for each country into the following categories: a) year round presence of marine turtles (0 = absence; 1 = presence; 2 = irregular records); b) presence of indigenous peoples (0 = absence; 1 = presence); c) status of recognition of the indigenous peoples (0 = no-recognition; 1 = only national recognition (i.e. recognition of own nations indigenous people); 2 = recognition by UN declaration (i.e. recognition of other nations indigenous people); 3 = recognition at the national and international level; d) legislation governing use of marine turtles (0 = absence; 1 = presence). When the legislation does exist, I examined whether it allowed the use of marine turtles by indigenous or non-indigenous people (0 = no; 1 = yes), and whether the use regulated in numbers, sizes, quantities, species, spatial areas, ethnicity (0 = non-regulated, 1 = regulated legal use) and e) type of use for marine turtle products (0 = legal to consume; 1 = illegal to consume).

I accept that some countries with either indigenous people or presence of marine turtles have disputed geopolitical boundaries, and recognition of indigenous people is disputed by some national Governments (IWGIA, 2007, 2008, 2009, 2010, 2013, 2014, 2015, 2016). To address these issues, I used the UN political boundaries. Hence, I mapped all the information in layers using ESRI ArcMap 10.2 (Redlands, California, USA) in order to evaluate the overlap of marine turtle populations and indigenous people. The majority of the information regarding indigenous peoples is found in IWGIA databases (2007, 2008, 2009, 2010, 2013, 2014, 2015), which is limited because some countries do not provide enough or accurate information regarding their indigenous people's presence, rights, and recognition.

Table 3.1. Logical matrix (sub-set of data) to evaluate the presence and status of recognition of indigenous people within each nation, and the presence of marine turtle species (regular, irregular or absent)

Country	**Indigenous people**						**Marine turtle presence**		
	Presence[1]		Recognition status[2]						
	Yes	No	Fully	Just international	Just national	Not recognised	Regular	Irregular	Absent
Argentina	X		X				X		
Australia	X		X				X		
Colombia	X		X				X		
Denmark	X			X				X	
Eq. Guinea	X					X	X		
Germany		X		X				X	
Ivory Coast		X				X	X		
Kenya	X				X		X		
Madagascar		X		X			X		
Mexico	X		X				X		
Norway	X		X						X
Papua New Guinea	X				X		X		
Venezuela	X		X				X		
Vietnam	X		X				X		

[1] Indigenous people recognised by the International Work Group for Indigenous Affairs. Source: www.iwgia.org. Independent institution which uses the United Nations Sub-Commission on the Prevention of Discrimination of Minorities (1986) definition, and the International Labour Organization (ILO) Convention no.169 (1989) concepts.

[2] Status categorisation using the ILO Convention no.169 (1989) (source: www.ilo.org), the United Nations Declaration on the Rights of Indigenous Peoples (2007) (source: www.un.org), plus the national legal framework regarding indigenous peoples or minorities.

3.3 RESULTS

I examined information on 152 countries with a marine coastline (including their overseas territories). One hundred and thirty-seven countries have a regular presence of marine turtles in their territorial waters, and there are five countries with an irregular presence of marine turtles (Belgium, Croatia, Denmark, Germany and Ireland). I found that 10 nations have no available published records of marine turtle occurrence (Estonia, Finland, Georgia, Iceland, Latvia, Lithuania, Norway, Poland, Russia and Sweden) (Table 2). Fifty-two experts from around the globe were contacted, and 38 responded with information from their region of expertise.

Due to the lack of published information, I cannot confirm that consumptive use is, or is not, occurring in all the countries evaluated. However, of the 137 countries with a regular presence of marine turtles, consumptive use of marine turtles would be considered by legislation as illegal in 98 and legal in 37 countries (Table 2). In particular, in 31 out of the 37 countries consumptive use of marine turtles is legal subject to one or more special regulations, such as species restrictions (n = 21), special permits required (n = 14), by regions or territories (n = 13), seasonal closures (n = 13), restrictions based on ethnicity (n = 11), quotas (n = 7), and others (n = 6). These regulations are not mutually exclusive; some countries have more than one type of special regulation within their territory. For example, the Nicaraguan Government allows the use of only green turtles that are no smaller than 65.0 cm curved plastron length, caught outside of a specific closed season between 1 March to 31 of July, and caught only for subsistence use by Miskito Indigenous people in the Caribbean region of the country. In addition, a written permit is required. Thus, Nicaragua has four regulations (Lagueux, 1998; Lagueux *et al.*, 2014, 2017).

In Albania, Bosnia and Herzegovina, Guyana, Nauru, Sudan and Syria, the legal consumptive use of marine turtles is allowed due to the absence of a legal framework that protect these species; however, this may change soon. For example, during my research, I found that the Guyana government started a public consultancy process in May 2016 to examine people's views regarding a new legal framework aimed at providing protection to several species of terrestrial and aquatic wildlife, including the marine turtles. Then in August 2016, it was passed by the Guyana National Assembly. The final document is available at http://dev.ultimate-dimensions.net/nredev/wp-content/uploads/2016/06/WILDLIFE-CONSERVATION-AND-MANAGEMENT-BILL-2016.pdf (revised in September 2017) (Guyana, 2016).

The green turtle (*Chelonia mydas*) is the most common species of marine turtle that is legally consumed, with associated regulations in twelve countries (Table 4). On the other hand, the leatherback turtle (*Dermochelys coriacea*) is the most commonly protected species within territories where legal and regulated use of other marine turtle species occurs (i.e. Grenada, Papua New Guinea, Solomon Islands, Somalia and Tonga). However, it is not fully protected across the world because use is evident in four countries (i.e. Haiti, Saint Lucia, Indonesia and Vanuatu) where other marine turtle species are considered protected. The full protection for hawksbill turtles (*Eretmochelys imbricata*) is expressed only in the Cayman Islands (United Kingdom overseas territory). The consumptive use of loggerhead (*Caretta caretta*) and olive ridley (*Lepidochelys olivacea*) turtles occurs only in four and three countries respectively; however, in the case of *L. olivacea*, use of its eggs is only permitted during *arribadas* in Costa Rica, Guatemala, and Panama (IAC, 2013b, 2015). The Australian Government allows Australian Aboriginal and Torres Strait Islanders to use flatback turtles (*Natator depressus*) for traditional, non-commercial purposes, although they are not commonly used (Bartlett, 2000). Kemp's ridley (*Lepidochelys kempii*) is the only species for which any type of consumptive use is forbidden.

I found indigenous people inhabit 56 of the countries with a regular presence of marine turtles. However, I also found that not all of the indigenous groups in these 56 countries reside adjacent to marine areas. For example, all the Argentinean indigenous groups are settled in the inland provinces without contact with marine areas (Neuquén, Salta, Jujuy, Santiago del Estero, and Tucuman provinces) (IWGIA, 2014, 2015).

Of the 152 countries I evaluated, four general trends of recognition of indigenous people were observed: a) *full recognition of indigenous people*, n= 30; b) *recognition of just national indigenous people,* n= 5; c) *recognition of just foreign indigenous people*, n= 66; d) *non-recognition of their own indigenous people but recognise foreign indigenous*, n= 20; or e) *non-recognition indigenous people at any level*, n= 31 (Figure 3.1). This is important, because up to eleven countries use ethnicity to regulate the use of marine turtles (Table 3.3): Australia, Fiji, France, Honduras, India, Indonesia, Japan, Mexico, Nicaragua, Palau and Vanuatu. These regulations include the recognition of their indigenous people as owners of their land and the natural resources on it. The majority of these countries recognise the presence and status of indigenous people within their territories. However, while Fiji, Palau and Vanuatu were categorised as "non-recognition" because they are not listed in the United Nations Declaration on the Rights of Indigenous Peoples in 2007 (UN, 2008), all reports of IWGIA for these countries demonstrate that the presence and positive recognition status for indigenous people is clear and evident (IWGIA, 2009, 2010, 2013, 2014, 2015, 2016).

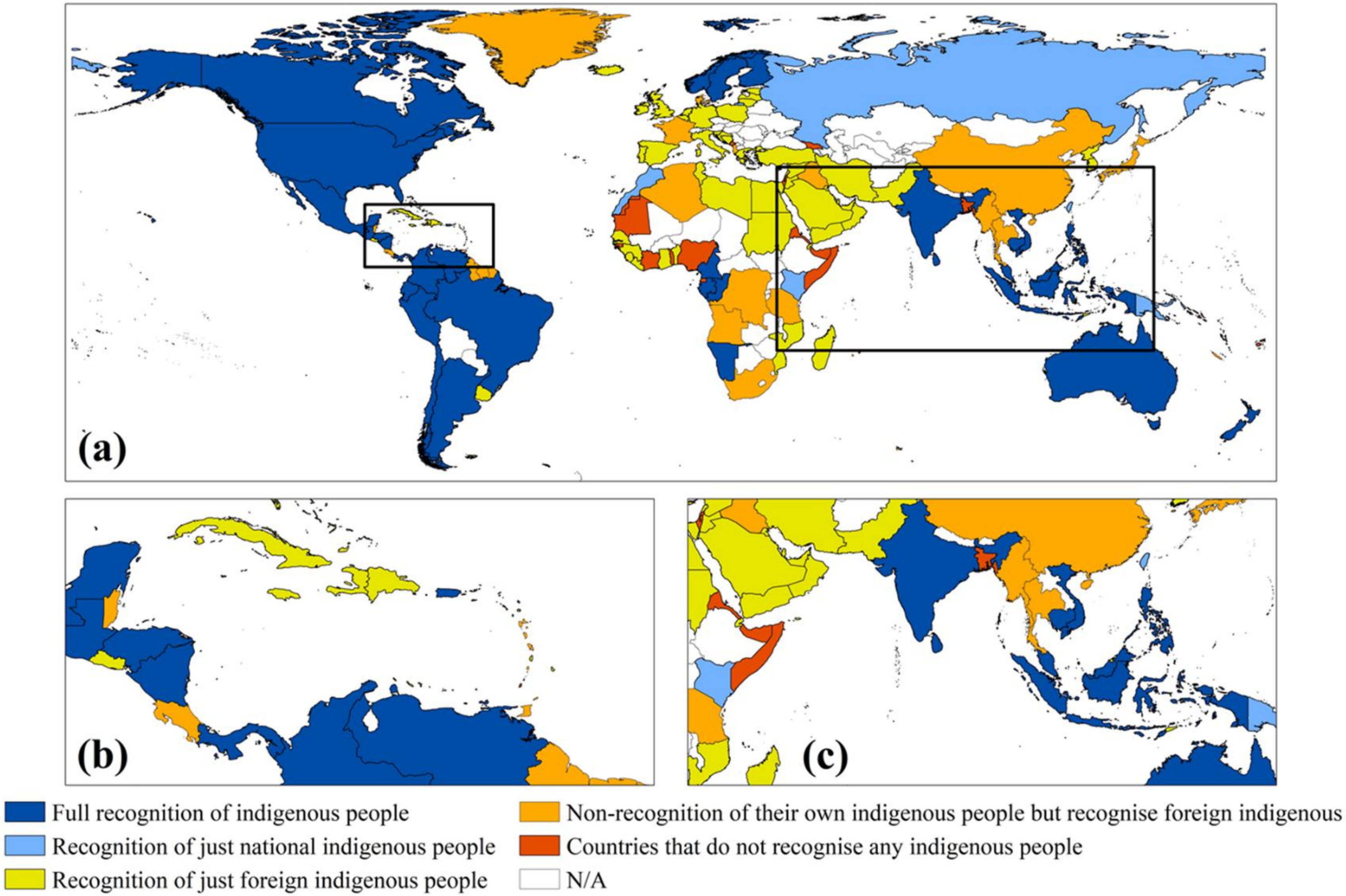


Figure 3.1 Recognition status of the indigenous people around the world. Colours reflect current status. (a) World scale (b) Caribbean Basin; (c) Australasian region.

Table 3.2. Trends of consumptive use of marine turtles. *The absence of a legal framework to protect marine turtles in their territorial waters is considered by this research as “legal use”

<table>
<tr><th colspan="5">Evaluated countries with marine areas (n = 152)</th></tr>
<tr><th colspan="5">Countries with presence of marine turtles (n = 142)</th></tr>
<tr><td colspan="5">Is this presence regular?</td></tr>
<tr><td colspan="4">Yes (n = 137)</td><td>No (n= 5)</td></tr>
<tr><td colspan="4">If the consumptive use occurs, it is considered to be:</td><td rowspan="4"></td></tr>
<tr><td colspan="2">Legal to consume (n = 37) *</td><td>Illegal to consume (n = 98)</td><td>Legal situation unclear (n = 2)</td></tr>
<tr><td colspan="2">Is this legal use regulated?</td><td colspan="2" rowspan="2"></td></tr>
<tr><td>Yes
(n = 31)</td><td>No
(n = 6)</td></tr>
</table>

Table 3.3 Regulations (non-mutually exclusive) regarding the legal consumptive use of marine turtles. Some countries regulated use of marine turtles by more than one parameter. Included: spatial protection (may be on nesting beaches) or special permit for hunting. Region or territory: some countries prohibit hunting inside of natural parks or reserves, other cases allow the use only in some specific areas.

Species	**Special permits**	**Region or territory**	**Season**	**Ethnicity**	**Quota**	**Other***
21	14	13	13	11	7	6

*Use regulated by size or weight of the animal hunted, subsistence use allowed, cultural purposes.

Table 3.4 Restrictions and permits to use marine turtles by species. For example, the Nicaraguan Government allows the use of green turtle but expresses the total protection of hawksbill turtle in the nation's waters.

Species	**Number of countries**	
	Allow its use	**Express its protection***
C. mydas	12	0
E. imbricata	9	1
C. caretta	4	0
L. olivacea	3	0
D. coriacea	3	5
L. kempii	0	0
N. depressus	1	0

*Allowing the consumptive use of at least one other marine turtle species.

3.4 DISCUSSION

My results can be used to categorise countries into three main groups with respect to their use of marine turtles. In the first group (n = 98 countries), the consumptive use of marine turtles is considered illegal, and there is no published evidence of illegal use occurring in many of them. In the second group (n = 37 countries), consumptive use of marine turtle is considered legal and within these countries there is a third group of 31 countries where consumptive use is legal and regulated (Table 2). These regulations vary among the countries: some of them have more than one type of regulation, yet information justifying the regulations is not always available. For example, the legal and regulated use of marine turtles in Nicaragua is determined by species, season, size, and user ethnicity (Garland, 2011; Lagueux *et al.*, 2014). These regulations are often created without fundamental biological data, jeopardising the population's survival for future generations (Bell *et al.*, 2006; Stringell *et al.*, 2013). The third group is comprised of two more countries where the legal status of consumptive use of marine turtle remains unclear (Algeria and North Korea).

The level of recognition of governments of their indigenous people is crucial to acknowledging indigenous peoples' presence and rights to use their land and natural resources for sustenance and/or traditional occasions. In allowing traditional use of marine turtles as part of a native culture, a government should recognise its indigenous groups and their cultural requirements (Weiss *et al.*, 2013). Once this recognition exists, it will be possible to work with indigenous people to create strategic plans which aim to regulate, evaluate and quantify the consumptive use of marine turtles or other culturally significant resources (Chapter 6) (Sobrevila, 2008). As an example, the Australian Government recognises the presence and rights of the Aboriginal and Torres Strait Islanders as Traditional Owners of the Australian territory and the natural resources within their traditional territories under the Native Title Act (1993). As part of this recognition, the Australian Government's Native Title Act 1993 allows Aboriginal and Torres Strait Islanders the rights to maintain their use of marine turtles and dugongs only for culturally-significant food and rituals as they relate to each indigenous group's requirements (Venn & Quiggin, 2007; Marsh *et al.*, 2015). In contrast, although the Venezuelan Government fully recognises the presence, rights and ancient customs of the Wayuu Indigenous people as traditional inhabitants of the Guajira peninsula, the use of marine turtles as key species in their traditional rituals and livelihood is considered illegal (Chapters 6 and 7). Indeed, the Venezuelan government considers any consumptive use of marine turtle illegal, and use by Wayuu Indigenous people can be penalised with legal prosecution (Antczak *et al.*, 2007; Barrios-Garrido & Montiel-Villalobos, 2016; Barrios-Garrido *et al.*, 2017b) (Chapter 6). Moreover, some national governments do not affirm or recognise the presence of traditional peoples within their territories. Non-recognition impacts the development of potential co-management plans that may be developed to intersect the social or cultural dimensions of conservation to mitigate consumption or overuse (Alexander *et al.*, 2017). A similar situation occurs in Equatorial Guinea and Bangladesh.

I found similar data on the spatial extent of turtle use to previous authors, in particular Humber *et al.* (2014), who evaluated the legal use of marine turtle products in several areas throughout the world. However, seven countries showed different results in my research: Algeria, Chile, Colombia, Costa Rica, Fiji, North Korea, and Panama. In the following paragraphs, I describe the reasons for these differences.

In Humber *et al.* (2014) study, Colombia is classified as a country in which the government allows the consumptive use of marine turtles by indigenous people. However, after my review of the Colombian legal framework regarding endangered species and my interviews with marine turtle experts from Colombia, I can confirm that consumptive use of marine turtles in Colombia is illegal. During my literature review, I noted that the Colombian Government formally acknowledged that consumption occurs in their national territory. Indeed, the Environmental Ministry of Colombia claimed, in the 2002 document entitled "Nesting and feeding areas of sea turtles in the Colombian Caribbean" [in Spanish: *Áreas de anidación y de alimentación de las tortugas marinas en el Caribe colombiano*], that Colombia has a framework to protect marine turtles, and it forbids consumptive use. However, they also formally accept that consumptive use is carried out mainly by indigenous and Afro-American people, although this use would still not be legal (Ministerio de Ambiente & Invemar, 2002). Importantly, the illegal use of marine turtle in the Colombian territory is being addressed by management plans which are currently under revision (Rueda-Almonacid *et al.*, 1992; Colombia, 2002; Bräutigam & Eckert, 2006; Villate, 2010), and the Colombian legal framework does not allow the use of marine turtles captured incidentally by industrial or artisanal fisheries (Colombia, 2002; Suárez, 2002; Campbell, 2014).

Regarding Chile, in-country experts stated that the reason for Humber *et al.*'s (2014) categorisation of Chile as a country with legal marine turtle use was that the current moratorium to protect these species is valid until 2025. This moratorium prohibits consumptive use until further actions are taken in the territory. However, the Chilean government and general public of this country have been improving their awareness regarding the situation of the marine turtles on Chilean territory (Álvarez-Varas *et al.*, 2015). Indeed, recently (October 2015) the Chilean government created a large marine protected area (MPA) including Easter Island (Rapa Nui) and its surroundings. Some of the target species the MPA aims to protect are marine turtles (Roberts, 2015). Hence, one of my interviewees affirmed that the Chilean Government is moving towards full protection of marine turtles.

Similar to Chile, Fiji has a moratorium on the consumptive use of marine turtles (valid until 2019). The Fijian moratorium allows only the subsistence use for Fijian Indigenous people, and it prohibits the selling of any products derived from marine turtles. However, previous authors indicate that, generally speaking, the enforcement of marine turtle protection legislation is not consistent, and marine turtles are being used for commercial and subsistence purposes (Laveti & MacKay, 2009). The commercial use of marine turtles in Fiji has not been quantified.

Also, the New Zealand classification is different in my study because, although Cook Islands and Tokelau are in free association with New Zealand, the latter holds a restrictive law that prohibits the lethal use of marine turtles in its territories. Hence, the consumptive use that may occur on these islands would be illegal (Miskelly, 2016). The legality of the use in Cook Islands and Tokelau has not been quantified, nor has its legal status been challenged in legal systems.

The North Korean and Algerian cases are related to lack of access to information on these countries. I did not have access to the legal framework of these countries, which meant it was not possible to evaluate and classify the legal status and trends of the marine turtles for either country. Hence in my evaluation, I categorised them as “legal situation unclear” (Table 2).

Regarding Costa Rica, I included the consumptive use of eggs. Hence, Costa Rica is a country which is classified as having legal and regulated use. Legal use results from the community-based harvest of eggs from *arribadas* in Ostional (Pacific coast) (Campbell *et al.*, 2007; Valverde *et al.*, 2012; IAC, 2015). However, the consumptive use of marine turtles on the Caribbean coast is forbidden – yet it stills occurs, although a different species is involved (leatherback, green, and hawksbill turtles) (Troëng *et al.*, 2004; Garcia Varela *et al.*, 2016). It is worth noting that a similar situation occurs in several countries that have regulated and legal use, but due to the difference perspectives on enforcement I only categorised them as "legal and regulated use" (e.g. France, Guatemala, Nicaragua, United Kingdom, among others).

I found different regions where the indigenous people and marine turtle populations coincide. One in the African continent (western and eastern coasts), others in the Indo-Pacific region, and in Central and South American areas. In these areas there is generally a strong connection between indigenous people and marine turtles, but the connection is not well documented in Western literature (Abd Mutalib *et al.*, 2013). Further outcomes are necessary to document, improve and maintain knowledge about the spiritual, cultural, and social relationships that between different groups of indigenous people and marine turtles, especially where marine turtles may be cultural keystone species (Garibaldi & Turner, 2004; da Nóbrega Alves, 2006; Álvarez-Varas *et al.*, 2015) (Chapter 7). A useful start would be to examine the varying levels of empowerment that the original inhabitants have with regards to the development and implementation of conservation programs involving marine turtles (e.g. Grayson *et al.*, 2010; Weiss *et al.*, 2013).

A country's economic status is also likely to have a large impact on national perspectives and approaches to conservation (Chapter 2). Conservation programs in developed countries are usually enforced by government agencies (Gemmill & Bamidele-Izu, 2002), while NGOs and local communities may be involved on a smaller scale. However, the governmental agencies in developing countries tend to rely on NGOs and local communities to implement conservation programs for protecting biodiversity (Campbell, 2007; Buitrago *et al.*, 2008; Cornwell & Campbell, 2012). This can create tension if the values of the government, indigenous people and NGOs are not aligned (Chapter 4).

It is important to highlight that recognising the presence of indigenous, tribal or First Nation peoples and their cultural traditions is a step towards co-management in the countries they inhabit. This recognition is limited in some countries or territories (Table 3). Acknowledging this may create the environment to provide opportunity for discussion around regulated use, which in the long term could be more sustainable than unregulated illegal use (Marsh *et al.*, 2015). For example, in Venezuela the national government already recognises the presence of its indigenous groups and their traditional use of natural resources (Venezuela, 2005); however, the use of marine turtles for traditional purposes is still considered illegal despite the turtles being key cultural species for the largest Venezuelan indigenous group (Wayuu people). This creates a conflict due to the unclear legal framework (Chapters 4, 6, and 7).

In my study, I did not document the perception or status of enforcement due to the dissimilar opinions of the marine turtle experts contacted. Based on information from the marine turtle experts, each of the 31 countries with regulated use have special conditions that allow the governments to compliance and enforcement their national laws and international treaties. For this reason, it is important to acknowledge that my study is not necessarily related to enforcement, but it is a valid exercise to evaluate the current status of the legal frameworks that protect marine turtles worldwide.

Chapter 4

CONSERVATION CONFLICTS RELATED TO MARINE TURTLE PROTECTION INITIATIVES IN THE CARIBBEAN BASIN

Green turtles to be butchered in the Guajira Peninsula.
Illegal consumptive use of marine turtles is among the most frequently cited causes of conservation conflict related to marine turtles in the Caribbean region.

Photo credit: Héctor Barrios-Garrido (2014).

ABSTRACT

Conflicts among local, national, regional and international stakeholders involved in marine turtle conservation are increasing. Often, they arise because of different socio-economic backgrounds of the people or groups involved. Here, I identified and assessed the conservation-based conflicts occurring in the Caribbean countries, identifying their frequency, level of severity, number of stakeholders' groups involved, the degree to which they hinder conservation goals, and potential solutions. Using a cross-sectional social survey, I evaluated the presence and details of conservation conflicts provided by 72 respondents. The respondents included conservation-based project leaders, researchers, people involved in policy-based decision-making, conservation volunteers (community-based conservation groups), and species experts with experience working on marine turtle conservation programs in the Caribbean. The respondents identified 136 conflicts, and I grouped them into 16 different categories. The most commonly mentioned causes of conflicts were: 1) the 'lack of enforcement by local authorities to support conservation based legislation or programs' (18%); 2) 'legal consumption of turtles by one sector of community clashing the conservation aspirations of other sectors of community (14%); and 3) 'variable enforcement of legislation to limit/prohibit use across range states of the species (10%). From the respondents, it is also apparent that illicit activities in the region are also impacting in the success of conservation based projects and programs. Overall, an exhaustive review was carried out, and the potential solutions were gathered. Due to the level of severity (physical violence) that some conflicts have reached, achieving those solutions are unlikely to occur, unless a mediation, mutual cooperation, and adaptive management arrangement take place.

Key Words: conservation-conflict, marine turtle, enforcement, adaptive management.

4.1. INTRODUCTION

Many of the world's species and habitats require legal protection from threatening activities. Indeed, most of the countries in the world with marine turtles have legislation to prevent, or regulate, commercial use (Humber *et al.*, 2014) (Chapter 3). However, government enacted legislation is only one tool used in species and habitat conservation, and it is only sufficient if monitoring, surveillance and enforcement are implemented (Keane *et al.*, 2008). Patterns or rates of law enforcement tend to increase when inclusive multi-stakeholder approaches are used in the community or society and when people generally believe the legislation will be enforced and perpetrators convicted (Watson *et al.*, 2015). Thus, while legislation and policy are generally seen as necessary to reduce threats to the environment, their success relies on enforcement, acknowledgement and support from society (Holmern *et al.*, 2007; Watson *et al.*, 2015).

Increased support for legislation by different stakeholders helps to guarantee the functional integration of legislation and policy into society, and this is believed to improve chances of the legislative meeting its goals (Redpath *et al.*, 2015). In the Caribbean's Latin-American countries, support for environmental-based legislation varies, this variation could result from resources limitations such as capacity for training and enforcement (Boza & Padilla, 2004; Velez-Zuazo *et al.*, 2017). However, the variety of cultural backgrounds and their associated values and interests towards environmental issues can lead to variation in the ways environmental issues are perceived and pro-environmental initiatives supported (Redpath *et al.*, 2013). In some cases, these differences can lead to conflicts (Chapters 5 and 6).

Different perspectives towards pro-environmental topics are part of human relationships and can be driven by cultural, social, political norms or economic circumstances (Douglas & Alie, 2014; IOSEA, 2014). While differences can lead to conflict and disengagement from conservation-based initiatives, some authors have claimed that conflicts have positive impacts, because over-time they can generate more sustainable solutions that articulate multiple-perspective approaches (Redpath *et al.*, 2013). Indeed, involving more people with various cultural values and socio-economic backgrounds is recommended because overtime it can improve cross-stakeholder relationships and governments ability to seek and achieve balanced conservation goals (e.g. alternative livelihood programs) (Carter *et al.*, 2016; Kouassi *et al.*, 2017). For instance, Hamann *et al.* (2006a) highlighted that the success of marine turtle conservation initiatives in Vietnam, such as the prevention of domestic sale of turtle products, is linked to the willingness of all stakeholder groups to cooperate and participate in initiatives and support legislation. Another example occurs in a marine turtle management program in Palau, where research by Risien and Tilt (2008) found that a bottom-up (community-based) conservation structure was successful because well-informed locals increased their participation in pro-environmental activities and they recommended that their program be implemented in other communities. Overall their success was linked to the community-based program having top-level government support which led to faster decision-making and the development of policy towards marine turtle conservation initiatives. However, achieving these goals is challenging because finding common or shared goals among multiple groups is often difficult (Mayberry *et al.*, 2017; Nguinguiri *et al.*, 2017).

Human-human conservation conflicts are generally associated with the differing values or perspectives towards the natural asset and the means or reasons underlying the desire to protect it. Some conflicts, such as those linked to the management of illegal or commercial use of wildlife (e.g. ivory, turtle shell and shark fin) are large, international and somewhat pervasive. For example, managing the legal, lethal, control of elephants in parts of Africa has created tensions among the interested parties environmental entities and environmental advocacy groups, NGOs (local and international), and Government decision-makers (Balmford *et al.*, 2001) for nearly five decades. Another example is how the global efforts to end the legal international trade of hawksbill turtle shell played out over several decades (Chen *et al.*, 2009; Hamilton *et al.*, 2015). While these conservation challenges are well known about, information related to the factors that lead to human-human conflicts, and/or how they impact species-based conservation programs are not well understood (such as reasons, solutions, approaches, or outcomes). Indeed, documenting the differences and the opportunities to reduce them could help future conservation initiatives.

Most marine turtle populations are found in the world's tropical and sub-tropical waters, including those of some of the most densely populated countries (Trewin, 2014) (Chapter 3). Plus, few of the worlds' marine turtle populations have not been exposed to human-generated initiatives or use which place either negative or positive pressure on them (Wallace *et al.*, 2011a). Cultural, social and/or economic links between marine turtles and people occurs in many countries and, and in some there is a strong cultural link between these marine turtles and traditional societies, which include traditions, rituals, customs, and uses (Chapter 7). The relationships human societies have with marine turtles, and how they value turtles may be influenced by the diverse social or cultural backgrounds among groups and the benefits, perceived or real, that are derived from them (Campbell, 2003; Erlandson & Rick, 2010). For instance, in Australia some pro-environmental groups have argued that the national government should prohibit the traditional, but non-commercial, use of marine turtles which is currently legal for Australian Aboriginal and Torres Strait Islander people and remains as an important cultural link to their land, sea and people (Grayson *et al.*, 2010; Butler *et al.*, 2012). Critics of the Indigenous use claim, variously, that it is unethical, and it is not traditional if modern boats are used and may not be sustainable (e.g. Thiriet, 2006) . However, the Indigenous use has been found by the Australian legal system to be about the intent and not the means, and as such it continues to be legal under Australia's Native Title Act 1993 and the Treaty between Australia and Papua New Guinea (Commission, 2015). Although there have been prosecutions of Indigenous individuals caught hunting in non-permitted areas or by non-permitted means (Watkin Lui *et al.*, 2016b). The issue of Indigenous use continues to be vigorously debated in public and political forums. It is generally believed that the legal structure is valid and that co-management or community-based management provide the best options to ensure continuation and sustainability of use (Marsh *et al.*, 2015; Watkin Lui *et al.*, 2016a; Watkin Lui *et al.*, 2016b).

In other cases, the low or uncertain economic differences among regions within a country, or between countries can have a noteworthy impact on the values of local people and their likely support for conservation initiatives towards marine turtles. For example, in some countries, the use of marine turtles as a food source occurs because there are high levels of poverty (Mancini *et al.*, 2011) (Chapter 6). In these cases, marine turtle meat is often considered to be an important and valuable source of protein (Chapter 7), especially in small, remote coastal villages (e.g. in Mozambique, Williams *et al.*, 2016; Williams, 2017). Hence, consumptive use of marine turtles often occurs where there is a strong economic driver, but this type of consumptive use is not generally encouraged under western conservation paradigms (Barr, 2001; Hamann *et al.*, 2006a; Poonian *et al.*, 2016) (Chapter 3 and 5).

In the majority of cases, conflict occurs over whether marine turtles should be consumed by people, whether it be for tradition or livelihoods. Consumptive use often generates conflict among the stakeholders because of ideological differences, or because no data on numbers of animal harvested is recorded and thus sustainability is questioned (Campbell, 2003; Hamilton *et al.*, 2015; Becking *et al.*, 2016; Lagueux *et al.*, 2017) (Chapter 5). The combined issues surrounding the consumptive use of marine turtles create tensions among people that in the long-term often generate conflicts that are not easy to solve. Examples of this type of conflict (solved and unsolved) was/is occurring among Central American stakeholders, where illegal use occurs over turtles (eggs, juveniles, and adult animals) and there have been clashes between local community members and those stakeholders who are trying to enforce the protection initiatives for marine turtles (Troëng *et al.*, 2004; Santidrián Tomillo *et al.*, 2008; Smith & Otterstrom, 2009; Madrigal-Ballestero & Jurado, 2017).

Marine turtles migrate between nations and across regions, and the socio-economic conditions and values of a country or regions people are highly variable. This variation in values makes initiating national or regional conservation programs a challenging strategy to protect migratory species, especially in regions where developing countries are the majority, such as the Caribbean Basin (Bräutigam & Eckert, 2006; Buitrago *et al.*, 2008) (Chapter 2, 5, 6, and 7). In the Caribbean there are 39 countries, consisting of various social, economic, and cultural differences both within and between countries. This heterogeneity is evident in the environmental initiatives carried out in the zone. Hence, the way to design conservation programs depends to some degree on the values of the people involved, especially in the way marine turtles or the conservation initiatives are considered by people with different values (Chapter 6 and 7). Moreover, recent research is indicating that potential solutions should consider the problem and solution from different perspectives (consider legal, social, cultural, scientific, ethical, and practical realities) to be effective and achievable (Redpath *et al.*, 2015).

Although marine turtles are species protected by international treaties and domestic legislation, management threats to them are challenging and all species remain conservation dependent. Some researchers affirm that marine turtle conservation initiatives are particularly challenging to initiate in the Caribbean due to the turtle's migratory behaviour and the variety of value and beliefs held by the region's residents (Horrocks *et al.*, 2016). Hence, the inter-agency and multinational approaches have become important for improving the success of conservation initiatives in the area. For this reason, in order to identify, assess, quantify, and evaluate the conservation conflicts regarding marine turtles (in the Caribbean Basin), I used qualitative and quantitative analysis to examine existing conflicts that could hinder conservation initiatives towards the marine turtles in the Caribbean region.

4.2. METHODS

In order to identify and evaluate the conflicts between people in relation to marine turtle conservation initiatives, a cross-sectional social survey was carried out (Lavrakas, 2008; Alonso *et al.*, 2017). The 66-question survey (Appendix 1) was designed and prepared in English, and then translated and delivered in Spanish and English to capture the two main languages of the Caribbean basin. The survey collected data in four sections: (a) general information about the respondents experience with the topic and their academic background; (b) identification of the potential conservation-based conflicts in the area where the respondent has experience; (c) evaluation of the severity of the conflicts they identify; (d) description of the potential solutions to minimise or eliminate the identified problems. The survey instrument included closed-ended, open-ended, likert scale, categories, and multi-choice questions. Hence the variables obtained were both qualitative and quantitative (Appendix 1). The survey was conducted between September and November 2016 (during 10 weeks).

For the section (b) of the survey, I proposed a list of fifteen potential conflicts based on conflicts commonly cited in the conservation literature. Then facilitate the analysis I coded them with a letter.

- 'Monitoring techniques differ within or across regions' (*"A"*);
- 'National Government initiatives and International Non-Government Organisation initiatives do not align' (*"B"*);
- 'Ecotourism or non-consumptive use of marine turtles and the legal consumptive use of marine turtles' (*"C"*);
- 'Conservation initiatives within a country or region and consumptive use occurs in countries elsewhere in the range of the species' (*"D"*),
- 'Lack of enforcement by local authorities to support conservation based legislation or programs' (*"E"*);
- 'Local community aspirations and National Government Initiatives do not align' (*"F"*);
- 'Legal Indigenous use and Western Conservation ideology' (*"G"*);
- 'Legal consumption of turtles by one sector of community clashing the conservation aspirations of other sectors of community' (*"H"*);
- 'Local community aspirations and International Non-Government Organisation conservation initiatives do not align' (*"I"*);
- 'Variable enforcement of legislation to limit/prohibit use across range states of the species' ("*J"*);
- 'Conflicts among environmental entities due to limited and often competition for funding' (*"K"*);
- 'Animal welfare interests and legal use of marine turtles' (*"L"*);
- 'Illegal use[12] and Western Conservation ideology' (*"M"*);
- "Stakeholders with different perspective towards non-consumptive use" (*"N"*);
- 'Unclear legal framework' (*"O"*);
- 'Other' (*Other1, Other2, Other3*… up to *Other8*) (*"P1; P2, P3…P8"*).

[12] "Illegal use and Western Conservation ideology" ('M'). This conflict occurs when illegal use of marine turtles is not regulated or prosecuted by authorities despite clear legal frameworks and this illegal use hinders conservation efforts by other sectors of the community.

Marine turtle experts were selected and invited by (1) using the contact list of the International Union for Conservation of Nature's (IUCN) Marine Turtle Specialist Group (MTSG), and (2) by using the contacts lists of the RedTMN (Network of Neotropical Marine Turtles, acronym in Spanish), and the c-turtle list-server. The contribution of the respondents was voluntary, and their anonymity was ensured. All respondents were involved with marine turtle conservation initiatives with at least one year (between 1 and 5) of direct experience working in the Caribbean basin (countries detailed – appendix 2).

Data obtained from the online survey were analysed using SPSS (V.22) for the numerical values (from the likert scale). The rest of the analysis was carried out using the qualitative analysis software NVIVO (V.22) to detect trends and significant differences in qualitative data related to respondents' opinions, perceptions, and attitudes towards the conservation conflicts related to marine turtle conservation programs in the Caribbean.

Finally, in order to identify the most important conflicts that are likely to impact the goals of marine turtle conservation programs in the Caribbean, I examined the responses which detail the degree to which each conflict hinders the goals of the conservation program. I used a scale of 1 (very low effect) to 5 (very high effect) (Appendix 1). To analyse the datasets, I used a Kruskal-Wallis H test to determine if there were differences in (a) the severity of the conflict and (b) the degree to which the conflict hinders success of the conservation program (1 to 5, from low to high) for each conflict categories. In addition, I ran a Somers' delta (Somer's d) test to examine whether a relationship exists between the severity of the conflict and the degree to which it is believed to hinder conservation success.

4.3. RESULTS

4.3.1. Participant attributes and trajectory within marine turtle conservation programs

Seventy-two complete responses were obtained, with a response rate of 29%. The interviewees (n= 72) represented: national and international NGOs (56%; n= 40); universities (21%; n= 15); government agencies (18%, n= 13), and others (5%, n= 4) (Figure 1). The respondents categorised themselves as being a ‘project leader’ (47%; n= 34), ‘researcher’ (28%, n= 20), ‘decision-maker’ (8%, n= 6), ‘volunteer’ (10%, n= 7), or ‘other’ (7%, n= 5). Most participants had 1 to 5 years (n= 18; 25%), 6 to 10 years (n= 17; 24%), then 11 and 15 years (22% n=16) of experience in working with marine turtle conservation projects or programs (Figure 4.1). The respondents represented 22 of the 39 countries/territories in the Caribbean basin (56% of the countries).

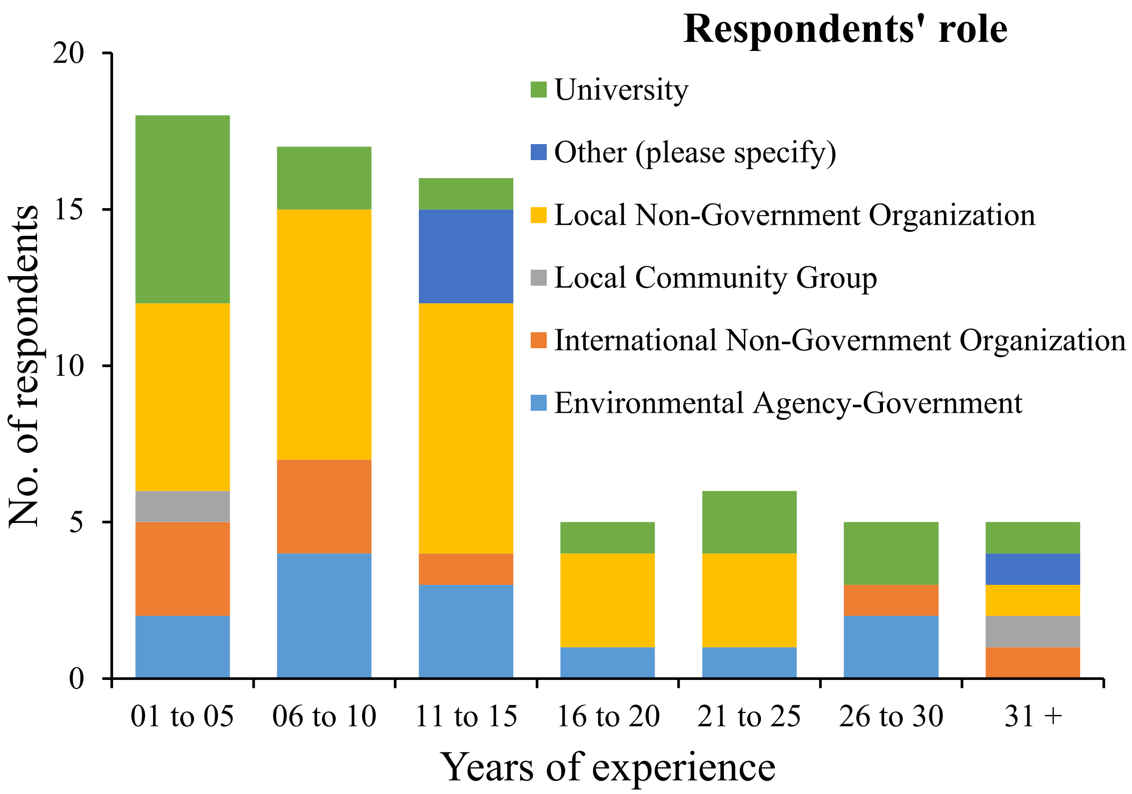


Figure 4.1 Respondents' role and their duration of experience with marine turtle conservation projects or programs in the Caribbean basin (n= 72).

4.3.2. Conservation conflicts findings:

Overall, of the 72 participants, all affirmed that there are conflicts occurring within his/her study area. Moreover, 52 of my respondents identified and provided further detailed information for the most important conflict they identified, and which is occurring or has occurred in the past 10 years – such as stakeholders involved, the severity and the degree to which the conflict hinders conservation. Some respondents provided details on one conflict, and others provided details on up to four different conflicts (Figure 4.2). Finally, the 52 detailed responses provided their perspectives about the causes of the identified conflicts and how these may be solved in the future (Figure 4.2).

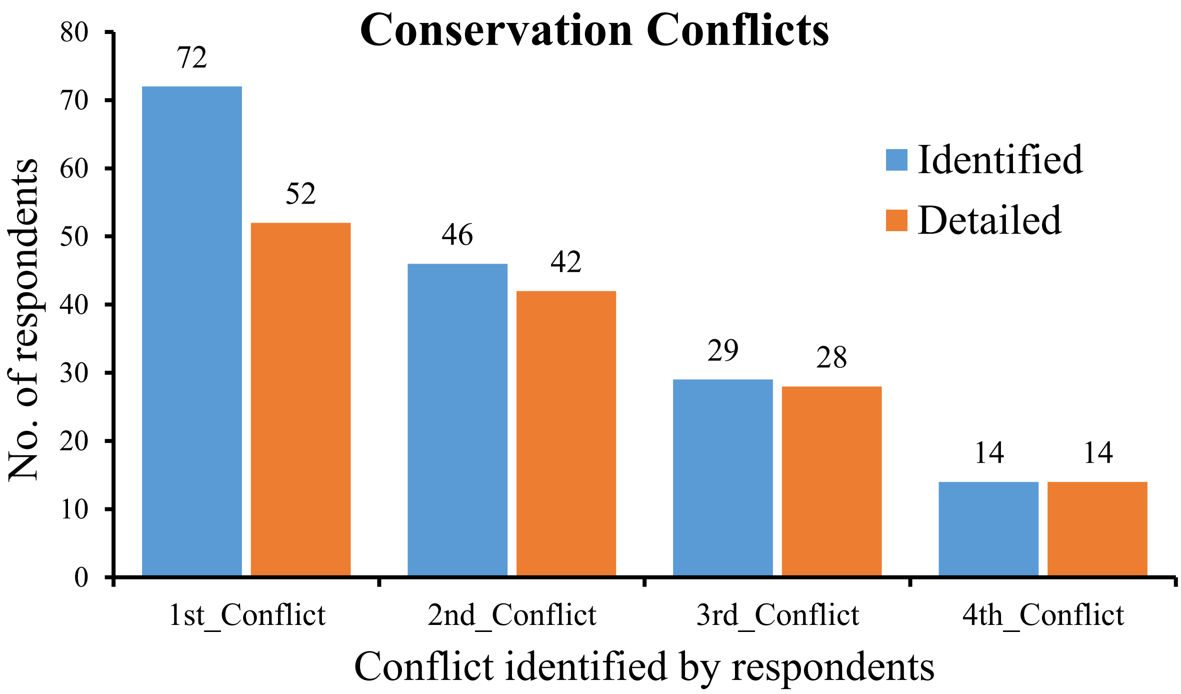


Figure 4.2 Frequency of (1) the number of conservation conflicts identified and (2) responses for which additional detail was provided for respondents 1st to 4th conflict they identified.

In total, respondents identified 161 human-derived conflicts in 16 categories (including 'other' as a different category), and each category was mentioned at least once by a respondent. Of the 161 conflicts, a total of 136 were coupled with additional details and the other 25 were identified as a type only. My data indicate that the most commonly mentioned conflicts arise from: 1) 'lack of enforcement by local authorities to support conservation based legislation or programs' (mentioned by 18% of respondents, E in Figure 4.3); 2) 'the legal consumption of turtles by one sector of community clashing with the conservation aspirations of other sectors of community' (14%, H in Figure 3); 3) 'variable enforcement of legislation to limit/prohibit use across range states of the species' (10%, J in Figure 3); and 4) 'illegal use occurs and clashes with western conservation ideology' (9%, L in Figure 3).

The conflicts, and the participant groups involved, varied among environmental entities, countries, and territories. In addition to the 15 conflict categories I highlighted in the survey there were eight new conflicts identified by respondents. The eight additional conflicts mentioned at least once were: (P1) a stolen project, where a local authority took over an established conservation program from a local NGO, (P2) conservation capacity becomes limited due to the elimination of the environment ministry in the country, (P3) the change of land tenure and use of the coastal areas important for nesting turtles without the alignment of policies among local, state and federal governments; (P4) illegal traffic of marine turtle products by people working in an environmental entity (government officers), (P5) illegal traffic of marine turtle by people working in an environmental NGO (local members of a NGO), (P6) lack of long-term evaluations of marine turtle populations to serve as a basis for directing priorities and activities, (P7) illegal inter- and intra- country drug trafficking within the region; and (P8) occasional presence of armed groups (either linked to crime or enforcement) being present along beaches that turtles use as nesting areas.

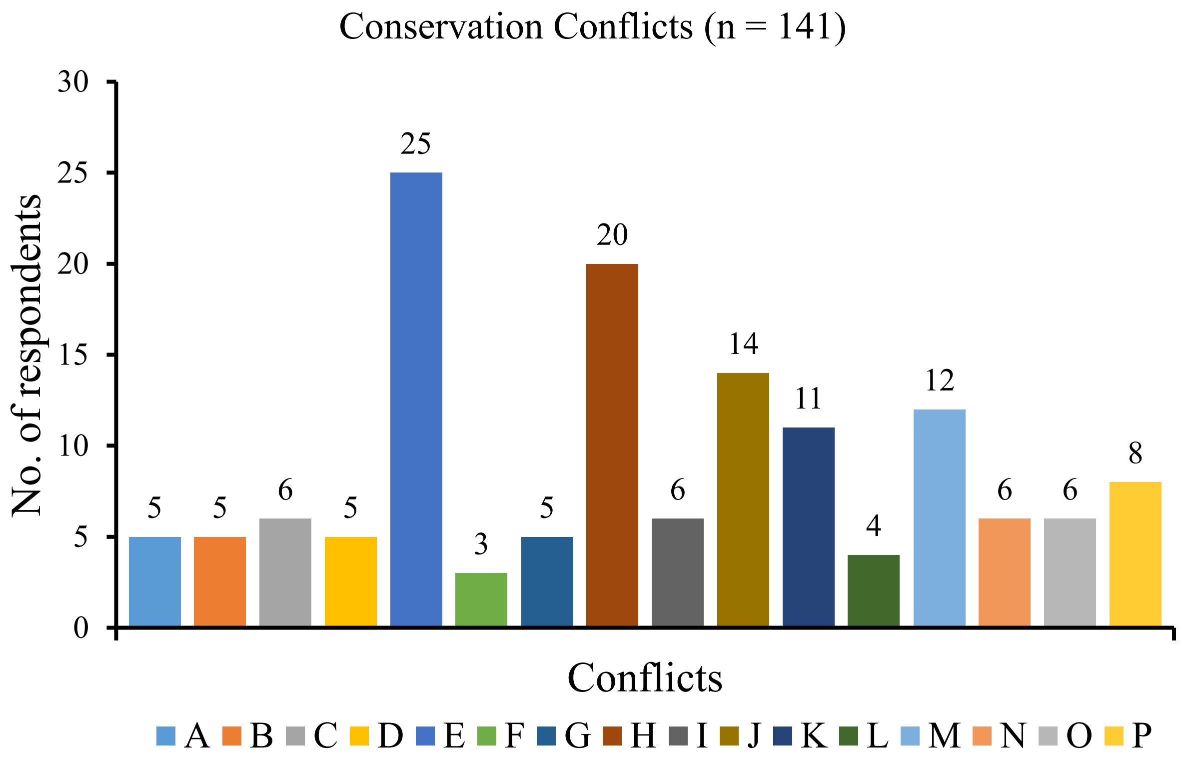


Figure 4.3 Frequency of the conflicts identified by respondents. The conflicts were coded as follow: 'Monitoring techniques differ within or across regions' (A); National government initiatives and international non-government organisation initiatives do not align (B); Ecotourism or non-consumptive use of marine turtles and the legal consumptive use of marine turtles (C); Conservation initiatives within a country or region and consumptive use occurs in countries elsewhere in the range of the species (D), Lack of enforcement by local authorities to support conservation based legislation or programs (E); Local community aspirations and National Government Initiatives do not align (F); Legal indigenous use and western conservation ideology (G); Legal consumption of turtles by one sector of community clashing the conservation aspirations of other sectors of community (H); Local community aspirations and International Non-Government Organisation conservation initiatives do not align (I); Variable enforcement of legislation to limit/prohibit use across range states of the species (J); Conflicts among environmental entities due to limited and often competition for funding (K); Animal welfare interests and legal use of marine turtles (L); Illegal use and western conservation ideology (M); Stakeholders with different perspective towards non-consumptive use (N); Unclear legal framework (O); 'Other' (P).

4.3.3. Severity of the conflicts previously identified

Distribution of severity scores among the fifteen main conflict categories (excluding "others" category) was not significantly different ($\chi2(13) = 13.627$, $p = 0.401$; Kruskal Wallis H test). However, I identified 27 cases among the 136 conflicts for which details were provided where conflicts have escalated to a level of physical violence. I regarded these as the 'most severe' conflicts, due to likely negative influence on marine turtle conservation and the people involved, and the challenging nature of solving them. Of the 'most severe' conflicts, six instances occurred within a single environmental group/organisation, seventeen occurred between two stakeholder groups, three were among three stakeholder groups, and three were among five groups of stakeholders (Figure 4.4).

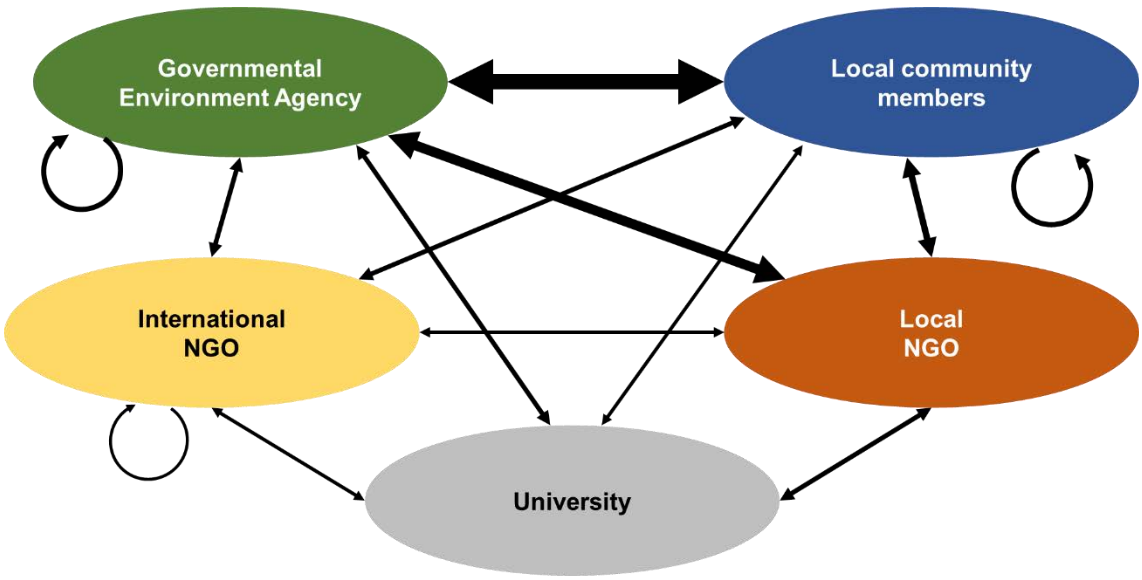


Figure 4.4 Diagram to synthesise the 'most severe' human-derived conservation conflicts described by my respondents in the Caribbean basin (n= 27). Arrow widths are proportional to the number of cases those groups of stakeholders were involved in the conflict according to my respondents.

4.3.4. Illegal activities occurrence and the presence of marine turtles

Illegal activities occurring in the region were also mentioned by my respondents, and illegal activities were central to some of the most severe conflicts. These illicit activities are prevalent in the countries of continental southern Caribbean and were mentioned in relation to smuggling of narcotics, illegal paramilitary presence, and the illegal traffic of bushmeat (including marine turtles). Of particular concern, the latter was mentioned by two respondents who described situations where members of environmental entities (a governmental authority, and a local NGO) have been involved in the illegal trafficking of marine turtle products (eggs and meat). No further details were provided by respondents.

4.3.5. Simple solutions for large problems

I compared the frequency of a conflict occurring (i.e. Figure 4.3) with the degree to which it is believed to hinder conservation success (Figure 4.5). The scores among the fifteen main conflict categories (excluding "others" category) were significantly different ($\chi 2(14) = 26.569$, $p = 0.022$; Kruskal Wallis H test). Four of the five most commonly cited conflicts are in the top five conflicts believed to have the highest negative influence on conservation. The addition to the top five is the inclusion of (I) conflict generated when local community aspirations and International Non-Government Organisation conservation initiatives do not align. This is believed to have a greater negative affect on conservation success than four of the top five most commonly cited conflicts. Also important in preventing conservation success is when conflict arises because the initiatives of national government and international non-government organisations do not align (A).

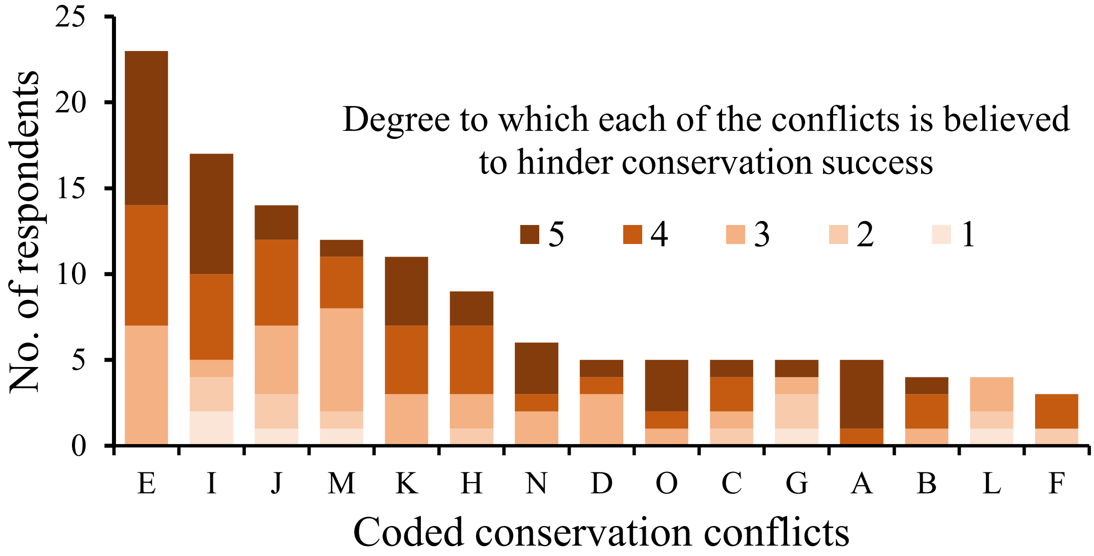


Figure 4.5 Accumulative frequency of how the conflicts identified are believed to hinder the goals of conservation program. The conflicts were coded as per Figure 4.3. Intensity of colours (from light brown, to dark brown) are reflected in the scale used of 1 for ‘very low effect’ to 5 for ‘very high effect’ (appendix 2).

4.3.6. Potential impact on conservation

There was a significant positive correlation between the degree to which respondents believed the conflict would affect marine turtle conservation and severity of the conflict (Figure 4.6) (d = .424, p < .0005; Somers’ d). More severe conflicts were believed to have a greater negative effect on conservation.

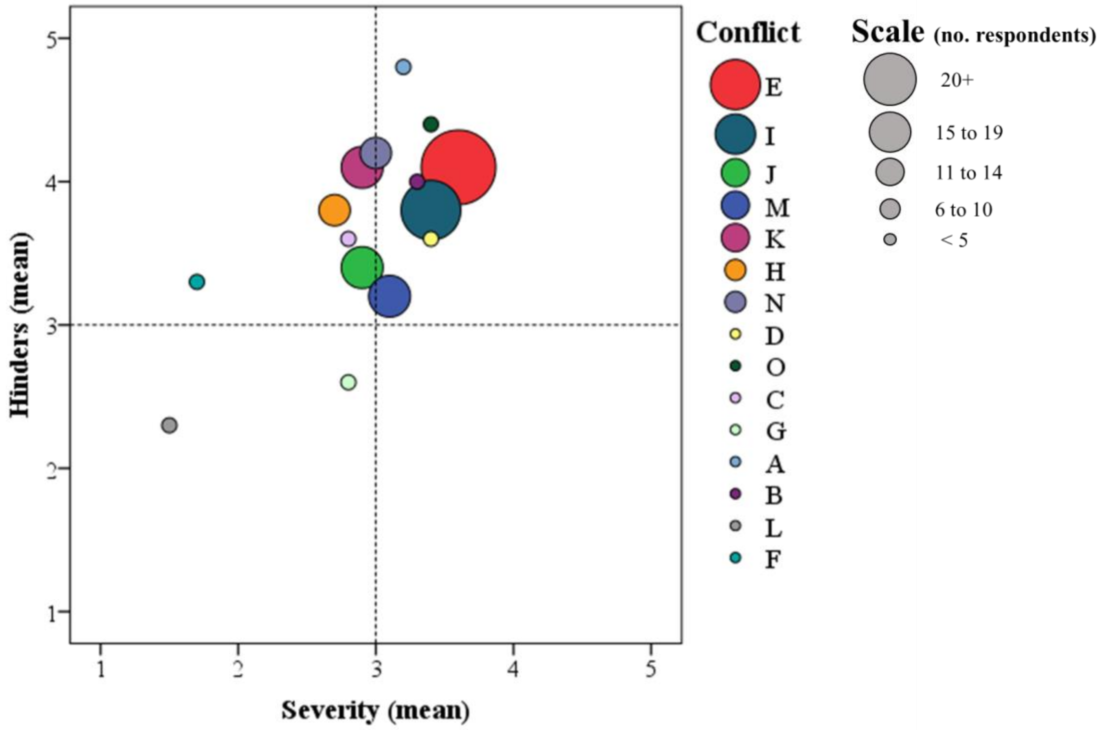


Figure 4.6 Scatter plot of the mean values for each conflict. The size of the circle corresponds to the number of respondents citing each conflict. The conflicts were coded as per Figure 4.3.

4.3.7. Potential solutions to minimise or eliminate the identified conflicts

Potential solutions and the possible roles of the stakeholders were provided by the participants. In total, I found 195 solutions and some conflicts require a multiple-solution approach (Figure 4.7). In addition, six respondents believed there are no solutions short and mid-term solutions because the conflicts are too pervasive. I grouped the suggested solutions into three categories: a) the need for environmental authorities (at local and national level) to become leading actors in conservation or direct conservation initiatives; b) the need to increase involvement and participation, of local community members and c) the need for national and regional scale workshops to develop capacity and knowledge for stakeholders (include research centres, universities, national and international NGO, and decision-maker entities).

The majority (n= 84; 43%) of responses about solutions highlighted the need for governments to play a key role, and the need for strong stakeholder partnerships to achieve effective marine turtle conservation (n=15; 8%). To accomplish these goals, some participants affirmed that government agencies needed to be more pro-active, supportive and develop trust-worthy attitudes with community people (n= 76; 39%) towards the conservation-based initiatives and non-government and community sectors. The other provided potential solutions highlighted the role of community members, academics, researchers, conservation actors, and volunteers (n= 20; 10%).

Figure 4.7 Word cloud produced after a content theme analysis of the potential solutions (n= 195) proposed by the respondents.

Most respondents (n= 77; 39%) identified a lack of collaboration among stakeholders within and between countries and suggest the development of initiatives to support and encourage active participation of government authorities with other groups. For example, below are some quotes from multiple respondents:

> "*Engagement with government authorities from the highest level down, to make them truly appreciate the value of marine turtles and to encourage active participation in enforcement initiatives, in collaboration with all key stakeholders*". R14

> "*Create networking among the environmental authorities, fishers' communities, tourism managers, and NGO's personnel, in order to improve the decision-making process in the national park".* R23

> *"Better education for the communities and better communication between the government and the people of the country".* R31

Along the responses it was possible to observe how the people commonly (n= 62; 32%) recommended an increase in the use, and participation, of local community members and a shift away from projects that are based on foreign volunteers or supported by foreign environmental agencies. This would require a paradigm shift in some programs, especially those using foreign donors or grants but respondents generally believed that creating networking groups of local people would help minimise conflict. It is very clear in the findings that a "top-down" combined with a "bottom-up approach is required to reduce main conflicts in the region for conservation efforts to succeed.

There were few solutions offered for mitigating the most severe conflicts (n=6; 3%). However, for some cases where the conflicts are generated by illegal activities. For instance, below are some quotes from different respondents:

> *"Better coordination among different administrations, and local people. Inclusive, increase the number and effectiveness of the checkpoint stations to minimise the smuggling of marine turtle products"*. R2

> *"Increase the resources dedicated to law enforcement, particularly in remote areas. Because illegal traffic of turtles is increasing"*. R8

> *"Involve local communities in the environmental activities, so encouraging conservation at local level. Then, generate alternative incomes (economic activities) that may supply the resources that nowadays are provided by smuggling marine turtle products"*. R10

Furthermore, respondents recurrently suggested (n= 57; 29%) the implementation of national and regional conservation workshops which include all the stakeholders. These could be used to (1) develop a respectful dialogue and also gain an understanding of shared conservation values, perspective and responsibilities. From identifying these shared areas, collaborative projects and activities could be developed for marine turtle conservation programs and (2) discuss collaborative relationships to aid with initiating economic livelihood alternatives of for current groups known to use marine turtles.

A commonly mentioned solution was to increase the level of collaboration between stakeholders (local, national, and regional level). For example, as best stated by one of my respondents '*…this conflict* [use] *requires strong international collaboration and changes to national legislation in some countries; this would need to be founded on information based on scientific study, to identify the impact of the continued take on the turtle populations in question. There would need to be a lot of effort put into engagement with local communities, and the development of possible strategies to provide economic alternatives to the use of marine turtles*'.

4.4. DISCUSSION

I documented the presence of conservation-conflicts in all of the countries represented by my respondents. Overall, the identified conflicts could be categorised into two types: I) practical problems, and II) dissimilar conservation values and attitudes between groups of humans (e.g. Table 4.1). The first type (I) occur where there is a lack of financial or capacity resources and/or support by the governments towards the conservation programs. The lack of resources was typically described by the participants as being human-based capacity (i.e. people trained and supported in roles related to monitoring and enforcement), as well as financial resources to increase the effort and presence of conservation participation. On the other hand, the second type of conflict (II), largely occurs when people from different groups or communities have differing perspectives or values towards marine turtles, such as their need for conservation, their value to people or their role in nature.

Table 4.1. Categories to identify the type of conflicts evaluated. Type I= practical problems, and Type II= dissimilar conservation values and attitudes between groups of people. The conflicts were coded as per Figure 4.3.

Conflict	Category (Practical – type I; or Values & Attitudes – type II)	Conflict	Category (Practical – type I; or Values & Attitudes – type II)
A	I	I	II
B	II	J	I
C	II	K	I
D	II	L	II
E	I	M	II
F	II	N	II
G	II	O	I
H	II		

The most commonly recorded conflict arose from situations where there is lack of enforcement by local authorities to support conservation based legislation or programs. This conflict was assigned as the conflict most likely to have a negative influence on marine turtle conservation.

Low levels of enforcement for pro-environmental legislation was recurrently suggested by my respondents. Hence, improving this will be necessary for achieving conservation's goals. One of the challenges, identified by seven respondents is that enforcement roles are often being conducted by people with no formal education or experience with environmental laws. Hence, solutions to these types of conflict will require increased resources to improve knowledge and capacity of enforcement officers. Plus, there needs to be greater clarity of the roles of various institutional agencies because inter-agency conflict is occurring. The result indicating that low levels of enforcement of environmental legislation has a negative impact on conservation is not new, but is certainly important, because it should be straightforward to solve. Respondents typically believed that responsibility for solutions resides with government environment-agencies and other stakeholders and one of the key mechanisms could be through increasing the developing education initiatives or courses aimed at government staff to improve their awareness of legislation, penalties and enforcement (Stringell *et al.*, 2015; Watson *et al.*, 2015). Strong enforcement was described by several authors as a key element for the conservation success (Keane *et al.*, 2008; Stringell *et al.*, 2015; Carter *et al.*, 2016) and there is evidence of conservation or law-enforcement based problems being solved by increased education and awareness campaigns and leading to conservation success (e.g. reductions in the amount of turtle shell products for sale in Vietnam (e. g. IOSEA, 2014; Migraine, 2015)).

Another source of conflict occurs in locations where the consumptive use of marine turtle is occurring in same/similar places as protective-based programs are conducted by other groups of people (Chapter 6 and 7). This clash tends to generate more severe conflicts because both groups of people are placing different, and conflicting values, on the turtles as a resource and deriving the benefits in conflicting ways; consumptive as a form of income or food, and non-consumptive use to attract tourists or as a bequest value. It is likely that marine turtle populations in the region are conservation dependent (NMFS & USFWS, 2007; Eckert *et al.*, 2012; Campbell, 2014; Seminoff *et al.*, 2015; Chapman & Seminoff, 2016), and the consequences of consumptive use generated conflict on community-based conservation are probably significant (my results). Being part of the same community, living in close proximity to each other, and having different values or beliefs towards conservation can increase the probability of more severe outcomes such as verbal or physical violence (Holmern *et al.*, 2007). In some cases, the differences were believed by my respondents to be irreconcilable due to the level of animosity and confrontation between community members. However, importantly, some of my respondents reported that in some locations, the groups, despite their different beliefs and values (Chapter 6), are also likely to share some values. It is these shared values or beliefs that could be used to find a middle group for the development of more cooperative conservation arrangements. Identification and agreement of local-scale solutions to common problems which would otherwise impact communities' livelihoods may help to bring together social groups or individuals and reconcile issues.

All of the fifteen potential conflicts I listed as options in the online survey were selected at least three times by my respondents. In addition, eight more were provided. Several cases reflect a multi-scale solution, where bottom-up actions and top-down changes need to co-occur, possibly as co-management, in the region to minimise the impact of take of marine turtles at local level having a negative impact on broader scale conservation. The need for greater levels of intra- or inter-country collaboration on conservation initiatives or legislation are well described, and are not limited to developing countries and nations, e.g. fisheries management and reporting de Carvalho *et al.* (2016); Riskas *et al.* (2016); Karr *et al.* (2017), who emphasised the need for agencies and institutions to collaborate to achieve universal solutions, such as Regional Fisheries Management Organisations (RFMOs).

Of the conflicts between stakeholders seventeen occurred between governmental environmental agencies and local community members. Previous authors found that when the circumstances of a conflict reach physical violence, the solutions are more challenging (and sometimes impossible) to be achieved (Greiner, 2012) – especially when they are based on differences in values and beliefs. Frequently, conservation practitioners make assumptions about the human attitudes and behaviour, based on their own experiences, but mediation involving all parties involved in the conflict are needed to rationalise the problem before trying to solve it (Dickman, 2010), then mutual cooperation may potentially lead resolutions. Mediation, focussing first on shared beliefs, may help in finding solutions between the stakeholders involved in a conflict. While the mediation may not resolve the problem quickly, it is useful in discovering the shared values and beliefs from which to base the future collaborative arrangement on. Adaptive management is a key component here because as trust is developed between groups, the conservation actions or activities can broaden in scale, and collaborative frameworks can be strengthened (Redpath *et al.*, 2013).

Overall, my results indicate that conflicts occur. They vary in nature and severity, but many of them are perceived to impede the success of marine turtle conservation programs. It is clear that (1) initiatives to improve the enforcement capacity of policy are essential in the Caribbean region, indeed some of the lack of capacity comes from lack of resources, so there needs to be more than new initiatives being discussed and implemented, and (2) there could be better integration of NGOs and government sector work within communities and community-based initiatives, these would likely build trust and enable more harmonious conservation initiatives. At a regional scale, understanding trade, including the impact of IUU fishing and other illegal activities on marine turtles are necessary, and involving Regional Fisheries Management Organisations (RFMOs). Resolving conflicts requires active participation of stakeholders in all phases of conservation – from designing projects, enforcing legislation and education and awareness. Similar findings were evaluated by Sterling *et al.* (2017), who assessed hundreds of conservation projects and found that the participation, especially at local level, is the key to improving the decision-making process and structure, leading to the development of successful conservation actions. Especially in developing nations or regions.

Chapter 5

HISTORICAL AND CURRENT STATUS OF MARINE TURTLES IN THE GULF OF VENEZUELA: THREATS AND TRENDS[1]

Hawksbill turtle rescued from the Gulf of Venezuela by the RAO-Zulia Network.

Photo credit: Héctor Barrios-Garrido (2011)

[1] Leatherback turtle's portion of the chapter was published in:
Barrios-Garrido, H., & Montiel-Villalobos, M. G. 2016. Strandings of Leatherback turtles (*Dermochelys coriacea*) along the western and southern coast of the Gulf of Venezuela. Herpetological Conservation and Biology, 11(1), 244-252.

ABSTRACT

Marine turtles face numerous threats throughout their life cycle. In the Gulf of Venezuela, the consumptive use of marine turtles is a serious threat frequently carried out by local inhabitants (mainly Wayuú indigenous people), despite its illegal nature. Also, there is extensive marine traffic in the region, mainly related to the petroleum industry. Importantly, the management of the environmental pressures affecting marine turtles in the region is hampered by a general lack of knowledge concerning marine turtle population biology and their habitat preferences. The aim of this chapter is to assess the historical and current demographical status of marine turtle stocks in the Gulf of Venezuela using multiple data sources. I gathered, compiled, and analysed different sources and database records of marine turtle strandings and tag-recapture data to perform a detailed evaluation of currently available marine turtle information, including size-class structures by species. Overall, my findings confirm that five species of marine turtle use the Gulf of Venezuela, and I provide baseline stranding trends for four of them (species-size structure). I evaluated 1,571 records of stranded marine turtles comprising of 82% green turtles, 8% hawksbill turtles, 5% leatherback turtles, 4% loggerhead turtles, and 1% olive ridley turtles. I found that 82% of the all turtles recorded as stranded were immature. The co-occurrence of multiple species and both immature and adult-size turtles indicates that the Gulf of Venezuela provides important habitat for year-round feeding and development.

Key Words: baseline data, management, strandings, Wayuú people, feeding grounds, size distribution.

5.1. INTRODUCTION

Venezuela's continental shelf provides foraging habitat for five species of marine turtle, and four of these species also use Venezuelan beaches as breeding sites (Guada & Vera, 1995; Guada & Sole, 2000). Venezuela is located in the equatorial region of the Caribbean, the shallow bathymetry in the Gulf of Venezuela (Figure 5.1), in the north-western region of the country, offers sufficient resources to support foraging marine turtle populations all year-round (Parra, 2002; Montiel-Villalobos & Barrios-Garrido, 2008; Montiel-Villalobos *et al.*, 2010). In particular, extensive seagrass meadows create a habitat for multiple populations of green turtles (Parra, 2002; Montiel-Villalobos, 2012); and various authors have indicated that the Gulf of Venezuela is one of the most important feeding areas in the Caribbean for green turtles, along with Miskitos Cays, the Bahamas, Barbados, Bonaire, North Carolina (USA), Cuba, and Puerto Rico (USA) (Carr *et al.*, 1982; Campbell & Lagueux, 2005; Becking *et al.*, 2016). In addition, the area is likely to support regionally valuable habitats for the other species of marine turtles from the Caribbean and Atlantic Ocean populations (Wildermann & Barrios-Garrido, 2012; Rojas-Cañizales, 2015; Barrios-Garrido & Montiel-Villalobos, 2016; Barrios-Garrido *et al.*, 2016b).

Unfortunately, marine turtles in Venezuela face many threats (Guada & Sole, 2000). Venezuela is recognised as one of the world's largest oil producing nations (Reynolds, 2014). One consequence of this is high shipping intensity, and the waters of Venezuela contain some of the busiest commercial maritime transport routes in the southern Caribbean. The Venezuelan national economy is based on petroleum, and it is thus tied to the variability in the international price of petroleum (Banco Central de Venezuela, 2014, 2016; Schenk *et al.*, 2017). The nation's annual budget varies across years and is calculated according to the projected prices of the petroleum for the next year, as a consequence of variation in national and internal economy, there are regions of Venezuela with high economic support and development, and other areas of the nation that are economically depressed. In poorer regions of the country, bushmeat consumption and illegal trafficking of wildlife species are key threats to the environment (Rodríguez, 2000; Sánchez-Mercado *et al.*, 2016; Barrios-Garrido *et al.*, 2017b) (Chapter 6), and limit the effectiveness of conservation strategies carried out by the national government (Buitrago *et al.*, 2008).

Close to 70% of Venezuela's oil production is extracted from Maracaibo Lake and then shipped through the Gulf of Venezuela (Schenk *et al.*, 2017). Consequently, thousands of commercial vessels use the coastal waters of the Gulf each month (Schenk *et al.*, 2017). Associated with this high shipping pressure are significant risks of petroleum spills (Figure 5.1) (Guada & Sole, 2000). For example in 1997, a tanker dropped 25,000 barrels of petroleum in the coastal waters of the Gulf of Venezuela causing the likely extinction of 28 species of invertebrates, with incalculable consequences to the broader environment and ecosystem (Severeyn *et al.*, 2003). However, no evaluation of the spill's impact on megavertebrates was done, essentially because no baseline information existed to allow an informed comparison of conditions.

Expansions of the petroleum industry have been recognised and planned for the country. In 2008, as part of a public document published with the endorsement of the Venezuelan Oil Company (Petróleos de Venezuela, S.A. – PDVSA), Klein and Ramos prepared an estimate of a 165,000 km^2 area within the Gulf of Venezuela with potential for hydrocarbon extraction (e.g. gas, oil) (Klein, 2008) (Figure 5.1). If undertaken, it would place the Gulf of Venezuela as the marine area with the greatest projected exploitation area for oil and gas in the country.

Given the importance of the Gulf of Venezuela for marine turtles and other marine life the expansion of the petroleum extraction and transport could cause problems. However, as noted in the Sea Turtle Recovery Action Plan (STRAP) for Venezuela, the increase in shipping, anchoring, destruction of benthic habitats, and discharge of waste (associated with the oil and gas exploitation) and their potential impact on the populations of marine turtles in Venezuela remains un-evaluated. Hence, potential impacts of any future resource extraction need to be subjected to risk assessments before they are given permission to proceed (Guada & Sole, 2000).

Furthermore, the frontier region of Venezuela and Colombia's Guajira is the ancestral territory of the Wayuú people, who have traditionally carried out the exchange of products between both countries (Robles, 2008; Delgado Rodríguez, 2012) (Chapter 6). Artisanal fisheries carried out by Wayuú indigenous people in the north-western region of the Gulf of Venezuela target marine turtles for traditional and commercial use, and approximately 3,600 green turtles have been taken annually from the "Zone of Major Extraction" (ZME) (Montiel-Villalobos, 2012); an area covering 397 km^2 of coast adjacent to the Guajira Peninsula (Figure 5.1). Also, the Wayuú indigenous people still participate in cultural rituals using marine turtles, such as pharmacopoeia (Guerra Curvelo, 2011; Chacín, 2016; Noguera Saavedra, 2016) (Chapter 7), and because of poor economic conditions in this region, they have developed a commercial economy with turtle products being sold between communities (Chapter 6). Marine turtles and marine turtle products are also illegally traded between people in Colombia and Venezuela (Rueda-Almonacid *et al.*, 1992).

In summary, the environmental values of the Gulf of Venezuela are under pressure from multiple activities (Figure 5.1) associated with the discovery, extraction and transport of petroleum based resources, as well as broader regional pressure such as consumptive use. The northern area of the Gulf of Venezuela is an area with high artisanal fisheries pressure and likely to be an area of high turtle use (Parra, 2002; Montiel-Villalobos, 2012; Rojas-Cañizales, 2015). As such this region may act as a "sink" for turtle populations, because there is a commercial artisanal fishery based on the use of marine turtles, which is conducted to for both cultural and subsistence purposes.

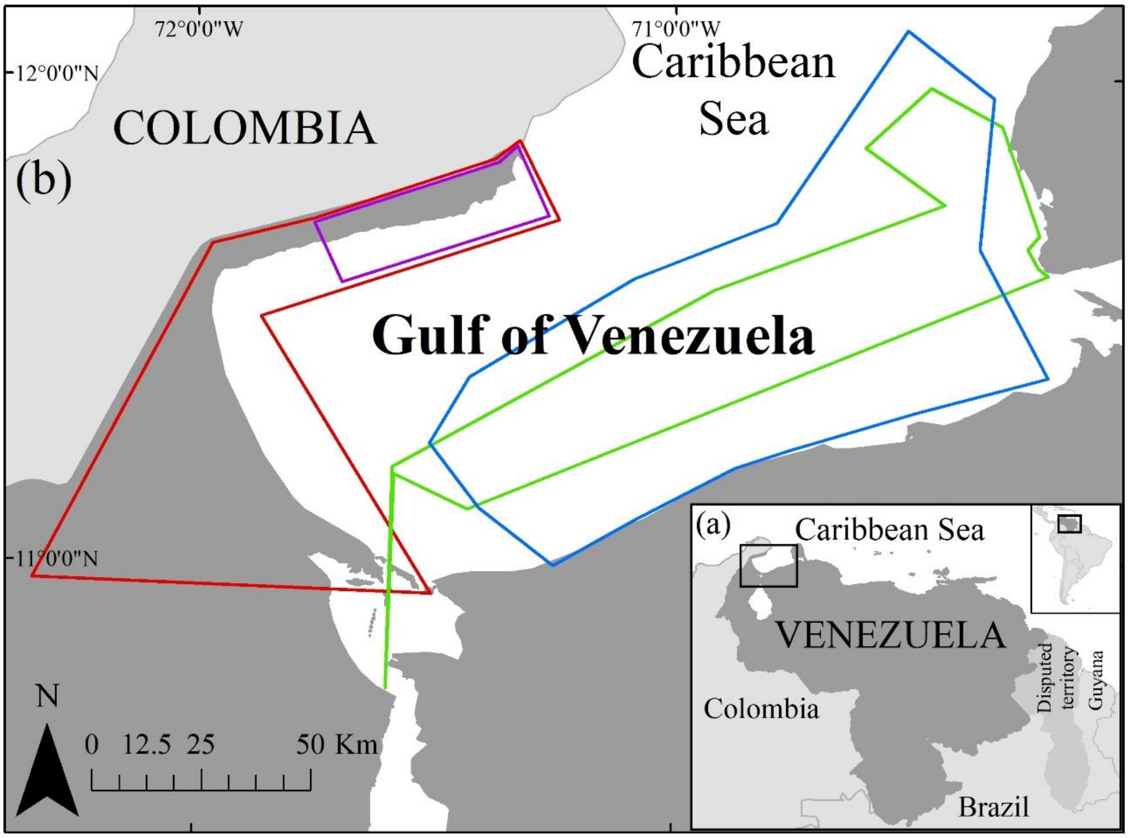


Figure 5.1 The Gulf of Venezuela and its threats and hazards areas. (a) Geographical location of the study area (dark rectangle) within Venezuela, showing the study area and its relative position within South America. (b) coast of the Gulf of Venezuela. Purple polygon: The "Zone of Major Extraction" (ZME) (Montiel-Villalobos, 2012), red polygon: The area where the illegal trade of marine turtle products has been reported (Chapter 6), blue polygon: The area determined to have gas and oil extraction potential (Klein & Ramos, 2008), and green polygon: The area of concentrated commercial marine traffic (tankers, tugs) (based on Schenk *et al.* (2017) and extracted from: www.marinetraffic.com).

Management of the environmental pressures in this region is hampered by a general lack of knowledge concerning marine turtle population biology and their habitat preferences. A systematic approach to quantify status and condition of marine turtle species in the area is needed. Hence, the aim of this chapter is to evaluate and summarise available data on marine turtles in the Gulf of Venezuela to: (a) provide a baseline of turtle strandings (frequency, sizes, temporal and spatial patterns); (b) deliver data on patterns of human use, (c) evaluate the causes of stranded animals in relation to human or non-human interaction (incidental or intentional), (d) understand the geographic origins of marine turtles recaptured in the area (national and international findings).

5.2. METHODS

5.2.1. Study area and species:

My study area covered a 160 km stretch of coastline along the north-western and southern Gulf of Venezuela – between Quisiro beach (Miranda Municipality) and Castilletes beach (Guajira Municipality) (Figure 5.2). I collected data on five species of marine turtles.

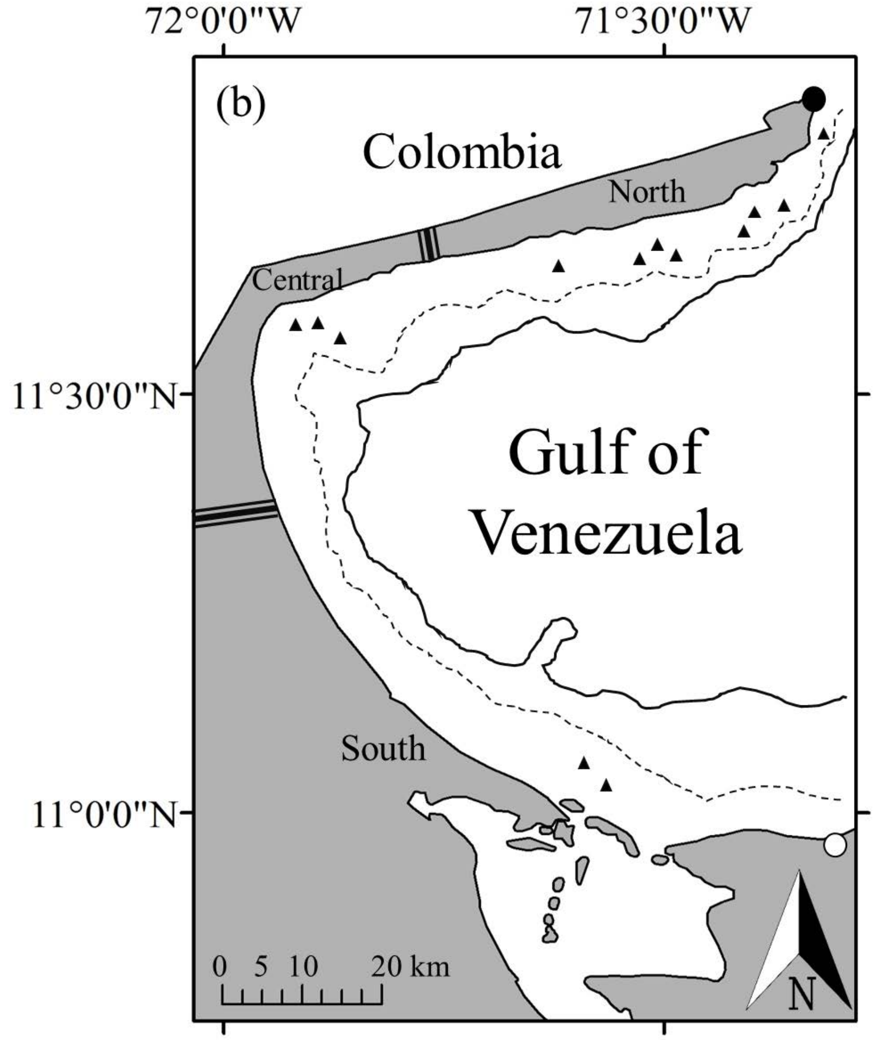


Figure 5.2 Study area. (b) Triple lines separate the regions of Upper Guajira (North), Middle Guajira (Central), and Low Guajira (South). Lines within the Gulf indicate water depths of 10 m (dashed) and 15 m (continuous), black triangles indicate areas containing year-round artisanal fishing nets. Black dot (●) indicates Castilletes Beach, and white dot (○) indicates Quisiro Beach.

5.2.2. Acquisition and preparation of data

5.2.2.1. Type and frequency of surveys for marine turtle stranding events

Following previous authors, I define a stranding as an event in which a marine turtle, which is not ashore for nesting nor hatchlings, is found dead or alive on the beach as a result of either natural causes or human impacts, such as fishery activities, boat strike, or plastic ingestion (Vélez-Rubio *et al.*, 2013; Lopes-Souza *et al.*, 2015). Stranding events which occurred in the study region between 1987 and 2017 (June) were compiled from records produced using four different methods (Barrios-Garrido & Montiel-Villalobos, 2016) as follows:

(1) *Scientific patrols*, where a biologist with expertise in marine turtle identification and biology surveyed (at least 40 of 160 km of the study area) for stranded turtles every 1 to 3 months between March 1998 and June 2004, and once a month between July 2005 and September 2007, using either a 4×4 vehicle or walking patrols (Barrios-Garrido & Montiel-Villalobos, 2016).

(2) *Community surveys conducted by the Opportune Information Network* (in Spanish, 'Red de Aviso Oportuno', RAO). RAO community members trained in techniques to search and document stranded turtles, conducted surveys every 2–4 weeks by foot from January 2005 to January 2007 (Vernet & Gómez, 2007).

(3) *Surveys by the Marine Turtle Working Group in the Gulf of Venezuela* (in Spanish, 'Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela', GTTM-GV), a non-governmental organisation, carried out walking patrols

opportunistically in the southern region of the Gulf of Venezuela at least once every two months between 2000 and 2017 (June) (Barrios-Garrido & Montiel-Villalobos, 2016).

(4) *Compiled data of strandings* from: National reports (Sideregts *et al.*, 1987; Acuña *et al.*, 1989), thesis manuscripts (Parra, 2002; Barrios-Garrido, 2003; Montiel-Villalobos, 2012; Rojas-Cañizales, 2015), and internal reports presented at scientific events (Montilla & Hernandez, 2005; Rincón *et al.*, 2010; Valero-Jiménez *et al.*, 2010) (See details in Table 5.1).

In order to avoid duplicate records of stranding events by the different approaches all stranded turtles recorded in each of the survey methods were marked with white paint or with a notch on the carapace edge (on dead stranded turtles), this protocol has been used by the GTTM-GV since 2001 (Barrios-Garrido & Montiel-Villalobos, 2016), and then carcasses or disarticulated bones were either moved to locations behind the first beach dune or buried off-site after evaluation. Every stranding record was registered in a central database.

During all the surveys, and following the protocol proposed by Vernet and Gómez (2007), when animals were found stranded in artisanal port areas, informal interviews were carried out with local residents to investigate when the animal washed ashore (dead or alive) or if it was captured deliberately. If there was no sign of fishery interaction or other obvious cause of death, or if the carcass was in an advanced stage of decomposition, the cause of death was categorised as unknown. Interviews were also used to identified and designate a “month” of stranding for when surveys were conducted less frequently than monthly.

5.2.3. Geographic distribution of strandings

To evaluate the geographical distribution of the strandings, I used the same categories as Montiel-Villalobos and Barrios-Garrido (2008) and Barrios-Garrido and Montiel-Villalobos (2016) to differentiate geographic areas (Figure 2). The north section (Upper Guajira) was located between Castilletes (11.8483° N; 71.3238° W) and Cojoro Creek (11.6319° N; 71.8458° W); central (Middle Guajira) was from Cojoro Creek to Caño Sagua (11.3827° N; 71.9488° W); and the south section (Low Guajira) was from Paraguaipoa Beach (11.3750° N, 71.9455° W) to Quisiro Beach (10.9772° N; 71.2661° W).

Table 5.1 Details about the bibliographic sources of strandings data compiled: Type of document, period of study, number and nature of turtles recorded, the survey area covered in the source, and my role in these investigations.

<table>
<tr><th>Source</th><th>Period of study</th><th colspan="2">Number and nature of records</th><th>References</th><th>Area surveyed - coastline</th><th>HBG's role in the research</th></tr>
<tr><td>National reports</td><td>1986-1987</td><td colspan="2">92 carapaces of C. mydas reported</td><td>Sideregts et al. (1987); Acuña et al. (1989)</td><td>160 km</td><td>Reviewed the literature</td></tr>
<tr><td rowspan="7">Theses</td><td>1998-2000</td><td colspan="2">227 records across all species. 127 of C. mydas. Only carapaces were recorded</td><td>Parra (2002)</td><td>160 km</td><td>Research assistant</td></tr>
<tr><td>2000-2003</td><td colspan="2">117 records of C. mydas, 39 of them with CCL data. 1 alive individual was recorded</td><td>Barrios-Garrido (2003)</td><td>160 km</td><td>Honours thesis author</td></tr>
<tr><td>2004-2007</td><td colspan="2">303 records of C. mydas. 81 of them with CCL data. Both alive and dead animals were recorded</td><td>Montiel-Villalobos (2012)</td><td>50 km From Cuzia to Castilletes</td><td>Research assistant</td></tr>
<tr><td rowspan="4">2013</td><td>154 records of C. mydas</td><td rowspan="4">Total: 167 dead animals</td><td rowspan="4">Rojas-Cañizales (2015)</td><td rowspan="4">5.23 km (Middle Guajira)

Only Kazuzain</td><td rowspan="4">Honours thesis supervisor</td></tr>
<tr><td>3 records of E. imbricata</td></tr>
<tr><td>9 records from of C. caretta</td></tr>
<tr><td>1 record from only D. coriacea</td></tr>
<tr><td rowspan="2">Conference papers</td><td>2004</td><td colspan="2">3 records of L. olivacea</td><td>Montilla and Hernandez (2005)</td><td>One port, Porshoure (Upper Guajira)</td><td>Reviewed the literature</td></tr>
<tr><td>2008-2010</td><td colspan="2">209 records of C. mydas. Only intervals of 10cm (bins) of CCL were reported.</td><td>Rincón et al. (2010)</td><td>160 kms</td><td>Supervisor of the project</td></tr>
</table>

	2003-2008	49 records of dead *E. imbricata*		Valero-Jiménez *et al.* (2010)	50 kms From Cuzia to Castilletes	
	2012-2013	27 records of dead *D. coriacea*		Vásquez *et al.* (2013)	110 kms Central and South sections	
Published articles	2010	1 record of *L. olivacea*		Wildermann and Barrios-Garrido (2012)	One port, Porshoure (Upper Guajira)	Co-researcher
	2001-2007	47 (of dead *D. coriacea*)		Barrios-Garrido and Montiel-Villalobos (2016)	160 kms	Principal researcher
	1992	1 (*D. coriacea*)		Acuña and Toledo Agüero (1994)	One port, Toas Island (Lower Guajira)	Reviewed the literature
	1994-1995	3 (*D. coriacea*) 1 (*E. imbricata*) 1 (*C. mydas*) 1 (*L. olivacea*)		Aguilera and Acuña (1996)	110 kms Central and South sections	Reviewed the literature
GTTM-GV database	2008-June-2017	227 (*C. mydas*) with CCL data, and 113 without.	411 animals, 73% alive (RAO-network)	This research	160 kms	PhD Thesis (Main researcher)
		28 (*E. imbricata*)				
		31 (*C. caretta*)				
		8 (*D. coriacea*)				
		4 (*L. olivacea*)				

5.2.4. Stranding evaluation

During each survey, the location of each stranded turtle was recorded using a handheld GPS. Then the species, size, weight, and age class of the animals were determined. Age class was categorised as immature, adult-sized, or adult (adult status was only confirmed if the animal was reported to have been nesting or if gonads were examined). Measurements of curved carapace length (CCL) and curved carapace width (CCW) were only obtained if the whole carapace was found. Both were measured using a flexible tape (± 0.2 cm). CCL was measured following Bolten (1999) for the cheloniidae individuals, and Steyermark *et al.* (1996) for leatherback turtles. CCW measurements were taken across the widest section of the carapace from opposing sides of the lateral ridges for leatherbacks (Steyermark *et al.*, 1996), and from marginal scutes for cheloniidae specimens (Limpus, 2009). Weight was recorded in kilograms and only collected when the whole turtle was found (categories 0, 1 or 2: see below for explanation of categories).

The distinction between immature and adult sized turtles was based on their CCL and followed the categories used by Bjorndal and Bolten (1988) for *C. mydas* (<94.9cm for immature, and >95cm CCL for adults), Moncada *et al.* (1999) for *E. imbricata* (<79.9cm for immature, and >80cm for adults), Dodd Jr (1988) for *C. caretta* (<69.9cm for immature, and > 70cm for adults), Eckert (2002b) and Stewart *et al.* (2007) for *D. coriacea* (<144.9cm for immature, and >145cm for adults), and Reichart (1993) for *L. olivacea* (<54.9cm for immature, and >55cm for adults).

The state of the animal was scored following the criteria of Limpus *et al.* (2012); Vélez-Rubio *et al.* (2013); and Barrios-Garrido and Montiel-Villalobos (2016). The categories were:

0 - alive; 1 - alive, but subsequently died; 2 - dead, carcass fresh; 3 - dead, carcass fair; decomposing but internal organs intact; 4 - dead, carcass poor; advanced decomposition state; 5 - dead, mummified carcass with skin holding bones together; and 6 - dead, disarticulated bones.

Seventy-four green turtles which were categorised as 0 or 1 were weighed and measured to calculate their body condition index (BCI). The BCI was calculated by first transforming CCL to straight carapace length (SCL) using SCL= -1.358 + 1.002 * (CCL) as per Lagueux (1998), and second by using (BCI= [body mass/SCL^3]*10^4) as per Bjorndal *et al.* (2000a) and Thomson *et al.* (2009). Animals were classed as ‘good condition’ if BCI> 1.10, ‘fair condition’ if BCI was between 1.09-1.00, or ‘poor condition’ if BCI values< 1.00 as per Limpus *et al.* (2012). Then I evaluated if there were significant differences in the frequencies of appearance of the different categories of BCI by regions within the study area using a Chi-square test (SPSS Statistics V.22) (Field, 2013), and 95% CI.

For all dead animals, the cause of death was categorised following Koch *et al.* (2006). Each stranding was classed as either an interaction with human activities (including signs of fishery interaction), a result of a natural event (such as a shark attack or disease) or of unknown cause. Interaction with human activities was inferred if the carcass (a) showed signs of being entangled in fishing gear or had fresh evidence of injuries (cuts or abrasions) consistent with fishing gear interaction (gillnet fishing, hooks, longlines, fishing lines, and/or other fishing gear; Figures 5.3a, 5.3b), (b) showed evidence of vessel strike (propeller cuts; Figure 5.3c), (c) exhibited evidence of knife marks (Figure 5.3d), or if either (d) living animals were found tethered to an artisanal fishing boat or anchored with a fishing buoy awaiting slaughter (Figure 5.3e), or (e) ‘rescued turtles’ living animals found ashore or in villages that would be killed without the intervention of the person conducting the survey (Figure 5.3f).

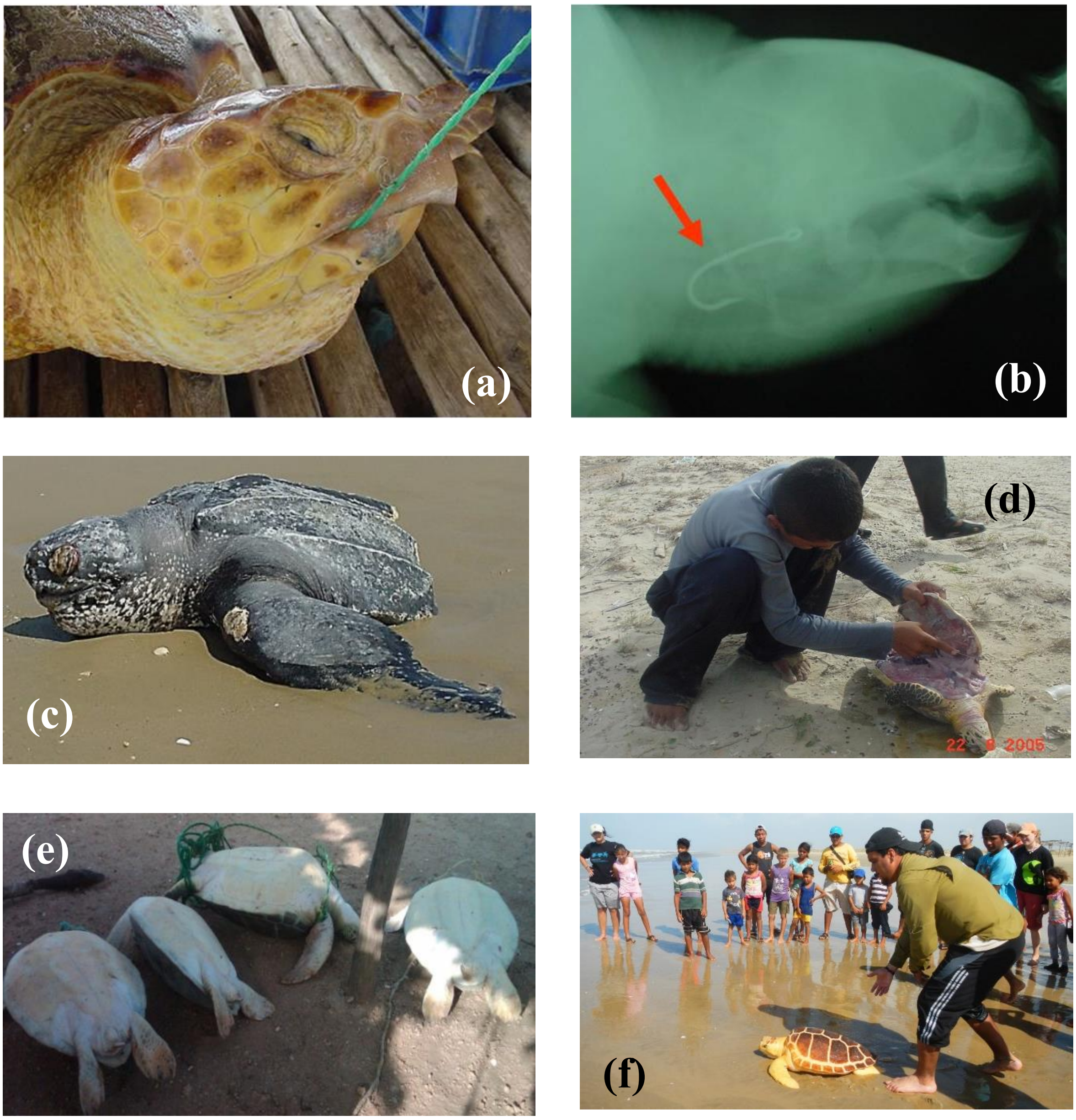


Figure 5.3 Stranded marine turtles in the Gulf of Venezuela with evidence of interaction with human impacts. (a) loggerhead turtle killed by interaction with fishing activity; (b) alive loggerhead turtle that was rescued with X-Ray evidence of a J-5 hook (red arrow) inside the oesophagus; (c) boat strike to a leatherback turtle; (d) butchered immature hawksbill turtle; (e) green turtles in an artisanal port ready to be sold in the local market; (f) live immature loggerhead turtle that would have been killed without the intervention of the conservation project in the Gulf of Venezuela.

5.2.5. Geographic origins of marine turtles recaptured in the Gulf of Venezuela (Tag return data)

Tagging of marine turtles at sites in the Caribbean began in the 1950s (Troëng *et al.*, 2005). Programs initially focussed on nesting green turtles but expanded to other species and to foraging sites. During surveys conducted between 1998 and June 2017, all stranded turtles were checked to see if they had flipper tags. The tag numbers and return address details of all flipper tags found were recorded, and the details of the event shared with the individual or group who conducted the initial tagging. However, in the majority of cases the tags were reported by fishers with no other data provided other than date (usually month and/or year) of capture. In the study area, a tagging program was implemented in Aug 2000 by the local NGO 'Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)'. The group permitted access to their database for the purposes of this chapter. Monel flipper tags, model 1005-681 (National Band), with the code "V-XXXX" were registered as a recapture from the current study area (Gulf of Venezuela), as were tags coded "P-XXXX", between P-2216 and P-2299, which allowed further details related to the animal to be compiled (date first tagged, location it was first tagged, and recapture locality) (Figure 5.4). The condition of the animal (alive or dead) was also recorded.

The above data was supplemented with records of tags which were recovered from turtles caught or stranded in the Gulf of Venezuela between 1960 and 2017 obtained from the Archie Carr Centre (ACC) database (Gainesville, Florida, USA shared by Dr. Peter Eliazar and Dr. Karen A. Bjorndal). These were generally tags found and reported by fishers or other third parties. I merged the ACC and the GTTM-GV database and removed the duplicate records of tag numbers from turtles caught within the broader Gulf of Venezuela region.

Figure 5.4 A loggerhead turtle tagged by the GTTM-GV at Caimare Chico beach (Middle Guajira) in 2011 before its release into the Gulf of Venezuela.

5.2.6. Rescued, tagged and re-released turtles

Although in the Gulf of Venezuela, the release of accidentally caught turtles has occurred since 1992 (Acuña & Toledo Agüero, 1994; Aguilera & Acuña, 1996), such events are now considered rare as most turtles are consumed (Barrios-Garrido & Montiel-Villalobos, 2010a). Occasionally, following the 'Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela' (GTTM-GV)'s incentives program (implemented since 2000), the Wayuú clan leaders of some communities would agree to release captured turtles. Before such turtles were released (Figure 5.3f), they would be tagged on the trailing edge of both front flippers with Monel tags (model 1005-681, National Band) (e.g. Figure 5.4). All turtle tags were registered in the database of the NGO GTTM-GV, as part of a collaborative program among environmental entities in the Zulia state ('Red de Varamientos del Estado Zulia' – Zulia state, stranding network).

5.3. RESULTS

5.3.1. Stranding records, species, and age groups

Overall there were 1,725 stranded marine turtles reported in the study region between 1987 and June 2017. This was comprised of 1,440 (82%) green turtles, 132 (8%) hawksbill turtles, 84 (5%) leatherback turtles, 61 (4%) loggerhead turtles, and 8 (1%) olive ridley turtles (Figure 5.5).

Of the stranding records that could be classified into a life stage, 82%, across four species, were categorised as immature. The exception was *L. olivacea*, where five of eight records were categorised as adult-sized (and the remaining three were not categorised). Due to the low numbers of olive ridleys – these turtles were not considered in any further analysis.

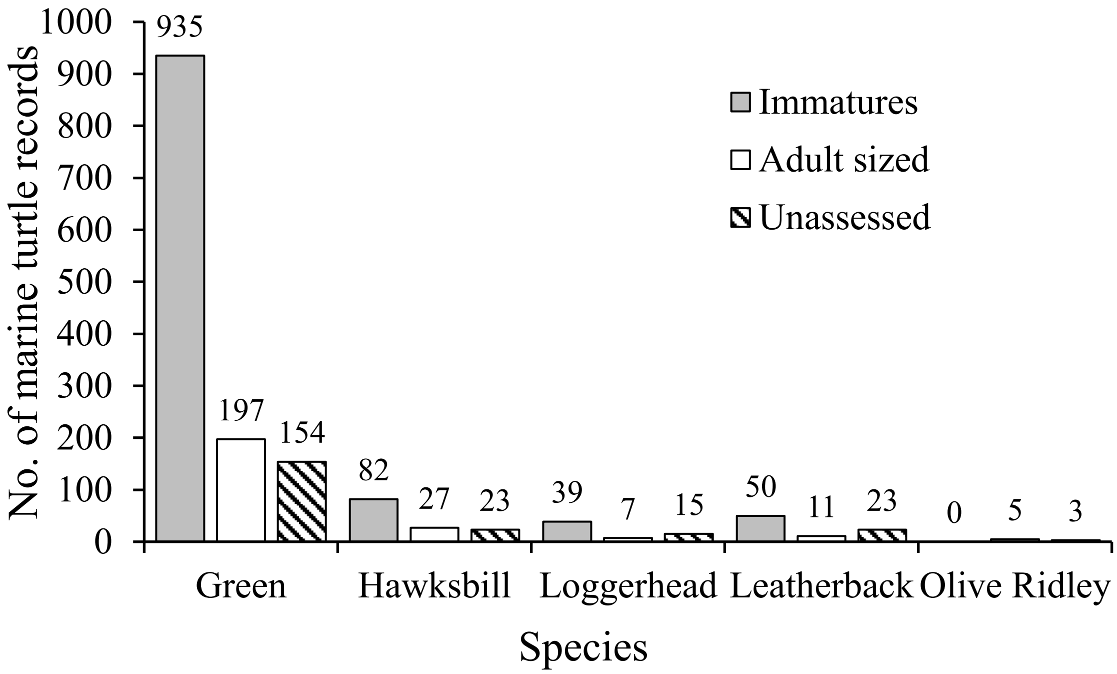


Figure 5.5 Frequency of strandings by species and size (immatures, adult-sized, and unassessed).

5.3.2. Spatial distribution among marine turtle species

Green, leatherback, hawksbill and loggerhead turtles were stranded or captured in each of the three sections of the study region, and olive ridley turtles were only recorded stranding in two regions (upper and lower Guajira) (Figure 5.6). There were small differences in the relative frequency with which different species were recorded across the three regions. Interestingly, green turtles were the predominant species recorded in the Upper and Mid, but there were higher proportions of loggerheads and leatherbacks found in the Lower region.

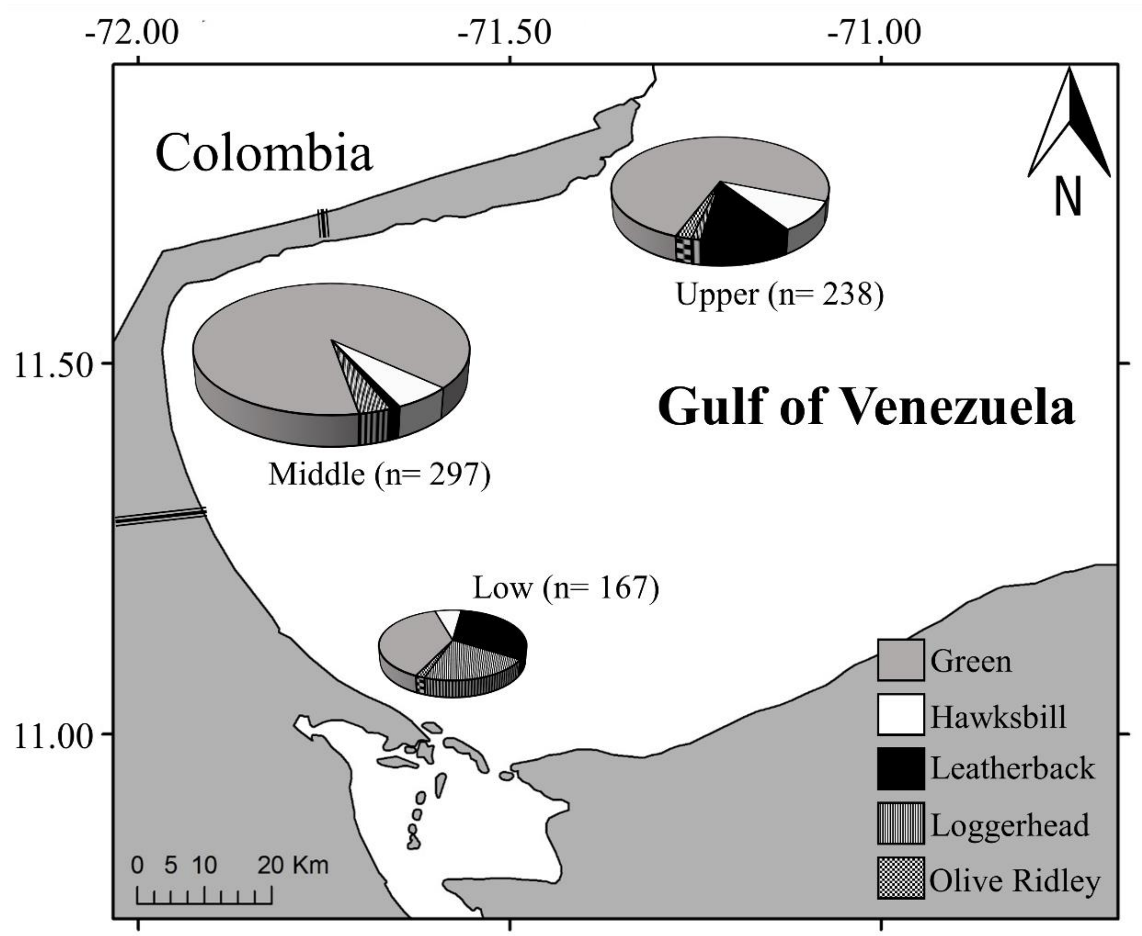


Figure 5.6 Distribution of marine turtle species found stranded in the three sections of the study area. Triple lines demark areas: Upper Guajira, Middle Guajira, and Low Guajira (See methods). Circle size represents the proportion of the total records by section.

5.3.3. Marine turtle species: key findings

5.3.3.1. Green turtle – *Chelonia mydas*

Of the 1,440 green turtle records, 1,089 (76%) were immature, 197 (14%) were considered to be adult-sized (Figure 5.7), and 154 (10%) could not be classified as either immature or adult-sized due to their stage of deterioration. Most of these latter records were comprised of pieces of carapaces, carapaces without peripheral plates, incomplete plastrons, or skulls, for which species identification was possible, but no further classification. The CCL measure of stranding was known for 595 of the 1,440 green turtle records. Of total green turtle records 845 had CCL reported to 10 cm bins in bibliographic sources. I assumed turtles in CCL bins <95cm to be immature, and >95cm as adult-sized animals.

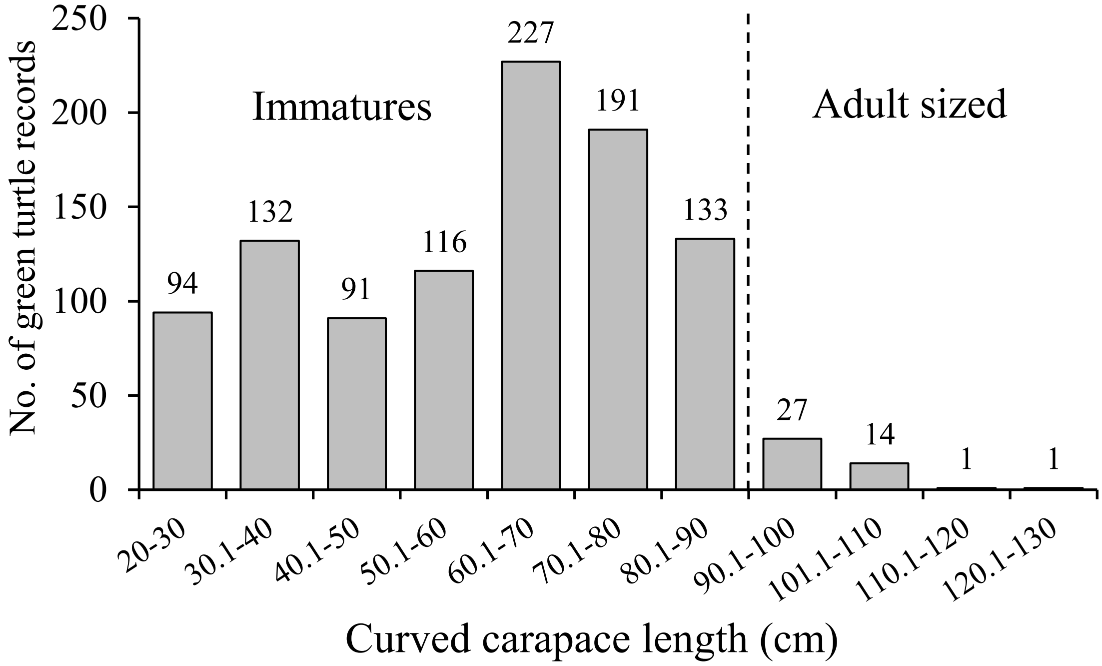


Figure 5.7 Size frequency distribution of the curved carapace length (CCL, cm) of green turtles (*Chelonia mydas*) recorded in the Gulf of Venezuela during the study. Dashed line represents the minimum size (95 cm) reported for adult females, within the southern Caribbean and north-western Atlantic Regional Management Units (RMUs) (Bjorndal & Bolten, 1988).

The size (curved carapace length – CCL) of the stranded green turtles ranged from 20.1 to 122.2 cm (mean = 58.3 ± 22.6 cm, n= 595). More than two-thirds of the green turtles registered during this study were immature-sized individuals (76%). On the other hand, 14% of the individuals (n= 197) were categorised as adult-size (>95 cm CCL) (Figure 5.7). Turtle weights ranged between 0.7 and 50 kg (mean= 5.8 ± 8.1 kg; n= 75). Seventy-six green turtles were weighed and measured. There was a positive relationship between curved carapace length (cm) and body mass in the immature green turtles (Body mass (kg) = 0.0183*(CCL)^2 - 0.9301*(CCL) + 14.238; R^2 = 0.9811) (Figure 5.8) and there were not enough adults weighed to calculate the relationship for adult-sized turtles. Using the BCI, 59 of 76 (78%) on immature animals, those found in categories 0 or 1, most were found to be in good condition, 4 in fair, and 13 in poor condition (Figure 5.9). Also, no statistically significant differences were found in body condition index (BCI) values between the three geographic areas ($\chi2(3)$=0,824; p=0,844); (mean= 1.117; SD= 0.33; range= 0.29 – 2.34).

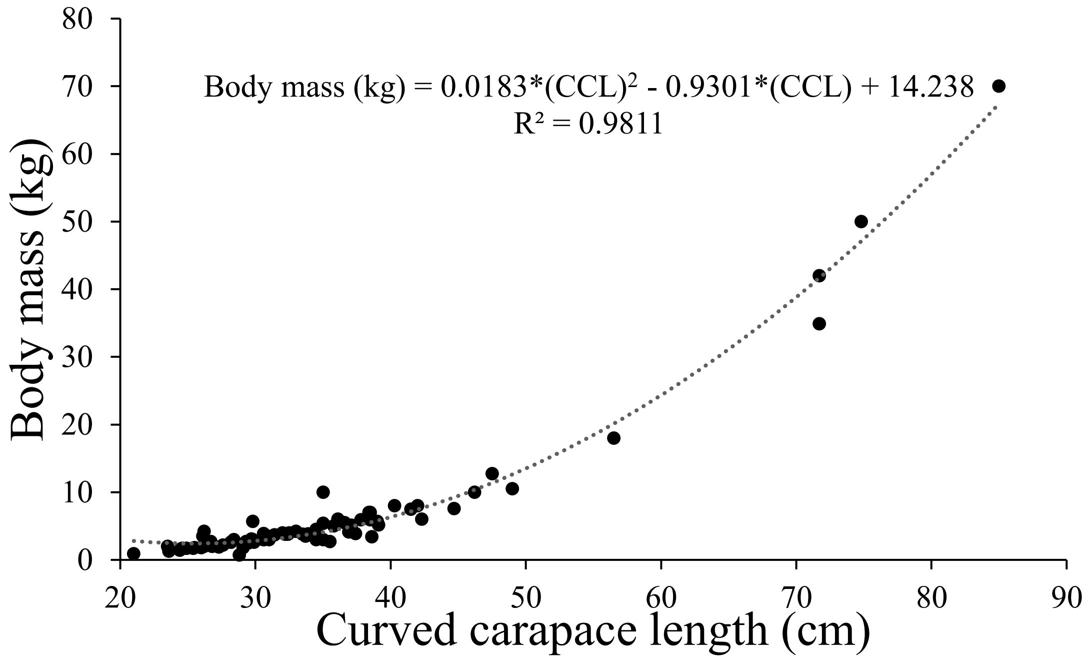


Figure 5.8 Relationship between curved carapace length (CCL) and body mass (kg) of green turtles in the Gulf of Venezuela which were weighed and measured (n= 76 of the turtles).

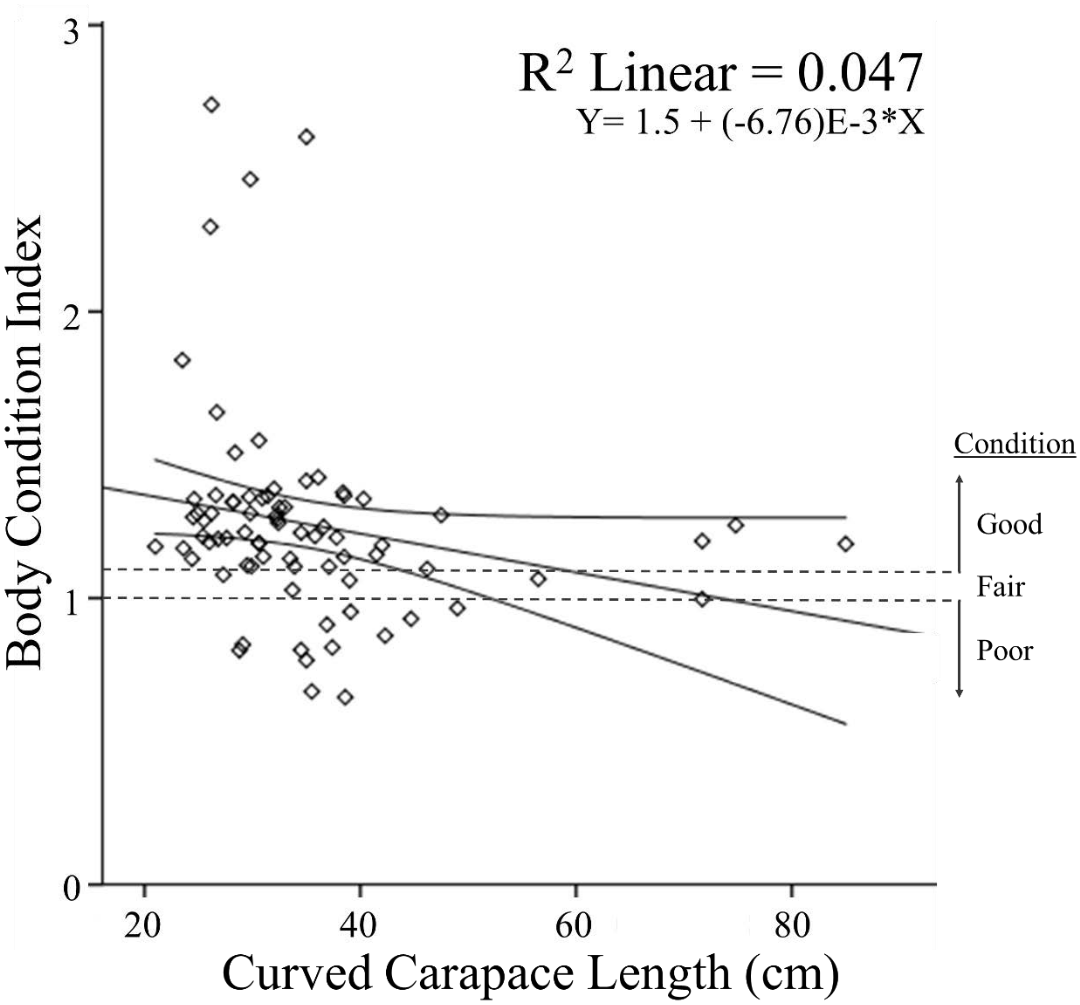


Figure 5.9 Body Condition Index (BCI) for 76 individual green turtles in the Gulf of Venezuela.

The correlation between curved carapace length (CCL) and curved carapace width (CCW) was $y = 0.9049x - 1.1241$; $R^2 = 0.98414$, indicating the relationship between these two morphometric parameters is isometric.

5.3.3.1.1. Seasonality of green turtles in the Gulf of Venezuela

The month of stranding was known for 394 of the 1,440 stranded green turtles. The data indicated that there is a year-round presence of green turtles in the study area (Figure 5.10). Peaks of stranding frequency roughly coincide with the peaks in local precipitation – generally between July and October, and April and May because during those periods the winds are generally calmer and fishers are able to increase their effort.

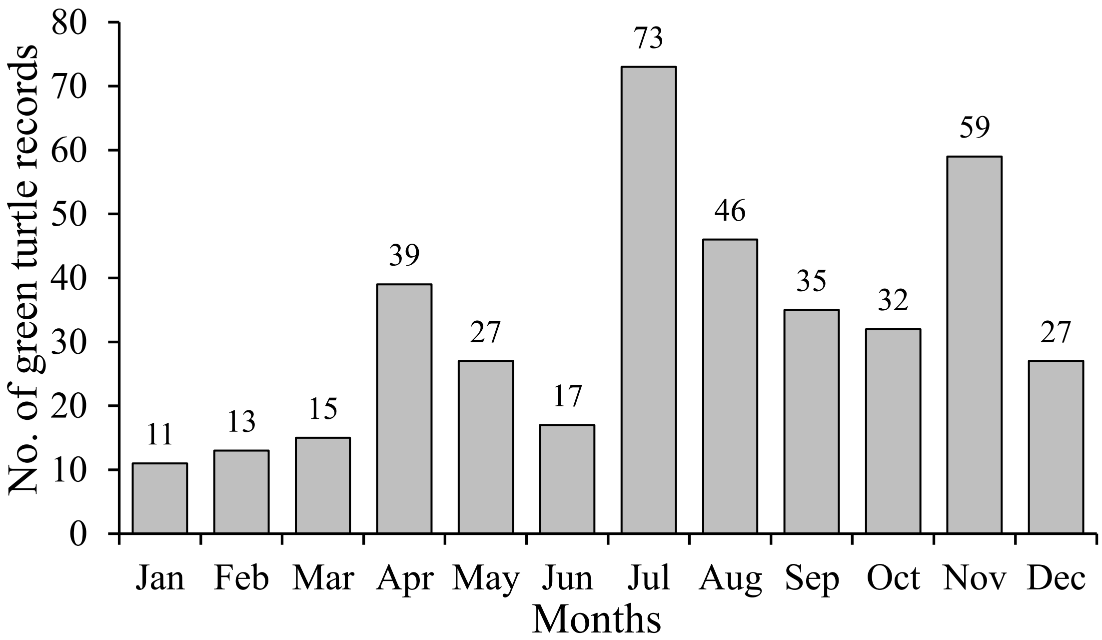


Figure 5.10 Records of green turtle stranding events registered by months in the study area (n= 394).

When the CCL data were analysed across time (Figure 5.11a-e) (n= 1027), there was a shift in the modal of size of CCL recorded between 1986 and 2017 (see methods) and a decline in the proportion of records for larger sized turtles after 2007.

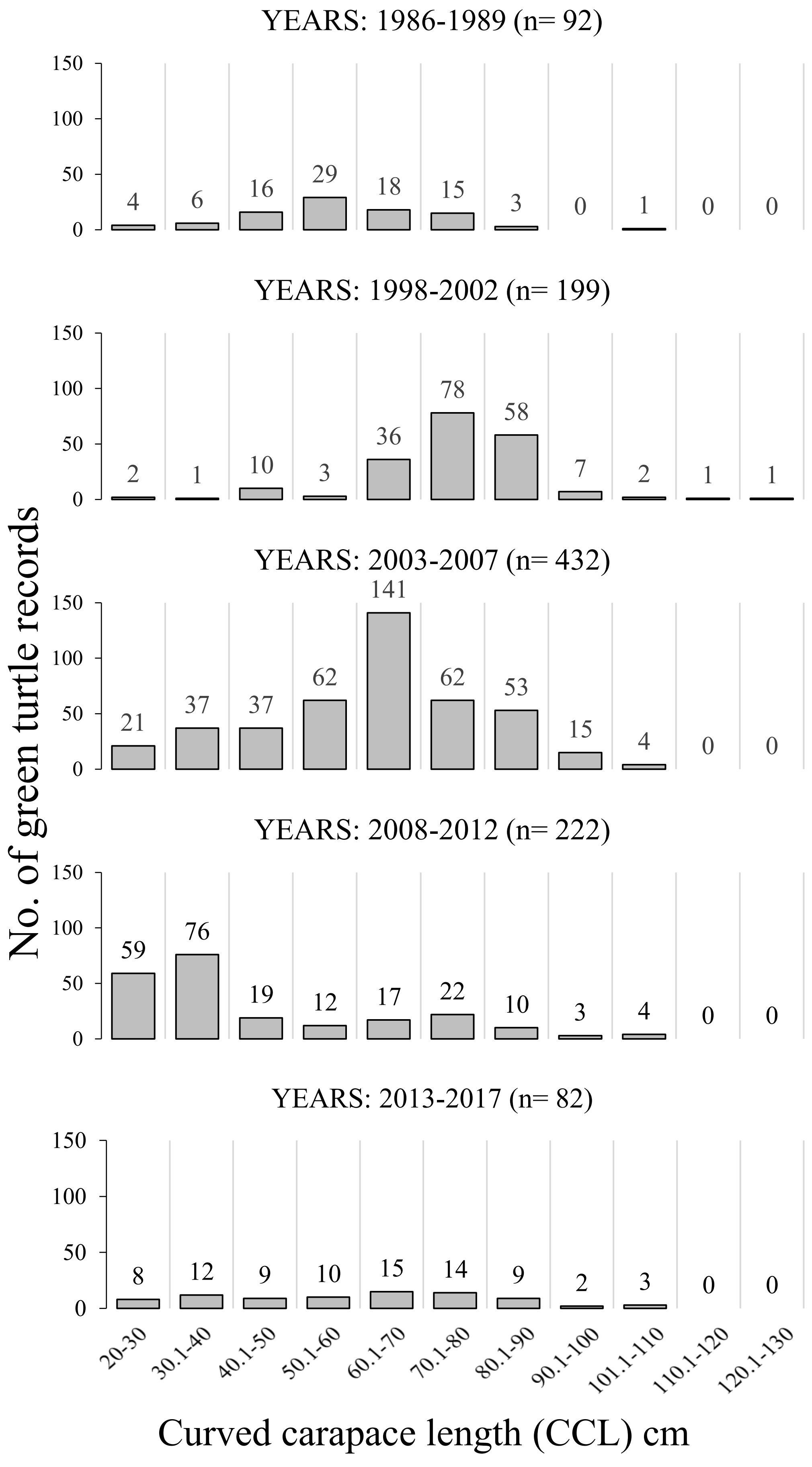


Figure 5.11 Curved carapace length (CCL) of all stranded green turtles (*Chelonia mydas*) during different time periods (a-e) (n= 1027).

5.3.3.1.2. Geographic distribution of green turtles – habitat drivers

The region of stranding green turtles was known for 509 of the 1,440 stranded animals. Green turtle stranding records were more frequent in the middle Guajira (266/509), than in the upper region (179 of 509), or the southern region of the Gulf of Venezuela (64 of 509) ($X^2(2)$ = 121.01, p< 0.0005; Chi-squared test; Figure 5.12). There were also significant differences in the distribution of their size classes, in general, larger animals were more likely to be found in the upper region of the Gulf of Venezuela than in the other two regions ($F_{(2,506)}$= 28.869, p= .001; One-way ANOVA).

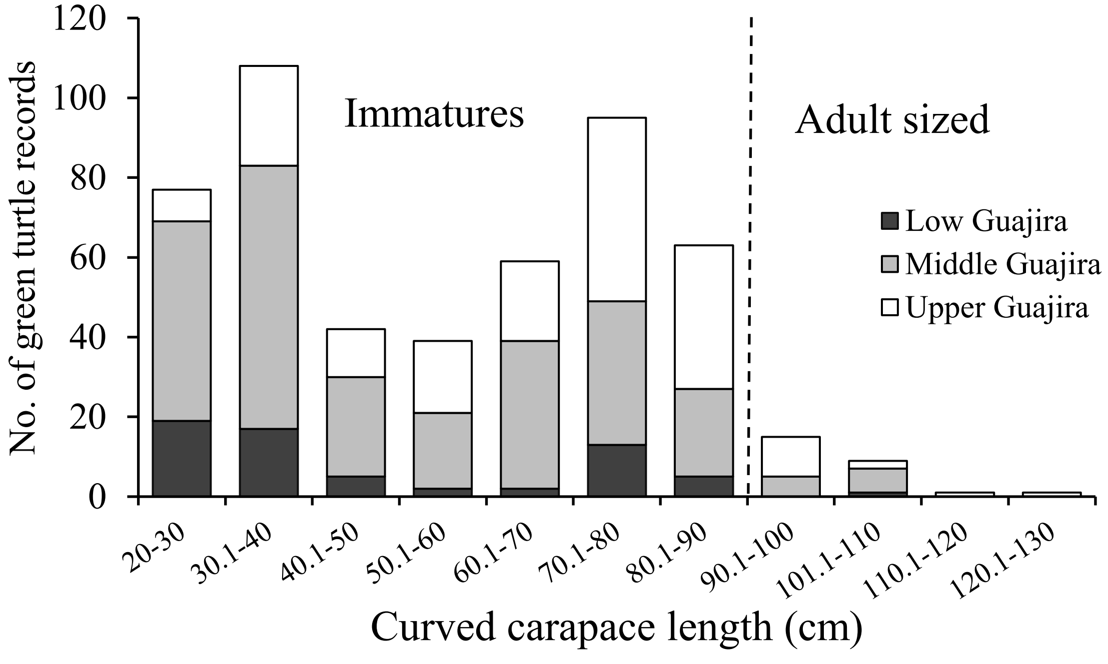


Figure 5.12 Size class frequency distribution of stranded green turtles among the three different regions within the Gulf of Venezuela (n= 509). Dark colour represents records from the lower Guajira, grey colour shows the records from middle Guajira, and white colour represents the records from the upper Guajira. Dashed line represents the minimum size reported for adult females, within the southern Caribbean and north-western Atlantic Regional Management Units (RMUs) (Bjorndal & Bolten, 1988).

Of the 1286 stranded green turtles that were classified as either immature or adult-sized animals, most (67%, n= 858) could not be linked to a cause of death or stranding. Of the total, 32% (n= 419) were likely caused by interactions with human activities and 1% (9) records resulted from natural mortality (critical fibropapillomatosis, coccidiosis, or shark predation).

5.3.3.2. Hawksbill turtle – *Eretmochelys imbricata*

132 stranded hawksbill turtles were recorded in the study area. Hawksbill turtles were recorded in each month of the year, and were registered in all three regions of the study area. However, the presence of three individuals (smaller than 11 cm CCL) from the southern region (Low Guajira) is interesting because this represents a size class not often seen in the Caribbean and may be related to the use of small mesh and artisanal trawling by the fisheries that caught the animals. Of the 132 records, 82 were categorised as immature (62%), 27 were classed as adults (20%), and the remainder were not assessed (n= 23; 17%) (Figure 5.5 and 5.13). The CCL ranged between 8.3 and 84.5 cm (mean= 48.3 cm; SD= 20.3; n= 52). Weights were collected from 12 turtles and ranged from 0.65 to 49 kg (mean= 9.07; SD= 13.24). There was a positive relationship between the CCL and the body mass in hawksbills that were both weighed and measured (Body mass (kg) = $0.0169*(CCL)^2 - 0.7253*(CCL) + 6.9564$; ($R^2$= 0.9239) (Figure 5.14). There was also a positive relationship between the CCL and the CCW (R^2 = 0.9872). The correlation between curved carapace length (CCL) and curved carapace width (CCW) was $y = 0.8731x - 0.2682$; (R^2 = 0.9872) indicating the relationship between these two morphometric parameters is isometric (n= 49). Because only a small number of turtles were weighed and measured, the body condition index was not

evaluated for this species. My data indicate that the recruitment size for *E. imbricata* in the study area was around 20 cm CCL, however the records of three individuals <11 cm in CCL may indicate the presence of post-hatchling animals within the GV.

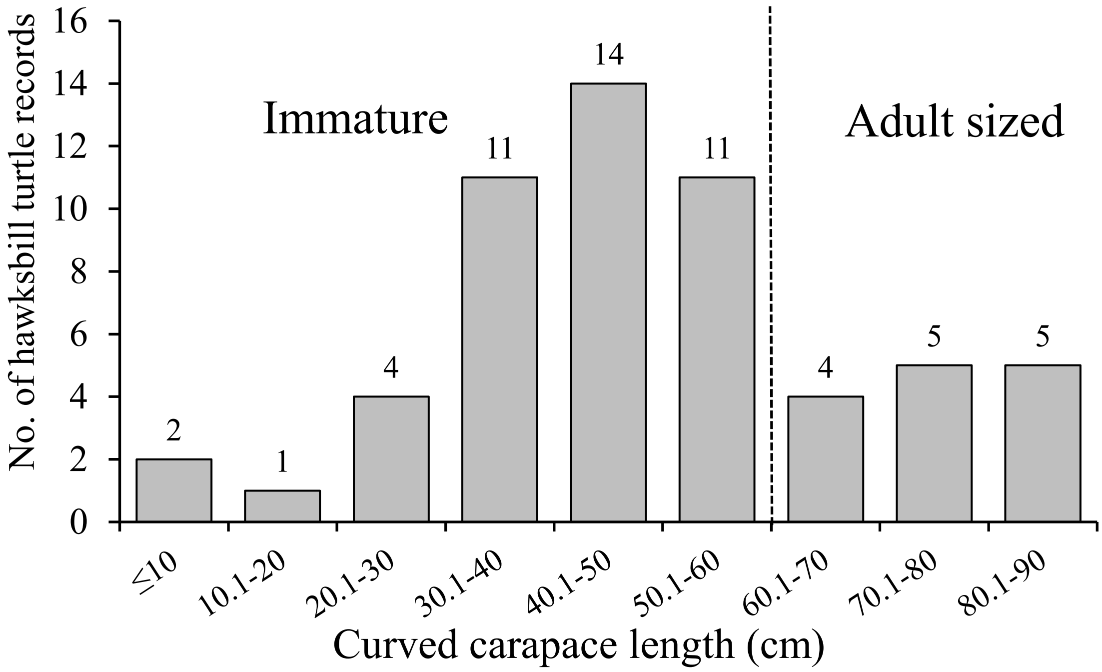


Figure 5.13 Size frequency distribution of the curved carapace length (CCL) of hawksbill turtles (*Eretmochelys imbricata*) recorded in the Gulf of Venezuela during the study. Dashed line represents the minimum size (60 cm) reported for adult females, within the western Atlantic Regional Management Unit (RMU) (Moncada *et al.*, 1999).

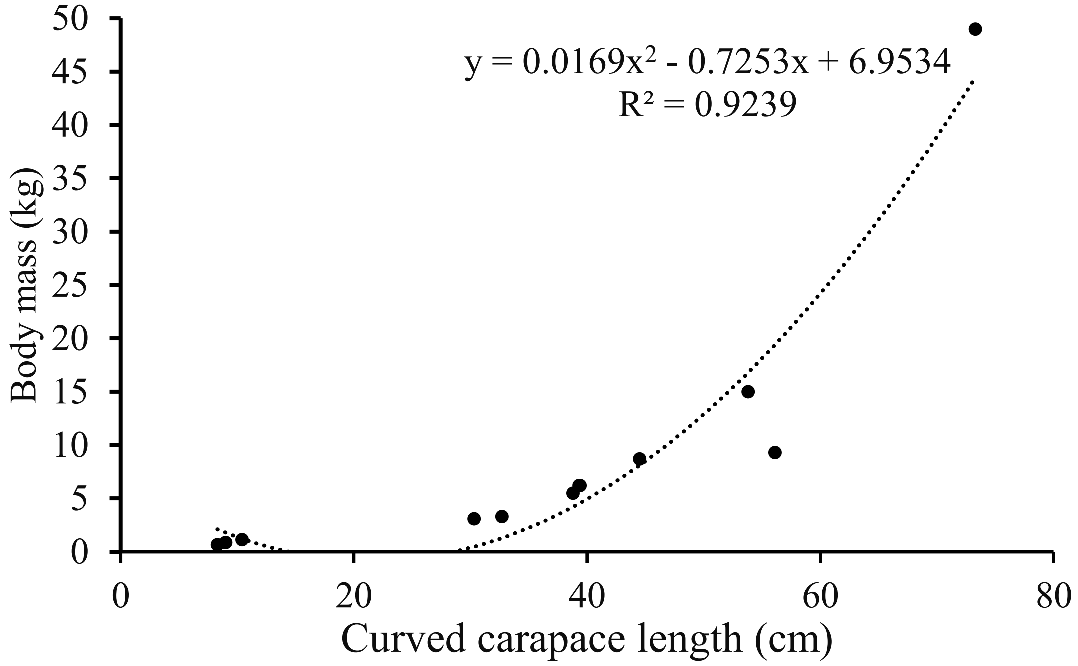


Figure 5.14 Relationship between curved carapace length and body mass (kg) of stranded hawksbill turtles (n= 12).

The month of stranding was known for 43 of the 132 stranded hawksbill turtles and there were records from all the months of the year (Figure 5.15). Individual animals where interactions with human activities were evident comprised 39% of the stranded turtles (n= 51), and for the remainder of the records the cause of stranding was unknown (61%, n= 81). The region of stranding was known for 52 of the 132 records. No significant different in the distribution of the hawksbill turtle records along the coastal area of the study site was found (Chi-Square test) (Figure 5.16).

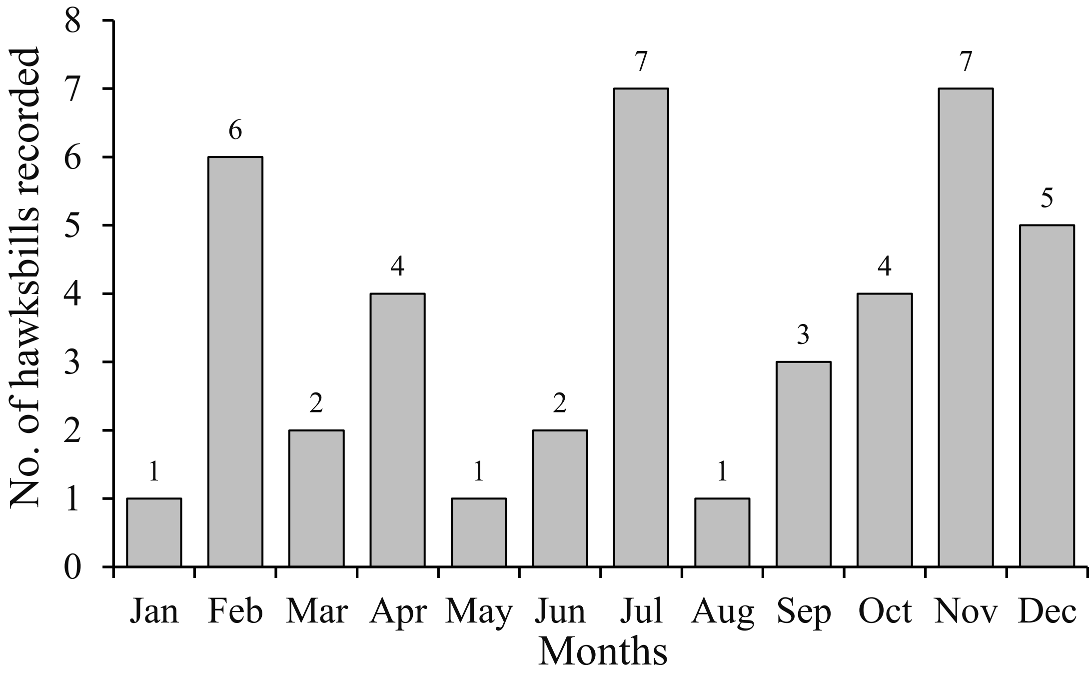


Figure 5.15 Records of hawksbill turtles registered by months in the study area (n= 43).

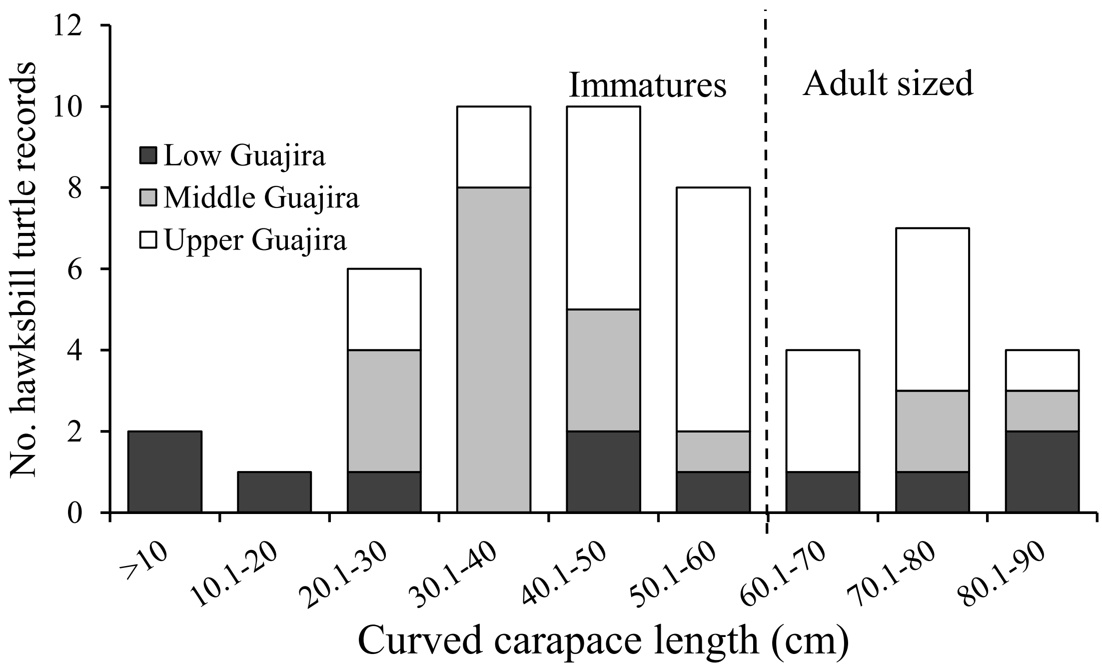


Figure 5.16 Size class frequency distribution of hawksbill turtle among the three different regions within the Gulf of Venezuela (n= 52). Dark colour represents records from the lower Guajira, grey colour shows the records from middle Guajira, and white colour represents the records from the upper Guajira. Dashed line represents the minimum size (60 cm) reported for adult females, within the western Atlantic Regional Management Unit (RMU) (Moncada *et al.*, 1999).

5.3.3.3. Loggerhead turtle – *Caretta caretta*

There were 61 stranded loggerhead turtles recorded in the study area. Loggerhead turtles were predominantly found in the southern section of the study area (Low Guajira), over ten months of the year. Eleven of the records were adult animals (18%), the majority (64%, n=39) were considered to be immature (Figure 5.17), the remainder could not be classified (18%). Fifty of the loggerhead turtles were measured and ten turtles were measured and weighed. One record was from an animal with a straight-length carapace – SCL of 5.6 cm. This animal was likely to be a stranded post-hatchling from the most recent breeding season. It was hand-caught by a fisher in a shallow section of a coastal lagoon, adjacent to the nesting beach for this species in Castilletes Beach (Cocinetas lagoon). The CCL evaluation was made excluding this post-hatchling record and thus ranged from 44.4 to 87.8 cm (mean= 65.4 cm; SD= 9.2; n=49). Weights ranged from 22 to 74 kg (mean= 36.9; SD= 15.1; n= 10). I found a relationship between the CCL (cm) and the body mass (kg) ($y = 0.0247x^2 - 1.956x + 55.494$; $R^2 = 0.89851$) (Figure 5.18), and a relationship between the CCL and the CCW ($y = 0.7977x + 9.6183$; $R^2 = 0.91072$; n= 46).

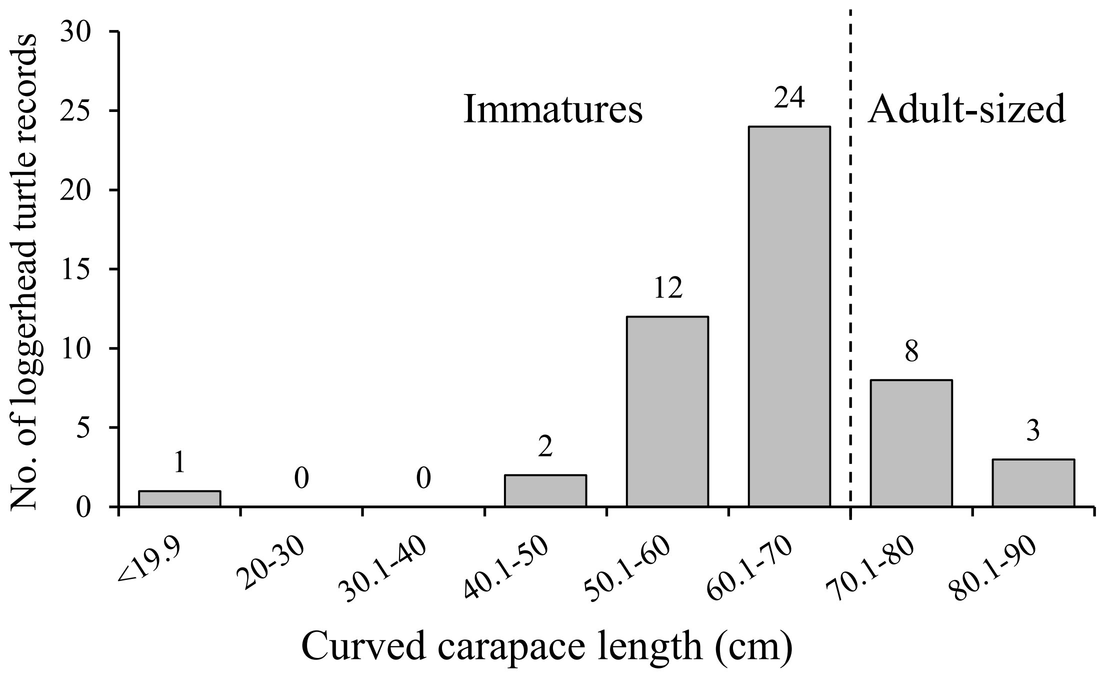


Figure 5.17 Size frequency distribution of the curved carapace length (CCL, cm) of loggerhead turtles (*Caretta caretta*) recorded in the Gulf of Venezuela during the study (n= 50). Dashed line represents the minimum size (70 cm) reported for adult females, within the north-western Atlantic Regional Management Unit (RMU) (Dodd Jr, 1988).

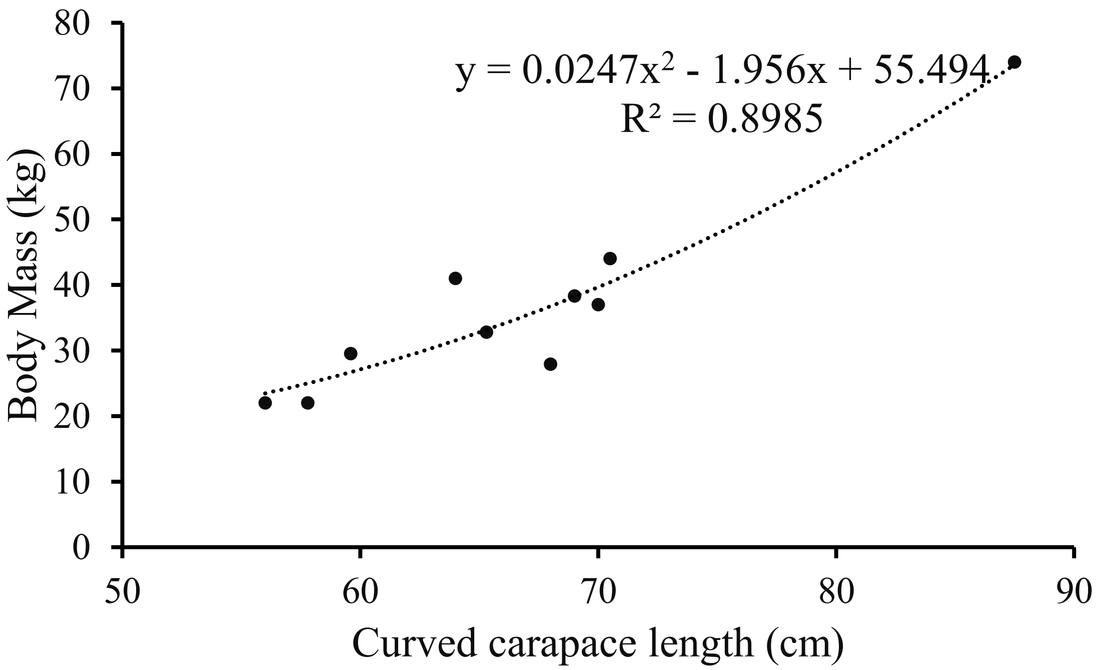


Figure 5.18 Relationship between curved carapace length and body mass (kilograms) of stranded loggerhead turtles (n= 10).

The month of stranding was known for 43 of the 51 loggerhead turtles and records occurred in ten months of the year. No loggerheads were recorded during October and December (Figure 5.19). A large proportion of loggerhead strandings were considered to be caused by interaction with human activities, mainly artisanal fisheries (longline and gillnets) (n = 28, 46% of reported strandings), 3% by natural causes (n= 2), and the cause of 51% strandings remained unknown. There was a significant difference in the distribution of records obtained between the three studied regions– most of the stranded loggerhead turtles were found in the lower and middle regions ($X^2(2)= 37.02$, $p< 0.0005$) (Chi-square tested) (Figure 5.20).

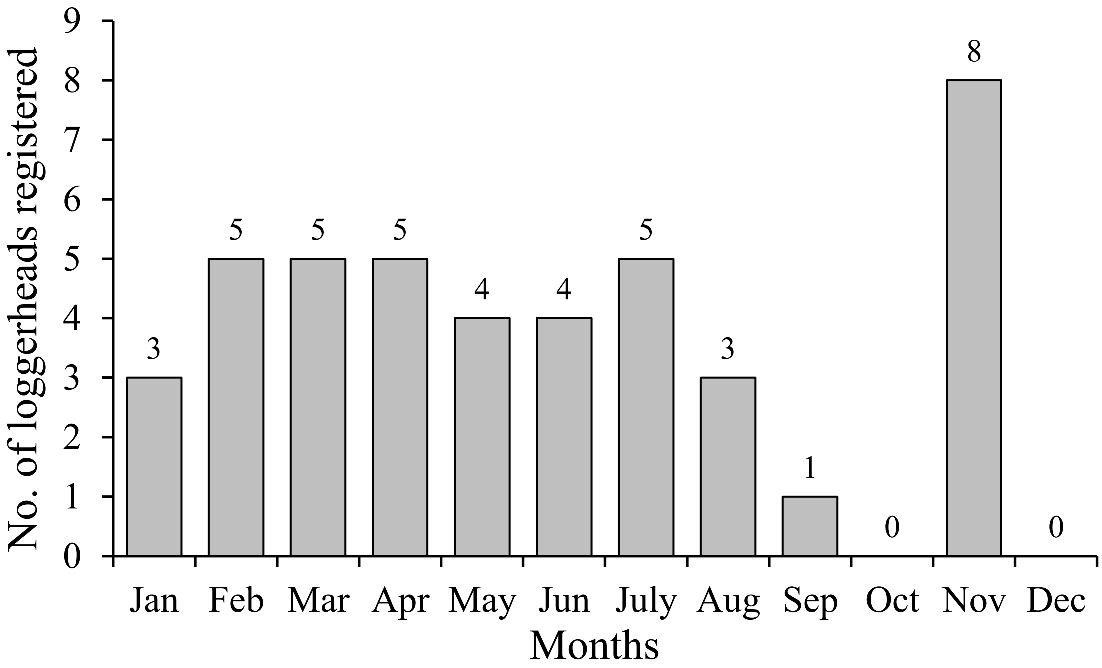


Figure 5.19 Records of loggerhead turtles registered by months in the study area (n= 43).

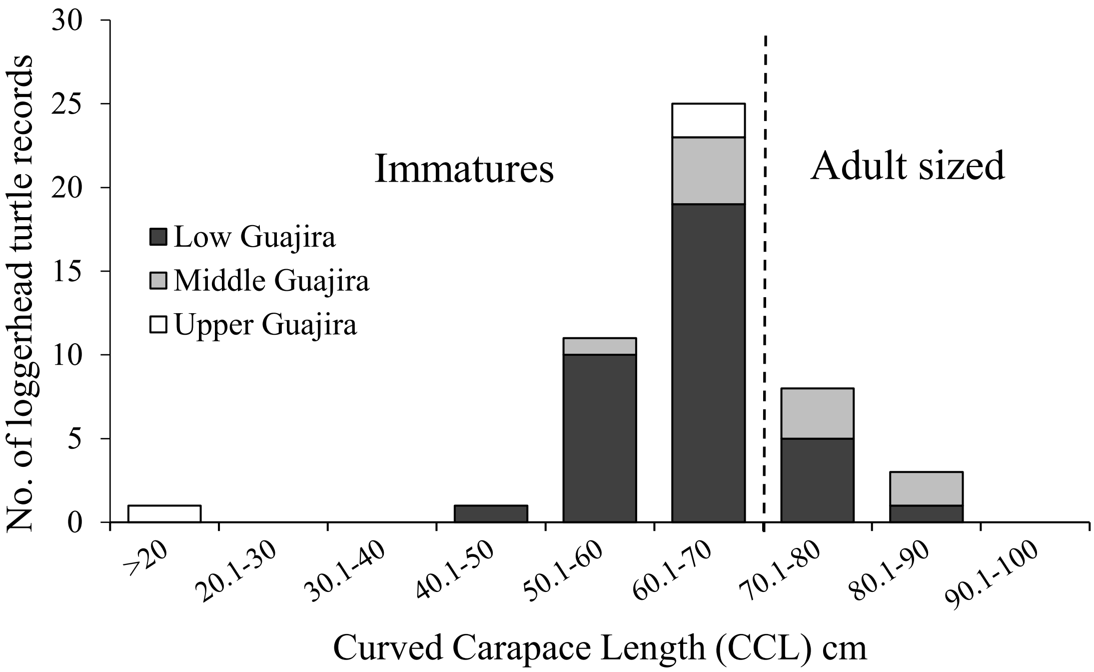


Figure 5.20 Size class frequency distribution of loggerhead turtle among the three different regions within the Gulf of Venezuela (n= 49). Dark colour represents records from the lower Guajira, grey colour shows the records from middle Guajira, and white colour represents the records from the upper Guajira. Dashed line represents the minimum size (70 cm) reported for adult females, within the north-western Atlantic Regional Management Unit (RMU) (Dodd Jr, 1988).

5.3.3.4. Leatherback turtle – *Dermochelys coriacea*

Between 1976 and June 2017, 84 stranded leatherback turtles were recorded within the study area. One animal was found alive (category 0) and another was found freshly dead (category 2); the remainder were in an advanced state of decomposition (categories 3 to 5). The 84 records include a turtles which washed ashore with a flipper tag. This data point was previously recorded by Pritchard (1976). Fifty-three of the stranded leatherback turtles were measured. The mean (± SD) CCL was 126.8 cm ± 20.9 (range 86–195 cm, n= 53; Figure 5.21), and the mean CCW was 99.1cm ± 12.6 (range 83–109 cm, n = 47). Of the measured turtles, 81% (n= 43) were immature. Most stranding events (n = 39; 46%) occurred between February and March, or August and September (n = 27; 32.14%, Figure 5.22). The majority of stranding events were considered to have been caused by interaction with human activities (n = 32; 38%).

The two areas with a higher number of leatherback stranding events in the Gulf of Venezuela were along the north coast (35%, n = 29) and the south coast (58%, n = 49), with sporadic strandings along the central coast (7%, n = 6; Figure 23). There were significant differences in the frequency of leatherback turtle strandings among the three regions (upper, middle, and low Guajira) ($X^2(2)= 33.07$, $p< 0.0005$) (Chi-square tested).

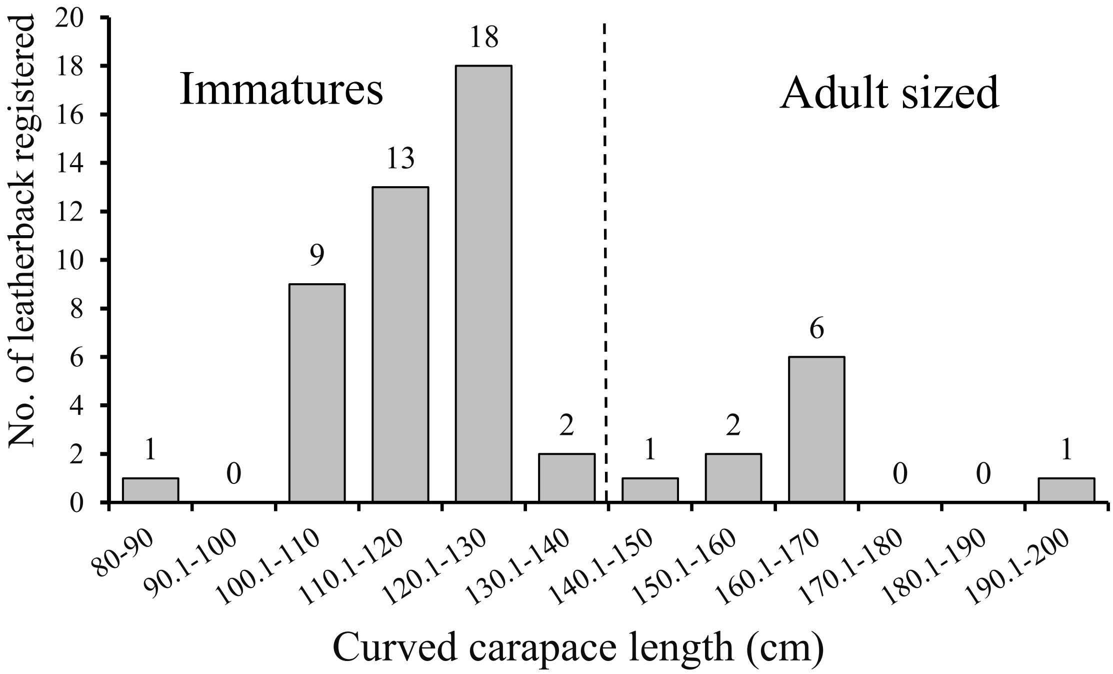


Figure 5.21 Size frequency distribution of the curved carapace length (CCL, cm) of leatherback turtle (*Dermochelys coriacea*) registered in the Gulf of Venezuela during the study (n= 53). Dashed line represents the minimum size (145 cm) reported for adult females, within the north Atlantic Regional Management Unit (RMU) (Eckert, 2002b; Stewart *et al.*, 2007).

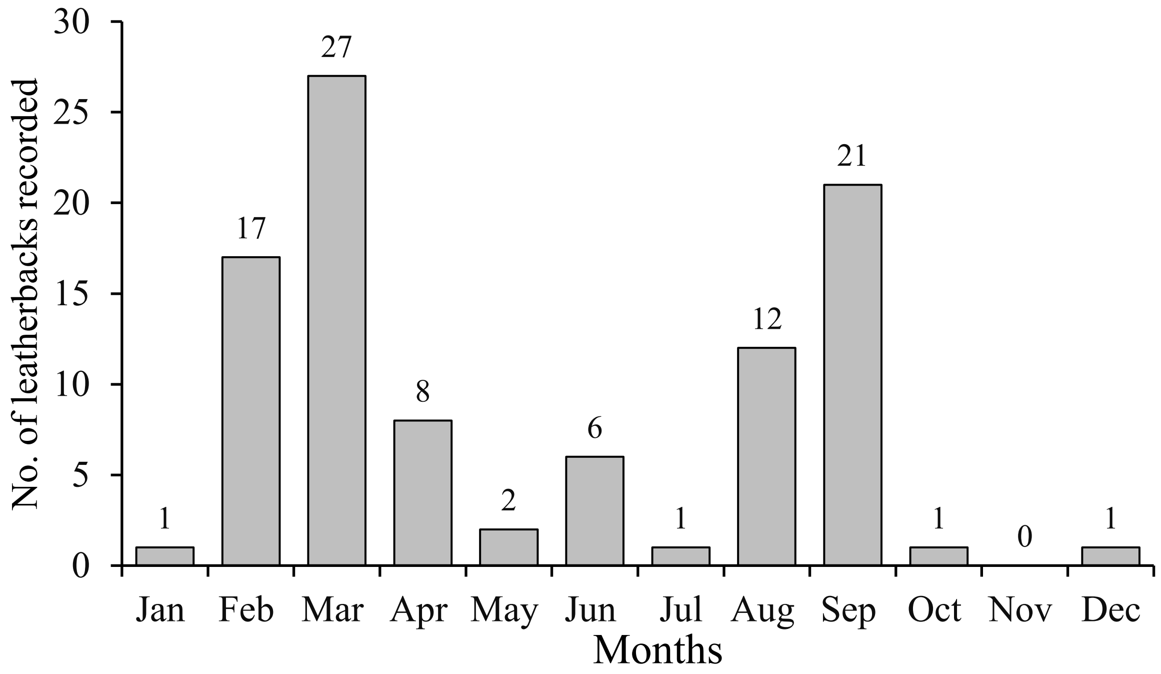


Figure 5.22 Temporal distribution by month of the leatherback turtles (*Dermochelys coriacea*) stranding records (n= 84).

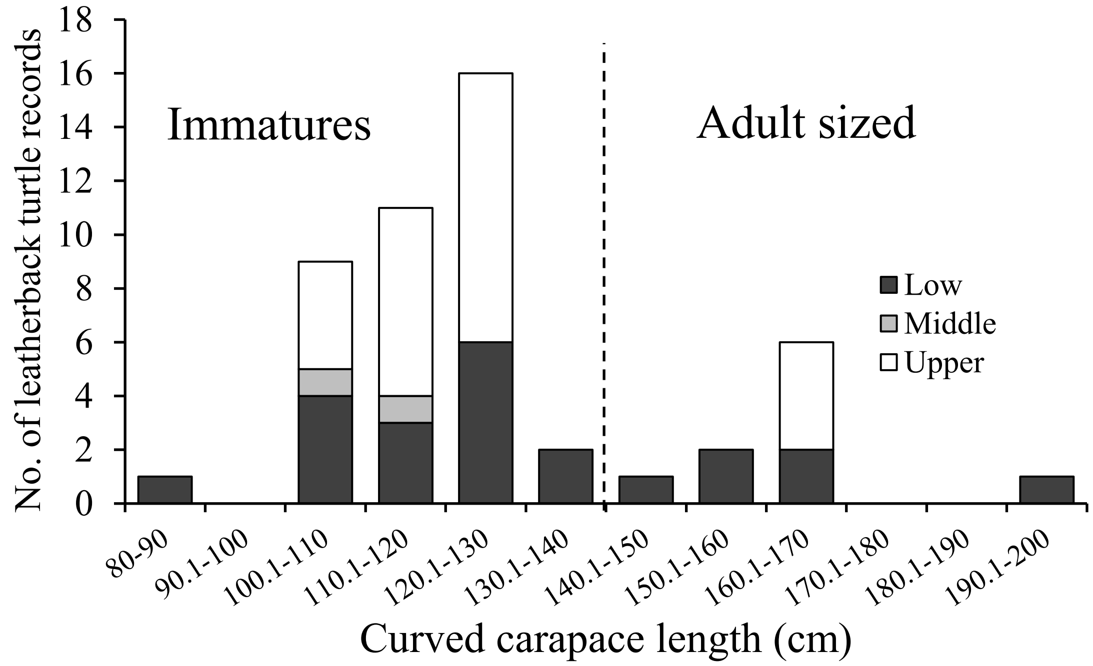


Figure 5.23 Size class frequency distribution of leatherback turtle among the three different regions within the Gulf of Venezuela (n= 53). Dark colour represents records from the low Guajira, grey colour shows the records from middle Guajira, and white colour represents the records from the upper Guajira. Dashed line represents the minimum size (145 cm) reported for adult females, the North Atlantic Regional Management Unit (RMU) (Eckert, 2002b; Stewart *et al.*, 2007).

5.3.4. Geographic origins of marine turtles recaptured in the Gulf of Venezuela (Tag return data)

During the field surveys 18 animals (from three species) were found with tags. This data was supplemented by 23 records of recaptured animals in the GV obtained from the Archie Carr Centre (AAC) database, which had been supplied by other projects. This data comprised 35 tagged green turtles, two tagged hawksbill turtles, and one tagged animal each of loggerhead turtle, leatherback turtle, and olive ridley turtle (Table 5.3).

The loggerhead turtle was originally tagged as an immature turtle in Azores (Portugal) before migrating into the Gulf of Venezuela. The leatherback turtle was first tagged while she was ashore nesting on Silebache Beach in French Guyana and the Gulf of Venezuela could have been her foraging area, or she could have been passing through. The olive ridley turtle was tagged while she nested at Eilanti Beach in Suriname and the Gulf of Venezuela could have been her foraging area, or she could have been passing through. Both hawksbills were immature; one was originally tagged in the "Archipiélago Los Roques" National Park foraging habitat, which is in Venezuela; and the second was initially tagged in the Carriacou feeding area, in Grenada.

Table 5.2 Details of recaptured marine turtles (five species) in the Gulf of Venezuela (GV). Including: original tagged date, recapture date, period (months) between original tagging date and recapture date, and source of the data. Note that dates are based on best available information and may not be complete. ACCSTR= Archie Carr Centre for Sea Turtle Research (University of Florida); STCB= Sea Turtle Conservation Bonaire; STC (Sea Turtle Conservancy); FCLR = Fundación Científica Los Roques; WIDECAST= Wider Caribbean Sea Turtle Conservation Network.

No. Record	Species	Tag Code	Tagging date	Recapture date	Period (months)	Origin locality	Recapture locality	Source
1	*C. mydas*	1985	September-1961	N/D	N/A	Tortuguero, Costa Rica	GV	ACCSTR
2	*C. mydas*	1667	22 July-1961	25/July-1963	24	Tortuguero, Costa Rica	Castilletes, Upper Guajira, GV	ACCSTR
3	*C. mydas*	6836	29 August-1970	N/D	N/A	Tortuguero, Costa Rica	GV	ACCSTR
4	*C. mydas*	7489	10 August-1971	N/D	N/A	Tortuguero, Costa Rica	Castilletes, Upper Guajira, GV	ACCSTR
5	*C. mydas*	8403	31 July-1972	N/D	N/A	Tortuguero, Costa Rica	GV	ACCSTR
6	*C. mydas*	8538	01 August-1972	N/D	N/A	Tortuguero, Costa Rica	GV	ACCSTR
7	*C. mydas*	H135	26 August-1972	N/D	N/A	Tortuguero, Costa Rica	GV	ACCSTR
8	*C. mydas*	18362	28 August-1978	N/D	N/A	Tortuguero, Costa Rica	Falcon State, Western coast, GV.	ACCSTR
9	*C. mydas*	38953	21 August-1986	N/D	N/A	Tortuguero, Costa Rica	Falcon State, Western coast, GV.	ACCSTR
10	*C. mydas*	54132	11/September-1990	N/D	N/A	Tortuguero, Costa Rica	Falcon State, Western coast, GV.	ACCSTR
11	*C. mydas*	1726	01 August-1961	07/May-1966	57	Tortuguero, Costa Rica	GV	ACCSTR
12	*C. mydas*	4437	10 August-1967	24/April-1968	8	Tortuguero, Costa Rica	Zapara Island, Southern GV	ACCSTR

13	*C. mydas*	5680	23 July-1969	February-1971	19	Tortuguero, Costa Rica	GV	ACCSTR
14	*C. mydas*	6870	11 September-1970	September-1971	12	Tortuguero, Costa Rica	Castilletes, Upper Guajira, GV	ACCSTR
15	*C. mydas*	7529	10 August-1971	January-1972	5	Tortuguero, Costa Rica	Falcon State, Western coast, GV.	ACCSTR
16	*C. mydas*	9036	17 August-1972	December-1972	4	Tortuguero, Costa Rica	GV	ACCSTR
17	*C. mydas*	7963	21 August-1972	December-1972	4	Tortuguero, Costa Rica	GV	ACCSTR
18	*C. mydas*	8953	14 August-1972	January-1973	5	Tortuguero, Costa Rica	GV	ACCSTR
19	*C. mydas*	21328	21 July-1980	October-1980	3	Tortuguero, Costa Rica	GV	ACCSTR
20	*C. mydas*	46274 46275	09 August-1988	1995?	84	Tortuguero, Costa Rica	Porshoure, Upper Guajira, GV	ACCSTR
21	*C. mydas*	B-7702	1991?	May-1998	84	Isla de Aves, Venezuela	Cuzia, Upper Guajira, GV	ACCSTR
22	*C. mydas*	K9116 K9117	19July-1990 (Tagged as juvenile)	August-1998	97	Daniels Head, Bermuda	Tapuri (Wourrepea port), Upper Guajira, GV	ACCSTR
23	*C. mydas*	BP3769 MM476	May-1993	November-1998	66	Vixen, Bermuda	Porshoure, GV	ACCSTR
24	*C. mydas*	X5215	11 March-1992	September-2000	102	Cow Ground Flat, Bermuda	Tapurí, Upper Guajira, GV	ACCSTR
25	*C. mydas*	MM400	23 August-1996	April-2004	91	Crescent East, Bermuda 32.39692N; 64.80143W	Cuzia, Upper Guajira, GV	Meylan & Meylan.
26	*C. mydas*	98083 – 98084	30 April-2004	June-2004	2	Tortuguero, Costa Rica	GV	ACCSTR
27	*C. mydas*	87916	15 August-2000 (Nesting again in 2003)	July-2005	59	Tortuguero, Costa Rica	Castilletes, Upper Guajira, GV	ACCSTR

28	*C. mydas*	IH 0617	Unknown	July-2008	N/A	Santa Marta, Colombia	Cuzia, Upper Guajira, GV	Inst. Humboldt
29	*C. mydas*	BBG260 WH5967	March-2009	July-2009	4	Lac Bay, Bonaire	Zapara Island, Southern GV	STCB
30	*C. mydas*	BX1169 WH1095	March-2006	August-2010	53	Lac Bay, Bonaire	Kazuzain, Middle Guajira, GV	STCB
31	*C. mydas*	MM676 MB470	August-1999	June-2011	142	Daniels Head, Bermuda	Kazuzain, Middle Guajira, GV	ACCSTR
32	*C. mydas*	12685 111828	September-2008	01/July-2014	70	Tortuguero, Costa Rica	Kazuzain, Middle Guajira, GV	STC
33	*C. mydas*	XXP749	November-2001	15/July-2014	152	Mosquito, Culebra, Puerto Rico	Porshoure, Upper Guajira, GV	C. Diez
34	*C. mydas*	PPM372	June-1998	01/April-2014	190	Mosquito, Culebra, Puerto Rico	Irramacira, Upper Guajira, GV	C. Diez
35	*C. mydas*	MM 706	August-1999	December-2016	207	Bermuda	Kazuzain, Upper Guajira, GV	Meylan & Meylan
36	*C. mydas*	111397 111398	August-2008	December-2016	100	Tortuguero, Costa Rica	Caño Sagua, Low Guajira, GV	ACCSTR
37	*E. imbricata*	N1596	1992	1994	24	P.N. Archipiélago Los Roques	Refugio de Fauna “Ciénaga Los Olivitos”. GV	FCLR
38	*E. imbricata*	WE5335 WE5336	January-2004	July-2014	126	Mount Pleasant, Isla Carriacou, Granada.	Castilletes, Upper Guajira, GV	WIDECAST
39	*C. caretta*	P 8111	October-2002	May-2005	31	Los Azores, Portugal	Zapara Island, Southern GV	A. Bolten Wildermann *et al.* (2009)
40	*D. coriacea*	D 2113	July-1972	October-1974	27	Silebache, French Guiana	GV	Pritchard (1976); Eckert *et al.* (2012)
41	*L. olivacea*	??	1983	1998	180	Eilanti. Surinam	GV	Schulz (1975); Pritchard and Trebbau (1984); Reichart (1993)

The majority of recapture records obtained for tagged turtles in this study were for green turtles. Twenty-four of the 36 green turtles were adult turtles originally tagged while ashore nesting at Tortuguero Beach in Costa Rica. Only 15 of these 24 recaptures were completely documented, including their recapture date (Figure 5.24). For these 15 turtles, there was a mean of 30.4 months (range 2 – 100) between tagging and recaptured events. In addition, one turtle was originally tagged while she was ashore nesting on Aves Island in Venezuela, which is the second most important nesting beach in the region (Seminoff, 2004; García-Cruz *et al.*, 2015). Although nesting green turtles have been tagged during a monitoring program on Aves Island since 1979, this is the only turtle tagged at Aves Island and then recaptured in the territorial waters of the Gulf of Venezuela. It is likely that the study area was the foraging habitat for these 25 turtles.

Eleven of the 36 tagged green turtles found were initially tagged during feeding habitat studies; six were originally tagged as juveniles in Bermuda (David Head, Vixen, Cow Ground Flat, and Crescent East localities), with an average time between tagging and recapture being 117 months (range 66 – 207) (Figure 5.24). Two were recaptured from Puerto Rico and two more from Bonaire, with intervals of 152 to 190 months for Puerto Rico, and 4 to 53 months for Bonaire. The final tagged green turtle was initially tagged at Santa Marta, Colombia. The 11^{th} tag return came from a juvenile turtle, but no further data on its tagging location are known (Humboldt Institute in Colombia) (Code IH 0617).

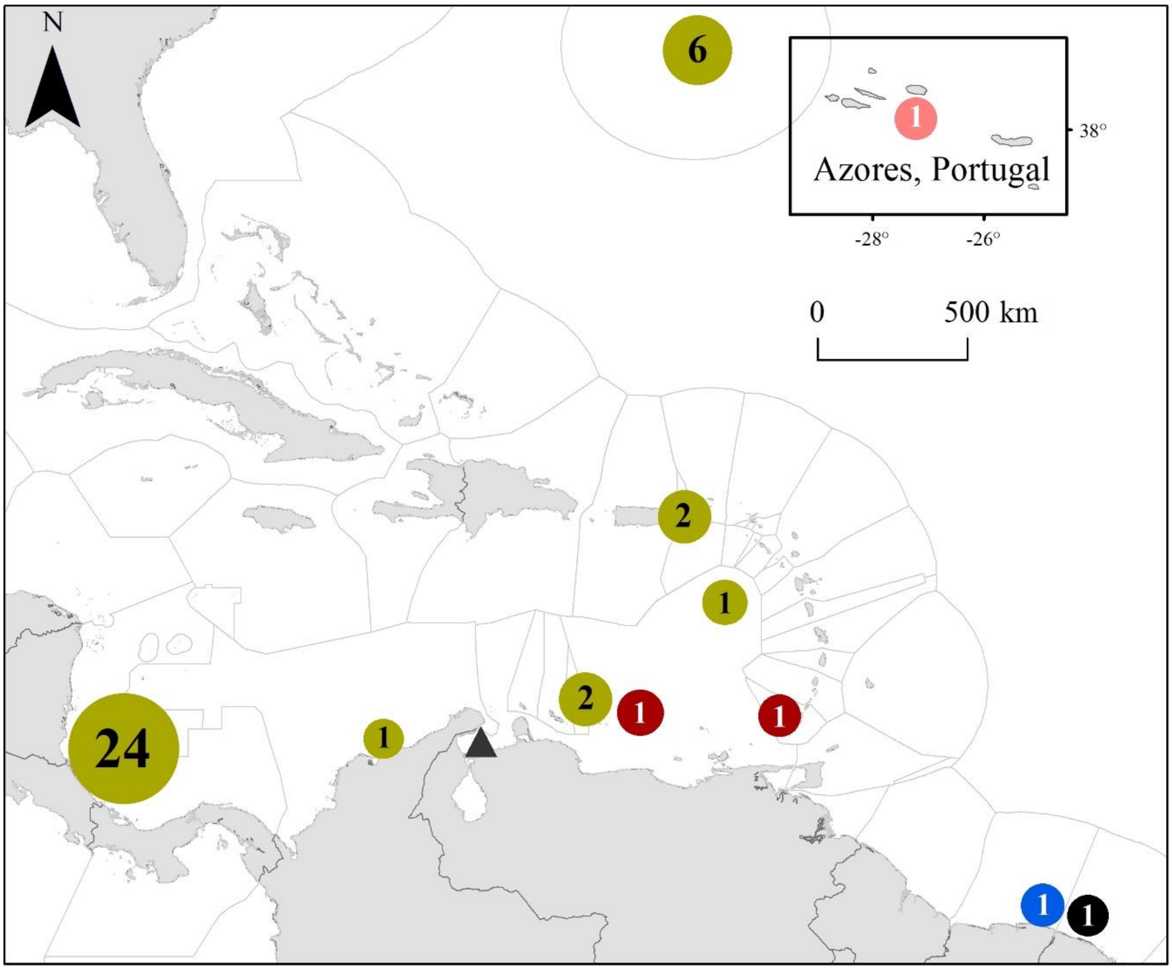


Figure 5.24 Turtle recaptures in the Gulf of Venezuela (black triangle). Circles represent original locations where turtles were tagged. Colour of circles differs according to the species: green (green turtles), red (hawksbill turtles), pink (loggerhead turtle), black (leatherback turtle), and blue (olive ridley turtle). Grey lines represent the exclusive economic zones (EEZ) for the Caribbean and Atlantic countries. See details in Table 3.

Forty of the 41 recaptured tagged turtles were deceased animals. In the majority of cases, the tag was provided by fishers, and further information surrounding the tag return gathered by informal interviews. Only one green turtle, initially tagged in Bonaire, was recaptured and released alive (in Zapara Island – Low Guajira) (Figure 5.25).

Figure 5.25 Green turtle tagged originally in Bonaire on 23 April 2008 (left) (photo credit: Mabel Nava – Sea Turtle Conservation Bonaire, STCB), and recaptured at Zapara Island, Low Guajira in the Gulf of Venezuela, on 11 July 2009 (right) (photo credit: Nínive Espinoza-Rodriguez – GTTM-GV).

5.3.5. Tagging program and recapture data from the Gulf of Venezuela

Of the 254 turtles that were found alive when they stranded (most of them were caught and landed) and later tagged and released by researchers, 22 were subsequently recaptured between 2008 and June 2017: one loggerhead, three hawksbills, and 18 green turtles. All of these 22 recaptured animals were immature sized turtles (Table 5.3).

Four patterns were observed for the 22 turtles tagged and recaptured in the present study: (a) turtles captured and released in the same location are then recaptured in a different location (n= 3); (b) turtles captured and released in different locations, and then recaptured adjacent to the release location (n=1); (c) turtles captured and released in different areas and recaptured in a third area (n=3); and (d) turtles captured and released in a different regions (i.e. Upper Guajira, Middle Guajira, Low Guajira), and recaptured in the vicinity of the original capture location (n= 13) (Table 5.3). This data was explored further below.

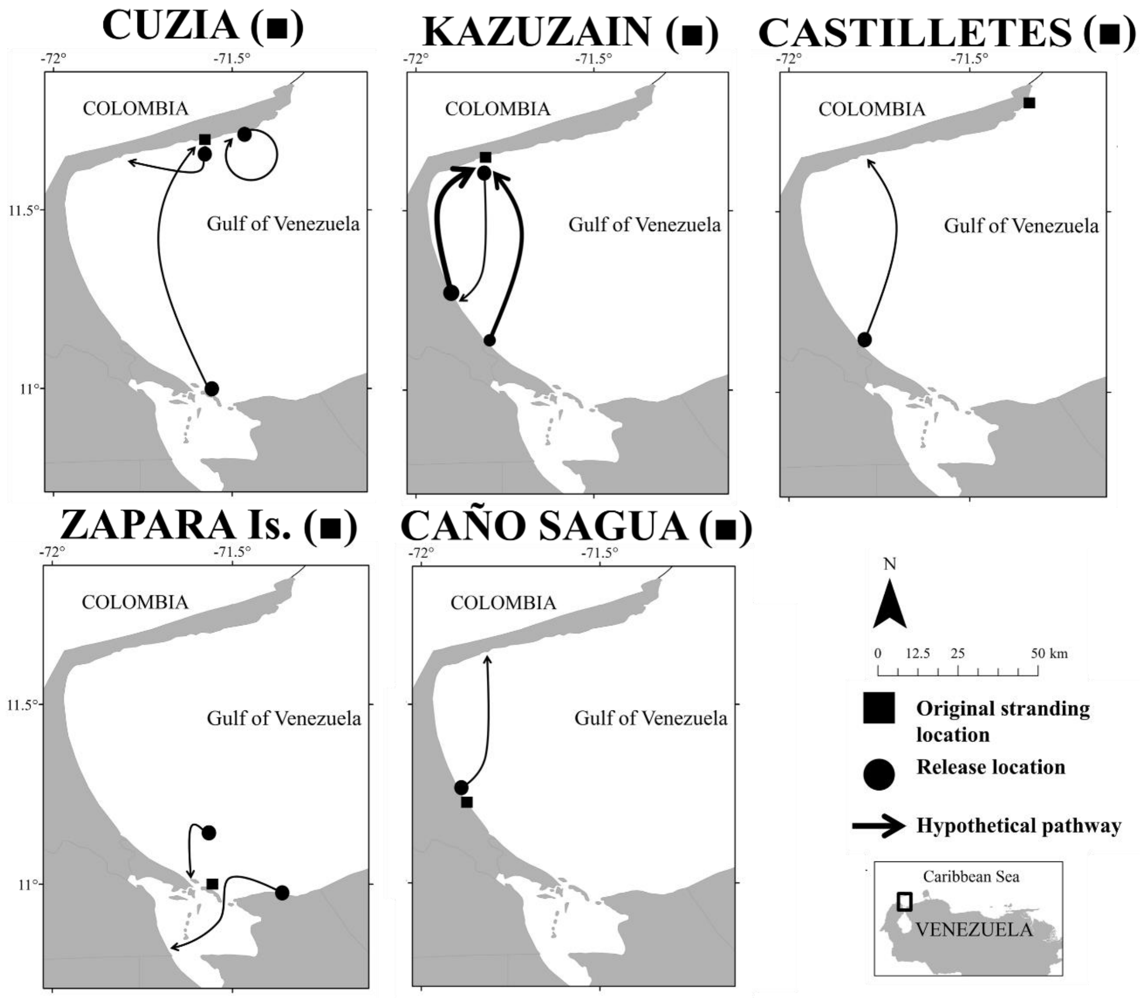
Table 5.3 Capture and recapture details of tagged turtles released within the Gulf of Venezuela

No. Record	Species	Tag Code	Tagging date	Recapture date	Months	Stranding location	Release location	Recapture location	Condition of the animal on recapture
1	*C. mydas*	V-0263	02/09/2008	16/09/2009	12	Cuzia	Cuzia	Kazuzain	Dead
2	*C. mydas*	V-0268	11/04/2008	01/09/2008	4	Cuzia	Zapara Island	Cuzia	Dead
3	*C. mydas*	V-0501 V-0502	09/01/2010	21/10/2010	9	Kazuzain	Caimare Chico	Kazuzain	Alive
4	*C. mydas*	V-0515 V-0516	11/03/2010	15/09/2010	6	Kazuzain	Caño Sagua	Kazuzain	Dead
5	*C. mydas*	V-0537 V-0538	21/09/2010	12/10/2010	0.5	Kazuzain	Caño Sagua	Kazuzain	Alive
6	*C. mydas*	V-0547 V-0548	26/08/2010	15/07/2014	47	Cuzia	Porshoure	Porshoure	Dead
7	*C. mydas*	V-0575 V-0576	02/10/2010	07/03/2011	5	Kazuzain	Caimare Chico	Kazuzain	Dead
8	*C. mydas*	V-0579 V-0580	02/10/2010	06/11/2010	1	Castilletes	Caimare Chico	Kazuzain	Alive
9	*C. mydas*	V-0585 V-0586	09/10/2010	02/04/2011	6	Kazuzain	Caño Sagua	Kazuzain	Dead
10	*C. mydas*	V-0609 V-0610	25/10/2010	19/01/2011	3	Kazuzain	Caimare Chico	Kazuzain	Dead
11	*C. mydas*	V-0615 V-0616	02/11/2010	26/01/2011	2.5	Kazuzain	Caño Sagua	Kazuzain	Dead
12	*C. mydas*	V-0621 V-0622	02/11/2010	15/03/2011	4.5	Kazuzain	Caño Sagua	Kazuzain	Dead
13	*C. mydas*	V-0639	27/11/2010	19/03/2011	3.5	Kazuzain	Caño Sagua	Kazuzain	Alive
14	*C. mydas*	V-0646	20/12/2010	01/07/2014	43	Kazuzain	Caño Sagua	Kazuzain	Dead

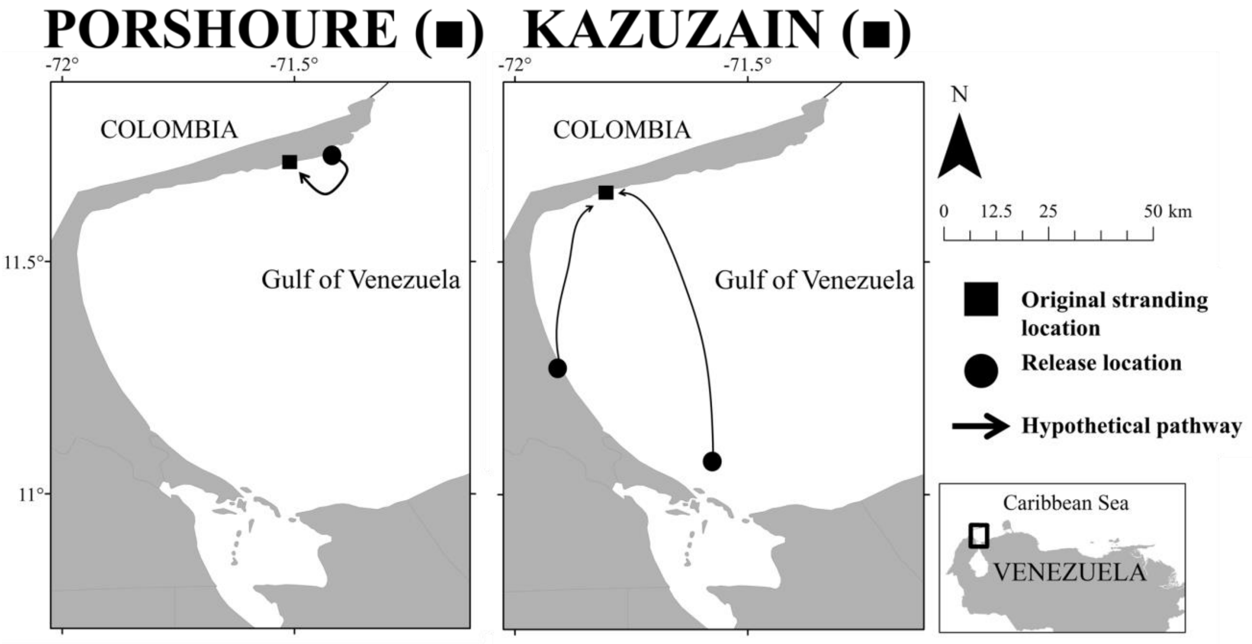
15	*C. mydas*	V-0961 V-0962	11/04/2013	22/05/2014	13	Zapara Island	Navigation Channel	San Bernardo	Dead
16	*C. mydas*	V-0923 V-0924	30/08/2016	01/09/2016	0.03	Zapara Island	Quisiro beach	Carbones del Guasare, Mara	Alive
17	*C. mydas*	V-0735 V-0736	15/07/2011	01/08/2016	61	Kazuzain	Kazuzain	Caño Sagua	Dead
18	*C. mydas*	V-1015	27/05/2017	25/06/2017	1	Caño Sagua	Caño Sagua	Kazuzain	Alive
19	*E. imbricata*	P-2218 P-2219	01/11/2003	18/11/2003	0.5	Porshoure	Parashiou	Porshoure	Dead
20	*E. imbricata*	V-0631 V-0632	08/11/2010	30/11/2011	12	Kazuzain	Navigation Channel	Kazuzain	Alive
21	*E. imbricata*	V-0721 V-0722	07/03/2011	27/04/2011	1.5	Kazuzain	Caño Sagua	Kazuzain	Alive
22	*C. caretta*	V-0535 V-0536	21/09/2010	16/02/2011	5	Puertos de Altagracia	Caño Sagua	Puertos de Altagracia	Alive

The interval period between release and recapture varied among species. Up to five months for the only record of loggerhead, from two weeks to 12 months for hawksbill turtles (n= 3), and from 3 days up to 61 months for green turtles (n= 18). Interestingly, after release, the recaptured loggerhead, all recaptured hawksbills, and 11 (of 18) recaptured green turtles all returned to an area close to where they were initially captured (Figure 5.26). All 22 recaptured animals were caught and reported by fishers, and thus they did not "drift" as dead/weak animals to the stranding site.

(a) Green turtles:



(b) Hawksbill turtles



(c) Loggerhead turtle

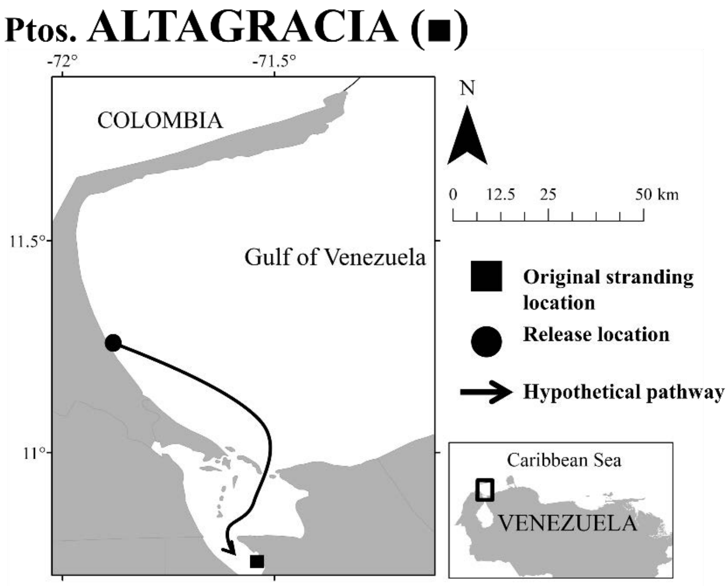


Figure 5.26 Localities in the Gulf of Venezuela where the turtles were originally captured or rescued (■), released (●), and then recaptured (end of the arrow). The arrows' width denotes the number of records, and represents a simplified return direction. Recapture species and details are differentiated as follows: (a) green turtles, (b) hawksbill turtles; (c) loggerhead turtle. See details in Table 4.

5.4. DISCUSSION

Compiling, comparing, and evaluating data from multiple sources over a period of 56 years is extremely challenging due to extensive sources which included different approaches that need to be considered. However, having completed this analysis, these are the most extensive and long-term data available on in-water marine turtle populations in nearshore waters of Venezuela to date.

5.4.1. Species frequency, composition, and life stage

My dataset confirms the year-round presence of four of the five species of marine turtle known to occur in the Gulf of Venezuela's waters, with the green turtle found to be the most common followed by hawksbill, leatherback, and loggerhead turtles. Overall, my results confirmed the presence of five marine turtle species from six different Regional Management Units in the study region (Wallace *et al.*, 2010; Montiel-Villalobos, 2012; Barrios-Garrido *et al.*, 2015; Buitrago *et al.*, 2015a; Buitrago *et al.*, 2015b; Guada *et al.*, 2015; Rondón-Médicci *et al.*, 2015). In addition, based on what is known about turtles in other areas of Venezuela, it is possible that the Gulf of Venezuela is the most important feeding and developmental area for green, hawksbill, leatherback, and loggerhead turtles in Venezuela. Continued marine turtle monitoring along the entire coast would be needed to confirm this belief. Extensive use by local community members was also registered, which is likely to represent the biggest impact to their development in the Gulf of Venezuela's waters. The majority of the marine turtle records on this research showed human interaction (incidental and intentional) as cause of their strandings. The mixed stocks of the five species of marine turtle registered represent six different Regional Management Units, which evidence of several natal origins.

The Gulf of Venezuela is characterised by different biophysical conditions and different types of habitat, including a large extent of mixed-species seagrass beds (Wildermann, 2012; Morán *et al.*, 2014), patchy coral reefs (Barrios-Garrido *et al.*, 2016b), soft muddy bottoms and mangrove forests (Medina & Barboza, 2003; Barrios-Garrido *et al.*, 2017a). These varied habitats, in combination with seasonal upwelling currents (Rueda-Roa & Muller-Karger, 2013), are likely to be key elements for the support of marine turtle populations. Nonetheless, these bio-physical conditions are also key factors for small-scale artisanal fisheries that in some cases incurred in illegal exploitation of protected species, due to a lack of sustainable management and baseline biological data. Finally, the extensive marine traffic has not been evaluated in the area, my findings about its potential impact is likely to open a public discussion among stakeholders about the regulations that it may have in the future.

The largest proportion of animals recorded during my study were immature, suggesting that the Gulf of Venezuela is an important foraging and developmental area, and supporting the hypotheses of previous authors (Pritchard & Trebbau, 1984; Acuña *et al.*, 1989; Parra, 2002). My data is also supported by data reported by Rueda-Almonacid *et al.* (1992) from animals sacrificed in public markets and restaurants in the Colombian portion of the Guajira Peninsula (mainly in Maicao and Riohacha cities). In the latter study, the proportion of species and the relationship between immatures (large juveniles) and adult-sized individuals were similar to the patterns found here i.e. mainly immature green turtle >70% (small and large immatures), and then adult-sized individuals. Overall, the Gulf of Venezuela and the Colombian portion of the Guajira Peninsula are likely to be important foraging and developmental zones for immature turtles from four of the five species of marine turtles found in the Caribbean.

The proportion of individuals by species varied across the region and I found that the upper and middle areas of the Guajira Peninsula were key areas for green turtles. This is supported by data gathered from benthic habitat surveys, which show that the upper and middle areas are predominantly seagrass habitats (mainly confirmed to be *Thalassia testudinum* and *Syringodium filiforme*) (Nava & Severeyn, 2010; Morán *et al.*, 2014). The foraging grounds in the lower Guajira appear to support fewer green turtles and a larger number of immature leatherback and loggerhead turtles. Although, there are patches of small coral and rocky reefs in the middle and upper Guajira regions (Barrios-Garrido *et al.*, 2016b), there were no clear patterns in the degree to which hawksbill turtles stranded in the Gulf. Finally, although there were few olive ridley animals recorded, they were found only in the upper and lower Guajira portions, and there were no records from the middle Guajira.

The Gulf of Venezuela's location is almost equidistant from the two most important green turtle nesting beaches in the Caribbean; Tortuguero in Costa Rica (to the north-west) and Aves Island in Venezuela (to the north-east). Thus, although there was a strong bias towards recaptures from Tortuguero, it was not surprising that my results demonstrate the presence of adult individuals from both rookeries within the GV. Importantly, from a perspective of stock or population-based management, these two beaches represent different RMUs: Atlantic northwest, and south Caribbean (Wallace *et al.*, 2010). Sampling of foraging turtles in the Gulf of Venezuela to assess the genetic stock assignment of turtles in the region would be a useful future research avenue.

5.4.2. Body condition index (BCI) evaluation

In general, most of the green turtles evaluated were in good condition (78%), with no difference in the BCI values among regions. Seventeen animals presented as fair (n= 4) or poor (n= 13) condition, and the majority of the turtles in good condition were small immatures (<45 cm CCL). Hence, I can infer that, in general, the individuals that are recruiting to the Gulf of Venezuela from the oceanic phase of their life cycle to their neritic habitat are in better condition (relationship between weight and CCL) than larger animals which were found stranded (>45cm CCL). In contrast to the findings of Labrada-Martagón *et al.* (2010) from studies along the Pacific coast of Mexico, I found a negative relationship between CCL and the BCI, this may be because the majority of animals included in my evaluation were using the Gulf of Venezuela as a recruitment region (i.e. they were turtles smaller than 45 cm CCL) (Jessop *et al.*, 2004). However, it is important to note that these differences in the BCI among my sampled animals were not significant, and further research is needed to increase the numbers of available BCI records and also evaluate BCI in larger turtles.

5.4.3. Demographic structure of green turtles in the Gulf of Venezuela

Although my data are largely derived from stranded turtles or turtles caught for consumption, I found there were mixed size/age classes and very few adult turtles present in the Gulf of Venezuela. This scenario is not common in other feeding areas in the Caribbean/west Atlantic regions. While mixed size/age aggregations are common in the Pacific and Indian Ocean basins (Limpus *et al.*, 1994; Seminoff *et al.*, 2002), the presence of green turtles of all size classes co-occurring in the same foraging ground is rare in the Caribbean (Meylan *et al.*, 2011; Meylan *et al.*, 2013). Indeed, only Jardim *et al.* (2016), working in the shallow reef areas of Bahia, Brazil (Atlantic Ocean), has reported mixed size/age aggregations of green turtles in shallow water habitats. Several studies carried out in the Caribbean have evaluated the distribution of the sizes of green turtles and found variations in the availability of different size classes. For example, there are areas where the majority of captured individuals are juvenile with a rare or zero presence of adult-sized animals such as Panama (Chiriqui lagoon, and Zapatilla Cays) (Meylan *et al.*, 2011), the Marquesas Keys (Mooney Harbor), Florida, USA (Bresette *et al.*, 2010), Mexico (Akumal Bay) (Labrada-Martagón *et al.*, 2017), and Puerto Rico (Tortuga Bay and Puerto Manglar) (Patricio *et al.*, 2011). In contrast, there are places such as Nicaragua, where the vast majority of green turtles are large juveniles and adults, and small immature turtles are rarely found and captured (Lagueux *et al.*, 2017). Hence, the data presented herein demonstrate for the first time the co-occurrence of small immature (juvenile) and larger adult-sized green turtle individuals within the same habitat in the Caribbean.

Of note, 23 green turtles registered in the evaluation were between 20.1 and 25.9 CCL. It is likely to be the recruitment size of green turtle into the Gulf of Venezuela (minimum size at recruitment was 20.1 cm CCL). With this evidence, the Gulf of Venezuela is likely to have the smallest recruitment size of green turtles in the Caribbean Basin (Bjorndal & Bolten, 1988; Meylan *et al.*, 2011; Patricio *et al.*, 2011; Labrada-Martagón *et al.*, 2017). The Gulf of Venezuela is an embayment that may be used by small juveniles of green turtle as recruitment, feeding and protection area. Similar, as described previous authors, to the use of inshore feeding grounds by turtles worldwide (Seminoff *et al.*, 2002; Chaloupka *et al.*, 2004; López-Mendilaharsu *et al.*, 2016).

Also, according to my dataset, the Gulf of Venezuela is used for adult-sized turtles that stay in the zone for non-breeding periods after reproductive episodes. Further data is required to verify if the study area is used by migratory turtles in transit to/from Tortuguero beach (Costa Rica) and Aves Island (Venezuela), or whether they use it as a foraging area between reproductive seasons.

Interestingly, when all data on the size of animals found is compared across years, the modal size of green turtles caught/stranded has reduced over time (Figure 9) – a development that is particularly evident when compared to size measurements recorded in by Acuña *et al.* (1989). Reasons for this change are currently unknown and may not necessarily mean there is a shift in the size classes which occupy the Gulf of Venezuela, but it needs to be analysed with caution. It could be that in recent years the incentive program provided by the GTMM-GV NGO (bags of food and toys for the community children each December) may have increased the rates in which records of smaller turtles, which can be easier to catch, were relayed to the data collectors in this study. It could also be that fishers preferentially exchanged smaller turtles for the incentives offered by the NGOs, while the larger, adult-sized turtles (whole animals or their meat) were transported by wholesalers to the illegal market (Rojas-Cañizales, 2015) (Chapter 6). By doing this, individual fishers would maximise their profit - by both receiving NGO incentives for the small turtles while also earning money from the more valuable larger turtles (through the illegal market). On the other hand, some authors suggest that an increasing abundance of small green turtles in the southern Caribbean could be related to positive conservation outcomes being produced by projects in some of the region's main nesting beach areas (e.g. Yucatan Peninsula, Mexico) (Gaona & Barragán, 2016; Labrada-Martagón *et al.*, 2017). Hence, assuming Mexican-based projects have increased green hatchling production in the Caribbean over the last ten years, in addition to the finding of a relatively high frequency of Mexican haplotypes among green turtles in the GV study area (Montiel-Villalobos, 2012), the increase of small juvenile individuals in the GV could be a positive conservation finding which provides support for the continued investment in the Mexican-based conservation projects. Further research into population genetics and in-water surveys in the Gulf of Venezuela are required to corroborate these scenarios.

5.4.4. Recaptured turtles from other localities

Most (67%) of the previously tagged green turtles recaptured in the Gulf of Venezuela were females originally tagged while nesting in Tortuguero, Costa Rica; only one other animal was previously tagged at a nesting beach other than Tortuguero. This latter animal was tagged at Aves Island, Venezuela, which is considered to be the second most important nesting ground in the Caribbean basin (García-Cruz *et al.*, 2015). This finding, along with the genetic work by Montiel-Villalobos (2012), shows that an important proportion of female turtles nesting along Costa Rican beaches use the Gulf of Venezuela as a feeding ground. Considering previous evidence of the post-nesting movements of females from Tortuguero, where a 'pelagic circle' was described (Troëng *et al.*, 2005), these animals may be arriving to the Gulf of Venezuela after completing an almost complete circle within the Caribbean, using variable benthic feeding grounds on the way.

The remainder of green turtle tag recoveries (31%) were from turtles which were first tagged in other feeding areas within the Caribbean, such as Bermuda, Puerto Rico, Bonaire, and Santa Marta (Colombia). This may be due to the ontogenetic movement of animals between several feeding areas during their immature period of life (Carman *et al.*, 2012; Shimada *et* *al.*, 2014). Because each of those locations have been reported in the literature as providing important habitat for immature foraging green turtles (Godley *et al.*, 2004; Patricio *et al.*, 2011; Esteban *et al.*, 2015; Bjorndal *et al.*, 2017), the data presented here may provide another piece of evidence of the occurrence of an ontogenetic shift among foraging grounds during the life cycle of green turtles in the Atlantic Ocean (Howell *et al.*, 2016).

5.4.5. Causes of stranded animals – overall outcomes

In general, 34% (n= 530) records were categorised as human interaction as the cause of stranding across all four species evaluated. A high proportion had evidence of direct take for consumption. The remainder of the records showed no evident cause of stranding. Less than 1% of the records were confirmed to be a result of natural causes (shark predation, illness, or severe fibropapillomatosis).

There is an evident and strong relationship between marine turtles and human communities in the area, where consumptive use is still not well understood or estimated (Chapter 6 and 7). Hence, it remains unclear how this human interaction (incidental or intentional) is impacting all of the species that are using the Gulf of Venezuela as feeding ground. A systematic evaluation to quantify this use is recommended to evaluate in the short-term.

5.4.6. Capture and recapture data – trends

My data also suggest a clear trend where displaced turtles return to their original capture area. Similar to Shimada *et al.* (2016) displaced turtles from my study generally went back to their original capture site. Hence, the use of intentional displacement to avoid place-specific threats may be effective if the threat is temporal (such as oil spill). However, in my study the displacement strategy was intended to be used to minimise the probability of recaptured animals being exposed to threats in the "Major Extraction Zone" (in the Middle and Upper Guajira) by artisanal fishers that may have not had any involvement with this project, and where the annual intentional take of green turtles has been calculated to be around 3,600 turtles per year by Montiel-Villalobos (2012). Based on my data, it is necessary to now re-think this displacement strategy. Also, given the prevalence of ontogenetic habitat shifts (Carman *et al.*, 2012; Hayashi & Nishizawa, 2015; Howell *et al.*, 2016), future studies that examine displacement in different age/stage classes of turtles in the Gulf of Venezuela could reveal interesting patterns and behaviours.

5.4.7. Causes of stranding events

Small-scale artisanal fisheries are carried out in the area, mainly by Wayuú Indigenous people and mestizo inhabitants, and these fisheries play a key role in the status and condition of the marine turtles in the Gulf of Venezuela (Wildermann *et al.*, 2009; Barrios-Garrido *et al.*, 2017a) (Chapter 6 and 7). There are several permanent, year-round artisanal fishing nets within my study region. The presence of these permanent artisanal fishing nets is most abundant in the Upper Guajira area; only three permanent nets were located in the middle

Guajira area and only two permanent nets were observed in the low Guajira area (Montiel-Villalobos, 2012; Barrios-Garrido & Montiel-Villalobos, 2016). The nets mainly targeted shark, rays, and lobsters; however, due to their mesh size and the habitat area where the nets are set, they also capture marine turtles (green turtle, hawksbill turtle, loggerhead turtle, leatherback turtle, and olive Ridley turtles), dolphins (mainly Guiana dolphin, *Sotalia guianensis*) (Barrios-Garrido *et al.*, 2016a), and rarely, Antillean manatees (*Trichechus manatus*) (Montiel-Villalobos & Barrios-Garrido, 2005). Moreover, in the southern area (Low Guajira) the fisheries use longlines to catch rays and catfish (Barrios-Garrido *et al.*, 2017a), gillnets to catch bait for the longline, and artisanal trawls to catch fish; all of these fisheries have been reported to impact marine turtles to varying degrees (Wildermann *et al.*, 2009; Wildermann *et al.*, 2012). Yet for the most part, the impact of these fisheries on marine turtles and/or their habitats remain unquantified. It is important to note that there is a poorly documented fishery, considered by national authorities as artisanal, but they have monofilament gillnets and with mean five days of autonomy (operability without refuel), locally they are known as 'bongos' (Casas & Hernandez, 2010). Future research may be carried out to evaluate the rate of bycatch for this fishery in the Gulf of Venezuela.

5.4.8. Recommendations and limitations of this research

The Gulf of Venezuela has only one marine protected area (MPA), the "Ciénaga de Los Olivitos" Wildlife Refuge and Fishery Reserve (Ramsar site) located in the Southern portion of this area (low Guajira) (Medina & Barboza, 2003), which does provide protection to marine turtles. The main objective of this MPA is to provide protection for the American crocodile (*Crocodylus acutus*), American flamingo (*Phoenicopterus ruber*), and migratory birds. Moreover, its area is formed by mangrove forests and swamps, with scarce records of marine turtle presence. No current MPA exists in the Gulf of Venezuela for the purpose of protecting marine turtles. In 2008, a Government document provided details of potential areas that could be protected using Marine Protected Area (MPA) frameworks, however to date, the idea remains to be considered by the national government in Venezuela. Based on my data, I recommended the creation of a marine protected area which includes critical habitat in the coastal zone (Upper and Middle Guajira) along the Gulf of Venezuela. The management of which should acknowledge and include the cultural background of the Wayuú people, as traditional custodians of this territory (Chapters 6 and 7).

As part of the project implemented by the NGO "GTTM-GV," the empowerment of the community members was crucial to achieve conservation aims (Roe *et al.*, 2017; Vizina & Kobei, 2017) (Chapter 7), to preserve the cultural values of indigenous Wayuú people related to marine turtles, and to protect marine turtles as an important species in the ecosystem (Castellano-Gil & Barrios-Garrido, 2006; Barrios-Garrido & Montiel-Villalobos, 2010a; Castellano-Gil & Barrios-Garrido, 2010). For this reason, I strongly recommend the continuation of capacity-building and training of local fishers and Wayuú people to gather biological data on marine turtles. This type of initiative could have a positive effect on the commitment of the Wayuú people to support and participate in activities aimed at maintaining marine turtle populations. As such the approach is worthy of discussion and consideration among all stakeholders.

Some limitations of this research were related to the original datasets. Part of the stranding data used in this chapter lacked details (months, regions, and locality) and for that reason there are differences in the sample size. In general, this occurred because there have not always been standardised methods and some data were collated from non-computerised historical files. A standardised approach to sampling methods is also one of the recommendations of this chapter.

The continued compilation of evidence into how marine turtles move between locations and habitats, how they migrate, and the degree to which they undertake ontogenetic shifts between several feeding areas are essential to manage the impacts to marine turtle populations at ecologically relevant scales (Rees *et al.*, 2016; Shimada *et al.*, 2016). Doing this will require strategies and cooperation between government, community-based monitoring programs, and NGOs to maintain or develop data-sharing systems to achieve better conservation outcomes. There is clear evidence of the positive outcomes which can be achieved through long-term marine turtle conservation, such as in Tortuguero Beach (Costa Rica) (Troëng & Rankin, 2005; Garcia Varela *et al.*, 2016). However, zones such as the Gulf of Venezuela, which is an area where the illegal take of turtles is likely to be significant, require incentives and capacity-building to create community-based or co-management systems to improve monitoring and conservation of marine turtles.

Chapter 6

TRADE OF MARINE TURTLES ALONG THE SOUTHWESTERN COAST OF THE GULF OF VENEZUELA [1]

Leatherback turtle harvested for consumption in the Guajira Peninsula, Venezuela.

Photo credits: Héctor Barrios-Garrido (2013)

[1] Barrios-Garrido, H., Espinoza-Rodríguez, N., Rojas-Cañizales, D., Palmar, J., Wildermann, N., Montiel-Villalobos, M., & Hamann, M. 2017. Trade of marine turtles along the southwestern coast of the Gulf of Venezuela. Marine Biodiversity Records, 10(1), 1-12. doi: 10.1186/s41200-017-0115-0.

ABSTRACT

Marine turtles play an important role in the culture and economy of numerous coastal communities around the world. However, the legal framework that regulates the consumptive use of these reptiles varies among countries. For example, the consumption of these reptiles has been regarded as common in several rural areas of Venezuela, especially in the eastern coast of the Guajira Peninsula. To assess the scale and cultural component of this use, I interviewed 35 residents from the southwestern coast of the Gulf of Venezuela (Venezuelan part of the Guajira Peninsula), using a combination of in-depth and semi-structured interviews. I carried out a field and detailed market-based observations on the Guajira Peninsula to detect the sale and use of marine turtle products. I focused on three main categories of use; the type of product, routes of trade, and the price of products. All of the marine turtle species reported from the Gulf of Venezuela were used, and the prices of products varied among their type, species of origin, and the distance from the capture area to a marketplace. I obtained evidence connecting Wayuú Indigenous people's traditions and beliefs with marine turtle use, and also, they are used as traditional products such as medicine, and as an economic resource to sustain their communities. It is probable that trade of marine turtle products is placing pressure on populations in the Gulf of Venezuela. I recommend the implementation of an inter-institutional conservation-portfolio be developed for the Peninsula to evaluate actions related to this concern.

Key Words: illegal trade, marine turtles, Gulf of Venezuela, Colombia, Wayuú people.

6.1. INTRODUCTION

Marine turtles are exposed to multiple, and cumulative threats throughout their lives, and the extent to which species are exposed differs among RMUs (Wallace *et al.*, 2011a). One well-documented threat is the capture for the intent of consumption, either as a result of incidental bycatch or intentional take. Consumptive use of marine turtles, especially illegal retention and use of these species is often linked to artisanal fisheries occurring in developing tropical countries (Buitrago *et al.*, 2008). However, in-depth investigations on this topic tend to be complicated due to the often clandestine nature of turtle fisheries (Mancini & Koch, 2009). In general, the data on this human-turtle interaction is lacking in the literature (Hamann *et al.*, 2010; Rees *et al.*, 2016).

For thousands of years marine turtles have played an important role in many cultures around the world (Olijdam, 2001; Frazier, 2005; Antczak *et al.*, 2007). Yet over the past few hundred years many populations have been exposed to some degree of systematic commercial use (Nada & Casale, 2011; Lagueux *et al.*, 2014, 2017). The scale, and impact of commercial use varied considerably and some populations were exposed to pervasive pressure that lasted many decades and caused declines in population sizes.

In recent decades, marine turtles have been afforded stronger conservation and protection at international (e.g. CITES) and national (e.g. legislation to regulate use) scales (Roberts & Hamann, 2016). The rise in the number of conservation and policy instruments protecting turtles has essentially meant that there are now fewer commercial markets (Humber *et al.*, 2014). However, marine turtles are still subject to use in some places of the world (Chapter 3). For example they are used legally by some indigenous cultures for traditional rites, culture and trade (Fleming, 2001; Frazier, 2009). For instance, in Australia, Aboriginal and Torres Strait Islander People maintain legal, non-commercial traditional use under Australia's Native Title Act (1993), which links non-commercial use to Traditional cultural protocols (Butler *et al.*, 2012; Weiss *et al.*, 2013). Similarly, in the American continent, the use and trade of marine turtle products occurs along much of the tropical coastline (Rueda-Almonacid *et al.*, 1992; Bräutigam & Eckert, 2006); and some indigenous people from the Caribbean continue to use marine turtles as a totem, a form of currency and as a spiritual link between humans and the divine world (Roe Hulse, 2005; Barrios-Garrido & Montiel-Villalobos, 2006; Ankersen *et al.*, 2015) (Chapter 7). In the majority of countries in the Caribbean the consumptive use of marine turtles is classed as illegal by national Government legislation (Humber *et al.*, 2014) (Chapters 2 and 3). For example, Venezuela, which, as a signatory state of several international treaties that protects marine turtles, has developed national laws and presidential decrees to protect marine turtles from consumptive use (Venezuela, 1996a, 1996b, 1996c; Venezuela, 2009) (Chapters 3 and 4).

Understanding how, where, when and why consumptive use may be occurring is crucial for the development or enforcement of policies or legislation that offer protection to marine turtles and/or their habitats. Further, the development of management strategies or the enforcement of legislation is especially challenging when the protective status of the species, or the legislation regarding threats such as consumption are not clear (Richardson *et al.*, 2006; Stringell *et al.*, 2013). For example, in the Caribbean waters of Nicaragua the consumptive use of marine turtle is considered legal but it is regulated by conditions dealing with ethnicity, turtle size, and species. Yet in reality, fishers do not always follow these rules when landing catches of marine turtles in the artisanal ports of this region (Lagueux *et al.*, 2014, 2017). As a result, the boundary between illegal and legal tends to be clouded.

Despite the legal framework protecting marine turtles in Venezuela, the use and trade of marine turtle products in the country is common, predominantly by people living in remote coastal areas (Guada & Sole, 2000; Vernet & Gómez, 2007; Montiel-Villalobos, 2012; Rojas-Cañizales, 2015) (Chapter 5). Here, in these coastal areas, especially in the Venezuelan Guajira Peninsula, and despite the legal protection of marine turtles in Venezuela, the Peninsula's Wayuú Indigenous inhabitants acknowledge that they continue to use marine turtles as a cultural tradition and to improve their livelihoods (Barrios-Garrido & Montiel-Villalobos, 2010b, 2016) (Chapter 7). However, the policy and legal situation is complex.

Although the Wayuú people's use of turtles would be classed as illegal under wildlife protection legislation, Venezuela also has national legislation aimed at protecting the rights of Indigenous peoples and their tribal communities. This legislation states that the Venezuelan Indigenous people have rights to use the regions natural resources, especially resources occurring within the ancestral territories (Venezuela, 2005). In addition, there is an International treaty signed and ratified by the Venezuela Government to protect the traditional use of natural resources within Venezuela (*Indigenous and Tribal Peoples Convention*) (ILO, 1989). Thus, it could be perceived that there is a conflict of legislation and/or policy, and progressing conservation initiatives for marine turtles in Venezuela and the southern Caribbean requires alignment of conservation and traditional goals of the indigenous people and the local Government.

The Wayuú people ("Guajiros" in their language: *"our people"*) comprise the largest demographic sector of Indigenous people in Venezuela (also in Colombia), with 443,544 in Venezuelan territory, and 128,727 in the Colombian portion of the Guajira Peninsula

(Cerquera Gonzalez, 2008). Based on their narratives during the Spanish conquest (mid 1700's), they were classified into two main groups: shepherds and fishermen (this latter also known as *Apaalanchi* in Wayuúnaikii) (Martínez, 2011). *Apaalanchis* reside along the coast and depend on coastal resources for their livelihoods. As a result, artisanal fishing is the most common economic activity in the region, and it is well established in the La Guajira Peninsula (especially in the Venezuelan part of it). *Apaalanchi* (Wayuú) elders, clan leaders and fishers have described themselves as "shepherds of the sea", and marine turtles as an animal used to sustain their culture; *"marine turtles are for our people like oil is to Venezuela"* (Interview: Fernández J., In: Soré *et al.*, 2006). Previous authors have also reported the consumptive use of marine turtles (and their secondary products) by the Wayuú people (Parra, 2002; Martínez, 2011); however, the details on how this use occurs were not provided, as well as the strong relationship between Wayuú culture.

Wayuú cultural laws are passed orally across generations and are well respected by people in their everyday life (Macías & Garzón, 2005; Balza-García, 2010; Paz Reverol *et al.*, 2010; Riaño-Alcalá, 2014). However, transcultural aspects have modified the needs of Venezuelan Indigenous communities, leading to the inclusion of a commercial component into their local economy and livelihood (Castellano-Gil & Barrios-Garrido, 2006; Robles, 2008). Now, Wayuú people use a variety of different marine turtle body parts as commercial items: for example, meat (mainly pectoral muscles), carapace, as well as the scutes of hawksbill turtles. This shift towards commercial use of marine turtles has placed increased pressure on the Gulf of Venezuela's marine turtles and its management is important because regional marine turtle populations are considered to be conservation dependent in Venezuela (Barrios-Garrido *et al.*, 2015; Buitrago *et al.*, 2015a; Buitrago *et al.*, 2015b; Guada *et al.*, 2015; Rondón-Médicci *et al.*, 2015). Hence, pervasive commercial use, or use not managed by community-based programs could compromise the status of marine turtle species within Venezuelan waters (Barrios-Garrido & Montiel-Villalobos, 2010b) (Chapter 5).

Green turtles have been reported as the species most impacted by commercial consumptive use in the Gulf of Venezuela (Guada & Sole, 2000; Rojas-Cañizales, 2015). In 1987 and 1989, trade and consumptive use of marine turtles in the area was reported but classified as low in magnitude (Sideregts *et al.*, 1987; Acuña *et al.*, 1989). However, recent studies carried out in the Venezuelan region have quantified the take to be around 3,649 ± 434 green turtles per year (Montiel-Villalobos, 2012). This number, plus the 5,000 to 6,000 green turtles captured annually and reported by Rueda-Almonacid *et al.* (1992) from the Colombian portion of the Guajira Peninsula places to the Guajira Peninsula as the second most important turtle fishery in the Caribbean after the fishery in Miskitos (Nicaragua) (Lagueux *et al.*, 2014, 2017). It is important to recognise that these numbers were calculated only for green turtles captured and did not include annual estimations for any other species of turtle.

The majority of green turtles taken annually between the Colombian and Venezuelan areas of the Guajira Peninsula are generally used for traditional consumption, or are traded commercially (Villate, 2010; Rojas-Cañizales, 2015). Indeed, some authors have shown there is also a high demand of marine turtle products among Wayuú people who reside in Colombian area of the Peninsula (Rueda-Almonacid *et al.*, 1992; Villate, 2010; Borrero Avellaneda *et al.*, 2013). However, while use appears to be widespread throughout the coastal areas of the Gulf of Venezuela the differentiation between the traditional use and illegal trade remains a challenge to understand and regulate (Chapters 5 and 7). The aim of this chapter is to assess the scale and magnitude and cultural component of this use on the southwestern coast of the Gulf of Venezuela (Venezuelan portion of the Guajira Peninsula), including some references to the legislation conflict among the national laws (environmental, cultural and social) and international treaties.

6.2. METHODS

6.2.1. Study area

The study was conducted in locations believed to be the principal trading centres of marine turtles (a) Guajira: Castilletes, Porshoure, Kazuzain, Neima, Paraguaipoa; (b) Mara: San Rafael del Moján; (c) Maracaibo: north-western Maracaibo (Bomba Caribe, La Tubería, Motocross, and Maicaito neighbourhoods). Trading centres were identified during preliminary surveys conducted by me and trained personnel in the Guajira, Mara and Maracaibo municipalities, using personal observation and informal interviews with fishers (Table 6.1).

The selected ports and public markets were located along the southwestern coast of the Gulf of Venezuela, from Castilletes (11.8483 N; 71.3240 W) to Zapara Island (10.9549 N; 71.5290 W) (Figure 6.1). In each locality the surrounding populated areas often lacked basic amenities, such as access to clean water supply, sewage service, and house-hold electricity (although in Paraguaipoa, San Rafael del Moján, and Maracaibo electricity is considered more reliable).

The Gulf of Venezuela is located in the upper and exterior slump of the Maracaibo Lake System (Medina & Barboza, 2003; Morán *et al.*, 2014; Barrios-Garrido *et al.*, 2016a), and this coastal region represents one of the most important feeding grounds for marine turtles in Venezuela (Barrios-Garrido *et al.*, 2015; Buitrago *et al.*, 2015a; Buitrago *et al.*, 2015b; Guada *et al.*, 2015; Rondón-Médicci *et al.*, 2015). Studies within the last decade have confirmed the presence of five marine turtle species in Gulf of Venezuela region (Parra, 2002; Barrios-Garrido, 2003; Montiel-Villalobos, 2012; Rojas-Cañizales, 2015) (Chapter 5); *Chelonia mydas* (green turtle), *Eretmochelys imbricata* (hawksbill turtle), *Caretta caretta* (loggerhead turtle), *Dermochelys coriacea* (leatherback turtle) and *Lepidochelys olivacea* (olive ridley turtle).

6.2.2. Data collection

Data were collected between January 2002 and January 2017 (Table 6.1). My data included semi-structured in-depth interviews (open-ended), preliminary observations and informal interviews, plus my own systematic observations in the markets and trading centres of Venezuelan portion of the Guajira Peninsula. The interviewees (key-informants) were fishers, transporters, wholesalers, business holders (restaurant and non-restaurant owners, and artisans), and buyers.

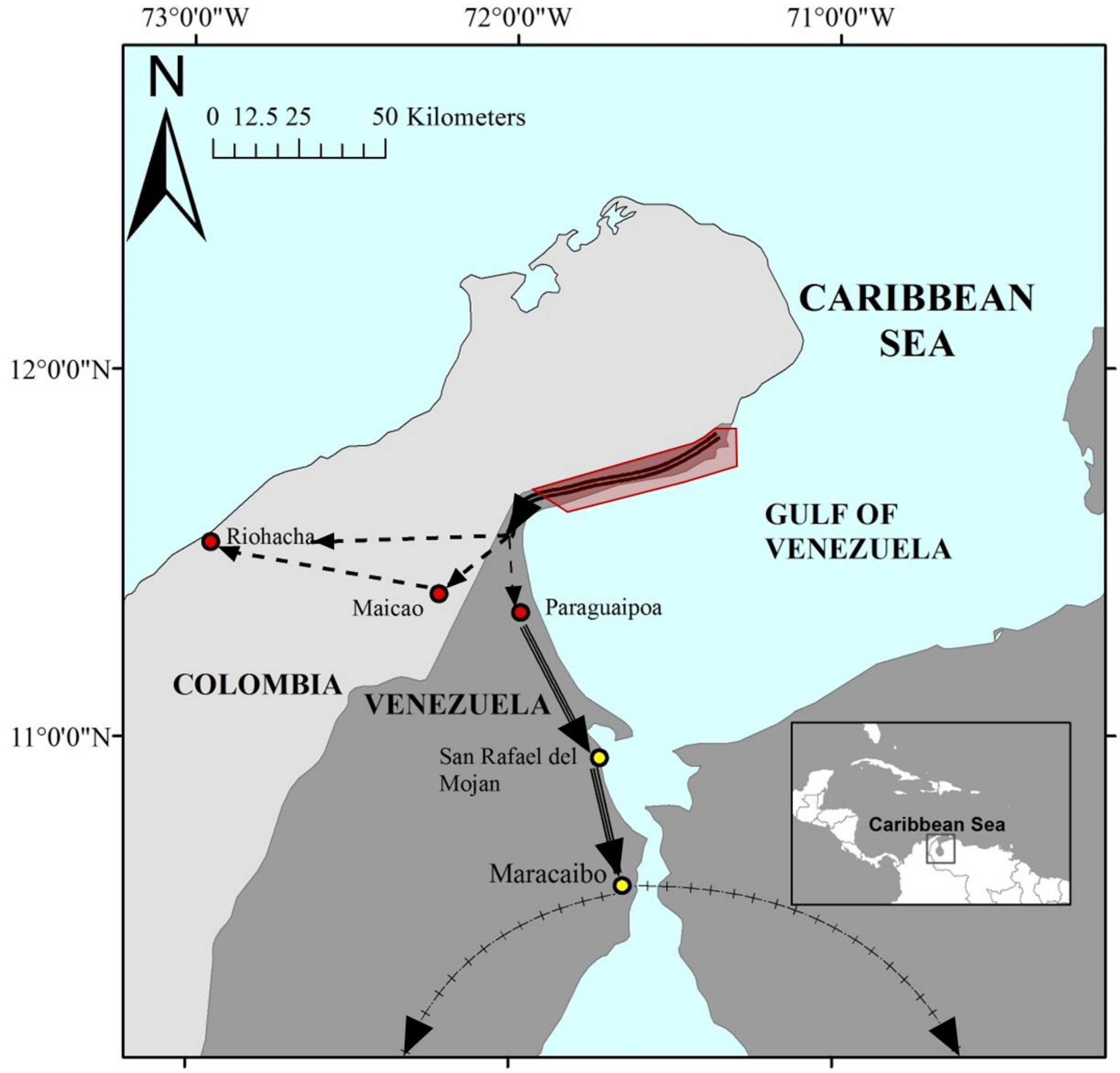


Figure 6.1 Geographical location of the study area and the relative position of the study area in the Caribbean Sea (insert). Red polygon represents the areas where I found the marine turtle products. Double line arrow represents the direction of trade by wholesalers or transporters towards secondary sellers or business holders, the latter are represented by red dots (in Colombia: Maicao and Riohacha, and in Venezuela: Paraguaipoa). Dashed arrows represent the general route used by secondary sellers or transporters. Triple line arrows represent general routes used by transporters or secondary buyer towards main populated centres (as San Rafael del Moján and Maracaibo – yellow dots). Crossed arrows represent the general routes used to send the products into San Cristobal, Merida, and Lara states (in Venezuela).

I categorised respondents (all Wayuu indigenous people) according to the main activity they conducted in the last five years: (a) fisher/fish collector is either specialised as a turtle hunter (owner of “turtle nets” – nets with more than 20 cm mesh size) or not specialised (opportunistic turtle catcher). Further, a fish collector is a person who owns a refrigeration system and could store butchered marine products (turtle, spiny lobster, and fishes) for periods of more than one week; (b) wholesaler or transporter; these are people who purchase turtles from the fishers and are then responsible for making secondary transactions, on-selling the products (wholesaler), or a person who has the financial capacity to not only buy the products, but transport them to another market or location (transporter), usually they have access to a 4x4 vehicle with an ice container to keep the products fresh (called "Turtle trucks" – in Spanish "*Camion Tortuguero*"); (c) business owners or final sellers, generally they purchase from the wholesalers or transporters and some of them have the means to keep the animals alive until their final use; (d) final buyers, person who buy the final product (e.g. turtle dish, hawksbill scutes, or other turtle products).

Table 6.1 Data collection methods for marine turtle trade evaluation in the Gulf of Venezuela (2002 – 2017).

Timeline	Method	Personnel involved	Places evaluated
January 2002 – July 2003	Informal interviews	Biologists with expertise on marine turtles (HBG, MGMV) and trained community members (JP)	Eight trade centres (artisanal fishing port areas)
	Market-based observation		Four markets (populated centres)
July 2005 – August 2008	Semi-structured in-depth interviews (Appendix 3)	Biologists with expertise on marine turtles (HBG, NER, MGMV) and trained community members (JP)	Six trade centres (artisanal fishing port areas)
September 2008 – May 2011	Market-based observation	Biologists with expertise on marine turtles (HBG, NER, NW)	Eight trade centres (artisanal fishing port areas)
			Three markets (populated centres)
November 2012 – November 2013	Semi-structured in-depth interviews (Appendix 3)	Biologists with expertise on marine turtles (DRC, NER) and trained community members (JP)	Two markets (populated centres)
			Two trade centres (artisanal fishing port areas)
August 2014	Market-based observation	Biologists with expertise on marine turtles (HBG, DRC)	Eight trade centres (artisanal fishing port areas)
			Four markets (populated centres)
January 2015 – January 2017	Personal observations	Trained community members (JP)	Four trade centres (artisanal fishing port areas)
			Four markets (populated centres)

All in-depth interviews were conducted by research volunteers and myself in collaboration with Opportune Information Network protocol (in Spanish, Red de Aviso Oportuno – RAO-Zulia) (Vernet & Gómez, 2007; Barrios-Garrido & Montiel-Villalobos, 2016). I located people to interview using the "snowballing" technique, in which the recommendation of each interviewee is used to locate additional potential interviewees (according to their perceived experience with the interview topic). The in-depth interviews, using open-ended questionnaires (Appendix 4), were carried out by the author in either Spanish or Wayuúnaikii (Wayuú Indigenous language) (I received help from one of the trained community member who is Wayuú clan leader, and the Wayuúnaikii is his first language). All the in-depth interviews were conducted in private locations within the localities listed in Figure 6.1. The interviewees were also asked about their general knowledge of marine turtle's species, presence and abundance in the area, and how they got that information.

To analyse the qualitative data, I extracted common themes about: trade, traditional use, and anecdotal information related to marine turtles. I then counted the number of respondents who discussed each theme and the value they attributed to each of them (cultural, economic, livelihood, utilitarian, mythical, and medicinal) (Table 6.2). Some interviewees' responses were classified into more than one theme and/or value (See Table 2) (D'Lima *et al.*, 2014).

I focussed on collecting data under three main themes: (a) trade (relates to the movement of the product such as capture and market locations, trade routes, and price of marine turtle products); (b) traditional use (non-commercial exchange of marine turtle products between families and clans); (c) anecdotic information about marine turtles (Tambiah, 1999) (Appendix 4). When it was possible in the markets and trade centres, I photographed the turtles and products on sale after seeking the oral permission from the people involved (Figures 6.2-6.6). I defined trade (or commercial use) as the exchange of marine turtle products and secondary-products for money; this action involves a seller, sometimes a dealer or transporter, and a buyer. I included Colombian localities (Maicao and Riohacha) in Figure 1 due to the common reference to them made by the interviewees of these locations.

I conducted visual observations in eight trade centres, and four markets (Table 6.1). In those places I collected the information regarding prices. Along with other non-Indigenous assistants, I approached sellers as a potential buyer, and then I contrasted the prices I received with the prices quoted to one of the Indigenous members of the community. Prices were calculated by 1 US dollar per 199 Venezuelan Bolivars (official Venezuelan rate in 2014, called SIMADI).

6.3. RESULTS

I interviewed 35 Wayuu Indigenous people (26 between July 2005 and August 2008, and nine between November 2012 and November 2013). Seventeen of them were categorised as fishers and could be turtle-hunters or casual turtle catchers, only seven of 17 fishers had the capacity to store products (refrigerator system). Nine of the 35 were classed as wholesaler or transporter. Five were classed as business owners or secondary sellers, and four were classed as final buyers of the product. All 35 provided data regarding the use of marine turtle that occurs in the area. My respondents were aged between 21 and 78 years old (24 men, 11 women). I obtained a 100% of response rate.

During my surveys, I visited 12 populated centres (between cities and towns) and eight markets (Table 6.1), and observed how the turtle products in some cases were exhibited, and in other cases the turtle products are hidden from the general public and only shown after some gentle persuasion of the sellers. I also confirmed the variation in the prices in relation to the ethnicity of the buyers (difference in the prices provided to JP and the rest of the team members).

In particular, responses to my surveys, combined with my observations in markets, revealed that Wayuú people use marine turtles as a food, economic and cultural resource at locations spread along the southwestern coast of the Gulf of Venezuela (Table 6.2; Figure 6.3). Also, among the potential marine turtle products I found were products with commercial value such as meat and guts from green and hawksbill turtles (Figure 6.4), carapaces, hawksbill turtle scutes (Figure 6.5), leatherback turtle oil which is used as medicine according with Wayuú's beliefs and traditions (Figure 6.6), and some less common products (such as dried organs), or a prepared full meal (often turtle meat with white rice and soup) (Figure 6.3).

Figure 6.2 Green turtles (*Chelonia mydas*) in the market place (Los Filúos) awaiting the final buyer(s). Photography: H. Barrios-Garrido.

Figure 6.3 Advertisement for turtle ("Tortuga") dishes. Advertisement placed next to the main route of the study area ("Troncal del Caribe"), next to the entrance to Caimare Chico beach, the most popular tourism destination in the Guajira municipality. Photography: H. Barrios-Garrido.


Figure 6.4 Green turtle meat, guts and fat for sale in "Los Filúos" market, Paraguaipoa, Zulia state. Photography: H. Barrios-Garrido.

Figure 6.5 Rooster spurs made from hawksbill turtle (*Eretmochelys imbricata*) scutes. Photography: H. Barrios-Garrido.

Figure 6.6 Leatherback turtle (*Dermochelys coriacea*) oil bottled to be sold or exchanged between families. Photography: H. Barrios-Garrido.

Table 6.2 Common themes extracted from interviewees' answers, number of respondents, values attributed to each theme, and illustrated examples.

Theme (No. of respondents)	**Value type**	**Illustrated example**
Marine turtles are key animals for Wayuú people (n= 35)	Utilitarian	*"I raised my family thanks to the marine turtles"*
		"if you put a turtle skull in a corral gate, the goats will have more offspring"
		"if turtles are around in the water the fish catching will be great"
		"My grandmother used the carapace as a container for food or clothes"
Wayuú fisher's economy is based in marine turtles (n=32)	Economic	*"...nowadays my grandsons are attending the primary school because I sell turtle meat to buy their books, uniforms, and everything"*
		"Alijünas in Colombia pay really well the turtle products"
		"We know that is considered illegal, but we need to use the turtles to buy goods"
Marine turtles are used as exchange trade products (n=21)	Livelihood	*"I prepare turtle oil for my brother, and he gives me goat's meat"*
		"In my family, we eat turtle at least once a month. If we do not eat it, we will feel bad"
		"During my childhood, my father had a corral for hens, and one corral for turtles"
Marine turtles are divine creatures (n=20)	Mythical	*"Marine turtles are gift from Maleiwa, but the Alijünas do not understand that"*
		"in the ancient cemeteries, I found mixed human and marine turtle bones"
	Medicinal / Mythical	*"Marine turtles saved my life"*
Marine turtles are the cultural core of Wayuú fishers (n=12)	Cultural / Mythical	*"My boy turned into a man when he sacrificed his first turtle"*
		"After the first period, the girls take a shower with 'moon water', and its container is a turtle carapace"

I found that at least four of the five species of marine turtles that inhabit the Gulf of Venezuela are used commercially by local communities (*Chelonia mydas, Eretmochelys imbricata, Caretta caretta, Dermochelys coriacea*) (Table 6.3; Figure 6.2). I received no information about the use of *Lepidochelys olivacea*.

Table 6.3 List of products and secondary products used commercially along the Southwestern Coast of the Gulf of Venezuela. *prices calculated by 1 US dollar per 199 Venezuelan Bolivars (official Venezuelan rate in 2014, called SIMADI)

Products and secondary – products	**Price***
Meat and guts (green/hawksbill/loggerhead)	US$ 5 to 6 per kilo
Complete turtle [13] (green turtle/hawksbill)	US$ 163 to 210
Marine turtle meal (restaurants) (all species)	US$ 8 to 9
Leatherback oil	US$ 5 per Littre
Dried penis (green turtle/hawksbill)	US$ 14 to 37 per penis
Carapace (hawksbill)	US$ 300
Roosters spurs (hawksbill scutes)	US$ 9 the pair

My data from market observations plus responses from interviewees affirm that the green turtle is the most common species involved in the trade. The most common products generated from green turtles are the meat and guts, which are sold in public markets, restaurants, and are sometimes transported out of the Zulia state limits (towards other Venezuelan states, or into Colombian towns). The asking prices for green turtles varied according to the size of the animal. In the case of hawksbill turtles, some interviewees (n= 8) believe that the species is the “male” of the green turtle, and they are scarcer nowadays in the GV in comparison with historical recollection. Although meat from hawksbill turtles was also found in markets, the most profitable products extracted from this species are the carapace and its scutes. While I did observe loggerhead turtle products in the markets, it was not common, probably because when it is available it is more commonly shared between families. Indeed, my respondents affirm that its taste is too fishy to be attractive to buyers.

[13] Any weight

Leatherback turtle's meat is not often consumed, rather its oil is the most popular item and it is generally used as medicine to cure or prevent asthma. According to five of my interviewees leatherback turtle oil is often requested by non-Indigenous people as well (called "*Alijünas*" in Wayuúnaikii) (Chapter 7).

The price of marine turtle products varied among species and product size/type. Prices typically range from US$5 (e.g. for one kilogram of green turtle meat) to US$300 for a whole adult-sized animal (green or hawksbill turtle) (Table 3). My respondents affirmed that this variation in price also fluctuates in relation to the difficulty associated with accessing animals (season, presence of army patrols, and frequency of the species). For example, hawksbill products tend to be more expensive due to their scarcity, and the relationship with this species and the traditional beliefs of the Wayuú people. I typically found lower prices in remote localities (for example from Castilletes to Neima) where most buyers were Indigenous and likely had lower incomes. This is in contrast to the higher prices (sometimes up to five times) that I found in localities where mestizos (non-Indigenous) customers were reported to purchase products (for example from Paraguaipoa to Maracaibo).

I found that juvenile and adult turtles were used commercially, were sold both dead and alive, and the prices varied according to the size of the turtles. I also found that the prices varied among years, localities, product, and trade centre. Close to one third of my respondents (29%) affirm that while some smaller sized green turtle (<35cm CCL) are sold, most are consumed by the fisher's family, especially if they are caught at the beginning of the "turtle season" (August to October), because it is considered as a symbol of prosperity from God.
I noted that the high demand for marine turtle products is not only driven by the needs of Indigenous local communities. In particular, nine of the wholesalers I interviewed said that

they have sold, on at least one occasion in the past five years, turtle products to non-local and non-Indigenous people. In addition, three of the four buyers I interviewed were non-Indigenous people. From my interview data, it appears that the products they purchased are obtained by fishers in the study area and are then transported to other places in the Zulia state, such as San Rafael del Moján, Maracaibo (capital city of Zulia state), La Cañada de Urdaneta, Sabaneta de Palmas (minor cities in Zulia state), and as far away as Mérida, Táchira and Lara States (Venezuelan Inland major cities) where the majority of inhabitants are not Wayuú. However, although the majority of the inhabitants of these populated centres were non-Indigenous members, my respondents (n= 20) affirmed that in the urban centre of Maracaibo the sellers tend to be part of the extended family of the fishers or wholesaler/traders. In Maracaibo, the main type of products sold were the turtle soup and turtle "empanadas" (similar to a meat pie), and they were sold both informally and at small restaurants (street stalls). I found this to occur in neighbourhoods where although traditionally Wayuú people lived, there is now a large proportion of mestizos (non-Indigenous people).

Thirty-three of my respondents also provided information indicating that marine turtle products originating from Venezuela are being sent across the border into Colombia. The most common Colombian destinations are Riohacha and Maicao, which are cities lying adjacent to the Gulf of Venezuela and within the Colombian Guajira Peninsula (Figure 6.1). However, there was less clarity around what species and products were being traded across the border as some respondents (n= 13) believed that the trade into Colombia comprised only of hawksbill turtle products (mainly its scutes) and the other products were being sent to different cities such as: Valledupar, Santa Marta, Barranquilla, Cartagena de Indias, Rosario

Islands (which are located outside of the Colombian portion of the Guajira Peninsula), or even into Panamá.

Of 35 interviewees, 21 indigenous people believed there should be special exception to the marine turtle protection laws because of their traditional ancestry and the desire to maintain cultural-based use of the marine turtles. For example, one respondent claimed:

> "*…Marine turtles are gift from Maleiwa, but the Alijünas do not understand that. This (the use of turtle) for us (Wayuú) should be legal, because is part of our culture. Look, I raised my family thanks to the marine turtles, and nowadays my grandsons are attending the primary school because I sell turtle meat to buy their books, uniforms, and everything,… but the army people does not understand that and tried to put me on jail*" (Table 6.2).

This difference of opinion between indigenous people and the legal situation creates a conflict between traditional customs and beliefs of Wayuú people and the agencies enforcing the national legal framework. Further comments are in the Chapter 5 and 7.

Between 2014 and 2017, as part of a separate study, I was able to re-visit all the trade centres and markets that I surveyed initially in 2002 (Table 6.1), and I were able to conduct market-based observations in each. Although, I found that the trade of products of green turtle, hawksbill, and leatherback turtle is still occurring in the area. I did not collect data on other social and economic aspects of the trade for these trips.

6.4. DISCUSSION

My results demonstrate that at least four species of marine turtle in Venezuela are subjected to use and trade, and their prices and value to the community are strongly influenced by culture, origin, species, product, quantity and demand and ethnicity from buyers. I found the most commonly traded species is the green turtle; however, the most expensive products were derived from the hawksbill turtle. The products varied in price from US$5 (e.g. for 1 kilogram of turtle meat) up to US$300 (for a carapace from an adult-sized hawksbill turtle - unmanufactured). Hawksbill turtle products were more expensive than products derived from the other species and this scenario is similar to those identified by Rueda-Almonacid *et al.* (1992) who found a clear difference between the prices of hawksbill, green, and loggerhead products when evaluating the trade of marine turtle products in the Colombian side of the Guajira Peninsula. It is possible that the species based differences could be related to the lower relative abundance to green turtles in my study area or more broadly in the Caribbean (Campbell, 2014), or reflect the availability of preferred habitat types for the two species (Buitrago & Guada, 2002; Parra, 2002).

My data demonstrate that despite use being illegal, the consumption of marine turtles is common and occurs without evidence of regulation or enforcement in the Guajira Peninsula. However, importantly, the Wayuú interviewees affirm that their people have an ancestral cultural connection with marine turtles and they used marine turtle products because they considered their use to be connected to an ancient cultural activity (Rueda-Almonacid *et al.*, 1992; Parra, 2002; Villate, 2010). In the Wayuu's tradition and belief systems marine turtles represent a gift from God (*Maleiwa* in Wayuúnaikii) (Guerra Curvelo, 2011), thus the use of them is seen as correct and regarded as culturally legal (Rueda-Almonacid *et al.*, 1992;

Robles, 2008; Villate, 2010). For instance, for the Wayuú people marine turtles represent the cattle of "*Pulowi*" (a deity). Several oral stories described how these animals were shared with the Wayuú people since ancient times to be consumed by Wayuú people (Chacín, 2016), also some elders explained a story about a sacred place (called "*Julirawanar*" hill) where the turtles are treated and healed by "*Pulowi*" (Guerra Curvelo, 2011). Hence, many of the products consumed have a significant traditional value (Villate, 2010). Importantly, some Wayuú interviewees affirm that in some cases the turtle product is not sold, rather the products are exchanged and shared among or between families, especially if the product will be used as medicine. The most common marine turtle product exchanged between Wayuú families was the leatherback turtle oil, which the respondents told me was a traditional cure or prevention for respiratory problems such as asthma, especially in children.

Despite the existence of national and internationals laws that prohibit international trade of marine turtles (Guada & Sole, 2000), my data and those of other researchers have found that Wayuú people follow their ancient laws and continue using marine turtles. However, there is now a commercial component to the trade (Robles, 2008). Given the commercial nature of the trade, plus the existence of commercial marine turtle use in nearby country and cities (Colombia, 2002; Amorocho, 2003). It is necessary to improve the knowledge of how the trade may impact local and regional marine turtle populations (number of animals traded, species, and lack of enforcement). Understanding the scale of use in relation to the marine turtle population size and the stability of the region's marine turtle populations as well as the attitudes towards culturally appropriate management would be a useful future steps to aid marine turtle conservation in the southern Caribbean (Weiss, 2011).

Thirty-two of the 35 interviewees stated that despite the cultural connections, it was the positive difference in monetary exchange rates when trading between the Colombian and Venezuelan currency that underpinned their part of the trade of marine turtles over the border. This international trade is possible because the Guajira Peninsula is located between Colombia and Venezuela, and traditional Wayuú territory occurs on both sides of the Peninsula's international border. Hence, the Wayuú people consider the entire peninsula as one ancient territory and not two nations (Perrin, 1989; Rueda-Almonacid *et al.*, 1992; Chacín, 2016). Importantly, my data reveal that the Wayuú people do not recognise this type of trade as international and instead they believe it is a continuation of their ancient use and trade of resources within their traditional territory (all Guajira Peninsula) (Parra, 2002; Carrasquero & Finol, 2010). However, the social reality of the peninsula's depressed economy means that the products now tend to be used commercially. Indeed, some interviewees claim that is worth selling the products further afield such as into Colombia's populated centres of Maicao or Riohacha (Guajira Department) to achieve greater value due to the Venezuelan Bolivars-Colombian Pesos exchange rate. Similarly, I presume, based on my data, that it is the potentially high profit margins that drive fishers to sell hawksbill scutes (handcrafted or not) to Colombian localities, or even to other international destinations, such as Panama. Interestingly, this monetary exchange rate was the opposite in the 1980s and 1990s (Rueda-Almonacid *et al.*, 1992) but it is not known whether the same or reverse patterns of use and trade existed.

I acknowledge that my data were collected over 15 years period. During this timeframe communities and patterns of use could change. However, the information that I received on use type, tradition, and trade routes indicate these aspects did not change among the survey periods. This is probably due to the nature of remote region of study area and the general lack of change in infrastructure. Plus the strong social background of the Wayuú communities settled in the Guajira Peninsula remains.

My findings indicate the trade of marine turtles remains a common issue in the study area. Indeed, during the last surveys between 2014 and 2017, I found marine turtle’s products are still being sold in trade centres and markets. However, it was not possible to establish a comparison in price over time for the products, because of the high variability on the prices and incongruences among the interviewees’ answers. This latter may be due to the lack of clarity about the exchange rate between Venezuelan Bolivars and Colombian Pesos, and the annual inflation registered and reported by the Venezuelan Government during 2014 to 2017 (Banco Central de Venezuela, 2014, 2016). Also, the high levels of illicit activities that were detected in Guajira Peninsula, such as smuggling essential goods (food and medicines) and fuel into Colombia, led the Government of Venezuela to declare an emergency state in the Peninsula and close the border with Colombia (IWGIA, 2016).

I found that illegal trade of marine turtle products is an issue throughout the study region, especially among the inhabitants of the Venezuelan Guajira. However, the Venezuela Government is a signatory to several international treaties which prevent consumptive use and/or international trade of marine turtles, in particular, the Inter-American Convention for the Protection and Conservation of Sea Turtles and CITES (Venezuela, 1996c; Naro-Maciel, 1998; Campbell *et al.*, 2002). Exemptions from national legislation for in-country use could be granted to a Government if they could demonstrate that the in-country use is local, sustainable, and regulated (and occurs to satisfy economic subsistence needs of traditional communities). Thus, if the use of marine turtles by Wayuú people is to be continued a possible exemption and the detail of knowledge required should be investigated. It is however likely that the commercial component would need to be removed if an exception was granted. A similar provision occurs in Australia, where the Aboriginal and Torres Strait Islander People hold a legal right to continue cultural, non-commercial, use of marine turtles, and this right is managed under combinations of legislation and community-based management (Grayson *et al.*, 2010).

My study found the issue of commercial use of marine turtles is currently occurring in Venezuelan territory and the cultural component is a key aspect to it (Martínez, 2011). The local NGO “Grupo de Trabajo en Tortugas Marinas del Golfo de Venezuela (GTTM-GV)” is currently carrying out a bilingual conservation-portfolio to address this situation in the area with the support of local stakeholders (Barrios-Garrido *et al.*, 2012) (Chapter 5). However, it will be necessary to support the domestic and international relationships and discussions among all involved entities to design an effective and inter-institutional management plan to allow differentiating the traditional use and the illegal use and manage it with cultural and ecologically appropriate means.

Chapter 7

MARINE TURTLE PRESENCE IN THE TRADITIONAL PHARMACOPOEIA, COSMOVISION AND BELIEFS OF WAYUÚ INDIGENOUS PEOPLE [1]

Marine turtle skulls hanging on a corral fence in Venezuela's Guajira Peninsula, traditional land of Wayuú people. Photo credit: Héctor Barrios-Garrido (2010)

[1] **Barrios-Garrido, H.;** Palmar, J.; Wildermann, N.; Rojas-Cañizales, D.; Diedrich, A.; Hamann, M. (*in press*). Marine turtle presence in the traditional pharmacopoeia, cosmovision, and beliefs of Wayuú Indigenous people. *Chelonian Conservation and Biology*.

ABSTRACT

Marine turtles are considered by people of several cultures to be a gift from God. This belief often leads to the use of these reptiles in the traditional and beliefs systems among aboriginal peoples. Certainly this is the case for the south-American Wayuú people, an indigenous group settled in the Guajira Peninsula between Venezuela and Colombia. To assess the value of marine turtles to Wayuú indigenous people, especially as a medicinal resource, I carried out a comprehensive open-ended question-based survey of traditional healers and caretakers from four Wayuú communities in the Venezuelan portion of the Guajira Peninsula. I documented customary practices where marine turtle body parts are used as key elements of the remedies. Eleven marine turtle body parts were identified by respondents as remedies used by Wayuú people, with seven different methods of administration. Four of the five species of marine turtles present in Venezuelan waters were identified as being used as traditional pharmacopoeia of Wayuú people. Some considerations about the Wayuú people's cosmovision, customs, traditions and beliefs systems are included here. My results can inform decision-makers by considering inclusion of traditional use of marine turtles in Venezuela in future evaluations of the current Venezuelan environmental legal framework.

Key Words: pharmacopoeia, traditional medicine, health values, Indigenous knowledge, aquatic bushmeat.

7.1. INTRODUCTION

Marine turtles are connected with many human social systems throughout the world (Frazier, 2003; Campbell, 2010; Alexander *et al.*, 2017) and many people consider marine turtles to be a sign of prosperity, wellbeing and connection to their indigenous or cultural values (Fretey *et al.*, 2007; Fretey *et al.*, 2015; Poonian *et al.*, 2016). For example, the Seri in Mexico (Felger & Moser, 1973; Lee, 2004), the Miskito in Nicaragua (Lagueux, 1998; Roe Hulse, 2005), and the Wayuú of Venezuela and Colombia (Villate, 2010; Guerra Curvelo, 2011) all have a common perspective that marine turtles are a gift from nature and a sign of prosperity. Indeed, the Wayuú have used marine turtles in many ways, including using their products as a health supplement, for thousands of years (Paz Reverol *et al.*, 2010; Chacín, 2016).

Wayuú people are the indigenous inhabitants of the coast of the Guajira Peninsula, an area shared between Venezuela and Colombia, and marine turtles are an important part of their culture and customs (Castellano-Gil & Barrios-Garrido, 2006; Noguera Saavedra, 2016). They consider marine turtles to be one of the most important wild species in their culture, because turtles are considered to be gifts from the ancestral God, *Maleiwa* (Soré *et al.*, 2006). Certainly, traditional stories passed down through oral tradition describe the way these reptiles were provided to Wayuú people for use as food and medicine; indeed, some elders consider a sacred place called *Julirawanar*, where the turtles are healed by *Pulowi* (a deity) (Guerra Curvelo, 2011) to be an important cultural site. Marine turtles are therefore seen as a divine gift, and as such they constitute an important component of the Wayuú people's knowledge system (Parra *et al.*, 2000; Robles, 2008; Riaño-Alcalá, 2014).

Although Wayuú people have traditionally used marine turtles as food and as a spiritual resource, current transcultural issues have led to the modification of traditional practices, such as the inclusion of a commercial use of marine turtle products into a traditionally trade-based local indigenous economy (Rueda-Almonacid *et al.*, 1992; Robles, 2008; Villate, 2010; Chacín, 2016) (Chapters 5 and 6), and the shift toward using Western technology such as nylon, outboard engines and GPS devices to catch fish and turtles (Carabalí Angola, 2007). It is also well recognised that in many parts of the world the commercial use of marine turtles has compromised the stability of some local and regional populations (Alfaro-Shigueto *et al.*, 2011; Poonian *et al.*, 2016). Thus without culturally-based management, continuation of a commercial turtle-based consumptive use by Wayuú could have negative implications for Caribbean marine turtle populations (Rueda-Almonacid *et al.*, 1992; Campbell, 2003) (Chapter 5).

For these reasons, in this chapter I aim to first describe the value of marine turtles to the health (physical and spiritual) of Wayuú culture, and second, describe the use of marine turtles in the traditional, cultural and ancestral medicine as remedies provided by nature (pharmacopoeia). This could help identify important traditions that will allow lawmakers to distinguish between commercial turtle use and traditional uses that have cultural meaning and value. Recovering Wayuu's values will benefit turtles and indigenous territory as an entire whole nation.

7.2. METHODS

To conduct the research, I carried out in-depth interviews with ten *Apaalanchis* elderly Wayuú indigenous people, categorised as either healers (in Spanish *mojanes*) (n= 4), or caretakers – witches (in Spanish *brujas*; in Wayuúnaikii *yurüüja*) (n= 6), from four different communities of the Venezuelan Guajira Peninsula: Paraguaipoa (n= 1), Kazuzain (n= 3), Porshoure (n= 4) and Castilletes (n= 2) (Chapter 6). Wayuú people were classified in two groups after the European invasion (the mid-1700s): shepherds and fishers (which are known as the latter *Apaalanchis* in Wayuúnaikii – Wayuú language) (Martínez, 2011; Barrios-Garrido *et al.*, 2017b) (Chapter 6). Hence, this research was carried out only in fisher's communities who maintain a close relationship with the marine environment.

Interviews with community participants is a widely-used data collection strategy in qualitative research, and it assumes that if questions are verbalised correctly, participants' expressions of their knowledge will reflect their knowledge of the environmental situation (Lambert & Loiselle, 2008). The interviewees were considered and approved by the community clan leader (in Spanish *cacique*) and were identified as people with a particular knowledge of medicinal animal use.

I used open-ended questions to collect information on several themes: a) the marine turtle species used; b) the indigenous name of the turtle species used; c) the body part(s) used; d) the method used to prepare and store the remedies; e) the symptoms that patients show in order to receive treatment; and f) the traditional application of the remedies by people. I conducted all interviews in cooperation with the RAO-Network (Barrios-Garrido & Montiel-Villalobos, 2016) (Chapter 5 and 6), either in Spanish or Wayuúnaikii (Mr. Jordano Palmar from the RAO network is a Wayuú clan leader, his first language is Wayuúnaikii, and he helped me translating). The qualitative analysis of the information provided by interviewees was carried out by extracting key topics about: (a) pharmacopoeia, and (b) traditional use (content themes) using NVivo software (Borokini *et al.*, 2013; D'Lima *et al.*, 2014; Barrios-Garrido *et al.*, 2017b) (Chapters 5 and 6).

I acknowledge there are potential differences in the names, customs, uses and treatments to those described in this chapter among other Wayuú communities. As previous authors have noted, the Wayuú traditional system is complex and has transformed since the European invasion (Perrin, 1989; Vásquez Cardozo & Correa, 2004; Paz Reverol *et al.*, 2010; Noguera Saavedra, 2016). Discrepancies among Wayuú local communities have been described by other researchers, and even some of my respondents acknowledged this issue.

7.3. RESULTS

All of the interviewees confirmed that marine turtles are used for health remedies, and all mentioned that Wayuú people use marine turtle products for cultural reasons such as improved physical and spiritual health. Plus, their use could prevent up to 15 different diseases or conditions. My interviews revealed that up to 11 different body parts (e.g. oil, blood, penis, fat, among others) were used (Table 7.1), and I identified species-specific uses to address various diseases or conditions. It was also clear that some body parts of the marine turtles are used for more than one reason. For example, the turtle fat is used to prevent asthma and insolation (Figures 7.1 and 7.2), the turtle meat is used to cure neoplasia and menstrual disorder (Figure 7.3).

Also, some specific parts of the marine turtle are used exclusively by women, men, children or elders, depending on the disease, condition or symptoms. The most common case was the use of turtle penis, especially from hawksbill turtles, which is used by elderly men to treat erectile dysfunction (Figure 7.4). Some interviewees claimed that the effectiveness of the treatment varied depending on the species.

Seven different modes of administration were described by the respondents (Table 7.1), and interviewees also mentioned that in addition to treating or preventing physical issues. Wayuú people also use marine turtle products for improving spiritual health, or more specifically, to rid them of “the bad spirits” (*Wanülüü* in Wayuúnaikii). This is because the presence of *Wanülüü* is believed to be the main source of illnesses and unfavourable conditions in the Wayuú families (Perrin, 1989; Morillo Arapé & Paz Reverol, 2008; Balza-García, 2010). As a traditional safeguard to prevent illness or other adverse conditions for their communities, Wayuú people often hang or place turtle carapaces and skulls in the corral gates (to increase fertility of livestock) (Chapter 6), kitchen, houses (Figure 7.5, 7.6 and 7.7), and boats. Moreover, the power of dreaming in the Wayuú culture indicates that the belief of dreaming about marine turtles will provoke good conditions at a personal level, in the family, community and town.

Table 7.1 Health-related uses of marine turtle parts by Wayuú people to treat diseases, or as preventive medicine. Wayuúnaikii names were taken from Captain and Captain (2005). Mode of administration codes are (a) mixed with food; (b) taken as drink; (c) mixed with alcoholic beverage; (d) worn as a talisman; (e) ingested cooked; (f) powder to be ingested with drink or food; (g) mixed with plant species. [1]It is used for humans, animals and houses. [2]Directed to children and young women. [3]Used as sunblock by mixing with fungal spores and covering women's faces

Disease / condition Wayuúnaikii name	Disease / condition English name	Body part of the marine turtle used	Marine turtle species	Mode of administration
Ayuisü nain	hypertension	blood	all	a, b, e
Suukala	diabetes	blood; gallbladder	all	a, b, e, g
Achecherusu	asthma	blood; fat	*D. coriacea* *C. caretta*	a, b, e, g
Shunui	influenza	liver	*D. coriacea* *C. caretta*	e
Ayuisü tachü	Renal lithiasis (kidney stones)	kidneys	all	e
Ayuisü tashirra	gallbladder disease	gallbladder	*D. coriacea* *C. caretta*	a, g
	urinary tract infections	kidneys	all	e
Aisü teipüse	arthritis	plastron	*C. mydas* *E. imbricata*	e
	rheumatism	bones; plastron	all	a, e,
Wanülü aisü	neoplasia	meat; liver	all	e, g
Sükashia	menstrual disorder	blood; meat	all	a, b, e, g
Malasü nierra, Outüsü nierra	erectile dysfunction	penis	*E. imbricata* *C. mydas*	c, f
Ayolojo, Ayaluju	"bad spirits" [1]	carapace; skull	all	d
Ayuulii	preventive medicine[2]	blood; meat	all	a, b, e, g
Atta jotüsü	insolation [3]	fat	*D. coriacea* *C. caretta* *C. mydas*	g

Figure 7.1 Bottle of oil from leatherback turtles. The oil is collected by Wayuú community members to be used as medicine to treat or prevent asthma, especially in children. Photo credit: H. Barrios-Garrido.

Figure 7.2 A Wayuú woman using marine turtle fat mixed with fungal spores as sunblock to protect her face. Photo credit: P. Barboza.

Figure 7.3 Green turtle meat is used to treat neoplasia and menstruation disorder, and to prevent general illness in women and children. Photo credit: H. Barrios-Garrido.

Figure 7.4 An elder fisher and clan leader shows dried penises of a green turtle (green oval on the left) and of a hawksbill turtle (red oval on the right) ready to be powdered and consumed as medicine. Photo credit: H. Barrios-Garrido.

Figure 7.5 A dozen marine turtle skulls (mix of green, hawksbill and loggerhead turtles) hanging on a corral fence in the Upper Guajira Peninsula, Venezuela. Photo credit: H. Barrios-Garrido.

Figure 7.6 A green turtle carapace being used as a plate to place food in order to transfer health properties from the carapace to the food, which is then eaten to treat the aliments for humans (left); for animals (right). Photo credits: H. Barrios-Garrido.

Figure 7.7 Use of turtle carapace in the house as an adornment or to prevent the arrival of "bad spirits". The photo shows a loggerhead turtle carapace painted with the face of "The Liberator" Simon Bolívar as evidence of transculturation. Photo credit: H. Barrios-Garrido.

I recorded names in *Wayuúnaikii* for four of the five marine turtle species with a presence in the waters of the Guajira Peninsula. *Sawain* (or *Sawaiunrrü*) for the green turtle (*Chelonia mydas*); *Tagüari* (or *Tagüari'já*) for the loggerhead turtle (*Caretta caretta*); *Öjono* (or *Achepa*) for the leatherback turtle (*Dermochelys coriacea*); and *Carrei* for the hawksbill turtle (*Eretmochelys imbricata*). The other turtle species with a presence in the waters of the Guajira Peninsula (olive ridley – *Lepidochelys olivacea*) has no name in the Wayuú language.

7.4. DISCUSSION

I identified that Wayuú people have strong cultural traditions of believing that there are important health benefits received through the use of the marine turtle products. As suggested by the respondents, marine turtles have been used for generations by the Wayuú community and it remains an important link to their past, and therefore maintenance of use is a significant part of the future culture. Moreover, the use of natural elements to treat health conditions is still used in Wayuú culture, converging with modern medicine (Paz Reverol *et al.*, 2010; Villalobos *et al.*, 2017). My results show the importance of marine turtles in the pharmacopoeia and the health values in the Wayuú rituals, traditions, customs and beliefs system.

My results found up to 11 different body parts of the turtle are used in Wayuú traditional medicine. Similar modes of administration, and parts of the turtle's body, are also used in the rituals and pharmacopoeia for aboriginal communities in western Africa (Fretey *et al.*, 2007), and some are still used by the African diaspora in the Caribbean. These similarities could have developed in isolation; however previous researchers affirm that in the 1500s, during European colonisation of the Americas, there were frequent encounters between African people—who had been transported to the American region (set up as part of slavery) and subsequently escaped from the European fortifications—with the indigenous people in America, including Wayuú people (Moreno Blanco, 2004; Vásquez Cardozo & Correa, 2004). This link could be one reason why there are similarities among traditional peoples in the use of these reptiles in their beliefs systems. Further research on both continents and in different indigenous communities are needed to clarify similarities and differences in the use of marine turtles and other natural elements (i.e. plants and wildlife).

The traditional use of marine turtle parts among Wayuú communities is commonly expressed by interviewees. Although I targeted my respondents, all of them affirmed that during their lives, they and their family members have received marine turtle-based medicine. This tradition is passed orally, through stories, among and by healers (in Wayuúnaikii *Piaches* and the *Oütsü*) who are the specialists in maintaining local traditional rituals and customs between generations. The transfer of knowledge between generations using stories, songs and art is well described in several indigenous cultures (Tchibozo & Motte-Florac, 2004; MacDonald & Steenbeek, 2015; Nunn & Reid, 2016), and maintenance of these storylines have become important considerations in continuing cultural identity and belonging for indigenous society (Koptseva & Kirko, 2014; Poonian *et al.*, 2016).

Although the traditional use of natural resources is legal according to the Venezuelan Organic Law of Indigenous People and Communities (in Spanish *Ley Orgánica de Pueblos y Comunidades Indígenas*) (Venezuela, 2005), the consumptive use of marine turtles is considered illegal under the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC), which is represented in Venezuelan environmental legislation. An exception, in the form of a special permit, can be granted if the country can demonstrate that this consumptive use is “local, sustainable, and regulated” (IAC, 2011, 2013a), which has occurred in Costa Rica, Guatemala and Panama (IAC, 2013b, 2015). However, Venezuela has not initiated the process to apply for the special permit.

Despite the traditional component in the use of marine turtle in the Wayuú culture, consumptive use of marine turtles is currently considered to be illegal according to Venezuelan environmental legislation. Moreover, Wayuú members have claimed that they have the right to use marine turtles, as it is part of their ancestral culture (Barrios-Garrido *et al.*, 2017b) (Chapter 6). This is similar to the case described by Hasting (2003) in the British Virgin Islands, where according to local traditions, *trunkers*—turtle people—use leatherback turtle oil as a traditional medicine. This use is classed as illegal under legislation, yet the use is important for the *trunkers'* traditional belief system. This conflict is also evident in Equatorial Guinea, where the traditional use of marine turtle eggs is penalised by national laws (Tomás *et al.*, 2010), despite the key cultural importance of the use to tribal groups. In general, these challenges arise because the Western culture legal framework in the countries did not include the traditional belief systems of indigenous people (Sandercock, 2000; Green, 2012), and in turn leads to a conservation conflict (Chapter 4).

Traditional names for marine turtles were compiled for four of the five species with presence in the Guajira Peninsula: *Sawain* (or *Sawaiunrrü*), *Tagüari* (or *Tagüari'já*), *Öjono* (or *Achepa*), and *Carrei*. There is evident influence of Western culture colonisation on one name, because the name of the hawksbill turtle in Spanish is *Carey* and the name given to in this research by the Wayuú people is *Carrei* (strong accent is evident), which is similar. Although it is a frequently-seen turtle in the region (the second most abundant turtle in the area) (Chapter 5), the hawksbill turtle is commonly considered by Wayuú as the 'male of green turtle' (Barrios-Garrido *et al.*, 2017b) (Chapter 6), this may be the reason for the use of this non-Wayuú name for this species. On the other hand, the olive ridley is the least commonly seen marine turtle in the area, and Wayuú people do not recognise this species as being different; instead is considered to be a 'rare green turtle'. *Achepa* turtle is the name for leatherback turtle, but is only used in the Colombian portion of the Guajira Peninsula (Borrero Avellaneda *et al.*, 2013).

The use of marine turtles as medicine is a key component of the cultural legacy of Wayuú families. For this reason, it is important to consider the Wayuú´s Indigenous Knowledge when informing future management plans for marine turtles in the Gulf of Venezuela. Also, from the perspective of maintaining the use of marine turtles by Wayuú for cultural, non-commercial reasons, the legal framework which penalises the traditional use of these species may need revision or clarification because the Organic Law of Tribal and Indigenous People in Venezuela allows the traditional practices and use of nature resources (Chapter 6).

Chapter 8

GENERAL DISCUSSION

A green turtle rescued and tagged as part of the Shäwa project based in the Gulf of Venezuela. Photo credit: Natalie Wildermann (2010).

Marine turtles are generally considered to be conservation dependent in many areas of the world (Wallace *et al.*, 2011a). They require management strategies which include multiple approaches, and which recognise the spatial and ecological scales necessary for effective conservation (Hamann *et al.*, 2010). Management of threats to marine turtles is challenging for multiple reasons: there is often a lack of baseline knowledge about the biology or status of populations, and there is often little knowledge about the socio-ecological interactions that underpin key threats to turtles. There is also always the potential for natural hazards, such as stochastic or severe weather events, to impede recovery of key habitats (Rees *et al.*, 2016). In addition, there are key knowledge gaps around human interactions associated with the use or conservation of turtles. Knowledge of these interactions is particularly important in relation to effective long-term conservation (Frazier, 2009).

Understanding the value of marine turtles to people is important because people play a key role in shaping the environmental, political, cultural, and/or economic systems of coastal communities across the world (Campbell, 2003; Troëng & Drews, 2004; Scheffer *et al.*, 2017). Traditions, customs, beliefs, mythical stories, and even divine connections are found in a large number of manuscripts that provide detailed information about marine turtles and their links to natural systems and people throughout time (Frazier, 2005; Kinan & Dalzell, 2005). In addition, more recently, there are an increasing number of communities in the world that rely upon marine turtles as a central part of wildlife-based or eco-tourism (Meletis & Campbell, 2007; Pegas & Stronza, 2010; Chao & Chao, 2017), and small communities can suffer economically when declining turtle numbers result in closures to tourism ventures (e.g. the case in Malaysia: Shanker & Pilcher, 2003; Troëng & Drews, 2004; Abd Mutalib *et al.*, 2013).

Hence, to create effective marine turtle conservation programs there is a strong need to understand the human dimensions of the conservation issue. Human values tend to vary across global, regional, and local scales (involving ideas, philosophies, global agreements, narratives, and governances) (Bennett *et al.*, 2017). As such, the applied social sciences required to study and recognise the human perspective of conservation are likely to play a crucial role in marine turtle conservation (Gruby *et al.*, 2015; Pont *et al.*, 2015; Kittinger *et al.*, 2017), especially in culturally diverse regions such as the Caribbean basin.

Interestingly, in recent years the use of global fauna assessments have become frequent in scientific literature (Riousset *et al.*, 2017). Those associated with marine turtles have investigated the delimitation of management units across continents and identified populations with critically low numbers and/or declining trends (Wallace *et al.*, 2010; Wallace *et al.*, 2011a), examined the status of consumptive and legal use of marine turtles (Humber *et al.*, 2014) or the resilience of marine turtle populations to climate change (Fuentes *et al.*, 2013). In the most recent global assessment, Mazaris *et al.* (2017) highlighted how conservation interventions to regulate use can be successful and lead to positive impacts for marine turtle populations across the globe. Although not directly related to marine turtles Robards and Reeves (2011) found that a global level food security and poverty are linked to the rates or occurrence of marine mammal consumption in coastal areas, with people from areas of the world with lower levels of food security being more likely to consume marine mammals. They also found that government agencies usually lack capacity for enforcement of policy aimed at regulating the use of wildlife.

Thesis findings:

For these reasons, to set the scene and understand broad scale aspects of human dimensions related to marine turtle conservation, I completed two global evaluations. First, I investigated the socio-economic drivers which are likely to influence the conservation status of marine turtle species (Chapter 2), and second I evaluated the legal frameworks aimed at managing turtles from consumptive use at national levels (Chapter 3).

In Chapter 2, I evaluated how socio-economic drivers may be used as proxies to evaluate and predict the conservation status of marine turtles (Chapter 2), I designed a Conservation Enforcement Capacity index (CECi) by compiling and comparing conditions within the 58 marine turtle Regional Management Units (RMU), and merging that information with available country-level data on socio-economic indicators and development. This combination allowed me to develop an index (CECi) which predicts the likelihood that each of the marine turtle populations worldwide could be considered as threatened.

The CECi that I designed can be used as a rapid assessment tool to identify the relative status of marine turtle populations, and it could be developed for use with other taxa. Numerous governments use the conservation status of species' provided by the IUCN, as part of their Red List species assessments, to aid management-decisions towards conservation programs for threatened species (Campbell, 2012). However, the IUCN criteria for marine turtles are generally based on a metric using the abundance of mature animals, and most populations do not have sufficient data available to make robust assessments (Godfrey & Godley, 2008). Assessing species using the IUCN Red List process also takes considerable time. While the intent of my chapter's results is not to replace the IUCN assessments, the CECi is a system that may enable decisions or processes to be made when empirical trend data are not available and there is a need to evaluate decisions based on the status of the species – especially at a regional level.

By applying the CECI I showed that several RMUs require urgent conservation attention because they occur in developing regions and/or have well recognised threats: rmu05 (olive ridley turtle, *Lepidochelys olivacea* in the east Atlantic Ocean); rmu55 (leatherback turtle, *Dermochelys coriacea* in the east Pacific Ocean); and rmu60 (flatback turtle, *Natator depressus*). The first two will require cooperation among governments of multiple nations, but regarding the flatback turtle RMU (rmu60) the recently published 'Recovery Plan for Marine Turtles In Australian Waters (2017-2027)' includes updated data and trends, and highlights the conservation status and actions that have been applied to protect, and improve the status, of this flatback turtle RMU (Australian Government, 2017). This situation is a good example of how the CECi is sensitive to available data and how new, more detailed, data can provide a more accurate result.

In the case of rmu05, there is a regional Memorandum of Understanding established for the marine turtles of west Africa (PNUE & CMS, 2000); however, it is not clear how effective the implementation of the conservation plan has been. Conservation of this RMU will be challenging because there are several large rookeries spread across the coast of some of the world's least developed countries, and in a geographical area of Africa known for conservation challenges (Barnett *et al.*, 2004). However, there are active pro-environmental groups focussed on the west African region, the threats are beginning to be quantified and awareness is growing regarding the need for coordinated conservation (e.g. the African Turtle Newsletter http://www.seaturtle.org/blog/africa/) (Weir *et al.*, 2007; Catry *et al.*, 2009;

Tomás *et al.*, 2010; Hancock *et al.*, 2016). The leatherback turtles of the eastern Pacific Ocean (rmu55) are well studied, their threats are well documented and there are long-term empirical data on population trends (Kaplan, 2005; Alfaro-Shigueto *et al.*, 2011; Santidrián Tomillo *et al.*, 2017). However, this downward trend is likely to be related to the low hatching success registered on their nesting beaches and high levels of mortality during certain life stages (e.g. longline fisheries, plastic pollution) (Mazaris *et al.*, 2017). However, there is an active network (established in 2015) which involves several stakeholder groups, called 'Red Laúd del Pacifico Oriental – Red Laúd OPO' (in English: Eastern Pacific Leatherback Conservation Network) which comprises more than thirty researchers and multiple NGO from Chile to the USA. Red Laúd OPO aims to consolidate the leatherback turtles as priorities in marine conservation in the East Pacific (see details at: https://savepacificleatherbacks.org/).

In chapter 3, I reviewed the global literature and collated data from experts to examine the legal status of the world's consumptive use of marine turtles. This chapter focussed on the legal and traditional use of marine turtles, and the regulations that governments apply to manage consumptive use. I found that no-law regulation of consumptive use of marine turtles occurs in six countries: Albania, Bosnia and Herzegovina, Guyana, Nauru, Sudan and Syria, while regulated consumptive use of marine turtles occurs in 31 countries (Chapter 3). I found that most commonly consumed species are green and hawksbill turtles, for which twelve and nine countries respectively allow this use. Interestingly, in 33 of the 57 RMUs that occur globally, which I classified as threatened using the CECi (Chapter 2), 26 include countries where the consumptive use of marine turtles is legal (Chapter 3). Most regulations (non-mutually exclusive) comprise species-based restrictions (21 countries), the need for special permits (14 countries), region or territory-based restrictions (13 countries), season or veda restrictions (13 countries), and ethnicity-based restrictions (11 countries). Also, I provide information which updates previous findings provided by Humber *et al.* (2014), including a revised legal status in countries where consumptive use of marine turtles is now forbidden under recently established national legislation, and/or national legislation currently under review which may eventually provide full protection to marine turtles. My results also support those of previous authors who suggested that legal and regulated use, may provide a better conservation outcome than illegal, unregulated, and unassessed use of marine turtles.

In Chapter 4, I examined the conservation conflicts that occur in relation to stakeholders' involvement in marine turtle conservation initiatives among Caribbean nations. In terms of conservation, western culture and the traditions of various social and cultural groups can lead to a divergence in attitudes towards the values and uses, of natural environmental features such as wildlife (Douglas & Alie, 2014; Gratani *et al.*, 2016). In some cases, individual people's attitudes are driven by the social and economic circumstances of the community in which they reside (Mancini *et al.*, 2011). Similarly, the values and attitudes of people towards marine turtles differ according to the cultural, social, or economic background of the groups of people involved with their use or conservation (Alexander *et al.*, 2017). Specifically, I identified several conflicts among groups of people which are likely to hinder marine turtle conservation objectives.

My research found that the most common conflicts identified by people working in marine turtle conservation research, monitoring or management projects in Caribbean nations were: 1) the 'lack of enforcement by local authorities to support conservation based legislation or programs'; 2) 'legal consumption of turtles by one sector of community clashing with the conservation aspirations of other community sectors'; and 3) 'variable enforcement of legislation to limit/prohibit use of marine turtles across range states of the species'. This is useful information to know because, although these conflicts may vary in origin, causes and severity, they are overall perceived to impede the success of marine turtle conservation programs in the Caribbean basin.

It is clear from my results that dissimilarities in the perspectives of people towards marine turtle conservation occur even at national or sub-national scales. For example, in Venezuela perceptions about the need for protection of marine turtles may differ between government conservation groups, NGOs, and Wayuú clan leaders in the Guajira Peninsula (Chapters 4, 6 and 7). Essentially, the groups all desire to see the survival of the species, but they do so for different reasons and based on different values. The former group's reasons may be linked to the perceived need to prevent use to protect a threatened species; conversely, the Wayuú clan leaders appear to desire the use of marine turtles primarily for culturally significant ancestral rituals (funerals or weddings) to maintain cultural links for his/her community. However, both are impacted when turtle numbers decline, and arguably the "user" more so than the "conservationist". Hence, identifying and understanding conservation conflicts that occur in the Caribbean is vital to minimise pressures on marine turtles and enable people to work towards finding solutions.

I identified 27 situations where conflicts were severe enough to lead to physical violence among stakeholders (Chapter 4). In general, respondents were not optimistic about the likelihood of finding short-term solutions to the severe conflicts, predominantly because these conflicts occur mainly between members of different stakeholder groups. Some respondents also found it hard to suggest any potential solutions for the most severe conflicts, due to the level of animosity that discussions have reached. However, my findings indicate that these conflicts may benefit from the involvement of a third party to act as a mediator, helping to improve awareness and understanding of complex issues for all involved parties.

Additionally, it is clear from my results that illegal activities contributing to the decline of marine turtles are/were occurring in many areas/countries of the Caribbean (Chapter 4). These include claims of drug smuggling, illegal paramilitary presence, and/or the illegal selling of bushmeat. Illegal activities create tensions among the conservation practitioners who work on the ground. Of note, the tragic death of young Costa Rican biologist and conservationist Jairo Mora Sandoval in 2013, who was kidnapped during a routine monitoring patrol on a nesting beach on the Caribbean coast of Costa Rica, and found dead the next day (Kopnina, 2016, 2017). Cases such as Jairo Mora Sandoval's are evidence of the risks associated with conducting field-based marine turtle conservation operations in some parts of the Caribbean (Bocarejo & Ojeda, 2016).

At regional scale, most Caribbean countries have limited baseline data on marine turtles, their marine turtle populations face numerous threats, and their governments and societies often have low capacity for conservation (Eckert, 2002a). This situation is also true in Venezuela. Indeed Guada and Sole (2000) wrote a "Sea Turtle Recovery Action Plan" (*Plan de Acción para la Recuperación de las Tortugas Marinas de Venezuela* – in Spanish) for Venezuela, and an important component of the plan was the need to (1) gather robust data about the distribution of feeding grounds, nesting areas, and developmental zones in the country, and (2) promote the conservation and recovery of mixed turtle stocks wherever they occur in Venezuela. Consequently, in Chapter 5, I compiled, analysed, identified, and considered all available data on the biology and ecology of marine turtles on their foraging grounds in the Gulf of Venezuela – arguably the key marine turtle foraging habitat in Venezuela (Chapter

5). My results provide important information about the biology, distribution and threats to marine turtles residing in the Gulf of Venezuela. I found that most of the species use the Gulf year round and coincide with areas of the Gulf which are frequently used for fishing and the resources industry, this probably because of the productivity of these areas (Rueda-Roa & Muller-Karger, 2013; Rueda-Roa *et al.*, 2018). My results may be used by environmental managers to decide on appropriate conservation measures for the Venezuelan portion of the Guajira Peninsula. For example, evaluating the frequencies and areas where strandings of marine turtles are concentrated (e.g. Upper Guajira, and Low Guajira – especially in Zapara Island) will allow space-based management options to be considered; also assessing the drivers for local harvesting pressure which occurs at local level in the Middle Guajira (especially in Kazuzain).

It is clear from my research that the involvement of multiple stakeholders is valuable and important for marine turtle conservation programs to succeed in my study regions (Chapters 4, 5, 6, and 7). This lends itself well to community-based or co-management initiatives that are described in the literature to work in the Caribbean or in the Gulf of Venezuela. Indeed community participation in conservation programs for endangered species is well known to be a key factor leading to the success of such conservation initiatives (Cohen & Steenbergen, 2015). However, aligning the goals of each stakeholder group may be problematic, resulting in conflicts, as indicated by the challenge of regulating or prohibiting consumptive use (Chapters 3 and 4).

In chapter 4, I found that conflicts such regulating or prohibiting consumptive use of marine turtles can lead to conflicts between stakeholder groups ultimately impeding conservation action or collaboration. One mechanism to get around this is to work with groups and identify common beliefs, attitudes, or goals and use them as a platform from which to build a partnership (Redpath *et al.*, 2015). Indeed, Redpath *et al.* (2013) affirmed that one possible option to resolve conflicts among stakeholders is to understand and distinguish the fundamental values of both parties, identify any similarities, including those that are not negotiable, and those which may change after an engaged and transparent negotiation (Figure 8.1).

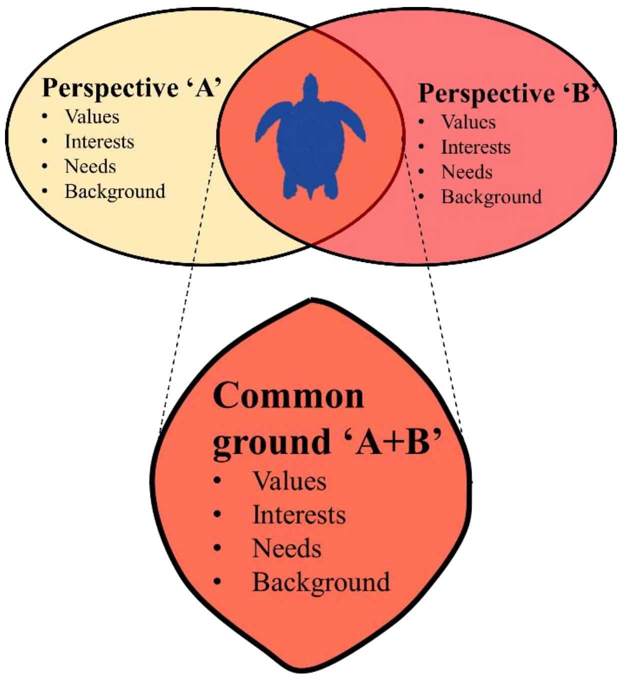


Figure 8.1. Hypothetical situation of conflict among stakeholders involved in marine turtle conservation. Identifying the distinct values and beliefs of the two groups and those which are shared may be useful in resolving conservation conflicts.

Other studies have suggested that the degree to which the conservation issue is deemed as a crisis by one or more stakeholder groups can influence the development of co-management initiatives (Grayson *et al.*, 2010). For example, in Baja California-Mexico, a large number of turtles (especially loggerheads) were being either poached or retained after being caught as fisheries bycatch (Koch *et al.*, 2006; Koch *et al.*, 2013). The high level of use, plus the threatened nature of the loggerhead turtle in the Pacific Ocean, led to the establishment of a pro-environment organisation called “Grupo Tortuguero”. It is now listed as a non-governmental organisation integrating multiple local, national, and international stakeholders, to develop conservation-based incentive activities (e.g. technical training, funding, and empowerment) at different scales in response to the critical loss of turtles (Senko *et al.*, 2011). Similarly, another important conservation initiative in the Latin American region was created to protect the hawksbill turtle population in the eastern tropical Pacific Ocean, called the “Iniciativa Carey del Pacífico Oriental (ICAPO; Eastern Pacific Hawksbill Initiative in English)” (Gaos *et al.*, 2010). The actions of this group were centred around the scarce records of hawksbill turtles in the eastern Pacific region and the belief that the hawksbill population in the Eastern Pacific Ocean was one of the most threatened marine turtle populations on the planet (Meylan & Donnelly, 1999). Hence, ICAPO was created to promote research and monitoring with local partners, while also developing education and outreach campaigns in the eastern Pacific nations (details in Gaos *et al.* 2010).

These types of groups work at small, local, national and regional scales, they involve multiple stakeholders, and they work where there is existing legislation or policy to frame their objectives. A similar arrangement could be developed for the Guajira Peninsula involving Wayuú community members in a bi-national conservation effort between Colombia and Venezuela. Ideally, this initiative would include stakeholders from both countries, plus Wayuú communities’ members that have been working on conservation projects in either of the countries (Colombia and Venezuela).

In chapter 6, I detailed how the trade and exchange of marine turtle products is being carried out in the Venezuelan portion of the Guajira Peninsula. My research found that marine turtles are key species in the Wayuú culture. The way the Wayuú people value marine turtles for cultural and health values are evident in conversations with the local inhabitants of the Guajira Peninsula. In some cases, the use of marine turtles is restricted to traditions, medical uses, and a cultural belief system or customs (e.g. rituals, weddings, funerals, or medical purposes). Indeed, I found that turtle parts were used as a curative element to treat up to eleven illnesses, administrated in seven different ways (powdered, consumed, or smeared); and four of the marine turtle species which inhabit the Gulf of Venezuela were used as traditional pharmacopoeia of Wayuú Indigenous people (Chapter 7). However, the majority of uses I found were commercial, including trade out of the Gulf of Venezuela and sometimes across nations. This type of use is unequivocally illegal under the Venezuelan legal framework.

However, the regulation and enforcement of this use is complex due to the ancestral customs involved and the fact that it occurs mainly in the remote, predominantly indigenous territories (Wayuú ancestral land). Furthermore, there is a lack of enforcement of environmental regulation, which requires changes in how these regulations are applied. Based on my research, I suggest the inclusion of regulations and concessions in legislation to allow for the traditional use of marine turtle by Wayuú inhabitants, such as those who remain settled on their ancestral territories. Similar legislation occurs in Australia (Weiss *et al.*, 2013; Marsh *et al.*, 2015). I acknowledge it will be challenging to develop a similar approach in Venezuela, but doing so will likely minimise the economic value of the marine turtle products, and as a consequence their value in commercial transactions. I also recognise that this proposed approach may not eliminate the non-traditional market for marine turtle products, but such trade will be easier to identify and enforce restrictions on.

Based on my 20 years of experience working in the area of the Gulf of Venezuela, I consider that illegal use of marine turtles is an impediment to conservation goals. The level of commercial use remains unquantified, and it should be recognised as the primary threat to marine turtles in the Gulf of Venezuela. Currently, Venezuela is signatory to several international environmental treaties, including the Inter-American Convention for the Protection and Conservation of Sea Turtles (IAC) and CITES. Recognising the presence of illegal trade of marine turtles in the region may represent the first step towards improved practices in conservation. Given the existence of similar Latin American conservation strategies which include community-based conservation as a key strategy to identify, minimise, and regulate the trade of marine turtles, I encourage people and groups of my study region to support established conservation programs, and create more strategies to minimise the non-traditional market for marine turtle products, as has occurred with Grupo Tortuguero and ICAPO's outcomes (e. g. Gaos *et al.*, 2010; Senko *et al.*, 2011). Moreover, in the case of the Guajira Peninsula, more stakeholders should be involved (national and international) in collaboration and decision making, and through the establishment of focus group discussions, and bi-national workshops between Colombian and Venezuelan environmental entities, the problem of illegal use of marine turtles in the area will hopefully be better addressed.

- *Future research and recommendations:*

I strongly recommend that research continues into each of the elements I investigated in my thesis. For example, it would be useful to examine whether the CECi index I developed (Chapter 2) could be applied by management agencies or NGOs when setting priorities regarding threatened species conservation. In addition, it would be useful to determine whether the CECi could be adapted for use with other species with similar life history traits to marine turtles (e.g. long-lived, migratory species, with broad distribution across multiple countries). Based on the evidence I have provided, the capacity to enforce legislation is a fundamental aspect of successful conservation (Chapter 4) and without it conflicts can occur, and conservation efforts may be less effective. It is also clear that enforcement capacity is to some degree linked to socio-economic indicators, such as education and socio-economic development (Chapters 2 and 4). However, if better data were available from each country it would be possible to repeat the CECi evaluations using the Multidimensional Poverty Index (MPI) which provides more precise information at an individual level (and not at national scale) in health, education, and standard of living – all of which are likely to affect how people use wildlife. Repeating my analysis with this data when it becomes available would allow examination of sub-country or country-level enforcement capacity in more detail, and thus enable future research to identify more specific barriers and opportunities to improve the likely success of conservation initiatives.

Legal frameworks are also a fundamental element in achieving long-term conservation goals (Chapter 3). Legally-binding instruments or legislation allow the government to protect, regulate, and use natural resources. Some countries have outdated laws that are not matched with the new realities of conservation (Stringell *et al.*, 2015). For example, trivial penalties, small fees, or penalties that governments are not able to enforce. I recommend encouraging environmental agencies, through international treaties, multinational training, and workshops, aimed to improve the status of laws in some nations, doing so would boost the national and regional capacity for conservation (i.e. Migraine, 2015). Transparent legal frameworks that are supported and adequately enforced are likely to improve the overall governance and support of conservation entities or community groups to carry out better enforcement.

Moreover, it is clear that several countries include legal regulations to manage consumptive or non-consumptive use of marine turtles such as Australia. It would be useful to know more details about how well each of these regulations work to minimise threats to marine turtles and how well they are based on science or supported by various stakeholders.

Based on my results regarding conservation conflicts (Chapter 4), I advocate for a more detailed evaluation to assess the presence, impact, and scale of the Illegal, Unreported, and Unregulated (IUU) fishing activities that are likely to be impacting marine turtles in the Caribbean. This evaluation could follow previous and standardised protocols (e.g. Riskas *et al.*, 2018) to measure the impact, as well as the elements of small-scale fisheries that are likely to be affecting marine turtles in the Caribbean, thereby potentially acting to identify hotspots of illegal fisheries that may be adversely impacting threatened regional management units of turtles.

To carry out the research recommended in Chapters 5, 6, and 7, regarding regulating the use of marine turtles by Wayuú Indigenous communities by making such use non-commercial. It is necessary to first evaluate the capacity of the Venezuelan research organisations (governmental and privates) to carry out these assessments. This is important because Venezuela is a signatory to the Inter-American Convention for the Protection and Conservation of Sea Turtles and under this legal-binding agreement, any country that wants to legalise or regulate use has to demonstrate that consumptive use is local, sustainable, and regulated. Doing so in Venezuela, especially in the current economic and political situation, would be challenging and thus require support of all relevant entities.

After describing the research that has been completed on marine turtles in the Venezuelan portion of the Guajira Peninsula (Chapter 5), it is evident that bi-national efforts need to continue in order to evaluate the Guajira Peninsula as a complete habitat used by marine turtles. In addition, it is clear that future research on marine turtles in the Gulf of Venezuela is needed. Priority projects include satellite tracking of adult turtles to examine habitat use, and the degree to which turtles use habitats affected by industrial development (e.g. oil and gas) (Whittock *et al.*, 2017), genetic assessment (especially of hawksbill, loggerhead, and leatherback turtles) to understand regional connections such as those to Mexico, Costa Rica, Aves Island (Venezuela) and Florida nesting areas (Patricio *et al.*, 2017), which are likely to be of the main nesting areas supplying turtles to the south-west Caribbean, and further human dimensions-related studies associated with conservation (Bennett *et al.*, 2017), and consumptive use that build on my thesis in the following ways. These evaluations are required to provide further details about the use, turnover or sales rates of marine turtle products, and the importance of marine turtles (of at least four of the five species present) in the study area. Doing so will increase our understanding of the spatio-temporal patterns of how turtles use the Guajira Peninsula waters, as key habitat, and allow focused conservation efforts to maximise conservation outcomes.

Finally, the Gulf of Venezuela has been exposed to multiple oil spills (from small localised to large broad-scale spills) in the last 20 years (e. g. Severeyn *et al.*, 2003; Pulido Petit *et al.*, 2017). Yet, the impact of these spills on the marine ecosystem in the area is poorly understood, and complicated by a lack of baseline data and the cumulative impacts of multiple spills coupled with other pressures. I advocate for a comprehensive monitoring plan to enable future evaluations of the effect(s) that oil spill events may have on marine species in this region. This could lead to the requirement for setting environmental offsets in the planning phase of commercial or industrial project developments, or lead to the development and enforcement of appropriate penalties and restoration work should future spills occur in the region. This assessment must include all marine species of interest (e.g. seabirds, invertebrates, aquatic mammals, sharks, and marine turtles).

Concluding remarks

Research on the human dimensions of marine turtle conservation (socio-economic index, legal frameworks, international agreements, and cultural value systems) are currently not as common in literature as ecological or biological research. Effective conservation status of marine turtles, especially those regarded as threatened, is contingent on understanding the human dimension because doing so gives a greater level of understanding about why threats occur and how they can be best managed. As a scientific society we should focus our efforts towards understanding why, after decades of pro-conservation efforts, many populations of marine turtles are still considered threatened. This is where the value of understanding the human dimension of conservation exists. Such an understanding will help managers to ensure that the actions of human societies can be modified to minimise threats to, and improve the status of, marine turtle populations. For example, here I included biological data of highly impacted mixed stocks in the Gulf of Venezuela, that despite high fishery pressures, are being supplemented with new recruited turtles as a result of increasing conservation measures in other countries. Hence, we should start having the difficult discussions aimed at understanding conflicts in values between relevant stakeholders in the region, as well as working towards the development of initiatives that focus on shared values or beliefs and how they influence marine turtle conservation.

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Appendices

Appendix 1

Logical matrix to evaluate the presence and status of recognition of indigenous people within each nation, and the presence of marine turtle species (regular, irregular or absent) (Number of countries evaluated= 152)

Country	Indigenous People						Marine turtle presence		
	Presence[14]		Recognition status[15]						
	Yes	No	Fully	Just international	Just national	Not recognised	Regular	Irregular	Absent
Albania	X			X			X		
Algeria	X			X			X		
Angola	X			X			X		
Antigua and Barbuda		X		X			X		
Argentina	X		X				X		
Australia	X		X				X		
Bahrain		X		X			X		
Bangladesh	X					X	X		
Barbados		X		X			X		
Belgium		X		X				X	
Belize	X			X			X		
Benin		X		X			X		
Bosnia and Herzegovina		X		X			X		
Brazil	X		X				X		

[14] Indigenous people recognised by the International Work Group for Indigenous Affairs. Source: www.iwgia.org. Independent institution which uses the United Nations Sub-Commission on the Prevention of Discrimination of Minorities (1986) definition, and the International Labour Organization (ILO) Convention no.169 (1989) concepts.

[15] Status categorisation using the ILO Convention no.169 (1989) (source: www.ilo.org), the United Nations Declaration on the Rights of Indigenous Peoples (2007) (source: www.un.org), plus the national legal framework regarding indigenous peoples or minorities.

Brunei		X		X			X		
Cambodia	X		X				X		
Cameroon	X		X				X		
Canada	X		X				X		
Cape Verde		X		X			X		
Chile	X		X				X		
China	X			X			X		
Colombia	X		X				X		
Comoros		X		X			X		
Costa Rica	X			X			X		
Croatia		X		X				X	
Cuba		X		X			X		
Cyprus				X			X		
Democratic Republic of the Congo	X			X			X		
Denmark	X			X				X	
Djibouti		X		X			X		
Dominica	X			X			X		
Dominican Republic		X		X			X		
East Timor		X		X			X		
Ecuador	X		X				X		
Egypt		X		X			X		
El Salvador		X		X			X		
Equatorial Guinea	X					X	X		
Eritrea		X				X	X		
Estonia		X		X					X
Federated States of Micronesia		X		X			X		
Fiji		X				X	X		
Finland	X		X						X
France	X			X			X		

Gabon	X		X				X		
Gambia		X				X	X		
Georgia		X				X			X
Germany		X		X				X	
Ghana		X		X			X		
Greece		X		X			X		
Grenada		X				X	X		
Guatemala	X		X				X		
Guinea		X		X			X		
Guinea Bissau		X				X	X		
Guyana	X			X			X		
Haiti		X		X			X		
Honduras	X		X				X		
Iceland		X		X					X
India	X		X				X		
Indonesia	X		X				X		
Iran		X		X			X		
Iraq	X			X			X		
Ireland		X		X				X	
Israel	X					X	X		
Italy		X		X			X		
Ivory Coast		X				X	X		
Jamaica		X		X			X		
Japan	X			X			X		
Jordan		X		X			X		
Kenya	X				X		X		
Kiribati	X					X	X		
Kuwait		X		X			X		
Latvia		X		X					X
Lebanon		X		X			X		
Liberia		X		X			X		

Libya		X		X			X		
Lithuania		X		X					X
Madagascar		X		X			X		
Malaysia	X		X				X		
Maldives		X		X			X		
Malta		X		X			X		
Marshall Islands		X				X	X		
Mauritania		X				X	X		
Mauritius		X		X			X		
Mexico	X		X				X		
Monaco		X		X			X		
Montenegro		X				X	X		
Morocco	X				X		X		
Mozambique		X		X			X		
Myanmar	X			X			X		
Namibia	X		X				X		
Nauru		X				X	X		
Netherlands		X		X			X		
New Zealand	X		X				X		
Nicaragua	X		X				X		
Nigeria		X				X	X		
North Korea		X		X			X		
Northern Cyprus		X				X	X		
Norway	X		X						X
Oman		X		X			X		
Pakistan		X		X			X		
Palau		X				X	X		
Palestine	X					X	X		
Panama	X		X				X		
Papua New Guinea	X				X		X		
Peru	X		X				X		

Philippines	X		X				X		
Poland		X		X					X
Portugal		X		X			X		
Qatar		X		X			X		
Republic of Congo	X		X				X		
Russia	X				X				X
Saint Kitts and Nevis		X				X	X		
Saint Lucia		X		X			X		
Saint Vincent and the Grenadines	X			X			X		
Samoa		X				X	X		
Sao Tome and Principe		X				X	X		
Saudi Arabia		X		X			X		
Senegal		X		X			X		
Seychelles		X				X	X		
Sierra Leone		X		X			X		
Singapore		X		X			X		
Slovenia		X		X			X		
Solomon Islands		X				X	X		
Somalia		X				X	X		
Somaliland		X				X	X		
South Africa	X			X			X		
South Korea		X		X			X		
Spain		X		X			X		
Sri Lanka	X		X				X		
Sudan		X		X			X		
Suriname	X			X			X		
Sweden	X		X						X
Syria		X		X			X		
Taiwan	X				X		X		
Thailand	X			X			X		

The Bahamas		X		X			X		
Togo		X				X	X		
Tonga		X				X	X		
Trinidad and Tobago	X			X			X		
Tunisia		X		X			X		
Turkey		X		X			X		
Tuvalu	X					X	X		
United Arab Emirates		X		X			X		
United Kingdom		X		X			X		
United Republic of Tanzania	X			X			X		
United States of America	X		X				X		
Uruguay		X		X			X		
Vanuatu		X				X	X		
Venezuela	X		X				X		
Vietnam	X		X				X		
Western Sahara		X				X	X		
Yemen		X		X			X		

Appendix 2

Questionnaire

Section A – Environmental role, context, and experience.

a) Select the most appropriate organisation that describes your place of work (only one):

Environmental agency-government   Local Non-Government Organisation   University
International Non-Government Organisation   Local Community
Other (Please describe) ______________________________

b) What is your role in that organisation?

Project leader   Volunteer   Decision-maker
Community member/leader   Organisation leader   Academic
Other (Please describe) ______________________________

c) How many years have you been involved with marine turtle conservation initiatives?
[Dropping list: 1 up to 30+] to pick the number of years.

d) Your current project(s) is (are) based in:
Caribbean Basin

e) Can you please specify how many years have you been working in this region?
[Dropping list: 1 up to 30+] to pick the number of years.

f) Please select the country or countries in the Caribbean Basin, where you have been working;
[Dropping list with all Caribbean countries and territories] (see appendix 2)

Section B – Conservation conflicts: definition, identification, measuring, solutions.

*I define **Conservation-conflict** as situations that impact the wildlife, when two or more people (individuals or groups) clash due to their different points of views over conservation objectives. Some clashes regarding the ways to approach these conservation initiatives are evident in some programs within areas of interest (Redpath et al., 2013).*

For example:

- *There are some adamant disagreements about lethal control between decision-takers and animal welfare organisations on different countries – Target animals: lions, pumas, jaguars, elephants, sharks.*
- *The traditional use of Dugongs by Indigenous communities in Australia generates critical clashes between Western Culture Non-Government Organisations and Indigenous Communities in Western Australia.*
- *Displacement of Maasai pastoralists from their traditional lands to create protected areas in Africa, in Serengeti plains in Tanzania and Kenya. Resulting in clashes between Traditional People and Western Culture protection plans.*
- *Rehabilitation centres for marine megafauna in Brazil receive strong criticisms for the expensive of those procedures, instead that use those resources in other conservation practices.*

In the case of marine turtles, although these reptiles are species protected by international treaties, there is a complex scenario, which includes the legal baselines and the local traditions, cultures, beliefs, and legal frameworks. Indeed, many countries allow the use and sale of marine turtle products (Campbell, 2003; Casale & Margaritoulis, 2010); on the other hand, in numerous regions, it is prohibited by law (Hamann et al., 2010). This complexity derives from the conflicts between the laws that seek the protection of marine turtles by regions (Lane & Corbett, 2005).

1) Are you aware of any conservation conflicts related to marine turtle conservation within the areas where you work?
YES   NO   NOT SURE / NO ANSWER

2) If no, please explain why do you think that conflicts have NOT occurred in the areas where you work? (Max. 100 words)
____
____

Section C. Identification and description of the conservation-conflicts

3) If you answered 'yes' to the previous question,

   a. Can you please select the conflicts that you are aware that occurred or are taking place in the areas where you work within the last **TEN** years?

   Dropping List: *Types of potential conflicts*

- Monitoring techniques differ within or across regions
- National Government initiatives & International Non-Government Organisation initiatives do not align
- Ecotourism or non-consumptive use of marine turtles and the legal consumptive use of marine turtles
- Conservation initiatives within a country or region & consumptive use occurs in countries elsewhere in the range of the species
- Lack of enforcement by local authorities to support conservation based legislation or programs
- Local community aspirations & National Government Initiatives do not align
- Legal Indigenous use & Western Conservation ideology
- Consumption of turtles by one sector of community & the Conservation aspirations of other sectors of community
- Local community aspirations & International Non-Government Organisation conservation initiatives do not align
- Variable enforcement of legislation to limit/prohibit use across range states of the species
- Conflicts among environmental entities due to limited and often competition for funding
- Animal welfare interests & legal use of marine turtles
- Illegal use & Western Conservation ideology
- Stakeholders with different perspective towards non-consumptive use
- Unclear legal framework
- None (Please specify in the bottom box)

Other(s): Please identify other clashing entities and/or short description (Max. 20 words):

Regarding the top four conflicts then I asked,

a) Can you please mark when conflict [ONE] occurred? Then [TWO], then [THREE], and [FOUR]
   ( ) Past ( ) Present

b) Can you please indicate what environmental entities are, or were, involved in the conflict [ONE]? (Select all the entities participating in the conflict). Then [TWO], then [THREE], and [FOUR]
   Environmental Agency Government Local Non-Government Organisation
   University
   International Non-Government Organisation Local Community Group
   Others (Please describe. Press Enter or ';' semicolon to separate entities):
   ____

c) Can you please identify areas or regions that are (or were) affected by this conflict [ONE]? Please select all the sectors or regions affected. Then [TWO], then [THREE], and [FOUR]
   [Dropping list with all Caribbean countries and territories] (see appendix 2)

d) On what spatial scale does occur (or occurred) this conflict [ONE]? Then [TWO], then [THREE], and [FOUR]
   Local
   National
   International

e) To what degree do you feel the conflict [ONE] hinders (or hindered) conservation success for marine turtle based initiatives? (1=Low, 5= High). Then [TWO], then [THREE], and [FOUR].
   Likert scale question

f) Please describe the impacts of the conflict [ONE] on environmental aspects? (No more than 100 words). Then [TWO], then [THREE], and [FOUR]

g) Please describe the impacts of the conflict [ONE] on social aspects? (No more than 100 words). Then [TWO], then [THREE], and [FOUR]

h) Please describe the impacts of the conflict [ONE] on economic aspects? (No more than 100 words). Then [TWO], then [THREE], and [FOUR]

i) Please select the number that reflects the severity of the conflict [ONE]. 1 to 5 (low to high). For example: 1 may be '*minor arguments among a few people*', 3 may be '*public and vigorous disagreements among groups of people*', and 5 may be '*physical violence*'). Then [TWO], then [THREE], and [FOUR]
Likert scale question

j) Has the conflict [ONE] been resolved? Then [TWO], then [THREE], and [FOUR]
(_) Yes (_) No (_) Partially (_) Not sure/don't know

k) If you answered 'yes' to the previous question, can you briefly explain how this conflict was resolved? (Max. 100 words) Then [TWO], then [THREE], and [FOUR]

l) … if you answered 'no' to the previous question. Can you please describe what are the barriers that block the solution of this conflict? Then [TWO], then [THREE], and [FOUR]

Lacking of…
(_) Money (_) Resources (_) Skills (_) Knowledge (_)Engagement
(_) Local collaboration (_) National collaboration (_) International collaboration
(_) Other: please specify ________________________________

m) Can you please describe what are the potential solutions for this conflict? (Max. 100 words). Then [TWO], then [THREE], and [FOUR]

n) Please select the number that reflects what you believe to be the viability of this potential solution to the conflict [ONE]. 1 to 5 (extremely unlikely to extremely likely). Then [TWO], then [THREE], and [FOUR]
Likert scale question

Section D. Rank of the identified conservation-conflicts
Can you please rank, according to the severity, all the conflicts that have occurred in your study area? (Ranking question)
Herein the selected conflicts will appear and the respondent did rank them using numbers from 1 and so on (using number as 1 highest conflict).

Appendix 3

Caribbean countries and territories included in the questionnaire:

1

Anguilla (UK)
Antigua and Barbuda
Aruba (NL)
Barbados
Belize
Bonaire (NL)
British Virgin Islands (UK)
Cayman Islands (UK)
Collectivity of Saint Martin (FR)
Colombia
Costa Rica
Cuba
Curaçao (NL)
Dominica
Dominican Republic
Grenada
Guatemala
Guyana
Haiti
Honduras
Jamaica
Martinique (FR)
Montserrat (UK)
Navassa Island (US)
Nicaragua
Panama
Puerto Rico (US)
Saint Barthélemy (FR)
Saint Kitts and Nevis
Saint Lucia
Saint Vincent and the Grenadines
Saint Maarten (NL)
Suriname
The Bahamas
Trinidad and Tobago
Turks and Caicos Islands (UK)
Venezuela
Virgin Islands (US)

Appendix 4

Questionnaire (carried out in Spanish or Wayuúnaikii)

Topic	Questions
General	Gender Age Home town What do you know about the presence of marine turtles in the area? Can you recognise the different species of marine turtles present in the locality? (I used photos of the species to validate the answers) What do you know about the use of marine turtle by the inhabitants of your locality?
Trade	Has trade of marine turtles has occurred in your locality? Have you heard about people trading marine turtles in the area? If yes, where does this trade occurs? How many people are involved on this activity? Can you please describe the routes used to transport the products? How did you get all this information? Do you know the prices of the marine turtle products (and secondary products) in the local market?
Traditional use	Do you know what the cultural importance of marine turtle for the Wayuú people is? Can you please provide details? What parts of the marine turtle are used in your community? What parts of the marine turtle are related to traditional Wayuú medicine? How this traditional use occurs? How the turtle is used among Wayuú families and clans? Can you please explain the Wayuú rituals that involve marine turtles?
Anecdotic information	Do you want to provide further details about this topic? Please explain